



**Development of a Household Food Security  
Index for Low-income Areas of Nelson Mandela  
Bay, Eastern Cape**

Miss M Nienaber

2025



Thesis

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**Development of a Household Food Security Index for Low-income Areas of  
Nelson Mandela Bay, Eastern Cape**

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Submitted in fulfilment of Doctor of Philosophy (Food, Nutrition, and Wellness)  
(Research) Degree in the Faculty of Health Sciences at the Nelson Mandela  
University

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**DECLARATION**



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**QUALIFICATION: PhD Food Nutrition and Wellness**

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**TITLE OF PROJECT:**

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**Development of a Household Food Security Index for Low-income Areas of Nelson  
Mandela Bay, Eastern Cape**

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**DECLARATION:**

In accordance with Rule G5.11.4, I hereby declare that the above-mentioned treatise/ dissertation/ thesis is my own work and that it has not previously been submitted for assessment to another University or for another qualification.

**Sign:** 

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**Date: 05/12/2025**

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## PREFACE

This study forms part of a broader international research initiative entitled “KaziAfya: a school-based physical activity and multi-micronutrient supplementation intervention in three African countries.” The overarching KaziAfya project was designed to examine the growth, health, and overall well-being of school-aged children, with a particular focus on assessing the impact and long-term sustainability of a structured physical activity intervention (Gerber, Ayekoé, Beckmann, Bonfoh, Coulibaly, Daouda, Du Randt, Finda, Gall, Mollel, Lang, Long, Ludyga, Masanja, Müller, Nqweniso, Okumu, Probst-Hensch, Pühse, Steinmann, Traoré, Walter & Utzinger, 2020). While the overarching project primarily focused on child growth, health, and well-being, this study created an ideal platform to investigate household food security within these communities (particularly in South Africa). Given the limited research in the area regarding household food security in low-income settings, the author’s dissertation is built on the foundations of the KaziAfya project by examining household food security dynamics and the development of a potential Household Food Security Index (HFSI) for the south African context.

Within this broader framework, the current doctoral study had two primary aims. Firstly, it sought to investigate the prevalence and patterns of household food security in low-income households in Nelson Mandela Bay (NMB), South Africa, and to explore how large-scale disruptions such as the COVID-19 pandemic may have influenced food security within these vulnerable populations.

Secondly, it aimed to develop a comprehensive HFSI as a robust, context-specific measure of household food security. The study further evaluated the validity and suitability of this index as a tool for assessing food security, particularly in times of crisis or widespread socio-economic disruptions.

This thesis drew on both data obtained through the KaziAfya project and additional unique data collected specifically for the purposes of this study. The researcher was actively involved in the KaziAfya project from its inception through to its completion, contributing to conceptual design, content development, intervention implementation,

workshop facilitation, data collection, statistical analyses, and dissemination of results through peer-reviewed publications and scientific presentations.

The data utilised from KaziAfya includes anthropometric measurements, dietary intake information collected via 24-hour recall questionnaires, and household-level information obtained through the Household Hunger Scale (HHS). In addition, this doctoral study incorporates unique datasets collected independently by the researcher, including responses to a COVID-19 impact questionnaire.

Furthermore, the study employs innovative approaches to utilise and integrate these data sources to identify child nutritional status, using anthropometrical data, assess household dietary diversity, household hunger and evaluate household food security. Collectively, the data informed the development and testing of the proposed HFSI, which was intended to contribute to more nuanced and contextually relevant measurement of household food security in economically disadvantaged South African households.

## LIST OF ABBREVIATIONS

Abbreviation	Full term
BMI	Body Mass Index
CSG	Child Support Grant
CSI	Coping Strategies Index
COVID-19	Coronavirus Disease 2019
DDS	Dietary Diversity Score
EC	Eastern Cape
EFA	Exploratory Factor Analysis
FAO	Food and Agriculture Organization
FBS	Food Balance Sheets
FCS	Food Consumption Score
FIES	Food Insecurity Experience Scale
FIC	Food Intake Checklist
GHS	General Household Survey
GFSI	Global Food Security Index
GHI	Global Hunger Index
HLPE	High Level Panel of Experts
HDDS	Household Dietary Diversity Score
HDDS_I	Index Household Dietary Diversity Score
HFSI	Household Food Security Index
HFIAS	Household Food Insecurity Access Scale
HHS	Household Hunger Scale
HHS_I	Index Household Hunger Scale
IFAD	International Fund for Agricultural Development
NDP	National Development Plan
NFNSS	National Food and Nutrition Security Survey
NFCS	National Food Consumption Survey
NIDS-CRAM	National Income Dynamics Study's Coronavirus Rapid Mobile Survey
NSNP	National School Nutrition Programme

NMB	Nelson Mandela Bay
NMBM	Nelson Mandela Bay Municipality
NCDs	Non-communicable Diseases
NS_I	Index Nutritional Status
SADAFF	South African Department of Agriculture, Forestry and Fisheries
SADoH	South African Department of Health
SADHS	South African Demographic and Health Survey
SANHANES	South African National Health and Nutrition Examination Survey
SDG	Sustainable Development Goals
SRD	Social Relief of Distress
StatsSA	Statistics South Africa
T1	Testing Round One
T2	Testing Round Two
T3	Testing Round Three
UNICEF	United Nations Children's Fund
VAT	Value Added Tax
WDDS	Women's Dietary Diversity Score
WFP	World Food Programme
WHO	World Health Organization

## GLOSSARY

**BMI-for-age:** A growth indicator used to assess the nutritional status of children and adolescents by comparing their Body Mass Index (BMI) to age-specific percentiles. BMI is calculated as weight (kg) divided by height squared (m<sup>2</sup>), and for individuals aged 2 to 19 years, it is interpreted relative to a reference population to determine whether a child is underweight, healthy weight, overweight, or obese. This method accounts for age- and sex-related differences in body composition (WHO, 2007).

**Dietary Diversity:** The consumption of a variety of nutritionally desirable foods or food groups including plenty of plant foods such as fruits, vegetables, legumes and whole grains (Swindale & Bilinsky, 2006).

**Disadvantaged Group:** Any population group that is unable to meet its basic needs and requirements for any reason or combination of reasons (FAO, IFAD, UNICEF, WFP, & WHO, 2020).

**Food Access:** The ability of individual households to acquire food, either by producing it themselves, hunting, fishing or gathering from wild sources, through purchase, exchanges, or as gifts. Purchasing power is a key determinant of access in most settings. Food access depends on household purchasing power, which varies in relation to market integration, market access, price policies, and local economies in terms of employment and livelihoods (Sibanda & Mwamakamba, 2021).

**Food Availability:** Adequate quantities of food, supplied through domestic production, stocks, imports and food aid to ensure that the minimum nutritional requirements of the population can be met. Food availability addresses the “supply side” of food security (Jones, Ngure, Pelto & Young, 2013).

**Food Insecurity:** Food insecurity exists when people are at risk of, or are consuming food of inadequate quality, quantity (or both) to meet their nutritional requirements. This may be a result of the physical unavailability of food, a lack of social or economic access to adequate food, inadequate food utilisation or a combination thereof. Food insecurity may be chronic, or acute, transitory, or cyclical. It may characterise

individuals, households, groups, areas, or an entire country (Coates, Swindale & Bilinsky, 2007).

**Food Security:** A situation that exists when all people, always, have physical, social, and economic access to sufficient, safe, and nutritious food that meets dietary needs and food preferences for an active and healthy life. Food security is often broken down into three components: availability (in an area), access (by a household) and utilisation/consumption (by individuals) (Coates, Swindale & Bilinsky, 2007).

**Height-for-age (Stunting):** Assesses linear growth and indicates chronic malnutrition when a child's height significantly deviates from the expected height for their age (Heidari-Beni, Riahi, Massoudi, Qorbani & Kelishadi, 2021).

**Household Dietary Diversity Score (HDDS):** A measure of the range of food groups (cereals, vegetables, meat, fish, etc.) consumed in a household in a given period (Swindale & Bilinsky, 2006).

**Household Food Security:** Year-round access to an adequate supply of nutritious and safe food to meet the needs of all household members (Swindale & Bilinsky, 2006).

**Hunger:** A situation in which someone cannot obtain an adequate amount of food, even if the shortage is not prolonged enough to cause health problems (FAO et al., 2020).

**Malnutrition:** Abnormal physiological condition due to an unbalanced diet (deficiency or excess) in quantity and/or quality (FAO et al., 2020).

**Nutritional status:** Nutritional status is the condition of the body resulting from the nutrient content of the food we eat in relation to our nutritional needs, and from the ability of our bodies to digest, absorb and use those nutrients (Heidari-Beni, Riahi, Massoudi, Qorbani & Kelishadi, 2021). To measure nutritional status, anthropometric, biochemistry, clinical and dietary data is used (Nieman, 2019). However, in this study only anthropometric and dietary data will be used as biochemistry and clinical data is

usually not initially collected and only used after the initial identification of a possible problem (Nieman, 2019).

**Utilisation:** It refers to the ability of the human body to ingest and metabolise food through adequate diet, clean water, good sanitation and health care to reach a state of nutritional well-being where all physiological needs are met (Best, Neufingerl, Van Geel, Van Den Briel & Osendarp, 2010).

**Weight-for-Age (Wasting):** Evaluates a child's weight concerning their age, indicating both acute and chronic malnutrition (Heidari-Beni et al., 2021).

## **ABSTRACT**

### **Rationale**

Despite global efforts to achieve Zero Hunger, food insecurity remains widespread in South Africa, particularly in low-socioeconomic communities where poverty, unemployment, and external shocks such as the COVID-19 pandemic exacerbate vulnerability. Existing measurement tools often fail to reflect the multidimensional nature of food insecurity, limiting their contextual accuracy. This study addresses this gap by developing a composite Household Food Security Index (HFSI) that integrates dietary diversity, hunger, and nutritional status to provide a more comprehensive and locally relevant assessment tool.

### **Aim**

The study investigated household food security in low-socioeconomic communities within Nelson Mandela Bay (NMB), Eastern Cape (EC), South Africa, with the aim of developing a multidimensional understanding of food insecurity and constructing a context-specific composite HFSI. The objectives were: (1) to determine the prevalence and interrelationships among key indicators of food security, dietary diversity, hunger, and child nutritional status; (2) to assess the impact of the COVID-19 pandemic on household food security across three time points; and (3) to develop and validate a composite HFSI.

### **Methods**

A longitudinal quantitative design was implemented in two phases within low-income communities in NMB, EC. Phase One involved a household questionnaire and anthropometric assessments of children aged 5–13 years enrolled in grades one to four across four public primary schools. The questionnaire, completed by primary caregivers, included a 24-hour dietary recall to compute the Household Dietary Diversity Score (HDDS), the Household Hunger Scale (HHS), and a COVID-19 impact survey. Nutritional status was determined using WHO (2008) guidelines. Phase Two involved developing and validating the composite HFSI through a Delphi process with ten national experts in nutrition, food security, and public health. Consensus ( $\geq 70\%$ ) was achieved on indicator weighting and construct validation. The final HFSI was

calculated as a weighted aggregation of normalized HDDS, HHS, and nutritional status indicators, supported by theoretical and expert-based validation.

## **Results**

Findings revealed a complex and worsening picture of household food insecurity. Although modest improvements in child weight status were observed, persistent stunting and rising overweight and obesity indicated a dual burden of malnutrition. Dietary diversity declined markedly, while household hunger increased, particularly during the COVID-19 pandemic. Households reporting pandemic-related disruptions experienced sharper declines in dietary diversity and higher hunger levels. The HFSI effectively captured these dynamic changes, demonstrating its robustness and sensitivity as a multidimensional assessment tool in resource-constrained contexts.

## **Conclusions and Recommendations**

Household food insecurity in low-income EC communities remains pervasive and intensifying, characterized by declining dietary diversity, increased hunger, and a double burden of malnutrition among children. The study highlights the limitations of single-indicator approaches and demonstrates the value of the HFSI as a sensitive, practical monitoring tool. Strengthening surveillance systems and implementing context-specific, targeted interventions are essential for improving household food security and resilience to socioeconomic shocks.

## **Key words**

COVID-19, food insecurity, household dietary diversity, household food security, household food security index, household hunger, nutritional status.

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## **CHAPTER 1: INTRODUCTION**

### **1.1 Background and theoretical concept of food security**

As of 2023, global hunger and food insecurity continue to provide significant challenges, with progress toward reducing hunger showing little advancement since 2015 (Von Grebmer, Bernstein, Wiemers, Reiner, Bachmeier, Hanano, Chéilleachair, Foley, Sheehan, Gitter, Larocque & Fritschel, 2023). The Global Hunger Index (GHI) score for the world stands at 18.3, which is categorised as moderate, reflecting minimal improvement from the 2015 score of 19.1. Alarming, the number of undernourished people has risen sharply from 572 million in 2017 to approximately 735 million in 2023 (Von Grebmer et al., 2023). According to the most recent Food and Agricultural Organisation (FAO) report, approximately 2.33 billion people globally experienced moderate or severe food insecurity in 2023, while nearly 900 million faced severe food insecurity. The report highlights that despite a slight global economic recovery, progress toward ending hunger has stalled, with over 3.1 billion people unable to afford a healthy diet (FAO, United Nations Children's Fund (UNICEF), World Food Programme (WFP), & World Health Organization (WHO), 2024). In addition, the Global Report on Food Crises 2023 Mid-Year Update, reveals that 238 million people in 48 countries are facing acute food insecurity (Langry & Rena, 2023). Recent global information indicated that approximately one billion people are experiencing food insecurity, with increases attributed to economic challenges, rising food prices and the impact of the Coronavirus Disease 2019 (COVID-19) pandemic (Pérez-Escamilla, 2024).

The regions most severely affected include Sub-Saharan Africa and South Asia, both recording a GHI score of 27.0, classified as serious (Von Grebmer et al., 2023). In total, 43 countries face serious or alarming hunger levels, with nine countries, including Somalia, South Sudan and Yemen, experiencing alarming or extremely alarming hunger conditions. These worsening trends are largely attributed to the compounding effects of global crises, including the COVID-19 pandemic, ongoing conflicts, climate change and economic instability. In particular, the COVID-19 pandemic increased the number of food-insecure individuals by an estimated 118 million in 2020 (FAO et al., 2020). These overlapping shocks have not only disrupted food systems but have also

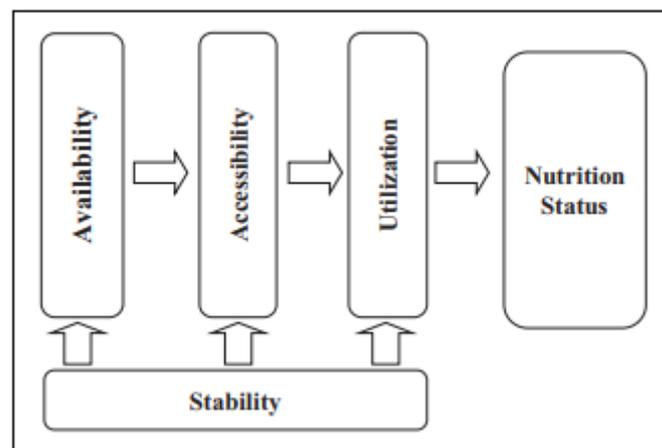
pushed millions into deeper poverty and malnutrition. Despite global commitments to achieving Zero Hunger by 2030, a global shock such as the pandemic have intensified poverty, inequality and food insecurity, particularly in vulnerable nations such as South Africa (FAO et al., 2020; De Groot & Lemanski, 2021).

In Africa, hunger levels rose from 256 million in 2019 to approximately 302 million in 2020, reflecting a surge of 46 million people (Pérez-Escamilla, 2024). Sub-Saharan Africa was disproportionately affected, with 239 million individuals experiencing hunger compared to 17 million in Northern Africa. Projections indicate that at the current pace, 58 countries will fail to achieve low hunger levels by 2030, as targeted by the United Nations Sustainable Development Goals (SDG) (Von Grebmer et al., 2023). This underscores the urgent need for transformative policies and resilient food systems, especially in vulnerable regions. In addition, addressing food insecurity necessitates targeted interventions that consider the underlying determinants of limited access to food and hunger, starting from household level (Ansah, Gardebroeck & Ihle, 2019).

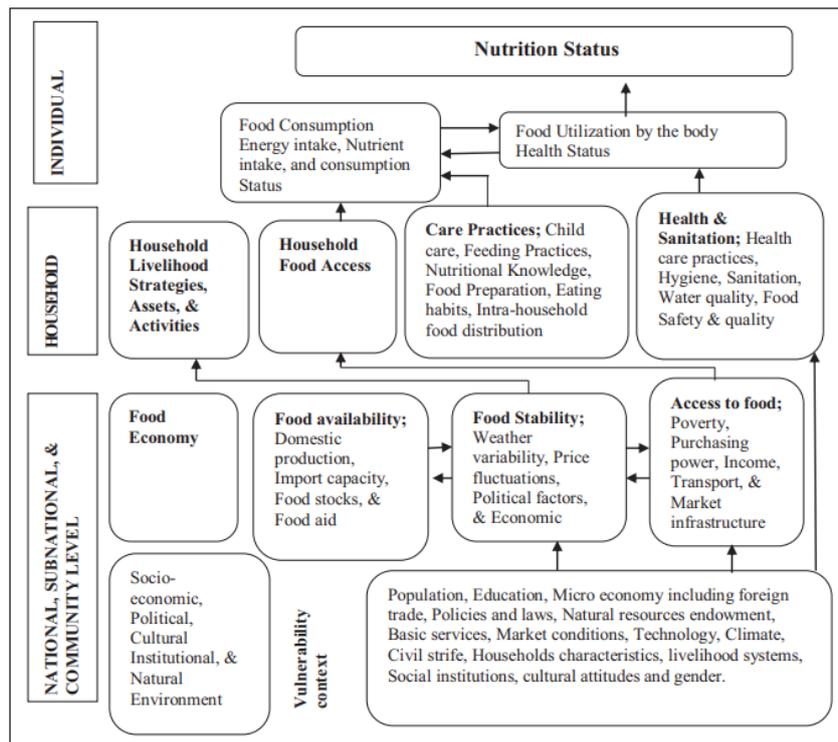
The widely accepted definition of food security, established at the World Food Summit in 1996, states that “food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (Maxwell, Coates & Vaitla, 2013). This definition underscores the multidimensional nature of food security, which extends beyond mere food availability to include accessibility, utilisation and stability (Fanzo, Rudie, Sigman, Grinspoon, Benton, Brown, Covic, Fitch, Golden, Grace, Hivert, Huybers, Jaacks, Masters, Nisbett, Richardson, Singleton, Webb & Willett, 2022). In addition, ensuring adequate food security entails not only meeting energy requirements but also fulfilling nutritional needs, such as essential vitamins and minerals (Jones, Ngure, Pelto & Young, 2013).

Food security operates at multiple levels, individual, household, regional and national, each influenced by distinct factors (Frongillo, Fram, Ghattas, Bernal, Jamaluddine, Kirkpatrick, Hammond, Aurino, Wolf, Goudet, Nyawo & Hayashi, 2022). At the household level, food security is primarily determined by access and utilisation, ensuring consistent access to sufficient, safe and nutritious food for an active and

healthy life (Piperata, Scaggs, Dufour & Adams, 2023). In contrast, regional and national food security are shaped by broader systemic availability factors, including agricultural productivity, food distribution systems and government policies (Hussein, Ahmed & Muhammed, 2018; Peng & Berry, 2019). Understanding the interactions between these dimensions is crucial for developing monitoring frameworks and comprehensive strategies to mitigate food insecurity at each level (FAO et al., 2020). Figures 1.1 and 1.2 illustrate the different levels and dimensions of food security, as well as their interactions.



**Figure 1.1: The relationship among the categorical elements of the framework of food and nutrition security (Göttingen, Stuttgart & Rottenburg, 2009).**



**Figure 1.2: The Food and Agricultural Organisation-Vulnerability Information and Mapping Systems (FAO-FIVIMS) framework (Simelane & Worth, 2020).**

### 1.1.1 Rethinking food security measurement

The measurement of food security has long been contested in both academic and policy arenas (Battersby, 2011). Traditionally framed around rural settings and food availability in Southern Africa, this perspective reflects a broader anti-urban bias in development studies, where poverty is viewed as primarily rural (Frayne, Crush & McCordic, 2017). Yet, rapid urbanisation, particularly in sub-Saharan Africa, is shifting the locus of poverty. Increasingly, the urban poor face food insecurity, driven not only by demographic change but also by deteriorating living conditions (Kushitor, Drimie, Davids, Delpont, Hawkes, Mabhaudhi, Ngidi, Slotow & Pereira, 2022). Crucially, the way food security is measured shapes both narratives and interventions, with indicators often chosen for political or reporting purposes rather than local relevance or developmental impact.

This dynamic of political and policy driven measurements are evident in the global practice of indicator-led development, most notably exemplified by the Millennium

Development Goals and their successor, the SDGs. As Fukuda-Parr and Taylor (2016) argue, the structure and composition of these indicators have come to define the scope and direction of development itself, often at the expense of more nuanced or context-specific assessments. Battersby (2011) further critiques these global frameworks for failing to capture the complexity of development issues and for promoting planning that is narrowly tailored to meet indicator targets, rather than addressing systemic challenges especially in developing countries.

Moreover, the application of standardized indicators across diverse local contexts can obscure critical local realities, especially in the global South. Such indicators often fail to account for definitional ambiguities, varied local experiences and inconsistent data collection practices (Hendriks, Van Der Merwe, Ngidi, Manyamba, Mbele, McIntyre, Mkandawire, Molefe, Mphephu & Ngwane, 2016). The political imperative to report progress to international audiences, typically influences the choice of measurement tools, which, in low-resource settings, may result in the use of such tools being the only form of food and nutrition assessment conducted. This can have profound consequences: macro-scale data and top-down indicators frequently shape national food security policies and programming, yet these may be poorly aligned with local conditions (Kushitor et al., 2022). Consequently, food security interventions risk being misdirected, with targeting that fails to reach those most in need.

A further concern is the tendency to oversimplify food insecurity, often reducing it to a single indicator, such as hunger or starvation (Hendriks et al., 2016). While hunger is a visible and urgent aspect of food insecurity, equating it with the entirety of the issue neglects its multidimensional character. Similarly, indicators such as nutrition status, obesity, or vulnerability are sometimes used as stand-alone proxies for food security. Although these factors are closely related, their isolated use can distort the broader picture. For instance, a narrow focus may overlook significant food system transitions, such as shifts in dietary patterns, rising rates of non-communicable diseases, or emerging inequalities in food access across different socioeconomic groups. Accurate measurement thus requires a diverse set of indicators tailored to specific levels of analysis (individual, household, national) and contextual realities. Different approaches ranging from food consumption surveys to anthropometric assessments and experiential scales, each have their own advantages and limitations but should be

used in combination to complement each other. These limitations often stem from the intricate interplay between food production, market access, environmental variability, seasonality, sociopolitical instability and structural inequality (Leroy, Ruel, Frongillo, Harris & Ballard, 2015).

Historically, food security measurement has evolved along three major themes. Initially, the focus was on sufficiency-based logics, emerging in response to food crises in the early 1970s, emphasizing energy availability at the national level. The groundbreaking work of Sen (1985) later shifted the focus to household and individual access, introducing a rights-based and entitlement framework. More recently, measurement approaches have expanded further to incorporate subjective, cultural, and psychosocial dimensions, including perceptions of food adequacy and anxiety about future food availability (FAO, International Fund for Agricultural Development (IFAD), UNICEF, & WHO, 2023). This evolution highlights the growing recognition that food security cannot be fully understood or addressed through a single lens. Instead, it calls for context-sensitive, multi-indicator frameworks that reflect the diverse realities of food systems and the people they serve. Without such an approach, measurement risks becoming not just inadequate, but counterproductive, shaping policy and practice in ways that overlook or misrepresent the lived experiences of food insecurity.

### 1.1.2 Household food security and the rationale for a context-specific Household Food Security Index (HFSI)

Household food security is a multidimensional concept encompassing the availability, access, utilization and stability of food necessary for a healthy life (FAO et al., 2023). Despite extensive research, measuring food security remains complex, particularly at the household level where social and economic factors interact. Existing tools vary in their conceptual frameworks and indicators, limiting comparability and contextual relevance (Jones et al., 2013). In South Africa, where food insecurity and malnutrition persist, there is a clear need for a context-specific tool that is both scientifically robust and practical for use in public health and community settings (Nengovhela, Ledwaba & Hlongwane, 2025). The development of a Household Food Security Index (HFSI) addresses this gap by combining theoretical and expert knowledge to create a

multidimensional, context-relevant measure suited to low-income households in South Africa.

Household food security is predominantly assessed through the lens of food access and utilisation, which encompasses dietary diversity, nutrient intake and adequacy, and overall health and nutritional status (NS) (Piperata et al., 2023). Despite the importance of considering all aspects of food security, their varying scales and contexts complicate the measurement process (Hussein et al., 2018). A vast array of food security measurement tools exists, each differing in its conceptualization of food security and intended purpose (Jones et al., 2013).

Household food security indicators fall into two main groups: process indicators (food access) and outcome indicators (food consumption) (Maxwell & Frankenberger, 2000). While process indicators capture factors like agricultural production, market access, and institutional capacity, recent work emphasizes outcome indicators that better reflect household food access (Downs, Bell & Blake, 2025). Direct outcome measures include the Dietary Diversity Score (DDS), a reliable proxy for food consumption and income (Hoddinott & Yohannes, 2002; Ruel, 2003) and the Household Hunger Scale (HHS), a cross-cultural tool for assessing food deprivation (Ballard, Coates, Swindale & Deitchler, 2011). Collecting reliable data for these indicators often relies on recalls, food frequency questionnaires, or food records (Mulasi-Pokhriyal & Smith, 2013). Indirect outcome indicators, such as anthropometry, capture NS through metrics like body mass index (BMI), weight-for-age (wasting), and height-or-age (stunting) (De Onis, 2007; Turck, Michaelsen, Shamir, Braegger, Campoy, Colomb, Decsi, Domellöf, Fewtrell, Kolacek, Mihatsch, Moreno & Van Goudoever, 2013; FAO et al., 2023). Though simple and affordable, these reflect longer-term rather than immediate food insecurity and are shaped by non-food factors such as health, hygiene, and caregiving.

Maxwell, Coates and Vaitla (2013) emphasize that food security indicators must be deliberately chosen to suit the purpose of the assessment and directly support decision-making. To ensure the effectiveness of measurement tools, they outline several essential criteria for evaluating and selecting appropriate indicators: availability, relevance, accuracy and timeliness. Availability refers to the practical considerations involved in collecting data.

Relevance emphasizes the importance of context. An indicator must capture dimensions of food security that are meaningful in the specific local setting being assessed. This involves understanding the social, economic and cultural conditions of the area, and ensuring that the data collected accurately reflect these realities.

Accuracy relates to the reliability and validity of the indicator in representing actual food security conditions. Accurate indicators should minimize bias and error, ensuring that the data collected are a true reflection of household experiences. This often involves careful attention to measurement tools and methodologies, as well as pre-testing indicators to ensure they are correctly interpreted by respondents.

Timeliness suggest that the data collection process must be fast and efficient enough to provide information within the time frame needed for decision-making. Delayed data can result in missed opportunities for intervention, particularly in rapidly changing contexts such as during food crises or seasonal shortages. Furthermore, timeliness also refers to the frequency with which data are updated to reflect current realities, which is essential for monitoring trends and responding proactively. Together, these criteria ensure that the indicators not only serve their analytical purpose but also contribute effectively to programme design, policy development, and targeted intervention strategies in diverse food security contexts.

Household food security research in South Africa remains fragmented, characterized by inconsistent methodologies and a lack of comprehensive longitudinal data (Misselhorn & Hendriks, 2017; Vyas-Doorgapersad, 2024). Food insecurity remains a persistent challenge in South Africa. While national surveys have informed evidence-based decision-making, the valuable insights from sub-national studies are often underutilized. A review by Misselhorn and Hendriks (2017) reveal that of 169 such studies conducted between 1994 and 2014, 27 different measures of food insecurity were used, limiting opportunities for meaningful comparative analysis at this level. The absence of standardized, consistence longitudinal national and regional food security monitoring remains a major gap in understanding and addressing food insecurity in South Africa from household level and beyond. Comprehensive data on food security, malnutrition, and related challenges are essential for developing evidence-based

policies and interventions to address these issues effectively (Nengovhela et al., 2025).

Addressing household food insecurity, particularly in low-income settings, effectively requires early identification at the primary healthcare level. However, the absence of standardised protocols or screening tools within clinical settings hampers timely intervention (Simelane, Mutanga, Hongoro, Parker, Mjimba, Zuma, Kajombo, Ngidi, Masamha, Mokhele, Managa, Ngungu, Sinyolo, Tshililo, Ubisi, Skhosana, Ndinda, Sithole, Muthige, Lunga, Tshitangano, Dukhi, Sewpaul, Mkhongi & Marinda, 2024). Early detection is crucial to ensure that vulnerable households are promptly linked to appropriate support systems, including income support, social protection mechanisms, and community-based food security initiatives. As important, recent studies underscore the need for an integrated policy approach to combat both acute and chronic food insecurity in South Africa (Letswamotse, Arshad, Bashir, Alsalman, Harsányi, Al-Dalahmeh & Mohammed, 2024). Proposals include strengthening climate-resilient agricultural practices, promoting local food systems and increasing investment in infrastructure to support small-scale farmers (Letswamotse et al., 2024). Additionally, incorporating food systems thinking into urban planning and social protection frameworks has been recommended as a path toward resilience (Nengovhela et al., 2025). The ongoing shifts in global food supply chains and climate patterns imply that, without adaptive governance and investment in food system transformation, South Africa's food insecurity risks will likely intensify over the next decade.

To overcome the challenges of effectively measuring food security, researchers emphasize the use of multiple indicators to capture its complex and multidimensional nature (Peng & Berry, 2019). This study introduces the development of a comprehensive HFSI tailored for low-income communities in NMB, EC, South Africa. The selected indicators for the index were required to assess food security at the household level, be contextually relevant, feasible for application in public health settings, cost-effective, time-efficient, and preferably already in use within existing public health frameworks. The proposed index integrates both direct and indirect outcome indicators of household food security that meet the criteria mentioned by (Maxwell et al., 2013) to provide a more accurate and context-sensitive assessment

of household food security. The three core indicators that were selected for the index are Household Dietary Diversity Score (HDDS), HHS and NS. These measures were chosen based on their practicality, suitability for the local context, and effectiveness in capturing critical dimensions of food security that can inform targeted household-level interventions. HDDS and NS offer insights into food security by evaluating dietary quality and individual health outcomes, making them relevant at both the household and individual levels. Meanwhile, HHS focuses on household-level food access, providing a reliable measure of food deprivation (Crush & Caesar, 2014). Together, these indicators form a robust framework for identifying and addressing household food insecurity in vulnerable communities.

## **1.2 Research problem and question**

Recognizing the multidimensional nature of food security at the household level, and the recent shift of focus in measurement methods as mentioned, allude to a call for more nuanced approaches and targeted strategies to identify and address food security at household level. To date, there is limited research available pertaining to the current household food security and child NS of low-income households in the NMB area. In addition, it is also not clear what the influence of a large-scale disaster, such as COVID-19, may have been on the household food security and child NS of these households. There is therefore a need to assess the current state of household food security and the extent of the impact of the COVID-19 pandemic, especially in low-income communities of developing countries, such as South Africa, where poverty and food insecurity is an existing problem. Although COVID-19 is largely regarded as a pandemic of the past, it serves as a valuable case study for examining the impact of large-scale pandemics and disasters on food security and child NS (Tanimonure, Ojo, Kehinde, Tijani & Ogundeji, 2025). As such, it is employed in this study to illustrate the broader implications of these occurrences.

Furthermore, the research landscape is characterized by the use of a wide array of food security measurement methods, creating challenges in terms of comparability (Sinyolo & Mudhara, 2018). Inconsistencies also arise because many researchers tend to utilize only one or two of these methods in their methodology. In South Africa, prioritizing the enhancement of food security is crucial due to the prevalence of high

poverty rates and child malnutrition in low-income communities, yet the country lacks a reliable system to analyse food insecurity conditions and lacks an up-to-date information system or monitoring framework for tailoring and evaluating interventions (Nengovhela et al., 2025). There is a need for harmonized measurement approaches to improve the reliability and policy relevance of food security data in South Africa (Sinyolo & Mudhara, 2018) which motivates the development of a specialized and multidimensional HFSI, tailored to the specific socio-economic conditions of low-income communities in the Nelson Mandela Bay (NMB), South Africa. The HFSI serves a dual function, it not only enhances the scope of research endeavours but also has possible future applications aimed at benefitting the community. It has the potential to provide a more comprehensive means of assessing household food security prevalence, particularly in low-income areas where data is essential for guiding and evaluating interventions particularly in the field of research. By introducing such an index, the province could in future establish a reliable and standardized way of identifying and analysing food insecurity conditions at household level contributing to a more effective and sustainable approach to addressing this critical issue.

This study was therefore intended to explore the need for a specialized and comprehensive HFSI, for the low-income areas in NMB by addressing the following research questions:

1. What is the prevalence of household food security of households living in low-income areas in NMB, South Africa?
2. What are the possible effects of a large-scale disaster such as the COVID-19 pandemic on the household-level hunger, child NS, dietary diversity and food security among low-income households in the NMB area of South Africa?
3. Can a comprehensive HFSI, utilizing key indicators such as the dietary diversity, household hunger and child NS (with the use of anthropometric and dietary data) provide a robust measure of household food security?

### **1.3 Research aim**

The overall aim of this study was to assess the prevalence and multidimensional characteristics of household food security among low-income households in the NMB area of Eastern Cape (EC), South Africa, and to develop and evaluate a context-

specific HFSI to enhance future monitoring and response to food insecurity routinely as well as during future large-scale disruptions such as the COVID-19 pandemic.

This study was conducted in two phases.

- During the first phase, the aim was to investigate the prevalence of household food security of low-income households in NMB, South Africa, and explore the possible effects of a disaster such as COVID-19 on the aforementioned group.
- In the second phase the aim was to develop a comprehensive HFSI, utilizing key indicators of household food security, to provide a robust measure of household food security within this context, and test the index score for measuring household food security in these economically disadvantaged households in NMB, SA. In addition, to evaluate the suitability of the proposed HFSI as a tool for assessing the impact of large-scale disruptions or disasters on food security, for example, the study compared HFSI values before and during the COVID-19 pandemic in low-income communities in the NMB, South Africa.

#### **1.4 Objectives**

To achieve the overall aim, the study had the following three main objectives, each comprising of a number of relevant sub-objectives:

Objective 1: To assess the prevalence of household food security and its associated indicators within low-socioeconomic areas in NMB, EC, South Africa.

This objective was reached by the following actions:

- 1.1 The prevalence of food insecurity was determined by using validated measures, including:
  - The HDDS based on a 24-hour dietary recall;
  - The HHS to measure household hunger and Household food security; and
  - Anthropometric indicators i.e. z-scores for BMI-for-age, height-for-age, and weight-for-age to assess child NS.

- 1.2 The relationships among HDDS, HHS, and child NS were explored to improve the understanding about how these indicators interact within the broader context of household food security.

Objective 2: To examine the potential effects of the COVID-19 pandemic on household food security, dietary diversity, hunger and child NS in low-income households in NMB to determine the impact of large-scale disruptions such as disasters and pandemics.

To reach this objective, the following was done:

- 2.1 The HDDS, HHS and child NS indicators were compared respectively across three time points before the pandemic (T1, T2) and during the pandemic (T3) to assess temporal trends related to the COVID-19 pandemic.
- 2.2 The relationship between caregivers' perceived COVID-19 impact (using the COVID-19 Impact Questionnaire) and changes in household food security indicators was analysed.

Objective 3: To construct and evaluate a multidimensional HFSI tailored to the socio-economic context of low-income households in NMB.

This objective was reached by:

- 3.1 The development of a composite HFSI by integrating key household food security indicators HDDS, HHS and child NS and improving the reliability of the HFSI by obtaining expert input using the Delphi-technique.
- 3.2 The validation of the construct of the formative HFSI by employing content validity through expert judgment using the Delphi technique, supported by a comprehensive assessment of a relevant conceptual framework.
- 3.3 An evaluation of the capacity of the HFSI to detect the impact of large-scale disruptions, such as COVID-19, by comparing HFSI scores over time and across perceived COVID-19 impact groups.

## 1.5 Hypotheses

From the objectives above, the following hypotheses were formulated:

### Hypothesis 1:

- 1.1 Household food security is poor within low-socioeconomic areas in NMB, EC, South Africa, characterized by:
  - A mean HDDS below 4, indicating inadequate dietary diversity;
  - Mean child NS z-scores below -1, suggesting early signs of malnutrition or growth deficits. Results correlate with South African National Health and Nutrition Examination Survey (SANHANES-1);
  - A mean HHS above 2, reflecting moderate to severe household hunger and household food insecurity.
  
- 1.2 There is a significant relationship between the HDDS, child NS, HHS and HFS within low-socioeconomic areas in NMB, EC, South Africa. This will be characterised by a higher HDDS is that is associated with better NS and lower HHS and household food insecurity.

### Hypotheses 2:

- 2.1 There are significant differences in HDDS, HHS, and child NS across the three time points (T1, T2, and T3), indicating changes in household food security over the COVID-19 pandemic period:
  - The HDDS and child NS are hypothesized to decrease/worsen progressively from before to during the pandemic, reflecting reduced dietary diversity and worsening nutritional outcomes;
  - Hunger levels and household food insecurity is hypothesized to increase progressively from before up to during the pandemic, indicating heightened household hunger and food insecurity.

- 2.2 Households that reported COVID-19-related disruptions (via COVID-19 Impact Questionnaire) exhibit significantly poorer outcomes in HDDS, HHS and NS compared to those that did not. They will show a greater negative effect in HDDS, HHS, and child NS from T1 to T3 compared to those that reported no disruption.

### Hypotheses 3:

- 3.1 The formative HFSI demonstrates strong construct validity as evidenced by a consensus of 70% or more among experts through the Delphi technique and alignment with established theoretical frameworks of household food security.
- 3.2 The HFSI significantly differs across time and/or between households with and without perceived COVID-19 impact, indicating its sensitivity to large-scale disruptions.

## **1.6 Significance of the study**

This study is significant in its potential to introduce a tailored, comprehensive HFSI for low-income communities in NMB, South Africa. The proposed index aimed to serve as a standardized measure for household food security in public health settings, enhancing the accuracy and effectiveness of household food security assessments as well as longitudinal monitoring of household food security. By improving the identification of food-insecure households, particularly in low-income areas, this index could play an important role in guiding and evaluating targeted interventions. Achieving SGD 2 (Zero Hunger) by 2030 necessitates the early detection of food-insecure populations, to facilitate the development of evidence-based, context-specific strategies.

The HFSI integrates three key indicators, HDDS, HHS and child NS, to provide a comprehensive assessment of household food security. This multidimensional approach ensures early identification of food insecurity and subsequently could guide

or enable the design of effective interventions that address both immediate needs (such as hunger) and long-term nutritional outcomes.

- The index functions as a screening tool, offering a quantifiable measure of a household's current food security status, which is currently lacking in low-income areas of South Africa.
- The proposed index offers valuable insights into household food security by focusing on access and utilisation, which can be directly addressed through interventions such as food aid, nutritional supplementation and education.
- By capturing multiple dimensions of food security, the HFSI ensures a holistic evaluation at household level, facilitating the design and implementation of targeted and effective responses.
- Moreover, it provides a foundation for further investigation into the underlying determinants of food insecurity, contributing to the development of sustainable, evidence-based policies that enhance food access and nutritional well-being.

#### 1.6.1 Holistic household-specific approach

While food availability and stability are influenced by broader systemic factors such as national policies and economic conditions, the proposed index focuses on access and utilisation, dimensions that can be directly impacted at the household level. This targeted approach enables the identification of at-risk households and facilitates the design of interventions that yield immediate, tangible benefits.

The inclusion of the HDDS, NS and HHS ensures that no critical aspect of household food security is overlooked. The HDDS provides insights into dietary diversity and a household's ability to access a variety of foods, linking directly to food access and utilisation. Child NS reflects the long-term health outcomes of food security, assessing whether food access and utilisation translate into positive health effects. The HHS captures the immediate experience of hunger, highlighting a household's ability to secure sufficient food. Together, these indicators provide a robust framework for identifying vulnerable households and tailoring interventions accordingly.

### 1.6.2 Practicality and feasibility in clinical settings

The selected indicators are designed to be easily administered during routine clinic visits and to provide a more holistic picture of household food security, compared to using these indicators in isolation. These indicators require minimal resources and time, making them suitable for use in resource-constrained environments such as South African public health clinics. The HFSI can serve as a practical screening tool for assessing and monitoring household food security, ensuring that healthcare providers can implement timely interventions without additional burden.

Furthermore, this study will contribute to a deeper understanding of the association between COVID-19, as example of the effect of large disasters, and household food security indicators in vulnerable communities. Such insights could streamline future targeted support efforts, strengthening food security strategies amid evolving public health and economic challenges.

## **1.7 Conclusion**

The proposed theoretical background emphasizes the importance of addressing household food security by focusing on the dimensions that are within the control of individual households, access and utilisation. By selecting indicators such as HDDS, child NS and HHS, which are easy to implement and provide valuable information, this framework enables the effective assessment and intervention in food security issues at the household level. Its implementation in clinics can enhance the identification of at-risk households, guide future targeted interventions, and support the monitoring and evaluation of food security programmes over time. By grounding the index in both theoretical and practical considerations, this approach ensures that it is not only scientifically robust but also contextually relevant and actionable.

## **1.8 Overview of the chapters in this thesis**

This thesis comprises of the following chapters:

Chapter 1 covers the introduction, theoretical background, research question, aims and objectives of the study.

Chapter 2 provides a comprehensive review of food security literature to establish a clear conceptual and analytical foundation for understanding the phenomena within the South African context.

Chapter 3 comprises of the methodology employed, including the instruments and procedures followed and ethical considerations.

Chapter 4 presents the results and discussion of the study for all the objectives.

Chapter 5 ends the thesis with the conclusion, study limitations and recommendations for future research.

## **CHAPTER 2: LITERATURE REVIEW**

### **2.1 Introduction**

This chapter presents a comprehensive review of the literature on food security, with the aim of building a clear conceptual and analytical foundation for understanding the issue in both global, but particularly the South African contexts. Food security is a complex and multidimensional phenomenon and as such, it has been defined and interpreted in various ways across disciplines, policies and institutions. This chapter begins by unpacking the key definitions and conceptual frameworks that underpin the study of food security, tracing their evolution and examining how they inform both theoretical and applied research.

Given its multidimensionality, measuring food security remains a significant challenge. The review explores the various dimensions and levels at which food security operates, ranging from global and national to household and individual levels, and discusses the major measurement tools used in assessing food security. These include both quantitative and qualitative methods. Each tool is examined in terms of its rationale, application and the specific aspects of food security it captures, highlighting the importance of selecting appropriate methods based on context and research objectives.

Furthermore, the chapter reviews the empirical literature on food security in South Africa, with particular attention to the socioeconomic, political and structural challenges that shape food insecurity in the country. It considers how food security is experienced and addressed at various levels, from households to national policy, while identifying key gaps, trends and debates within the literature. This synthesis provides critical insight into the current state of knowledge on food security and household food security, laying the groundwork for the subsequent rationale of this study of creating a comprehensive HFSI to assess household food security in low-income areas of NMB, SA.

## **2.2 Definition and concepts of food security**

### 2.2.1 Introduction

Food insecurity remains one of the most critical global challenges of our time, with widespread implications for public health, human development and economic sustainability. Globally, food insecurity offers challenges both from achieving targets of the SDG and the welfare perspective of many poor households. Food security is defined as when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (Peng & Berry, 2019). As the definition illustrates, food security is a complex construct, multidimensional and multifaceted in nature. It consists of four dimensions namely; availability, access, utilisation and stability, making it challenging to measure (Peng & Berry, 2019).

### 2.2.2 Theoretical background and evolution of food security

Food security is a dynamic concept that has been defined in various ways by numerous organizations across the globe. The concept of food security emerged in the 1970s, a period marked by global food crises that highlighted significant vulnerabilities in the world food system (Shaw, 2007). These crises were largely attributed to the shifting dynamics of the global food economy, prompting an initial focus on supply-side concerns. Early definitions of food security emphasized the availability of adequate food supplies and the stability of prices for basic food commodities, primarily at the national level.

In response to widespread hunger, famine and food instability, the World Food Conference, held in 1974, redefined food security to reflect these urgent challenges (*Report of the World Food Conference, Rome, 5-16 November 1974*, 1975). This redefinition introduced a focus on the needs and behaviours of vulnerable and affected populations, marking a significant shift from national supply metrics to considerations of individual and community impact. Subsequently, the concept evolved further as attention shifted from mere food availability to ensuring access to food. This progression was embodied in the FAO's broader definition, which emphasized the

importance of ensuring that vulnerable populations could obtain food that was available (Peng & Berry, 2019). This represented a conceptual balance between the supply and demand aspects of food security, recognizing that access is as critical as availability.

A major milestone in the evolution of the concept occurred in 1986 with the World Bank's influential report *Poverty and Hunger* (Shaw, 2007). This report introduced a time-based understanding of food insecurity, distinguishing between chronic food insecurity, typically linked to persistent poverty, and acute or transitory food insecurity, which arises from sudden shocks such as health or natural disasters or conflict.

Further conceptual development took place in 1994 with the Human Development Report by the United Nations Development Programme, which explicitly framed food security as a fundamental human right (Shaw, 2007). This rights-based perspective reinforced the idea that access to food is not merely a matter of policy or economy but a moral and legal imperative. Recognizing the multidimensional and context-specific nature of food security, the 1996 World Food Summit offered a revised and more comprehensive definition. This updated view emphasized food access at the individual and household levels, reflecting the importance of the household as the primary social unit through which individuals acquire food.

In the 1990s, the terminology and scope of food security evolved further with the emergence of the concept of food and nutrition security. This shift marked an important transition in focus, from the mere adequacy of energy intake to the broader quality of diets, including the critical role of micronutrients and the body's ability to utilize consumed food effectively. This refinement recognized that addressing hunger required more than just providing sufficient energy; it also demanded attention to hidden forms of malnutrition, particularly micronutrient deficiencies that undermine health and development outcomes. Building on this expanded perspective, the definition of food security was further refined in *The State of Food Insecurity in the World 2001* by incorporating a stronger emphasis on its social dimensions (Peng & Berry, 2019). It was acknowledged that while addressing poverty is essential, it is not sufficient on its own to achieve food security.

The most recent official revision of the definition came in 2009 during the World Food Summit which brought about a deepening of the understanding of food security (FAO, 2009). It added a fourth dimension to its definition, namely stability. This was identified as the indicator for the short-term ability of food systems to survive shocks, whether they were artificial or natural. This newly added fourth dimension took the lead in introducing the concept of steadiness in food security (Peng & Berry, 2019).

As demonstrated, the understanding of food security has continued to evolve in response to the increasingly complex realities of global nutrition. The focus has expanded from traditional concerns around poverty and undernutrition, especially stunting and micronutrient deficiencies, to also address the triple burden of malnutrition. This includes undernutrition, micronutrient deficiencies, overnutrition such as obesity and diet-related non-communicable diseases (NCDs) (Mkhize & Sibanda, 2020). These conditions frequently coexist within the same populations, communities, and even households, reflecting deep structural inequalities in access to nutritious, safe, and culturally appropriate food. The emergence of the triple burden underscores the urgent need to address the full spectrum of nutritional challenges, not only food quantity but also dietary quality, diversity, and the health outcomes associated with food consumption.

In light of these complex challenges, leading experts and international bodies have advocated for a redefinition of food security that includes two additional dimensions: agency and sustainability (FAO) et al., 2023).

- Agency refers to the capacity of individuals and communities to make autonomous decisions about what they eat and how it is produced, reflecting values, preferences and cultural norms (FAO et al., 2023). Agency also refers to the freedom of individuals to pursue their own goals and values, including both empowerment and active participation in shaping societal decisions and policies (Sen, 1985). In the context of food systems, agency is critical for achieving sustainable development and food security, as it enables individuals and communities to influence decisions related to food production, distribution and governance. However, historically marginalized groups often experience limited agency, which contributes to their heightened vulnerability to food

insecurity. Governments have a key role in fostering agency by supporting democratic engagement, reducing power imbalances, and enhancing both individual and collective capacities. The concept of agency is deeply connected to human rights, especially the right to food. The Right to Food Guidelines emphasize the importance of inclusive decision-making processes and equitable access to information and resources as fundamental to exercising agency in food systems (High Level Panel of Experts, 2020a).

- Sustainability is a core component of food security, widely acknowledged in both academic research and global policy frameworks such as the SDGs. It refers to the long-term ability of food systems to deliver adequate nutrition while preserving the environmental, economic and social foundations necessary for future generations (High Level Panel of Experts (HLPE), 2020). As challenges such as climate change and social inequality intensify, integrating sustainability into food systems becomes increasingly essential. This requires coordinated action across ecological, economic and social domains to ensure resilient, diverse and nutritious food production (FAO et al., 2023). Together, these additions represent a critical shift toward a more comprehensive, inclusive, and systems-based understanding of food security for the future.

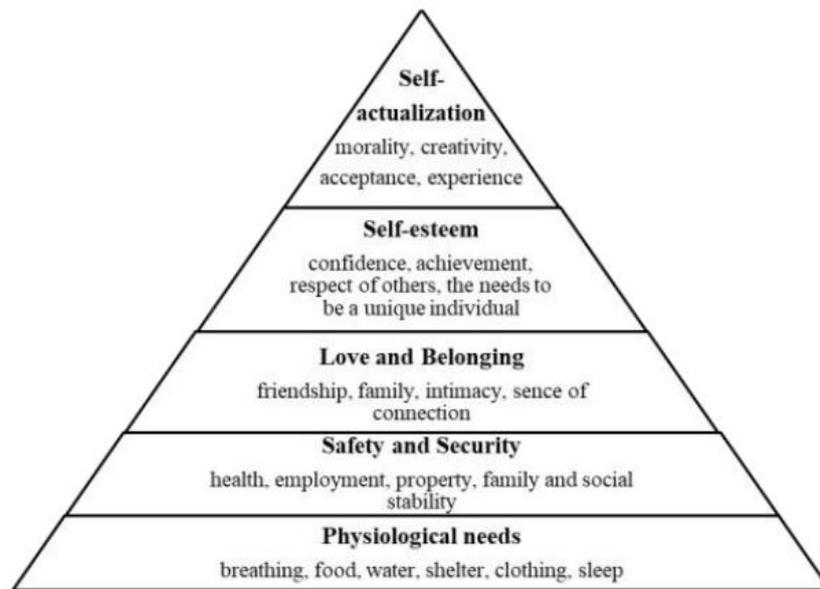
### 2.2.3 Maslow hierarchy of needs and household food security

Maslow's hierarchy of needs is a psychological, motivational theory proposed by Abraham Maslow in 1943, which remains influential in understanding human behaviour, development and well-being. The theory posits that human needs are arranged in a hierarchical order (Figure 2.1), beginning with basic physiological requirements and progressing toward higher-level psychological and self-fulfilment needs (Maslow, 1943). The hierarchy consists of five levels:

1. Physiological needs such as food, water and shelter;
2. safety needs, including physical safety and security;
3. love and belongingness, encompassing social relationships, affection and connection;
4. esteem needs, related to self-respect, recognition and achievement; and

5 self-actualization, the realisation of an individual's potential and personal growth.

Maslow suggested that lower-level needs must be at least partially satisfied before individuals can attend to higher-level needs (Maslow, 1943).



**Figure 2.1: Maslow's hierarchy of needs pyramid (Maslow, 1943)**

While the theory has undergone adaptations over time, its core structure remains a valuable lens for understanding human behaviour and development (Tay & Diener, 2011).

At the base of the hierarchy are physiological needs, which are essential for human survival. These include access to food, water, air, shelter, sleep and other bodily requirements. These needs are considered the most fundamental because, without their satisfaction, the human body cannot function effectively (Maslow, 1943). In contexts such as food security, public health and poverty alleviation, addressing physiological needs is a critical starting point (Al Maamari, 2025).

Once physiological needs are met, the next level pertains to safety and security. This includes personal security, financial stability, health and protection from accidents, illness, or harm. In both physical and psychological terms, safety needs represent an

individual's desire for stability and order (Maslow, 1943). In modern applications, these needs extend to secure employment, access to healthcare and safe living environments (Al Maamari, 2025). A lack of safety can result in anxiety, stress and hindered development or productivity.

Understanding household food security through the lens of Maslow's Hierarchy of Needs provides a view of how access to sufficient, safe and nutritious food interacts with broader human needs, motivations and well-being. Maslow's theory posits that individuals are motivated to satisfy a hierarchy of needs, beginning with physiological necessities and progressing through safety, social belonging, esteem and ultimately self-actualization (Maslow, 1943). Food, as a basic human requirement, sits at the base of this pyramid and influences all subsequent levels of functioning.

At the most fundamental level, food security, particularly the access and utilisation dimension, aligns directly with the physiological tier of Maslow's model. A household is considered food secure when all members have consistent, physical and economic access to sufficient, safe and nutritious food to meet their dietary needs (FAO, 2008). When food is scarce or unreliable, individuals struggle to maintain health, energy and cognitive function, which in turn impairs the ability to meet higher-order needs (Coates et al., 2007). Chronic food insecurity can trap households in a survival mode, limiting the capacity for personal well-being and development.

The second tier of Maslow's Hierarchy of Needs, safety and security, encompasses the need for safety, stability and health. In the context of household food security, this translates to reliable, stable access to sufficient, safe and nutritious food that supports healthy living over time referring the stability of food access and utilisation. While meeting immediate energy needs is vital, the quality, safety and sustainability of that access are equally critical to food utilisation and ensuring long-term well-being (Coates et al., 2007; FAO, 2008).

Food insecurity, particularly when it involves poor dietary quality or inconsistent access, undermines this level of need, negatively affects food utilisation and poses significant health risks. Diets that lack diversity and essential nutrients are associated with increased rates of malnutrition, stunting in children, micronutrient deficiencies and

non-communicable diseases such as obesity, diabetes and hypertension (Frongillo et al., 2022). Furthermore, households that cannot consistently obtain safe food are more vulnerable to foodborne illnesses and chronic stress, both of which compromise physical and mental health (Fanzo et al., 2022).

From a Maslovian perspective, when the safety associated with dependable nutritious food access is not assured, households and individuals remain in a state of vulnerability, unable to focus on higher-level needs such as social participation, self-esteem, or personal growth. For this reason, ensuring stable access to safe and nutritious food is not only a matter of survival but also foundational to achieving broader developmental and health-related goals within households and communities.

Food also plays a central role in fulfilling belongingness and love needs, the third level in Maslow's hierarchy. Shared meals, cultural food practices and the social act of eating together contribute to social identity, emotional well-being and family cohesion (Lalli, Turner & Rutland, 2023). In food-insecure households, the inability to engage in culturally appropriate food preparation or participate in communal eating can exacerbate feelings of isolation, shame and marginalization, further compromising psychosocial health (Loopstra & Tarasuk, 2013).

Access to adequate food can impact a household's and individual's sense of self-worth and dignity. Food insecurity often leads to feelings of shame, inadequacy and powerlessness, especially when households must rely on external assistance. In addition, food insecurity can erode self-esteem and perceived social status, particularly when households are forced to adopt coping strategies that are socially stigmatizing, such as skipping meals or sending children to bed hungry (Frongillo et al., 2022).

At the highest level, food security contributes to self-actualization, the fulfilment of potential and autonomy. Households that are fully food secure are more likely to engage in productive activities, education and community development, indicators of self-actualization and social flourishing. Thus, food security is not only a basic need but also a foundation for long-term human development and societal progress (Burchi & De Muro, 2012).

Applying Maslow's Hierarchy of Needs to the analysis of household food security highlights that food security occupies a foundational position within the pyramid, aligning with the physiological needs that form the base of human motivation. In low-income settings, where food insecurity remains a persistent challenge, access to sufficient, safe and nutritious food is a critical prerequisite for individuals and households to meet higher-order needs. The pyramid underscores that immediate food access and utilisation must be secured to support not only physical survival but also the conditions necessary for pursuing broader socioeconomic development. After which the stability of sufficient, safe, and nutritious food is needed before progress can be made to higher levels of the hierarchy. Without first addressing these fundamental needs, efforts to improve other aspects of well-being, such as education, employment, and social integration, may be undermined. Thus, Maslow's model provides a useful lens through which to understand the centrality of food security in the broader context of human development, particularly in vulnerable and resource-constrained households.

#### 2.2.4 Pillars of food security

The four pillars of food security are interconnected and should be present to some degree for people to be considered food secure; none of them alone can ensure sustained food security (FAO et al., 2023). When any one of these elements is compromised, food insecurity can arise, affecting people at national, household, or individual levels. Notably, food security at one level does not guarantee the same at another. Thus, a comprehensive understanding and approach to all dimensions is essential for addressing and preventing food insecurity effectively.

##### *2.2.4.1 Availability*

Availability is defined by the WFP as "the presence of food in a specific country through all different domestic production forms, imports, food stocks and food aid" (FAO, 2009). The supply side of food security is addressed by food availability and is determined by the food production and stock levels, as well as imports and exports

and losses in storage. The term is traditionally applied to food availability at macro-level (regional, national levels) and not micro-level (household, individual levels). However, this dimension often overlooks critical aspects of food quality and nutrient intake. Studies have examined the relationship between food availability and nutritional outcomes, including child nutrition and dietary diversity and found that it is not a strong indicator, suggesting that definitions of food security that emphasize on availability may present an incomplete picture of food insecurity, particularly when contrasted with definitions that focus on nutrient intake (Göttingen et al., 2009).

To assess food availability, several measurement tools and indicators are used, each providing a different perspective on the presence of food within a given area.

- **Food Balance Sheets (FBS)**  
The Food Balance Sheets (FBS) are one of the most comprehensive tools used globally to assess food availability. Published by the FAO, the FBS provides data on the supply of food available for human consumption in a country. The FBS compiles data on the production of food commodities, adjustments for changes in stocks and trade flows (imports and exports). It also accounts for losses during storage, processing and distribution. The final figures give an overview of the total food supply available per capita, which is used to assess trends in food availability and the potential for food insecurity (Gross, Schoeneberger, Pfeifer & Preuss, 2000).
- **Global Food Security Index (GFSI)**  
The Global Food Security Index (GFSI), developed by the Economist Intelligence Unit based in London, is another tool for measuring food availability. The GFSI assesses food security across countries based on four aspects: affordability, availability, quality and safety, and natural resources and resilience. The availability aspects specifically evaluate factors such as agricultural production, infrastructure, food loss and access to finance for farmers. This index provides a composite score that helps compare food security levels across different nations and highlights vulnerabilities in food supply chains (FAO, IFAD, UNICEF, WFP, & WHO, 2019). Recent information

by the Economist Impact (2022) highlighted that the GFSI has declined since 2019 due to long-term systemic issues, worsened by the COVID-19 pandemic and rising commodity prices. Affordability fell by 4% between 2019 and 2022, while conflict and political instability caused further setbacks. However, there have been gains in agricultural technology, education and innovation, offering hope for future improvements. Top-performing countries include Finland, Ireland and Norway, while Syria, Haiti and Yemen rank lowest, highlighting global disparities in food security. South Africa emerged as Africa's most food-secure country, ranking 59th globally in the 2022 GFSI, a significant rise from its 70th position in 2021. This marks the first time that a Sub-Saharan African nation has led the continent in food security. South Africa's achievement comes despite major global challenges such as global pandemics, climate change, inflation and the fertilizer crisis triggered by the Ukraine war (Economist Impact, 2022).

Each of these methods provides unique insights into the availability of food, but they also have limitations. For example, while the FBS provides a broad national-level view, it does not capture inequalities in food distribution within a country (Schott, Rezende, Priore, Ribeiro & Franceschini, 2020). Market and price data can be timely and reflective of immediate availability issues, but they may not account for long-term trends. Combining multiple methods is often necessary to obtain a comprehensive understanding of a country's food availability and its impact on food security. In practice, these tools are used by governments, international organizations and non-government organisations to monitor food security and guide policy decisions.

#### *2.2.4.2 Access*

This dimension of food security highlights that the mere presence of food does not guarantee food security; individuals must also be able to obtain it. Physical access to food involves the logistics of transporting food from production areas to consumers. This issue underscores the importance of infrastructure, such as roads, storage facilities and transportation networks, in ensuring that food can reach those who need it (Napoli, De Muro & Mazziotta, 2011). Economic access is determined by an

individual's ability to afford food. This dimension is closely linked to income levels, employment status and the overall economic environment. Food security, from an economic perspective, depends on whether individuals have sufficient financial resources to purchase adequate food. Rising food prices, unemployment and economic instability can all hinder economic access to food, leading to increased food insecurity (FAO, IFAD, UNICEF, WFP, & WHO, 2021). The social dimension of food access considers the socio-cultural factors that may prevent individuals from obtaining food. Even when food is physically available and economically affordable, social barriers, such as discrimination based on gender, ethnicity, or social class, can restrict access. Social access to food also includes factors such as food preferences and cultural acceptability, which influence the types of food that individuals can or choose to consume (Napoli et al., 2011).

To assess food access, various quantitative and qualitative methods have been developed, each providing insights into different aspects of this dimension.

- **Household Income and Expenditure Surveys**  
Household Income and Expenditure Surveys are used to assess economic access to food. These surveys collect data on household income, food expenditure and consumption patterns, providing a detailed picture of how much of a household's resources are allocated to food. This information assists in the understanding of economic barriers to food access, such as high food prices or low-income levels. However, Webb, Coates, Frongillo, Rogers, Swindale and Bilinsky, (2006) criticize this approach for its reliance on monetary values, which may not fully capture the complexities of food access, particularly in non-market economies or among households relying on subsistence agriculture. The 2022/2023 Household Income and Expenditure Surveys by Statistics South Africa (StatsSA) reveals that total annual household consumption expenditure reached approximately R3 trillion between November 2022 and November 2023. The primary spending categories included housing and utilities, food and non-alcoholic beverages, transport and insurance and financial services. Urban households dominated national consumption, contributing 81.5% of total expenditure, followed by households in traditional areas (15.3%) and farm areas (3.2%). Clear

differences in total household expenditure on food, beverages, tobacco and narcotics were observed across settlement types. Traditional (28.1%) and farm (22.2%) households devoted a larger share of their budgets to these items, while urban households spent the smallest share (15.6%), below the national average of 17.7%. Yet, in absolute terms, urban households spent the most (R26,119 annually), exceeding the national average, whereas farm (R24,981) and traditional (R23,784) households spent less. This suggests that urban households have higher overall incomes, allowing them to spend more despite a smaller budget share, whereas rural households prioritize these items due to limited resources.(StatsSA, 2023a).

- Food Insecurity Experience Scale (FIES)

The Food Insecurity Experience Scale (FIES), developed by the FAO, is a tool to measure food access at the individual and household levels. The FIES evaluates the severity of food insecurity, which reflects a hidden condition tied to the lack of access to sufficient food needed for a healthy, active and dignified life. This measure is based on the households' reported experiences and behaviours (of the last 12 months) in response to eight questions, all of which indicate difficulties in accessing food due to insufficient financial means or other resources. This tool allows for an understanding of how food access issues manifest in daily life. A limitation of the FIES is its vulnerability to recall bias, as it relies on respondents' retrospective reporting of food insecurity experiences, which may result in misreporting due to memory inaccuracies. (FAO et al., 2019). The FIES module is included in the General Household Survey (GHS) in South Africa and in 2023, it estimated that 19.7% of households experienced moderate to severe food insecurity, with 8.0% classified as severely food insecure. Notably, households residing in traditional areas were disproportionately affected, with approximately one in four (25%) experiencing moderate to severe food insecurity, the highest prevalence among all settlement types. Furthermore, 10.8% of households in these traditional areas faced severe food insecurity, again representing the highest rate compared to other residential categories (StatsSA, 2025).

- Coping Strategies Index (CSI)

The Coping Strategies Index (CSI) is a qualitative tool used to assess food access by examining the strategies that households employ to cope with food shortages. The CSI measures the frequency and severity of behaviours such as reducing meal sizes, skipping meals, or relying on less preferred foods. This index provides valuable insights into the resilience of households in the face of food access challenges and helps identify vulnerable populations that may require targeted interventions (Maxwell et al., 2013). A practical application of the index in research illustrates households that used three or more coping strategies faced significantly higher mental health risks, with 22.6% of respondents showing signs of probable anxiety and 33.7% showing signs of probable depression (Dlamini, Mtintsilana, Craig, Mapanga & Norris, 2024).

- Household Food Insecurity Access Scale (HFIAS)

The Household Food Insecurity Access Scale (HFIAS) includes questions about the availability of food in households, specifically addressing whether households have sufficient food to meet their needs. The HFIAS captures food insecurity over a 30-day recall period. This tool is especially useful in identifying seasonal variations in food access and the impact of economic shocks on household food supplies (Coates et al., 2007). The HFIAS was included in the National Food and Nutrition Security Survey (NFNSS) of South Africa in 2021/2022 indicating that 63.5% of South African households were food insecure, with 17.5% severely, 26.7% moderately, and 19.3% mildly food insecure, while only 36.5% were food secure (Simelane et al., 2024). One primary concern is its reliance on self-reported data, which introduces subjectivity and potential recall bias. Respondents may either overstate or understate their food insecurity due to memory issues or social desirability. Another limitation is that the HFIAS does not assess the nutritional adequacy or dietary quality of consumed food. A household may report sufficient food access yet still experience malnutrition due to poor dietary diversity or lack of micronutrients (Coates et al., 2007).

- Household Hunger Scale (HHS)

The HHS is a widely used tool for measuring the access dimension of food security, specifically capturing experiences of hunger at the household level. Developed by the Food and Nutrition Technical Assistance project in collaboration with the United States Agency for International Development, the HHS assesses households' access to sufficient food by gauging the frequency and severity of hunger-related experiences over a 30-day recall period (Ballard et al., 2011).

The scale focuses on three key indicators: household members going to bed hungry; households experiencing a day without eating; and household members having insufficient food (Ballard et al., 2011).

These indicators reflect acute food insecurity, making the HHS a crucial measure in areas where households face significant barriers to accessing adequate food. One of the strengths of the HHS is its simplicity and ease of administration, especially in low-resource settings. Studies have shown that households with low access to food are more likely to report higher scores on the HHS, indicating that the scale is a reliable measure of access-related food insecurity (Ballard et al., 2011). A limitation of the HHS is that it relies on self-reported perceptions of hunger, which may be skewed by social desirability bias as respondents aim to give socially acceptable answers. Practical application of the HHS can be seen in the recent NFNSS which indicated the majority (79.2%) of households in South Africa experienced "little" to "no hunger", while 15.3% reported 'moderate hunger' and 5.6% experienced 'severe hunger', indicating that although food insecurity is widespread, the intensity of hunger is relatively low for most households (Simelane et al., 2024).

- Dietary Diversity Score (DDS)

The Dietary Diversity Score (DDS), officially introduced by Ruel, (2003), is a widely used indicator for assessing food access. DDS measures the number of different food groups consumed over a specific period, providing an indication of the variety and quality of the diet. A higher DDS is generally associated with better nutrient intake and, by extension, better food utilisation (Ruel, 2003). The DDS is particularly useful in assessing the dietary patterns of individuals and households, offering insights into potential nutritional deficiencies or imbalances (Hoddinott & Yohannes, 2002). Various forms of DDSs have been developed to assess dietary patterns at different levels of analysis; each tailored to specific population groups and objectives. The DDS is classified into different dimensions, including (United States Agency for International Development, 2006): HDDS; Individual Dietary Diversity Score, which comprises the Child Dietary Diversity Score; and the Women Dietary Diversity Score. The DDS tools provide a robust framework for evaluating dietary diversity across different demographic groups and informing policy and programmatic responses. A key limitation of the DDS is that it measures food group diversity without accounting for precise quantity, so similar scores may mask significant differences in dietary adequacy.

The HDDS is a commonly applied tool in food security research, used to evaluate the capacity of households to access a variety of foods, thereby serving as a proxy for dietary quality (Kennedy, Ballard & Dop, 2011). It is based on the number of different food groups consumed by a household within a 24-hour recall period, reflecting the likelihood of meeting essential micro- and macronutrient needs. According to Swindale and Bilinsky, (2006), HDDS scores range from zero to twelve, with higher scores indicating greater dietary diversity and, by extension, improved food access and nutritional adequacy. The HDDS draws on twelve standardized food groups: cereals; roots and tubers; vegetables; fruits; meat and poultry; eggs; fish and seafood; pulses, legumes, and nuts; milk and milk products; oils/fats and offal; sugar/honey; and miscellaneous items. It is a valuable food security indicator, as greater dietary diversity is associated with adequate energy and protein intake, more animal-based protein, and increased household income (Swindale & Bilinsky, 2006). Studies have

emphasized that households with low HDDS often rely heavily on starchy staples, excluding critical nutrient sources such as protein and micronutrient-rich foods (Cheteni, Khamfula & Mah, 2020; Gassara & Chen, 2021; Harper, Goudge, Chirwa, Rothberg, Sambu & Mall, 2022). Therefore, HDDS is recognized as a key indicator for identifying food-insecure households, particularly in low-resource settings, and is instrumental in guiding nutrition-sensitive policy and programme development.

Individual Dietary Diversity Score evaluates dietary quality at the individual level. Nine food groups are considered whereby a DDS below four categorized as low and associated with dietary inadequacies (Steyn, Nel, Labadarios, Maunder & Kruger, 2014). It is particularly useful for evaluating intra-household food distribution and identifying disparities in nutritional intake among different household members, including children, woman and the elderly.

The Women's Dietary Diversity Score is a specialized tool developed by the FAO used to assess the micronutrient adequacy of diets among women of reproductive age (15–49 years), recognizing their unique nutritional needs (Kennedy et al., 2011). Women's Dietary Diversity Score considers the consumption of nine food groups, with higher scores linked to better micronutrient intake and improved maternal and child health outcomes. These tools are essential for gender- and age-sensitive analysis of dietary quality and play a critical role in nutrition surveillance, programme targeting, and policy development.

In summary, measuring food access is a complex process that requires context-specific approaches to adequately capture the diverse factors shaping this dimension of food security. While the Household Income and Expenditure Surveys provides detailed economic data, tools like the FIES and CSI offer insights into the lived experiences of food insecurity. Market access surveys and livelihoods analysis further enhance understanding by considering the physical and socio-economic context in which food access occurs. In the South African context, these measurement methods are widely used by policymakers and national institutions to monitor food security and inform the design of targeted interventions at both the national and household levels. For instance, tools such as the FIES have been aligned with global frameworks like the SDGs to track progress in reducing food insecurity (FAO et al., 2019). The HFIAS,

HHS, HDDS and NS have been included in the NFNSS to measure and monitor food and nutritional security status of South African households (Simelane et al., 2024).

#### *2.2.4.3 Utilisation*

The FAO defines food utilisation as an adequate diet, clean water, functional sanitation and health care to reach a state of nutritional well-being where all physiological needs are met. This brings out the importance of non-food inputs in food security (FAO, 2006). Food utilisation also refers to the ability of the body to consume and metabolize food effectively, ensuring that the nutrients derived from food contribute to overall health and well-being (Gross et al., 2000). Food utilisation depends on a number of factors including food storage, processing and preparation, feeding practices, food sharing practices within a household, and health status of each member in the household (FAO, 2006). Many of these factors are influenced by the application of adequate nutrition knowledge. While food availability and access are critical components of food security, they alone do not guarantee that individuals will achieve optimal NS. The safety and nutritional quality of food, as well as the body's ability to absorb and utilize nutrients, are essential for food security (Napoli et al., 2011). The concept of food utilisation is multifaceted, involving both socio-economic and biological dimensions. Socio-economic factors influence food utilisation through household decision-making processes regarding food consumption, allocation and preparation. In households where food is not distributed equitably, certain members may suffer from inadequate nutrient intake, even if overall food access is sufficient (Jadeja & Sharma, 2022). Additionally, economic constraints, such as limited access to education, job opportunities and credit, can impede food utilisation by restricting the ability of households to obtain and apply nutrition knowledge (Coates, Webb & Houser, 2003). On the biological side, food utilisation is determined by the body's ability to absorb and metabolize nutrients. This process is influenced by factors such as health status, access to healthcare, and the quality of the living environment, including access to clean water and sanitation. Proper sanitation and a healthy environment are crucial for the effective absorption of nutrients, as they prevent the onset of diseases that can impair the body's ability to utilize food (Capanzana, Aguila, Gironella & Montecillo, 2018).

To assess food utilisation, various indicators and measurement methods have been developed, focusing on both the socio-economic and biological dimensions.

- **Anthropometric Measures**

Anthropometric measurements, such as BMI, height-for-age, weight-for-age, and BMI-for-age z-scores are critical indicators of NS and food utilisation, especially in children. These measures contribute to the assessment of the long-term and immediate NS of individuals, reflecting the effectiveness of food utilisation at the household and individual levels (WHO, 2008). For example, stunting is an indicator of chronic malnutrition, while wasting indicates acute malnutrition, both of which are outcomes of poor food utilisation (De Onis, 2007). Similarly, BMI-for-age is used to assess overall NS, indicating undernutrition, normal weight, or overweight/obesity in children and adolescents (De Onis, 2007).

- **Food Consumption Score (FCS)**

The Food Consumption Score (FCS) is another indicator used to assess food utilisation. The FCS measures the frequency and diversity of food consumption over a seven-day period, weighted by the nutritional value of the consumed food groups. This score provides an overview of both the quantity and quality of food consumed, offering insights into the adequacy of food utilisation within a household (FAO et al., 2019). The FCS is particularly valuable in emergency settings to monitor the NS of populations and guide food assistance programmes. A limitation of the FCS is that it relies on respondents recalling foods consumed over the past seven days, which increases the risk of inaccurate reporting due to memory lapses or intentional misreporting, which can affect the reliability of the data.

- Biochemical Indicators

Biochemical indicators, such as haemoglobin levels, vitamin A status and iron levels, are direct measures of nutrient absorption and utilisation in the body. These indicators are often used in conjunction with dietary assessments to provide a more complete picture of food utilisation, but are costly to implement, especially in low-income settings. Biochemical indicators are useful for identifying specific nutrient deficiencies and guiding targeted interventions to improve food security ( WHO & UNICEF, 2021).

The measurement of food utilisation is complex and influenced by several factors. Anthropometric measures and biochemical indicators offer direct evidence of the NS of individuals, while sanitation and hygiene indicators complement and contextualize food utilisation by highlighting the environmental factors that impact nutrient absorption and overall health. In practice, these measurement methods are employed by governments and international organizations to monitor food security and implement nutrition programmes. For instance, the WFP uses the FCS to assess the impact of food aid interventions on food security and to adjust strategies as needed (FAO, 2018). Similarly, anthropometric measures and biochemical indicators are integral to public health monitoring and the design of targeted nutrition interventions, particularly in vulnerable populations (FAO et al., 2020).

#### *2.2.4.4 Stability*

Food stability is a critical dimension of food security that ensures the consistent availability, access and utilisation of food over time. Stability in food availability, access and utilisation is essential for achieving effective and sustained food security (FAO, 2008). A household that has adequate food intake today but faces uncertainty in future access to food, is considered food insecure. The FAO (2008) highlights that both permanent and temporary disruptions in access to food or resources necessary for obtaining food can undermine food stability. These disruptions can be caused by various factors, including health pandemics, climate variability, economic instability and sociopolitical unrest (Göttingen et al., 2009). Climate variability is one of the most

significant factors influencing food stability. Changes in weather patterns, such as droughts, floods and extreme temperatures, can lead to crop failures, reduced agricultural productivity and disruptions in food supply chains (Göttingen et al., 2009). In addition to climate variability, economic factors such as loss of income, unemployment and economic crises can also destabilize food security. When households experience a loss of income, their ability to purchase food diminishes, leading to food insecurity even if food is available in the market. Health pandemics can significantly disrupt the stability of food security by hindering food production, supply chains and market access due to movement restrictions and labour shortages. Additionally, pandemics often exacerbate economic vulnerability, reducing household purchasing power and access to sufficient, nutritious food (Kumareswaran & Jayasinghe, 2022). Sociopolitical factors, including conflict, civil unrest and political instability, can further exacerbate food instability (FAO, IFAD, UNICEF, WFP, WHO, 2022). Political decisions and policies, such as trade restrictions or subsidies, can also impact food prices and availability, affecting the stability of food access at both the household and national levels. Improving food stability requires effective management of external risks, such as climate change, natural disasters and economic volatility (Göttingen et al., 2009). Furthermore, stability, refers to the capacity of a nation, community, household, or individual to withstand disruptions to the food system, whether these shocks are caused by natural disasters such as climate events, or by human-induced crises such as wars or economic downturns.

#### 2.2.5 Food insecurity

Food insecurity is defined as a condition in which individuals lack consistent access to sufficient, safe and nutritious food necessary for leading an active and healthy life (Ibok, Osbahr & Srinivasan, 2019). This state also includes anxiety about food access or the inability to afford food when supplies are exhausted (FAO, 2018). Those experiencing food insecurity are often unable to grow or obtain adequate food due to constrained resources. It is particularly prevalent among victims of conflict, the urban poor and low-income households, especially in developing nations (FAO, 2018).

Von Braun, Bouis, Kumar and Pandya-Lorch (1992) identify two primary forms of food insecurity: chronic and transitory. These categories help explain the duration, causes and impacts of food shortages experienced by vulnerable populations.

Chronic food insecurity refers to a prolonged and persistent lack of access to adequate food, primarily driven by poverty and the absence of productive or financial resources (FAO, 2008). It affects individuals and households that are consistently unable to meet the minimum requirements to produce or purchase enough food. Chronic food insecurity creates conditions of vulnerability, defined as a continual susceptibility to future food shortages (Devereux & Waidler, 2017). Often categorized as mild to moderate in severity, this form of food insecurity becomes prevalent in the context of sustained structural or market failures within a nation. Well-designed nutritional policies are essential strategies to address the challenges of chronic food insecurity (FAO, 2008).

Transitory food insecurity, in contrast, is short-term and results from sudden disruptions such as economic shocks, natural or health disasters, or sharp fluctuations in food prices (FAO, 2008). It occurs when there is a temporary decline in a household's ability to secure sufficient food, either through purchase or self-production. Though it is of limited duration, transitory food insecurity can have severe consequences, including hunger and famine, making it one of the most acute forms of food insecurity at the household level (FAO, 2008). Poorly implemented or reactive government policies can exacerbate the problem by destabilizing food consumption patterns.

Chronic and transitory food insecurity are often interlinked. Chronic insecurity frequently emerges from repeated instances of transitory shocks (Ericksen, Thornton, Notenbaert, Cramer, Jones & Herrero, 2011). Household coping mechanisms offer insights into this relationship. For example, in response to transitory food shortages, households may sell off key assets to meet immediate food needs. While this may offer temporary relief, it undermines their long-term capacity to generate food or income, pushing them deeper into chronic insecurity. This cycle is known as the "poverty trap" (Ericksen et al., 2011).

### 2.2.6 Role of expert consensus and validation in research

Expert (tacit) knowledge from professionals in the fields of food security, nutrition, and public health was incorporated to evaluate the contextual relevance and practicality of the HFSI as well as relative importance of each indicator included in the index. This expert insight was systematically gathered through the Delphi technique, a structured consensus-building method that integrates professional judgment to enhance the validity and applicability of the index within real-world settings

It systematically gathers and synthesizes expert judgments, making it particularly effective for developing multidimensional measures, such as household food security, where diverse perspectives are essential (Hsu & Sandford, 2007). Additionally, its iterative rounds provide a means to converge on reliable indicators and weightings, enhancing the validity and relevance of the resulting index (Skulmoski, Hartman & Krahn, 2007).

The Delphi technique is a structured, multistage process employed to achieve a convergence of opinion among a panel of experts on a specific issue or topic. Originating from forecasting research, the method is now widely used in healthcare, social sciences, education, and policymaking to develop consensus, identify priorities, or validate frameworks (Niederberger & Renn, 2023). It includes four key features: anonymity, iteration, controlled feedback, and statistical aggregation (Hsu & Sandford, 2007). The technique relies on iterative rounds of questionnaires, controlled feedback, and statistical aggregation of group responses. This process is repeated over multiple rounds until a predetermined level of consensus is reached.

Definitions of consensus vary widely, with percent agreement being one of the most popular methods. For example, studies frequently use a level of 70–80% agreement as a practical standard, while higher levels, such as 90–100%, may be required for studies on critical issues like healthcare/medical guidelines (Niederberger & Spranger, 2020). Despite its centrality to the Delphi process, consensus remains inconsistently defined, creating challenges in achieving standardized results across studies. For this reason, researchers are encouraged to clarify their definitions and thresholds for consensus, especially in studies involving complex social or health-related constructs

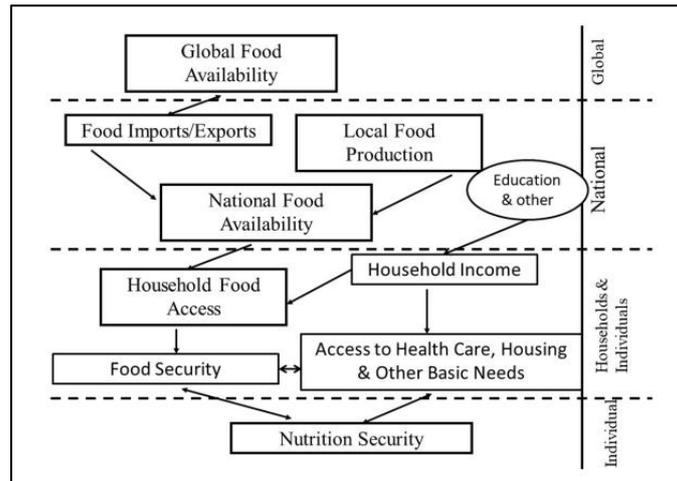
(Niederberger & Renn, 2023). For studies developing indices or models, such as this study measuring household food security, a consensus level of 70% generally balances reliability and practicality. While achieving full agreement is challenging, consensus in this range is considered rigorous and achievable for multi-round Delphis, especially those with heterogeneous expert panels (Niederberger & Renn, 2023).

Anonymity ensures that participants remain unaware of each other's identities, reducing potential biases and influence from perceived hierarchies (Skulmoski et al., 2007). Controlled feedback provides experts with an anonymous summary of group responses, and statistical aggregation summarizes collective responses, creating a structured, quasi-objective basis for consensus (Hsu & Sandford, 2007). Although expert consensus represents a lower tier in the evidence hierarchy, it is essential for developing practical tools, particularly when higher-level evidence is limited or when addressing context-specific challenges such as household food security in South Africa (Boulkedid, Abdoul, Loustau, Sibony & Alberti, 2011; Diamond, Grant, Feldman, Pencharz, Ling, Moore & Wales, 2014).

Participants are purposively selected based on their expertise, experience, or professional standing in the subject area. The panel size generally ranges from 10 to 30 experts, although it can vary depending on the scope and complexity of the study. Heterogeneity among experts is encouraged to enrich the range of perspectives (Hasson, Keeney & McKenna, 2000).

### **2.3 Levels of food security**

Food security operates at multiple levels, global, national, household and individual, each influenced by different dimensions of food security as shown in Figure 2.2 below. While global and national food security focus on food availability, food production, distribution and policies; household and individual food security determine daily access to sufficient, safe and nutritious food as well as food utilisation. Given that food security is most acutely experienced and manifested at the household and individual levels, measurement frameworks should prioritize these levels, and interventions as well as policy responses should be strategically designed and implemented to target these levels and to ensure meaningful and sustainable outcomes.



**Figure 2.2: The relationships between global food security, household food security, and nutrition security (Pérez-Escamilla, 2024)**

### 2.3.1 Global food security

Global food security encompasses a range of ecological, social, economic and political dimensions that influence the ability to access food (Pérez-Escamilla, 2024). It is closely linked to food systems that involve interconnected activities such as food production, processing, distribution and consumption across various regions (Pangaribowo, Gerber & Torero, 2013). Ensuring global food security means producing enough food on a global scale to enable countries and sub-national entities to maintain adequate access to food. This concept addresses factors that impact the availability and distribution of food at both international and national levels.

### 2.3.2 National food security

National food security is defined as a nation's ability to produce, import, store and maintain sufficient food to meet the minimum per capita nutritional requirements of its population (Göttingen et al., 2009). The state of food security varies across nations, with high-income countries generally achieving greater stability, while low- and middle-income countries face significant challenges (FAO, IFAD, et al., 2022). Countries with strong food systems and efficient governance structures are better equipped to mitigate food insecurity, while those facing economic downturns, political instability

and environmental challenges struggle to provide consistent food access to their populations (FAO et al., 2021). Populations most affected by national food insecurity include low-income households, rural communities and marginalized groups who experience economic and social barriers to food access (FAO, IFAD, et al., 2022).

Two key indicators are commonly used to assess a nation's food status. The first is the projected food supply, which is calculated by combining domestic food production, including agricultural contributions to the gross domestic product, with commercial imports, and then subtracting non-food uses. The second is the nutritious food supply, which is determined by measuring the gap between the projected food supply and the quantity of food required to meet the nutritional needs of the population, particularly focusing on individuals with the lowest income levels (Labadarios, Mchiza, Steyn, Gericke, Maunder, Davids & Parker, 2011). To assess national food security, governments and international organizations rely on various indicators and measurement tools. The FIES is used to evaluate the severity of food insecurity within a country's population, providing valuable insights for policy interventions (Ballard et al., 2011). The prevalence of undernourishment is a widely used indicator by the FAO that estimates the percentage of a country's population with insufficient energy intake (FAO et al., 2023). The GFSI, assesses national food security based on affordability, availability, quality and safety (Kumareswaran & Jayasinghe, 2022). National governments also monitor malnutrition rates to track nutritional outcomes and food access disparities within their populations (Swindale & Bilinsky, 2006).

### 2.3.3 Household food security

Household food security refers to the ability of a household to consistently access sufficient, safe and nutritious food to meet the dietary needs and preferences of all its members for an active and healthy life (FAO et al., 2023). While national food security ensures a stable food supply at a country level, household food security focuses on the distribution and accessibility of food within families and communities (FAO et al., 2023). This level of food security of a household is influenced by physical, economic and social accessibility as mentioned. Households experience food insecurity when they lack the ability to obtain adequate food, leading to issues such as hunger,

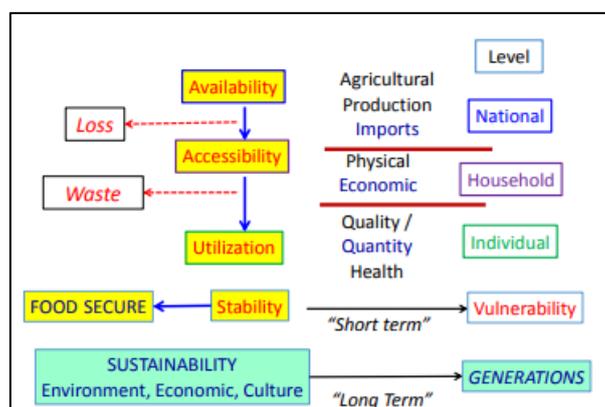
malnutrition and poor health outcomes (WHO & UNICEF, 2021). Household food security will be explored in-dept further on in this chapter (Section 2.6).

### 2.3.4 Individual food security

Individual food security refers to a person’s ability to access, afford and consume sufficient, safe, and nutritious food to meet their dietary needs and preferences for an active and healthy life (FAO et al., 2023). While household food security ensures food availability and access at the family level, individual food security focuses on how food is distributed among household members and whether each person receives adequate nutrition, based on their specific needs (FAO, IFAD, et al., 2022). Factors such as age, gender, health status and socioeconomic conditions influence individual food security (FAO et al., 2023).

## 2.4 Pathways of food security

As contextualized, food security, operates across multiple dimensions and levels: availability is primarily a national concern, accessibility is centred at the household level, utilisation pertains to the individual, and stability acts as a time-based dimension that influences all these levels. Figure 2.3 illustrates the pathway of the dimensions of food security as well as the level within each function.



**Figure 2.3: The pathway of the dimensions of food security** (Peng & Berry, 2019)

Peng and Berry (2019) argues that food security is more accurately understood as a dynamic, interconnected pathway, from food production (national), through distribution

and processing to eventual consumption (household/individual), rather than as four isolated “pillars”. While the 2009 World Summit on Food Security introduced the widely used framework of the “four pillars” of food security, this pillar analogy may misrepresent the complexity of the concept. It implies that the four dimensions are independent and equally weighted, which oversimplifies their inherently interdependent and context-specific nature. Their significance varies by context. For example, developing countries may face physical access issues due to poor infrastructure, while economic barriers are more prominent in developed nations. After natural disasters, all dimensions can be disrupted, but not necessarily equally.

The illustrated pathway traces a logical and causal sequence: from food production (availability) to household-level access (accessibility), and down to individual nutrition and health outcomes (utilisation). At household level food accessibility is multifaceted, encompassing physical access (infrastructure and transport), economic access (purchasing power), and socio-cultural factors including food preferences and norms. These, in turn, influence health outcomes and highlight the importance of social protection systems (Peng & Berry, 2019). The concept of stability introduces a temporal dimension, emphasizing the need for consistent access to food over time.

Furthermore, food security should not be viewed as a one-way progression. It can also be circular in nature, where improved utilisation, through better nutrition, enhances human capital and productivity, which in turn positively affects food availability through increased production capacity (Peng & Berry, 2019). This feedback loop reinforces the interconnected nature of the dimensions and underlines the need for a holistic and flexible understanding of food security across varying contexts.

## **2.5 Factors affecting household food insecurity**

### **2.5.1 Poverty**

Households in low-income, poverty stricken settings are particularly vulnerable to food insecurity, as they may face financial constraints that limit their food purchasing power (FAO, IFAD, et al., 2022). Poverty is often characterized by a lack of access to adequate income, employment, housing, education and healthcare (Potts & Bowyer-

Bower, 2014). In households experiencing poverty, limited financial resources frequently force individuals to choose between essential needs, such as housing, utilities and food, leading to both insufficient quantity and poor quality of dietary intake (Grobler, 2016).

Poverty is a fundamental factor underlying many aspects of food security. Absolute poverty occurs when an individual cannot adequately meet basic needs such as food, healthcare, clean water, shelter, education and participation in community life (Grobler, 2016). Food insecurity is deeply intertwined with poverty, forming a vicious cycle in which each reinforces the other. Hunger perpetuates poverty by hindering individuals from reaching their full potential and contributing to societal development (Mbajjorgu & Odeku, 2022). Poverty often leads to increased malnutrition, especially among children, where the effects are widespread and persistent (Mkhize & Sibanda, 2020). It increases vulnerability to illness, weakens the body, and diminishes the capacity to work and support dependents. Poor households lack the resources necessary to attain food security, provide adequate care, or access and assist essential health services. This destructive cycle often repeats across generations and will persist unless decisive action is taken to break it. In addition to poverty, factors such as unemployment, inflation and rising food prices further exacerbate household food insecurity in these households, making it difficult for families to afford nutritious diets (Mbajjorgu & Odeku, 2022).

In South Africa, many households struggle to meet the essential components of a food-secure environment due to poor socioeconomic conditions (Wekeza & Sibanda, 2019). Limited financial resources reduce the ability of households to access, afford, or prioritize nutritious food options. Income, therefore, emerges as a determinant of food security. Studies have indicated that a positive correlation exists between income levels and food preferences as well as the consumption of healthy foods (De Marco & Thorburn, 2009; Wekeza & Sibanda, 2019).

### 2.5.2 Socioeconomic classification of geographical location

Low-income settings/areas are settlements situated on the urban periphery, where urban and rural features coexist, and where residents, typically poor or economically

marginalized, face limited access to formal infrastructure, employment opportunities, housing, and essential services such as water, sanitation, healthcare and education (Mgidlana, Mbanga & Hamunakwadi, 2025). In these settings, poverty often manifests as job instability and inflated living costs, while in rural areas, it may be linked to limited agricultural productivity, climate vulnerability and infrastructural deficits. Research suggests that food insecurity is particularly prevalent in low-income areas, where demographic pressures and economic constraints from rapid urbanization exacerbate the problem (Potts & Bowyer-Bower, 2014). Urban food insecurity is often "hidden". Households may appear to have better physical access to food but still struggle to afford it due to high living costs and unstable income streams (Maxwell & Frankenberger, 2000). Food availability, as in these areas, alone does not guarantee food security. Many poor households may lack the financial means or productive assets needed to access adequate food, even if it is available in the market (Grobler, 2016). In South Africa, despite economic growth, income inequality is present, and households already in poverty sink deeper. Many of these households reported that food was the first area of expenditure they had to cut, leading to adverse nutritional and health outcomes (Nontu, Mdoda, Dumisa, Mujuru, Ndwandwe, Gidi & Xaba, 2024).

In low-income settings, food access is often limited, both in terms of quantity and quality. These communities frequently face restricted access to fresh fruits, vegetables and other nutrient-rich foods (Lujabe, Pretorius, Goliath & Sibanda, 2022). Low-income neighbourhoods may have fewer grocery stores, and those that do exist may offer a limited selection of fresh, healthy foods at higher prices than in wealthier areas (Jadeja & Sharma, 2022). Instead, residents rely on convenience stores and fast-food outlets, which predominantly offer inexpensive, energy-dense and nutrient-poor foods. As a result, even when food is available, it may not provide the necessary nutrients for a healthy and balanced diet, contributing to household food insecurity (FAO et al., 2023).

Additionally, food insecurity is not solely an issue of food access but also of food utilisation, households must have the knowledge and resources to store, prepare and consume food safely (Swindale & Bilinsky, 2006). These resources are limited in low-income settings. In these settings, education level often affects food choices, dietary

diversity and overall access to nutritious foods. Studies have shown that households with higher levels of education, particularly in the area of nutrition, tend to make better-informed food choices, which are associated with improved food security outcomes (Hoddinott & Yohannes, 2002). Education contributes to a better understanding of nutrition, meal planning and food preparation, which directly impacts the quality and quantity of food consumed in the household (Coates et al., 2003). In low-income settings, the lack of education exacerbates poor food choices, often resulting in diets that are heavily reliant on low-cost, energy-dense and nutrient-poor foods (Coates et al., 2003). Limited knowledge of healthy eating patterns may lead to the consumption of cheaper, processed foods, which are high in unhealthy fats, sugar and salt, but low in essential vitamins and minerals. Such diets contribute to malnutrition, food insecurity and a high prevalence of diet-related diseases (Nengovhela, Belete, Hlongwane & Oluwatayo, 2022).

Households in low income settings, experiencing food insecurity, often adopt coping strategies to manage food shortages, such as reducing meal portions, prioritizing food for children, or relying on less nutritious and cheaper food options (FAO et al., 2023). In severe cases, families may skip meals, rely on food assistance programmes, or engage in distress selling of assets to afford food (FAO et al., 2023). Women and children are disproportionately affected by household food insecurity, as they often have lower economic opportunities and are more vulnerable to malnutrition (FAO, IFAD, et al., 2022).

### 2.5.3 Large scale disasters

The impact of the COVID-19 pandemic, used as an example of a large-scale disaster, has shocked the global and national food systems. The food supply and demand channels, which indicated a decrease in food stock and a rise in food prices, were directly affected by the pandemic (Mukiibi, 2020). COVID-19 prevention measures such as lockdown, stay-at-home order, mass quarantine and a transport halt, were highly challenging for all societies. The global COVID-19 pandemic and social distancing efforts implemented to slow its spread, disrupted economies and food systems globally and locally, with extensive food security ramifications. Sub-Saharan Africa was severely affected, particularly the agriculture sector, as in many countries

the pandemic occurred during the planting seasons of staple foods (Ayanlade & Radeny, 2020). Most affected were social and economic aspects in sub-Saharan Africa, as the pandemic came at a time when countries were already struggling with food insecurity (Mukiibi, 2020).

The disruption of food systems globally, had profound implications on food security, particularly in low- and middle-income countries like South Africa. The pandemic exacerbated existing inequalities and vulnerabilities within the food system, leading to a substantial increase in food insecurity at both national and household levels. South Africa, which already had a high prevalence of food insecurity, saw an alarming surge in hunger due to the socioeconomic impacts of lockdowns, job losses and disruptions in food supply chains (Langry & Rena, 2023). At the national level, the pandemic disrupted food supply chains, limiting the availability of key food products. Lockdowns and restrictions on movement hampered the transportation of food, and the closure of borders restricted food imports. Agricultural production was impacted as farm workers faced difficulties accessing fields, and some agricultural inputs became unavailable due to global trade disruptions (Langry & Rena, 2023). This resulted in price increases for staple foods such as maize and wheat, further impacting on food insecurity in vulnerable communities.

At the household level, the economic ramifications of the pandemic were devastating. With South Africa experiencing one of its worst economic recessions, unemployment surged to over 30% in 2020, and household incomes declined, leaving millions unable to afford sufficient food (StatsSA, 2020). Research conducted during the pandemic found that food insecurity in South African households increased sharply, with many families going without meals or reducing portion sizes to cope with the financial strain (Van den Berg and Walsh, 2023). The pandemic highlighted stark inequalities in South Africa's food system, as low-income households and informal workers were disproportionately affected. In urban areas, many informal food traders were forced to close due to lockdown restrictions, limiting both the income of traders and the access to affordable food for low-income households (Nevhutalu, Mayekiso & Gidi, 2023). Rural areas, on the other hand, experienced challenges related to physical access to food due to disrupted transport networks, further compounding food insecurity in these regions.

The widespread unemployment and loss of income during the pandemic affected the overall purchasing power of consumers and exacerbating underlying socio-economic inequalities especially in low-income settings. Already, poor households spend a large proportion of their income on the food they consume, meaning that households have had less income to secure food. A significant portion of the population, particularly the urban poor, engaged in manual labour and the informal sector, experienced substantial income loss during the reported period, as highlighted by Mukiibi (2020). De Groot and Lemanski, (2021) on the other hand emphasized that the informal food sector, vital for sustaining the urban poor, faced greater disruptions compared to formal traders, underscoring the glaring inequality where wealthier households remained relatively unaffected while the urban poor bore the brunt of these economic challenges.

A national survey conducted in May 2020 revealed that nearly half of South African households ran out of money to buy food during the lockdown, while one in five households reported experiencing hunger (StatsSA, 2020). Women and children were particularly vulnerable, with increased rates of malnutrition observed in children under the age of five (FAO et al., 2021). This underscores the long-term impact of the pandemic on nutrition security, which could have lasting effects on public health and human capital development.

In response to the escalating food crisis, the South African government implemented a series of social relief measures. The introduction of the COVID-19 Social Relief of Distress (SRD) grant provided temporary income support to unemployed individuals, helping to mitigate the economic impact on vulnerable households (Megannon, 2022). Additionally, food parcels and feeding schemes were rolled out in communities experiencing severe food shortages. However, despite these efforts, many households did not benefit due to issues with the distribution of relief and the inadequacy of support in relation to the scale of need (Megannon, 2022). Kajiita and Kang'ethe (2024) report widespread issues, including delays, exclusion errors and corruption, with ineligible individuals accessing funds while many qualifying applicants were left out. Inefficiencies and mal-administration within South African Social Security Agency, which, along with corruption, undermined the grant's effectiveness, particularly for vulnerable groups (Megannon, 2022). Civil society organizations played a crucial role

in addressing food insecurity during the pandemic by distributing food aid and advocating for more comprehensive government support. However, their efforts were often constrained by limited resources and logistical challenges (Megannon, 2022).

The pandemic revealed significant gaps in South Africa's social protection system, underscoring the need for more robust and inclusive safety nets to protect against future shocks. While government relief efforts provided some assistance, the scale of the crisis highlighted the need for long-term strategies to improve food security and strengthen resilience against future shocks. Food security measurement tools, such as household food security indices, offer a rapid and effective means of assessing food security conditions during large-scale disasters. These instruments could provide timely data to inform and guide relief strategies implemented by government and civil society organizations.

## **2.6 Assessment indicators of household food security**

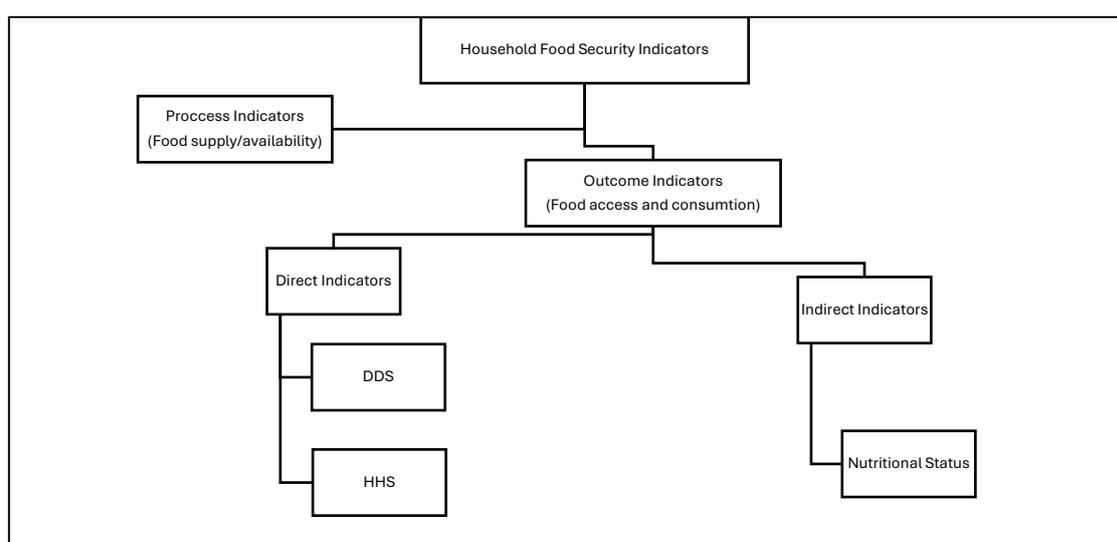
Extensive research during the late 1980s aimed to better understand the concepts of household food security, food insecurity and hunger. This work culminated in the development of widely accepted conceptual definitions by an expert working group from the American Institute of Nutrition (Bickel, Nord, Price, Hamilton & Cook, 2000), later published in 1990 by the Life Sciences Research Office of the Federation of American Societies for Experimental Biology:

- Food security is defined as *"access by all people at all times to enough food for an active, healthy life."* This includes, at a minimum: the consistent availability of nutritionally adequate and safe foods, and the ability to obtain such food in socially acceptable ways (i.e., without relying on emergency food supplies, scavenging, stealing, or other coping mechanisms).
- Food insecurity refers to the *"limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire/access acceptable foods in socially acceptable ways."*
- Hunger is described as *"the uneasy or painful sensation caused by a lack of food,"* and more specifically, *"the recurrent and involuntary lack of access to*

food." Over time, hunger can lead to malnutrition, and while it is often a result of food insecurity, it is not a necessary outcome in every case.

Addressing household food insecurity requires first assessing its extent and underlying causes, tailored to the specific population and context. Accurate measurement and ongoing monitoring are essential for designing effective policies and evaluating existing programmes (Bickel et al., 2000).

Maxwell and Frankenberger (2000) classifies household food security indicators into two main categories: process indicators related to food supply/availability and outcome indicators related to food access and consumption. Process indicators include factors like agricultural production, market access, and institutional capacity, varying across regions, gender, and social classes. These factors lie beyond the direct control of individual households and are instead conditions that households experience or are subjected to (Peng & Berry, 2019). Outcome indicators as developed and illustrated in Figure 2.4 below, are closely linked to household food access and consumption, which relates to food utilisation. Unlike process indicators, these outcomes are largely within the sphere of influence and control of individual households. The outcome indicators are further divided into direct indicators which are closely related to actual food access and consumption and include measurements such as DDS and HHS and indirect indicators such as NS.



**Figure 2.4: Household food security indicator categories**

As the concept of household food security evolved, there has been a growing shift from focusing solely on monitoring process indicators (food supply and availability) to emphasizing outcome indicators (food access and utilisation) (Downs et al., 2025). In addition, Mulasi-Pokhriyal and Smith (2013) argue for collecting quantitative food data, such as measurements in metric units, to enable the computation of key household food security indicators, rather than relying solely on subjective or perception-based measures.

### 2.6.1 Direct outcome indicators

Food consumption, through indicators such as dietary diversity and household hunger, is a critical direct outcome indicator of household food security, as it directly measures dietary quality (Bashir & Schilizzi, 2012). Common methods for collecting this data include 1-day, 7-day and 30-day recalls, food frequency questionnaires and food records. While recall-based methods rely on memory, food records may offer more accuracy through real-time logging (Bashir & Schilizzi, 2012).

#### *2.6.1.1 Household Dietary Diversity Score*

Dietary diversity refers to the variety of foods or food groups consumed over a specific period (Kennedy et al., 2011). It is widely regarded as a key indicator of diet quality, as consuming a range of food groups helps ensure adequate intake of essential nutrients, thereby supporting overall health (Leroy et al., 2015). Hoddinott and Yohannes (2002), in a study for International Food Policy Research Institute, highlighted dietary diversity as a valuable alternative indicator of food security. Defined as the number of unique foods or food groups consumed over a given period, dietary diversity was traditionally used to assess nutrient adequacy rather than food security. Their multi-country analysis showed strong correlations: a 1% increase in dietary diversity was linked to a 1% rise in per capita food consumption (a proxy for income), a 0.7% increase in total energy availability, 1.4% from non-staples, and 0.5% from staples, suggesting dietary diversity is a strong procurator for food security. Ruel (2003) also supported its use but emphasized the need to refine the indicator. Key areas include proper food grouping,

accounting for portion sizes and frequency, and setting appropriate scoring methods and reference periods to enhance reliability and validity.

The HDDS, which was originally designed to track changes in household access to both the quality and quantity of food, is a tool specifically focused on the household level. It also serves to assess the effectiveness of food-related interventions and programmes. The reliability of the HDDS indicator, as developed by the Food and Nutrition Technical Assistance project, lies in its initial validation through its correlation with household per capita energy consumption. This consumption metric, used as a substitute for assessing access to adequate food, includes both staples and non-staples and served as a benchmark in early evaluations of the HDDS (Leroy et al., 2015).

The HDDS tool was developed to offer a practical, alternative measure of household access to food (Kennedy et al., 2011). The HDDS questionnaire collects data on the consumption of twelve distinct food groups within the previous 24 hours. During interviews, the respondent should be the individual primarily responsible/knowledgeable on meal preparation in the household, as they are best positioned to recall all meals, snacks and beverages consumed by each household member. The FAO defines twelve food groups, namely: (1) cereals, (2) white tubers and roots, (3) vegetables, (4) fruits, (5) meat, (6) eggs, (7) fish and seafood, (8) legumes, nuts, and seeds, (9) milk and milk products, (10) oils and fats, (11) sweets, and (12) spices, condiments, and beverages.

According to FAO, (2018), the HDDS provides insight into the variety of food groups consumed by a household within the past 24 hours. Based on the FAO classification for Africa, the HDDS ranges from zero, indicating the lowest level of dietary diversity, to twelve, which signifies the consumption of food items from all twelve recognized food groups. An increase in the number of food groups consumed reflects an improvement in household access to food and is often interpreted as an enhancement in food security and overall diet quality (FAO, 2018). The HDDS is closely tied to the access dimension of household food security and cover the components of quality and quantity of food consumed, as households with higher dietary diversity are more likely to meet their nutritional needs (Vellema, Desiere & D'Haese, 2016). A diverse diet

ensures that households consume an array of essential nutrients, which are crucial for maintaining health and preventing malnutrition (Beal, Manohar, Miachon & Fanzo, 2024).

The HDDS was designed to capture the access dimension of food security, with a focus on time sensitivity, objectivity and ease of implementation. It offers a quick and relatively simple method for data collection and analysis, making it a valuable alternative indicator for food security assessments. Its usefulness stems from several key points (FAO, 2018) i.e.:

1. A more diverse diet is, a positive nutritional outcome;
2. greater dietary diversity has been linked to improved health outcomes, such as better anthropometric status and higher birth weights;
3. it can help detect “hidden hunger,” which is the result of micronutrient deficiencies that are not easily observed.

One of the major advantages of dietary diversity tools like the HDDS is their computational simplicity, especially when combined with low-cost, rapid data collection methods described as “user-friendly and easily administered” (Cafiero, Melgar-Quiñonez, Ballard & Kepple, 2014). However, this simplicity may come at the cost of precision. Errors may arise from the misclassification of food items into inappropriate food groups, leading to artificial fluctuations in diversity scores. To reduce such errors and enhance reliability, it is essential to adapt food group classifications to the specific dietary context and food availability of the area being assessed.

Although HDDS cannot serve as a fully comprehensive measure of food security, it offers a meaningful approximation of household energy consumption. When interpreted alongside other food security-related data, the HDDS contributes to a more complete understanding of a household’s NS and access to a diverse diet (Cafiero et al., 2014). Furthermore, the HDDS helps identify households at risk of poor nutrition, especially in settings where food insecurity and poverty limit access to diverse food options. By capturing household-level dietary behaviours, the HDDS could also reflect broader socio-economic and food security dynamics. However, to ensure relevant data are collected using this method, it should be tailored to the cultural setting for which it is used.

### 2.6.1.2 Household Hunger Scale

The HHS is a tool designed to measure household-level food deprivation, particularly in contexts experiencing significant food insecurity (Ballard et al., 2011). It was developed through efforts to adapt the U.S. Household Food Security Survey Module for application in developing countries and to evaluate the cross-cultural validity of the HFIAS. The foundation of the HHS lies in the recognition that food deprivation within households leads to common, observable experiences. These experiences can be systematically captured through a standardized survey and translated into a reliable scale.

Respondents are asked the following three questions referring to the previous 30 days:

1. Was there ever no food at all in your house due to lack of resources?
2. Did any household member go to bed hungry because there was not enough food?
3. Did any household member go a whole day and night without eating?

In the HHS, each affirmative ("Yes") response is followed by a question assessing the frequency of the experience, scored as follows: 0 for "No", 1 for occurrences that were "Rarely" (1–2 times) or "Sometimes" (3–10 times), and 2 for those that occurred "Often" (more than 10 times). The scores are then summed to yield a total ranging from zero to six. Based on this total score, households are categorized into three levels of hunger severity: a score of 0–1 indicates "little to no hunger", 2–3 reflects "moderate hunger", and 4–6 represents "severe hunger".

The HHS stands out from other household food insecurity indicators due to its specific development and validation for cross-cultural applicability (Ballard et al., 2011). This unique feature ensures that the HHS generates valid, consistent and comparable results across diverse cultural and geographical contexts. As a result, it enables meaningful comparisons between different population groups, facilitating the identification of areas where resources and targeted interventions are most needed. Furthermore, the cross-cultural validity of the HHS enhances its usefulness in the

design, implementation, monitoring and evaluation of food security policies and programmes at both national and international levels.

The HHS is especially well-suited for use in regions with high levels of food insecurity. In such settings, the scale serves multiple purposes, including (Maxwell, Vaitla & Coates, 2014):

- Tracking hunger trends over time and across countries or regions, supporting the monitoring of international development goals;
- assessing food security conditions at the national, regional and community level to inform evidence-based policymaking and programme development aimed at reducing hunger;
- evaluating the effectiveness of hunger-related interventions, including those implemented across different cultures and communities;
- providing early warning information for nutrition and food security surveillance systems;
- supporting standardized humanitarian and food security phase classifications.

To ensure the validity and reliability of the data collected, it is essential that the complete set of HHS questions be administered. A flaw of this method, is that households may deliberately distort their response in order to gain developmental assistance (Ballard et al., 2011). It is important to highlight that the HHS specifically addresses the quantity aspect of food access, whether households have enough food to eat, it does not measure the quality or nutritional adequacy of the diet (Ballard et al., 2011).

Furthermore, because it is a household-level indicator, it does not capture other components of food security such as national-level food availability or individual-level utilisation (e.g., dietary intake, absorption, or nutritional outcomes). Ideally, the HHS should not be used as a standalone measure of food insecurity (Maxwell et al., 2014). Instead, it should be integrated as part of a broader set of tools that collectively assess the various dimensions of food insecurity. A comprehensive household food insecurity assessment toolkit may include additional components such as anthropometric measurements of women or children, data on household income, expenditure, food production and consumption, coping mechanisms, or household/individual dietary

diversity indicators, depending on what the goal of the measure is. Together, these measures provide a more holistic and accurate picture of food security status (FAO et al., 2023).

## 2.6.2 Indirect outcome indicators

Food security can also be assessed through indirect indicators, which reflect the underlying factors that influence a household's ability to access adequate food. NS (especially anthropometry) is often used as an indirect indicator of household food security, as it reflects the long-term outcomes of food access, dietary quality, and health status (De Onis, 2007). Commonly assessed through anthropometric measurements, such as height-for-age (stunting), weight-for-age (wasting), and BMI-for-age (underweight), NS provides insight into the adequacy and consistency of nutrient intake over time (WHO, 2008). Data are typically collected through national health surveys or growth monitoring programmes. While not a direct measure of food consumption, poor NS in vulnerable groups, especially children under five, often signals chronic food insecurity and underlying socio-economic and health-related challenges.

### *2.6.2.1 Nutritional Status*

Anthropometric measurements, which involve standardized physical assessments of the human body, are widely used to evaluate NS and serve as indirect outcome indicators of food insecurity. They provide essential insights into health, growth, and survival (Azupogo, Abizari, Aurino, Gelli, Osendarp, Bras, Feskens & Brouwer, 2022). The WHO developed growth curves for school-age children and adolescents to align with its child growth standards, with interpretation based on sex- and age-specific z-scores (WHO, 2008; Turck et al., 2013). These scores enable standardized comparisons against reference populations considered to represent optimal health and development.

As proxies for food consumption, anthropometric indicators are valued for their simplicity, affordability, and precision. NS itself reflects the condition of the body in

relation to dietary intake, absorption, and physiological needs (FAO, 2008). It is shaped by food availability, access, utilisation, and stability (Abbade, 2017), and captures the long-term interactions between diet, health, and environmental conditions. Evidence consistently highlights the importance of NS for assessing the effectiveness of food utilisation, particularly in low-income settings (Bhutta, Akseer, Keats, Vaivada, Baker, Horton, Katz, Menon, Piwoz, Shekar, Victora & Black, 2020).

In practice, anthropometric data are commonly collected in nutrition surveys, including weight-for-age and weight-for-height in children under five, BMI in adults, and less reliable adolescent measures due to pubertal variability (Heidari-Beni et al., 2021). Under-nourishment is typically defined by values falling below international standards, while stunting provides a robust marker of chronic food insecurity, offering insights into the stability of access to adequate food. Nonetheless, anthropometric indicators are influenced by non-food factors such as caregiving, hygiene, and disease burden, and in some cases (e.g., stunting) may reflect historical rather than current insecurity (Mkhize & Sibanda, 2020).

The relevance of anthropometric indicators is heightened in developing countries, where populations experience the triple burden of malnutrition i.e. undernutrition, overnutrition, and micronutrient deficiencies (Mkhize & Sibanda, 2020; Manikas, Ali & Sundarakani, 2023). These overlapping conditions, increasingly prevalent among low-income groups, underscore the importance of NS as both a health outcome and a marker of food system performance. As such, anthropometry provides valuable evidence for evaluating the equity and effectiveness of food security interventions, informing policies and targeted responses such as dietary support, supplementation, and nutrition education (FAO et al., 2023).

Although anthropometric indicators primarily capture longer-term or chronic forms of food insecurity and rely on accurate age data for reliability, they remain widely regarded as robust, objective measures. Compared to socio-economic or experiential indicators, they are less subjective and allow for meaningful data disaggregation across populations. This makes them an indispensable tool in both academic research and applied interventions aimed at strengthening food security monitoring and policy.

## **2.7 Conceptual framework for household food security index (HFSI)**

This study is underpinned by a multidimensional conceptual systems framework of household food security that integrates the dynamic pathway model of food security dimensions, Maslow's hierarchy of needs, and a multi-level ecological perspective. See Figure 2.2. Food security is conceptualised as a progression from national food availability to household food access and individual food utilisation, moderated by stability, agency and sustainability. These dimensions operate within broader structural determinants including poverty, socioeconomic inequality and large-scale shocks. The framework positions household food security as an outcome of interacting macro-, meso- and micro-level processes and provides the conceptual basis for constructing the HFSI, which integrates dietary diversity, hunger severity and nutritional status, validated through expert consensus using the Delphi technique.

### 2.7.1 Global food systems

At the structural and macro level, household food security is situated within the broader global food system, which encompasses interconnected economic, environmental and political processes that shape national food environments. Global food systems are influenced by climate change, pandemics, economic shocks, conflict, trade policies and political stability, all of which directly affect food production, distribution and market functioning (FAO, 2008; FAO, IFAD, et al., 2022). Climate variability and extreme weather events disrupt agricultural productivity and supply chains, while pandemics and geopolitical conflicts destabilize labour markets, trade routes and commodity prices. Economic shocks and inflation alter purchasing power and food affordability, particularly in low- and middle-income countries. Trade policies and political governance further regulate food imports, exports and national stock management. Collectively, these macro-level forces primarily influence the availability of food within countries and the stability of food systems over time. Although households do not control these structural determinants, they are profoundly affected by them, particularly in contexts characterised by vulnerability and inequality. This level therefore establishes the exogenous conditions within which national and household food security processes operate (Ericksen et al., 2011; FAO, IFAD, et al., 2022).

### 2.7.2 Food security dimensions – national and household food security

The conceptualisation of the dimension of food security is as a dynamic and interconnected pathway operates primarily at national and household levels. This pathway begins with food availability, referring to national food production, imports, exports and stock levels that determine the overall food supply within a country. However, availability alone does not ensure food security. It must translate into food access at the household level, encompassing economic access (income and purchasing power), physical access (infrastructure and market proximity) and social access (cultural acceptability and equity). Access, in turn, influences food utilisation at the individual level, which reflects the biological and socio-economic capacity to consume, absorb and metabolise nutrients effectively. Food utilisation ultimately manifests in nutritional status and health outcomes, including anthropometric indicators and micronutrient adequacy.

Surrounding and moderating these three core dimensions are stability, agency and sustainability. Stability introduces a temporal component, emphasising resilience against shocks and the consistency of availability, access and utilisation over time. Agency refers to the capacity of individuals and households to make autonomous decisions regarding food acquisition, production and consumption, reflecting empowerment and participation in food systems. Sustainability incorporates environmental, economic and social durability, ensuring that food security can be maintained across generations. Importantly, this pathway is not linear but cyclical. Improved food utilisation enhances human capital through better health and cognitive functioning, which increases productivity and economic participation, thereby strengthening food availability at national and household levels. This feedback loop underscores the systems-based and mutually reinforcing nature of food security (Peng & Berry, 2019).

### 2.7.3 Household contextual vulnerability – socioeconomic context

The level situates the dynamic food security pathway within the specific household socioeconomic context, particularly within low-income areas such as NMB. Household food security is significantly shaped by poverty, unemployment, income instability,

urban–rural inequalities, food environment characteristics, education levels and gender dynamics (Grobler, 2016; Potts & Bowyer-Bower, 2016; FAO, IFAD, et al., 2022). Poverty and unemployment constrain purchasing power, limiting economic access to adequate and diverse food. Urban–rural disparities influence both physical access to markets and exposure to food price volatility. The local food environment, including the availability of fresh produce versus energy-dense processed foods, shapes dietary choices and nutritional quality (Jadeja & Sharma, 2022). Education, particularly nutrition literacy, affects food preparation practices and dietary decision-making, while gender dynamics influence intra-household food allocation and caregiving roles (Coates et al., 2003; FAO et al., 2023).

This contextual layer primarily modifies the access and utilisation dimensions of food security. Even where food is nationally available, socioeconomic vulnerability can prevent households from translating availability into adequate dietary intake and nutritional well-being. Thus, household food insecurity is not solely a function of national supply constraints but is deeply embedded within structural inequalities and localised socioeconomic conditions.

#### 2.7.4 Maslow’s Hierarchy

Maslow’s hierarchy of needs is integrated within the framework to provide a motivational and human development perspective on food security. At the base of the hierarchy, physiological needs correspond directly to food availability, access and utilisation, as adequate and nutritious food is fundamental for survival and biological functioning. The second tier, safety, aligns with the stability dimension of food security, emphasising the importance of reliable and secure access to food over time. Without stability, households remain in a state of vulnerability and uncertainty, inhibiting broader developmental progress (Ericksen et al., 2011).

The belonging dimension reflects the social and cultural aspects of food access, including the ability to participate in shared meals and consume culturally appropriate foods. Esteem relates to dignified access to food, free from stigma, shame or reliance on distress coping strategies. Finally, self-actualisation is enabled when households are food secure, allowing individuals to pursue education, productive employment and

personal development (Al Maamari, 2025). The integration of Maslow's theory demonstrates that food security is not merely a nutritional or economic issue but a foundational prerequisite for broader human development and societal participation. Food security thus underpins the progression from survival to self-realisation.

#### 2.7.5 Household Food Security Index (HFSI)

The final level operationalises the conceptual framework through the construction of the HFSI. The HFSI is designed to capture household food security as a multidimensional outcome, integrating both direct and contextual indicators. Direct outcome indicators include the HDDS, which measures dietary variety as a proxy for food access and quality; the HHS, which captures the severity of food deprivation; and anthropometric measures reflecting nutritional status. These indicators collectively assess the realised outcomes of availability, access and utilisation within the household.

Indirect or contextual indicators, such as household income, education and coping strategies, provide additional explanatory depth and reflect structural vulnerabilities influencing food security status. To ensure contextual relevance, methodological rigour and appropriate weighting of indicators, the index is validated using the Delphi technique. This structured expert consensus approach allows for the systematic integration of professional judgement, enhancing the reliability, validity and applicability of the HFSI within low-income South African settings. Through this measurement framework, the conceptual framework is translated into a practical and empirically grounded tool for assessing household food security.

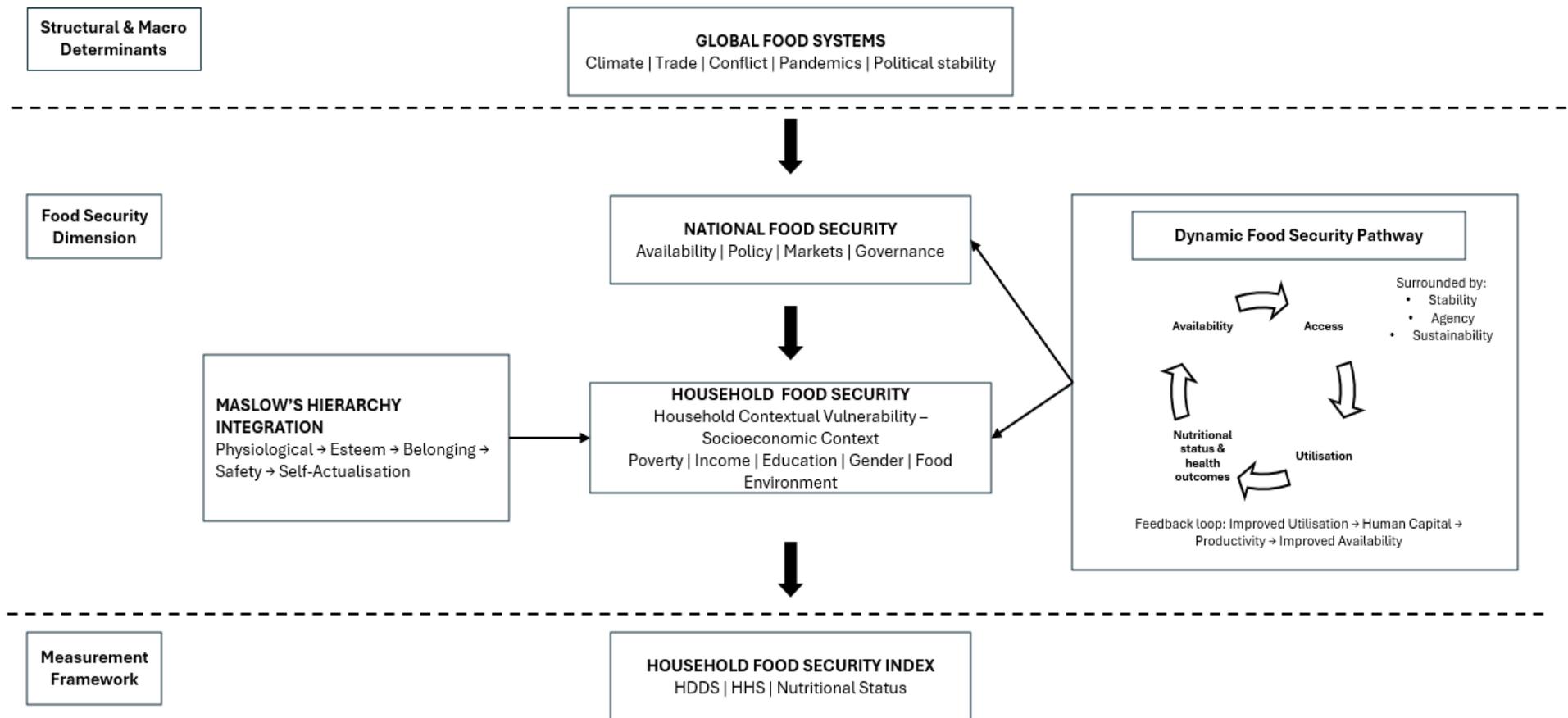


Figure 2.5: Conceptual framework for household food security index (HFSI)

## **2.8 The need for a comprehensive HFSI in South Africa**

Identifying food-insecure households remains a major challenge within South Africa's healthcare system, particularly at the primary care level. While significant progress has been made in food security research, several shortcomings persist. Many studies focus on quantitative assessments of food security without incorporating qualitative dimensions such as food preferences and cultural acceptability (Hendriks et al., 2016). Additionally, regional disparities in food security measurement highlight the need for more localized studies that consider socio-economic and environmental factors. The reliance on national-level data often masks regional household food distribution inequalities (Ramkissoon, 2018). The lack of a standardized measuring method also hinders comparisons across research initiatives, emphasizing the need for a consistent approach (Ramkissoon, 2018).

Moreover, there is limited longitudinal data tracking the impact of food security interventions over time. The development of a standardized regional food security index, incorporating indicators such as dietary diversity, food access and nutritional health status, could guide policy responses and resource allocation. Despite the recognition of food insecurity as a critical public health issue, there is currently limited standardized protocol or national policy guiding healthcare workers to screen for or respond to household food insecurity in clinical settings (De Villiers, Cerbone & Van Zijl, 2020). This absence severely limits the ability of local health practitioners to intervene early or provide referrals to social support systems, exacerbating the cycle of malnutrition, poor health outcomes and poverty. Although national surveys such as the GHS and the National Income Dynamics Study provide valuable macro-level insights, they are not designed for routine use in clinics or community health programmes (StatsSA, 2022).

This gap is further underscored by results from the 2022 Healthy Active Kids South Africa Report Card, which highlighted persistent challenges in nutritional status and body composition among children, alongside limited nationally representative surveillance data, reinforcing the need for integrated, routine monitoring tools that can be applied at community and primary healthcare levels (Nyawose, Naidoo, Christie, Bassett, Coetzee, Van Gent, Monyeki, Gradidge, Janse Van Rensburg, Cozett, Young,

Slemming, Morrow, Pienaar, Krog, Walter, Kholvadia, De Milander, Naidoo & Lambert, 2024).

In response, this study proposes the development of a comprehensive formative HFSI, tailored for low-income communities in NMB, EC, South Africa. The proposed index integrates both direct and indirect outcome indicators to reflect the complex nature of household food security in the local context. Formative models have been effectively used in prior food security research. For instance, Feleke, Francis, Alene, Abdoulaye, Wossen, Tufa and Manyong (2019) constructed a multidimensional food security index using a formative approach, arguing that food security emerges from the combination of diverse variables such as food access, nutrition outcomes, and socioeconomic conditions which is context specific. Similarly, Grimaccia (2022) demonstrated that a formative index approach yielded more culturally and contextually valid interpretations of food security compared to reflective models. Further, in the domain of social indicators research, Lauro, Grassia and Cataldo (2018) emphasized that formative constructs are necessary when dealing with composite indicators of wellbeing, development, or deprivation, categories to which food security arguably belongs.

Given the multidimensional nature of food security, a locally adapted HFSI could provide a more streamlined and practical mechanism to assess food insecurity at the household level in clinical and community settings. Such an index would enable healthcare professionals to screen for food insecurity during routine visits, improving early detection and targeted interventions, particularly among vulnerable groups such as pregnant women, children, and people living with chronic diseases (Govender, Pillay, Siwela, Modi & Mabhaudhi, 2016; Mkhize & Sibanda, 2020).

Furthermore, integrating a HFSI into existing health information systems would allow for more evidence-based planning and policy formulation, supporting South Africa's broader goals of achieving SDG two and the National Development Plan's (NDP) nutrition targets (National Planning Commission, 2012). The development and implementation of a validated, evidence-based HFSI could bridge the current divide between health services and food security interventions, ensuring that food-insecure households are identified, supported and tracked more effectively within the healthcare system.

## 2.9 Food security measurement in South Africa

Measurement tools past and current, typically involve recall data over the past day, week, or month at the individual or household level as well as anthropometrical measurements. Such tools include the FIES, HFIAS and the HHS and complemented by dietary diversity scores like the HDDS, which reflects the quality and variety of diets. In addition, some methodologies utilize anthropometric indicators such as stunting, wasting, underweight, overweight, obesity and BMI, disaggregated by demographic and socioeconomic factors. The combination of these measurements offer insight into both subjective experiences and objective nutritional indicators (Labadarios, Steyn, Maunder, MacIntyre, Gericke, Swart, Huskisson, Dannhauser, Vorster, Nesmvuni & Nel, 2005).

Food security in South Africa is measured using various approaches, each focusing on different levels of analysis:

- **National Level:** The GHI provides an international comparative perspective on South Africa's food security status (Shisana, Labadarios, Rehle, Simbayi, Zuma, Parker, Maluleke, Gugu Mchunu, Naidoo, Davids, Mokomane, Onoya & Team, 2013), while at national level, food security is assessed through macro-economic indicators such as agricultural production, food availability and price indices. In addition, national surveys provide data on national and regional food security trends only. Table 2.1 illustrates the major surveys measuring food security.

**Table 2.1: Major national food security surveys in South Africa**

<b>Survey Name</b>	<b>Year(s)</b>	<b>Description</b>	<b>Food Security Indicator(s) Used</b>	<b>Reference</b>
<b>National Food Consumption Survey (NFCS)</b>	1999	First national-level dietary intake and hunger status survey.	CCHIP 8-item index, 3-month recall stunting, underweight, wasting in children 1–9 years	(Labadarios et al., 2005)
<b>National Food Consumption Survey – Fortification Baseline (NFCS-FB)</b>	2005	Follow-up to NFCS, used to assess micronutrient fortification.	CCHIP index child growth indicators, micronutrient status	(South African Department of Health, 2005)
<b>South African National Health and Nutrition Examination Survey (SANHANES-1)</b>	2012	Comprehensive health, nutrition and food security survey.	CCHIP index, dietary recall BMI, stunting, obesity, blood micronutrient levels	(Shisana et al., 2013)
<b>General Household Survey (GHS)</b>	Annual (2002–present)	Tracks living conditions, including food access and hunger levels.	Household hunger questions (self-report)	(StatsSA, 2024)
<b>Living Conditions Survey (LCS)</b>	Periodic (e.g., 2008, 2014/15)	Measures poverty and living standards, including food expenditure and access.	Household food adequacy indicators	(StatsSA, 2017a)
<b>South African Demographic and Health Survey (SADHS)</b>	1998, 2003, 2016	National survey on health, including maternal/child nutrition.	Food security inferred through child growth and nutrition data	(South African Department of Health (SADoH), StatsSA, SAMRC, & ICF, 2019)
<b>Health and Activity Kids South Africa Study</b>	2010–2022	School-based study conducted among primary school children to assess physical activity, dietary intake, body composition, and health behaviours in disadvantaged communities in South Africa.	Dietary intake (24-hour recall/food frequency questionnaire), anthropometry (BMI, stunting, overweight/obesity), physical activity levels; food security inferred through dietary diversity and socio-economic status indicators.	(Draper, Basset, De Villiers & Lambert, 2014; Draper, Tomaz, Bassett, Harbron, Kruger, Micklesfield, Monyeki & Lambert, 2019; Uys, Bassett, Draper, Micklesfield, Monyeki, De Villiers & Lambert, 2016; Nyawose et al., 2024)
<b>Provincial Dietary Intake Study (PDIS)</b>	2018	Determine the socio-demographic predictors of malnutrition	Anthropometry, socio-demographic and household hunger questionnaires	(Senekal, Nel, Malczyk, Drummond, Harbron & Steyn, 2019)

<b>2020/2021 National Income Dynamics Study's Coronavirus Rapid Mobile Survey (NIDS-CRAM)</b>	2020-2021	Track COVID-19 impacts on food insecurity and household and child hunger.	If the household ran out of money for food in the last months, and if and how often anyone in the household, specifically children, went hungry in the last seven days	(Van Der Berg, Patel & Bridgman, 2022)
<b>National Food and Nutrition Security Survey (NFSS)</b>	2017–present	National-level monitoring tool to assess hunger, dietary diversity, and NS across provinces.	HDDS, HFIAS, anthropometry, micronutrient intake	(Simelane et al., 2024)

- **Regional Level:** At the regional level, food security is assessed through the analysis of national surveys that provide disaggregated regional data. Other tools include Geographic Information System mapping as well as localized agricultural and economic data. The government conducts periodic assessments to identify regions at risk of food insecurity, particularly in response to climate-related shocks. Studies have examined disparities in food access across provinces, showing that provinces such as Limpopo and EC face higher levels of food insecurity compared to Gauteng and Western Cape (StatsSA, 2024). These disparities are often linked to differences in employment opportunities, agricultural productivity, and infrastructure development.
- **Household Level:** Household food security is predominantly measured by the South African Vulnerability Assessment Committee using various survey-based tools such as the HFIAS, the HHS, and the FIES (Labadarios et al., 2005). The use of dietary diversity scores, such as the HDDS, also provides insights into nutritional adequacy at the household level. Anthropometric indicators including stunting, wasting, underweight, overweight, obesity and BMI are also utilized as complimentary methodologies. These tools help policymakers identify vulnerable populations and develop targeted interventions, such as food assistance programmes and nutrition education campaigns.

In South Africa, inconsistent methodologies limit trend analysis and data comparability, while reliance on single indicators underestimates the scale of food insecurity (Hendriks et al., 2016). Researchers call for composite indices integrating food access, utilisation, and stability to capture its multidimensional nature (Ibok et al., 2019). The absence of standardized measures and clear policy in local public healthcare hampers the identification of food-insecure households. Greater uniformity and clarity in measurement would improve targeting, strengthen interventions, and enable more reliable evaluation of outcomes.

## 2.10 Nutritional indicators and malnutrition in South Africa

The WHO emphasizes that a nutritious diet is essential for preventing all forms of malnutrition and reducing the risk of NCDs, including diabetes, cardiovascular disease, stroke and cancer (Kashutina, Fadeeva & Zhernov, 2023). Malnutrition is influenced by multiple interconnected factors, such as food and nutrition insecurity, poverty, micronutrient deficiencies, overweight and obesity, as well as poor dietary habits and unhealthy lifestyle choices (Govender, Pillay, Siwela, Modi & Mabhaudhi, 2021).

Anthropometric indicators used to identify NS are critical for evaluating the utilisation dimension of food security in South Africa. “Stunting” signifies chronic “undernutrition”, reflecting long-term deficiencies in dietary intake and exposure to adverse health and environmental conditions. Wasting serves as a short-term indicator of acute nutritional stress or recent illness, while underweight encapsulates both chronic and acute undernutrition (WHO, 2008). Studies link chronic undernutrition to impaired cognitive and physical development, reduced educational attainment, and long-term productivity losses (Beal et al., 2024).

South Africa has implemented an extensive set of food and nutrition-related policies over the past two decades to improve child health and nutritional outcomes (May, Witten & Lake, 2021). However, despite these efforts, chronic undernutrition remains a serious public health challenge. National data show that the prevalence of “stunting”, has shown only marginal improvement over the past three decades (StatsSA, 2025). Child malnutrition remains a crucial reflection of household food insecurity and structural poverty in South Africa. Notably, indicators of acute malnutrition such as “wasting” and “underweight” have improved over time. The prevalence of “wasting” among children under five declined from 5.2% in 2003 to 2.5% in 2016, reaching a level considered below public health concern by the WHO. Similarly, “underweight” prevalence dropped from 11.5% to 6% over the same period, indicating moderate progress. However, moderate and severe acute malnutrition remains a critical issue, contributing to 48% of child deaths in hospitals (May et al., 2021). This paradox highlights the inadequacy of national averages in capturing sub-population vulnerabilities. In addition, chronic under-nutrition, measured by stunting, has

remained concerningly high. Stunting rates have hovered around 27% since 2003, with the 2016 South African Demographic and Health Survey (SADHS) reporting 27% of children under five as stunted. Recent evidence indicates that the prevalence of stunting among children in South Africa is approximately 25%, which is marginally higher than the rate reported in lower-income countries such as Zimbabwe, where the prevalence stands at 23.5% (Nengovhela et al., 2025). This finding is particularly alarming given that South Africa is considered an upper middle-income country with comparatively greater economic resources, infrastructure, and social support systems than many of its regional counterparts (Nengovhela et al., 2025). Stunting has profound long-term implications, including impaired physical and cognitive development, diminished educational achievement, and lower economic productivity (Prendergast & Humphrey, 2014). Moreover, it perpetuates intergenerational cycles of poverty, as stunted girls are more likely to give birth to low birthweight children. This stagnation points to ongoing structural and dietary challenges that impede improvements in long-term child growth and development. Recent research shows that South Africa continues to face a substantial burden of undernutrition with approximately 12% of the population experiences chronic hunger (FAO, European Union, CIRAD, & DSI-NRF Centre of Excellence in Food Security (CoE-FS), 2022).

Simultaneously, South Africa faces rising levels of overnutrition, contributing to the growing triple burden of malnutrition. Overweight among children was reported at 10.6% in 2005 and rose to 13.3% by 2016 (May et al., 2021). Gender-disaggregated data from the 2012 SANHANES survey show even higher rates among girls (16.5%) compared to boys (11.5%). Obesity, though inconsistently reported, also showed upward trends among adolescent girls, with 7.1% affected in 2012 (SADoH, StatsSA, SAMRC, & ICF, 2018). More recent research report that approximately 17.1–22.8% of children are overweight or obese, with higher rates among girls and those living in urban areas (StatsSA, 2020; UNICEF, WHO, & The World Bank, 2025). Among children under five, the proportion classified as overweight is estimated at 12 to 3%, reflecting an upward trend compared to previous decades (StatsSA, 2020). This growing prevalence is closely linked to South Africa's nutrition transition, characterized by increased consumption of ultra-processed foods and reduced physical activity (Kehoe, Wrottesley, Ware, Pioreschi, Draper, Ward, Lye & Norris, 2021). Importantly, obesity co-exists with undernutrition, creating the “double burden” of malnutrition

where stunting and overweight can occur within the same household (Harper et al., 2022). The World Bank has highlighted the economic implications of childhood obesity in South Africa, estimating that one in seven children is now affected (Shekar, Okamura, Vilar-Compte & Dell'Aira, 2024). Together, these findings underscore the urgent need for comprehensive nutritional assessments which guide multi-sectoral strategies to address the structural drivers of childhood obesity in the country.

In support of these national trends, the 2022 Healthy Active Kids South Africa Report Card reported that body composition proxies for overweight and obesity in children and adolescents were graded D, indicating that less than half of South African children fall within healthy body composition ranges. Furthermore, undernutrition was graded C, reflecting persistent challenges in stunting and thinness despite some improvements in physical activity indicators. Notably, while overall physical activity showed improvement (B–), most nutrition indicators and body composition measures remained largely unchanged from the 2018 report, reinforcing the continued coexistence of under- and overnutrition within the same population. These results highlight the complex interaction between dietary quality, food security and physical activity in shaping child nutritional status and support the need for integrated surveillance systems within South Africa's food security framework (Nyawose et al., 2024)

In terms of micronutrient deficiencies, also referred to as “hidden hunger,” South Africa has made partial progress but continues to face significant challenges (Simelane et al., 2024). The 2005 National Food Fortification Baseline Survey found that 45% of children aged 1 to 9 years were at risk of zinc deficiency, while 25% had iron deficiency or anaemia, and 15% had iodine deficiency. Although Vitamin A deficiency decreased from 64% in 2005 to 43.6% in 2012, the prevalence remains at levels of public health concern. The SADHS 2016 indicated the prevalence of anaemia among children age 6 to 9 months is 61%, with 24% classified as mildly anaemic, 35% as moderately anaemic, and 2% as severely anaemic (SADoH et al., 2019). These deficiencies undermine immune function, cognitive development, and overall child survival (FAO, European Union, et al., 2022). Moreover, the persistently high rates of stunting and micronutrient deficiency, despite food fortification and supplementation programmes,

raise critical questions about the bio-availability of nutrients, dietary diversity, and implementation coverage.

Adding to this, the fact that the COVID-19 pandemic and its associated lockdowns had a severe impact on household food security and child nutrition (May et al., 2021). In May/June 2020, 47% of households reported running out of money to buy food, with child and adult hunger rising to 15% and 22%, respectively. Though the rollout of relief grants (caregiver and COVID-19 SRD grants) led to a temporary decline in hunger levels by July/August 2020, they remained significantly above pre-pandemic levels. At the same time, the cost of basic food commodities increased steeply. Research conducted shows that the Household Food Basket in Pietermaritzburg rose by 14.4%, from R3,106.42 in November 2019 to R3,554.64 in November 2020 (May et al., 2021). This sharp increase also continued after COVID-19 and as of April 2025, the Household Food Basket was R5 420.30 (Motadi, Nkuna, Mugware & Zuma, 2025). These price surges further limited access to nutrient-dense foods, likely worsening the overall quality of children's diets and escalating the risk of micro-nutrient deficiencies.

More recent studies have advanced the understanding of the relationship between food insecurity and health outcomes in South Africa (Hunter-Adams, Battersby & Oni, 2019; Kehoe et al., 2021; Militao, Uthman, Salvador, Vinberg & Macassa, 2024). These studies consistently confirm strong correlations between inadequate food access and both under- and overnutrition. Food insecurity is increasingly linked with the triple burden of malnutrition, as well as a rise in NCDs. Structural inequalities, urbanization and poor dietary diversity are commonly cited as critical contributors (Hunter-Adams et al., 2019; Kehoe et al., 2021; Militao et al., 2024). Additionally, research on informal food markets has revealed their significant role in urban food security, as they provide affordable and accessible food options for low-income communities (Crush & Caesar, 2014).

Child hunger continues to serve as a critical proxy for household food insecurity in South Africa. Although self-reported household hunger declined substantially from 30% in 2002 to 11% in 2018, such measures are inherently subjective and often fail to capture the nutritional quality and diversity of diets (May et al., 2021). The expansion of social protection, most notably the Child Support Grant (CSG), was central to this

reduction, with evidence showing that by 2007 the proportion of households reporting hunger had fallen to 12% (Agüero, Carter & Woolard, 2007; Hall, Proudlock & Budlender, 2023). Nonetheless, progress has not been linear. The global financial crisis and the severe drought of 2015 temporarily reversed earlier gains, underscoring the vulnerability of households to macroeconomic and environmental shocks. While hunger levels fluctuated somewhat between the early 2000s and 2020, the long-term trajectory pointed downward. Unfortunately, the COVID-19 pandemic marked a turning point, contributing to a renewed surge in household hunger and raising concerns about the sustainability of prior achievements in reducing food insecurity (Van Der Berg et al., 2022).

Recent results from the South African Food Security Index 2024 indicate that hunger disproportionately affects the poorest households, with approximately 24% of extremely poor households reporting that children in their homes experienced hunger “sometimes,” “often,” or “always” over the past year. In addition, a lack of variety across different food groups is highly prevalent among the extremely poor, with 48% of households reporting low dietary diversity (Simelane et al., 2024). This limited access to diverse foods increases vulnerability to nutrient deficiencies and undermines overall child growth and development as mentioned. Research indicates that a balanced diet incorporating a variety of foods can help reduce stunting, particularly among vulnerable population groups (FAO et al., 2023). In addition, data reveal that food insecurity is more prevalent in households with children and in female-headed households, and that food and nutrition insecurity could lead to health problems, particularly among children and women, resulting in issues like stunting and obesity (Dlamini et al., 2024).

Research has further illustrated that experiencing hunger and lacking access to a sufficient variety of foods are strongly associated with geographic location (FAO, European Union, et al., 2022). Hunger rates have shown to be higher across all demographic groups in rural areas compared to urban areas, and limited dietary diversity within households follows a similar rural-urban pattern. Provincial data from the GHS 2023 indicate that 6% of households in the EC reported experiencing hunger, compared to the national average of 11.8%. Additionally, 23.45% of households in the

province reported limited food variety, slightly higher than the national figure of 22.1% (StatsSA, 2025).

Overall, while some progress has been made in reducing acute forms of malnutrition, South Africa continues to struggle with chronic undernutrition and hunger, rising overweight and obesity, and widespread micronutrient deficiencies. These patterns reinforce the need for improved monitoring frameworks to guide integrated nutrition strategies that address both ends of the malnutrition spectrum and focus on improving the quality, diversity, and affordability of diets, particularly for vulnerable populations.

### **2.11 Household food security trajectories in democratic South Africa (1994 – 2023)**

The trajectory of household food security in South Africa since the democratic transition in 1994 has been shaped by enduring structural inequalities, episodic policy interventions, and socio-economic shocks. National surveys and smaller empirical studies collectively suggest that while incremental improvements have occurred over the last three decades, food insecurity remains pervasive, particularly in historically marginalised provinces such as the EC (Table 2.2). Understanding these trends requires situating household food security within a multidimensional framework, encompassing NS, dietary adequacy, economic access, and social vulnerability.

**Table 2.2: Food security research and findings in South Africa (1994–2023)**

Survey / Study	Year(s)	Methodology / Indicators	Key National Results	Eastern Cape Findings	Limitations / Notes	Source
<b>October Household Surveys (OHS)</b>	1994–1999	Household income and expenditure; food access indicators	Increasing household vulnerability and inability to provide sufficient food for children	Not disaggregated	Inconsistent tools, discontinued; no time-series continuity	(Amoateng, Richter, Makiwane & Rama, 2004)
<b>National Food Consumption Survey (NFCS)</b>	1999	24-hour dietary recall, 6-month food frequency, household inventory, 8-item hunger scale	20% stunting; 10% underweight; >50% households experiencing hunger	High malnutrition and hunger; structural rural poverty	Focused only on children (1–9 yrs); no seasonality; limited comparability	(Labadarios et al., 2005)
<b>NFCS–Fortification Baseline (NFCS-FB)</b>	2005	Fortification baseline; dietary adequacy and experiential hunger	52.3% food secure; 26% at risk; 21.6% experiencing hunger	33.5% food secure; 38.2% experiencing hunger	National averages obscure provincial disparities	(South African Department of Health, 2005)
<b>South African Social Attitudes Survey (SASAS)</b>	2006–2008	Self-reported food sufficiency (“not enough to eat”)	23% adults reported food insufficiency	No provincial data	Attitudinal measure only	(Labadarios et al., 2011)
<b>Household Income and Expenditure Survey (HIES)</b>	2005/06	Income–expenditure modelling (Wooldridge estimator)	64% household food insecure	76% food insecure (EC)	Income-based approach only; no diet data	(Labadarios et al., 2011)
<b>Health and Activity Kids South Africa Study</b>	2010-2022	School-based cross-sectional and cohort data; anthropometry	Persistent double burden of malnutrition: coexistence of stunting	Higher prevalence of stunting and food insecurity proxies in	Not a dedicated household food security survey;	(Draper et al., 2014, 2019; Uys et al., 2016;

		(BMI, stunting, overweight/obesity); dietary intake (24-hr recall/FFQ in sub-samples); physical activity measures; socio-economic indicators; body composition proxies	and rising overweight/obesity in children; low physical activity levels; poor dietary diversity in lower SES groups	disadvantaged and rural communities; elevated overweight/obesity in urbanising areas	food security inferred indirectly (dietary diversity, SES, anthropometry); limited national representativeness in early waves; provincial variability	Nyawose et al., 2024)
<b>South African National Health and Nutrition Examination Survey (SANHANES-1)</b>	2012	Household hunger scale; provincial disaggregation	45.6% food secure; 26% experiencing hunger	40.5% food secure; 30.8% hungry	Stagnation despite earlier progress	(Shisana et al., 2013)
<b>General Household Survey (GHS)</b>	2002–2023	Household and individual vulnerability measures	Household vulnerability ↓ from 23.8% (2002) → 9.6% (2023)	15.8% households vulnerable (2023)	Different tools across years; recall variation	(StatsSA, 2023b)
<b>COVID-19 &amp; NIDS-CRAM</b>	2020	Rapid telephonic survey on income and hunger	47% ran out of money for food; 21% hunger prevalence	22.1% households, 28.4% individuals hungry	Short recall; crisis conditions	(StatsSA, 2022; Van Der Berg et al., 2022)
<b>StatsSA Food Access Report</b>	2023	GHS food access classification	23.1% households with inadequate/severe access	26.5% households with inadequate access	Persistent provincial disparities	(StatsSA, 2023c)

The October Household Surveys (1994–1999) conducted by StatsSA provided early insight into post-apartheid household vulnerability but lacked consistency in instruments, preventing reliable longitudinal comparison (Amoateng et al., 2004).

The first comprehensive national study, the 1999 National Food Consumption Survey (NFCS), introduced an integrated approach combining nutritional and experiential measures. Among children aged one to nine years, stunting affected nearly 20%, and over half of households reported hunger (Labadarios et al., 2005). Diets were heavily maize-dependent, lacking essential micronutrients. The EC emerged as one of the most food-insecure provinces, reflecting deep-seated rural poverty. Methodological constraints, such as the focus on children and omission of seasonal variability, limited cross-study comparability.

The NFCS–Fortification Baseline revealed modest improvement nationally, with 52.3% of households classified as food secure. However, only 33.5% of EC households met that threshold, while 38.2% experienced hunger, nearly double the national average (South African Department of Health, 2005). These disparities confirmed that aggregate statistics concealed severe provincial inequalities.

Subsequent surveys reinforced the persistence of food insecurity. The South African Social Attitudes Survey (2006–2008) indicated that 23% of adults experienced periodic food insufficiency (Labadarios et al., 2011), consistent with quantitative results.

Income-based assessments such as the 2005/06 Household Income and Expenditure Survey showed that 64% of households were food insecure nationally, rising to 76% in the EC (Labadarios et al., 2011). In contrast, Gauteng displayed lower insecurity (43%), highlighting the significance of urbanization and market access.

The SANHANES (Shisana et al., 2013) provided new provincial detail, reporting 45.6% of households as food secure, while 26% experienced hunger. The EC remained one of the most affected regions, with 30.8% of households experiencing hunger.

According to the GHS conducted by StatsSA between 2002 and 2023, household vulnerability has shown a marked decline, from 23.8% in 2002 to approximately 9.6%

in 2023 with the EC consistently remaining above national averages. It is important to note that methodological refinements and differences in recall periods across survey years may affect comparability (StatsSA, 2022, 2023b).

External shocks have repeatedly undermined food security gains. The El Niño droughts of 2015–2016 and the early 2020s depressed maize yields, elevating staple prices (Letswamotse et al., 2024). The COVID-19 pandemic exacerbated household hunger through income loss and disrupted markets. The 2020 GHS showed that household vulnerability increased from 10.3% (2019) to 17.6% (2020), with the EC worst affected (22.1% of households). The National Income Dynamics Study's Coronavirus Rapid Mobile Survey (NIDS-CRAM) data corroborated this, showing that 47% of households ran out of money for food and 21% experienced hunger (Van Der Berg et al., 2022). While social protection interventions mitigated some effects, inefficiencies and corruption constrained their impact (Cluver, Zhou, Edun, Lawi, Langwenya, Chipanta, Sherman, Sherr, Ibrahim, Yates, Gordon & Toska, 2024). By 2023, continuing structural disparities were evident: 23.1% of households nationally and 26.5% in the EC faced inadequate or severely inadequate food access (StatsSA, 2023c).

Comparison of these surveys reveals significant methodological variation, from dietary recall and anthropometric measurement to experiential hunger scales, limiting trend comparability. For instance, while the NFCS (1999) reported that 52% of households experienced hunger, the 2007 GHS indicated 10–22%. GHS data (2002–2023) show a decline in household vulnerability from 23.8% to 9.6%, however the 2023 Food Access Report indicates that 23.1% of households still experience inadequate food access, suggesting either renewed vulnerability or measurement divergence. Such discrepancies stem from differences in survey design, recall period, and population focus. From a policy perspective, these inconsistencies hinder evidence-based planning and evaluation of interventions such as the National School Nutrition Programme (NSNP), food fortification, and targeted social grants.

The researchers (Drimie and Ruysenaar (2010) and Vyas-Doorgapersad (2024), underscore the need for integrated, multidimensional, and context-sensitive methodologies that capture not only food access and consumption but also social and

cultural determinants. Provincial-level analyses, particularly in historically marginalised areas such as the Eastern Cape, remain vital for designing targeted, evidence-based interventions.

## **2.12 Current national and provincial dynamics of household food security in South Africa**

Over the past two decades, South Africa has experienced marked volatility in food security outcomes as illustrated, despite being categorized as an upper middle-income country and one of the most food-secure nations on the African continent in terms of domestic production (Vyas-Doorgapersad, 2024). According to the South African Food Security Index (2024), the country reached its lowest recorded level of food security in 2023 since the index's inception in 2012. The Index declined sharply from a peak value of 64.6 in 2019 to 45.3 in 2023, indicating a significant deterioration in national food security. At the national level, evidence from the GHS 2024 and the NFNSS 2021/22 reflects both persistent vulnerabilities and regional disparities. According to the GHS 2024, 18.6% of households were classified as vulnerable to hunger, while 11.9% were severely food insecure (StatsSA, 2024). The NFNSS results present a more severe picture, estimating that 63.5% of households experienced some form of food insecurity, including 17.5% facing severe food insecurity (Simelane et al., 2024). These discrepancies underscore the importance of understanding methodological differences in food security assessment: the FIES, utilized in the GHS, relies on a 12-month recall period and primarily captures self-perceived access limitations, whereas the HFIAS, employed in the NFNSS, uses a 30-day recall and assesses both the frequency and severity of food insecurity experiences. Such differences illustrate how single-measure approaches can under- or overestimate vulnerability, particularly in chronically food-insecure regions.

Food insecurity has disproportionately affected rural provinces, such as Limpopo and the EC, where subsistence agriculture is prevalent and household reliance on home-grown staples remains high. Challenges such as unemployment, poverty, energy crises and rising living costs, negatively impact food security, contributing to increased food inadequacy and hunger in these regions and make them more susceptible to both acute and chronic food insecurity. Provinces such as Northern Cape, North-West, and

the EC consistently report above-average rates of food insecurity, whereas Gauteng and the Western Cape exhibit lower prevalence, largely reflecting higher incomes, employment opportunities, and urban infrastructure development (StatsSA, 2024).

Rural households experience higher food insecurity compared to urban households due to structural disadvantages, including limited access to markets, inadequate infrastructure, and low agricultural productivity. Urban informal settlements, however, are emerging as critical areas of vulnerability, as households in these settings face income volatility, inflated food prices, and constrained access to diverse diets. National trends thus reinforce the multidimensional and context-specific nature of food insecurity, emphasizing that effective monitoring is needed to guide the formulation of interventions.

The EC, South Africa's fourth most populous province, epitomizes the intersection of historical marginalization, structural inequality, and entrenched food insecurity. With a population exceeding 7.2 million, predominantly Black African and isiXhosa-speaking, the province has persistently high unemployment rates (41% overall; 30.9% in NMB) and extensive reliance on social grants (62.2% of households) (Eastern Cape Socio-Economic Consultative Council, 2024; StatsSA, 2024). Despite some progress in reducing multidimensional poverty by 17.5% since 2001, entrenched disparities in income, infrastructure, and education constrained household food security and resilience. Literacy rates in the province (85%) remain below the national average (90%), limiting employment opportunities and reinforcing socio-economic vulnerabilities that directly impact access to nutritious food (StatsSA, 2022).

Sub-national studies conducted in the EC between 1999 and 2021 provide detailed insights into the province's food insecurity landscape. Rural assessments in Tsolwani and Nkonkobe districts revealed that only 2% of households were food secure, while over two-thirds were moderately food insecure and 6% severely food insecure (Musemwa, Muchenje, Mushunje, Aghdasi & Zhou, 2015). In Ngqushwa Local Municipality, 82% of households reported insufficient food, highlighting chronic deprivation and structural inequalities in subsistence-dependent communities (Musemwa et al., 2015). In Alice, unemployment was strongly associated with household hunger: 72% of unemployed households experienced moderate hunger,

and 20% severe hunger, whereas households earning above R3 500 per month were largely food secure (Dodd & Nyabvudzi, 2014). These results emphasize that income generation and employment remain key determinants of food access in the province.

Urban households in the EC are not immune to food insecurity. The STOP-SA study conducted by Okop and co-workers (2019) in metropolitan and peri-urban areas reported 40% to 42% of households as food insecure, with seasonal variations demonstrating the sensitivity of household food access to temporal shocks. More recent assessments using the HDDS and FCS further reveal limited dietary diversity in EC villages: only 21% of households were food secure, with the majority consuming starchy staples and inadequate protein or micronutrient-rich foods (Cheteni et al., 2020). Similarly, Ningi and colleagues (2022) found that in Hamburg and Melani, 60.3% of households were food insecure, reinforcing intra-provincial variation in severity while highlighting persistently high vulnerability in rural areas.

Provincial statistics corroborate these results. StatsSA (2022) indicated that only 78% of EC households reported adequate food access, below the national average of 80.4%, with 16.6% and 5.5% experiencing inadequate and severely inadequate access, respectively, the highest rates nationally. In NMB, only 82.6% of households reported adequate access, indicating that metropolitan status does not fully mitigate vulnerability, particularly in former township and informal settlement areas characterized by high unemployment and income inequality. The historical legacies of the Ciskei and Transkei homelands, regions marked by poverty, limited infrastructure, and systemic neglect, continue to shape the province's socio-economic landscape and exacerbate household-level food insecurity.

Collectively, national and provincial evidence underscores the multidimensional and persistent nature of food insecurity in South Africa, with rural households, informal settlements, and historically marginalized regions disproportionately affected. Differences across measurement tools, recall periods, and survey timing, such as those between FIES, HFIAS, HHS, and HDDS, highlight methodological challenges that complicate direct comparisons but also reveal the nuanced realities of food insecurity. For instance, between 2019 and 2023, FIES data indicated an increase in moderate to severe food insecurity from 15.8% to 19.7%, with severe food insecurity

rising from 6.4% to 8.0%. In contrast, the NFNSS conducted in 2021/22 reported far higher levels of food insecurity using the HFIAS, estimating that 63.5% of households were food insecure, including 17.5% facing severe food insecurity. These discrepancies are largely attributable to methodological differences: FIES employs a 12-month recall and measures self-perceived limitations, while HFIAS uses a 30-day recall and captures both frequency and severity of food-related experiences. As a result, FIES tends to underreport food insecurity when compared to more granular tools like HFIAS, especially in regions facing chronic access limitations. The divergence is further reflected at the provincial level. For example, Limpopo was ranked among the most food-secure provinces under FIES and the HHS, yet HFIAS data identified it as having one of the highest rates of moderate food insecurity (32%). Similarly, the North-West Province showed the highest severe hunger levels under HHS (10%) but was also one of the most food-insecure under HFIAS (25% severe). These inconsistencies underscore the importance of understanding different measurement methods and indicators. At the same time, national dietary quality, as assessed through the HDDS, appeared relatively high, with 80.8% of households consuming six or more food groups. However, this finding contrasted with the country's growing malnutrition burden, evidenced by rising child stunting (28.8%) and increasing obesity rates, suggesting that HDDS may reflect short-term consumption patterns rather than sustained dietary adequacy.

Urban-rural differences further complicate the picture. While both FIES and HFIAS confirm higher food insecurity in rural areas, the scale and progression differ by tool. For instance, FIES data showed moderate to severe food insecurity in rural households increasing from 19.4% in 2019 to 26.8% in 2023, whereas HFIAS in 2021/22 suggested a significantly higher burden overall. These discrepancies reflect differences not only in indicator sensitivity but also in the timing of data collection. Finally, while individual indicators such as FIES, HFIAS, HHS, and HDDS provide valuable insights, their inconsistent application and lack of harmonized definitions hinder integrated interpretation. For example, GHS data indicated that 80% of households had sufficient food access, while NFNSS data in the same period estimated that only 36.5% were fully food secure highlighting a critical inconsistency in classification thresholds. These inconsistencies point to an urgent need for a harmonized, multidimensional measurement framework that combines access and

nutritional dimensions of food insecurity. Without such alignment, policy interventions risk being fragmented, misdirected, or ineffective.

The literature emphasizes the need for harmonised, multi-indicator frameworks capable of capturing both access and nutritional dimensions of food insecurity and monitoring over time. Such frameworks are critical for designing context-specific interventions, including social protection, employment generation, agricultural support, and nutrition-sensitive programmes, which are essential for addressing structural determinants, enhancing resilience, and reducing entrenched food insecurity, particularly in vulnerable provinces such as the EC.

### **2.13 The role of social protection in alleviating malnutrition and food insecurity in South Africa**

The Constitution of the Republic of South Africa (1996) enshrines the right to food through several key provisions. Section 27(1)(b) guarantees everyone the right to have access to sufficient food, while Section 28(1)(c) emphasizes the right of every child to basic nutrition. Additionally, Section 35(2)(e) ensures that detained individuals have the right to adequate nutrition (Nengovhela et al., 2025). These constitutional commitments place a legal obligation on the State to take reasonable legislative and other measures, within its available resources, to progressively realise these rights and ensure access to sufficient food and nutrition for all. While South Africa recognizes food security as a basic human right and has policies like the National Policy on Food and Nutrition Security to address food insecurity, challenges persist.

Food security remains a major public health concern in South Africa, driven by persistent poverty, unemployment and rising food costs, despite the country's agricultural capacity and policy interventions. Low-income households are particularly vulnerable, facing both undernutrition and micro-nutrient deficiencies. Concurrently, a growing reliance on processed foods has contributed to rising rates of obesity and diet-related non-communicable diseases (Fanzo et al., 2022). Addressing food insecurity could potentially improve these problems but requires adequate monitoring systems and frameworks to identify those at risk and affected by food insecurity.

Over the past three decades, South Africa has implemented a range of policy instruments aimed at improving food security, nutrition, and health outcomes across diverse population groups. These policies reflect both national imperatives and global commitments to sustainable development. One of the first policies introduced was the Zero Value Added Tax (VAT) Rating of Basic Foodstuffs, introduced in 1994. It marked an early intervention in food affordability by exempting 19 staple food items from VAT. This measure was designed to protect vulnerable groups by reducing the cost of essential foods (Treasury, 1994). Following this, the White Paper on Agriculture (1995) established a foundational framework for transforming South African agriculture. It prioritized the development of a market-oriented commercial farming sector while ensuring equitable access to land and support services. The policy also emphasized environmental sustainability, alignment with market trends, and support for novice and resource-poor farmers (SADoH, 1995).

In 2002, the Integrated Nutrition Programme was implemented to address malnutrition through cross-sectoral interventions. Its core objective was to improve the NS of all South Africans, with a focus on vulnerable populations (SADoH, 2002). The same year, the Integrated Food Security Strategy was introduced to consolidate various food-related initiatives under one framework, aiming for universal food security and a healthy life for all citizens (South African Department of Agriculture, Forestry and Fisheries (SADAFF), 2002). Following these, the Regulations Relating to the Fortification of Certain Foodstuffs came into effect in 2003, mandating the fortification of key food vehicles with essential micro-nutrients. The regulations also governed importation, labelling, and compliance to reduce nutrient deficiencies (SADoH, 2003).

Almost a decade later, in 2012, the NDP emerged as a cornerstone for long-term socio-economic transformation. It sought to eradicate poverty and reduce inequality by fostering citizen participation, economic growth, infrastructure development and institutional reform. The NDP became a critical anchor for subsequent sectoral strategies (National Planning Commission, 2012). The Roadmap for Nutrition in South Africa was launched in 2013 as a strategic plan to guide interventions that improve nutritional outcomes. Its overarching goal was to ensure optimal nutrition for all South Africans through coordinated efforts and targeted policy measures (SADoH, 2015a).

The National Policy on Food and Nutrition Security responded to rising concerns about food accessibility and nutritional adequacy. It emphasized public investment in food systems, food distribution enhancement, small-scale farmer support, and strategic market interventions to ensure the presence and affordability of safe and nutritious food (SADAFF, 2014a). Simultaneously, the Agricultural Policy Action Plan 2015–2019, provided a practical framework for revitalizing agriculture and agro-processing. Aligned with the NDP, Agricultural Policy Action Plan focused on commodities with high growth and job creation potential, prioritizing infrastructure, land capability and capacity building (SADAFF, 2014b). In 2015, the government introduced the Taxation of Sugar-Sweetened Beverages as a public health measure to curb excessive sugar intake. A levy of 2.29 cents per gram of sugar was imposed to discourage consumption and address obesity-related health risks (Boatema, Drimie & Pereira, 2018). That same year, the Strategy for the Prevention and Control of Obesity in South Africa set a national target to reduce obesity prevalence by 10% by 2020, focusing on lifestyle promotion and risk factor reduction (SADoH, 2015a).

At the international level, South Africa committed to the SDGs in 2015, using them as a universal benchmark for development. Goals particularly relevant to food security include SDG 2 (Zero Hunger), SDG 3 (Good Health), SDG 12 (Responsible Consumption) and SDG 13 (Climate Action), among others. The SDGs serve as a comprehensive framework for assessing national progress across environmental, social, and economic dimensions (StatsSA, 2017b).

The South African government has also implemented several other policies and programmes to address food insecurity such as social protection programmes. Initiatives such as the CSG and the NSNP have been effective in mitigating food insecurity among vulnerable populations (World Bank, 2021). The CSG was introduced in 1998 with an initial value of R100, the CSG has become the single biggest programme for alleviating child poverty in South Africa. The number of infants receiving the CSG was 509 000 in 2023. There is substantial evidence that social grants, including the CSG, are being spent on food, education and basic goods and services. The evidence shows that the CSG not only helps to alleviate income poverty and realise children's right to social assistance, but is also associated with improved nutritional, health and education outcomes (Hall et al., 2023). These programmes

provide critical support to children and low-income families, ensuring they have access to at least one nutritious meal per day.

In response to the economic and food-security shocks triggered by the COVID-19 pandemic, the South African government introduced the SRD grant to serve as a rapid, emergency social protection instrument. The SRD grant, initially set at a monthly amount of R350, was aimed at adults who were unemployed and not receiving other forms of social assistance or benefits such as the Unemployment Insurance Fund (Kajiita & Kang'ethe, 2024). The SRD grant was introduced in response to COVID-19 lockdowns, which caused widespread job losses in the informal sector and among low-income households, exacerbating food insecurity and malnutrition. The grant provided a crucial income safety net, supporting basic consumption and stimulating local demand. However, the SRD fell below the national food poverty line (R585 in August 2020), limiting its ability to ensure adequate nutrition. Administrative challenges, including outdated data systems, digital access barriers, and payment delays, also restricted reach, particularly in rural areas (Oukouomi Noutchie, 2025). Despite these limitations, the SRD functioned as a shock-responsive safety net, helping vulnerable households maintain access to food and mitigating further under-nutrition, especially among adults previously excluded from formal social-assistance programmes (Hart, Davids, Rule, Tirivanhu & Mtyingizane, 2022; Mthembu & Raniga, 2024).

Finally in 2022, the Strategic Plan for the Prevention and Control of NCDs was launched to support SDG 3.4 by focusing on health systems that manage NCDs. It emphasizes prevention, access to care, and strategic monitoring of health-related trends to reduce disease burden and promote lifelong well-being (Basu, 2022).

Progress has also been made on a provincial front. In the EC, to date various home-based food production initiatives have been introduced to improve household food security. The Siyazondla Programme supported over 106 000 households with inputs like seeds, seedlings, poultry feed and fertilizers. Under the Presidential Employment Stimulus, around 32 000 households received input vouchers worth R165.5 million. To promote sustainable practices, climate-smart agriculture was introduced through 14

production tunnels equipped with 3 720 vegetable boxes. Additionally, spring water protection projects in five districts installed 757 taps across 36 villages, benefiting 8 781 households, several schools, a clinic and a youth cooperative (Eastern Cape Socio-Economic Consultative Council, 2024). These initiatives collectively aim to boost food self-sufficiency and resilience in vulnerable communities.

Despite these efforts, cracks remain in policy implementation, particularly in monitoring and evaluating the effectiveness of food security interventions. Coordination among government departments, civil society organizations and the private sector, remains a challenge, leading to inefficiencies and overlapping initiatives. The Integrated Food Security Strategy, introduced in 2002 to harmonize departmental efforts, was undermined by inadequate funding, poor administrative capacity, and the absence of enforcement mechanisms (Drimie & Ruysenaar, 2010). While food parcels and starter packs were introduced as immediate relief, they lacked sustainability. In addition, implementation at the local level is often undermined by political interference and inadequate resources (Drimie & Ruysenaar, 2010). Furthermore, critics argue that the National Policy on Food and Nutrition Security lacks essential components and effective implementation at the household level and lacks formal evaluations, coordination and enforceable legislative measures (Ramkissoo, 2018). Fragmentation among government departments and inconsistent funding have limited the effectiveness of even well-designed policies.

Nutrition-specific interventions under the Integrated Nutrition Programme have also struggled, with multi-sectoral implementation limited by weak strategic capacity and inadequate resources (Boatema et al., 2018). Subsequent policies, such as the Roadmap for Nutrition (2013–2017) and the 2013 Food and Nutrition Security Policy, echoed previous frameworks without resolving the core issues of coordination and accountability (SADoH, 2015a). Despite drawing on Brazil's Zero Hunger model, these initiatives were weakened by vague planning, minimal stakeholder engagement and structural fiscal barriers (Drimie & Ruysenaar, 2010).

At the local level, political interference, top-down mandates and budget real-locations have further eroded implementation capacity. Ward committees remain under-resourced and dis-empowered, limiting genuine community participation (Boatema

et al., 2018). Mis-alignment between national goals and local execution reflects deeper governance flaws, including siloed structures and limited institutional support (Hendriks, 2013).

Realising meaningful progress requires decentralised planning capacity, cross-sectoral alignment, and stronger mechanisms for community engagement and accountability. In addition, improving food security in South Africa requires a shift from top-down policy design to more inclusive, household-centred implementation. Effective multi-sectoral collaboration, essential for addressing food insecurity, depends on sustained investment in trust-building and coordination, elements currently lacking in many low-income communities (HLPE, 2023). Meaningful progress also hinges on grassroots advocacy and political prioritisation. Without community mobilisation and civil society engagement, national efforts risk remaining disconnected from household food security needs. A coordinated, well-resourced approach that centres household experiences and enables local voices in planning and evaluation is crucial. This would ensure policies are not only ambitious but also grounded in the day-to-day struggles of food-insecure households, especially in South Africa's poorest communities.

The proposed HFSI, the focus of this study, could help address the issues mentioned by capturing the layered realities of household food security spanning access and utilisation, beyond single measurement indicators. The HFSI could become a standardized tool for assessing household food security, reducing current discrepancies between fragmented indicators. Standardization would enable comparability across regions and programmes, improving both national monitoring and international alignment. Brazil's Zero Hunger programme illustrates the importance of such robust monitoring frameworks (Da Silva, Grossi & De França, 2012). South Africa's policies, by contrast, have faltered partly due to vague planning and inconsistent measurement. The HFSI possibly will bridge the gap between national frameworks and local realities by providing disaggregated, household-level data that reflect lived experiences and support evidence-based resource allocation and real-time programme adjustment, helping overcome fiscal and planning weaknesses that have undermined previous policies.

## 2.14 Conclusion

In conclusion, the literature affirms that food security is a multi-dimensional and context-specific phenomenon, operating across global, national, household and individual levels. It is shaped by the interplay of economic, environmental, social, and political forces, which collectively determine access to adequate and nutritious food. Global disruptions, such as climate change, conflict, and market volatility, undermine food systems, while national food security is mediated by domestic policies, trade dynamics and public welfare mechanisms. At the household level, food security is closely linked to food access and the utilisation thereof, as well as external factors such as income stability, housing conditions, education levels and social networks. Individual-level food security further reflects nutritional adequacy, dietary diversity, and health status, underscoring the deeply personal dimension of food-related well-being.

In applying Maslow's Hierarchy of Needs to household food security emphasizes its foundational role in human development. As a core physiological need, food security, through access, utilisation and stability, is essential for enabling individuals to meet higher-level needs like safety, social belonging and self-actualization. Without first addressing these necessities, broader development goals in education, employment and well-being remain out-of-reach, especially in low-income and vulnerable settings. These layers of complexity highlight the need for integrated and localized approaches to food security measurement and intervention, ones that recognize both systemic drivers and individual vulnerabilities.

A wide array of tools has been employed to assess food security at various levels, offering important insights into both systemic and localized vulnerabilities. However, household food security remains a critical focal point, as it directly influences daily food access, dietary quality, and health outcomes within families. Vulnerable populations, particularly low-income households and those living in informal settlements, face heightened risks due to persistent income inequalities, limited access to diverse and nutritious food and insufficient social support structures.

Notably, there is currently no single, comprehensive tool capable of capturing the full complexity of household food security, especially within marginalized communities.

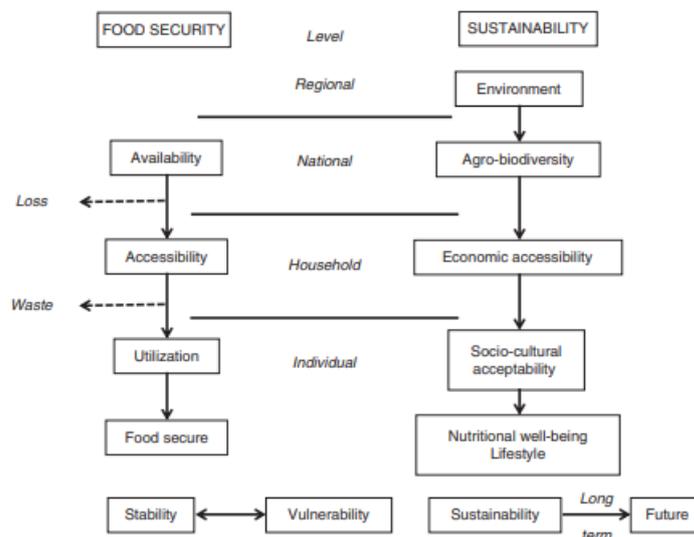
Existing tools such as the HDDS, the HHS and individual NS assessment, each present methodological limitations when used in isolation. This highlights the need for an integrated, multi-dimensional tool that combines these indicators to enable more accurate, context-sensitive assessments and facilitate valid comparisons across similar communities and over time.

Addressing household food insecurity effectively will require not only such robust measurement systems but also proactive early detection mechanisms within primary healthcare settings and the implementation of targeted, community-based interventions. Collectively, these approaches are essential for promoting sustainable and equitable household food security.

## CHAPTER 3: METHODOLOGY

### 3.1 Introduction

This chapter begins by describing to what extent the present study forms part of the larger international KaziAfyra study, highlighting how the two studies align and complement one another. It further outlines the methodology used to develop the comprehensive HFSI and to assess the prevalence of household food security in low-socioeconomic communities within NMB, EC, South Africa. The study aims to assess household food security by focussing on the dimension of access and utilisation which is relevant at household and individual level as illustrated by Figure 3.1. A combination of indicators, including HDDS, indicating dietary quality, HHS which indicate the level of hunger of the household and from which household food security is derived, as well as anthropometric measurements indicating child NS was assessed. These indicators offer a comprehensive understanding of the multidimensional nature of household food security.



**Figure 3.1 Dimensions and associated levels of food security** (Berry, Dernini, Burlingame, Meybeck & Conforti, 2015)

To address the study objectives, a range of statistical methods were applied, including descriptive and inferential statistics such as t-Tests, chi-square goodness-of-fit tests and correlation analyses. In addition, the Delphi technique was employed to refine the

proposed HFSI through expert input. This methodological approach of this study ensures a thorough examination of the food security and child NS of low-income households in NMB and provides insights into the potential role of the COVID-19 pandemic in intensifying household food insecurity. Additionally, it supports the development of the HFSI and facilitates the validation of its practicality and effectiveness.

### **3.2 Overall Methodological Framework of the Study**

This doctoral study was embedded within the broader KaziAfya project but adopted a distinct methodological framework tailored to investigating household food security and child NS in low-income communities within NMB, EC, South Africa. The study employed a quantitative longitudinal design consisting of two interrelated phases, integrating empirical household-level data with expert-informed index development.

#### **3.2.1 Phase One: Longitudinal Household Assessment (T1–T3)**

Phase One focused on assessing the prevalence and dynamics of household food security over time, as well as examining the potential impact of the COVID-19 pandemic.

Data were collected at three time points:

- Testing round one (T1): February–April 2019 (Pre-pandemic). In this phase baseline data, including household questionnaire and child anthropometric data was collected as situational analysis
- Testing round two (T2): September–November 2019 (Pre-pandemic). This phase took place midway through the interventions that were being implemented, but the participant in this study was of the control group and the interventions therefore did not have an influence.
- Testing round three (T3): August–November 2021 (Mid-pandemic). This was the final data collection phase to conclude the study.

This phase aligned with the first two research objectives:

1. To assess the prevalence of household food security and its associated indicators within low-socioeconomic areas in NMB, EC, South Africa.

2. To examine the potential effects of the COVID-19 pandemic on household food security, dietary diversity, hunger and child NS in low-income households in NMB to determine the impact of large-scale disruptions such as disasters and pandemics.

Data collection combined:

- 24-hour dietary recall → HDDS
- HHS
- COVID-19 impact questionnaire (T3)
- Anthropometric measurements (height, weight → height-for-age, weight-for-age, BMI-for-age z-scores)

The analytical strategy included descriptive statistics (means, frequencies), inferential statistics (t-tests, chi-square tests), and correlation analyses. Comparisons across T1, T2 and T3 enabled evaluation of both chronic structural food insecurity and acute pandemic-related disruptions.

### 3.2.2 Phase Two: Development and Validation of the Household Food Security Index (HFSI)

Phase Two addressed the third research objective:

3. To construct and evaluate a multidimensional HFSI tailored to the socio-economic context of low-income households in NMB.

This phase followed a structured formative index development process grounded in:

- A theoretical framework of household food security (access and utilisation dimensions)
- Indicator selection (HDDS, HHS, NS)
- Expert consultation via a modified Delphi technique
- Statistical mapping and weighted aggregation procedures

The Delphi technique was conducted over three rounds (September–October 2024) to achieve ≥70% consensus on:

- Conceptual model structure
- Indicator relevance
- Indicator weighting

Final weights derived through expert consensus were:

- HDDS = 35%
- NS = 35%
- HHS = 30%

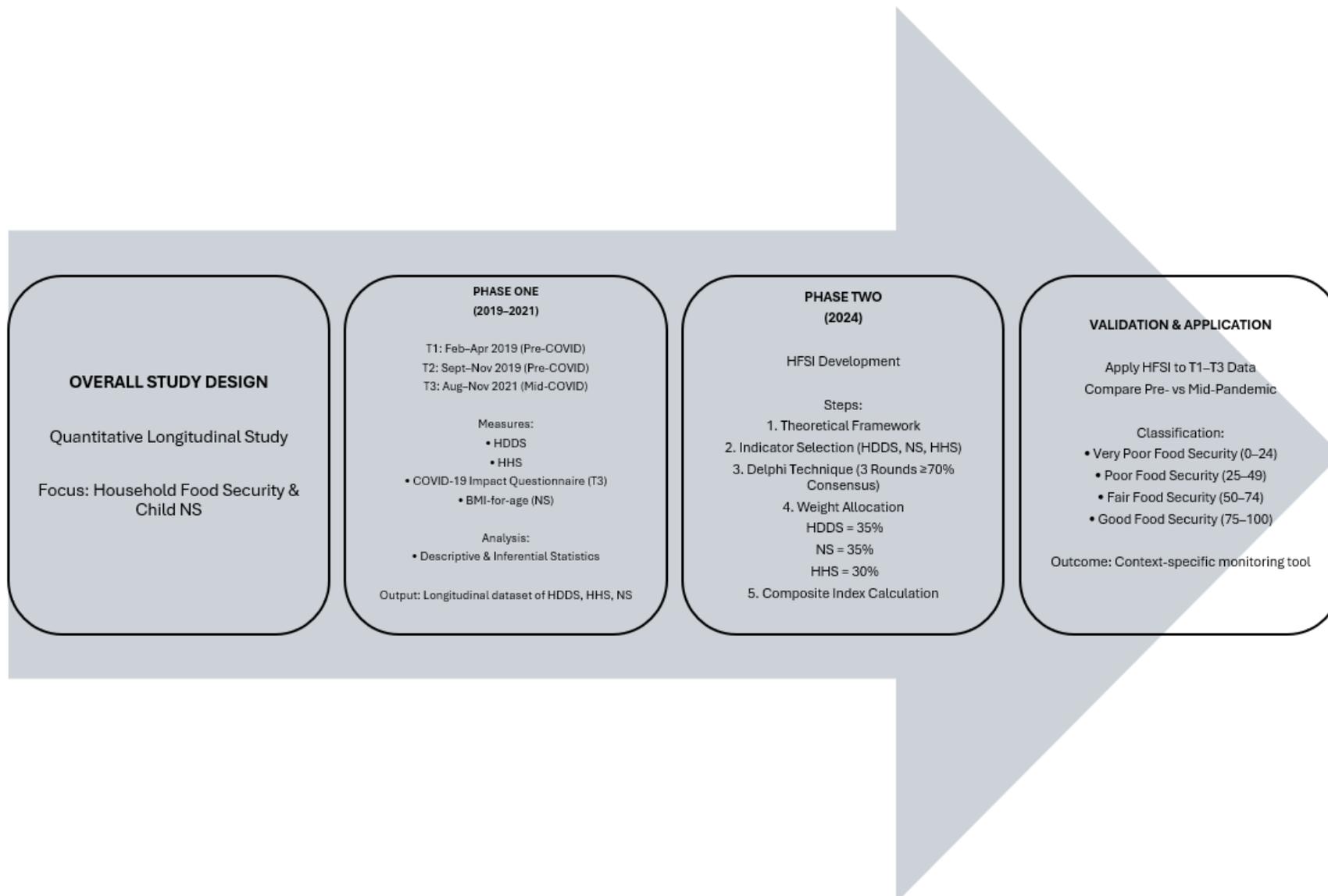
Indicators were normalised on a 0–100 scale and aggregated into a composite HFSI score, allowing classification into four categories: Very Poor, Poor, Fair, and Good Food Security. The index was subsequently applied to the Phase One dataset to evaluate performance, differentiation capacity and responsiveness to COVID-19-related changes.

### 3.2.3 Integrated Methodological Logic

The methodological framework reflects a sequential and integrative structure:

1. Empirical measurement (Phase One) generated longitudinal household-level food security data.
2. Conceptual synthesis and index construction (Phase Two) transformed these indicators into a composite monitoring tool.
3. Validation and comparative analysis ensured theoretical, statistical and contextual robustness.

This integrated approach ensured alignment between research objectives, data collection procedures, analytical methods, and index development, thereby strengthening construct validity, contextual relevance, and practical applicability within low-resource settings. See Figure 3.2



**Figure 3.2 Methodological framework for the study**

### **3.3 Integration with the KaziAfya study and methodological framework**

This doctoral research is situated within the broader framework of the KaziAfya project, an international, multi-country initiative, aimed at examining the interrelationships among physical activity, micronutrient deficiencies, body composition, infectious diseases, inflammatory and cardiovascular risk markers and sleep indicators in school-aged children across South Africa, Tanzania, and Côte d'Ivoire. The KaziAfya project further investigates the effects of a school-based intervention, combining physical activity and multi-micronutrient supplementation, thereby contributing to evidence-based strategies to enhance child health and educational outcomes in low- and middle-income settings. More information regarding the study can be found in the published protocol (Gerber et al., 2020). For the purposes of this doctoral research, only participants from the control groups were included; therefore, the multi-micronutrient supplementation component of the intervention did not influence the outcomes examined in this study.

Aligned with the overarching objectives of the KaziAfya project, the present doctoral study focuses specifically on the South African cohort, employing both existing KaziAfya datasets and additional data collected independently by the researcher. This integration facilitates a comprehensive and contextually grounded analysis of household food security, NS, and dietary diversity, with a particular emphasis on the effects of the COVID-19 pandemic on these dimensions. By combining project-level and independently collected data, this study extends the scope of the original KaziAfya research by exploring household-level determinants of nutrition and food security, thereby complementing and deepening the KaziAfya project's objectives. The following sections describe how the current study fits into the KaziAfya project.

#### **3.3.1 Anthropometric assessment**

Anthropometric measurements, including body weight and height, were derived from the KaziAfya dataset. Gender-specific height-for-age, weight-for-age, and BMI-for-age z-scores were computed, using the WHO growth reference standards (WHO, 2008). These indicators served to evaluate the nutritional and growth status of children within the study population.

While the KaziAfya protocol includes assessments of body composition and applied both Center for Disease Control and Prevention and WHO growth standards, the present study restricted its focus to height and weight measurements. This methodological adjustment was made to align with the present study's specific research objectives concerning NS (measured with anthropometrical measurements and dietary data and not including biochemical and clinical data) and food security rather than detailed body composition analysis.

### 3.3.2 Dietary intake assessment

For the current study, dietary intake data were collected through parent- or guardian-reported 24-hour dietary recall questionnaires (Addendum K). These data were used to construct a Food Intake Checklist (FIC), from which the HDDS was computed to assess dietary diversity at the household level.

This approach differs from the KaziAfya core protocol, which utilized a culturally adapted Food Frequency Questionnaire to estimate macro- and micronutrient adequacy through the Women's Dietary Diversity Score and FCS. The methodological divergence reflects the focus of the current study on household dietary patterns and their direct association with household food access, rather than the broader nutrient adequacy emphasized in the KaziAfya framework.

### 3.3.3 Household food security and hunger assessment

In contrast to the KaziAfya framework, which employed the HFIAS to assess household food insecurity, the present study utilized the HHS to measure the severity and prevalence of household hunger as well as food insecurity. This approach provides a more nuanced understanding of the intensity and frequency of food access challenges experienced by households.

Furthermore, the study integrates a tailored COVID-19 Impact Questionnaire, designed to evaluate the pandemic's influence on household-level food security, and its associated indicators. The inclusion of this dataset enabled the analysis of

exogenous shocks and their intersection with household food security, thereby contributing to novel evidence on the pandemic's nutritional impacts within the South African subsample thus expanding the analytical scope beyond the original KaziAfya framework.

#### 3.3.4 Contribution and complementarity

In summary, while the KaziAfya project primarily investigates physical activity, micronutrient status and health outcomes among school-aged children across diverse African settings, this doctoral study complements and extends that framework by conducting a household-level analysis of food security, dietary diversity and hunger within the South African subsample.

By integrating independently collected data on household dietary patterns, experiences of hunger, and the impacts of COVID-19, this study offers critical insights into household-level food security and the ways in which external shocks intersect with nutritional vulnerability. The combination of the KaziAfya project data with researcher-collected household information enabled a multidimensional understanding of household food security and nutrition within low-resource South African communities. This integration not only strengthened the internal validity of the research but also enhanced its capacity to generate policy-relevant evidence on food security resilience and nutritional well-being, particularly in the face of disruptions such as the COVID-19 pandemic.

Moreover, it introduces the potential use of a HFSI as a monitoring tool to aid future policy and intervention efforts aimed at addressing food insecurity in South African and comparable low-resource contexts. Through these extensions, the current study not only aligns with but also enriches the KaziAfya project's overarching objectives by situating its findings within the broader discourse on nutrition, health promotion, and resilience in low-resource settings.

### 3.4 Study design

This study employed a quantitative longitudinal approach to comprehensively address the research objectives.

The study was conducted in two phases, each employing unique methodologies to achieve the set objectives. A summary of the phases is as follows:

#### Phase One

- Investigate the prevalence of household food security of low-income households in NMB, South Africa and if there was a change over time;
- Explore the possible effects of COVID-19 on household food security and its indicators applicable to low-income households in NMB, South Africa.

#### Phase Two

- Develop a comprehensive HFSI, utilising key indicators of household food security as predictors, to provide a robust measure of household food security within this context and test the index score for measuring household food security in these economically disadvantaged households in NMB, South Africa. (This was achieved by incorporating theoretical frameworks and established guidelines for index construction, expert consultation through the Delphi technique, and statistical procedures for index development);
- Evaluate the suitability of the proposed HFSI as a tool for assessing the impact of large-scale disruptions or disasters on household food security by comparing HFSI values before and during the COVID-19 pandemic in low-income communities in NMB, South Africa.

### **3.5 Study population and sample, sampling and setting**

#### **3.5.1 Study area**

The study was conducted in disadvantaged, low socio-economic communities within NMB, EC, South Africa. These areas face high levels of poverty and unemployment, compounded by the historical effects of colonialism and apartheid, as well as current public health and economic challenges (Myer, Ehrlich & Susser, 2004).

Nelson Mandela Bay Metropolitan Municipality (NMBM) is one of eight metropolitan municipalities in South Africa and is located along the south-eastern coast within the EC Province. The municipality encompasses the urban centres of Port Elizabeth (renamed Gqeberha), Uitenhage (now Kariega), and Despatch, along with surrounding peri-urban and rural areas. As of the most recent demographic updates, the municipality is home to over 1.2 million people, making it the largest urban centre in the province and one of the top five in the country by population size (StatsSA, 2023c). Geographically, NMB spans approximately 1 950 square kilometres and features a coastal temperate climate, which influences both agricultural and economic activities. The region is characterised by a blend of industrial zones, residential suburbs, and large informal settlements that reflect long-standing socio-economic inequalities (NMBM, 2024).

Economically, the municipality is heavily reliant on the manufacturing and automotive sectors, supported by the Coega Special Economic Zone and the Port of Ngqura, which serve as critical industrial and logistics hubs. However, despite these assets, NMB has one of the highest poverty and unemployment rates in South Africa. The Integrated Development Plan 2023/2024 indicates that unemployment exceeds 35%, with youth unemployment even higher (NMBM, 2024). A large proportion of households depend on social grants as their primary income source (Eastern Cape Socio-Economic Consultative Council, 2022).

The municipality also grapples with critical challenges related to food insecurity, limited access to quality healthcare, and insufficient service delivery, especially in low-income and informal settlements. These challenges are compounded by economic stagnation,

climate vulnerability, and enduring spatial inequality resulting from apartheid-era planning. In terms of food security, NMB is marked by both chronic and cyclical food insecurity, largely driven by structural poverty, rising food prices and limited dietary diversity. According to the Community Survey 2023, a significant number of households in the EC, especially in metros like NMB, reported inadequate food consumption patterns (StatsSA, 2023c).

Given its complex socio-economic profile and high burden of poverty and malnutrition, NMB offers a critical case for examining the dynamics of household food security, particularly within vulnerable low-income communities.

### 3.5.2 Study population and sample

#### *3.4.2.1 Phase One*

##### *School selection*

The study focused on children (and their respective household) attending one of four primary schools within the NMB area. For the KaziAfya study, schools were selected through a multi-step process facilitated by a meeting hosted by the Eastern Cape Department of Education. This meeting was attended by 200 principals representing 349 primary schools in Port Elizabeth, where the study was introduced. From this, 20 schools expressed interest, and presentations were subsequently given to their management teams. Further engagement involved twelve schools, which demonstrated a deeper willingness to participate. Ultimately, four schools, that were the control schools in the KaziAfya study, were selected, based on the number of participants (1 320) required to achieve at least a small effect ( $f = 0.10$ ) in the primary outcomes of the larger KaziAfya study. Convenience sampling was used, guided by the following criteria:

- Geographic location in townships or northern areas of NMB.
- No participation in other clinical trials or helminthiasis control interventions during the study period.
- Not involved in government food or nutritional programmes, except the NSNP that provides one meal per day on school days that are offered to all schools

classified as quintile 1, 2 or 3 schools. South Africa's education system is divided into five quintiles, based on the socio-economic status of the area surrounding the school. Quintile 1 represents the poorest schools, while quintile 5 represents the wealthiest. The ranking system was established to address the inequality in education funding and resources in SA (CAPS 123, 2023). All the schools in the low socio-economic areas are either quintile 1, 2 or 3 schools. For this and the KaziAfya study, only quintile 3 schools were used.

- Commitment to supporting the study's data collection for its duration.

### *Participant selection*

For this study a priori power analysis was conducted using G\*Power 3.1 (Faul, Erdfelder, Buchner & Lang, 2009), with a significance level of  $\alpha = 0.05$  and desired power of 0.80, as recommended by Cohen, (1992). The analysis indicated a minimum required sample size of 250 participants to ensure adequate statistical power. The study population comprised of 1 368 children enrolled in grades one to four (ages five to 13 years) at the selected schools and their respective household (represented by the parent/guardian who is the main food preparer). Non-probability purposive sampling targeted these groups.

### *Eligibility criteria*

Schools:

- Quintile 3 public schools from disadvantaged areas.
- Enrolment size of two to three classes per grade.
- No involvement in ongoing nutrition interventions or located in areas with government nutrition programmes, except the NSNP.

Children:

- Enrolled in grades one to four during the first round of data collection.
- Aged five to 13 years during the first round to minimise variability in body composition due to the onset of puberty.
- Written informed consent obtained from parent or guardian.
- Assent provided by the child.

Exclusion criteria:

- Parent/guardian under the age of 18.
- Lack of consent from parent/guardian or assent from the child.
- Children with disabilities, as their condition might influence food diversity and food security.

#### 3.4.2.2 Phase Two

##### *Expert panel selection for the Delphi technique to refine the HFSI*

The Delphi technique involves recruiting a panel of "experts", though the term "expert" is open to interpretation and varies across studies (Hasson et al., 2000). Unlike traditional surveys that aim for representativeness, Delphi studies use a non-random sampling method, selecting participants based on recognized expertise in the field, which may introduce selection bias, as those interested in the topic are more likely to participate (Hsu & Sandford, 2007). Criteria for expertise vary widely, including factors like educational attainment, years of practical experience, and professional publications, though there are no standardised guidelines for defining or selecting experts (Trevelyan & Robinson, 2015). Common requirements for Delphi panellists include relevant experience, knowledge, willingness to participate, time availability and good communication skills (Diamond et al., 2014).

“Experts” were selected based on the following criteria:

- A minimum of five years’ experience in malnutrition, food security, or related fields.
- Practical experience assessing household food security.
- Willingness to participate in multiple rounds of discussions and availability to commit time.

The optimal number of participants in Delphi studies remains an ongoing debate, with panel sizes ranging from as few as four to several thousand, though eight to 20 participants are common (Diamond et al., 2014). Smaller panels may yield unstable results as individual responses heavily influence outcomes, however larger panels provide more stability but may complicate data collection and management (Skulmoski

et al., 2007). Larger panel sizes can enhance reliability but may also introduce logistical challenges in maintaining high response rates (Niederberger & Spranger, 2020). Ensuring participants remain engaged with regular updates and reminders helps retain diverse expert opinions throughout the Delphi rounds. Attrition is also a challenge in multi-round Delphi studies, where informed consent, clear communication, and short time frames between rounds are critical to maintaining engagement (Skulmoski et al., 2007).

For this study a list of potential national experts was compiled through institutional affiliations, published research on related topics, and identification of public health professionals working in South African clinics familiar with food security measurements. Non-random sampling was employed, targeting individuals with recognised expertise, however this does introduce the potential for selection bias (Hsu & Sandford, 2007). Invitation letters (see Addendum L) were sent to 15 experts who met the study's selection criteria as well as explanation of the study, with ten confirming their availability and willingness to participate. Upon obtaining informed consent, the theoretical framework of the index (see Addendum M), along with the first-round questionnaire (see Addendum N), was distributed to these experts for completion. All communication was conducted via email, and the questionnaire was completed online, using Microsoft forms.

## **3.6 Instruments**

### 3.6.1 Assessment instruments – Phase One

The first phase of the study focused on collecting data to address the first and second study objectives. A combination of a questionnaire and anthropometric measurements was used to gather comprehensive quantitative information.

#### *3.6.1.1 Questionnaires*

- 24-hour dietary recall: The 24-hour dietary recall was used to document all foods consumed by household members within a 24-hour period. The multiple

pass method was used to obtain as much information as possible and respondents had to report on the previous day (24 hours). Following the recall, a food item checklist was employed to determine the food groups consumed. This method adhered to the guidelines prescribed by the FAO for evaluating HDDS (Kennedy et al., 2011).

- HHS: The HHS, a subset of the HFIAS, is designed to assess the severity of household food insecurity specifically linked to hunger (Ballard et al., 2011; Jones et al., 2013). The scale has been developed and validated for use across diverse cultural and geographic settings (Deitchler, Ballard, Swindale & Coates, 2010). In this study, the HHS was used to determine household hunger levels, and household food security status was derived from this instrument in accordance with the methodology outlined by Knueppel and co-workers (2010). Caregivers were asked if: In the past 30 days, (i) was there no food to eat of any kind in your house due to lack of resources, (ii) did any household member go to sleep at night hungry because there was not enough food, and (iii) did any household member go a whole day and night without eating.
- COVID-19 impact questionnaire: A questionnaire, based on methodology of Nguyen, Kachwaha, Pant, Tran, Ghosh, Sharma, Shastri, Escobar-Alegria, Avula and Menon (2021) but adapted for the local context, was designed to assess the potential impact of the COVID-19 pandemic on household food security. It included two categorical survey items; COVID\_Q1 evaluated the possible impact on child nutrition and asked questions on how the child's diet was influenced, while COVID\_Q2 assessed the potential impact on overall household food security with questions on the household's food security, with an explanation requested if an answer was affirmative.

### *3.6.1.2 Anthropometric measurements*

- Height and weight: Anthropometric measurements, particularly height and weight, of children were collected at local primary schools to evaluate their

NS. These measurements followed the WHO (WHO, 2008) guidelines for assessing child growth and nutritional outcomes which are discussed in 3.7.1.4

### 3.6.2 Assessment instruments – Phase Two

The second phase of the study addressed the third objective which aimed to develop a comprehensive HFSI to measure food security at the household level in low-income settings of NMB. The creation of a formative index employed a multi-step approach involving theoretical guidelines and a framework for formative index development, expert input and consensus, using the Delphi technique, and statistical methods to create the index. The process focused on developing and validating the index using established methodologies and was tested by means of using the pre-existing dataset from phase one.

#### *3.6.2.1 Index development and construction*

The HFSI was developed using step-wise guidelines proposed by (Nardo, Saisana, Saltelli, Tarantola, Hoffman and Giovannini (2005) as instrument and the use of it is outlined as follows:

Step 1: Developing a theoretical framework: This step comprises of defining the concept of household food security and stating a theoretical basis for the selection and combination of single indicators into a composite index. This was conducted as part of the literature review. Household food security by definition is the ability of a household to consistently access sufficient, safe, and nutritious food to meet the dietary needs and preferences of all its members for an active and healthy life (FAO et al., 2023). Household food security primarily operates within the access and utilisation dimensions of the broader food security framework which guided indicator selection.

Step 2: Selecting variables/indicators: Based on the theoretical framework of assessing household food security in low-income settings, three key

indicators, the HDDS, child NS and thirdly, the HHS, were selected. These measures were chosen for their practicality, cost-effectiveness, ease of implementation in clinical settings, and their ability to provide a comprehensive view of food security at household level. In addition to their ability to capture critical aspects of household food security, they are ideal to be used in low-income settings. The HDDS and child NS measurements focus on the access and utilization dimension of food security at individual and household levels, assessing dietary quality and health outcomes within a home, while the HHS reflects household-level access to food. This was supported by expert input obtained with the Delphi technique.

Step 3: Weight allocation of indicators: Indicators were weighted based on expert consensus derived through the Delphi technique, which is a systematic, iterative method well-suited for synthesising expert judgment in areas lacking sufficient empirical data (Niederberger & Renn, 2023). This technique was specifically selected for indicator weight allocation due to its ability to minimise biases and generate reliable consensus without being influenced by small or non-representative sample sizes, which can compromise the validity of statistical weighting methods (Okoli & Pawlowski, 2004; Hsu & Sandford, 2007). Its application ensures methodological rigor and enhances the contextual relevance of the HFSI by incorporating domain expertise into the weighting process.

#### *3.6.2.2 Delphi technique (Questionnaire)*

All communication with experts was conducted via email, and questionnaires were developed based on what input was required in each round. The questionnaires were administered online, using Microsoft forms to facilitate convenient and efficient participation.

For the first round, experts were sent the theoretical framework of the index, along with the first-round questionnaire. The initial questionnaire was formulated based on the theoretical framework and a thorough review of existing literature on household food security. It comprised of quantitative components including Likert scale ratings,

percentage allocation and open-ended feedback on index indicators. Responses were collected and analysed, with aggregated feedback presented back to the panel along with their response. This feedback included the percentage for each Likert scale option selected, along with a proposed weighting of indicators.

For round two and three, the subsequent questionnaires only contained quantitative questions with items achieving 70% or more as consensus, excluded from the questionnaire. After each round aggregated feedback was presented back to the panel. This iterative process continued until the predetermined level of consensus ( $\geq 70\%$ ) was reached on the model structure, indicator weightings and relevance and practicality of the HFSI. Consensus was reached after the third round. Final feedback was provided to the panel, summarising the level of agreement on each item, culminating in the formulation of the HFSI.

### *3.6.2.3 Calculation of HFSI*

The HFSI was calculated as a weighted composite of three normalised indicators: Index Household Dietary Diversity Score (HDDS\_I), derived from the HDDS; Index Household Hunger Scale (HHS\_I), derived from the HHS; and Index Nutritional Status (NS\_I), representing NS measured as BMI-for-age. Their normalised values were aggregated to form a single index value. The weights applied in the aggregation were derived through the Delphi technique, which involved expert consultation to determine the relative significance of each indicator. This approach ensures that the final index accurately reflects a balanced and expert-informed assessment of household food security (Ogbeifun, Agwa-Ejon, Mbohwa & Pretorius, 2016).

Based on HFSI scores (total score out of a 100), households were classified into four categories: “Very Poor Food Security”, “Poor Food Security”, “Fair Food Security” and “Good Food Security”. This classification provides a nuanced understanding of household food security in low-income settings of NMB.

## **3.7 Data collection procedures**

### **3.7.1 Phase One**

Data collection for phase one was conducted across three rounds/timepoints (T1, T2, T3), spanning from February 2019 to November 2021. This phase aimed to investigate the prevalence of household food security among low-income households in NMB, South Africa, and to explore the potential impacts of a large-scale disaster such as the COVID-19 pandemic on the before mentioned group.

Timeline of data collection rounds:

- T1: February-April 2019 (pre-pandemic)
- T2: September-November 2019 (pre-pandemic)
- T3: August-November 2021 (mid-pandemic)

The first two rounds of data collection took place prior to the onset of the COVID-19 pandemic, while the third round occurred during the pandemic. The study population was based in predominantly low-income areas characterised by high unemployment rates and limited access to food, which contributed to food insecurity and child malnutrition. The integration of data from all three rounds allowed for a comparative analysis of household food security, dietary diversity and child NS before and during the COVID-19 pandemic. The data collection context captured both chronic risks associated with structural poverty and acute challenges introduced by the pandemic.

#### ***3.7.1.1 Questionnaire***

A structured questionnaire was administered to a representative from each household responsible for food preparation and most knowledgeable about the household's food consumption patterns. Data collection was conducted by trained research assistants who received detailed instruction on the study objectives, ethical considerations, and standardized data collection procedures prior to commencement.

Questionnaire administration was carried out in person at participating schools during both testing phases in 2019, and telephonically in 2021 due to COVID-19 restrictions. The predominant home languages within the study population were Afrikaans, English, and Xhosa. To minimise potential language barriers, research assistants fluent in Afrikaans and Xhosa were included in the team and provided explanations when participants had trouble understanding questions posed in English.

Dietary intake information was collected using a 24-hour dietary recall and a FIC. Parents or guardians were asked to report all foods and beverages consumed by the household during the previous 24 hours, including portion sizes, preparation or cooking methods, and the time of day each item was consumed.

Household hunger and food security data were collected using the HHS which was adapted to suit the specific socio-economic and cultural context of the study community. Additionally, COVID-19 impact questions were included to assess the pandemic's influence on household food security and dietary patterns. Further details on each instrument can be found in Section 3.5.

#### *3.7.1.2 Household Dietary Diversity Score*

Dietary diversity refers to the variety of foods or food groups consumed over a specific period (HLPE, 2020a). In this study, dietary diversity was calculated according to the HDDS. HDDS was assessed using a 24-hour dietary recall combined with a FIC indicating the twelve food groups, following the guidelines of the FAO (FAO, 2018). This method documented all foods and beverages consumed by the household from the first item in the morning to the last item at night, reducing recall bias and aligning with similar studies. The three pass method was used to ensure that participants recall all items to ensure that the recall was complete (Ruel, 2003; Kennedy, 2009). Trained final-year dietetics students conducted interviews systematically, using randomly assigned recall days. Efforts were made to avoid festive or atypical eating patterns by rescheduling interviews when necessary. The fieldworkers were trained to include questions on locally available foods. Fieldworkers fluent in Afrikaans and Xhosa facilitated communication, ensuring clarity and minimising language barriers.

Respondents were probed to recall all foods eaten on that day, both inside the home and at school or elsewhere, including all meals, snacks, special foods for children and added ingredients (e.g. sugar, sauces and oils). Mixed dishes were deconstructed to account for individual ingredients.

Twelve food groups, as defined by the FAO, were scored as “1” (consumed) or “0” (not consumed). These were:

1. Cereals
2. White tubers and roots
3. Vegetables
4. Fruits
5. Meat
6. Eggs
7. Fish and seafood
8. Legumes, nuts, and seeds
9. Milk and milk products
10. Oils and fats
11. Sweets
12. Spices, condiments, and beverages

The HDDS ranges from 0 to 12, with “low” (0-3), “moderate” (4-5), and “high” (6-12) household dietary diversity (Maxwell et al., 2013). The HDDS is closely tied to food security, as households with higher dietary diversity are more likely to meet their nutritional needs. A diverse diet ensures that households consume an array of essential nutrients, which are crucial for maintaining health and preventing malnutrition. Furthermore, the HDDS can be used to identify households at risk of poor nutrition, especially in settings where food insecurity and poverty limit access to diverse food options (Hoddinott & Yohannes, 2002).

### *3.7.1.3 Household Hunger Score (HHS) and Household Food Security (HFS)*

The HHS was measured using a questionnaire that is based on the HFIAS (Coates et al., 2007). The HHS has been validated in industrialised countries as well as low to

middle income countries. For example, the study by Knueppel and co-workers (2010) showed satisfactory validity and reliability among poor households in rural Tanzania.

Frequency-of-occurrence questions were categorized as:

- Rarely: 1–2 times
- Sometimes: 3–10 times
- Often: More than 10 times

Responses were scored for each of the three questions as follows:

- No = 0
- Rarely (1–2 times) = 1
- Sometimes (3–10 times) = 1
- Often (more than 10 times) = 2

This resulted in a classification of maximum 6 marks.

The Household Hunger Score (HHS) was therefore classified as:

- 0–1: Little to no hunger
- 2–3: Moderate hunger
- 4–6: Severe hunger

To measure household food security the study applied the method developed by Knueppel and colleagues (2010), which makes use of the HHS. It has been validated for use in low-income, rural settings such as Tanzania.

The total score of the HHS was used to classify household food security levels as follows:

- 0–1: Food secure
- 2–6: Food insecure

Summed answers ranged from a score of 0 indicating good access to food (household food security) and 6 indicating prevalence of hunger (household food insecurity). The HHS is a direct measure of food deprivation within households, capturing the severity and frequency of hunger experienced by household members and an indirect measure of household food security.

#### 3.7.1.4 Nutritional Status

Anthropometric measurements were used to assess the child's NS and involves standardised physical measurements of the human body, which provide key insights into individual physical characteristics and overall health (Azupogo et al., 2022). This study collected anthropometric data for children, including age, height and weight.

*Age:* Age data were obtained from parental or caregiver consent forms and cross-verified with school records to ensure accuracy and resolve any discrepancies.

*Height:* Height was measured using a stadiometer to capture the vertical distance from the base of the stadiometer to the top (vertex) of the head while the child stood erect. The field worker ensured proper posture by aligning the child's heels, buttocks, shoulders, and back of the head against the stadiometer. Measurements were taken barefoot and recorded to the nearest 0.1 cm (WHO, 2008). The measurement was confirmed by a second fieldworkers to ensure accuracy.

*Weight:* Weight was measured using a wireless body composition monitor (Tanita MC-580; Tanita Corp., Tokyo, Japan) to the nearest 0.1 kg. The participants were asked to fast for 3 h prior to the data assessment and to empty their bladder before the assessment. Children were weighed in minimal clothing and asked to stand barefoot on the metal plates of the scale, being guided by the research assistant to ensure optimal contact according to the device manufacturer's instructions All measurements were recorded manually on paper data collection forms and electronically extracted from the device. The two records were cross-checked for consistency, and in cases of discrepancy, the electronically recorded value was retained to ensure data accuracy and minimise transcription error. The scale was annually calibrated using a standardised, certified masses (weights) to ensure measurement accuracy (WHO, 2008). Measurements were taken twice and if the measurements differed with more than 0.1 kg, a third measurement was taken. The measurement that was then different, was discarded.

NS, namely weight-for-age, height-for-age and BMI-for-age z-scores were calculated using WHO AnthroPlus software version 1.0.4 and classified according to the WHO growth standards z-scores, which offer a standardised comparison of individual measurements to a healthy reference population (WHO, 2008). WHO z-scores are gender-independent and categorized by gender and age (Turck et al., 2013).

Table 3.1 below, outlines the classification of NS based on z-scores. Weight-for-age reference data were not available for older children (above ten years of age) due to their inability to distinguish relative height and body mass during the pubertal growth spurts (De Onis, 2007).

**Table 3.1: World Health Organization (WHO) classification of nutritional status using z-scores**

Measurement (z-score)	Classification
Weight-for-age (5-10 years)	
±1.00	Normal
-2.00 to -1.01	Mildly underweight
-3.00 to -2.01	Underweight
< -3.00	Severely underweight
Height-for-age (5-19 years)	
±1.00	Normal
-2.00 to -1.01	Mild stunting
-3.00 to -2.01	Stunted
< -3.00	Severely stunted
BMI-for-age (5-19 years)	
≥2.00	Obese
1.01 to 2.00	Overweight
±1.00	Normal
-3.00 to -2.01	Thinness
< -3.00	Severe thinness

(WHO, 2008)

NS is closely associated to household food security as it serves as an indirect indicator of the multidimensional nature of food security, encompassing access, and utilisation of food resources (Abbade, 2017). Anthropometric and health-related indicators such

as NS offers an integrated measure of the capacity of food systems to meet household and individual nutritional needs.

### 3.7.2 Phase Two

Data collection for phase two was conducted from September to October 2024. This phase aimed to develop a comprehensive HFSI, utilising key indicators of household food security as predictors, to provide a robust measure of household food security. This was achieved by incorporating a theoretical framework and established guidelines for index construction, expert consultation through the Delphi technique, and rigorous statistical procedures for index development. All expert communications were carried out through email, while the questionnaire was accessible online using Microsoft Forms to ensure convenient and efficient participation.

#### *3.7.2.1 The Delphi technique*

The Delphi technique was employed in this study to achieve expert consensus on three key aspects of the HFSI: its conceptual model, the weighting of its indicators, and its practical application within the study context. Consensus, a central principle of Delphi studies, is commonly defined through measures such as percentage agreement, median ratings, or the dispersion of responses (Diamond et al., 2014). In this study, consensus was defined as 70% or higher agreement for each question. Items meeting this threshold were accepted as finalized. Typically, two to three rounds are sufficient to reach consensus, though additional rounds may be warranted for complex or contentious topics.

A “modified” Delphi approach was adopted, consistent with contemporary methodological adaptations that deviate from the classical format (Hasson et al., 2000). The process began with the presentation of a theoretical framework and a clear rationale for developing the HFSI. This background information was provided alongside the initial questionnaire, which included quantitative questions such as Likert-scale ratings, percentage allocations, and open-ended feedback that were categorised afterwards, to elicit diverse perspectives. and give some elaboration. This

design enabled experts to contextualize their responses and offer comprehensive input on the conceptual foundations and indicators of the HFSI.

Subsequent rounds were streamlined to include only quantitative questions with no elaboration. Items that had already achieved consensus were excluded, minimizing redundancy and enhancing the efficiency of the process (Ogbeifun et al., 2016). This progressive refinement encouraged continued expert engagement and ensured that each round focused on unresolved or emerging issues.

By the conclusion of the third round, a satisfactory level of consensus, defined as 70% or higher agreement, had been reached across all indicators. The researcher then compiled the results and provided final feedback to the expert panel, summarising the agreed-upon elements of the index. This feedback stage served as a validation checkpoint, allowing experts to confirm that the finalized HFSI reflected their collective judgment and aligned with the study's objectives. The resulting index represented a rigorously developed, contextually relevant, and practically applicable tool, with expert-derived weightings assigned to each indicator according to their perceived importance.

The development of the Delphi questionnaires followed a systematic and methodologically sound approach designed to ensure clarity, comprehensiveness, and adherence to best practices in survey design. Initial questionnaire items were formulated based on an extensive literature review and the theoretical framework underlying household food security research (Hasson et al., 2000). In line with expert recommendations, the number of items was intentionally limited to prevent response fatigue and maintain participant engagement. To promote honest and unbiased responses, all expert feedback was anonymised throughout the process.

Round-by-round data collection:

- Round one: Experts were sent the theoretical framework of the index, along with the first-round questionnaire. Responses were collected and analysed, with aggregated feedback presented to the panel along with their response. This feedback included the percentage for each Likert scale option selected, along with proposed weighting of indicators.

- Round two, three: The subsequent questionnaires was sent to the experts for completion which allowed them to refine their responses based on the aggregated feedback. Items achieving  $\geq 70\%$  consensus were excluded from further iterations/rounds. After each round aggregated feedback was presented back to the panel. This iterative process continued until consensus was reached on the model structure, indicator weightings and relevance and practicality of the HFSI. Consensus was reached after three rounds.
- After satisfactory consensus was reached, final feedback was provided to the panel, summarising the level of agreement for each item, culminating in the formulation of the HFSI. This process allowed for the iterative refinement of a contextually relevant and theoretically sound HFSI.

The Delphi technique was employed in this study for several reasons. It enabled systematic prioritisation of indicators of the index relevant to the NMB area of EC and in a South African context, ensuring that it is culturally specific and practically applicable within local healthcare and community settings. In addition, the iterative nature of the Delphi method allowed for rounds of feedback, where experts could refine their opinions based on collective insights, ultimately strengthening the reliability and validity of the chosen indicators. Finally, the technique facilitated the inclusion of diverse expertise, from public health to nutrition and social sciences, fostering a holistic approach to index development.

### **3.8 Index development and construction**

To create a context specific comprehensive HFSI, a multi-methodological approach was utilised, incorporating a theoretical framework and established guidelines for index construction, expert consultation through the Delphi technique, as well as statistical procedures. In this study, the HFSI was conceptualised and operationalised as a formative index, consistent with the multifaceted nature of food security as defined by global standards (FAO, 2008). Formative indices are particularly suitable when the construct of interest is an aggregate of multiple, distinct dimensions, rather than a unidimensional latent trait manifested through its indicators (Diamantopoulos, Riefler & Roth, 2008; Henseler, Ringle & Sinkovics, 2009).

In developing the formative HFSI, emphasis was placed on construct validation. Construct validity in such models relies primarily on theoretical rationale and expert consensus rather than purely statistical criteria. To strengthen this aspect, a structured Delphi process was incorporated, enhancing both the content validity and contextual relevance of the HFSI. This methodological approach aligns with established best practices for validating formative models in complex, multi-dimensional research contexts (Nardo et al., 2005). Further empirical validation was conducted by applying the index to the existing dataset to assess its performance, consistency, and ability to differentiate between varying levels of household food security (Nardo et al., 2005).

### 3.8.1 Formative index model rationale

Formative models differ from reflective models in that the causal direction flows from the indicators to the construct, rather than from a latent variable to its manifestations (Henseler et al., 2009). In the context of household food security, this means that components such as HDDS, HHS and NS contribute uniquely and non-redundantly to the overall food security status of a household. Unlike reflective indicators, where indicators are assumed to be highly correlated and interchangeable, formative indicators may not be correlated and are not expected to share variance (Diamantopoulos et al., 2008). In this study, each indicator within the HFSI is expected to exhibit consistently low inter-item correlations, indicating that each captures a distinct and independent dimension of household food security.

This aligns with the understanding that household food security is a multi-dimensional construct, encompassing aspects of access, utilisation and stability over time (Santeramo, 2015). Reflective models are not suitable for constructing a HFSI, as each indicator represents a unique and essential aspect of household food security, removing any one of them would change the overall meaning of the index. In contrast, formative models are more appropriate, as they define the construct through its indicators and account for the multi-dimensional nature of food security (Grimaccia, 2022).

### 3.8.2 Methodological approach for the development of the HFSI

The multi-methodological approach for the development and validation of the HFSI is outlined as follows:

- (1) Developing a theoretical framework. This was conducted as part of the literature review.
- (2) Selecting variables/indicators. Based on the theoretical framework of assessing household food security in low-income settings, three indicators i.e. HDDS, NS, and the HHS, were selected in addition to refinement from expert input using the Delphi technique.
- (3) Weight allocation of indicators. Indicators were weighted according to expert input using the Delphi technique. A panel of subject-matter experts participated in multiple rounds of evaluation and feedback to determine the relative importance of each indicator. Based on the final consensus reached through this iterative process, the following weights were assigned:
  - HDDS: 35%
  - NS: 35%
  - HHS: 30%

These final weightings reflect the collective judgment of the expert panel regarding the relative contribution of each indicator to the overall index.

- (4) Calculation of the HFSI

The HFSI is calculated as the weighted sum of three indicators: HDDS\_I based on the HDDS score, HHS\_I based on the HHS scores and NS\_I (NS) based on BMI-for-Age. The weights used in the calculation of the index are those that were obtained using the Delphi method. The three indicators were derived by mapping the observed HDDS, HHS and BMI-for-Age scores onto a 0 to 100 range in such a way that the interpretation of the indicator scores is consistent:  $HFSI < 25$  “very poor food security”,  $25 \leq HFSI < 50$  “poor food security”,  $50 \leq HFSI < 75$  “fair food security”,  $HFSI \geq 75$  “good food security”,

and that there would be no bias due to the different scales used for the indicators. Because of its regular intervals, the mapping for BMI-for-age could be done using a linear function. However, due to the highly non-linear nature of the HDDS and HHS intervals, tables must be used for mapping their scores onto a 0 to 100 range with the correct interpretation intervals as illustrated in Table 3.2 and 3.3 respectively.

**Table 3.2: World Health Organization (WHO) classification of nutritional status (NS) using z-scores**

HDDS Sum	HDDS_I
0	0.00
1	6.25
2	12.50
3	18.75
4	25.00
5	50.00
6	75.00
7	79.17
8	83.33
9	87.50
10	91.67
11	95.83
12	100.00

HDDS = Household Dietary Diversity Score; HDDS\_I = Household Dietary Diversity Score Index

**Table 3.3: Conversion of household hunger scale (HHS) sum to household hunger scale index (HHS\_I)**

HHS Score	HHS_I
0	100.00
1	75.00
2	50.00
3	25.00
4	16.67
5	8.33
6	0.00

HHS = Household Hunger Scale; HHS\_I = Household Hunger Scale Index

Conversion of NS to NS\_I:

$NS\_I = \text{MAX}(0, \text{MIN}(100, 25*(3+BZ)))$  with the MIN and MAX to ensure that NS\_I = 0 for BMI-for-Age  $\leq -3$ , and NS\_I = 100 for BMI-for-Age  $\geq 1$

The formula for the HFSI:

$$\text{HFSI} = \text{WD1}(\text{HDDS\_I}) + \text{WD2}(\text{HHS\_I}) + \text{WD3}(\text{NS\_I})$$

Where, WD1, WD2 and WD3 are the weights obtained using the Delphi method, being WD1 = 0.35, WD2 = 0.30 and WD3 = 0.35

(5) Interpretation and classification of the HFSI

The HFSI score provides a quantitative basis for categorizing households according to their relative food security status. Higher scores represent better food security conditions, while lower scores indicate vulnerability to food insecurity, hunger, and malnutrition. This classification aids in identifying households most at risk and in designing targeted interventions to improve food access and nutritional well-being. Table 3.4 presents the classification of households according to their HFSI scores, outlining four major categories ranging from “Good food security” to “Very poor food security”, along with their respective descriptions.

**Table 3.4: Household food security index (HFSI) classification**

HFSI Score	Category	Description
75<=HFSI<=100	Good food security	Households have consistent access to and utilisation of adequate, nutritious food, supporting an active, healthy life.
50<=HFSI<75	Fair food security	Households experience occasional concern or uncertainty about food access but generally meet basic needs without regular shortages.
25<=HFSI<50	Poor food security	Households report frequent or chronic reductions in food quantity, quality, or desirability, with potential experiences of hunger or nutritional deficiencies.
0<= HFSI<25	Very poor food security	Households face severe, ongoing food shortages, often experiencing hunger, skipped meals, and poor diet quality, with high risk of nutritional deficiency and compromised health and well-being.

HFSI = Household Food Security Index

### 3.8.3 Validation of the HFSI

Construct validity refers to the degree to which a measurement instrument such as the HFSI accurately captures the theoretical construct it intends to measure (Cronbach & Meehl, 1955). However, the process of assessing construct validity differs significantly between reflective and formative models. In formative measurement such as the HFSI, indicators are not assumed to be interchangeable nor reflective of an underlying latent variable; instead, they are defining characteristics of the construct itself. As such, traditional validity metrics like internal consistency (e.g., Cronbach's alpha) or factor loadings are not entirely applicable or meaningful (Diamantopoulos et al., 2008). The validation of the formative HFSI therefore focused on content validity to ensure that the indicators comprehensively capture relevant dimensions of the construct, which is foundational in formative models (Jarvis, MacKenzie & Podsakoff, 2003).

In this study, the construct validity of the formative HFSI was primarily established through content validity using expert judgment through the Delphi technique, reinforced by theoretical mapping and frameworks. To ensure strong content validity and mitigate indicator omission bias, the Delphi technique was incorporated into the development phase of the HFSI. It is especially suitable for validating complex, multidimensional constructs like food security, where expert knowledge is essential in selecting appropriate indicators.

For noting:

- Experts in nutrition, food security, and public health were invited to participate in a Delphi consultation.
- They reviewed the proposed HFSI and its indicators for relevance, practicality and level of importance within the index.
- Their input contributed to refining the final index and the ranking of each component.

This process addressed a common critique of formative indices: the risk of arbitrary or biased indicator selection (Diamantopoulos et al., 2008). By drawing on expert consensus, the Delphi approach helped ensure that all selected indicators are both

conceptually grounded and contextually relevant, which is crucial for formative constructs where each indicator directly shapes the construct meaning.

#### 3.8.4 Application and practical use of the HFSI

The HFSI is designed to serve both clinical and public health functions. In public health and clinical settings, the index is proposed to act as a screening tool to identify at-risk households on site. It can inform referrals for nutritional counselling, social welfare, and food assistance. In public health programmes, it could support the identification, monitoring and evaluation of the programmes by tracking changes in household food security over time and measuring the impact of large disasters or interventions. The index is designed to be feasible in resource-constrained environments. All indicators require minimal training and can be integrated into routine data collection during community health visits or surveys.

### **3.9 Data analysis**

All statistical analyses were conducted under the guidance of a qualified statistician from Nelson Mandela University to ensure accuracy and methodological rigor. The researcher initially recorded the data in a Microsoft Excel spreadsheet. Data was double entered and validated using EpiData version 3.1 (EpiData Association; Odense, Denmark) to ensure quality and accuracy of data entry. The dataset was subsequently cleaned, checked for consistency, and verified by the statistician before formal analysis. IBM SPSS Statistics software (Version 24) was used for all statistical procedures (Pallant, 2020).

#### 3.9.1 Descriptive statistics

Descriptive statistics were computed to summarise the study variables. These included measures of frequency and percentage distributions for categorical variables, as well as measures of central tendency (mean, median) and dispersion (standard deviation, range) for continuous variables (Gravetter, Wallnau, Forzano & Witnauer, 2021).

### 3.9.2 Inferential statistics

Inferential analyses were carried out to test hypotheses and explore patterns within the data (Gravetter et al., 2021). These were organised into univariate and bivariate inferential statistical procedures.

#### *3.9.2.1 Univariate inferential statistics*

Univariate inferential analyses examined whether single study variables differed significantly from hypothesised values or expected distributions.

One-Sample t-Tests: Used to assess whether mean values for continuous study variables differed significantly from reference points across time points. Effect sizes were calculated using Cohen's  $d$  according to Gravetter and coworkers (2021), interpreted as:

- Small:  $0.20 \leq d < 0.50$
- Moderate:  $0.50 \leq d < 0.80$
- Large:  $d \geq 0.80$

Chi-Square goodness-of-fit tests: Employed to determine whether observed categorical frequencies (e.g., change between T1 and T2) differed significantly from expected distributions. Practical significance was assessed using Cramér's  $V$ , with interpretation based on the number of degrees of freedom ( $df = \min[\text{rows}-1, \text{columns}-1]$ ) (Gravetter et al., 2021):

- $df = 1$ : Small = 0.10–0.29; Moderate = 0.30–0.49; Large  $\geq 0.50$
- $df = 2$ : Small = 0.07–0.20; Moderate = 0.21–0.34; Large  $\geq 0.35$
- $df \geq 3$ : Small = 0.06–0.16; Moderate = 0.17–0.28; Large  $\geq 0.29$

#### *3.9.2.2 Bivariate inferential statistics*

Bivariate inferential analyses explored differences or relationships between two variables, either categorical or continuous.

Independent-Samples t-Tests: Used to examine mean differences in study variables between groups (e.g., by sex or COVID-19 impact survey item). Effect sizes were calculated using Cohen's *d*, as per thresholds above.

Correlation Analysis: Pearson's product-moment correlation coefficient (*r*) was used to assess the strength and direction of relationships between continuous variables. The following interpretation thresholds were applied (Gravetter et al., 2021):

- Small:  $0.10 \leq r < 0.30$
- Moderate:  $0.30 \leq r < 0.50$
- Large:  $r \geq 0.50$

### 3.9.2.3 *Threshold for significance and practical importance*

A significance threshold of  $p < 0.05$  was applied across all inferential tests to minimise Type I error. However, statistical significance alone was not considered sufficient for interpretation. Each test was therefore supplemented with effect size statistics (Cohen's *d*, Cramér's *V*, eta squared, or Pearson's *r*) to evaluate the practical significance of the results (Gravetter et al., 2021).

## 3.10 Ethical considerations

Ethics encompass the moral principles that guide the behaviour and decisions of researchers, assistants, sponsors, and participants in scientific investigations (De Vos, Strydom, Fouché & Delport, 2011). The researcher prioritised participant well-being, ensuring benefits, confidentiality and anonymity throughout the study. The study was conducted in accordance with the ethical principles outlined in the Belmont Report specifically autonomy, non-maleficence, beneficence, and justice (Varkey, 2021). As the research involved children under the age of 18, these ethical principles were carefully explained to both the parents or legal guardians and the children themselves to ensure informed understanding and voluntary participation.

A research proposal was submitted and approved by the Faculty Postgraduate Studies Committee and the Nelson Mandela University Research Ethics Committee (Human).

Ethical clearance was granted (REC-H number: H23-HEA-DIET-010) by the Nelson Mandela University Research Ethics Committee (Human), and permissions were obtained from the Eastern Cape Department of Education and relevant schools.

Participation in the study was entirely voluntary, with informed consent obtained from all participants. For minors, written assent was obtained from the child, along with written consent from the parent or legal guardian (see Addendum I and J). Participants were fully informed about the study's purpose and procedures and were assured that they could withdraw from the study at any time without experiencing any negative consequences.

The same ethical principles applied to the expert panel participating in the Delphi method. The study procedures were clearly explained in the invitation to participate letter, and participation was strictly voluntary. Informed consent was obtained from all panel members (involved in the Delphi procedure), who were also informed of their right to withdraw at any stage without any adverse repercussions.

To uphold the principles of justice and non-maleficence, the researcher ensured fair and equitable treatment of all participants, considering their individual needs and circumstances. The principle of non-maleficence was maintained by creating a safe and respectful environment in which participants were protected from any form of physical or emotional harm.

All procedures were conducted in accordance with strict ethical protocols to minimise potential psychosocial discomfort, embarrassment, or perceived judgment during anthropometric measurements and questionnaire administration. Questions relating to sensitive topics, such as food access and household experiences, were approached with empathy and sensitivity. Participants were clearly informed that they could decline to answer any question that made them uncomfortable. In instances where participation elicited emotional distress, appropriate support and referral mechanisms were available to ensure participant well-being (De Vos et al., 2011).

Privacy was protected by using unique codes instead of the names of the participants to maintain anonymity. Participant data was securely stored on an access-controlled

cloud-based platform with strong passwords, and paper records will remain confidential. Data was stored securely in a locked room and accessible only to authorized personnel. All the data collected will be used exclusively for scientific research purposes. When publishing the finding of the study no names or personal identities will be revealed. With the completion of the study all data were given to the primary responsible person (supervisor) who securely stored the data as mentioned above and it will be destroyed after five years to ensure confidentiality.

The researcher upheld ethical standards through competence, honesty and sensitivity. The well-being of participants was prioritized, avoiding harm and providing accurate, timely reports (De Vos et al., 2011).

To ensure the control of quality, final-year dietetic students, trained to administer and analyse the questionnaires, conducted a 20-participant pilot study. Volunteers fluent in Afrikaans and isiXhosa assisted with translations to ensure understanding.

### **3.11 Strengths and limitations**

Strengths of the study include methodological rigor through a quantitative research design. This design allowed for the integration of expert knowledge with empirical data. The modified Delphi method provided a systematic and transparent process for eliciting expert consensus, incorporating diverse disciplinary perspectives from public health, nutrition, and food security. This method enhanced the validity and credibility of the selected indicators by ensuring alignment with real-world conditions and practitioner expertise. The use of both a theoretical framework and expert input ensures that the index reflects not only theoretical importance but also empirical relevance. This hybrid approach improves the accuracy and reliability of the HFSI (Hasson et al., 2000; De Villiers, De Villiers & Kent, 2005). This approach strengthened the development of a contextually relevant and statistically robust HFSI (Carletto, Zezza & Banerjee, 2013; Fetters, Curry & Creswell, 2013; Boateng, Neilands, Frongillo, Melgar-Quinonez & Young, 2018).

The study is grounded in a socio-economically disadvantaged setting (NMB, EC) and designed for practical application in both clinical and public health environments which

could support future targeted interventions and continuous monitoring of this vulnerable population, aligning with Sustainable Development Goal 2 (Zero Hunger) (FAO et al., 2023).

The results of the study should however be interpreted in the light of the following limitations. A notable limitation of this study lies in the potential for recall bias, particularly stemming from the reliance on self-reported responses during surveys. These data, while essential, are vulnerable to memory distortion or selective recollection. This bias is especially relevant for the 24-hour dietary recall, which assumes accurate remembrance of all food items consumed, an expectation that may be less reliable in low-literacy settings or among older caregivers (Vucic, Glibetic, Novakovic, Ngo, Ristic-Medic, Tepsic, Ranic, Serra-Majem & Gurinovic, 2009; Gibson, Charrondiere & Bell, 2017). Similarly, questions related to food access required participants to reflect on the past, potentially leading to temporal confusion or emotional reinterpretation of events.

Moreover, recall bias may not be random; it could be systematically influenced by sociodemographic factors such as age, education level, or psychological well-being (Jackson, Williams, Stein, Herman, Williams & Redmond, 2010). For example, households under chronic food insecurity might underreport hunger episodes due to normalization, while others may overemphasise hardships due to recent traumatic events (Althubaiti, 2016). Results that are based on self-reported or memory-dependent data should be interpreted with measured caution, acknowledging the potential underreporting or overreporting introduced by recall bias (Tadesse, Abate & Zewdie, 2020).

To minimise the impact of recall bias in this study, several mitigating strategies were implemented throughout data collection and analysis. First, the study employed standardised and validated survey instruments. These tools were specifically designed to prompt accurate memory recall and ensure consistency across respondents. Field workers received comprehensive training regarding data collection, reducing the risk of introducing interviewer bias. The recall periods were intentionally kept short to reduce memory decay and enhance precision. In addition, the survey tools and methods were pilot tested prior to deployment, allowing refinement of items prone to

misunderstanding or recall difficulties. Collectively, these measures enhanced the reliability of self-reported data and mitigated, though did not eliminate, the limitations associated with recall bias. Future research should consider using shorter recall periods (e.g., same-day food diaries), incorporate objective health records or school feeding logs to supplement anthropometric and dietary data and potentially integrating mobile-based real-time reporting tools, which reduce retrospective distortion.

Other limitations of the study include expert selection bias during the Delphi method. Although purposive sampling was appropriate, the selection of experts may have introduced selection bias, as those with an interest in food security were more likely to participate (Hasson et al., 2000). This may limit the diversity of perspectives represented. With ten experts completing all rounds, the panel size, while within acceptable Delphi guidelines, may limit response stability and generalisability of the consensus findings. Larger panels might yield more diverse viewpoints or refine the HFSI further.

Lastly, while the index is tailored to the South African context, specifically NMB, its generalisability to other regions, particularly rural or formal urban settings, remains limited and necessitates further empirical validation and contextual adaptation. Reasons being that the structure and assumptions of the index are rooted in socio-economic and infrastructural conditions specific to NMB, which may not be representative of broader regional or national realities. In rural contexts, for example, key variables such as informal economies, traditional governance systems, and subsistence-based livelihoods may be under-represented or entirely absent from the index framework. Cultural, institutional, and policy differences across regions and countries further limit direct transferability, as the priorities, vulnerabilities, and capacities in other contexts may differ markedly. As such, meaningful application beyond the original study area would require contextual adaptation. Therefore, while the index holds potential as a replicable framework, its transferability is not automatic and demands careful, context-sensitive modification backed by localised data collection, stakeholder input, and pilot testing in diverse settings.

### **3.12 Conclusion**

This chapter has detailed the methodological approach employed to examine household food security and child NS among low-income households in NMB, EC, South Africa. It outlined the study design, sampling procedures, data collection tools, and analytical techniques used to ensure methodological rigor, reliability, and validity of the results. The use of validated instruments and a robust analytical strategy support the credibility of the results and ensures that the research objectives and hypotheses are addressed systematically. Additionally, the inclusion of the modified Delphi method and statistical validation procedures strengthens the development of the HFSI, ensuring that it is contextually relevant and empirically sound.

The next chapter presents and discusses the study's results. It begins by describing the demographic characteristics of the sample population, followed by an examination of child NS, household dietary diversity, and household experiences of hunger. The chapter further explores the extent and patterns of food security, including observed changes before and during the COVID-19 pandemic, to highlight the impact of the pandemic's disruptions on household food security. Finally, it concludes with the presentation and validation of the HFSI, developed to provide a comprehensive measure of household food security within the NMB context.

## **CHAPTER 4: RESULTS AND DISCUSSION**

### **4.1 Introduction**

This chapter presents and discusses the results regarding household food security amongst low-income households in NMB, EC, South Africa. In this chapter, the results are presented and after each section the results are discussed so that it is not necessary to go back to compare results and discussions. It commences by discussing the demographic profile of the sample. The chapter then discusses the NS of the children in addition to the diversity of diet and hunger experienced by the household. It also covers the level of food security among households. Furthermore, changes in household food security and its associated indicators over time, including the potential impact of a large-scale disruption such as the COVID-19 pandemic, are examined. It concludes with the outcomes of the constructed HFSI, developed to robustly assess the level of household food security within the study population.

### **4.2 Demographic profile of the sample**

This section presents the demographic characteristics of the participants included in the study. Key demographic variables such as age, gender and other relevant attributes are summarized to provide a clear profile of the study population.

The study tracked a cohort of 1 270 school-aged children (52% male, 48% female) across three longitudinal assessment points (T1, T2, and T3) between 2019 and 2021. The near-equitable gender distribution indicates that the dataset is broadly representative of both genders, thereby minimizing the risk of gender-based sampling bias and ensuring inclusivity in subsequent analyses.

Participant retention demonstrated a gradual decline over time, with 1 270 participants completing assessments at T1, 1 232 at T2, and 526 at T3. This attrition pattern likely reflects the broader contextual challenges of the study period, including COVID-19-related school disruptions, health concerns, and movement restrictions that impeded

consistent participation. Attrition effects were accounted for in the statistical analyses to preserve the validity of longitudinal comparisons.

The frequency distribution across the four participating schools reveals that school one had the highest representation, accounting for 33% (n = 428) of the total sample. School two followed closely with 31% (n = 404). Both school three and school four had equal but lower representations, each contributing 18% (n = 240 and n = 234) respectively. The inclusion of the four schools ensures a balanced and diverse dataset.

At T1, most participants were between the ages of six and nine, with age seven the most common (23.5%). At T2, the distribution remains similar, with age seven still having the highest count (n = 295, 23.9%), followed closely by ages eight and nine. At T3, the age distribution shifts significantly, with a higher concentration of older individuals. Age nine (n = 129; 24.5%), age ten (n = 116; 22.1%), and age eleven (n = 127; 24.1%) made up most of the sample at this time point, indicating a natural progression of aging across the study period.

### **4.3 Phase One**

The first phase of this study examined household food security within low-income households in NMB, EC, South Africa. The analysis was guided by two key objectives. The first was to assess the prevalence of food security and its associated indicators within households located in low-socioeconomic areas of NMB, EC. The second was to explore the potential effects of the COVID-19 pandemic on household food security, dietary diversity, hunger and child NS in this population. The results presented in this section address these objectives, providing insights into both the baseline conditions of household food security and the extent to which they may have been influenced by the pandemic.

#### **4.3.1 Description of indicators for Phase One**

Descriptive statistics of central tendency and dispersion of the study variables for each time point (T1, T2 and T3) in phase one are presented in Table 4.1.

**Table 4.1: Description of indicators for phase one variables**

Variable	Time point	N	Mean	S.D.	Minimum	Quartile 1	Median	Quartile 3	Maximum
Age (years)	T1	1 270	7.83	1.46	5.00	7.00	8.00	9.00	13.00
	T2	1 232	8.39	1.45	6.00	7.00	8.00	9.25	13.00
	T3	526	10.37	1.38	8.00	9.00	10.00	11.00	14.00
Height (cm)	T1	1 270	124.70	9.24	102.20	117.93	124.00	131.00	152.00
	T2	1 232	127.57	9.33	104.20	120.60	126.90	133.93	177.40
	T3	526	139.41	9.62	115.90	132.40	138.85	145.90	168.30
Weight (kg)	T1	1 270	25.39	6.87	13.50	20.80	23.90	28.20	61.20
	T2	1 232	27.50	7.40	14.50	22.60	25.90	30.50	70.30
	T3	526	36.18	11.27	18.70	28.33	33.10	40.90	86.40
Weight/age z-score	T1	1 231	-0.42	1.26	-4.12	-1.25	-0.51	0.24	6.35
	T2	1 142	-0.13	1.26	-3.51	-0.96	-0.23	0.55	5.07
	T3	282	0.14	1.43	-3.46	-0.87	-0.09	0.81	7.08
Height/age z score	T1	1 270	-0.67	1.04	-3.88	-1.37	-0.71	0.00	4.90
	T2	1 230	-0.65	1.00	-3.49	-1.34	-0.68	-0.01	3.13
	T3	526	-0.57	1.08	-3.83	-1.35	-0.61	0.22	2.99
BMI/age z score	T1	1 270	-0.12	1.27	-4.86	-0.92	-0.21	0.56	6.58
	T2	1 230	0.11	1.14	-2.87	-0.67	0.01	0.73	5.44
	T3	526	0.21	1.32	-2.96	-0.73	0.07	1.03	5.00
HDDS	T1	965	5.31	1.93	0.00	4.00	5.00	7.00	10.00
	T2	958	4.85	1.78	0.00	4.00	5.00	6.00	11.00
	T3	210	3.45	1.45	0.00	2.00	3.00	4.00	9.00
HHS	T1	724	2.21	1.19	0.00	2.00	2.00	3.00	6.00
	T2	730	2.34	1.33	0.00	2.00	2.00	3.00	6.00
	T3	210	3.28	1.97	0.00	2.00	2.00	6.00	6.00

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3

#### 4.3.1.1 Anthropometry

The anthropometric results revealed in general a concerning state of child growth and NS within the study population (Table 4.1). Nevertheless, incremental improvements were observed across several growth indicators over time. These results highlight the persistent challenges faced by low-income communities, while simultaneously revealing the emergence of more complex and interrelated child health and nutrition concerns, most notably the triple burden of malnutrition, which encompasses the coexistence of undernutrition, micronutrient deficiencies, and overweight or obesity within the same population, household, or even individual (Harper et al., 2022; FAO et al., 2023; Moyo, Egal & Oldewage-Theron, 2023). Within this shifting context, understanding child growth dynamics becomes essential. In particular, the phenomenon of growth catch-up provides critical insight into how children respond to periods of nutritional deprivation followed by recovery. Catch-up growth typically refers to accelerated weight or height gain that occurs after a phase of slowed growth, as the body attempts to realign with its genetic potential when environmental conditions improve (Prentice, Ward, Goldberg, Jarjou, Moore, Fulford & Prentice, 2013; Jee, Baron, Phillip & Bhutta, 2014). However, when catch-up occurs predominantly in weight without corresponding improvements in height, it may reflect partial or maladaptive recovery, potentially increasing the risk of later-life overweight, obesity and metabolic disorders (McLaren, Steenkamp, Feeley, Nyarko, Cur & Venter, 2018). Therefore, examining the patterns of anthropometric changes in this study not only reveals the enduring challenges of undernutrition but also exposes the emerging dual and triple burdens of malnutrition within vulnerable South African communities.

For the weight-for-age z-score, the mean value at T1 was negative ( $-0.42 \pm 1.26$ ), indicating that participants were, on average, below the reference population's mean weight-for-age and exhibited signs of mild wasting. At T2, the mean weight-for-age remained negative ( $-0.13 \pm 1.26$ ), although slightly closer to the reference mean, suggesting marginal improvement. By T3, the mean z-score had shifted into the positive range ( $0.14 \pm 1.43$ ), reflecting a progressive trend toward enhanced weight status relative to the reference population. This upward trajectory implies modest but meaningful gains in nutritional outcomes over time.

The height-for-age mean scores presented a concerning pattern, reflecting more limited improvement over time. At T1, the mean height-for-age z-score was  $-0.67 \pm 1.04$ , indicating mild stunting relative to the reference population. At T2, the mean height-for-age remained largely unchanged ( $-0.65 \pm 1.00$ ), showing minimal progress. A slight improvement was observed at T3 ( $-0.57 \pm 1.08$ ), suggesting modest gains in linear growth, though the overall trend continued to reflect suboptimal height outcomes compared to reference standards. This pattern reflects a phenomenon widely described as “catch-up growth”, a process in which a child who has experienced early growth retardation exhibits accelerated weight or height gain following the alleviation of previous constraints (Ong, 2000). Catch-up growth is typically observed following periods of nutritional deprivation or illness and represents the body’s physiological attempt to restore growth trajectories when conditions improve (McLaren et al., 2018). However, the pattern identified in this study, weight recovery without substantial linear growth, suggests partial catch-up, which may be insufficient to fully mitigate the consequences of early-life stunting (Handa & Peterman, 2016). This finding aligns with evidence that children in socioeconomically constrained settings often experience early nutritional insults that affect skeletal growth, leading to long-term deficits in height despite improvements in body mass (Ong, 2000; Prentice et al., 2013; Handa & Peterman, 2016; McLaren et al., 2018).

The BMI-for-age mean scores exhibited a pattern of gradual improvement over time, consistent with the trend observed for weight-for-age. At T1, the mean BMI-for-age z-score was slightly negative ( $-0.12 \pm 1.27$ ), indicating a tendency toward mild underweight relative to the reference population. By T2, the mean had increased to a positive value ( $0.11 \pm 1.14$ ), reflecting an improvement in overall weight status. This positive trend continued at T3, where the mean further increased to  $0.21 \pm 1.32$ , suggesting a sustained shift toward a healthier and more favourable NS among the study participants.

**Table 4.2: Description of nutritional status characteristics**

<b>Variable</b>	<b>Time point</b>	<b>N(%)</b>
<b>Weight/age</b>		
Severely underweight	T1	17(1.4)
	T2	6(0.5)
	T3	2(0.7)
Underweight	T1	77(6.3)
	T2	44(3.9)
	T3	6(2.1)
Mildly underweight	T1	298(24.22)
	T2	225(19.7)
	T3	48(17.0)
Normal	T1	839(68.2)
	T2	867(75.9)
	T3	226(80.1)
<b>Height/age</b>		
Severely stunted	T1	10(0.8)
	T2	6(0.5)
	T3	3(0.6)
Stunted	T1	103(8.1)
	T2	89(7.2)
	T3	42(8.0)
Mild stunting	T1	387(30.5)
	T2	365(29.7)
	T3	141(26.8)
Normal	T1	770(60.6)
	T2	770(62.6)
	T3	340(64.6)
<b>BMI/age</b>		
Severe thinness	T1	10(0.8)
	T2	0(0.0)
	T3	0(0.0)
Thinness	T1	48(3.8)
	T2	23(1.9)
	T3	18(3.4)
Normal weight	T1	1 009(79.4)
	T2	980(79.7)
	T3	374(71.1)
Overweight	T1	119(9.4)
	T2	146(11.9)
	T3	75(14.3)
Obese	T1	84(6.6)
	T2	81(6.6)
	T3	59(11.2)

T1 = Time point 1; T2 = Time point 2; T3 = Time point 3

The categorical anthropometric results presented in Table 4.2, also indicated a generally concerning state of child growth and NS within the study population. Although incremental improvements were observed over time, indicators of wasting, stunting, and undernutrition remained evident, accompanied by emerging cases of overweight and obesity. These results underscore the persistent nutritional challenges faced by low-income communities, while also highlighting the growing complexity of child health and nutrition concerns within this context (Nengovhela et al., 2025).

Levels of underweight among children remained a concern throughout the study period. Nevertheless, an improvement in weight-for-age status was observed over time. At T1, 68.2% children classified as having a normal weight, while 31.9% were underweighted to varying degrees. By T2, the percentage of individuals with normal weight increased to 75.9%, while those classified as underweight declined to a combined 24.1%. At T3, the percentage of individuals with normal weight further increased to 80.1%, while those classified as underweight decreased to 19.9%. Within this category, 17.0% were mildly underweight, 2.1% were underweight, and 0.7% were severely underweight. Despite this decrease in undernutrition, almost one in five children in the final round of data collection remained underweight, which is concerning and underscores the persistence of undernutrition in this vulnerable population.

These results are consistent with Harper, Goudge, Chirwa, Rothberg, Sambu and Mall (2022), who reported that nationally 88% of children aged 10-17 in South Africa were classified as normal weight and 7.7% as underweight. However, children in low-income communities face heightened risks of malnutrition due to factors such as food insecurity, inadequate maternal education and limited access to healthcare, which contribute to poorer NS (Ijaiya, Anjorin & Uthman, 2024). For instance, a study in the EC province found a higher prevalence of malnutrition among children in low-income communities (Moyo et al., 2023). Additionally, more recent international research on child food poverty indicated that 23% of children in South Africa live in severe food poverty, making them up to 50% more likely to suffer from life-threatening malnutrition (UNICEF, 2024a). These results highlight the need for targeted interventions to address the nutritional challenges faced by children in low-income communities.

Although modest improvements were observed over the study period, a substantial proportion of children continued to experience some degree of stunting, highlighting the persistent nature of chronic undernutrition in the study population. As presented in Table 4.2 at baseline (T1), 60.6% of children were classified as having a normal height-for-age, while 39.4% exhibited varying degrees of stunting. Of those affected, 30.5% presented with mild stunting, 8.1% were moderately stunted, and 0.8% were severely stunted. By T2, the proportion of children with normal height increased to 62.6%, accompanied by a reduction in the prevalence of stunting to 37.4%. A similar trend was noted at T3, with 64.6% of children classified as normal height-for-age and 35.4% still affected by stunting. Although this indicates a gradual improvement in linear growth over time, the persistence of stunting in more than one-third of the sample population remains a significant concern.

This pattern mirrors broader national and regional results, suggesting that despite some progress, stunting continues to affect a large proportion of South African children, particularly those from low-income households. Prendergast and Humphrey (2014) highlighted that stunting is often established within the first 1,000 days of life and is difficult to reverse thereafter, even when nutritional conditions improve. This underscores the importance of early-life nutrition interventions, as linear growth deficits during critical developmental windows can have lasting impacts on physical growth, immune function, and cognitive outcomes. Similarly, May and colleagues (2021) demonstrated that while South Africa has made progress in reducing underweight and wasting, rates of stunting have declined only marginally over the past decade, largely due to persistent socioeconomic inequalities and inadequate dietary diversity among children in impoverished communities. More recently, Nengovhela, Ledwaba and Hlongwane (2025) reported comparable results in Limpopo Province, where 36% of children under five remained stunted despite improvements in food availability, suggesting that improvements in energy intake do not necessarily translate into improved linear growth when dietary quality remains poor.

In alignment with these studies, the results confirm that linear growth faltering remains a key public health concern in low-income communities in NMB. The slight but consistent improvements in height-for-age observed across time points suggest that while nutritional access and energy adequacy may have improved, the underlying

determinants of chronic undernutrition, such as limited dietary diversity and poor maternal nutrition, continue to hinder optimal growth. The pattern observed in this cohort also reflects a potential catch-up in weight without proportional gains in height, a phenomenon noted in populations exposed to early nutritional deprivation followed by improved food availability. This incomplete catch-up, as discussed in (Prentice et al., 2013), may contribute to the dual burden of malnutrition observed in this study, where children simultaneously face risks associated with both stunting and rising overweight prevalence.

The BMI-for-age status presents a concerning picture, indicating the double burden of malnutrition which is the coexistence of underweight, normal weight, and overweight individuals within the population. The nutritional trend indicates an increase in the proportion of children with normal weight and a decrease in those who are underweight, while simultaneously highlighting a rise in the prevalence of overweight classifications. At T1, most individuals (79.4%) were classified as having a normal weight. However, 20.6% of the population fell outside the normal range, with 9.4% being overweight, 6.6% classified as obese, 3.8% as thin, and 0.8% as severely thin. At T2, the percentage of individuals with normal weight increased marginally to 79.7%. The underweight categories almost disappeared, while the percentages for overweight and obese remained relatively stable at 11.9% and 6.6% respectively. At T3, the percentage of overweight individuals increased to 14.3%, and obesity increased to 11.2%, while thinness rose to 3.4%.

These results also support the evidence of a nutritional transition. By the final timepoint, more than one in four children (25.5%) were classified as overweight or obese, compared to 16% at baseline. The shifts mirror national trends reported by May and co-workers (2020) and Popkin, Corvalan and Grummer-Strawn (2020), pointing to the coexistence of persistent undernutrition with rising risks of overweight and obesity. This phenomenon has been linked to South Africa's nutrition transition of increased consumption of ultra-processed foods and reduced physical activity (Kehoe et al., 2021).

Overall, the anthropometric data from the study indicate a nuanced nutritional profile among the participating children. Over the three time points, there was a noticeable

decline in the prevalence of wasting and stunting, suggesting some improvements in nutritional outcomes over time. Nevertheless, both forms of undernutrition remain concerning due to their well-documented long-term implications for health, cognitive development, and overall growth (UNICEF et al., 2025). Concurrently, an increase in the prevalence of overweight and obesity was observed, highlighting the emergence of a double burden of malnutrition, a phenomenon increasingly evident in South African children living in vulnerable settings (Shisana et al., 2013; SAdoH, 2015b; Shekar et al., 2024; UNICEF, 2024a). This trend is particularly alarming from a public health perspective, as excess weight in childhood is associated with a higher risk of developing cardiovascular diseases, type 2 diabetes, and other chronic conditions, many of which persist into adulthood (Popkin et al., 2020).

Concurrently, an increase in the prevalence of overweight and obesity was observed, highlighting the emergence of the double burden of malnutrition—a phenomenon increasingly documented among South African children living in socioeconomically vulnerable settings (Shisana et al., 2013; South African Department of Health [SAdoH], 2015b; Shekar et al., 2024; UNICEF, 2024a). This coexistence of undernutrition and excess weight within the same communities, households, and even individuals reflects the complex nutritional transition occurring in South Africa and other low- and middle-income countries.

It should be acknowledged that BMI-for-age is not a direct measure of adiposity, but rather an index of weight relative to height that serves as a proxy indicator of body fatness (De Onis, 2007). Although BMI-for-age is widely recommended for population-level surveillance and epidemiological studies in children and adolescents, it does not distinguish between fat mass and lean body mass and may therefore misclassify adiposity in certain contexts (Freedman, Wang, Maynard, Thornton, Mei, Pierson, Dietz & Horlick, 2005). Emerging evidence increasingly supports the inclusion of direct measures of adiposity (e.g., skinfold thickness, dual-energy X-ray absorptiometry) or alternative anthropometric indices such as waist-to-height ratio when assessing cardiometabolic and nutritional risk in paediatric populations (McCarthy & Ashwell, 2006; Hales, Freedman, Akinbami, Wei & Ogden, 2022).

However, the present study population was not sport-specific and was not characterised by elevated lean muscle mass that could substantially distort BMI classification. In resource-constrained, primary care and community-based settings, particularly in low-income contexts, BMI-for-age remains a practical, cost-effective, non-invasive, and easily implementable screening tool (UNICEF, 2024a). Its use in this study was therefore justified on the basis of feasibility, scalability and alignment with national and international child growth monitoring guidelines. Nevertheless, the limitations of BMI as a proxy for adiposity should be considered when interpreting findings related to overweight and obesity prevalence.

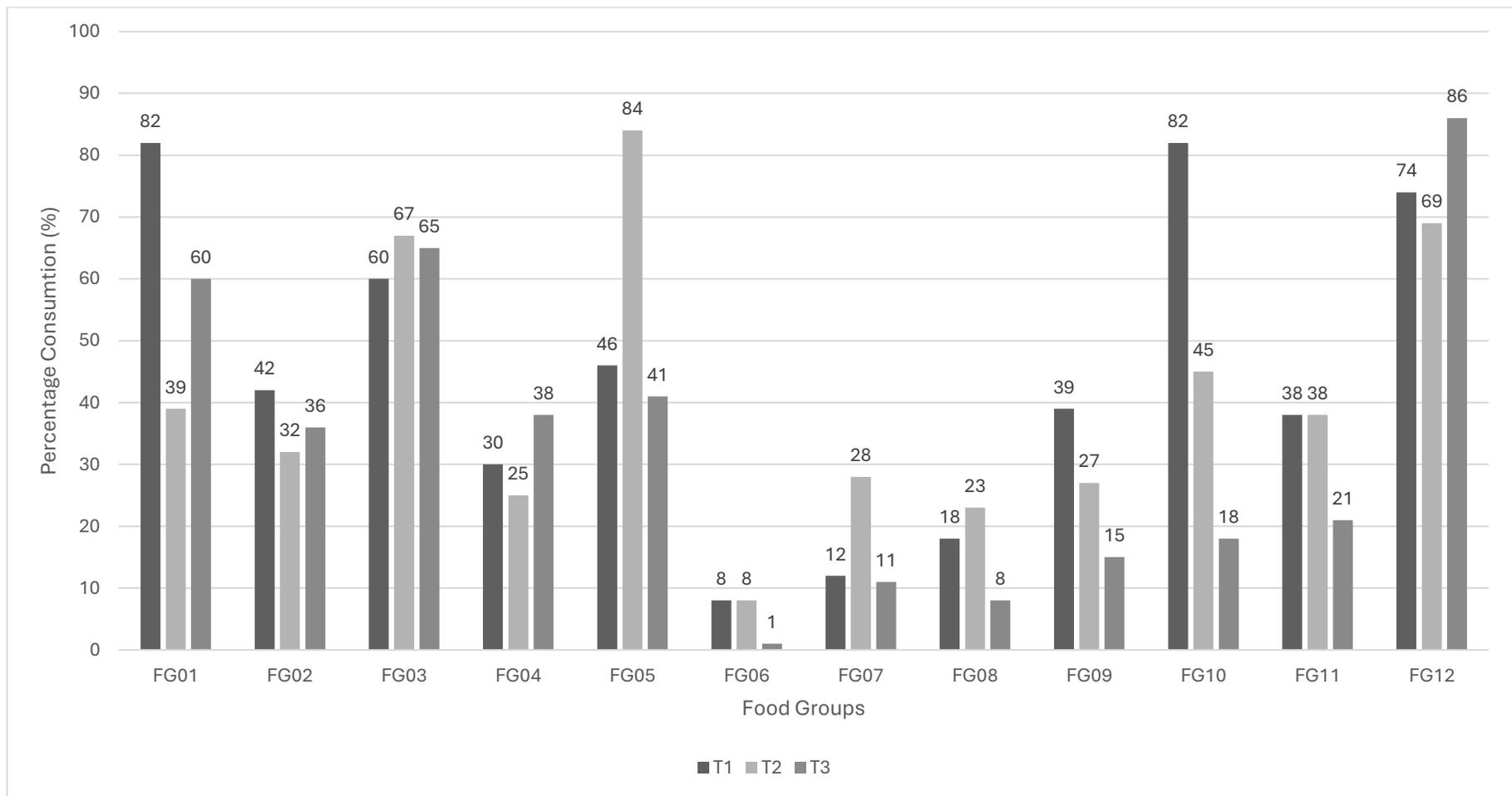
At baseline, anthropometric indicators reflected mild undernutrition and stunting, consistent with the ongoing challenges of inadequate dietary intake, food insecurity, and early-life growth deficits in the study population. Over the course of the study, modest improvements were observed in weight-for-age and BMI-for-age scores, suggesting gradual enhancements in energy intake and short-term nutritional outcomes. In contrast, height-for-age showed limited improvement, indicating persistent linear growth deficits.

The persistence of stunting, even in the context of improved weight status, underscores the need for nutrition-sensitive interventions that go beyond energy sufficiency. It is suggested that programmes aimed at addressing child growth should prioritize dietary quality, micronutrient adequacy and early-life nutrition, alongside efforts to improve household food security and socioeconomic conditions. Furthermore, these results highlight the importance of continuous monitoring of both short-term (weight-based) and long-term (height-based) growth indicators to fully understand child NS and to inform public health strategies aimed at mitigating the double burden of malnutrition.

#### *4.3.1.2 Household dietary diversity*

##### *Food group consumption patterns*

Figure 4.1 illustrates the consumption of the nine food groups used to determine dietary diversity in this study, by households over the study period. Analysis of household dietary diversity revealed pronounced disparities in food group consumption across the study period, reflecting both persistent dietary limitations and a deterioration in access to nutrient-dense foods.



FG = Food group; FG01 = Cereals; FG02 = White tubers and roots; FG03 = Vegetables; FG04 = Fruits; FG05 = Meat; FG06 = Eggs; FG07 = Fish and seafood FG08 = Legumes, nuts, and seeds; FG09 = Milk and milk products; FG10 = Oils and fats; FG11 = Sweets; FG12 = Spices, condiments, and beverages; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3

**Figure 4.1: Food group consumption by households**

At baseline, the participants' diet was primarily composed of cereals, white tubers and roots, vegetables, oils and fats, spices, condiments, and beverages. By the end of the study period, dietary patterns had shifted, with cereals, vegetables, spices, condiments, and beverages remaining predominant. However, overall consumption levels declined, particularly for fats and oils and milk and milk products. Consumption of key food groups such as eggs, fish and seafood and legumes, nuts and seeds remained minimal throughout the study potentially causing risk for macro- and micronutrient deficiencies, particularly iron, zinc and vitamin A ( Ndungu & Chege, 2019; Diop, Becquey, Turowska, Huybregts, Ruel & Gelli, 2021) This nutritional inadequacy may further contribute to the triple burden of malnutrition, characterized by the simultaneous presence of undernutrition, micronutrient deficiencies, and overweight or obesity within the same population (Nengovhela et al., 2025). This phenomenon underscores the nutritional transition occurring in many low- and middle-income settings, where limited dietary diversity and the consumption of energy-dense but nutrient-poor foods coexist (Popkin et al., 2020). Simultaneously, reliance on refined cereals and fats contributes to the rising prevalence of overweight and diet-related non-communicable diseases (Swinburn, Kraak, Allender, Atkins, Baker, Bogard, Brinsden, Calvillo, De Schutter, Devarajan, Ezzati, Friel, Goenka, Hammond, Hastings, Hawkes, Herrero, Hovmand, Howden, Jaacks, Kapetanaki, Kasman, Kuhnlein, Kumanyika, Larijani, Lobstein, Long, Matsudo, Mills, Morgan, Morshed, Nece, Pan, Patterson, Sacks, Shekar, Simmons, Smit, Tootee, Vandevijvere, Waterlander, Wolfenden & Dietz, 2019).

A notable decline was observed across several food groups, indicating reduced dietary diversity and a shift toward nutritionally limited consumption patterns. The most pronounced decrease was seen in the intake of oils and fats, which fell sharply from 82% at baseline to 18% by T3, suggesting a substantial reduction in dietary energy sources. Similarly, the proportion of households consuming milk and milk products declined from 39% to 15%, reflecting decreased access to or affordability of these nutrient-dense foods. Eggs remained the least consumed food group, with household consumption never exceeding 12% throughout the study period. Fish and seafood, as well as pulses, legumes, and nuts, also showed persistently low consumption levels, with uptake remaining below 30% at all time points. These results further indicate the possibility of micro-nutrient deficiencies (Nengovhela et al., 2025) and are consistent

with those of Sambo, Oguttu and Mbombo-Dweba (2022), who reported that 78% of South African households in the Nkomazi Local Municipality consumed vegetables and 69% consumed condiments and beverages, whereas only 3% consumed eggs or fish, and 16% consumed legumes, patterns indicative of a strong reliance on a narrow range of food groups among low-income households.

Similar patterns of dietary decline have been reported globally, underscoring a widespread reduction in food diversity among low-income households. The observed reductions in the consumption of animal-sourced foods, dairy, and oils are consistent with research documenting that economic shocks and food price inflation have led to declines in both dietary quality and energy adequacy (Ambikapathi, Schneider, Davis, Herrero, Winters & Fanzo, 2022; Khandoker, Singh & Srivastava, 2022). The FAO and co-workers (2023) also reported a global decrease in the consumption of milk, eggs, and fish among poorer populations, attributing this trend to the combined effects of rising food costs, supply chain disruptions, and limited access to nutrient-dense foods.

In Nigerian households, similar patterns were reported where oils, dairy products, and protein-rich foods are commonly excluded during periods of food scarcity. Likewise, persistently low consumption of eggs and pulses has been documented in low-income African households, driven by both affordability constraints and cultural preferences (Mekonnen, Trijsburg, Achterbosch, Brouwer, Kennedy, Linderhof, Ruben & Talsma, 2021; Balana, Ogunniyi, Oyeyemi, Fasoranti, Edeh & Andam, 2023; Headey, Alderman, Hoddinott & Narayanan, 2024). These results align closely with Choudhury, Headey and Masters (2019) who demonstrated that reductions in fats and oils intake significantly lower dietary energy availability, thereby increasing the risk of undernutrition among vulnerable groups. Comparable reductions in dietary diversity have also been observed in East Africa and Southeast Asia, with similar transitions toward energy-dense but micronutrient-poor diets in Kenya and Indonesia, respectively (Nurhasan, Ariesta, Utami, Fahim, Aprillyana, Maulana & Ickowitz, 2024; Kipkoech, Korir, Fischer & Ruto, 2025). Collectively, these studies highlight a global nutritional transition characterized by declining diversity, reduced access to high-quality foods and increased dependence on inexpensive staples.

The implications of these results are multifaceted and far-reaching. As mentioned, nutritionally, the decline in the consumption of energy- and protein-rich foods increases the risk of micronutrient deficiencies, particularly in vitamins A, D, and B12, as well as iron and calcium, and contributes directly to anaemia, protein-energy malnutrition and stunted growth among children (Hoddinott, Gillespie & Yosef, 2015; FAO et al., 2021; Bonuedi, Kornher & Gerber, 2022). From a health perspective, such dietary narrowing weakens immune function and diminishes both physical and cognitive performance (Headey et al., 2024). Economically, households experiencing food insecurity tend to reallocate spending toward low-cost, energy-dense staples with poor nutrient profiles, thereby reinforcing cycles of poverty and malnutrition (Devereux, Béné & Hoddinott, 2020). These dietary shifts also point to increased volatility in protein intake and a growing instability in household food environments (Harper et al., 2022). Moreover, as Gatto, Kuiper and Van Meijl (2023) caution, heavy reliance on a narrow range of staple foods heightens vulnerability to market shocks and seasonal food insecurity, especially among low-income populations.

The persistence of high consumption of cereals, condiments and beverages across all study periods reflects their relative affordability and accessibility compared to other food groups. However, these food categories contribute minimally to overall nutritional quality, emphasizing the growing risk of diets dominated by foods with low nutrient density. Cereal-based products, such as refined maize meal, white rice, and bread, are typically low in protein, essential vitamins (particularly B-complex vitamins), and minerals, while some processed varieties are enriched with added sugars and fats, leading to excessive carbohydrate and energy intake (Cheteni et al., 2020; Gassara & Chen, 2021). This nutritional imbalance not only compromises household wellbeing but also exacerbates long-term risks of NCDs such as obesity, type 2 diabetes, and cardiovascular illness (Nguyen et al., 2021).

Although fruit consumption exhibited a modest increase toward the later stages of the study, overall intake remained below national and international dietary recommendations, while vegetable consumption, though relatively stable, did not offset the declining intake of nutrient-dense food groups such as dairy, fish and legumes. More recently, Beal and colleagues (2024) demonstrated that declining dietary diversity among vulnerable populations often reflects broader systemic

constraints, including decreased purchasing power, volatile food prices and recurrent exposure to global shocks. The observed temporal fluctuations in household food group consumption in this study may therefore reflect the lingering effects of external crises such as the COVID-19 pandemic, which disrupted food systems, increased economic instability, and reduced food availability and accessibility (Akseer, Kandru, Keats & Bhutta, 2020; Laborde, Martin & Vos, 2021).

In summary, the patterns of food group consumption point to an erosion of household dietary diversity over time, with increasing reliance on inexpensive, energy-dense staples and declining access to nutrient-rich foods, declining intake of animal-source foods, and persistently low access to legumes and fish. This narrowing of dietary options poses significant risks for micronutrient adequacy, child growth, and overall household food security (FAO, IFAD, et al., 2022). The results reinforce concerns that households in low-income informal settlements are not only facing worsening food insecurity, but are increasingly reliant on nutritionally inadequate diets, a trend with profound implications for public health and long-term development (Militao, Salvador, Uthman, Vinberg & Macassa, 2022).

#### *Household dietary diversity*

The mean HDDS, as presented in Table 4.1, reflected a pattern of moderate dietary diversity across the study period; however, a notable decline over time raises concern. The mean dietary diversity score was highest at T1 ( $5.31 \pm 1.93$ ), indicating moderate diversity in household diets. This was followed by a gradual decrease at T2 ( $4.85 \pm 1.78$ ) and a more pronounced decline at T3 ( $3.45 \pm 1.45$ ), though still within the moderate diversity range. The median dietary diversity scores mirrored this downward trend, suggesting a progressive reduction in the variety of food groups consumed by households, particularly evident at T3. This decline may reflect worsening access to diverse foods or changes in household food security over time (Gassara & Chen, 2021).

A key contextual factor influencing this trend was the COVID-19 pandemic, which coincided with the final data collection period (T3). The pandemic and associated lockdown restrictions had profound socioeconomic impacts, particularly on low-income communities already vulnerable to food insecurity. Studies across South Africa

reported sharp declines in household income, increased unemployment, and disrupted food supply chains during this period (Laborde et al., 2021; Rusere, Hunter, Collinson & Twine, 2025). These disruptions reduced the affordability and availability of diverse foods such as fruits, vegetables, and animal-source proteins, while simultaneously increasing reliance on cheaper, energy-dense staple foods.

Evidence from national and provincial surveys supports this interpretation: StatsSA (2022) and the NIDS-CRAM documented a significant rise in household food insecurity and a decline in dietary quality during and after the lockdown periods (Alaba, Hongoro, Thulare & Lukwa, 2022; StatsSA, 2022; Van Der Berg et al., 2022). Gassara and Chen, (2021) similarly noted that household coping strategies in response to pandemic-related shocks often involved reducing meal frequency, limiting dietary variety, and prioritizing staple foods over nutrient-dense options.

The pattern observed in this study aligns closely with these broader results. The decline in HDDS at T3 likely reflects the compounding effects of economic strain, food price inflation, and constrained food access during the pandemic, all of which exacerbated existing inequalities in food security and nutrition. These results underscore how external shocks, such as COVID-19, can reverse gains in dietary diversity and highlight the need for resilient, context-specific interventions that strengthen local food systems and safeguard nutritional wellbeing during crises.

**Table 4.3: Description of household dietary diversity score (HDDS) variable characteristics**

	<b>Time point</b>	<b>N(%)</b>
Low diversity	T1	144(15)
	T2	186(19)
	T3	107(51)
Moderate diversity	T1	377(39)
	T2	438(46)
	T3	90(43)
High diversity	T1	444(46)
	T2	334(35)
	T3	13(6)

T1 = Time point 1; T2 = Time point 2; T3 = Time point 3

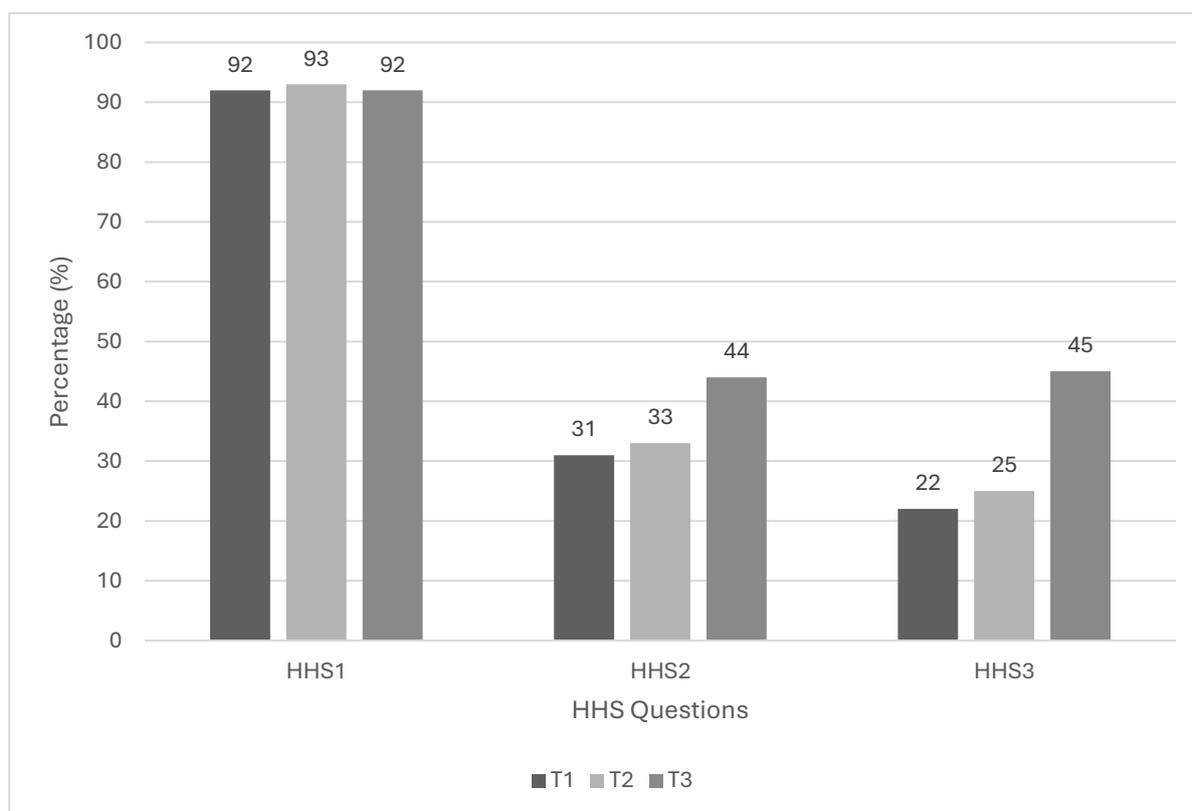
The HDDS results (Table 4.3) indicated that most households experienced moderate to high dietary diversity during the initial stages of the study. However, by the final timepoint, dietary diversity had declined significantly, raising concerns. At T1, 46% of households reported high dietary diversity; however, this proportion declined to 35% at T2, accompanied by an increase in households with moderate (46%) and low (19%) diversity. By T3, the decline was more pronounced, with over half of households (51%) classified as having low dietary diversity, while only 6% maintained high diversity. The progressive decline observed in this study underscores growing household vulnerability to food insecurity and an elevated risk of micronutrient deficiencies.

These results contrast with national estimates from the 2020 South African Child Gauge, which reported that 80.8% of households consumed highly diverse diets, 14.9% had moderate diversity, and only 4.3% reported low diversity. The discrepancy may be explained by the characteristics of the study population, which comprises households from low-income and vulnerable settings only and is therefore not representative of the national sample. The results of this study are consistent with those of Sambo, Oguttu and Mbombo-Dweba (2022), who found that 40.28% of households, in comparable low-income settings, had low dietary diversity, 49.86% had medium dietary diversity, and only 9.86% achieved high dietary diversity, with a mean of 3.90, indicating that the population consumed a diet of moderate diversity. These similarities underscore the persistent challenges in achieving adequate dietary diversity within vulnerable populations. They are also alarming, as a balanced and varied diet has broader implications for public health. It can play a crucial role in reducing stunting among vulnerable populations, as research indicates that limited dietary diversity increases the risk of nutrient deficiencies and impedes child growth and development (FAO et al., 2023). Moreover, the NS outcomes in this study corroborate the observed low levels of dietary diversity, consistent with evidence from prior research, thereby highlighting the imperative of strengthening HDDS as a possible strategic intervention to enhance child growth and overall developmental outcomes.

### 4.3.1.3 Household hunger

#### HHS responses

Household hunger responses revealed persistent and intensifying food insecurity across the study period, with patterns pointing to both chronic deprivation and a deterioration in more severe forms of hunger. Figure 4.2 illustrates the distribution of affirmative (“Yes”) responses for three hunger scale items (HHS1, HHS2, HHS3), while Table 4.4 provides the frequency of these experiences over the preceding 30 days.



HHS1= Household Hunger Scale question 1; HHS2= Household Hunger Scale question 2; HHS3 = Household Hunger Scale question 3; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3

**Figure 4.2: Percentage distributions of affirmative responses to HHS questions**

**Table 4.4: Description of frequency of occurrence distributions of household hunger scale (HHS) questions**

Variable	Never N(%)	Rarely/Sometimes N(%)	Often N(%)
T1: HHS1	56(8)	191(26)	477(66)
T2: HHS1	54(7)	178(24)	498(68)
T3: HHS1	17(8)	28(13)	165(79)
T1: HHS2	503(69)	183(25)	28(5)

T2: HHS2	492(67)	176(24)	62(8)
T3: HHS2	117(56)	24(11)	69(33)
T1: HHS3	563(78)	128(18)	33(5)
T2: HHS3	551(75)	124(17)	55(8)
T3: HHS3	116(55)	20(10)	74(35)

HHS1= Household Hunger Scale question 1; HHS2= Household Hunger Scale question 2; HHS3 = Household Hunger Scale question 3; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3

Consistently high affirmative responses to HHS1, which measures whether there was ever no food of any kind in the household, were observed across all time points (over 90%), as shown in Figure 4.2, 92% at T1, 93% at T2, and 92% at T3. This indicates that most households experienced chronic and recurrent food shortages throughout the study. The frequency distribution (Table 4.4) reinforces this interpretation, with 79% of households at T3 reporting food shortages occurring often in the past 30 days, compared to 66% at baseline. These results suggest that food scarcity was not only widespread but also became increasingly frequent over time.

Affirmative responses to HHS2, which measures whether any household member went to bed hungry, were lower compared to HHS1, but demonstrated a notable upward trend, increasing from 31% at T1 to 33% at T2, and rising sharply to 44% at T3 (Figure 4.2). This pattern indicates a worsening of household food access over time. For HHS2, related to the frequency of going to sleep hungry, as illustrated by Table 4.4, indicated that at T1 69% of households reported that no one ever went to sleep hungry, while 25% indicated that it occurred rarely or sometimes, and 5% experienced it often. By T2, these figures shifted slightly, with 67% never experiencing hunger at bedtime, 24% reporting it rarely or sometimes, and 8% frequently. However, by T3, the prevalence of going to sleep hungry increased notably, with only 56% of households never experiencing it, 11% reporting it rarely or sometimes, and a significant rise to 33% experiencing it often. This trend highlights a worsening in food security over time, particularly in T3, suggesting that a growing proportion of households faced persistent food insufficiency by the end of the day, a finding with significant implications for public health and psychosocial well-being.

For HHS3, the most severe measure, asked whether any household member went a whole day and night without eating (Figure 4.2). Although less common at baseline (22%), this indicator showed the steepest deterioration over time. By T3, 45% of

households experiencing it. Table 4.4 illustrates that at T1, 78% of households reported that no one ever went a whole day and night without eating, while 18% indicated that it occurred rarely or sometimes, and 5% experienced it often. However, by T3, the prevalence of going a whole day and night without eating increased notably, with only 55% of households never experiencing it, 10% reporting it rarely or sometimes, and a significant rise to 35% experiencing it often. This escalation reflects a critical erosion of household resilience, with families unable to buffer themselves from the most extreme manifestations of hunger.

Together, these results highlight an intensification of hunger and food insecurity across all levels of severity, culminating in substantial increases in the most extreme forms of hunger by the final timepoint. The results resonate with recent national surveys (StatsSA, 2025), which reported rising rates of household hunger in South Africa, but the magnitudes observed here were considerably higher, reflecting the disproportionate vulnerability of low-income households compared to national averages as mentioned before.

The observed patterns of persistent and worsening food insecurity align with evidence from regional research. Investigations conducted in the EC province further substantiate and provide contextual depth to these results. Ngema, Sibanda and Musemwa (2018) reported that over 70% of households experienced some level of food insecurity, primarily due to unemployment, limited livelihood diversification and dependence on social grants. Similarly, Ngarava (2022) found that rural households exhibited persistent food insecurity and low dietary diversity, with 64% of households classified as severely food insecure.

Manduna (2023) further highlighted that the COVID-19 pandemic exacerbated food insecurity in the EC, with disrupted food supply chains, rising staple prices, and loss of informal income contributing to worsening hunger. This trend closely parallels the deterioration from T2 to T3 observed, suggesting that pandemic-related shocks amplified pre-existing structural vulnerabilities.

Notably, while the baseline prevalence of hunger for this study (HHS1 >90%) was already higher than most EC averages, the rate of increase in severe hunger indicators

(HHS2 and HHS3) over time mirrors the province-wide surge observed between 2020 and 2022 (Lujabe et al., 2022). This consistency strengthens the argument that households in structurally and economically disadvantaged settings were disproportionately affected by COVID-19's socioeconomic impacts and ongoing cost-of-living pressures.

The trajectory observed aligns with results from Cheteni, Khamfula and Mah (2020), who identified unemployment, inequality, and food price inflation as primary determinants of food insecurity in South Africa. Similarly, Ningi and co-workers (2022) showed that rural households across South Africa and Zimbabwe face chronic food shortages driven by low agricultural productivity and insufficient social safety nets. Within this context, the persistence of high HHS1 scores across all time points suggests that the households in this study were operating under structural deprivation, with minimal capacity to recover from shocks or rebuild food reserves.

The FAO and co-workers (2023) report similarly emphasizes that the COVID-19 pandemic magnified existing inequities, increasing the prevalence of moderate to severe food insecurity globally. For the EC and similar regions, these impacts were compounded by geographic isolation, limited infrastructure, and market access constraints, all of which reduced food availability and affordability during lockdowns.

The sustained and intensifying pattern of food insecurity has profound implications for physical and mental health. Leroy and colleagues (2015) argue that chronic exposure to food insecurity produces cumulative physiological and cognitive effects, including malnutrition, weakened immune function, and psychosocial distress. In the current study, the rise in households frequently going to bed hungry or spending entire days without food, suggests a transition from episodic to chronic hunger, which may contribute to poor child growth outcomes, increased stress and reduced work capacity.

In summary, the HHS indicators depict a troubling escalation from chronic but moderate food insecurity at baseline to widespread and severe hunger by the end of the study period. The increasing frequency of going to bed hungry and spending entire days without food underscores the urgent importance of continued monitoring of food security. Evidence from this study wider EC literature illustrates a consistent trajectory

of deepening food insecurity marked by structural inequality, economic marginalization, and limited social safety nets. Furthermore, the results reinforce that household food insecurity in the region has become chronic and systemic, with families increasingly unable to buffer themselves against both economic shocks and environmental stresses.

### *Household hunger*

The experience of hunger over time revealed moderate levels of household hunger within the sample, accompanied by a concerning worsening trend across the study period. As shown in Table 4.1, the mean HHS at T1 was  $2.21 \pm 1.19$ , indicating a moderate level of hunger with relatively low variability among households. At T2, the mean increased slightly to  $2.34 \pm 1.33$ , suggesting a mild deterioration in hunger levels and greater variation in household experiences, though still within the moderate range. By T3, the mean hunger score had risen markedly to  $3.28 \pm 1.97$ , remaining within the moderate category but reflecting a marked deterioration in household hunger. This upward shift in mean score, coupled with increased variability, points to intensifying and more uneven experiences of hunger across households; an alarming trend with important implications for nutritional and food security (FAO et al., 2021; Wudil, Usman, Rosak-Szyrocka, Pilař & Boye, 2022).

These results align with regional and national patterns observed in South Africa, where household hunger remains a persistent concern among low-income populations. According to the FAO (2021), moderate hunger indicates that households regularly experience uncertainty or insufficiency in food access, often leading to reduced meal quantity or quality. This reflects a condition of transitory food insecurity, where families may oscillate between periods of relative adequacy and deprivation depending on income stability, food prices, and access to social support systems. Wudil and co-workers (2022) similarly found that moderate-to-severe hunger disproportionately affects urban poor and informal settlement communities in sub-Saharan Africa, where food systems are highly sensitive to economic and environmental shocks.

The marked deterioration in HHS between T2 and T3 observed in this study coincides with the COVID-19 pandemic period (2020–2021), suggesting that the pandemic substantially exacerbated household hunger among the study population. Multiple

studies have documented how COVID-19 and associated lockdown measures intensified food insecurity by disrupting livelihoods, reducing household income, and constraining physical access to markets and diverse foods (Jee et al., 2014; Kundu, Banna, Sayeed, Sultana, Brazendale, Harris, Mandal, Jahan, Abid & Khan, 2021; Laborde et al., 2021; Gelo & Dikgang, 2022; StatsSA, 2022; Rusere et al., 2025). In South Africa, widespread job losses and the closure of informal trading networks disproportionately affected low-income households, many of which relied on unstable or casual employment to sustain daily food needs (Arndt, Davies, Gabriel, Harris, Makrelov, Robinson, Levy, Simbanegavi, Van Seventer & Anderson, 2020).

Evidence from the NIDS-CRAM Survey further demonstrated that during the first year of the pandemic, over 47% of South African households reported running out of money to buy food, with child hunger doubling compared to pre-pandemic levels (Van Der Berg et al., 2022). These results correspond closely with the rise in HHS at T3 observed in this study, indicating that the socioeconomic disruptions of COVID-19 directly worsened household hunger and food insecurity in the sample population. Households likely adopted coping strategies such as skipping meals, reducing portion sizes, or prioritizing children’s food intake, behaviours consistent with moderate-to-severe hunger classifications (FAO et al., 2021).

**Table 4.5: Description of household hunger scale (HHS) variable characteristics**

	<b>Time point</b>	<b>N(%)</b>
Little to no hunger	T1	131(18)
	T2	121(17)
	T3	20(10)
Moderate hunger	T1	505(70)
	T2	496(68)
	T3	106(50)
Severe hunger	T1	88(12)
	T2	113(15)
	T3	84(40)

T1 = Time point 1; T2 = Time point 2; T3 = Time point 3

The household hunger status within the population, as illustrated in Table 4.5, is concerning, as the majority of households experienced moderate levels of hunger throughout the study period. Notably, significant fluctuations were observed over time, reflecting trends similar to those seen in household dietary diversity. At T1, 12% of

households reported experiencing severe hunger, which increased to 15% in T2. By T3, this figure rose dramatically to 40%, signalling a critical escalation in food insecurity. Moderate hunger remained the most common experience across the study periods, with 70% of households affected at T1 and 68% at T2. However, by T3, the percentage of households experiencing moderate hunger declined to 50%.

The pronounced escalation in severe hunger at T3 may be attributed to a combination of economic instability, resource constraints, and broader socio-economic challenges that intensified household vulnerability. Importantly, the third data collection period (T3) coincided with the aftermath of the COVID-19 pandemic, which significantly disrupted household food security across South Africa.

This trend aligns closely with national evidence highlighting the widespread deterioration of household food security during and after the COVID-19 pandemic. Reports by StatsSA (2021, 2022) consistently emphasize the pandemic's adverse effects on food access and affordability, particularly among low-income households. The Centre of Excellence in Food Security (2021) reported a marked worsening of household food insecurity and dietary quality in the wake of the pandemic (Adeniyi, Losch & Adelle, 2021). This was largely driven by rising food prices, disruptions in food supply chains, job losses, and reduced income opportunities, which collectively eroded household resilience. Furthermore, the National Food and Nutrition Security Report (2024) similarly documented that 5.6% of households experienced severe hunger and 15.3% moderate hunger during the pandemic, illustrating the significant impact of COVID-19 on national food access (Simelane et al., 2024).

These results contextualize the observed increase in severe hunger at T3, suggesting that the pandemic likely accelerated pre-existing trends of food insecurity. The convergence of economic strain reduced income opportunities and inflationary food prices likely contributed to worsening household hunger, particularly among low-income households.

#### 4.3.1.4 Household food security

Household food security as illustrated by Table 4.6 revealed striking results, with majority of the sample classified as food insecure across all timepoints. Moreover, the situation deteriorated over time, underscoring the severity of food insecurity within this population.

**Table 4.6: Description of household food security variable characteristics**

	Time point	N(%)
Household food security	T1	131(18)
	T2	121(17)
	T3	20(10)
Household food insecurity	T1	593(82)
	T2	609(83)
	T3	190(90)

T1 = Time point 1; T2 = Time point 2; T3 = Time point 3

At T1, only 18% of households were classified as food secure, while the remaining 82% experienced varying degrees of food insecurity across the 724 households surveyed. By T3, the situation had worsened considerably, with food security declining to 10% of households and 90% experiencing food insecurity. These stark differences underscore the acute vulnerability of households in informal settlements, where structural poverty, limited income-generating opportunities, and precarious livelihoods exacerbate nutritional risk and constrain access to sufficient, safe, and diverse foods (FAO, IFAD, et al., 2022; Sambo et al., 2022).

It is important to note that the levels of food insecurity observed in this study are substantially higher than national estimates. The National Food and Nutrition Security Survey (NFNSS) reported an overall food insecurity prevalence of 63.5%, indicating that households in low-income settings are disproportionately affected relative to the broader population (Simelane et al., 2024).

The marked deterioration in food security over the study period coincides with the COVID-19 pandemic, which had profound socio-economic impacts on vulnerable communities. Lockdowns, disruptions to informal employment, and widespread income losses reduced household purchasing power, while inflation and supply chain

disruptions further limited access to nutritious foods (Alaba et al., 2022; Gelo & Dikgang, 2022). National surveys during the pandemic reported a sharp rise in household food insecurity, with many families relying on coping strategies such as reducing meal frequency or dietary diversity (StatsSA, 2021, 2022). The timing of T3 suggests that COVID-19-related economic shocks likely contributed substantially to the heightened prevalence of food insecurity observed in this study, compounding pre-existing structural vulnerabilities.

In conclusion, the results reveal a complex and evolving landscape of household food security within these low-income communities. The nutritional profile of the participating children further underscores the severity of the situation, highlighting persistent vulnerabilities and raising significant concern regarding both current and long-term health outcomes. At baseline, evidence indicated mild undernutrition and stunting, consistent with chronic nutritional deprivation and limited dietary diversity. Over time, modest improvements in weight-for-age and BMI-for-age scores were observed, suggesting gradual progress in short-term nutritional recovery. However, height-for-age z-scores exhibited limited improvement, indicating persistent linear growth deficits despite gains in body mass.

This pattern reflects a common phenomenon known as catch-up growth, where increases in weight precede or occur without proportional gains in height (Victora, De Onis, Hallal, Blössner & Shrimpton, 2010; Prentice et al., 2013; McLaren et al., 2018). In the context of this study, the observed improvement in weight-for-age without corresponding height gains suggests the occurrence of partial or disproportionate catch-up, primarily in body mass rather than stature. Such patterns are typical in environments where short-term nutritional access improves, yet chronic structural conditions, such as poverty, food insecurity, and limited dietary diversity, continue to constrain long-term linear growth (Victora et al., 2010; Prentice et al., 2013).

Importantly, while catch-up in weight may indicate temporary nutritional recovery, it can also carry metabolic risks if rapid weight gain occurs without proportional skeletal or lean tissue development (Black, Singhal, Uauy & Adair, 2014; Wells, Sawaya, Wibaek, Mwangome, Poullas, Yajnik & Demaio, 2020). This imbalance increases the likelihood of childhood overweight and obesity, a pattern that emerged in the current

cohort alongside persisting stunting, illustrating the double burden of malnutrition. These results mirror national trends in South Africa, where improvements in food access and energy intake coexist with poor dietary quality and persistent micronutrient deficiencies (StatsSA, 2021; FAO et al., 2023).

Parallel to these individual-level nutritional dynamics, household dietary diversity and hunger indicators displayed a declining trend over the study period, signalling worsening food security amid broader socioeconomic stressors. The deterioration in household food access suggests that the modest nutritional improvements observed among children may have been achieved under increasingly constrained conditions, reflecting the fragility of nutritional gains in the context of systemic inequality and economic instability (FAO et al., 2023).

Collectively, these results underscore that catch-up growth, when occurring in the absence of sustained dietary quality and household food security, may represent a compensatory but unstable adaptation. The multidimensional nature of malnutrition in South Africa, where short-term gains in weight coexist with long-term growth deficits and rising obesity, shaped by the intersection of poverty, urbanization and nutritional transition, is clear in this study. The persistence of stunting despite apparent weight recovery emphasizes the urgent need for nutrition-sensitive interventions that move beyond energy adequacy to prioritize dietary quality, early-life nutritional support, and the reduction of structural inequities within food systems. Such efforts should be guided by the continuous monitoring of child NS and household food security indicators to ensure sustained and equitable improvements in growth and well-being.

#### 4.3.2 Differences of the phase one study variables over time

Table 4.7 illustrates the inferential statistics of central tendency and dispersion differences of the study variables over time. Cohen's *d* effect sizes interpreted the magnitude of these changes, with values classified as small (0.2-0.5), medium (0.5-0.8), or large (>0.8) (Gravetter & Wallnau, 2016). Majority of study variables exhibited statistically significant changes across the time points, with effect sizes ranging from small to large, reflecting varying degrees of practical significance.

**Table 4.7: Differences of study variables over timepoints (H1:  $\mu \neq 0.00$ )**

Variable	Time point	N	Mean	S.D.	95%CI Lo	95%CI Hi	t	d.f.	p	Cohen's d	
Height (cm)	T2-T1	1 196	2.96	2.81	2.8	3.12	<b>36.47</b>	1 195	<b>&lt;0.001</b>	<b>0.44</b>	<b>Small</b>
	T3-T2	523	11.62	3.95	11.28	11.96	<b>67.23</b>	522	<b>&lt;0.001</b>	<b>1.88</b>	<b>Large</b>
	T3-T1	518	14.64	3.43	14.34	14.94	<b>97.21</b>	517	<b>&lt;0.001</b>	<b>3.05</b>	<b>Large</b>
Weight (kg)	T2-T1	1 196	2.19	1.43	2.11	2.28	<b>53.15</b>	1195	<b>&lt;0.001</b>	<b>1.40</b>	<b>Large</b>
	T3-T2	523	8.5	4.78	8.09	8.91	<b>40.63</b>	522	<b>&lt;0.001</b>	<b>0.90</b>	<b>Large</b>
	T3-T1	518	10.66	5.37	10.2	11.13	<b>45.19</b>	517	<b>&lt;0.001</b>	<b>1.20</b>	<b>Large</b>
Weight/age z-score	T2-T1	1 111	0.3	0.49	0.27	0.33	<b>20.44</b>	1 110	<b>&lt;0.001</b>	<b>8.04</b>	<b>Large</b>
	T3-T2	281	0.34	0.63	0.27	0.42	<b>9.03</b>	280	<b>&lt;0.001</b>	<b>6.08</b>	<b>Large</b>
	T3-T1	278	0.51	0.69	0.43	0.6	<b>12.46</b>	277	<b>&lt;0.001</b>	<b>5.36</b>	<b>Large</b>
Height/age z-score	T2-T1	1 194	0.02	0.43	0	0.05	1.86	1 193	0.062	9.61	Large
	T3-T2	523	0.05	0.4	0.01	0.08	<b>2.7</b>	522	<b>0.007</b>	<b>10.34</b>	<b>Large</b>
	T3-T1	518	0.08	0.53	0.04	0.13	<b>3.5</b>	517	<b>0.001</b>	<b>7.76</b>	<b>Large</b>
BMI/age z-score	T2-T1	1 194	0.23	0.5	0.2	0.26	<b>15.85</b>	1 193	<b>&lt;0.001</b>	<b>7.89</b>	<b>Large</b>
	T3-T2	523	0.08	0.53	0.04	0.13	<b>3.64</b>	522	<b>&lt;0.001</b>	<b>7.82</b>	<b>Large</b>
	T3-T1	518	0.31	0.67	0.25	0.37	<b>10.64</b>	517	<b>&lt;0.001</b>	<b>5.81</b>	<b>Large</b>
HDDS	T2-T1:	950	-0.45	1.68	-0.55	-0.34	<b>-8.17</b>	949	<b>&lt;0.001</b>	<b>0.26</b>	<b>Small</b>
	T3-T2:	178	-0.99	2.18	-1.31	-0.67	<b>-6.06</b>	177	<b>&lt;0.001</b>	<b>0.45</b>	<b>Small</b>
	T3-T1:	173	-1.71	2.12	-2.03	-1.39	<b>-10.60</b>	172	<b>&lt;0.001</b>	<b>0.81</b>	<b>Large</b>
HHS	T2-T1	711	0.08	0.54	0.04	0.12	4.09	710	<b>&lt;0.001</b>	0.15	Not sig.
	T3-T2	140	1.04	2.33	0.65	1.42	<b>5.27</b>	139	<b>&lt;0.001</b>	<b>0.45</b>	<b>Small</b>
	T3-T1	128	1.40	2.44	0.97	1.83	<b>6.47</b>	127	<b>&lt;0.001</b>	<b>0.57</b>	<b>Medium</b>

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values in bold indicate statistical significance ( $p < 0.05$ )

Table 4.8 presents the inferential statistics of frequency distribution differences of the categorical study variables over time. Chi-square tests of independence were conducted, and practical significance was assessed using Cramér's V, with interpretation based on the number of degrees of freedom. In the context of a chi-square test, the degrees of freedom represent the number of independent values that are free to vary when estimating the association between categorical variables. This value indicates the complexity of the cross-tabulation and influences both the chi-square distribution and interpretation of Cramér's V effect size (Agresti, 2018).

Statistically significant changes ( $p < 0.001$ ) were observed over time for BMI-for-age status, HDDS, HHS, and overall household food security, with effect sizes ranging from small to large, indicating varying levels of practical significance. Although weight-for-age and height-for-age indicators did not reach statistical significance, several notable trends and patterns were observed across change intervals, indicating potential subtle shifts in these household food security–related outcomes.

**Table 4.8: Frequency distributions differences of categorical study variables over time**

Variable	Time point	Chi <sup>2</sup> (d.f.)	N	p	Cramér's V	
Weight/age	T2-T1	1.34 (3)	1111	0.721	0.03	None
	T3-T2	4.76 (3)	281	0.191	0.13	Small
	T3-T1	3.95 (3)	278	0.267	0.12	Small
Height/age	T2-T1	2.44 (3)	1194	0.485	0.05	None
	T3-T2	5.35 (3)	523	0.148	0.10	Small
	T3-T1	4.28 (3)	518	0.232	0.09	Small
BMI/age	T2-T1	18.51 (4)	1194	<b>0.001</b>	<b>0.12</b>	<b>Small</b>
	T3-T2	5.17 (4)	523	0.271	0.10	Small
	T3-T1	10.64 (4)	518	<b>0.031</b>	<b>0.14</b>	<b>Small</b>
HDDS	T2-T1	129.76 (4)	950	<b>&lt;0.001</b>	<b>0.37</b>	<b>Large</b>
	T3-T2	0.89 (4)	178	0.926	0.07	Small
	T3-T1	19.83 (4)	173	<b>0.001</b>	<b>0.34</b>	<b>Large</b>
HHS	T2-T1	414.98 (4)	711	<b>&lt;0.001</b>	<b>0.76</b>	<b>Large</b>
	T3-T2	6.38 (4)	140	0.172	0.21	Moderate
	T3-T1	39.91 (4)	128	<b>&lt;0.001</b>	<b>0.56</b>	<b>Large</b>
HFS	T2-T1	189.02 (2)	711	<b>&lt;0.001</b>	<b>0.52</b>	<b>Large</b>
	T3-T2	3.22 (2)	140	0.200	0.15	Small
	T3-T1	17.04 (2)	128	<b>&lt;0.001</b>	<b>0.36</b>	<b>Large</b>

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; HFS = Household Food Security; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values presented in bold are statistically significant (p < 0.05)

#### 4.3.2.1 Anthropometry

The anthropometric results presented in Table 4.7 indicate a consistent pattern of physical growth and nutritional improvement across the study period. Mean height increased steadily at each time point, showing a modest gain from T1 to T2 and a more pronounced increase by T3, reflecting continuous linear growth and normal physical development over time. Similarly, mean weight demonstrated significant progressive increases between all time points, with particularly large gains observed from T2 to T3 and T3 to T1, consistent with expected age-related weight progression.

Clear and statistically significant improvements in anthropometric indicators were evident over the study period. Significant differences in mean weight-for-age z-scores were observed across all timepoints. Differences were found between T2 and T1 ( $0.30 \pm 0.49$ ,  $p < 0.001$ ,  $d = 8.04$ ), T3 and T2 ( $0.34 \pm 0.63$ ,  $p < 0.001$ ,  $d = 6.08$ ), and T3 and T1 ( $0.51 \pm 0.69$ ,  $p < 0.001$ ,  $d = 5.36$ ), all reflecting large effect sizes. These results indicate a progressive and statistically significant increase in weight-for-age z-scores, suggesting meaningful improvements in child growth over time. Height-for-age z-scores showed more modest but still significant improvements between T3 and T2 ( $0.05 \pm 0.40$ ,  $p = 0.007$ ,  $d = 10.34$ ) and between T3 and T1 ( $0.08 \pm 0.53$ ,  $p = 0.001$ ,  $d = 7.76$ ), both with large effect sizes, indicating a significant increase over time. Finally, significant differences in BMI-for-age z-scores were also found between all timepoints, with T2 and T1 ( $0.23 \pm 0.50$ ,  $p < 0.001$ ,  $d = 7.89$ ), T3 and T2 ( $0.08 \pm 0.53$ ,  $p < 0.001$ ,  $d = 7.82$ ), and T3 and T1 ( $0.31 \pm 0.67$ ,  $p < 0.001$ ,  $d = 5.81$ ), all showing significant increases. Overall, the anthropometrical results indicate consistent and statistically significant improvements in child growth and NS over time, as reflected by progressive increases in weight-for-age, height-for-age, and BMI-for-age z-scores.

The progressive increase in weight-for-age, height-for-age, and BMI-for-age z-scores observed across time points could be indicative of catch-up growth, a phenomenon whereby children experiencing early growth retardation exhibit accelerated growth once nutritional or environmental constraints are alleviated as previously mentioned. Catch-up growth represents a physiological adaptation allowing for partial or full

recovery of growth deficits following periods of undernutrition, illness, or food insecurity (Prentice et al., 2013).

In low-income contexts, particularly in sub-Saharan Africa, catch-up growth has been documented when improvements occur in dietary diversity, child feeding practices, and health interventions (De Onis & Branca, 2016; Akombi, Agho, Hall, Wali, Renzaho & Merom, 2017). The pattern observed in this study, steady gains in weight-for-age and BMI-for-age z-scores with more gradual improvements in height-for-age, is consistent with the typical sequence of nutritional recovery: weight gains precede linear growth as children first restore fat and lean mass before height increases manifest (Victora et al., 2010; Martorell & Young, 2012).

Table 4.8 indicated that of the anthropometrical categorical variables, fewer significant results were found compared to the mean scores; however, some variables still demonstrated statistical significance. Weight-for-age status did not change significantly across time points ( $p > 0.001$ ; Cramer's  $V = 0.03\text{--}0.13$ ), indicating weak associations. Most participants remained in the same weight-for-age category throughout the study (84.2% from T1–T2, 87.9% from T2–T3, and 79.9% from T1–T3), with only small proportions showing declines (2.2–2.9%). Improvements were more frequent, particularly over the longer term, with up to 17.2% of participants improving from T1 to T3. Overall, the weight-for-age categories remained largely stable, with a slightly greater tendency toward improvement than decline.

Similarly, stunting classifications also did not indicate any statistically significant differences across time, suggesting overall stability in prevalence despite significant gains in mean height-for-age z-scores. Most participants remained in the same height-for-age category across all intervals (83–87%). Small proportions showed declines (5–7%) or improvements (5–10%), with very few improving by two levels.

In contrast, BMI-for-age classifications did indicate statistically significant distribution changes, significant results obtained between T2 and T1 ( $\chi^2(4, 1194) = 18.51, p = 0.001, V = 0.12$ ), particularly for participants classified as "Heavier 1 level" and "Heavier 2 levels." A significant result was also obtained for T3 to T1 ( $\chi^2(4, 518) = 10.64, p = 0.031, V = 0.14$ ), with greater variability noted for "Heavier 1 level". These

results suggest more participants increased in BMI-for-age classifications over the longer period.

These results align with research highlighting a concerning rise in overweight and obesity among South African children, representing a significant public health challenge. Among children aged five to 19, the prevalence of overweight increased from 9% in 2000 to 21% in 2022, while obesity rates rose from 2% to 7% over the same period (UNICEF, 2025). The implications of this trend are considerable, as childhood obesity is associated with a heightened risk of developing non-communicable diseases later in life, including type 2 diabetes, hypertension, and cardiovascular disease (FAO et al., 2023). The significant increase observed in BMI-for-age classifications are consistent with results from other longitudinal studies, which have documented shifts in BMI categories, particularly during the pandemic. These studies suggest that such changes are frequently influenced by factors including dietary habits, physical activity levels, and socioeconomic conditions (Lange, Kompaniyets, Freedman, Kraus, Porter, Blanck & Goodman, 2021).

Potential explanations for the limited statistically significant differences observed in weight-for-age and height-for-age status compared to BMI-for-age status, particularly in categorical analyses, may be attributed to the composite nature of BMI, which accounts for both body mass and stature. Unlike weight-for-age and height-for-age, which are indicators of longer-term growth and nutritional adequacy, BMI-for-age measurement is sensitive to both short-term weight fluctuations and longer-term growth patterns (De Onis, 2007). Consequently, BMI-for-age tends to show greater variability and deviations from expected distributions, especially in populations experiencing rapid nutritional or lifestyle transitions, which may have been the case in the present sample (Azupogo et al., 2022). This heightened responsiveness underscores BMI-for-age's utility as a sensitive marker for detecting early shifts in body composition, while also highlighting the need to interpret such changes alongside more stable anthropometric indices to accurately assess overall growth and NS (WHO, 2008; Best, Neufingerl, Van Geel, Van Den Briel & Osendarp, 2010; Moursi, Tanofsky-Kraff, Parker, Loch, Bloomer, Te-Vazquez, Nwosu, Lazareva, Yang, Turner, Brady & Yanovski, 2023).

The large effect sizes observed suggest that these trends represent meaningful changes, likely influenced by dietary patterns, physical activity, or broader environmental and socioeconomic influences (Popkin et al., 2020; FAO et al., 2021; FAO, IFAD, et al., 2022; Azrak, Fasano, Avico, Sala, Casado, Padula, Kruger, Malpeli & Andreoli, 2023; FAO et al., 2023). The COVID-19 pandemic could provide a possible rationale for the statistically significant differences observed. The anthropometrical results are consistent with Azrak and co-workers (2023), who reported increases in children's BMI-for-age status during the COVID-19 pandemic, particularly in households experiencing food insecurity. These results align with evidence showing that the COVID-19 pandemic was associated with increased reliance on high-energy, nutrient-poor foods, particularly in households experiencing food insecurity. Meta-analytic evidence also confirms consistent increases in children's BMI and body weight during the pandemic, with poor dietary quality identified as a plausible mechanism (Moursi et al., 2023). Disruptions to food supply chains, reduced access to fresh and perishable items, and financial constraints often pushed families toward more affordable, and ultra-processed products that are energy-dense but low in nutritional quality (Adams, Caccavale, Smith & Bean, 2020; Lee, Oldewage-Theron, Lyford & Shine, 2023). Studies further indicate that changes in the home food environment, including reliance on packaged foods, contributed to excess energy intake and weight gain among children (Nour & Altıntaş, 2023).

While the significant rise in BMI-for-age classifications observed in this study can be interpreted as a positive indicator of nutritional recovery and improved energy balance, it may also reflect a double-edged manifestation of catch-up growth. In contexts of prior undernutrition, catch-up growth can inadvertently predispose children to excess adiposity accumulation if the nutritional and metabolic environment changes rapidly (Victora et al., 2010; Prentice et al., 2013).

Evidence from low- and middle-income countries shows that when children recover from early growth faltering under conditions of dietary transition, they tend to regain weight more rapidly than lean mass or height, resulting in disproportionate increases in BMI (De Onis & Branca, 2016). This accelerated adipose rebound has been documented in several longitudinal studies from sub-Saharan Africa, including the Eastern Cape, where improvements in food availability and access to energy-dense

but nutrient-poor foods have driven a growing coexistence of undernutrition and overweight within the same populations (Kimani-Murage, Muthuri, Oti, Mutua, Van De Vijver & Kyobutungi, 2015; Nel & Steyn, 2022).

In the present study, the statistically significant upward shift in BMI-for-age classifications may therefore reflect a compensatory growth process following chronic food insecurity observed earlier in the cohort. This aligns with the “growth acceleration hypothesis,” which posits that rapid post-deprivation weight gain is associated with greater fat deposition relative to lean tissue, particularly in children previously exposed to nutritional stress (Black et al., 2014). Such patterns are increasingly observed in transitioning economies where persistent food insecurity coexists with rising access to inexpensive, energy-dense foods, a hallmark of the “nutrition transition” (Popkin et al., 2020).

Moreover, the COVID-19 pandemic period likely amplified these dynamics. Studies have reported that school closures, limited physical activity, and increased consumption of low-cost, high-energy foods contributed to accelerated weight gain among children (Lange et al., 2021). Thus, the BMI-for-age increases seen here may represent both a rebound from prior undernutrition and a shift toward early overweight risk, a trajectory consistent with global post-pandemic observations (FAO et al., 2023; UNICEF, 2025).

This duality highlights the complex nature of catch-up growth in low-income and food-insecure populations: while it signals improved nutritional recovery, it also introduces metabolic risks if dietary improvements are not matched by nutritional quality and physical activity. As mentioned before, managing catch-up growth requires balancing nutritional adequacy with prevention of excessive energy intake, particularly during early recovery phases. Integrating these insights into community nutrition interventions, by emphasizing balanced dietary diversity rather than energy surplus, remains critical for preventing the transition from recovery to overweight.

Overall, the anthropometric results reveal a complex but informative trajectory of nutritional change. While significant improvements in weight-for-age, height-for-age, and BMI-for-age scores reflect meaningful progress in child growth and recovery from

earlier nutritional deficits, the concurrent rise in BMI-for-age classifications points to an emerging shift from undernutrition toward excess weight. This pattern is characteristic of catch-up growth in transitional, low-income settings, where rapid post-deprivation weight gain, though initially beneficial, can predispose children to overweight and obesity if unaccompanied by balanced dietary quality and active lifestyles.

The improvements observed across time points should be interpreted within the broader socioeconomic and environmental context. Fluctuations between T1, T2 and T3 likely reflect shifting household income stability, access to social protection, and food availability during and after the COVID-19 pandemic (FAO et al., 2023; StatsSA, 2024; Gelo & Dikgang, 2022). The concurrent increase in BMI-for-age alongside declining dietary diversity suggests that weight gains may have been driven more by increased reliance on affordable, energy-dense foods than by improved diet quality (Popkin et al., 2020; FAO et al., 2021; Azrak et al., 2023).

Seasonal variation in food prices and access to fresh produce may also have contributed to short-term weight changes without proportional improvements in linear growth (FAO et al., 2023). Thus, the anthropometric shifts likely reflect an interaction between catch-up growth and evolving household food environments rather than uniform nutritional improvement.

#### *4.3.2.2 Household dietary diversity*

Dietary diversity declined significantly across the study period, with the largest reductions observed between T1 and T3 (Table 4.7). Between T2 and T1, HDDS decreased slightly ( $-0.45 \pm 1.68$ ,  $p < 0.001$ ,  $d = 0.26$ ), indicating a small effect. While a greater reduction was observed between T3 and T2 ( $-0.99 \pm 2.18$ ,  $p < 0.001$ ,  $d = 0.45$ ), with a moderate effect size. The largest decline occurred between T3 and T1 ( $-1.71 \pm 2.12$ ,  $p < 0.001$ ,  $d = 0.81$ ), reflecting a large effect. These results indicate a significant deterioration in household dietary diversity over the study period.

Results from Table 4.8 confirmed significant categorical changes in dietary diversity over time. Between T2 and T1, significant shifts occurred ( $\chi^2(4, 950) = 129.76, p < 0.001, V = 0.37$ ), with most households (56.6%) remaining unchanged, while 28.0% experienced a decline and 15.3% improved. No significant differences were detected between T3 and T2, though the overall direction remained downward. From T1 to T3, significant long-term decline was evident ( $\chi^2(4, 173) = 19.83, p = 0.001; V = 0.34$ ), with 60.7% of households showed a decline and only 9.9% improved, with just 29.5% remaining unchanged. Both significant differences indicted a large effect size, suggesting a substantial long-term decline in dietary diversity over the study period.

The observed decline in dietary diversity raises critical nutritional concerns, reflecting reduced intake of essential nutrients and an elevated risk of micronutrient deficiencies, particularly among vulnerable populations (Diop et al., 2021). This reduction in dietary variety, with households progressively shifting toward lower diversity categories, signals worsening food insecurity and deteriorating diet quality.

Several studies have further associated the effects of the COVID-19 pandemic with disruptions in food environments, which in turn contributed to reductions in dietary diversity and may partly explain the decline observed in the present study. Kundu and co-workers (2021) conducted a study in Bangladesh that identified key determinants of household food security and dietary diversity during the COVID-19 pandemic. Their results highlighted that factors such as income loss, reduced access to markets, and disruptions in food supply chains led to decreased dietary diversity among households. These disruptions were particularly pronounced in low-income communities, where access to a variety of foods was already limited. Similarly, Kumareswaran and Jayasinghe (2022) performed a systematic review examining the global impacts of the COVID-19 pandemic on food systems. They found that the pandemic led to significant disruptions in agricultural production, food distribution, and market access, all of which negatively affected dietary diversity. The review emphasized the need for resilient food systems to mitigate such impacts in future global emergencies.

In the South African context, Nevhotalu, Mayekiso and Gidi (2023) investigated the food security status of rural households in Makhado Municipality before and during COVID-19-induced restrictions. Their study revealed a significant decline in dietary

diversity during the pandemic, attributed to factors such as income loss, limited access to diverse food sources, and increased food prices. Furthermore, Rusere and co-workers (2025) explored the resilience and coping strategies of rural households in Bushbuckridge, Mpumalanga Province, during the COVID-19 lockdown. Their research indicated that while some households employed coping mechanisms to maintain food security, overall dietary diversity declined due to reduced income and limited access to a variety of foods.

The greater decline observed over the long-term comparison (T1–T3) likely reflects cumulative socioeconomic strain rather than a single disruption. Persistent income instability, rising food prices, and constrained purchasing power following the pandemic may have progressively limited access to diverse foods (FAO et al., 2023; StatsSA, 2024).

Seasonal fluctuations in fresh food availability may have further reinforced reliance on staple-based diets during financially constrained periods (Kundu et al., 2021). Together, these structural pressures likely explain the sustained downward trajectory in HDDS.

Collectively, these studies underscore the multifaceted impact of the COVID-19 pandemic on food environments and dietary diversity. Disruptions in food systems, economic hardships, and limited access to diverse food sources have been identified as significant contributors to the observed decline in dietary diversity. These results are consistent with the trends observed in the present study and underscore the profound impact that a large-scale crisis, such as the COVID-19 pandemic, can have on household food security, especially within vulnerable communities.

#### *4.4.2.3 Household hunger*

The mean HHS showed a progressive increase across the study period, indicating increased hunger levels (Table 4.7). Between T2 and T1, the rise was minimal ( $0.08 \pm 0.54$ ,  $p < 0.001$ ,  $d = 0.15$ ) and a greater increase was observed from T2 to T3 ( $1.04 \pm 2.33$ ,  $p < 0.001$ ,  $d = 0.45$ ), reflecting a modest but significant change. The most

substantial increase occurred between T1 and T3 ( $1.40 \pm 2.44$ ,  $p < 0.001$ ,  $d = 0.57$ ), indicating a medium effect and illustrates a pronounced worsening of household hunger over the study period.

Household hunger also experienced significant categorical changes over the study period. Table 4.8 illustrates that between T1 and T2, hunger distributions were significantly different, with a large effect size ( $\chi^2(4, 711) = 414.98$ ,  $p < 0.001$ ,  $V = 0.76$ ), though most households remained in the same category and only minor deterioration occurred. From T2 to T3, changes were not statistically significant, indicating relative stability but some households experienced worsening hunger. Over the full period from T1 to T3, significant shifts were again observed ( $\chi^2(4, 128) = 39.91$ ,  $p < 0.001$ ;  $V = 0.56$ ), with a substantial proportion of households declining by one or two levels and very few showing improvement, reflecting a marked overall increase in household hunger.

The statistical analysis confirms a worsening trend in household hunger, particularly in the long-term comparison, where significant deterioration was observed, reflecting an erosion of household resilience and increased exposure to severe food deprivation. The moderate but nonsignificant changes between T2 and T3 suggest temporary fluctuations rather than sustained improvements. These results resonate with broader national and international reports that link worsening hunger in low-income households to structural inequities, fluctuating economic conditions and limited safety nets (FAO et al., 2023; StatsSA, 2025).

The pronounced increase in hunger from T1 to T3 suggests cumulative erosion of household resilience. While short-term stability may reflect temporary coping strategies or intermittent relief measures, prolonged income instability and rising food prices likely drove the long-term worsening trend (Nwosu et al., 2022; FAO et al., 2023; StatsSA, 2025). Seasonal employment variability in low-income contexts may also explain fluctuations between specific time points (Alaba et al., 2022).

Additionally, research has highlighted the association between the COVID-19 pandemic and these underlying conditions, which ultimately exacerbated household hunger. Research using South Africa's National Income Dynamics Study –

Coronavirus Rapid Mobile Survey, revealed that child hunger increased during the pandemic, particularly in poorer households. Key determinants included socioeconomic status, housing type, and lack of infrastructure. In the same study, inequalities in child hunger became more pronounced over successive rounds of the survey (Alaba et al., 2022). Another longitudinal study examined food insecurity and health outcomes during COVID-19. It found that many households continued to face food shortages even as the economy began to reopen. Among hunger-affected households, a large share reported going without food often or daily; worse yet, the removal of pandemic-related relief measures (like grant top-ups) contributed to a resurgence of hardship (Nwosu, Kollamparambil & Oyenubi, 2022). A further paper assessed the impact of labour market shocks tied to lockdowns. Households with job losses were significantly more likely to report both child hunger and household hunger. Importantly, social protection mechanisms (e.g. child support grants or old age pensions) were shown to mitigate but not fully prevent the increase in hunger (Gelo & Dikgang, 2022). The results collectively support the assertion that the COVID-19 pandemic aggravated food insecurity in low-income contexts. The mechanisms included income loss, disrupted access to food, declining purchasing power, dependency on safety nets that were under-stress or diminished, and unequal exposure to risk.

#### *4.3.2.7 Household food security*

Household food security status showed short-term stability but long-term decline. Table 4.8 illustrates that between T1 and T2, results were significant with a large effect size ( $\chi^2(2, 711) = 189.02, p < 0.001, V = 0.52$ ), with 98.7% of households maintaining their status. Between T3 and T2, no significant differences were found, with 22.9% moved from security to insecurity, 6.4% improved, and only 70.7% remained unchanged. From T1 to T3, significant long-term shifts occurred again with a large effect size ( $\chi^2(2, 128) = 17.04, p < 0.001, V = 0.36$ ). 30.5% of households declined to insecurity, 7.8% improved, and 61.7% maintained their status, indicating an overall increase in food insecurity.

The results suggest that while household food security appeared relatively stable in the short term, long-term comparisons indicate a clear decline. These long-term changes suggest that external pressures such as economic instability, seasonal variation, or policy dynamics may have shaped household experiences of food security (Pérez-Escamilla, 2024; StatsSA, 2024).

Among these pressures, the COVID-19 pandemic has been identified as a major contributing factor. Research has shown that the pandemic disrupted food supply chains, reduced household incomes, and limited access to markets, disproportionately affecting vulnerable communities as mentioned. These disruptions not only restricted the availability of diverse and nutritious foods but also intensified the frequency and severity of household food insecurity. Consequently, households already facing socioeconomic disadvantages were more likely to experience chronic and recurrent food shortages, highlighting the need for targeted interventions to enhance food system resilience and safeguard vulnerable populations during large-scale crises (Adams et al., 2020; Kundu et al., 2021; Gelo & Dikgang, 2022; FAO et al., 2023).

Additionally, the FAO and co-workers (2023) indicated that the COVID-19 pandemic exacerbated existing vulnerabilities in food systems, leading to increased food insecurity globally. The report emphasized the importance of strengthening food systems to build resilience against future shocks and ensure food security for all populations. The results underscore the fragility of food security in vulnerable contexts, where even minor shocks can trigger substantial declines in household food security status, reinforcing the need for continuous and standardized monitoring frameworks to effectively assess and respond to household food security dynamics (World Bank, 2021; FAO et al., 2023; WFP, 2025).

#### 4.3.3 Differences in the study variables by gender

Table 4.9 presents the central tendencies and dispersion differences for the study variable by gender. Independent sample t-tests were conducted to examine whether there were statistically significant differences between boys and girls across the study variables. Statistically significant differences between males and females were observed for age and HDDS, indicating that these variables varied by gender.

**Table 4.9: Differences in the study variables by gender (Ho difference = 0.00; Tails = 2 for the t-tests)**

Variable	Gender	N	S.D.	Difference	t	d.f.	p	Cohen's d	
T1: Age	Female	613	1.40	-0.13	-1.53	1 268	0.126	0.09	None
	Male	657	1.51						
T2: Age	Female	588	1.40	-0.18	-2.15	1 230	<b>0.032</b>	0.12	None
	Male	644	1.49						
T3: Age	Female	288	1.35	-0.33	<b>-2.74</b>	524	<b>0.006</b>	<b>0.24</b>	<b>Small</b>
	Male	238	1.39						
T1: Height	Female	613	9.45	-0.95	-1.82	1268	0.069	0.10	None
	Male	657	9.02						
T2: Height	Female	588	9.51	-0.87	-1.63	1230	0.103	0.09	None
	Male	644	9.15						
T3: Height	Female	288	9.80	0.14	0.16	524	0.870	0.01	None
	Male	238	9.41						
T1: Weight	Female	613	7.14	-0.11	-0.28	1268	0.776	0.02	None
	Male	657	6.62						
T2: Weight	Female	588	7.93	0.21	0.49	1230	0.623	0.03	None
	Male	644	6.88						
T3: Weight	Female	288	12.10	1.53	1.55	524	0.122	0.14	None
	Male	238	10.13						
T1: Weight/age z-score	Female	600	1.38	-0.10	-1.46	1229	0.145	0.08	None
	Male	631	1.13						
T2: Weight/age z-score	Female	553	1.32	0.08	1.14	1140	0.254	0.07	None
	Male	589	1.20						
T3: Weight/age z-score	Female	166	1.57	0.04	0.21	280	0.836	0.03	None
	Male	116	1.21						
T1: Height/age z-score	Female	613	1.06	-0.09	-1.58	1268	0.114	0.09	None
	Male	657	1.02						

T2: Height/age z-score	Female	587	1.01	0.03	0.54	1228	0.590	0.03	None
	Male	643	1.00						
T3: Height/age z-score	Female	288	1.07	0.11	1.19	524	0.234	0.10	None
	Male	238	1.10						
T1: BMI/age z-score	Female	613	1.45	0.01	0.14	1268	0.885	0.01	None
	Male	657	1.08						
T2: BMI/age z-score	Female	587	1.17	0.06	0.84	1228	0.399	0.05	None
	Male	643	1.12						
T3: BMI/age z-score	Female	288	1.38	0.11	0.96	524	0.338	0.08	None
	Male	238	1.26						
T1: HDDS	Female	477	1.92	-0.01	-0.06	963	0.952	0.00	None
	Male	488	1.94						
T2: HDDS	Female	473	1.82	0.05	0.42	956	0.674	0.03	None
	Male	485	1.75						
T3: HDDS	Female	108	1.57	-0.40	<b>-2.00</b>	208	<b>0.047</b>	<b>0.28</b>	<b>Small</b>
	Male	102	1.29						
T1: HHS	Female	360	1.20	0.02	0.21	722	0.831	0.02	None
	Male	364	1.18						
T2: HHS	Female	362	1.33	0.00	0.00	728	0.999	0.00	None
	Male	368	1.34						
T3: HHS	Female	108	1.93	-0.32	-1.18	208	0.239	0.16	None
	Male	102	2.01						

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values given in bold are statistically significant (p < 0.05)

Table 4.10 presents the frequency distribution differences for the categorical study variable by gender. Anthropometric measures, specifically weight-for-age and BMI-for-age status, exhibited statistically significant differences between males and females, with small effect sizes. In contrast, the remaining variables did not demonstrate any statistically significant results.

**Table 4.10: Association between categorical study variables and gender**

Variable	Time point	N	Chi <sup>2</sup> Goodness-of-Fit Statistics			
			Chi <sup>2</sup> (d.f.)	p	Cramér's V	
Weight/age	T1	1 231	19.82 (3)	<b>&lt; 0.001</b>	<b>0.13</b>	<b>Small</b>
	T2	1 142	7.65 (3)	0.054	0.08	None
	T3	282	1.98 (3)	0.577	0.08	None
Height/age	T1	1 270	6.48 (3)	0.091	0.07	None
	T2	1 230	8.53 (3)	<b>0.036</b>	0.08	None
	T3	526	2.16 (3)	0.540	0.06	None
BMI/age	T1	127	39.66 (4)	<b>&lt; 0.001</b>	<b>0.18</b>	<b>Small</b>
	T2	1 230	4.09 (4)	0.252	0.06	None
	T3	526	2.34 (4)	0.504	0.07	None
HDDS	T1	965	0.15 (2)	0.926	0.01	None
	T2	958	0.31 (2)	0.857	0.02	None
	T3	210	3.72 (2)	0.156	0.13	None
HHS	T1	724	0.45 (2)	0.800	0.02	None
	T2	730	0.41 (2)	0.814	0.02	None
	T3	210	2.15 (2)	0.341	0.10	Small
HFS	T1	724	0.37 (1)	0.545	0.02	None
	T2	730	0.16 (1)	0.690	0.01	None
	T3	210	0.11 (1)	0.737	0.02	None

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; HFS = Household Food Security; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values given in bold are statistically significant (p < 0.05)

Table 4.11 presents the central tendencies and dispersion of study variable differences over time by gender. Majority anthropometric measures showed statistically significant differences between males and females, with effect sizes ranging from small to medium. Conversely, the HDDS and the HHS did not exhibit statistically significant differences.

**Table 4.11: Differences in the study variables by gender over time (Ho difference = 0.00; Tails = 2 for the t-tests)**

Variable	Gender	N	S.D.	Difference	t	d.f.	p	Cohen's d	
T2-T1: Height	Female	575	2.66	0.22	1.36	1194	0.175	0.08	None
	Male	621	2.93						
T3-T2: Height	Female	286	2.77	1.86	<b>5.50</b>	521	<b>&lt;0.001</b>	<b>0.48</b>	<b>Small</b>
	Male	237	4.84						
T3-T1: Height	Female	284	3.59	2.01	<b>6.96</b>	516	<b>&lt;0.001</b>	<b>0.61</b>	<b>Medium</b>
	Male	234	2.86						
T2-T1: Weight	Female	575	1.45	0.32	<b>3.84</b>	1194	<b>&lt;0.001</b>	<b>0.22</b>	<b>Small</b>
	Male	621	1.39						
T3-T2: Weight	Female	286	5.19	2.04	<b>4.97</b>	521	<b>&lt;0.001</b>	<b>0.44</b>	<b>Small</b>
	Male	237	3.97						
T3-T1: Weight	Female	284	5.91	2.40	<b>5.19</b>	516	<b>&lt;0.001</b>	<b>0.46</b>	<b>Small</b>
	Male	234	4.28						
T2-T1: Weight/age z-score	Female	541	0.46	0.19	<b>6.54</b>	1109	<b>&lt;0.001</b>	<b>0.39</b>	<b>Small</b>
	Male	570	0.49						
T3-T2: Weight/age z-score	Female	166	0.66	0.06	0.75	279	0.452	0.09	None
	Male	115	0.60						
T3-T1: Weight/age z-score	Female	163	0.62	0.36	<b>4.42</b>	276	<b>&lt;0.001</b>	<b>0.54</b>	<b>Medium</b>
	Male	115	0.73						
T2-T1: Height/age z-score	Female	574	0.50	0.11	<b>4.55</b>	1192	<b>&lt;0.001</b>	<b>0.26</b>	<b>Small</b>
	Male	620	0.35						
T3-T2: Height/age z-score	Female	286	0.40	0.07	2.08	521	<b>0.038</b>	0.18	None
	Male	237	0.40						

T3-T1: Height/age z-score	Female	284	0.60	0.20	<b>4.27</b>	516	<b>&lt;0.001</b>	<b>0.38</b>	<b>Small</b>
	Male	234	0.40						
T2-T1: BMI/age z-score	Female	574	0.55	0.03	1.05	1192	0.293	0.06	None
	Male	620	0.46						
T3-T2: BMI/age z-score	Female	286	0.53	0.16	<b>3.55</b>	521	<b>&lt;0.001</b>	<b>0.31</b>	<b>Small</b>
	Male	237	0.51						
T3-T1: BMI/age z-score	Female	284	0.71	0.20	<b>3.34</b>	516	<b>0.001</b>	<b>0.29</b>	<b>Small</b>
	Male	234	0.60						
T2-T1: HDDS	Female	471	1.74	0.06	0.57	948	0.570	0.04	None
	Male	479	1.62						
T3-T2: HDDS	Female	94	2.33	-0.05	-0.14	176	0.888	0.02	None
	Male	84	2.00						
T3-T1: HDDS	Female	93	2.23	0.12	0.37	171	0.714	0.06	None
	Male	80	2.01						
T2-T1: HHS	Female	355	0.54	-0.01	-0.34	709	0.734	0.03	None
	Male	356	0.54						
T3-T2: HHS	Female	75	2.29	0.47	1.19	138	0.236	0.20	Small
	Male	65	2.36						
T3-T1: HHS	Female	70	2.36	0.35	0.81	126	0.422	0.14	None
	Male	58	2.55						

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values in bold are statistically significant (p < 0.05)

Table 4.12 presents the frequency distribution differences for the categorical study variable over time by gender. Anthropometric measures, namely weight-for-age and height-for-age status, showed statistically significant differences between males and females, with small effect sizes, whereas the remaining variables did not yield statistically significant results.

**Table 4.12: Differences in categorical study variable over time**

Variable	Time point	N	Chi <sup>2</sup> Goodness-of-Fit Statistics			
			Chi <sup>2</sup> (d.f.)	P	Cramér's V	
Weight/age z-score	T2-T1	1 111	32.38 (3)	<b>&lt; 0.001</b>	<b>0.17</b>	<b>Small</b>
	T2-T3	281	1.41 (2)	0.494	0.07	None
	T3-T1	278	14.33 (3)	<b>0.002</b>	<b>0.22</b>	<b>Small</b>
Height/age z-score	T2-T1	1 194	20.90 (3)	<b>&lt; 0.001</b>	<b>0.13</b>	<b>Small</b>
	T2-T3	523	3.40 (3)	0.333	0.08	None
	T3-T1	518	13.03 (2)	<b>0.001</b>	<b>0.16</b>	<b>Small</b>
BMI/age z-score	T2-T1	1 194	8.42 (4)	0.077	0.08	None
	T3-T2	523	4.05 (3)	0.256	0.09	None
	T3-T1	518	4.64 (4)	0.326	0.09	None
HDDS	T2-T1	950	8.93 (4)	0.063	0.10	Small
	T3-T2	178	3.09 (4)	0.544	0.13	Small
	T3-T1	173	2.67 (4)	0.615	0.12	Small
HHS	T2-T1	711	2.22 (3)	0.528	0.06	None
	T3-T2	140	4.76 (4)	0.313	0.18	Small
	T3-T1	128	4.34 (4)	0.362	0.18	Small
HFS	T2-T1	711	1.00 (2)	0.605	0.04	None
	T3-T2	140	1.50 (2)	0.473	0.10	Small
	T3-T1	128	0.45 (2)	0.798	0.06	None

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; HFS = Household Food Security; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values in bold are statistically significant ( $p < 0.05$ )

#### 4.3.3.1 Anthropometry

Table 4.9 illustrates that across all three time points, comparisons of anthropometric measurements between boys and girls showed no meaningful differences, with effect sizes consistently small. Age was the only variable with statistically significant differences, with males ( $10.55 \pm 1.39$ ) slightly older than females ( $10.22 \pm 1.35$ ) at T3 ( $p = 0.006$ ,  $d = 0.24$ ), although these differences were minor. Overall, the results suggest that boys and girls demonstrated similar growth patterns, indicating that gender was not a major factor influencing anthropometric outcomes in this sample.

Table 4.10 revealed limited but notable gender differences in anthropometrical status indicators. For weight-for-age, a significant association emerged at T1 ( $\chi^2(3) = 19.82$ ,  $p < 0.001$ ,  $V = 0.13$ ), where males were more often classified as normal weight (71.8% vs. 64.3%), while females showed higher prevalence of underweight (8.5% vs. 4.1%) and mild underweight (24.8% vs. 23.6%). Severe underweight was rare overall (1.4%), but slightly more common among females (2.3% vs. 0.5%). No significant differences were detected at later timepoints, suggesting that gender disparities in weight status diminished over the study period. For BMI-for-age status, differences were again evident only at T1 ( $\chi^2(4) = 39.66$ ,  $p < 0.001$ ,  $V = 0.18$ ). Males were more frequently within the normal range (85.5% vs. 72.9%), while females exhibited higher rates of thinness/severe thinness (7.3% vs. 2.0%), overweight (10.6% vs. 8.2%) and obesity (9.1% vs. 4.3%).

The observed dual burden of malnutrition among South African females reflects patterns noted in other South African and sub-Saharan studies, which have reported girls facing greater risks of both undernutrition and early onset overweight, often linked to sociocultural feeding practices and differential food allocation within households (Shisana et al., 2013; StatsSA, 2021; Kumareswaran & Jayasinghe, 2022). This burden can potentially be explained by interacting sociocultural, economic and biological mechanisms. Evidence suggests that gendered food allocation and cultural feeding hierarchies often disadvantage women and girls, who may consume less diverse diets despite comparable household food availability (Seifu, Mare, Legesse & Tebeje, 2024; Tamir, Mekonen, Workneh, Techane, Terefe & Zegeye, 2024).

Moreover, biological and hormonal differences in fat storage and metabolism may predispose females to higher fat retention under conditions of fluctuating food security (Popkin et al., 2020; Wells et al., 2020). Meanwhile, South Africa's ongoing nutrition transition, marked by increased access to energy-dense, nutrient-poor foods, has contributed to rising overweight and obesity, particularly among adolescent girls and young women (Popkin et al., 2020).

Similarly, Table 4.11 revealed that girls consistently showed greater anthropometric gains than boys, with negligible significant variation in other food security measures.

For height, differences were evident in T2–T3 and T3–T1 ( $p < 0.001$ ,  $d = 0.48–0.61$ ), while for weight, girls gained more across these periods ( $p < 0.001$ ,  $d = 0.22–0.46$ ), with small to medium effect sizes. Improvements for females were also larger for weight-for-age (T2–T1, T3–T1;  $p < 0.001$ ,  $d = 0.39–0.54$ ), height-for-age (all periods,  $p < 0.05$ ,  $d = 0.18–0.38$ ), and BMI-for-age (T2–T3, T3–T1;  $p < 0.005$ ,  $d = 0.29–0.31$ ). Overall, girls displayed stronger growth trajectories, with small-to-moderate effects.

Lastly, Table 4.12 also showed higher anthropometric gains among females than males, with no significant variation in other food security measures. Weight-for-age classifications indicated significant differences among males and females between T2–T1 ( $\chi^2(3) = 32.38$ ,  $p < 0.001$ ,  $V = 0.17$ ) and T3–T1 ( $\chi^2(3) = 14.33$ ,  $p = 0.002$ ,  $V = 0.22$ ). Most participants remained in the same category (84.2% at T2–T1; 79.9% at T3–T1), but females showed greater increases. At T2–T1, 17.9% of females improved by one level compared to 8.6% of males, while more males declined (3.9% vs. 0.4%). By T3–T1, 23.3% of females improved by one level and 1.2% by two levels, versus only 7.0% of males improving by one level and none by two. Declines were again more common among males (6.1% vs. 0.6%). No significant associations were found between T2–T3.

For height-for-age classifications, significant associations were found between T2–T1 ( $\chi^2(3) = 20.90$ ,  $p < 0.001$ ,  $V = 0.13$ ) and T3–T1 ( $\chi^2(2) = 13.03$ ,  $p = 0.001$ ,  $V = 0.16$ ). Stability was high (86.0% unchanged at T2–T1; 83.0% at T3–T1), but females again showed greater improvements. At T2–T1, 12.3% of females improved compared to 5.2% of males, while declines were more frequent among males (6.8% vs. 3.8%). By T3–T1, 14.8% of females improved compared to 5.1% of males, with similar proportions declining (6.7% vs. 6.4%). In contrast, no comparisons reached statistical significance for BMI-for-age status, with negligible to small effect sizes.

Overall, the present results align with prior research indicating that females are more likely than males to demonstrate positive improvements in both weight-for-age and height-for-age over time, while males tend to experience stagnation or decline (Harper et al., 2022). Evidence suggests that girls may possess a biological advantage in early growth resilience, potentially linked to differences in hormonal regulation, fat metabolism, and immune response during periods of nutritional stress (Gebremichael,

Abera, Biadgilign, Baye, Zhou & Haile, 2025). In contrast, boys often exhibit greater vulnerability to stunting and underweight outcomes, particularly in food-insecure or environmentally constrained settings (Jiang, Sung, Sawhney, Cai, Xu, Ng & Sun, 2023). Despite these gender-based disparities in linear and ponderal growth, no significant differences were observed for BMI-for-age or broader food security indicators, such as dietary diversity and hunger scores, consistent with results from comparable cohorts in Limpopo and the EC (Mafhungo, Cele, Mathibe & Modjadji, 2025).

These gendered patterns in anthropometric outcomes mirror a substantial body of literature, highlighting boys' heightened susceptibility to undernutrition and girls' relative resilience or predisposition toward higher adiposity. Khan and Ahmed (2005) demonstrated that male children are more prone to growth faltering in response to nutritional stress and infection, largely due to higher metabolic demands and immunological vulnerabilities during early development. Similarly, Jinabhai and co-workers (2007) found that across several African contexts, boys experienced higher rates of stunting and wasting than girls, even when dietary intakes were comparable. They attributed these differences to a combination of biological sensitivity and gendered caregiving practices, wherein girls may receive greater caregiver attention in certain cultural environments.

A broader regional synthesis by Wamani and colleagues (2007) reinforced this pattern, showing through meta-analysis that boys under five years of age across 16 sub-Saharan African countries were consistently more likely to be stunted than girls. The authors linked these disparities to biological factors, including boys' higher postnatal growth velocity and energy expenditure, as well as their increased exposure to infection.

Extending this evidence to the context of global nutrition transitions, Popkin, Corvalan and Grummer-Strawn (2020) observed that girls, particularly in emerging middle-income regions, are increasingly susceptible to overweight and early adiposity rebound due to shifts in dietary patterns and declining physical activity levels. Thus, while girls in this study exhibited greater anthropometric gains, these improvements may also signal the early onset of body composition changes associated with the

double burden of malnutrition. Taken together, these results underscore a complex interplay between biological, environmental, and sociocultural factors shaping growth trajectories across genders.

#### 4.3.3.2 HDDS and HHS

Table 4.9 shows that neither HDDS nor HHS indicated any significant differences between females and males at T1 and T2 ( $p > 0.05$ ,  $d = 0.00-0.03$ ). At T3, a small but statistically significant difference emerged for HDDS, with households represented by a male in the sample ( $3.66 \pm 1.29$ ) reported higher scores than those with a female ( $3.26 \pm 1.57$ ,  $p = 0.047$ ,  $d = 0.28$ ). However, no significant gender differences were found for HHS at T3 ( $p = 0.239$ ,  $d = 0.16$ ).

Across all timepoints, Tables 4.10 to 4.12 revealed no statistically significant gender differences in the HDDS, HHS or overall household food security. Effect sizes were minimal (HDDS  $d = 0.02-0.06$ ; HHS  $d = 0.14-0.20$ ), indicating that dietary diversity and hunger patterns were shaped primarily by shared household constraints rather than gender-specific disparities. The lack of association between gender and food security measures suggests that intra-household dynamics and decision-making power, rather than total food access, are more influential determinants of nutritional outcomes (Steyn & Mchiza, 2014).

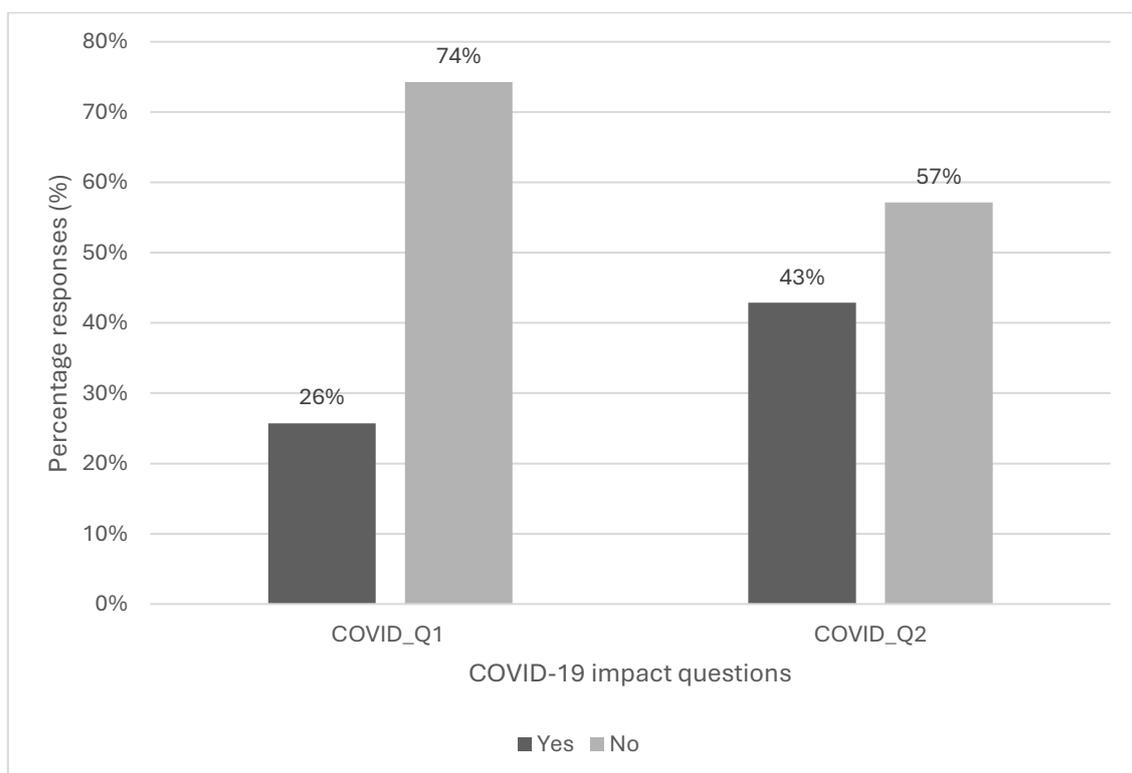
Overall, these results suggest that while gender-related nutritional disparities were evident at baseline, they were not sustained longitudinally. Instead, household- and community-level determinants appeared to shape food access and growth outcomes similarly for both genders, consistent with research highlighting the overriding influence of structural poverty and food insecurity on child nutrition in low-income South African settings (May et al., 2021). This pattern suggests that while biological factors contribute to gender-differentiated growth trajectories, household-level determinants of food access and diet quality likely exert similar effects on both genders.

#### 4.3.4 Perceived impact of COVID-19 on households

The potential impact of the COVID-19 pandemic on household food security was assessed using a COVID-19 Impact Questionnaire, which included two categorical survey items. COVID\_Q1 evaluated the possible impact on child nutrition, while COVID\_Q2 assessed the potential impact on overall household food security. The results are presented below, highlighting trends in perceived pandemic-related challenges and their relationship to household food security status.

##### 4.3.4.1 COVID-19 impact questions

Figure 4.3 presents the perceived impacts of COVID-19 on child nutrition (COVID\_Q1) and household food security (COVID\_Q2) based on 210 valid responses, with a summary of the frequency distributions provided.



COVID\_Q1 asked whether COVID-19 had affected the child's diet; COVID\_Q2 asked whether COVID-19 had impacted the household's food security, with an explanation requested if an answer was affirmative.

**Figure 4.3: Percentage distributions of responses to COVID\_Q1 (question 1) and COVID\_Q2 (question 2)**

Analysis of the categorical survey items revealed that 26% (n = 54) of households reported the COVID-19 pandemic negatively affected their child's diet, while 74% (n = 156) reported no such impact. In contrast, a higher proportion (43%; n = 90) indicated adverse effects on overall household food security. These results suggest that children's diets were relatively protected compared to household food security, which appeared more vulnerable to pandemic-related disruptions. This distinction between child-level dietary effects and household-level food security concerns provides a meaningful context for interpreting the broader quantitative results related to household food security over time (Section 4.3).

A plausible explanation for this relative protection of child nutrition is the role of the NSNP. The NSNP, established by South Africa's Department of Basic Education, provides daily nutritious meals to over nine million learners in public schools, particularly targeting children from low-income households (South African Department of Basic Education, 2021). Although school closures during the early phases of the COVID-19 pandemic initially disrupted meal delivery, legal advocacy and government action, prompted by civil society organisations and supported by court rulings, ensured that the programme continued through community distribution points and take-home food parcels (Spaull & Van Der Berg, 2020). This continuation of school feeding initiatives likely mitigated the immediate nutritional impact on children, helping to sustain dietary adequacy even as households faced economic shocks and reduced food access.

In contrast, household food security was more severely affected due to adults and other non-school-going family members not benefiting directly from such structured feeding interventions. The divergence between child-level dietary resilience, partially safeguarded by the NSNP, and household-level vulnerability highlights the uneven protective effects of social safety nets. This underscores the importance of integrating school-based nutrition programmes with broader household-level support mechanisms, such as social grants and food relief packages, to ensure comprehensive protection of nutrition across age groups during crises (HLPE, 2020b; UNICEF, 2024b).

Consequently, these results emphasize the need for standardized monitoring frameworks for household and child food security. Such frameworks could guide the development of targeted social protection policies, like the NSNP and complementary household food assistance, to strengthen resilience against future disruptions.

#### 4.3.4.2 Thematic analysis of COVID-19 impact questions

##### COVID\_Q1: Influence on child's diet

Respondents who indicated that COVID-19 influenced their child's diet (n = 55) were invited to explain why, multiple responses per person where possible. The distribution of responses across identified themes is presented in Table 4.13 below.

**Table 4.13: COVID\_Q1 (question 1 ) themes**

Theme	N(%)
Theme 3 (Decreased food availability)	35(64)
Theme 1 (Job loss and unemployment)	26(47)
Theme 2 (Reduced household income)	12(22)
Theme 4 (Food price increase)	6(11)
Theme 5 (Reliance on social grants)	5(9)
Theme 6 (Death of household member)	2(4)

Table 4.13 illustrates several recurring themes regarding the impact of COVID-19 on children's nutrition. The most frequently reported was decreased food availability (64%; n = 35), *"Shops had limited stock, so we couldn't get some of the basic food items our children were used to."*, reflecting supply chain disruptions and reduced household food stocks. Job loss and unemployment (47%; n = 26), *"My husband lost his job and we had no steady income, so we had to cut back on food."*, and reduced household income (22%; n = 12), *"Even though I kept my job, my salary was reduced and we had to buy cheaper food."*, were also prominent, underscoring the economic challenges limiting food access. Less frequently cited but notable themes included food price increases (11%; n = 6), reliance on social grants (9%; n = 5), and the death of a household member (4%; n = 2). Collectively, these themes illustrate how both economic strain and disruptions to food systems undermined households' ability to sustain children's nutrition during the pandemic.

The thematic analysis indicates that COVID-19's impact on the child's diets was shaped not only by economic hardship but also by reduced food access and availability, consistent with prior research (De Groot & Lemanski, 2021). Job loss and income decline further weakened household resilience, while social grants, though offering some relief, proved insufficient to prevent dietary compromise in vulnerable households (Kajiita & Kang'ethe, 2024). The presence of multiple themes per respondent suggests that food-related hardships were multifaceted and compounding, reinforcing the need for multi-dimensional assessment tools to guide integrated policy responses that address food access and economic vulnerabilities in future crises.

*COVID\_Q2: Influence on household food security*

Participants who indicated that COVID-19 influenced household food security (n = 94) were asked to elaborate on the reasons for this impact, multiple responses per person where possible. The thematic distribution of responses is presented in Table 4.14.

**Table 4.14: COVID\_Q2 (question 2) themes**

<b>Theme</b>	<b>N(%)</b>
Theme 1 (Job loss and unemployment)	42(45)
Theme 3 (Decreased food availability)	37(39)
Theme 2 (Reduced household income)	33(35)
Theme 4 (Food price increase)	17(18)
Theme 6 (Death of household member)	2(2)
Theme 5 (Reliance on social grants)	1(1)

Job loss and unemployment was identified as the most frequently cited factor contributing to household food insecurity (45%; n = 42), *"I lost my job during lockdown, and with no income, we struggled to afford basic food."*, followed by decreased food availability (39%; n = 37), *"Even when we had money, some stores had empty shelves and we couldn't get what we needed."*, and reduced household income (35%; n = 33), *"My pay was cut in half, and we had to choose between rent and groceries."*. These themes highlight both economic vulnerability and systemic supply chain disruptions as key drivers of food insecurity during the pandemic. Additional themes included food price increases (18%; n = 17), death of a household member (2%; n = 2), and reliance on social grants (1%; n = 1), which, though less frequently reported, further illustrate the multiple pressures undermining household food security.

These results complement previous research as well as the results already reported in this study by adding critical contextual depth, emphasizing the importance of adopting multidimensional monitoring strategies to assess household food security, that go beyond single indicators (Lujabe et al., 2022). Such an approach is essential for capturing the complex and overlapping challenges households face in achieving and maintaining food security, particularly as they confront fluctuating access, dietary inadequacies, and broader socio-economic vulnerabilities during public health emergencies.

#### *4.3.4.3 Relationships between COVID-19 impact questions and study variables*

This section presents the inferential statistics examining the relationship between the two COVID-19 impact questions and the study variables. To determine whether caregiver perceptions of COVID-19 impacted on their child's diet (COVID\_Q1) and household food security (COVID\_Q2) were associated with differences in household food security indicators and nutritional outcomes. Analyses compared groups at three timepoints; T1 and T2 (pre-pandemic) and T3 (during the pandemic), as well as across change intervals (T2–T1, T3–T2, and T3–T1).

##### *COVID\_Q1: Influence on child's diet*

Table 4.15 presents the inferential statistics investigating the relationship between the COVID\_19 impact question (COVID\_Q1) and the study variables. Independent samples t-tests were conducted comparing groups across three time points as well as for change scores across T2–T1, T3–T2, and T3–T1. None of the household food security indicators indicated significant results. Although no significant results were observed for any of the study variables, some minor trends and shifts across groups and time points are noted.

**Table 4.15: Differences in study variables and COVID\_Q1 (question 1) (Ho difference = 0.00)**

Variable	COVID_Q1	N	Mean	S.D.	Difference	t	d.f.	p	Cohen's d	
T1: BMI/age z-score	No	154	0.00	1.29	-0.34	-1.72	205	0.087	0.27	Small
	Yes	53	0.34	1.14						
T2: BMI/age z-score	No	149	0.22	1.15	-0.30	-1.63	199	0.105	0.26	Small
	Yes	52	0.52	1.04						
T3: BMI/age z-score	No	69	0.27	1.33	-0.14	-0.46	92	0.650	0.11	None
	Yes	25	0.41	1.14						
T2-T1: BMI/age z-score	No	147	0.26	0.64	0.07	0.75	196	0.456	0.12	None
	Yes	51	0.19	0.38						
T3-T2: BMI/age z-score	No	69	0.07	0.48	0.16	1.49	91	0.140	0.35	Small
	Yes	24	-0.09	0.41						
T3-T1: BMI/age z-score	No	68	0.23	0.48	0.06	0.57	91	0.573	0.13	None
	Yes	25	0.17	0.41						
T1: HDDS	No	129	5.16	1.86	-0.46	-1.43	171	0.155	0.25	Small
	Yes	44	5.61	1.78						
T2: HDDS	No	134	4.51	1.84	-0.08	-0.24	176	0.809	0.04	None
	Yes	44	4.59	1.67						
T3: HDDS	No	156	3.38	1.42	-0.26	-1.15	208	0.251	0.18	None
	Yes	54	3.65	1.53						
T2-T1: HDDS	No	129	-0.55	1.84	0.47	1.49	171	0.138	0.26	Small
	Yes	44	-1.02	1.75						
T3-T2: HDDS	No	134	-1.08	2.23	-0.38	-1.00	176	0.320	0.17	None
	Yes	44	-0.70	2.00						
T3-T1: HDDS	No	129	-1.71	2.13	0.02	0.06	171	0.953	0.01	None
	Yes	44	-1.73	2.13						

T1: HHS	No	90	2.18	1.50	0.28	1.02	126	0.307	0.20	Small
	Yes	38	1.89	1.25						
T2: HHS	No	102	2.51	1.73	0.12	0.35	138	0.725	0.07	None
	Yes	38	2.39	1.69						
T3: HHS	No	156	3.28	2.06	0.00	-0.01	208	0.995	0.00	None
	Yes	54	3.28	1.71						
T2-T1: HHS	No	90	0.18	0.79	-0.28	-1.66	125	0.099	0.32	Small
	Yes	37	0.46	1.04						
T3-T2: HHS	No	102	1.05	2.40	0.05	0.11	138	0.912	0.02	None
	Yes	38	1.00	2.16						
T3-T1: HHS	No	90	1.37	2.56	-0.11	-0.23	126	0.822	0.04	None
	Yes	38	1.47	2.18						

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3

Table 4.16 below reports inferential statistics on the relationship between caregiver perceptions of COVID-19 dietary impacts on the child (COVID\_Q1) and categorical study variables. Chi-square tests of independence were conducted at three timepoints (T1, T2 pre-pandemic; T3 during the pandemic) and across change intervals (T2–T1, T3–T2, T3–T1), with Cramér’s V indicating effect size. Significant results were observed for HHS, indicating a measurable relationship with the COVID-19 dietary impact question (COVID\_Q1). In contrast, most other study variables did not reach statistical significance; however, several notable trends and patterns were identified across time points and change intervals, suggesting potential subtle shifts in household food security and related outcomes.

**Table 4.16: Association between categorical study variables and COVID\_Q1 (question 1)**

Variable	Time point	N	Chi <sup>2</sup> (d.f.)	p	Cramér's V	
BMI/age	T1	207	5.82 (4)	0.213	0.17	Small
	T2	201	1.79 (3)	0.616	0.09	None
	T3	94	0.83 (3)	0.843	0.09	None
	T2–T1	198	0.71 (2)	0.703	0.06	None
	T3–T2	93	5.85 (2)	0.054	0.25	Small
	T3–T1	93	3.63 (2)	0.163	0.20	Small
HDDS	T1	173	1.06 (2)	0.590	0.08	None
	T2	178	2.47 (2)	0.291	0.12	Small
	T3	210	0.68 (2)	0.710	0.06	None
	T2–T1	173	2.68 (2)	0.262	0.12	Small
	T3–T2	178	1.19 (2)	0.553	0.08	None
	T3–T1	173	1.87 (2)	0.393	0.10	Small
HHS	T1	128	0.79 (2)	0.674	0.08	None
	T2	140	1.92 (2)	0.382	0.12	Small
	T3	210	2.99 (2)	0.224	0.12	Small
	T2–T1	127	10.50 (2)	<b>0.005</b>	<b>0.26</b>	<b>Small</b>
	T3–T2	140	0.51 (2)	0.775	0.06	None
	T3–T1	128	1.30 (2)	0.523	0.10	Small

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values in bold indicate statistical significance ( $p < 0.05$ )

### *Anthropometry*

No statistically significant differences were observed in BMI-for-age z-scores between the caregivers who reported COVID-19 impact on their child’s diet and those who did

not. At T1, the COVID\_Q1 = Yes group ( $0.34 \pm 1.14$ ) scored higher than the COVID\_Q1 = No group ( $0.00 \pm 1.29$ ;  $p = 0.087$ ,  $d = 0.27$ ), a pattern repeated at T2 ( $0.52 \pm 1.04$  vs.  $0.22 \pm 1.15$ ;  $p = 0.105$ ,  $d = 0.26$ ). By T3, the difference narrowed ( $0.41 \pm 1.14$  vs.  $0.27 \pm 1.33$ ;  $p = 0.650$ ,  $d = 0.11$ ). In addition, change scores across timepoints were similarly non-significant: T2–T1 ( $p = 0.456$ ,  $d = 0.12$ ), T3–T2 ( $p = 0.140$ ,  $d = 0.35$ ), and T3–T1 ( $p = 0.573$ ,  $d = 0.13$ ). The slightly higher BMI-for-age z-scores observed among children in reported COVID-19 affected households may point to subtle, non-significant shifts in NS, potentially reflecting variations in household coping strategies or dietary adaptations during the pandemic (Hassen & El Bilali, 2024).

The BMI-for-age status, presented in Table 4.16, were not significantly related to perceived COVID-19 impact on the child's diet at individual time points. However, the near-significant result for T3–T2 may indicate that changes in BMI-for-age group distribution during this period could be related to shifts in perceived pandemic impact on the diet of the child. Overall, effect sizes were small, indicating largely similar growth trajectories across groups.

The absence of statistically significant differences in BMI-for-age z-scores between children whose caregivers reported COVID-19 dietary impacts and those who did not is consistent with evidence from several studies across South Africa and other low- and middle-income countries. Research indicates that short-term pandemic disruptions did not significantly alter child anthropometric outcomes, despite reported food insecurity and dietary changes (Sestito, Velásquez, Orel & Keiser, 2021). For example, a longitudinal study by (Spaull & Van Der Berg, 2020) found that although school closures temporarily affected meal access through the NSNP, subsequent resumption of feeding support mitigated measurable declines in child growth indicators.

Similarly, Alaba and colleagues (2022) observed that child BMI-for-age z-scores in low-income South African households remained relatively stable during 2020 to 2021, likely due to household coping strategies, such as reallocating food resources to children and leveraging school or community food distribution schemes. Studies from Nigeria, Kenya and Ghana echo these results, showing limited short-term effects on child anthropometry, despite increased food insecurity and reduced dietary diversity

(Aboaba, Fadiji & Hussayn, 2020; Zhu, Mhango, Vinnakota, Mansour & Coss-Bu, 2022; Lokuruka Napoo, Pharis Ndwiga & Musi Musitia, 2023).

The slightly higher, though non-significant, BMI-for-age z-scores among children in households reporting dietary impacts may reflect adaptive responses, including increased reliance on energy-dense but less diverse foods (HLPE, 2020b; UNICEF, 2024b). This pattern aligns with results that pandemic-related shocks often shift consumption toward affordable staples while maintaining or slightly increasing total energy intake at the expense of dietary quality (Devereux et al., 2020). The small effect sizes observed here mirror broader regional trends showing resilience in anthropometric indicators despite nutritional and economic strain.

#### *Household dietary diversity*

Table 4.15 illustrate that at baseline, households reporting COVID-19 impact had a higher mean HDDS ( $5.61 \pm 1.78$ ) than unaffected households ( $5.16 \pm 1.86$ ), suggesting slightly more diverse diets. However, this difference was small and statistically insignificant. At T2, dietary diversity declined for both groups ( $4.59 \pm 1.67$  for COVID\_Q1 = Yes vs.  $4.51 \pm 1.84$  for COVID\_Q1 = No), indicating reduced access to varied foods. The near-identical means show that both groups experienced a similar drop in dietary diversity. By T3, HDDS scores further decreased ( $3.65 \pm 1.53$  for COVID\_Q1 = Yes vs.  $3.38 \pm 1.42$  for COVID\_Q1 = No), showing a general downward trend in dietary diversity over time. Although the COVID-impacted group maintained slightly higher means, the difference remained non-significant.

Both groups experienced declines in dietary diversity from T1 to T2, with the COVID\_Q1 = Yes group dropping more sharply ( $-1.02 \pm 1.75$  vs.  $-0.55 \pm 1.84$ ). This suggests the COVID-affected households might have faced greater dietary reduction, though not at a significant level. From T2 to T3, both groups continued to lose dietary diversity, though the COVID\_Q1 = Yes group showed a smaller decline ( $-0.70 \pm 2.00$  vs.  $-1.08 \pm 2.23$ ). Over the full period, both groups saw a similar total drop in dietary diversity ( $-1.73 \pm 2.13$  vs.  $-1.71 \pm 2.13$ ), indicating consistent reductions irrespective of COVID-19 impact. This reflects an overall trend of declining food variety.

The observed decline in HDDS across all time points suggests that overall dietary quality and access to a variety of foods deteriorated over the study period, likely reflecting broader socioeconomic and supply chain disruptions during the COVID-19 pandemic (Sambo et al., 2022). Although households reporting COVID-19 impacts consistently had slightly higher HDDS values, these differences were small and statistically insignificant, indicating that both affected and unaffected households experienced similar constraints in food availability and diversity.

This pattern may be attributed to widespread challenges such as reduced income, market access limitations, and inflation of food prices that affected all households regardless of perceived COVID-19 impact (Hassen & El Bilali, 2024). The non-significant differences imply that the pandemic's influence on dietary diversity was systemic rather than limited to households reporting specific COVID-19 disruptions.

Table 4.16 illustrates that none of the categorical changes in HDDS were significant, indicating that dietary diversity levels were not significantly related to perceived COVID-19 impact on the child's diet at any time point, nor were changes in HDDS over time associated with shifts in participants' reported experiences of the pandemic on the diet of the child.

These results suggest only minor fluctuations in dietary diversity, without evidence of subjective pandemic-induced divergence, consistent with research reporting low to moderate HDDS scores, diets dominated by staple foods, and only modest declines in dietary diversity during the early phases of the COVID-19 pandemic (Sambo et al., 2022). Evidence from low-income South African settings suggests that subsistence farming served as an important coping strategy to mitigate declines in dietary diversity and buffer against worsening food insecurity amidst the pandemic (Baxter, Nambiar, Penny, Gallegos & Byrne, 2024; Rusere et al., 2025).

#### *Household hunger*

Table 4.15 presents that at T1, households reporting COVID-19 impact on their child's diet (COVID\_Q1 = Yes) reported slightly lower hunger scores ( $1.89 \pm 1.25$ ) than those in the COVID\_Q1 = No group ( $2.18 \pm 1.50$ ), indicating better food access, though the difference was not statistically significant ( $p = 0.307$ ,  $d = 0.20$ ). At T2, the COVID\_Q1

= Yes group ( $2.39 \pm 1.69$ ) continued to report slightly lower scores than the COVID\_Q1 = No group ( $2.51 \pm 1.73$ ), with a reduced gap ( $p = 0.725$ ,  $d = 0.07$ ). By T3, hunger levels had converged completely across groups (Yes:  $3.28 \pm 1.71$ ; No:  $3.28 \pm 2.06$ ;  $p = 0.995$ ,  $d = 0.00$ ). Change score analyses showed a steeper rise in hunger from T1 to T2 among COVID\_Q1 = Yes households ( $0.46 \pm 1.04$ ) compared to COVID\_Q1 = No households ( $0.18 \pm 0.79$ ), approaching significance ( $p = 0.099$ ,  $d = 0.32$ ). In contrast, differences for T3–T2 ( $p = 0.912$ ,  $d = 0.02$ ) and T3–T1 ( $p = 0.822$ ,  $d = 0.04$ ) were negligible.

Categorical analyses of household hunger presented in Table 4.16 revealed no significant associations between perceived COVID-19 child dietary impacts and hunger at any single time point (T1, T2, or T3). However, change analysis indicated a meaningful association between T1–T2 hunger status and later perceived COVID-19 child dietary impacts ( $\chi^2(2, 127) = 10.50$ ,  $p = 0.005$ ,  $V = 0.26$ ). This suggests that households later identifying COVID-19 impacts on their child's diet were already experiencing worsening hunger prior to the pandemic, highlighting pre-existing vulnerabilities. In contrast, T3–T2 and T3–T1 showed no significant associations.

Hunger at individual time points was not linked to perceived child dietary impacts, but early changes (T1–T2) appear to have been predictive of later perceptions. By T3, hunger had risen substantially across the entire sample, with Yes households consistently reporting higher rates of severe hunger. These results suggest that pre-pandemic fragility amplified pandemic-related food insecurity, in line with global evidence, while the convergence of trajectories by T3 reflects the levelling effects of systemic shocks (FAO et al., 2021). This is consistent with results from low-income South African settings, where household hunger stabilized during the pandemic through coping strategies and external support (Rusere et al., 2025).

Although no statistically significant group differences were observed, several small effect sizes indicated consistent trends. Households perceiving COVID-19-related child dietary impacts tended to be more food secure at baseline but experienced sharper early declines in dietary diversity and food access. By T3, insecurity had become widespread across all households, erasing earlier differences and reflecting the levelling effects of systemic shocks. This convergence is consistent with broader

literature showing how pandemics and systemic crises compress pre-existing disparities in food access (Laborde et al., 2021; Éliás & Jámbo, 2021). Gebeyehu, East, Wark and Islam, (2023) and Hassen and El Bilali (2024), reported that COVID-19 compromised multiple dimensions of food security while reducing variation between groups over time. Evidence from South Africa, Kenya, and India similarly indicates that initial socioeconomic advantages offered temporary protection, but these diminished as the crisis persisted (Zhu et al., 2022; Lokuruka Napoo et al., 2023; Upton, Tennant, Fiorella & Barrett, 2023)

Caregivers in relatively food-secure households may also have been more sensitive to modest disruptions or more proactive in protecting child diets, buffering children from severe household-level insecurity (Picchioni, Goulao & Roberfroid, 2022; Baxter et al., 2024). This suggests that subjective perceptions of dietary impact may reflect adaptive responses and early coping behaviours, rather than objective deterioration in NS.

Overall, no statistically significant differences were observed in any of the study variables between caregivers who reported COVID-19 related impacts on their child's diet and those who did not. Patterns of change in BMI-for-age z-scores, HDDS, and HHS were similar across both groups, indicating that the deterioration in nutritional and food security indicators occurred consistently, regardless of caregivers' subjective experience of COVID-19 dietary effects. This underscores the pandemic's universal and systemic influence on nutrition and food security, highlighting the importance of early monitoring of dietary and household indicators as precursors to vulnerability during prolonged crises.

#### *COVID\_Q2: Influence on household food security*

Table 4.17 presents the inferential statistics investigating the relationship between the COVID\_19 impact question (COVID\_Q2) and the study variables. The results indicate a significant association between the COVID-19 dietary impact question (COVID\_Q2) and both the HDDS and the HHS, however the BMI-for-age z-score indicator did not reach significance.

**Table 4.17: Differences in study variables and COVID\_Q2 (question 2) (Ho difference = 0.00)**

Variable	COVID_Q2	N	Mean	S.D.	Difference	t	d.f.	p	Cohen's d																																																																																																																																																															
T1: BMI/age z-score	No	119	-0.03	1.23	-0.28	-1.61	205	0.109	0.23	Small																																																																																																																																																														
	Yes	88	0.25	1.28							T2: BMI/age z-score	No	113	0.19	1.15	-0.24	-1.52	199	0.131	0.22	Small	Yes	88	0.44	1.09	T3: BMI/age z-score	No	57	0.26	1.31	-0.12	-0.43	92	0.669	0.09	None	Yes	37	0.38	1.24	T2-T1: BMI/age z-score	No	112	0.26	0.56	0.04	0.52	196	0.601	0.08	None	Yes	86	0.22	0.61	T3-T2: BMI/age z-score	No	57	0.06	0.48	0.09	0.91	91	0.367	0.19	None	Yes	36	-0.03	0.44	T3-T1: BMI/age z-score	No	57	0.27	0.48	0.15	1.51	91	0.134	0.32	Small	Yes	36	0.12	0.42	T1: HDDS	No	98	4.99	1.87	-0.65	-2.32	171	<b>0.021</b>	0.36	Small	Yes	75	5.64	1.76	T2: HDDS	No	102	4.44	1.87	-0.22	-0.79	176	0.428	0.12	None	Yes	76	4.66	1.70	T3: HDDS	No	120	3.49	1.44	0.09	0.45	208	0.652	0.06	None	Yes	90	3.40	1.47	T2-T1: HDDS	No	98	-0.45	1.79	0.51	1.84	171	0.068	0.28	Small	Yes	75	-0.96	1.84	T3-T2: HDDS	No	102	-0.88	2.33	0.25	0.75	176	0.452	0.11	None	Yes	76	-1.13	1.96	T3-T1: HDDS	No	98	-1.41	2.10	0.70	2.17	171
T2: BMI/age z-score	No	113	0.19	1.15	-0.24	-1.52	199	0.131	0.22	Small																																																																																																																																																														
	Yes	88	0.44	1.09							T3: BMI/age z-score	No	57	0.26	1.31	-0.12	-0.43	92	0.669	0.09	None	Yes	37	0.38	1.24	T2-T1: BMI/age z-score	No	112	0.26	0.56	0.04	0.52	196	0.601	0.08	None	Yes	86	0.22	0.61	T3-T2: BMI/age z-score	No	57	0.06	0.48	0.09	0.91	91	0.367	0.19	None	Yes	36	-0.03	0.44	T3-T1: BMI/age z-score	No	57	0.27	0.48	0.15	1.51	91	0.134	0.32	Small	Yes	36	0.12	0.42	T1: HDDS	No	98	4.99	1.87	-0.65	-2.32	171	<b>0.021</b>	0.36	Small	Yes	75	5.64	1.76	T2: HDDS	No	102	4.44	1.87	-0.22	-0.79	176	0.428	0.12	None	Yes	76	4.66	1.70	T3: HDDS	No	120	3.49	1.44	0.09	0.45	208	0.652	0.06	None	Yes	90	3.40	1.47	T2-T1: HDDS	No	98	-0.45	1.79	0.51	1.84	171	0.068	0.28	Small	Yes	75	-0.96	1.84	T3-T2: HDDS	No	102	-0.88	2.33	0.25	0.75	176	0.452	0.11	None	Yes	76	-1.13	1.96	T3-T1: HDDS	No	98	-1.41	2.10	0.70	2.17	171	<b>0.032</b>	0.33	Small	Yes	75	-2.11	2.10								
T3: BMI/age z-score	No	57	0.26	1.31	-0.12	-0.43	92	0.669	0.09	None																																																																																																																																																														
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T2-T1: BMI/age z-score	No	112	0.26	0.56	0.04	0.52	196	0.601	0.08	None																																																																																																																																																														
	Yes	86	0.22	0.61							T3-T2: BMI/age z-score	No	57	0.06	0.48	0.09	0.91	91	0.367	0.19	None	Yes	36	-0.03	0.44	T3-T1: BMI/age z-score	No	57	0.27	0.48	0.15	1.51	91	0.134	0.32	Small	Yes	36	0.12	0.42	T1: HDDS	No	98	4.99	1.87	-0.65	-2.32	171	<b>0.021</b>	0.36	Small	Yes	75	5.64	1.76	T2: HDDS	No	102	4.44	1.87	-0.22	-0.79	176	0.428	0.12	None	Yes	76	4.66	1.70	T3: HDDS	No	120	3.49	1.44	0.09	0.45	208	0.652	0.06	None	Yes	90	3.40	1.47	T2-T1: HDDS	No	98	-0.45	1.79	0.51	1.84	171	0.068	0.28	Small	Yes	75	-0.96	1.84	T3-T2: HDDS	No	102	-0.88	2.33	0.25	0.75	176	0.452	0.11	None	Yes	76	-1.13	1.96	T3-T1: HDDS	No	98	-1.41	2.10	0.70	2.17	171	<b>0.032</b>	0.33	Small	Yes	75	-2.11	2.10																																						
T3-T2: BMI/age z-score	No	57	0.06	0.48	0.09	0.91	91	0.367	0.19	None																																																																																																																																																														
	Yes	36	-0.03	0.44							T3-T1: BMI/age z-score	No	57	0.27	0.48	0.15	1.51	91	0.134	0.32	Small	Yes	36	0.12	0.42	T1: HDDS	No	98	4.99	1.87	-0.65	-2.32	171	<b>0.021</b>	0.36	Small	Yes	75	5.64	1.76	T2: HDDS	No	102	4.44	1.87	-0.22	-0.79	176	0.428	0.12	None	Yes	76	4.66	1.70	T3: HDDS	No	120	3.49	1.44	0.09	0.45	208	0.652	0.06	None	Yes	90	3.40	1.47	T2-T1: HDDS	No	98	-0.45	1.79	0.51	1.84	171	0.068	0.28	Small	Yes	75	-0.96	1.84	T3-T2: HDDS	No	102	-0.88	2.33	0.25	0.75	176	0.452	0.11	None	Yes	76	-1.13	1.96	T3-T1: HDDS	No	98	-1.41	2.10	0.70	2.17	171	<b>0.032</b>	0.33	Small	Yes	75	-2.11	2.10																																																					
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	Yes	36	0.12	0.42							T1: HDDS	No	98	4.99	1.87	-0.65	-2.32	171	<b>0.021</b>	0.36	Small	Yes	75	5.64	1.76	T2: HDDS	No	102	4.44	1.87	-0.22	-0.79	176	0.428	0.12	None	Yes	76	4.66	1.70	T3: HDDS	No	120	3.49	1.44	0.09	0.45	208	0.652	0.06	None	Yes	90	3.40	1.47	T2-T1: HDDS	No	98	-0.45	1.79	0.51	1.84	171	0.068	0.28	Small	Yes	75	-0.96	1.84	T3-T2: HDDS	No	102	-0.88	2.33	0.25	0.75	176	0.452	0.11	None	Yes	76	-1.13	1.96	T3-T1: HDDS	No	98	-1.41	2.10	0.70	2.17	171	<b>0.032</b>	0.33	Small	Yes	75	-2.11	2.10																																																																				
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	Yes	75	-0.96	1.84							T3-T2: HDDS	No	102	-0.88	2.33	0.25	0.75	176	0.452	0.11	None	Yes	76	-1.13	1.96	T3-T1: HDDS	No	98	-1.41	2.10	0.70	2.17	171	<b>0.032</b>	0.33	Small	Yes	75	-2.11	2.10																																																																																																																																
T3-T2: HDDS	No	102	-0.88	2.33	0.25	0.75	176	0.452	0.11	None																																																																																																																																																														
	Yes	76	-1.13	1.96							T3-T1: HDDS	No	98	-1.41	2.10	0.70	2.17	171	<b>0.032</b>	0.33	Small	Yes	75	-2.11	2.10																																																																																																																																															
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	Yes	75	-2.11	2.10																																																																																																																																																																				

T1: HHS	No	67	2.22	1.54	0.27	1.08	126	0.282	0.19	None
	Yes	61	1.95	1.30						
T2: HHS	No	76	2.61	1.77	0.28	0.95	138	0.343	0.16	None
	Yes	64	2.33	1.64						
T3: HHS	No	120	2.83	1.95	-1.03	-3.88	208	<b>&lt;0.001</b>	0.54	Medium
	Yes	90	3.87	1.86						
T2-T1: HHS	No	67	0.28	0.97	0.05	0.32	125	0.748	0.06	None
	Yes	60	0.23	0.77						
T3-T2: HHS	No	76	0.57	2.42	-1.03	-2.66	138	<b>0.009</b>	0.45	Small
	Yes	64	1.59	2.09						
T3-T1: HHS	No	67	0.93	2.68	-0.99	-2.33	126	<b>0.021</b>	0.41	Small
	Yes	61	1.92	2.05						

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values marked in bold are statistically significant (p < 0.05)

Table 4.18 below presents the inferential statistics investigating the relationship between the COVID\_19 impact question (COVID\_Q2) and the categorical study variables. Significant results were observed for the HHS, indicating a measurable relationship with the COVID-19 dietary impact question (COVID\_Q2). In contrast, most other study variables did not reach statistical significance.

**Table 4.18: Association between categorical study variables and COVID\_Q2 (question 2)**

Variable	Time point	N	Chi <sup>2</sup> Goodness-of-Fit Statistics			
			Chi <sup>2</sup> (d.f.)	P	Cramér's V	
BMI/age	T1	207	3.23 (4)	0.520	0.12	Small
	T2	201	1.76 (3)	0.624	0.09	None
	T3	94	0.74 (3)	0.863	0.09	None
	T2–T1	198	1.93 (2)	0.382	0.1	Small
	T3–T2	93	2.86 (2)	0.239	0.18	Small
	T3–T1	93	1.94 (2)	0.379	0.14	Small
HDDS	T1	173	5.84 (2)	0.054	0.18	Small
	T2	178	1.73 (2)	0.422	0.1	Small
	T3	210	2.06 (2)	0.357	0.1	Small
	T2–T1	173	5.4 (2)	0.067	0.18	Small
	T3–T2	178	4.1 (2)	0.129	0.15	Small
	T3–T1	173	4.16 (2)	0.125	0.16	Small
HHS	T1	128	0.44 (2)	0.801	0.06	None
	T2	140	0.35 (2)	0.840	0.05	None
	T3	210	18.24 (2)	<b>0.001</b>	<b>0.29</b>	<b>Small</b>
	T2–T1	127	1.41 (2)	0.493	0.11	Small
	T3–T2	140	10.28 (2)	<b>0.006</b>	<b>0.27</b>	<b>Small</b>
	T3–T1	128	9.07 (2)	<b>0.011</b>	<b>0.27</b>	<b>Small</b>

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values marked in bold are statistically significant ( $p < 0.05$ )

### *Anthropometry*

Children in households reporting COVID-related increases in household food insecurity consistently showed slightly higher BMI-for-age z-scores across all time points as presented in Table 4.17, though none of the differences were statistically significant and effect sizes were small.

BMI-for-age status at T1 showed no significant associations ( $\chi^2(4, 207) = 3.23, p = 0.520, V = 0.12$ ), with similar results at T2 and T3 as illustrated by Table 4.18. Change analyses also revealed no significant relationships. Overall, BMI-for-age outcomes

were not meaningfully associated by perceived COVID-19 impacts on household food security in this sample. However, the finding that children in households reporting COVID-related increases in food insecurity consistently showed slightly higher BMI-for-age z-scores across all timepoints, suggests a complex relationship between food insecurity and child nutritional outcomes. These results are consistent with evidence showing that the COVID-19 pandemic intensified dependence on inexpensive, energy-dense, and nutrient-poor foods in food-insecure households, potentially contributing to excess weight gain among children (Azrak et al., 2023).

These results are further supported by research demonstrating that disruptions to food supply chains, reduced access to fresh and nutrient-rich foods, and heightened financial strain during the COVID-19 pandemic prompted many households to depend on more affordable, shelf-stable, and ultra-processed products, contributing to excess energy intake and weight gain among children (Adams et al., 2020; Lee et al., 2023; Nour & Altıntaş, 2023; Hassen & El Bilali, 2024). Such patterns highlight the paradoxical nature of food insecurity, where economic hardship and restricted food access coexist with a rising risk of overweight and obesity, particularly in vulnerable communities.

#### *Household dietary diversity*

Table 4.17 illustrates that at T1, households subsequently reported COVID-related food insecurity had significantly higher dietary diversity scores ( $5.64 \pm 1.76$ ) compared to those that did not ( $4.99 \pm 1.87$ ;  $p = 0.021$ ,  $d = 0.36$ ). However, this difference diminished over time, with no significant associations observed at T2 and T3. Change analyses revealed that the COVID\_Q2 = Yes group experienced somewhat larger declines in dietary diversity, particularly between T1 and T3 ( $-2.11 \pm 2.10$  vs.  $-1.41 \pm 2.10$ ;  $p = 0.032$ ,  $d = 0.33$ ), suggesting greater dietary disruption during the pandemic, although the difference was not statistically significant.

The near-significant association between HDDS categories and perceived household food insecurity at T1 ( $\chi^2(2, 173) = 5.84$ ,  $p = 0.054$ ,  $V = 0.18$ ) suggests an early link between dietary diversity and the perceived impact of COVID-19 on food access. However, this relationship diminished over time, indicating that dietary diversity and subjective food insecurity evolved differently as the pandemic progressed. Initially,

households with higher dietary diversity may have had more stable access to diverse foods, reflecting relative economic security or better coping capacity. Yet, as pandemic-related disruptions intensified, these households experienced sharper declines, possibly due to reduced income, inflated food prices, and limited access to informal food markets (Picchioni et al., 2022; Gebeyehu et al., 2023; Travasso, Joseph, Swaminathan, John, Makkar, Webb, Kurpad & Thomas, 2023)

Similar trajectories have been observed globally. Kansiime and co-workers (2021) found that dietary diversity in Kenyan and Ugandan households dropped significantly within the first months of lockdowns due to disrupted food supply chains and declining purchasing power. Harris and colleagues (2020) reported comparable results in rural India, where previously food-secure households experienced rapid reductions in dietary variety once savings and informal credit networks became strained. Picchioni, Goulao and Roberfroid (2022) highlight that COVID-19 shocks had cascading effects across food systems, initially affecting food diversity and later manifesting as broader food insecurity.

In South Africa substantial increases in food insecurity among lower- and middle-income households were evident during school closures, further constraining dietary diversity (Spaull & Van Der Berg, 2020). Despite temporary social protection measures (e.g., the COVID-19 Social Relief of Distress Grant), inflationary pressures and disrupted local markets continued to undermine household dietary quality (Laborde et al., 2021; StatsSA, 2023a). These contextual factors likely explain the steeper HDDS declines among households reporting perceived dietary impacts, even though statistical associations were modest.

Overall, the evidence suggests that dietary diversity served as an early and sensitive indicator of household vulnerability during the pandemic. The observed pattern, initial divergence followed by convergence across groups, reflects a systemic equalizing effect, where prolonged shocks reduce differentiation as more households experience widespread deprivation (Hassen & El Bilali, 2024). The results reinforce the need for longitudinal monitoring of HDDS alongside subjective measures of food insecurity to better capture evolving nutritional vulnerabilities during crises.

### *Household hunger*

Hunger levels did not differ significantly between groups at T1 ( $p = 0.282$ ,  $d = 0.19$ ) or T2 ( $p = 0.343$ ,  $d = 0.16$ ) as presented in Table 4.17. At T3, households reporting COVID-related food insecurity exhibited significantly higher hunger levels compared to those not reporting such increases ( $3.87 \pm 1.86$  vs.  $2.83 \pm 1.95$ ;  $p < 0.001$ ,  $d = 0.54$ ). This pattern was further corroborated by change analyses, which revealed slightly steeper increases in hunger scores among the COVID\_Q2 = Yes group from T2-T3 ( $1.59 \pm 2.09$  vs.  $0.57 \pm 2.42$ ;  $p = 0.009$ ,  $d = 0.45$ ) and from T1-T3 ( $1.92 \pm 2.05$  vs.  $0.93 \pm 2.68$ ;  $p = 0.021$ ,  $d = 0.41$ ), however it was not statistically significant. These results potentially indicate a significant rise in hunger among households affected by COVID-related household food insecurity.

In terms of HHS categories, presented in Table 4.18, at T3, a significant association emerged between hunger levels and perceived COVID-19 impact ( $\chi^2(2,210) = 18.24$ ,  $p = 0.001$ ,  $V = 0.29$ ). A larger proportion of COVID-affected households reported severe hunger (56.7% vs. 27.5%), while fewer reported little to no hunger (6.7% vs. 11.7%). Change analyses further demonstrated significant worsening for the COVID\_Q2 = Yes households from T2-T3 (53.1% vs. 28.9%;  $\chi^2(2,140) = 10.28$ ,  $p = 0.006$ ,  $V = 0.27$ ) and from T1-T3 (68.9% vs. 43.3%;  $\chi^2(2,128) = 9.07$ ,  $p = 0.011$ ,  $V = 0.27$ ). This aligns with global evidence showing that the COVID-19 pandemic disproportionately worsened hunger in already vulnerable populations. Studies have consistently demonstrated that income shocks, employment losses, and food price inflation during lockdowns severely constrained access to sufficient and nutritious foods (FAO et al., 2023; Hassen & El Bilali, 2024). This lack of access is associated with poorer dietary quality, increased risk of diet-related diseases, and elevated hunger levels (Cai, 2023; Odoms-Young, Brown, Agurs-Collins & Glanz, 2024).

Longitudinal analyses across low- and middle-income countries reveal similar trends. Laborde, Martin & Vos (2021) reported that household hunger increased significantly in regions with limited safety net coverage, as pandemic-related disruptions to labour markets and trade heightened vulnerability. Comparable patterns were documented in Kenya and Uganda, where Kansiime and colleagues (2021) found that over 60% of households faced reduced meal frequency and portion sizes within the first six months of the pandemic.

In South Africa, research confirms a sharp rise in food insecurity and hunger. Studies found that nearly half of surveyed households reported running out of money for food during the early months of lockdown, while hunger rates doubled compared to pre-pandemic levels (Arndt et al., 2020; Van Der Berg et al., 2022; Nevhutalu et al., 2023).

The sustained hunger among these households may also reflect structural barriers to food access. Researchers found that COVID-19 exacerbated disparities in food affordability and availability, particularly affecting women-headed and low-income households (Hart et al., 2022; Cai, 2023; Odoms-Young et al., 2024). Limited mobility, market closures, and elevated staple prices further constrained dietary adequacy, leading to an overreliance on cheaper, energy-dense foods with lower nutritional quality (Picchioni et al., 2022).

Collectively, these results reinforce that the pandemic deepened household hunger and widened nutritional inequities, especially where social protection mechanisms were weak or inconsistently applied. The observed increases in severe hunger from T1–T3 in the Yes households thus mirror a broader, global pattern of COVID-19 induced food system fragility. Continuous monitoring of HHS is therefore critical for identifying at-risk groups and designing targeted resilience strategies, such as local food distribution networks and nutritional support mechanisms.

Overall, these results demonstrate that households which reported that COVID-19 affected their household food security experienced significantly greater increase in hunger compared to those who did not. Notably, child NS remained stable across groups, suggesting that households may have prioritized children's nutritional needs or benefited from social safety nets. However, the marked rise in hunger and drop in dietary diversity in affected households underscores the vulnerability exposed by the pandemic, especially for food access. While statistical evidence is modest, these consistent patterns reinforce the value of using perceived household impact perceptions as an early-warning signal for policy and programmatic intervention to address food insecurity during large-scale disasters.

The observed differences in dietary diversity and hunger between households reporting COVID-related food insecurity and those that did not may be partly explained by the role of South Africa's social protection system. Evidence indicates that continued access to regular social grants, such as the CSG, Old Age Pension, and Disability Grant, served as a critical buffer against income shocks and rising food prices during the pandemic (Arndt et al., 2020; Kajiita & Kang'ethe, 2024). The introduction of the COVID-19 SRD grant in 2020 further mitigated hunger among previously ineligible individuals, especially the unemployed and informal workers (Van Der Berg et al., 2022; Bassier, Budlender, Zizzamia & Jain, 2023). NIDS-CRAM data show that households receiving these grants were significantly less likely to run out of food and reported smaller declines in dietary diversity compared to non-recipients (Van Der Berg et al., 2022). Consequently, the steeper declines in HDDS and the higher hunger scores observed among COVID-affected households in this study may reflect disparities in access to grant income and heightened vulnerability among those who experienced employment loss or the death of a household member without adequate social support. Although grants offered temporary relief, inflation and market disruptions eroded their protective effect over time (Laborde et al., 2021; StatsSA, 2023a). These findings underscore the importance of sustained and inclusive social protection to maintain dietary quality and mitigate hunger during future crises.

In conclusion, the observed worsening in the earlier reported individual study variables and levels of food security over time (Section 4.3.2) cannot be attributed to random variation alone, as indicated by the statistical significance of the results. The significance strengthens the argument that the changes observed were systematic and meaningful, rather than incidental. When the quantitative results are further interpreted alongside participants' perceptions of the impact of COVID-19 (Section 4.2.4), the evidence suggests that the deterioration in outcomes may be linked to a large-scale disruptive event, most plausibly the COVID-19 pandemic. The convergence of statistical evidence with subjective experiences reinforces the notion that the pandemic functioned as a critical external shock, exacerbating vulnerabilities and reshaping food security dynamics in the study population. This alignment between empirical patterns and contextual interpretations provides a compelling basis for considering the significant differences to be attributed to COVID-19 as a central explanatory factor influencing the trajectory of the variables of the study. The results

are consistent with broader literature documenting the pandemic's role in intensifying social and economic inequalities, particularly with regards to food security and its associated indicators (Ayanlade & Radeny, 2020; Mukiibi, 2020; Hirvonen, De Brauw & Abate, 2021; Lujabe et al., 2022).

#### **4.4 Phase Two**

The second phase of the study focused on the development and evaluation of a comprehensive HFSI designed to capture multiple dimensions of food security within low-income households in NMB, EC South Africa. The primary objective was to construct a multidimensional index tailored to the socio-economic realities of these households and to assess its effectiveness as a robust measure of household food security. A further objective was to evaluate the suitability of the HFSI as a tool for assessing the impact of large-scale disruptions, such as the COVID-19 pandemic, by comparing index scores before and during the pandemic. The results presented in this section address these objectives by, first, outlining the construction of the HFSI through the Delphi technique to establish expert consensus on the relative importance of its indicators, and second, evaluating the validity and applicability of the HFSI in capturing household food security dynamics within vulnerable communities.

##### 4.4.1 The Delphi technique

A three-round Delphi technique was employed to achieve expert consensus on the proposed HFSI. The panel consisted of ten experts, who evaluated the relevance, reliability, and feasibility of three indicators, HDDS, HHS and BMI-for-age z-scores as indicator of child NS, in assessing household food security within a low-income South African setting. Items had to reach at least 70% consensus to be considered resolved and were then excluded from subsequent rounds, allowing the process to progressively refine agreement on key aspects of the index. The following subsections present the results for each Delphi round, accompanied by interpretation of the results.

#### 4.4.1.1 Round one results

The first round established baseline expert perceptions regarding indicator relevance, conceptual validity, and weighting preferences illustrated in Table 4.19 below.

**Table 4.19: Delphi round one feedback (N = 10)**

Item	Response Options	N(%)
Relevance of indicators		
HDDS	Very relevant	10(100)
	Moderately relevant	0(0)
	Not relevant	0(0)
NS	Very relevant	10(100)
	Moderately relevant	0(0)
	Not relevant	0(0)
HHS	Very relevant	7(70)
	Moderately relevant	3(30)
	Not relevant	0(0)
Agreement with conceptual statements		
HDDS captures utilization dimension	Strongly agree	4(40)
	Agree	4(40)
	Neutral	1(10)
	Disagree	1(10)
NS reflects utilization/health outcomes	Strongly agree	9(90)
	Neutral	1(10)
HHS addresses access dimension	Strongly agree	7(70)
	Agree	3(30)
Equal weighting of indicators appropriate?	Yes	0(0)
	No	10(100)
Weight allocation preferences		
HDDS	30%	3(30)
	35%	5(50)
	40%	2(20)
NS	30%	5(50)
	35%	2(20)
	50%	3(30)
HHS	20%	5(50)
	30%	5(50)

Overall reliability and feasibility		
Three indicators reliable for assessing household food security	Agree	6(60)
	Strongly agree	4(40)
Indicators reflect access and utilization dimensions	Agree	7(70)
	Strongly agree	3(30)
HFSI effective in low-income South African settings	Agree	10(100)
Time/resources reasonable for clinics	Strongly agree	4(40)
	Agree	4(40)
	Neutral	2(20)
Practical implementation in clinical settings	Agree	10(100)

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; NS = Nutritional Status

As shown in Table 4.19, experts unanimously agreed that both HDDS and NS were very relevant (100%) for measuring household food security. The HHS was also considered relevant, although with slightly lower consensus, 70% rated it very relevant and 30% moderately relevant. On conceptual validity, 80% either agreed or strongly agreed that HDDS captures the utilization dimension, while 90% strongly agreed that NS reflects utilization and health outcomes. The HHS was endorsed as addressing food access by all experts, with 70% strongly agreeing and 30% agreeing.

All panel members rejected equal weighting of indicators (100%, n = 10), indicating a recognition of differing indicator importance. Weighting preferences were varied, but most clustered around 35% for HDDS (50%) and 30% for NS (50%), while HHS received an even split between 20% and 30% (50% each). Reliability and feasibility were also strongly supported: 100% agreed that the HFSI would be effective in low-income South African settings, and 100% agreed that the index could be practically implemented in clinics.

#### 4.4.1.2 Round two results

In the second round, items that had already reached consensus in Round one was removed, and experts were asked to refine their responses on remaining items. As presented in Table 4.20, consensus strengthened.

**Table 4.20: Delphi round two feedback (N = 10)**

Item	Response Options	N(%)
Agreement with conceptual statements		
HDDS captures utilization dimension	Strongly agree	2(20)
	Agree	8(80)
	Neutral/Disagree/Strongly disagree	0(0)
Three indicators are reliable for assessing household food security	Agree	10(100)
Time/resources reasonable for clinics	Agree	8(80)
	Neutral	2(20)
Weight allocation preferences		
HDDS	30%	1(10)
	35%	9(90)
NS	35%	7(70)
	40%	2(20)
	45%	1(10)
HHS	20%	1(10)
	25%	1(10)
	30%	8(80)

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; NS = Nutritional Status

Agreement that HDDS effectively captures utilization increased, with 100% of experts now agreeing or strongly agreeing. Similarly, unanimity was achieved on the reliability of the three indicators (100%). Weight allocation preferences converged further. For HDDS, 90% assigned a weight of 35%, while 70% allocated 35% to NS, with a small number assigning higher values (20% at 40%, 10% at 45%). For HHS, 80% preferred a 30% weight. This represents a clear stabilization of weighting preferences compared to Round 1. Feasibility was endorsed by 80% of the panel, with two experts remaining neutral, suggesting near-complete consensus on practical considerations.

#### 4.4.1.3 Round three results (final consensus)

The third and final round, presented in Table 4.21, confirmed and consolidated expert consensus across all dimensions.

**Table 4.21: Delphi round three feedback (N = 10)**

Item	Response Options	N(%)
Relevance of indicators		
HDDS	Very relevant	10(100)
NS	Very relevant	10(100)
HHS	Very relevant	7(70)
	Moderately relevant	3(30)
Agreement with conceptual statements		
HDDS captures utilization dimension	Strongly agree	2(20)
	Agree	8(80)
NS reflects utilization/health outcomes	Strongly agree	9(90)
	Neutral	1(10)
HHS addresses access dimension	Strongly agree	7(70)
	Agree	3(30)
Equal weighting of indicators appropriate?	Yes	0(0)
	No	10(100)
Weight allocation preferences		
HDDS	30%	1(10)
	35%	9(90)
NS	35%	7(70)
	40%	2(20)
	45%	1(10)
HHS	20%	1(10)
	25%	1(10)
	30%	8(80)
Overall reliability and feasibility		
Three indicators reliable for assessing food security	Agree	10(100)
Indicators reflect access and utilization dimensions	Strongly agree	3(30)
	Agree	7(70)
HFSI effective in low-income South African settings	Agree	10(100)
Time/resources reasonable for clinics	Agree	8(80)
	Neutral	2(20)
Practical implementation in clinics	Agree	10(100)

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; NS = Nutritional Status

As summarized in Table 4.21, HDDS and NS again achieved unanimous endorsement as very relevant (100%). HHS remained slightly less strongly supported, with 70% rating it very relevant and 30% moderately relevant. Weight allocation consensus stabilized fully. For HDDS, 90% supported a 35% weight; for NS, 70% supported 35%, with the remainder favouring 40% (20%) or 45% (10%). HHS reached 80% consensus at 30%. These distributions indicate a final agreed weighting structure prioritizing HDDS and NS while still recognizing the importance of HHS. Reliability and conceptual alignment received full endorsement (100%). Feasibility was also strongly confirmed, with 80% agreeing that time and resource demands were reasonable, and 100% agreeing the index could be implemented in clinical settings.

The Delphi process effectively established expert consensus on the HFSI's structure and application. Across three iterative rounds, the panel consistently endorsed HDDS, NS, and HHS as valid and relevant indicators, though HHS showed slightly lower strength of consensus. The weighting exercise highlighted that experts did not view all indicators as equally important. Instead, the final consensus placed the greatest emphasis on HDDS and NS, with slightly lower weighting for HHS. This reflects an expert judgment that while access remains central, measures of diet quality and nutritional outcomes provide a more comprehensive assessment of household food security in low-income South African contexts. Practicality and feasibility were also strongly confirmed. Experts recognized that the index could be realistically applied in clinical settings, with minimal burden on resources. This is crucial for ensuring that the HFSI can move beyond theory and be implemented as a screening and monitoring tool in real-world practice in future research.

In summary, a strong consensus was reached across three Delphi rounds with a panel of ten experts regarding the relevance, conceptual validity, weighting, and overall feasibility of the proposed HFSI. These results provide a robust foundation for applying the HFSI in clinical and community settings, positioning it as a practical and reliable tool for identifying and addressing household food insecurity in low-income settings in South Africa.

#### 4.4.2 Relationship between the HFSI indicators

The HFSI in this study was developed as a formative construct, composed of three conceptually distinct but complementary indicators: the HDDS, the HHS, and BMI-for-age z-score as child NS indicator. Each of these indicators was selected to capture a unique aspect of household food security: HDDS reflects dietary quality and access to diverse foods; HHS measures the experience of hunger and food scarcity; and NS represents the physiological outcomes of food insecurity. Given the formative nature of the index, high inter-item correlations were not expected. Rather, the goal was to ensure comprehensive representation of the multifaceted dimensions of food security and empirically verify the independence and non-redundancy of the indicators across three time periods (T1, T2, T3). To empirically explore the relationships among these indicators, Pearson Product Moment Correlation analysis ( $r$ ) was conducted across the three time points as illustrated by Table 4.22 below. The value of  $r$  ranges from -1 to +1, where values closer to  $\pm 1$  indicate stronger relationships, and values near 0 suggest little to no linear association. In this study, correlations were tested for both statistical significance ( $p < 0.05$ ) and practical significance ( $r \geq 0.300$ ), following thresholds appropriate to the sample sizes at each time point (Gravetter & Wallnau, 2016).

##### 4.4.2.1 Correlation analysis of HFSI indicators

Table 4.22 illustrates the Pearson product moment correlations for each HFSI indicator across each timepoint.

**Table 4.22: Pearson product moment correlations of household food security index (HFSI) indicators**

		HDDS	HHS	NS
T1	HDDS	-	-0.039	0.01
	HHS	-0.039	-	0.011
	NS	0.01	0.011	-
T2	HDDS	-	0.071	0.007
	HHS	0.071	-	-0.017
	NS	0.007	-0.017	-
T3	HDDS	-	<b>-0.194</b>	-0.005
	HHS	<b>-0.194</b>	-	-0.045

	NS	-0.005	-0.045	-
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HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; NS = Nutritional Status; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3

At T1, all correlations between indicators fell below thresholds for statistical ( $r \geq 0.064$ – $0.074$ ) and practical significance ( $r \geq 0.300$ ). Specifically, HDDS–HHS ( $r = -0.039$ ), HDDS–NS ( $r = 0.010$ ), and HHS–NS ( $r = 0.011$ ) showed no meaningful linear relationships, indicating that each indicator captures distinct dimensions of household food security. At T2, correlations between indicators remained weak and below thresholds for statistical ( $r \geq 0.065$ – $0.075$ ) and practical significance ( $r \geq 0.300$ ). Specifically, HDDS–HHS ( $r = 0.071$ ), HDDS–NS ( $r = 0.007$ ), and HHS–NS ( $r = -0.017$ ) showed no meaningful linear relationships, indicating that each indicator continued to capture distinct dimensions of household food security. At T3, correlations among HDDS, HHS, and NS were generally weak. HDDS–HHS showed a statistically significant but practically negligible inverse association ( $r = -0.194$ ), while HDDS–NS ( $r = -0.005$ ) and HHS–NS ( $r = -0.045$ ) were not significant. These results indicate that the indicators largely capture independent dimensions of household food security, with temporal variability in associations potentially reflecting changing household dynamics or contextual disruptions.

These results coincide with a growing body of evidence showing that widely used indicators of household food security, such as HDDS, HHS, and anthropometric measures of NS, tend to capture different and often weakly correlated dimensions of household food security. Studies have consistently found that HDDS, while sometimes associated with nutrition outcomes, often exhibits low or inconsistent correlations across contexts (Hoddinott & Yohannes, 2002; Ruel, 2003). Similarly, the HHS has been validated as a distinct experiential measure that reflects household hunger but not dietary quality or child growth outcomes (Coates et al., 2007; Ballard et al., 2011).

Large-scale reviews and comparative studies highlight that these measures are not interchangeable, with correlations among them frequently weak or non-significant (Cafiero et al., 2014; Maxwell et al., 2014; Leroy et al., 2015). Instead, each indicator contributes unique information to the understanding of food security, supporting the argument that household food security is best represented through a formative

measurement model, such as the HFSI, rather than a reflective one (Carletto et al., 2013; Headey & Ecker, 2013; Jones et al., 2013).

More recent research reinforces these distinctions. Acheampong and co-workers (2022) demonstrated that while HDDS and the FCS were moderately related to household food security, neither correlated strongly with anthropometric indicators of nutrition in Ghana. Maxwell and colleagues (2023) confirmed that the HHS remains a robust experiential tool for identifying severe food insecurity and famine risk but does not effectively capture dietary diversity or nutritional adequacy. Tesafa, Mulugeta and Tsehay (2025) further noted that dietary diversity indicators (HDDS and Minimum Dietary Diversity for Women measure consumption behaviour distinct from physiological nutrition outcomes, underscoring the multidimensional nature of food security.

Bashir, Schilizzi and Pandit (2012) similarly found weak correlations between expenditure-based and anthropometric indicators, suggesting that these tools each capture unique aspects of household well-being rather than a single construct. Complementary evidence from Ogunleye, Ogundeji and Danso-Abbeam (2025) supports the combined use of dietary, experiential, and anthropometric indicators to provide a holistic understanding of food insecurity, particularly under systemic shocks such as the COVID-19 pandemic, when household experiences of food access, hunger, and nutritional outcomes may diverge.

Further supporting evidence from diverse global contexts underscores the complex and often indirect relationships between household food security indicators and nutritional outcomes. Ambikapathi and colleagues (2018) using a validated food access assessment tool in the Peruvian Amazon, found that while food purchase patterns and household food access were predictive of dietary diversity among children, these measures did not directly translate into improved NS. Their results highlight that dietary diversity and food access may influence nutrient intake without immediately reflecting in anthropometric measures, due to mediating factors such as illness, food utilization, and intra-household allocation.

Similarly, Dinku, Mekonnen and Adilu (2020), studying urban households in north-central Ethiopia, observed that child dietary diversity and food security were only modestly associated with child anthropometric indices, particularly height-for-age and weight-for-age z-scores. Their study emphasized that urban food systems and household socioeconomic conditions shape both dietary diversity and child nutrition, but not always in parallel. These results align with the current study's results, where differences in HDDS, HHS, and BMI-for-age z-scores were small and inconsistent, suggesting that these measures capture distinct but interrelated dimensions of food security and nutrition.

Overall, the convergence of these studies emphasizes that HDDS, HHS, and anthropometric measures are complementary but not interchangeable. Their combined application enables a more nuanced assessment of food security dynamics, especially in contexts where both food access and nutritional adequacy are disrupted, as observed in this study.

In summary, across all three survey rounds, correlations among HDDS, HHS, and NS were low and mostly non-significant, supporting the formative measurement model. This independence indicates that each indicator uniquely contributes to the composite HFSI, reflecting distinct dimensions of household food security. The results reinforce the index's construct validity and justify the use of a formative approach, where multiple indicators collectively define the construct rather than serve as interchangeable measures.

#### *4.4.2.2 Exploratory Factor Analysis (EFA) of the HFSI indicators*

To explore the underlying structure among the three core indicators of the HFSI an Exploratory Factor Analysis (EFA) was conducted using data from 1 487 respondents. The EFA produced three eigenvalues (Table 4.23), with the first factor accounting for 35.35% of the total variance. The remaining factors accounted for 32.78% and 31.87%, respectively. Given that only the first factor had an eigenvalue greater than 1 and explained the most variance, a single-factor model was deemed appropriate for interpretation.

**Table 4.23: Exploratory factor analysis (EFA) of household food security index (HFSI) (N = 1487)**

Factor	Eigenvalues	% Total Variance
1	1.060	35.35
2	0.983	32.78
3	0.956	31.87

*Factor loadings*

The single-factor model loadings (Table 4.24) indicated that all three indicators contributed meaningfully to the latent construct. HDDS had the strongest loading at 0.666, followed by HHS at 0.586, and NS with a negative loading of  $-0.523$ . All loadings exceeded the minimum significant threshold of 0.300, supporting their inclusion in the index. The negative loading of NS reflects an inverse relationship with the latent household food security construct, which aligns with theoretical expectations.

**Table 4.24: Exploratory factor analysis (EFA) Loadings (1 Factor Model) for household food security index (HFSI) indicators (N = 1487; Minimum significant loading = 0.300)**

Item	Factor 1
HDDS	0.666
HHS	0.586
NS	-0.523
Total % of Variance Explained = 35.3%	

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; NS = Nutritional Status

*Weight derivation: EFA Approach compared to the Delphi method*

Weights were calculated for each indicator by squaring the factor loadings to obtain communalities and dividing by the total variance explained (1.060). Table 4.25 illustrates the yielded EFA-based weights of 0.42 for HDDS, 0.32 for HHS, and 0.26 for NS. These values reflect the relative contribution of each indicator to the underlying food security factor, based on the empirical data.

**Table 4.25: Comparison of exploratory factor analysis-derived (EFA) and Delphi-derived weights for the household food security index (HFSI) indicators**

	Loading	Loading <sup>2</sup>	EFA Weights	Delphi Weights
HDDS	0.666	0.444	0.444 / 1.060 =	0.42
NS	0.586	0.344	0.344 / 1.060 =	0.32
HHS	-0.523	0.273	0.273 / 1.060 =	0.26
	Sum	1.060		

HDDS = Household Dietary Diversity Score; HHS = Household Hunger Scale; NS = Nutritional Status; EFA = Exploratory Factor Analysis

Although EFA provides a useful, data-driven approach for index construction, a well-documented limitation is that factor weights are highly sample-dependent and may not replicate across different populations or contexts. Schmitt (2011) emphasize that factor loadings derived from EFA are sensitive to sample characteristics, including size, composition, and measurement error, which can lead to unstable solutions. Preacher, Zhang, Kim & Mels (2013) further highlight that decisions about the number of factors and their interpretation are influenced by sampling variability, making generalization problematic. More recent work confirms that factor structures obtained in one dataset often fail to hold in others, underscoring the need for validation through confirmatory factor analysis or replication in independent samples (Schreiber, 2021; Goretzko & Bühner, 2022). Consequently, while EFA weights can inform index construction, they should be interpreted cautiously and not assumed to generalize beyond the specific sample used.

To address this limitation, the study adopts the Delphi-derived weights; 0.35 for HDDS, 0.35 for NS, and 0.30 for HHS as the final weights for the HFSI. The Delphi method reflects expert consensus and is widely recognized for enhancing the stability, validity, and applicability of indices across diverse contexts (Dalkey & Helmer, 1963; Okoli & Pawlowski, 2004; Keeney, Hasson & McKenna, 2006; Hsu & Sandford, 2007; Diamond et al., 2014)

However, as discussed above, it is acknowledged that the result of this study only reflects the situation at low-socio-economic populations in NMB and that the exact weights may not be applicable for all populations. This is one of the limitations of the study and further research is necessary to determine whether these weights are also applicable in other socio-economic groups and other geographic areas.

#### 4.4.3 Description of the HFSI

Table 4.26 presents descriptive statistics for the HFSI score across the three time points, T1, T2, and T3. The results indicate that at T1 and T2, the mean HFSI scores reflected a state of fair food security among households; however, by T3, the mean score demonstrated a transition toward poor food security. This progressive decline in mean HFSI scores over time reflects a deterioration in household food security.

**Table 4.26: Description of household food security index (HFSI) scores**

Variable	N	Mean	S.D.	Minimum	Quartile 1	Median	Quartile 3	Maximum
T1: HFSI	706	58.14	14.03	8.75	48.89	58.46	67.50	94.17
T2: HFSI	687	56.35	13.92	10.33	46.68	56.56	66.35	94.17
T3: HFSI	94	45.91	12.44	15.66	36.63	44.44	54.70	73.75

HFSI = Household Food Security Index; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3

At T1, the mean HFSI score was  $58.14 \pm 14.03$  indicating fair food security. The scores ranged from 8.75 to 94.17. At T2, the mean decreased slightly to  $56.35 \pm 13.92$ , still indicating fair food security, with a similar range. During T3, the mean dropped significantly to  $45.91 \pm 12.44$ , indicating poor food security, with the minimum and maximum values narrowed to 15.66 to 73.75. This downward trend in average scores is accompanied by declines in the median (from 58.46 to 44.44) and interquartile range, suggesting an overall worsening of household food security status and increased vulnerability over time. These results are consistent with the patterns observed across the individual indicators assessed in phase one of this study, thereby reinforcing the evidence of poor food security status and a progressive decline in household food security over the study period.

Table 4.27 provides a categorical breakdown of the HFSI, classified into four levels: Very Poor, Poor, Fair, and Good. Household food security initially showed the majority of the sample classified as fair; however, it notably deteriorated over the study period, with most households ultimately classified as poor.

**Table 4.27: Description of household food security index (HFSI) characteristics**

Variable	Very poor n(%)	Poor n(%)	Fair n(%)	Good n(%)	Total N
T1: HFSI	8(1)	186(26)	420(59)	92(13)	706
T2: HFSI	7(1)	224(33)	387(56)	69(10)	687
T3: HFSI	4(4)	57(61)	33(35)	0(0)	94

HFSI = Household Food Security Index; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3

At T1, most households were in the Fair (59%) and Poor (26%) categories, with only 13% in the Good category and 1% classified as Very Poor. At T2, there was a modest shift toward more households falling into the Poor category (33%), and fewer in the Good category (10%). By T3, the possible impact of cumulative stressors became apparent: 61% of households were classified as Poor, 35% as Fair, 4% as Very Poor, and no households were categorized as Good. These shifts confirm a notable deterioration in household food security over time, with the most severe decline observed between T2 and T3. The results align with the negative trends observed across the individual indicators in phase one of this study, underscoring the reliability and validity of the HFSI. The index consistently detected changes in household food security at each time point, reinforcing its capacity to capture both short-term disruptions and underlying vulnerabilities within the study population.

#### 4.4.4 Differences in the HFSI over time

Table 4.28 presents the 95% confidence intervals for the mean HFSI scores across three timepoints, T1, T2, T3. These intervals provide a range within which the true population mean is likely to fall, with 95% certainty, based on the sample data.

**Table 4.28: Changes in household food security index (HFSI) scores over time**

Variable	N	Mean	S.D.	95% CI Lo	95% CI Hi
T1: HFSI	706	58.14	14.03	57.10	59.18
T2: HFSI	687	56.35	13.92	55.31	57.39
T3: HFSI	94	45.91	12.44	43.36	48.46

HFSI = Household Food Security Index; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3

At T1, the mean HFSI score was  $58.14 \pm 14.03$ , with a 95% CI of 57.10-59.18. At T2, the mean decreased to  $56.35 \pm 13.92$ , with a CI of 55.31-57.39. At T3, the mean

dropped further to  $45.91 \pm 12.44$ , and the CI ranged from 43.36-48.46. The non-overlapping confidence intervals between T1-T2 and T3 suggest a statistically significant decline in household food security levels from earlier timepoints to the final measurement. This decline supports the conclusion that food security deteriorated over the study period. While the reduction from T1 to T2 is modest, the sharper decrease at T3, with a mean nearly 10 points lower, likely reflects the compounding effects of external shocks, such as the COVID-19 pandemic, on already vulnerable households.

Table 4.29 below illustrates the one-sample t-tests that were conducted to assess changes in HFSI scores over time. The mean differences were compared at each time point against a reference value of 60.00, testing the hypothesis  $H1: \mu \neq 60.00$ .

**Table 4.29: Differences in household food security index (HFSI) scores over time (H1:  $\mu \neq 60.00$ )**

Variable	N	Mean	S.D.	95%CI Lo	95%CI Hi	t	d.f.	p	Cohen's d	
T2-T1: HFSI	652	-1.42	10.33	-2.21	-0.63	-151.77	651	<b>&lt;0.001</b>	5.94	Large
T3-T2: HFSI	68	-10.70	17.67	-14.98	-6.42	-32.99	67	<b>&lt;0.001</b>	4.00	Large
T3-T1: HFSI	62	-14.99	16.47	-19.17	-10.80	-35.84	61	<b>&lt;0.001</b>	4.55	Large

HFSI = Household Food Security Index; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values marked in bold are statistically significant ( $p < 0.05$ )

For T2–T1, the mean change in HFSI category was statistically significant ( $-1.42 \pm 10.33$ ,  $p < 0.001$ ,  $d = 5.94$ ), with the one-sample t-test indicating a highly significant decline and large effect size, suggesting substantial change. For T3–T2 the mean difference was also significant with a large effect size ( $-10.70 \pm 17.67$ ,  $p < 0.001$ ,  $d = 4.00$ ). During T3–T1 the cumulative effect showed the most pronounced decline in household food security. The result was statistically significant and again a large effect size was observed ( $-14.99 \pm 16.47$ ,  $p < 0.001$ ,  $d = 4.55$ ).

These results collectively point to a consistent and significant decline in household food security over the three time points, with large effect sizes across all intervals, underscoring the magnitude of change in the population studied. These inferential statistics reinforce results from the phase one of this study and provide robust evidence that the observed changes in household food security are not due to random

variation but reflect meaningful trends in the population studied. These results further support the HFSI as a robust composite measure of household food security, with strong capacity to detect changes over time and in response to external shocks.

Changes in HFSI were examined categorically, classifying participants as experiencing worse, same, or better outcomes across time intervals. Frequencies and 95% confidence intervals are reported in Table 4.30.

**Table 4.30: Changes in household food security index (HFSI) categories over time**

Variable	Worse N(%)	Same N(%)	Better N(%)	Total N	95% Confidence Intervals		
					Worse	Same	Better
T2-T1: HFSI	122(19)	449(69)	81(12)	652	15.7%-21.7%	65.3%-72.4%	9.9%-15.0%
T3-T2: HFSI	33(49)	29(43)	6(9)	68	36.7%-60.4%	30.9%-54.4%	2.1%-15.6%
T3-T1: HFSI	38(61)	20(32)	4(6)	62	49.2%-73.4%	20.6%-43.9%	0.3%-12.6%

HFSI = Household Food Security Index; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3

For T2–T1, most households remained in the Same category (69%), while 19% worsened and 12% improved. The confidence intervals were narrow, suggesting stable estimates with 15.7%–21.7% Worse, 65.3%–72.4% Same, 9.9%–15.0% Better. For T3–T2 the distribution showed a higher rate of worsening conditions (49%) and fewer improvements (9%), indicating a sharper decline post-T2. For T3–T1 the deterioration was even more pronounced, with 61% classified as Worse, only 6% Better, and 32% remaining unchanged.

To assess the statistical significance of categorical shifts in HFSI, Chi-square goodness-of-fit tests were conducted, comparing distributions across time points to reference proportions as illustrated in Table 4.31.

**Table 4.31: Change in household food security index (HFSI) categories over time**

	Chi <sup>2</sup> Goodness-of-Fit Statistics			
	N	Chi <sup>2</sup>	p(d.f.=2)	Cramér's V
Comparison with T2-T1 percentages:19%, 69%, 12%				
T3-T2: HFSI	68	38.62	<0.001	0.75 Large
T3-T1: HFSI	62	72.08	<0.001	1.08 Large
Comparison with T3-T2 percentages:49%, 43%, 9%				

T3-T1: HFSI	62	4.02	0.134	0.25	Moderate
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HFSI = Household Food Security Index; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values marked in bold are statistically significant ( $p < 0.05$ )

For T3–T2 (vs. T2–T1 Reference), the observed frequencies differed significantly from the reference distribution with a large effect size ( $\chi^2(2) = 38.62$ ,  $p < 0.001$ ,  $V = 0.75$ ). This indicates substantial change in categorical HFSI status between T2 and T3. For T3–T1 (vs. T2–T1 Reference), the difference was even more statistically robust, with an extremely large effect size ( $\chi^2(2) = 72.08$ ,  $p < 0.001$ ,  $V = 1.08$ ), suggesting severe deterioration in food security over the full period. Finally, for T3–T1 (vs. T3–T2 Reference), this comparison did not reach statistical significance ( $\chi^2(2) = 4.02$ ,  $p = 0.134$ ,  $V = 0.25$ ). This suggests that the distributional changes between T3 and T1 were not substantially different from those seen between T3 and T2, possibly indicating a plateau in the rate of worsening conditions.

The bivariate analyses present compelling evidence of a statistically and practically significant decline in household food security across the observed periods. The longitudinal analyses provide strong evidence for the reliability of the HFSI in capturing household food security dynamics over time. Both continuous (t-tests) and categorical (Chi-square) comparisons demonstrated consistent patterns of decline, with large and highly significant effect sizes particularly evident between T3 and T1. The ability of the HFSI to detect statistically robust and practically meaningful shifts across different time intervals underscores its sensitivity to both gradual and acute changes in food security status.

The convergence of results across analytical approaches further reinforces the internal consistency of the index, suggesting that the HFSI is a dependable tool for monitoring household food security trends. Importantly, the comparable distributional changes observed between T3 and T2 relative to T3 and T1 suggest that the index is also capable of capturing periods of intensified deterioration as well as potential plateaus in worsening conditions.

Moreover, the observed trends correspond closely with the results of the individual indicators assessed in phase one as mentioned. This alignment demonstrates that the

HFSI not only consolidates the information provided by these measures but also enhances their interpretive power by offering a composite index capable of detecting both short-term shocks and longer-term vulnerabilities. Collectively, these results highlight the reliability of the HFSI as a comprehensive and consistent measure of household food security. These results warrant further investigation to support the potential application of the HFSI within public health settings, particularly in low-income communities in EC, South Africa, as a tool to detect and monitor household food insecurity.

#### 4.4.5 Relationships between COVID-19 impact questions and HFSI

The following section presents the inferential statistics investigating the relationship between the COVID-19 impact questions and the HFSI. To assess whether caregiver perceptions that COVID-19 affected their child’s diet (COVID\_Q1) or household food security (COVID\_Q2) were associated with differences in the HFSI, analysis were conducted comparing groups across three time points: T1 and T2 (pre-pandemic) and T3 (during the pandemic) as well as for change across T2–T1, T3–T2, and T3–T1.

##### *4.4.5.1 COVID\_Q1: Influence on child diet*

Table 4.32 presents the inferential statistics investigating the relationship between the COVID-19 impact question (COVID\_Q1) and the HFSI score. Independent samples t-tests were conducted comparing groups across three time points as well as for change across T2–T1, T3–T2, and T3–T1.

**Table 4.32: Differences in household food security index (HFSI) scores by COVID\_Q1 (question 1) (Ho difference = 0.00)**

Variable	COVID_Q1	N	Mean	S.D.	Difference	t	d.f.	p	Cohen's d	
T1: HFSI	No	89	59.90	14.17	-4.45	-1.58	124	0.118	0.31	Small
	Yes	37	64.35	15.04						
T2: HFSI	No	98	55.84	15.07	-2.71	-0.93	133	0.353	0.18	None
	Yes	37	58.55	15.06						
T3: HFSI	No	69	45.76	12.28	-0.57	-0.20	92	0.845	0.05	None

	Yes	25	46.33	13.13						
T2-T1: HFSI	No	85	-2.28	11.90	4.39	1.80	118	0.074	0.36	Small
	Yes	35	-6.68	12.76						
T3-T2: HFSI	No	52	-11.99	18.87	-5.49	-1.09	66	0.281	0.31	Small
	Yes	16	-6.50	12.64						
T3-T1: HFSI	No	46	-15.76	17.57	-2.98	-0.62	60	0.537	0.18	None
	Yes	16	-12.78	13.04						

HFSI = Household Food Security Index; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values marked in bold are statistically significant ( $p < 0.05$ )

Table 4.32 illustrate that at T1, households reporting perceived COVID-19-related dietary impacts demonstrated higher HFSI scores than unaffected households (64.35 vs. 59.90), though this difference was not significant. Scores declined in both groups by T2, with sharper losses in the COVID\_Q1 = Yes group (-6.68 vs. -2.28), and by T3 food insecurity had deteriorated substantially across all households, converging at similarly low levels (Yes: 46.33; No: 45.76). While none of the mean differences reached statistical significance, small effect sizes ( $d = 0.31-0.36$ ) may suggest notable trends. The results suggest a trend where households reporting COVID-19-related dietary impacts experienced greater declines in food security over time. By T3, both groups had converged at similarly low HFSI scores, indicating a general worsening of household food security across the sample.

Table 4.33 presents the inferential statistics investigating the relationship between the COVID-19 impact question (COVID\_Q1) and HFSI categories. Chi-square tests of independence were conducted at three timepoints (T1, T2 pre-pandemic; T3 during the pandemic) and across change intervals (T2-T1, T3-T2, T3-T1), with Cramér's V indicating effect size. The categorical analyses revealed no statistically significant results; however, trends are notable.

**Table 4.33: Association between household food security index (HFSI) categories and COVID\_Q1(question 1)**

Variable	Time points	N	Chi <sup>2</sup> (d.f.)	p	Cramér's V	
HFSI	T1	126	4.41 (3)	0.220	0.19	Small
	T2	135	1.58 (3)	0.663	0.11	Small
	T3	94	1.25 (2)	0.535	0.12	Small
	T2-T1	120	2.59 (2)	0.274	0.15	Small
	T3-T2	68	4.82 (2)	0.090	0.26	Small
	T3-T1	62	2.36 (2)	0.307	0.20	Small

HFSI = Household Food Security Index; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values marked in bold are statistically significant ( $p < 0.05$ )

At T1, respondents who answered COVID\_Q1 = Yes, indicating perceived dietary impact on their child, had a higher mean HFSI score ( $64.35 \pm 15.04$ ) than those who answered No ( $59.90 \pm 14.17$ ). Although this difference did not reach statistical significance. At T2 the gap between groups narrowed (Yes:  $58.55 \pm 15.06$ ; No:  $55.84 \pm 15.07$ ), and the difference was not significant. This suggests the start of a decline in food security for both groups, though still more pronounced in those later reporting COVID-related impacts. By T3, during the pandemic period, HFSI scores had declined notably across the sample. Mean scores for the Yes group dropped to  $46.33 \pm 13.13$  and for the No group to  $45.76 \pm 12.28$ . The minimal difference was not significant, reflecting a convergence in food insecurity levels, with both groups experiencing comparable levels of hardship during the pandemic. From T1 to T2, households in the COVID\_Q1 = Yes group showed a steeper decline in HFSI ( $-6.68 \pm 12.76$ ) compared to the COVID\_Q1 = No group ( $-2.28 \pm 11.90$ ). Although this difference was not statistically significant. Between T2 and T3, both groups experienced further deterioration, though the difference was also not significant. From T1 to T3, overall changes showed that both groups suffered substantial declines in food security, with the COVID\_Q1 = Yes group dropping by  $-12.78 \pm 13.04$  points and the COVID\_Q1 = No group by  $-15.76 \pm 17.75$ . This final difference was statistically not significant, indicating that the pandemic had a levelling effect, equalizing food insecurity across households regardless of perceptions.

Although none of the group differences reached statistical significance, several meaningful trends were observed. Households reporting perceived COVID-19-related child dietary impacts began the study period in a relatively stronger food security position but experienced a steeper early decline between T1 and T2 ( $d = 0.36$ ), indicating heightened vulnerability even before the onset of the pandemic. By T3, food security had deteriorated across all households, with mean scores converging to similarly low levels, suggesting that the pandemic's effects were broad-based and transcended initial household differences. These results imply that early declines in food security may have been early warning signs of which households would later perceive pandemic-related dietary impacts. The convergence in widespread insecurity

by T3 underscores the levelling effects of systemic shocks, consistent with prior evidence that pandemics compress pre-existing disparities in food access (Éliás & Jám bor, 2021). The results reinforce the validity of the HFSI as a sensitive tool for capturing both gradual and acute food security disruptions. While statistical significance was not achieved, the consistent small effect sizes and parallel trends reinforce the importance of monitoring early, pre-crisis vulnerabilities as indicators of household resilience and sensitivity to future shocks

#### 4.4.5.2 COVID\_Q2: Influence on household food security

Table 4.34 presents the inferential statistics investigating the relationship between the COVID\_19 impact question (COVID\_Q2) and the HFSI. A statistically significant result was noted at T1, together with other marginal shifts over time.

**Table 4.34: Differences in household food security index (HFSI) scores by COVID\_Q2 (question 2) (Ho difference = 0.00)**

Variable	COVID_Q2	N	Mean	S.D.	Difference	t	d.f.	p	Cohen's d	
T1: HFSI	No	66	57.80	14.18	-7.16	-2.84	124	<b>0.005</b>	0.51	Medium
	Yes	60	64.96	14.05						
T2: HFSI	No	72	54.56	15.07	-4.33	-1.68	133	0.096	0.29	Small
	Yes	63	58.89	14.83						
T3: HFSI	No	57	47.45	11.81	3.89	1.49	92	0.139	0.31	Small
	Yes	37	43.55	13.17						
T2-T1: HFSI	No	62	-1.92	11.95	3.41	1.53	118	0.129	0.28	Small
	Yes	58	-5.33	12.46						
T3-T2: HFSI	No	40	-8.36	18.85	5.68	1.31	66	0.194	0.32	Small
	Yes	28	-14.04	15.57						
T3-T1: HFSI	No	36	-11.54	16.97	8.23	1.99	60	0.052	0.51	Medium
	Yes	26	-19.76	14.76						

HFSI = Household Food Security Index; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values marked in bold are statistically significant ( $p < 0.05$ )

At T1, households that later reported experiencing COVID-19-related food insecurity had a significantly higher HFSI score ( $64.96 \pm 14.05$ ) compared to those who did not ( $57.80 \pm 14.18$ ), with a medium effect size ( $p = 0.005$ ,  $d = 0.51$ ). This suggests that prior to the pandemic, households that would later report pandemic-related challenges were better off in terms of food security. At T2, the COVID\_Q2 = Yes group still reported a higher mean HFSI score ( $58.89 \pm 14.83$ ) than the COVID\_Q2 = No group

( $54.56 \pm 15.07$ ), but the difference was no longer statistically significant. At T3, the COVID\_Q2 = No group reported higher food security ( $47.45 \pm 11.81$ ) than the COVID\_Q2 = Yes group ( $43.55 \pm 13.17$ ), but the difference was not statistically significant. Thus, by the time the pandemic, households who perceived themselves as impacted by COVID-19 had transitioned from being relatively food secure to significantly less secure. From T1-T2, the COVID\_Q2 = Yes group showed a mean decline of  $-5.33 \pm 12.46$ , while the No group declined by only  $-1.92 \pm 11.95$ , which was not significant. From T2-T3, the COVID\_Q2 = Yes group experienced a sharper decline ( $-14.04 \pm 15.57$ ) compared to the COVID\_Q2 = No group ( $-8.36 \pm 18.85$ ), although not significantly, suggesting that food security deteriorated more severely for affected households during the pandemic. From T1-T3, the overall cumulative decline was markedly greater for the COVID\_Q2 = Yes group ( $-19.76 \pm 14.76$ ) compared to the COVID\_Q2 = No group ( $-11.54 \pm 16.97$ ) and indicated towards significance, with a medium effect size ( $p = 0.052$ ,  $d = 0.51$ ). This indicates a substantial and sustained worsening of food security in households that reported pandemic-related hardship.

Collectively, the results reveal a trajectory of decline in food security for households that perceived themselves as impacted by COVID-19. Before the pandemic, these households had significantly better food security than their counterparts. However, by the time of the pandemic (T3), this relative advantage had eroded, and their overall food security had deteriorated more sharply, as evidenced by medium effect sizes in both T1 and cumulative change (T3–T1). These results, reinforce the conclusion that COVID-19 had a pronounced and disproportionate impact on food security in households that reported pandemic related impact. While early differences may reflect pre-existing economic strength, the pandemic amplified vulnerability and exposed the fragility of household food systems even in previously secure contexts.

Table 4.35 presents the inferential statistics investigating the relationship between the COVID\_19 impact question (COVID\_Q2) and the HFSI categories. Overall, no statistically significant results were found, however systemic trends were noted.

**Table 4.35: Association between household food security index (HFSI) categories and COVID\_Q2 (question 2)**

Variable	Time point	Chi <sup>2</sup> Goodness-of-Fit Statistics				
		N	Chi <sup>2</sup> (d.f.)	p	Cramér's V	
HFSI	T1	126	5.42 (3)	0.143	0.21	Small
	T2	135	4.72 (3)	0.193	0.19	Small
	T3	94	2.27 (2)	0.322	0.16	Small
	T2–T1	120	1.52 (2)	0.468	0.11	Small
	T3–T2	68	4.61 (2)	0.100	0.26	Small
	T3–T1	62	4.30 (2)	0.117	0.26	Small

HFSI = Household Food Security Index; T1 = Time point 1; T2 = Time point 2; T3 = Time point 3; p values marked in bold are statistically significant ( $p < 0.05$ )

At T1, households later reporting COVID-related food security impacts (COVID\_Q2 = Yes) were slightly better off, with more classified as good (28.3% vs. 15.2%) and fewer as poor (13.3% vs. 24.2%), though differences were not significant. This modest advantage persisted at T2, with the COVID\_Q2 = Yes group more concentrated in fair and less in poor. By T3, food security declined across both groups, with over half classified as poor and none in good. The COVID\_Q2 = Yes group experienced sharper deterioration, with 8.1% in very poor versus 1.8% in No. Change analyses showed stability between T1–T2, but greater decline in the COVID\_Q2 = Yes group between T2–T3 (53.6% worsened vs. 45.0%), with none improving, compared to 15.0% improvement in COVID\_Q2 = No households. Across T1–T3, 73.1% of COVID\_Q2 = Yes households worsened versus 52.8% of COVID\_Q2 = No. Overall, while not statistically significant, effect sizes ( $V = 0.16–0.26$ ) indicate systematic trends; households perceiving COVID-related impacts entered the pandemic stronger but experienced sharper, sustained declines, highlighting the pandemic's role in deepening vulnerabilities.

Together, these results suggest that households perceiving COVID-19 dietary impacts on the household began more secure but were disproportionately destabilized, eroding their initial advantage. This pattern is consistent with phase one results of this study as well as broader literature highlighting COVID-19's contribution to worsening inequalities in food access and nutrition. Laborde, Martin and Vos (2021) report that while some households began the pandemic with relative strength, the economic disruptions precipitated by COVID-19 eroded prior advantages, leading to a rise in

food insecurity even among previously secure populations. Similarly, Gebeyehu, East, Wark and Islam (2023) and Hassen and El Bilali (2024) find that the pandemic compromised multiple dimensions of food security and reduced variance between groups over time. In conclusion, these results build on earlier analyses of individual indicators, suggesting that perceived COVID-19-related dietary impacts reflect complex vulnerability profiles characterized by early declines, brief stabilization, and longer-term stagnation in food security.

Although the statistical evidence is modest, the consistency of these patterns underscores the value of the HFSI, together with subjective perceptions of household impact during large-scale crises, as effective tools for detecting early warning signals of emerging food insecurity. Such measures can provide critical insights to guide timely policy and programmatic interventions aimed at strengthening household resilience (Gebeyehu et al., 2023).

#### **4.5 Conclusion**

Overall, the results of this study highlight the complex and interconnected nature of household food security within the study population. While some positive changes were observed over time, persistent challenges related to dietary diversity, NS and household vulnerability remain evident. The results underscore the influence of external shocks such as the COVID-19 pandemic, on food access and utilization. Collectively, these insights emphasize the importance of integrated, context-specific measurement strategies to guide future interventions that address both immediate nutritional needs and the broader determinants of household food security.

In addition, the creation and application of the HFSI provided a valuable composite measure for capturing the multidimensional aspects of food security. The HFSI provided a more holistic assessment of household resilience and vulnerability by capturing multiple dimensions of food security at the household level. The index revealed nuanced variations and temporal shifts that were not fully captured by single-dimension indicators alone.

Furthermore, the HFSI proved effective in identifying households at risk of chronic and transitory food insecurity, particularly during periods of external stress such as the COVID-19 pandemic. Its multidimensional structure could allow policymakers and programme implementers to target interventions more effectively.

Future applications of the HFSI should consider refining weightings of component indicators based on local context and validating the index through longitudinal studies. As a dynamic tool, the HFSI holds potential to enhance monitoring frameworks and support data-driven decision-making in advancing sustainable food security outcomes.

## CHAPTER 5: CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

### 5.1 Introduction

This study set out to investigate household food security in low-socioeconomic communities in NMB, EC, South Africa, with the overarching aim of developing a multidimensional understanding of food insecurity and constructing a composite HFSI suited to the local context. To achieve this, three interrelated objectives were pursued.

The first objective focused on establishing the prevalence and interrelationships of key indicators of household food security, namely dietary diversity, hunger, and child NS. This dual emphasis on both dietary and anthropometric outcomes was intended to provide a comprehensive picture of food insecurity, beyond what single measures could capture.

The second objective examined the impact of the COVID-19 pandemic as a large-scale shock that exposed and intensified existing vulnerabilities. By assessing household food security across three time points, two pre-pandemic and one during the pandemic, the study sought to determine both the persistence and trajectory of dietary diversity, hunger and child nutrition in the face of systemic disruptions.

The third objective centred on the development and validation of a composite HFSI that integrates key food security dimensions. Through expert input via the Delphi technique and assessment of conceptual validity, this tool was designed to offer a more robust and context-sensitive measure for both research and practical application in low-resource settings.

Together, these objectives guided the generation of empirical evidence, theoretical insights, and methodological innovations. The following sections summarise the key results of the study, highlight their implications, and reflect on how they contribute to the broader understanding of household food insecurity and its measurement in South Africa and similar contexts. The study further acknowledges its limitations and proposes directions for future research to strengthen understanding and inform evidence-based responses to household food insecurity.

## 5.2 Summary of study results

This section summarises the key results of the study, highlighting the main empirical results and their broader significance. It also illustrates how the objectives of the study were achieved. It also demonstrates how the research objectives were successfully addressed through the analysis and interpretation of the data. Objectives one and two correspond to the results presented in Sections 5.2.1 to 5.2.5, while objective three is addressed through the results summarised in Section 5.2.6.

### 5.2.1 Child NS

The anthropometric analysis revealed a dual narrative of nutritional outcomes. On one hand, improvements in weight-for-age z-scores and a reduction in the prevalence of underweight children suggest modest progress in alleviating some forms of undernutrition. However, persistent stunting and a significant increase in overweight and obesity highlight the coexistence of chronic undernutrition and emerging risks of overnutrition. These results reflect the double burden of malnutrition, a phenomenon increasingly evident in South Africa and other low to middle-income contexts undergoing rapid nutritional transitions. This duality underscores the precariousness of only using child growth trajectories to assess household food security. In addition, the observed short-term improvements in underweight prevalence, despite the persistence of stunting and a marked deterioration in household food security, point to evidence of partial catch-up growth within the population. This pattern suggests that while some weight recovery occurred following periods of nutritional deprivation, it did not translate into proportional gains in linear growth. Such incomplete recovery may reflect compensatory weight gain in response to improved energy intake but limited dietary quality, potentially contributing to the rising prevalence of overweight and obesity observed among children. While short-term improvements in weight were observed, they occurred within an environment characterised by worsening household-level food deprivation. These findings reinforce the need for integrated policy responses that address both the immediate and underlying determinants of malnutrition in transitional contexts.

### 5.2.2 Household dietary diversity

Household dietary diversity declined substantially over the study period, with a marked contraction in the number of food groups consumed. The loss of dietary variety, particularly reductions in milk and dairy, and oils and fats, points to a deterioration in dietary adequacy. Low consumption of nutrient-rich food groups, such as vegetables, eggs, legumes, nuts and seeds, and fish, further accentuates risks of micronutrient deficiencies. This could contribute to the rising prevalence of the triple burden of malnutrition, a phenomenon commonly observed in South Africa and other African countries. These results are consistent with evidence linking food price volatility, reduced purchasing power, and structural poverty to constrained diets in low-income households. The erosion of dietary diversity in this population could have profound implications, not only for child nutrition, but also for long-term public health, as inadequate dietary patterns increase the risk of both malnutrition and NCDs.

### 5.2.3 Household hunger

The HHS results revealed both chronic and escalating hunger across the study period. High proportions of households reported running out of food, going to bed hungry, and increasingly, spending entire days without eating. By the final timepoint, severe hunger had become widespread, indicating a critical erosion of household resilience. Importantly, hunger was not episodic but rather a persistent feature of household life, suggesting that coping mechanisms were either insufficient or exhausted. The intensification of hunger reflects broader structural vulnerabilities; rising unemployment, inflation and inadequate social safety nets, exacerbated by the economic and social shocks associated with the COVID-19 pandemic.

### 5.2.4 Household food security

The composite picture of household food security status was deeply concerning. More than four in five households were already food insecure at baseline, with the prevalence rising to nine in ten by the final survey. Levels of food insecurity far exceeded national averages, highlighting the disproportionate burden borne by households in low-income areas. Importantly, the results demonstrate that food

insecurity was not static; rather, it intensified over time, reflecting households' heightened exposure to socioeconomic shocks. The decline in food security, despite modest improvements in some child anthropometric measures, underscores the fragile and unsustainable nature of nutritional gains in the absence of broader structural interventions.

#### 5.2.5 Impact of COVID-19 on household food security

Key results indicate that while the children's NS remained largely stable across timepoints, significant disruptions were observed in household-level indicators, particularly dietary diversity and hunger, among households reporting perceived COVID-19 impacts. Specifically, households identifying pandemic-related effects on household food security experienced sharper declines in dietary diversity and substantially greater increases in household hunger during the pandemic, with effect sizes ranging from moderate to large. In contrast, perceived impacts on the diets of the children were associated with small-to-moderate directional changes in HDDS and hunger, though these differences were largely non-significant, suggesting that households may have actively buffered children from the most severe effects of food insecurity, consistent with the literature on parental prioritization of child nutrition during crises. The continuation of the NSNP may also have contributed to this relative stability in children's nutritional outcomes. Although school closures during the early phases of the COVID-19 pandemic initially disrupted meal delivery, it later continued via community distribution points and take-home food parcels (Spaull & Van Der Berg, 2020). This sustained provision of school meals likely mitigated the immediate nutritional impact of the pandemic on children, supporting dietary adequacy even as households experienced significant economic shocks and food access constraints.

Temporal analyses reveal a notable convergence of food security outcomes over time. Households initially reporting greater resilience or higher dietary diversity experienced sharper early declines, whereas previously more vulnerable households showed relative stabilization during the pandemic. This pattern aligns with broader evidence indicating that large-scale crises compress pre-existing disparities in food access and amplify systemic vulnerabilities. These results are consistent with global and local research demonstrating that the COVID-19 pandemic exacerbated household food

insecurity, disrupted dietary quality, and intensified socio-economic inequalities (Azrak et al., 2023; Lujabe et al., 2022; FAO et al., 2021). The thematic analysis further elucidated the mechanisms underlying these changes. Reduced food availability, accessibility, job loss and declines in household income emerged as the most frequently cited drivers of both child-level dietary compromise and broader household food insecurity. Supply chain disruptions and rising food prices compounded economic vulnerabilities, highlighting the multifaceted nature of pandemic-induced hardships. Importantly, these results underscore that perceived COVID-19 impacts are not isolated phenomena, but reflect overlapping economic, social and logistical pressures that collectively shape household food security trajectories.

An important contextual factor shaping these findings is the moderating role of South Africa's social protection system. Continued access to social grants may have assisted in buffering many households against income losses and rising food prices during the pandemic (Arndt et al., 2020; Kajiita & Kang'ethe, 2024). The introduction of the COVID-19 SRD grant further provided short-term assistance to unemployed and informal workers (Van Der Berg et al., 2022; Bassier et al., 2023). Households with grant income showed smaller declines in dietary diversity than those without such support, suggesting that grants played a protective role. The sharper deterioration among COVID-affected households may thus reflect unequal grant access, compounded by inflation and local market disruptions (Laborde et al., 2021; StatsSA, 2023a).

Overall, the results support the notion that the deterioration in household food security indicators during the study period cannot be attributed to random variation alone. The alignment between caregivers' perceptions and quantitative trends provides evidence that the COVID-19 pandemic functioned as a critical external shock, amplifying pre-existing vulnerabilities and reshaping the nutritional landscape in low-income households. While child NS remained relatively stable, likely reflecting targeted household coping strategies and social safety nets, the pronounced rise in hunger and declines in dietary diversity underscore the vulnerability of households to economic and supply-side shocks, and highlight the importance of multidimensional monitoring to identify early-warning signals during crises.

### 5.2.6 Development and application of the HFSI

The third objective of this study was to construct and evaluate a multidimensional HFSI appropriate for low-income households in NMB. This objective was achieved through the integration of expert consensus, empirical testing and longitudinal analysis, thereby addressing the need for a contextually grounded and operationally feasible tool to assess household food security.

The Delphi technique provided a rigorous foundation for indicator verification and weighting. Experts strongly endorsed the inclusion of HDDS, HHS and child NS, with HDDS and child NS assigned the highest weightings. This consensus underscored the multidimensional nature of household food security, combining dietary quality, access, and nutritional outcomes. The alignment of expert-derived weights with those generated by EFA strengthened confidence in the validity of the final index structure, while the emphasis on feasibility confirmed its practical utility in resource-limited clinical settings.

Application of the HFSI revealed a clear and worsening trajectory of household food insecurity across the three survey rounds. Household scores declined significantly over time, with the most severe deterioration occurring by T3, coinciding with the height of the COVID-19 pandemic. Categorical analyses confirmed the marked shift towards poorer food security classifications, with no households remaining in the “Good” category by the end of the study period. These results provide compelling evidence of the index’s sensitivity to both gradual changes and acute shocks, reinforcing its value as a monitoring tool.

The analysis of inter-indicator relationships further validated the index’s formative design. Weak and non-significant correlations among HDDS, HHS and child NS confirmed that these dimensions capture distinct, non-redundant aspects of household food security. This independence ensures that the HFSI offers a more comprehensive and nuanced assessment than reliance on single indicators.

Finally, the examination of subjective COVID-19 impacts demonstrated the index's ability to capture the dynamic effects of external shocks. Households reporting pandemic-related disruptions initially displayed higher levels of security but experienced sharper declines, converging with more vulnerable households by T3.

Although not always statistically significant, these patterns reflect the compressive effects of systemic crises, whereby disparities narrow as broader insecurity deepens. Such insights highlight the potential of the HFSI for use in crisis contexts, where timely and sensitive measurement is critical. Beyond its methodological contribution, the HFSI offers actionable potential for public health practitioners and policymakers, enabling early detection of vulnerabilities and more effective targeting of interventions, particularly in times of economic or social disruption.

### 5.2.7 Evaluation of hypotheses in light of the study findings

This section revisits and evaluates the hypotheses formulated in Chapter 1, assessing the extent to which each was supported by the empirical results presented in Sections 5.2.1 to 5.2.6. Together, these findings provide an integrated understanding of household food security, nutritional outcomes, and the performance of the HFSI within the context of low-socioeconomic communities in NMB, EC.

#### *5.2.7.1 Hypothesis 1: Baseline household food security and interrelationships*

Hypothesis 1.1 proposed that household food security would be poor within low-socioeconomic areas of NMB, reflected in a mean HDDS below 4, mean child NS z-scores below  $-1$ , and mean HHS above 2. The results strongly **support this hypothesis**. Across the study period, dietary diversity remained consistently low, with mean HDDS scores indicating inadequate consumption of nutrient-rich foods. The majority of households experienced moderate to severe hunger (HHS  $> 2$ ), confirming widespread food insecurity. Child anthropometric data similarly revealed suboptimal growth, particularly in height-for-age, with stunting rates remaining persistently high. These patterns confirm that households in these settings experience structural and chronic food insecurity, aligning with evidence from SANHANES-1 and other national surveys.

Hypothesis 1.2 posited significant relationships among HDDS, child NS, HHS, and HFS. This was partially supported. Correlation analyses revealed expected associations between HDDS and HHS—households with more diverse diets experienced lower hunger scores and better overall food security. However, relationships between HDDS and child NS were weaker and often non-significant, suggesting that while dietary diversity and hunger are closely linked at the household level, improvements in dietary diversity do not immediately translate into measurable changes in child anthropometric outcomes. This may reflect lag effects, intra-household food allocation, or the influence of other non-dietary factors such as illness and sanitation on child growth. Nevertheless, the direction of relationships was consistent with theoretical expectations, providing partial support for Hypothesis 1.2.

#### *5.2.7.2 Hypothesis 2: Temporal changes and covid-19-related impacts*

Hypothesis 2.1 proposed that household food security indicators would deteriorate over time, with HDDS and child NS declining and HHS increasing, reflecting worsening conditions during the COVID-19 pandemic.

This hypothesis was largely supported. The results demonstrated a marked and statistically significant decline in dietary diversity from T1 to T3 and a parallel rise in household hunger, particularly during the pandemic. The proportion of households reporting severe hunger increased substantially, confirming heightened vulnerability. Although child NS did not deteriorate as severely as expected, this relative stability can be explained by household coping strategies and social protection mechanisms (e.g., social grants and continuation of the NSNP), which buffered children against the worst effects of food insecurity. Thus, while the deterioration in HDDS and HHS was clear and consistent with the hypothesis, the expected decline in child NS was less pronounced, indicating partial support.

Hypothesis 2.2 posited that households reporting COVID-19-related disruptions would show significantly poorer outcomes in HDDS, HHS, and child NS than those reporting no disruption.

This hypothesis was supported for household-level indicators but partially supported

for child outcomes. Households that perceived COVID-19 impacts reported significantly lower HDDS and higher HHS scores, indicating greater food insecurity. However, differences in child NS between the two groups were smaller and mostly non-significant, again reflecting the protective effects of social grants and parental buffering strategies. The temporal trajectory further revealed that households initially better off experienced sharper declines during the pandemic, suggesting the compressive effects of widespread crises on food access and resilience.

#### *5.2.7.3 Hypothesis 3: Development and validation of the HFSI*

Hypothesis 3.1 predicted that the formative HFSI would demonstrate strong construct validity, with  $\geq 70\%$  expert consensus through the Delphi process and theoretical alignment with established frameworks.

This hypothesis was fully supported. The Delphi exercise achieved strong expert agreement exceeding 80%, confirming the inclusion and weighting of HDDS, HHS, and child NS as core indicators. The high level of convergence between expert judgment and empirical factor structure confirmed the conceptual soundness and theoretical robustness of the index.

Hypothesis 3.2 anticipated that HFSI scores would differ significantly across time and between households with and without perceived COVID-19 impacts, demonstrating the tool's sensitivity to contextual disruptions.

This was strongly supported. HFSI scores declined significantly from T1 to T3, capturing both gradual deterioration and acute shocks associated with the pandemic. Households reporting COVID-related disruptions experienced greater declines, confirming the index's responsiveness and construct sensitivity. These findings affirm the index's utility for longitudinal monitoring in dynamic, crisis-prone contexts.

Across all hypotheses, the findings provide strong empirical support for the conceptual framework of this study. Household food insecurity in NMB's low-socioeconomic areas was both severe and multidimensional, driven by economic vulnerability, dietary inadequacy, and pandemic-related shocks. While certain hypotheses (particularly

those involving child NS) were only partially supported, the overall patterns align with national and global evidence on food insecurity trends in low-resource communities.

### **5.3 Implications of the results of the study**

The results of this study present several implications for research, policy and practice, with corresponding recommendations as outlined below:

#### **5.3.1 Measurement and monitoring**

The observed trends: improvements in underweight prevalence, rising levels of overweight and obesity, persistent stunting, and worsening household food insecurity, underscore the critical need for multidimensional measurement frameworks. Reliance on single indicators risks masking the complex realities of food insecurity at the household level. It is recommended that future monitoring employ composite indices that integrate different dimensions of household food security, thereby offering a more comprehensive and contextually sensitive assessment.

#### **5.3.2 Contribution to research**

This study contributes to the national and global evidence base by providing empirical insights into how structural poverty and health shocks, such as the COVID-19 pandemic, intersect to exacerbate food and nutritional insecurity in vulnerable populations. The results underscore the critical need for context-specific interventions that address both immediate food access and the underlying socioeconomic determinants of nutritional vulnerability. Moreover, the study emphasizes the value of longitudinal approaches and standardized measurement tools, such as the HFSI, in capturing the temporal patterns and cumulative effects of shocks on household food security, thereby informing policy and programmatic responses aimed at building resilience in marginalized communities.

### 5.3.3 Contextual and longitudinal studies

The results underscore the importance of conducting longitudinal analyses using standardized tools such as the HFSI to assess the prolonged effects of socioeconomic shocks, including pandemics, inflationary pressures and seasonal fluctuations on household food security. It is recommended that future research apply the HFSI in comparative longitudinal studies across diverse socio-economic and geographical groups to capture context-specific vulnerabilities, coping mechanisms and resilience pathways. Such studies would enhance understanding of the dynamic nature of food insecurity and inform more targeted, evidence-based interventions.

### 5.3.4 Policy-focused research

Given the high prevalence and deteriorating trajectory of food insecurity in low-income areas, there is an urgent need for policy-oriented research. Future studies should systematically evaluate the effectiveness of targeted interventions such as social protection schemes, food subsidies and child-focused nutrition programmes such as the NSNP. Such research could provide evidence on the extent to which these policies buffer households against economic shocks, while simultaneously improving both immediate and long-term food and nutrition security outcomes as shown by this study.

### 5.3.5 Application of the HFSI in policy and practice

Beyond its methodological contribution, the HFSI offers considerable practical value for public health practitioners and policymakers. Its use can enable the early identification of households at risk of food insecurity, allowing interventions to be more precisely targeted. This not only improves the effectiveness of programmes but also has potential economic benefits: by focusing resources on the most vulnerable, financial support can be allocated more efficiently, reducing expenditure on broad, blanket interventions.

Future research should explore how the HFSI can be integrated into routine monitoring systems, particularly during periods of economic or social disruption, to support timely,

evidence-based responses that mitigate food insecurity and enhance household resilience.

#### **5.4 Limitations of the study**

While this study makes important empirical and methodological contributions, several limitations should be acknowledged. Firstly, the study was conducted in low-socioeconomic communities within NMB, EC. Although this setting reflects contexts of heightened vulnerability, the results may not be generalisable to other socio-economic groups, other regions of South Africa or to rural settings where food environments and coping strategies may differ. The focus on a geographically bounded sample therefore limits the external validity of the results.

Secondly, the use of caregiver-reported measures, including the HDDS and HHS, introduced the potential for recall and reporting bias. While standardised, validated tools were employed, dietary recall may under- or overestimate true consumption, and social desirability bias could have influenced reporting of food access and hunger. In addition, anthropometric assessments were limited to children within the sampled households, constraining the ability to capture broader household-level nutritional outcomes. Furthermore, although BMI-for-age is widely recommended for population-level surveillance, it is an indirect proxy for adiposity and does not distinguish between fat mass and lean body mass. The absence of direct adiposity measures (e.g., skinfold thickness or waist-to-height ratio) may therefore have limited the precision of overweight and obesity classification, although BMI-for-age was selected due to its feasibility, cost-effectiveness and suitability for use in low-resource primary care settings.

Furthermore, the study's ability to fully capture the effects of the COVID-19 pandemic was constrained. Although the inclusion of a pre- and mid-pandemic time point offered valuable insights, data collection was inevitably affected by restrictions, logistical challenges and attrition, which may have influenced representativeness and comparability across survey rounds.

Finally, while the development of the HFSI represents a methodological innovation, its validation was based primarily on expert consensus and construct assessment. Further testing across diverse populations and contexts is required to strengthen its robustness, predictive validity and policy applicability.

Overall, these limitations suggest that the results should be interpreted with caution. Nevertheless, the study provides a critical foundation for understanding household food insecurity in low-resource settings and for refining a multidimensional tool that can support evidence-based policy and practice.

## **5.5 Recommendations for further study**

Building on the limitations identified in this study, several avenues for future research are recommended to strengthen the evidence base and address outstanding gaps:

### 5.5.1 Broader geographic and contextual scope

As this study was limited to low-socioeconomic communities in NMB, future research should extend to other urban and rural contexts in South Africa and beyond. Comparative studies across diverse regions would enable stronger generalisability of results and help identify context-specific food environments, coping strategies and vulnerabilities.

### 5.5.2 Enhanced data collection methods

Given the reliance on caregiver-reported measures such as HDDS and HHS, future studies should consider triangulating self-reported data with objective measures, including direct observation of food consumption or the use of technology-assisted dietary assessments. This would help to minimise recall and reporting biases, thereby improving data validity.

### 5.5.3 Expanded NS assessments

The current study focused on child anthropometrics, which limits the understanding of household-level nutritional dynamics. Further research should include assessments of additional household members to provide a more comprehensive picture of intra-household food and nutrition security. Additionally, future studies could incorporate biomarkers of NS to complement the anthropometric measures.

### 5.5.4 Strengthened longitudinal designs

Although the inclusion of pre- and mid-pandemic data provided valuable insights, COVID-19 restrictions introduced challenges that may have affected representativeness and comparability. Future longitudinal studies with more frequent follow-ups, larger sample sizes, and strategies to minimise attrition are recommended to capture the sustained and evolving impacts of socioeconomic shocks, including pandemics, inflation, and climate variability.

### 5.5.5 Rigorous validation of the HFSI

While the development of the HFSI represents an important methodological innovation, its validation remains limited. Further research should test the HFSI across diverse populations, geographic settings, and cultural contexts to assess its robustness, predictive validity, and utility for policymaking. Incorporating cross-country comparisons would strengthen its applicability as a standardised measurement tool.

## **5.6 Conclusion**

This study highlights the precarious state of household food security in low-income communities in NMB, EC, South Africa. The results reveal a complex picture marked by persistent child stunting, rising overweight and obesity, declining dietary diversity, and escalating hunger. These outcomes underscore the multidimensional and dynamic nature of household food insecurity, which is challenging to capture by any single measure.

Food insecurity in this low-income area emerged as both widespread and intensifying, shaped by structural poverty, the nutritional transition, and pandemic-related shocks. While modest improvements in child growth were observed, these gains remain fragile within households facing chronic hunger and constrained diets. The evidence therefore signals an urgent need for integrated, context-sensitive interventions that address both the quantity and quality of food available to vulnerable households.

Empirically, the study documents the persistence and worsening of food insecurity during the COVID-19 pandemic, while methodologically it develops and validates a composite HFSI that integrates dietary diversity, hunger, and child NS. The HFSI is both sensitive to change and feasible for use in clinical and community settings, offering a practical tool for surveillance, policy design, and intervention evaluation.

By aligning evidence of household trajectories with an innovative measurement approach, this research provides a foundation for more targeted and effective responses. Ultimately, it demonstrates that multidimensional, context-specific approaches are essential not only for understanding household food insecurity but also for shaping responsive public health and policy action in South Africa and similar settings.

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# Addendum A: NMU Research Ethics Committee (Human) Phase One Approval



PO Box 77000, Nelson Mandela University, Port Elizabeth, 6031, South Africa [mandela.ac.za](http://mandela.ac.za)

Chairperson: Research Ethics Committee (Human)  
Tel: +27 (0)41 504 3624  
[Dalray.Gradidge@mandela.ac.za](mailto:Dalray.Gradidge@mandela.ac.za)

NHREC registration nr: REC-042508-025

Ref: [H22-HEA-DIET-007] / Approval: 27 October 2022 – 27 October 2023

27 October 2022

Prof A Gresse  
Faculty: Health Sciences

## THE EFFECT OF COVID-19 ON FOOD SECURITY AND DIETARY DIVERSITY IN LOW-INCOME HOUSEHOLDS IN A SELECTED AREA OF NELSON MANDELA BAY, EASTERN CAPE

PRP: Prof A Gresse  
PI: Ms M Nienaber

Your above-entitled application served at the Research Ethics Committee (Human) (meeting of 24 August 2022) for approval. The study is classified as a medium risk study. The ethics clearance reference number is **H22-HEA-DIET-007** and approval is subject to the following conditions:

1. The immediate completion and return of the attached acknowledgement to [Imtiaz.Khan@mandela.ac.za](mailto:Imtiaz.Khan@mandela.ac.za).
2. Approval for data collection is for 1 calendar year from date of receipt of this ethics approval letter.
3. The submission of an annual progress report by the PRP on the data collection activities of the study (form RECH-004 available on Research Ethics Committee (Human) portal) by 15 November this year for studies approved/extended in the period October of the previous year up to and including September of this year, or 15 November next year for studies approved/extended after September this year.
4. In the event of a requirement to extend the period of data collection (i.e. for a period in excess of 1 calendar year from date of approval), completion of an extension request is required (form RECH-005 available on Research Ethics Committee (Human) portal).
5. In the event of any changes made to the study (excluding extension of the study), RECH will have to approve such amendments and completion of an amendments form is required PRIOR to implementation (form RECH-006 available on Research Ethics Committee (Human) portal).
6. Immediate submission (and possible discontinuation of the study in the case of serious events) of a report to RECH in the event of any unanticipated problems, serious incidents or adverse events observed during the course of the study.
7. Immediate submission of a Study Termination Report to RECH (form RECH-008 available on Research Ethics Committee (Human) portal) upon expected or unexpected closure/termination of study.
8. Immediate submission of a report to RECH in the event of any study deviations, violations and/or exceptions.
9. Acknowledgement that the study could be subjected to passive and/or active monitoring without prior notice at the discretion of Research Ethics Committee (Human).

Please quote the ethics clearance reference number in all correspondence and enquiries related to the study. For speedy processing of email queries (to be directed to [Imtiaz.Khan@mandela.ac.za](mailto:Imtiaz.Khan@mandela.ac.za)), it is recommended that the ethics clearance reference number together with an indication of the query appear in the subject line of the email.

We wish you well with the study.

Yours sincerely

A handwritten signature in black ink, appearing to read 'D Gradidge', written over a white oval shape.

**Dr D Gradidge**  
Chairperson: Research Ethics Committee (Human)

Cc: Department of Research Development  
Faculty Admin: Health Sciences

[Appendix 1: Acknowledgement of conditions for ethical approval](#)

## ACKNOWLEDGEMENT OF CONDITIONS FOR ETHICS APPROVAL

27 October 2022 – 27 October 2023

PRP: Prof A Gresse

PI: Ms M Nienaber

I, **PROF A GRESSE** (PRP) of the study entitled, **[H22-HEA-DIET-007] THE EFFECT OF COVID-19 ON FOOD SECURITY AND DIETARY DIVERSITY IN LOW-INCOME HOUSEHOLDS IN A SELECTED AREA OF NELSON MANDELA BAY, EASTERN CAPE**, do hereby agree to the following approval conditions:

1. The submission of an annual progress report by myself on the data collection activities of the study by 15 November this year for studies approved in the period October of the previous year up to and including September of this year, or 15 November next year for studies approved after September this year. It is noted that there will be no call for the submission thereof. The onus for submission of the annual report by the stipulated date rests on myself. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the submission of the annual report.
2. Submission of the relevant request to RECH in the event of any amendments to the study for approval by RECH prior to any partial or full implementation thereof. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the requesting for any amendments to the study.
3. Submission of the relevant request to RECH in the event of any extension to the study for approval by RECH prior to the implementation thereof.
4. Immediate submission of a report to RECH in the event of any unanticipated problems, serious incidents or adverse events. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the reporting of any unanticipated problems, serious incidents or adverse events.
5. Immediate discontinuation of the study in the event of any serious unanticipated problems, serious incidents or serious adverse events.
6. Immediate submission of a report to RECH in the event of the unexpected closure/discontinuation of the study (for example, de-registration of the PI).
7. Immediate submission of a report to RECH in the event of study deviations, violations and/or exceptions. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the reporting of any study deviations, violations and/or exceptions.
8. Acknowledgement that the study could be subjected to passive and/or active monitoring without prior notice at the discretion of RECH. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the active monitoring of a study.

Signed: \_\_\_\_\_



Date: \_\_\_27 October 2022\_\_\_\_\_

## Addendum B: NMU Research Ethics Committee (Human) Phase Two Approval



Summerstrand North  
Faculty of Health Sciences  
Tel.+27(0)41 504 3501  
PaulaEzinne.melariri@mandela.ac.za  
Chairperson: Faculty Postgraduate Studies Committee (FPGSC) Health Sciences

**Ref: [H23-HEA-DIET-010] /Approval]**

Date: 12 February 2024

Prof A Gresse  
Department of Human  
Nutrition and Dietetics  
Faculty of Health Sciences

Dear Prof Gresse

PRIMARY RESPONSIBLE PERSON (PRP): Prof A Gresse  
CO-SUPERVISORS: Prof R Du Randt  
Dr C Lang  
PRIMARY INVESTIGATOR(PIs): Ms M Nienaber  
STUDENT NUMBER: 218202873  
QUALIFICATION: PhD (Food Nutrition & Wellness)  
TITLE: **A HOUSEHOLD FOOD SECURITY INDEX TO IDENTIFY  
HOUSEHOLD FOOD SECURITY, DIETARY DIVERSITY, AND  
NUTRITIONAL STATUS OF CHILDREN IN NELSON  
MANDELA BAY, EASTERN CAPE**

Your above-entitled application served at the **23 November 2023** Faculty of Health Sciences Postgraduate Studies Committee meeting for approval. The study is classified as a negligible/low-risk study. The ethics clearance reference number is **H23-HEA-DIET-010** and approval is subject to the following conditions:

1. The immediate completion and return of the attached acknowledgement to [Thembeke.Sdinane@mandela.ac.za](mailto:Thembeke.Sdinane@mandela.ac.za).
2. Approval for data collection is for 1 calendar year from date of receipt of this approval.
3. The submission of an annual progress report by the PRP on the data collection activities of the study (form RECH-004 to be made available shortly on Research Ethics Committee (Human) portal) by 15 November this year for studies approved/extended in the period October of the previous year up to and including September of this year, or 15 November next year for studies approved/extended after September this year.
4. In the event of a requirement to extend the period of data collection (i.e. for a period in excess of 1 calendar year from date of approval), completion of an extension request is required (form RECH-005 to be made available shortly on Research Ethics Committee (Human) portal).
5. In the event of any changes made to the study (excluding extension of the study), completion of an amendments form is required PRIOR implementation (form RECH-006 to be made available shortly on Research Ethics Committee (Human) portal).
6. Immediate submission (and possible discontinuation of the study in the case of serious events) of

the relevant report to RECH (form RECH-007 to be made available shortly on Research Ethics Committee (Human) portal) in the event of any unanticipated problems, serious incidents or adverse events observed during the course of the study.

7. Immediate submission of a Study Termination Report to RECH (form RECH-008 to be made available shortly on Research Ethics Committee (Human) portal) upon unexpected closure/termination of study.
8. Immediate submission of a Study Exception Report of RECH (form RECH-009 to be made available shortly on Research Ethics Committee (Human) portal) in the event of any study deviations, violations and/or exceptions.
9. Acknowledgement that the study could be subjected to passive and/or active monitoring without prior notice at the discretion of the Faculty Postgraduate Studies Committee (FPGSC).

Please quote the ethics clearance reference number in all correspondence and enquiries related to the study.

We wish you well with the study.

Yours sincerely,



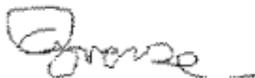
Prof P Melariri: Faculty Postgraduate Studies Committee (FPGSC) Chairperson  
Faculty of Health Sciences  
Nelson Mandela University

*Appendix 1: Acknowledgement of conditions for ethical approval*

**APPENDIX 1: ACKNOWLEDGEMENT OF CONDITIONS FOR ETHICS APPROVAL**

I, **Prof A Gresse**, PRP of the study, **A HOUSEHOLD FOOD SECURITY INDEX TO IDENTIFY HOUSEHOLD FOOD SECURITY, DIETARY DIVERSITY, AND NUTRITIONAL STATUS OF CHILDREN IN NELSON MANDELA BAY, EASTERN CAPE., (H23-HEA-DIET-010)**, do hereby agree to the following approval conditions:

1. The submission of an annual progress report by myself on the data collection activities of the study by 15 November this year for studies approved in the period October of the previous year up to and including September of this year, or 15 November next year for studies approved after September this year. It is noted that there will be no call for the submission thereof. The onus for submission of the annual report by the stipulated date rests on myself.
2. Submission of the relevant request to RECH in the event of any amendments to the study for approval by RECH prior to any partial or full implementation thereof.
3. Submission of the relevant request to RECH in the event of any extension to the study for approval by RECH prior to the implementation thereof.
4. Immediate submission of the relevant report to RECH in the event of any unanticipated problems, serious incidents or adverse events.
5. Immediate discontinuation of the study in the event of any serious unanticipated problems, serious incidents or serious adverse events.
6. Immediate submission of the relevant report to RECH in the event of the unexpected closure/discontinuation of the study (for example, de-registration of the PI).
7. Immediate submission of the relevant report to RECH in the event of study deviations, violations and/or exceptions.
8. Acknowledgement that the study could be subjected to passive and/or active monitoring without prior notice at the discretion of RECH.

Signed:  \_\_\_\_\_

Date: 15/02/2024

## Addendum C: NMU Research Ethics Committee (Human) - KaziAfya Study



PO Box 77000, Nelson Mandela University, Port Elizabeth, 6031, South Africa [mandela.ac.za](http://mandela.ac.za)

Chairperson: Research Ethics Committee (Human)  
Tel: +27 (0)41 504 2347  
[sharlene.govender@mandela.ac.za](mailto:sharlene.govender@mandela.ac.za)

NHREC registration nr: REC-042508-025

Ref: [H18-HEA-HMS-006 / Amendment]

26 October 2021

Prof C Walter / Prof R du Randt  
Faculty: Health Sciences

Dear Prof Walter and Prof du Randt

### EFFECTS OF SCHOOL-BASED PHYSICAL ACTIVITY AND MULTI-MICRONUTRIENT SUPPLEMENTATION INTERVENTION ON GROWTH, HEALTH AND WELL-BEING OF SCHOOL CHILDREN IN THREE AFRICAN COUNTRIES: THE KAZIAFYA PROJECT

PRP: Prof C Walter / Prof R du Randt  
PI: Prof C Walter / Prof R du Randt

The request for an amendment to the above-entitled study served at the Research Ethics Committee (Human) (22 September 2021) together with the annual progress report for approval. We take pleasure in informing you that the Research Ethics Committee (Human) approved both the progress report and amendment. The ethics number remains [H18-HEA-HMS-006]; approval is subject to the following conditions:

1. The immediate completion and return of the attached acknowledgement to [Imtiaz.Khan@mandela.ac.za](mailto:Imtiaz.Khan@mandela.ac.za).
2. The submission of an annual progress report by the PRP on the data collection activities of the study (form RECH-004 available on Research Ethics Committee (Human) portal) by 15 November this year for studies approved/extended in the period October of the previous year up to and including September of this year, or 15 November next year for studies approved/extended after September this year.
3. In the event of a requirement to extend the period of data collection (i.e. for a period in excess of 1 calendar year from date of approval), completion of an extension request is required (form RECH-005 available on Research Ethics Committee (Human) portal)
4. In the event of any changes made to the study (excluding extension of the study), RECH will have to approve such amendments and completion of an amendments form is required PRIOR to implementation (form RECH-006 available on Research Ethics Committee (Human) portal).
5. Immediate submission (and possible discontinuation of the study in the case of serious events) of the relevant report to RECH (form RECH-007 available on Research Ethics Committee (Human) portal) in the event of any unanticipated problems, serious incidents or adverse events observed during the course of the study.
6. Immediate submission of a Study Termination Report to RECH (form RECH-008 available on Research Ethics Committee (Human) portal) upon expected or unexpected closure/termination of study.
7. Immediate submission of a Study Exception Report of RECH (form RECH-009 available on Research Ethics Committee (Human) portal) in the event of any study deviations, violations and/or exceptions.
8. Acknowledgement that the study could be subjected to passive and/or active monitoring without prior notice at the discretion of Research Ethics Committee (Human).

Please quote the ethics clearance reference number in all correspondence and enquiries related to the study. For speedy processing of email queries (to be directed to [Imtiaz.Khan@mandela.ac.za](mailto:Imtiaz.Khan@mandela.ac.za)), it is recommended that the ethics clearance reference number together with an indication of the query appear in the subject line of the email.

We wish you well with the study.

Yours sincerely



**Dr S Govender**  
**Chairperson: Research Ethics Committee (Human)**

Cc: The Office of Research Development  
Faculty Manager: Health Sciences

[Appendix 1: Acknowledgement of conditions for ethical approval](#)

**ACKNOWLEDGEMENT OF CONDITIONS FOR ETHICS APPROVAL – AMENDMENT**

We, **Prof. Walter and du Randt** (PRPs) of the study entitled **EFFECTS OF SCHOOL-BASED PHYSICAL ACTIVITY AND MULTI-MICRONUTRIENT SUPPLEMENTATION INTERVENTION ON GROWTH, HEALTH AND WELL-BEING OF SCHOOL CHILDREN IN THREE AFRICAN COUNTRIES: THE KAZIAFYA PROJECT [H18-HEA-HMS-006]**, do hereby agree to the following approval conditions:

1. The submission of an annual progress report by myself on the data collection activities of the study by 15 November this year for studies approved in the period October of the previous year up to and including September of this year, or 15 November next year for studies approved after September this year. It is noted that there will be no call for the submission thereof. The onus for submission of the annual report by the stipulated date rests on myself. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the submission of the annual report.
2. Submission of the relevant request to RECH in the event of any amendments to the study for approval by RECH prior to any partial or full implementation thereof. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the requesting for any amendments to the study.
3. Submission of the relevant request to RECH in the event of any extension to the study for approval by RECH prior to the implementation thereof.
4. Immediate submission of the relevant report to RECH in the event of any unanticipated problems, serious incidents or adverse events. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the reporting of any unanticipated problems, serious incidents or adverse events.
5. Immediate discontinuation of the study in the event of any serious unanticipated problems, serious incidents or serious adverse events.
6. Immediate submission of the relevant report to RECH in the event of the unexpected closure/discontinuation of the study (for example, de-registration of the PI).
7. Immediate submission of the relevant report to RECH in the event of study deviations, violations and/or exceptions. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the reporting of any study deviations, violations and/or exceptions.
8. Acknowledgement that the study could be subjected to passive and/or active monitoring without prior notice at the discretion of RECH. I am aware of the guidelines (available on Research Ethics Committee (Human) portal) pertinent to the active monitoring of a study.

Signed: \_\_\_\_\_



Date: 26 October 2021

## Addendum D: Letter of Permission to Re-use KaziAfya Data



South Campus  
Department of Human Movement Science  
Faculty of Health sciences  
Cheryl.Walter@mandela.ac.za  
12 July 2022

Dear Ms Nienaber

### Approval of your request

Your attached letter has reference. We hereby give permission for you to use the listed data from the following research project:

REC-H number: **H18-HEA-HMS-006**

### Project title:

**EFFECTS OF SCHOOL-BASED PHYSICAL ACTIVITY AND MULTI-MICRONUTRIENT SUPPLEMENTATION INTERVENTION ON GROWTH, HEALTH AND WELL-BEING OF SCHOOL CHILDREN IN THREE AFRICAN COUNTRIES: THE KAZIAFYA PROJECT**

Relevant dietary data requested relate to that obtained from the following measuring instruments:

- 24-hour recall questionnaires and anthropometry
- Food frequency questionnaires
- Food security questionnaires

### Motivation

1. We can confirm that you have been involved in the KaziAfya project since 2019, particularly in obtaining nutrition related information.
2. An amendment to the project, among others, to acknowledge you as a co-researcher in the KaziAfya umbrella project was approved by REC-H (see proof of approval attached) The amendment mentioned that you are a registered Masters degree student that wishes to use the relevant information obtained during various testing time points for the purposes of your dissertation. It also acknowledged that you would submit your own proposal to REC-H via the DRC and FPGSC.

Wishing you all the best with the rest of your data collection, analyses and research report.

Yours sincerely

Two handwritten signatures in black ink, one on the left and one on the right, positioned above the typed names.

Prof Cheryl Walter and Prof R du Randt  
PRPs for the KaziAfya project

## **Addendum E: Letter to Eastern Cape Department of Education**

October 2022

Dr Ntsiko  
Acting District Director  
Ethel Valentine  
Sutton Road, North End  
Fax: (041) 451 0193

### **REQUEST FOR PERMISSION TO CONDUCT RESEARCH**

Dear Dr. Ntsiko

We hereby wish to apply for permission to conduct a research project entitled “The effect of COVID-19 on food security and dietary diversity in low-income households in a selected area of Nelson Mandela Bay, Eastern Cape.”, including parents/guardians of children who attend four schools in Nelson Mandela Bay.

This study aims to investigate household food security and dietary diversity of low-income households in Nelson Mandela Bay, South Africa, as well as explore the possible effects of COVID-19 on the before mentioned as it is not yet known. The study is described in detail in the attached protocol which includes copies of the measures, consent and assent forms to be used in the research process, as well as a copy of the approval letter which we received from the Nelson Mandela University Research Ethics Committee (REC-H). The approval number is H22-HEA-DIET-010.

Data collection will be in the form of a telephonic questionnaire addressed to the parent/guardian who oversees food preparation of the child. There will be no interaction or questions posed to the child, nor will any data collection take place at the school. The questionnaire will consist of a 24-hour dietary recalls (recollection of food and drink intake of the child for the past 24-hour/previous day), and questions on food security (availability and accessibility of food in the household). The data will be used to establish dietary intake, dietary diversity, and food security of these

households as well as identify any possible effect of COVID-19 on the before mentioned.

All procedures will adhere to standardised, quality-controlled protocols according to good clinical practice (GCP). Participants are thoroughly informed about the procedures and written informed consent will be sought before the start of the study by the parent/guardian and the child. Participation is voluntary, and confidentiality is ensured by creating unique identification numbers for the participants and the participants can stop participating at any time if they want to do so. Only members of the research team will have access to the data and computers with data will be password protected.

Upon completion of the study, we will provide the Department of Education with feedback regarding the outcome of the study. If you require any further information, please do not hesitate to contact me, Madeleine Nienaber ([Madeleine.Nienaber@mandela.ac.za](mailto:Madeleine.Nienaber@mandela.ac.za)) (researcher and Masters student) or my supervisor ([Annelie Gresse, Annelie.Gresse@mandela.ac.za](mailto:Annelie.Gresse@mandela.ac.za)). Thank you for your time and consideration in this matter.

Yours sincerely

A handwritten signature in black ink, appearing to read 'MN' with a stylized flourish.

Madeleine Nienaber

**Addendum F: Letter to Principal (Gatekeeper)**

**South Campus**  
**Department of Human Nutrition and Dietetics**  
**Faculty of Health sciences**  
Tel. +27 (0)41 5042048  
Madeleine.Nienaber@mandela.ac.za

.....[name of principal]

The Principal

.....[name of school]

Nelson Mandela Bay

Dear .....

The effect of COVID-19 on food security and dietary diversity in low-income households in a selected area of Nelson Mandela Bay, Eastern Cape.

We hereby wish to inform you about the research project titled: "The effect of COVID-19 on food security and dietary diversity in low-income households in a selected area of Nelson Mandela Bay, Eastern Cape." This is a research project conducted at the Nelson Mandela University in Port Elizabeth, South Africa.

This study aims to investigate household food security and dietary diversity of low-income households in Nelson Mandela Bay, South Africa, as well as explore the possible effects of COVID-19 on the aforementioned, as it is not yet known. The study will contribute to a deeper understanding of the association between COVID-19, household food security and dietary diversity in vulnerable communities. In addition, the research will provide a comprehensive update on the status of food security amongst children in the selected areas in Nelson Mandela Bay, South Africa.

To assess the above mentioned, we would like to invite your school to take part in our research project. Approximately 1300 parents/guardians with children from four primary schools (Alpha Primary, Greenville Primary, Isaac Booi Primary and David Vuku Primary school) located in Port Elizabeth will take part in this study. The data assessment will take place in October 2022, and consists of a telephonic questionnaire

addressed to the parent/guardian who oversees food preparation of the child. The same questionnaires that were used in the KaziAfya study in which your school participated, will be used again as we would like to compare food intake before COVID-19 with current food intake. The questionnaire will consist of three 24-hour dietary recalls (recollection of food and drink intake of the child for the past 24-hour/previous day), and questions on food security (availability and accessibility of food in the household).

There will be no interaction or questions posed to the child, nor will any data collection take place at the school. We shall strictly keep to ethical research principles. Written informed consent will be sought before the start of the study by the parent/guardian and the child. We would like to ask for permission to hand out information letters to the children at the school so that they can give it to their parent/guardian. Once they have signed, we will ask the child to bring it back to school for us to collect at a convenient time. Participation is voluntary, and confidentiality is ensured by creating unique identification numbers for the participants. Only members of the research team will have access to the data and computers with data will be password protected. Parents/guardians may stop participating in the study at any time. Children can also ask their parents/guardians to stop at any time. The study is described in detail in the attached protocol which includes copies of the measures, consent and assent forms to be used in the research process, as well as a copy of the approval letter which we received from the Nelson Mandela University Research Ethics Committee (REC-H). The approval number for the study is H22-HEA-DIET-007.

The necessary permission from the Departments of Education will be obtained. If you are interested in the study, please liaise with Ms Madeleine Nienaber the primary investigator for a presentation, which explains exactly what the study is about. A decision on participation can then be finalized. Contact details: 0761941764 (cell) or [madeleine.nienaber@mandela.ac.za](mailto:madeleine.nienaber@mandela.ac.za) (email)

Thanking you in anticipation.

Yours sincerely

Prof. Annelie Gresse

Madeleine Nienaber

HoD: Department of Human Nutrition and Dietetics

Primary Investigator

Ph: 041-504 2048

Research Ethics Committee (Human) of Nelson Mandela University

(rd@mandela.ac.za)

**Addendum G: Written information given to volunteers prior to participation, at the point of enrolment.**

Dear Student

You are invited to assist in the data collection of the following research project titled:  
**A HOUSEHOLD FOOD SECURITY INDEX TO IDENTIFY HOUSEHOLD FOOD SECURITY, DIETARY DIVERSITY, AND NUTRITIONAL STATUS OF CHILDREN IN NELSON MANDELA BAY, EASTERN CAPE.**

One of the study aims is to investigate household food security and dietary diversity of children aged between eight and twelve years in low-income households in Nelson Mandela Bay, South Africa, as well as explore the possible effects of COVID-19 on the before mentioned as it is not yet known.

What would be expected of you:

- Complete training with regards to the project protocol as well as data collection procedure prior to commencement of the project.
- Conduct 24-hour recall, food frequency and food security questionnaires telephonically with parents of children participating in the study. Stationary, questionnaires, sim cards and airtime will be provided. Telephonic questionnaires can be conducted remotely and during times that suite you. (Data collection to take place in the month of October 2022).
- Analyse the 24-hour recalls using Foodfinder software.
- Keep all information with regards to the project and participants confidential at all times

Remuneration:

- You will be given R30 for each questionnaire successfully completed and 24-hour recall analysed.

My contact details are as follows:

Cell number: 0761941764

Email: Madeleine.Nienaber@mandela.ac.za

## Addendum H: Phase One Recruitment and Enrolment Information of Participants

Dear Parents/Guardians

You and your child are invited to take part in a study titled: The effect of COVID-19 on food security and dietary diversity in low-income households in a selected area of Nelson Mandela Bay, Eastern Cape. The approval number from the Research Ethics Committee (Human) is **H22-HEA-DIET-007**. If you agree to participate you will be contacted telephonically and asked to answer a few questions with regards to the food your child eats. The questions are summarized below:

- Information about all foods, beverages and possibly dietary supplements your child consumed in the past 24 hours (from midnight to midnight the previous day). You will also be asked about the type and amount (portion size) of all food and beverages consumed as well as preparation/cooking method and time of day the food was consumed.
- Indicate (using a checklist) which foods and beverages have been consumed by the child over the last month.
- Questions about the availability/accessibility of foods and beverages for your household.

The questions will be asked by trained volunteers, and all answers will be strictly confidential, no one outside the group will see the answer sheets. You and your child will get a number, and your names will not appear in any reports, you will be kept anonymous. It will take approximately 30 minutes to complete the questions and there will be no cost to you. If we phone on an inconvenient time, we can reschedule to a time that better suits you. It is your choice whether to have your child participate or not. If you choose not to give consent, all school services for your child will continue and nothing will change. You may also choose to change your mind later and stop participating, even if you agreed earlier. You can stop by telling us that you do not want to go further and then the questionnaire will be destroyed, and your data will not be used.

Please note that the data collected will be kept for a maximum of five years should it be necessary to plan follow-up studies or interventions.

If you agree to participate via a telephone interview (at no cost to you) and in order for us to contact you, please provide us with the following information and consent:

Print name and surname of parent or guardian:	
Contact number:	
Preferred time of call:	Morning / Afternoon / Evening Weekday / Weekend
Signature of parent or guardian:	
Date:	

Any complaints or concerns can be expressed to the following authorities:

Researcher – Madeleine Nienaber

0761941764

[Madeleine.Nienaber@mandela.ac.za](mailto:Madeleine.Nienaber@mandela.ac.za)

or the supervisor – Annelie Gresse ([Annelie.gresse@mandela.ac.za](mailto:Annelie.gresse@mandela.ac.za)) or the Research Ethics Committee (Human) of Nelson Mandela University ([rd@mandela.ac.za](mailto:rd@mandela.ac.za))

[Should you have concerns, you may also address it with the](mailto:nhrec@health.gov.za) National Health Research Ethics Council ([nhrec@health.gov.za](mailto:nhrec@health.gov.za)). See also the newsletter attached.

## Addendum I: Parent/Guardian Informed Consent Form

Dear Parents/Guardians

You and your child are invited to take part in a study titled: The effect of COVID-19 on food security and dietary diversity in low-income households in a selected area of Nelson Mandela Bay, Eastern Cape. The approval number from the Research Ethics Committee (Human) is **H22-HEA-DIET-007**. If you agree to participate you will be contacted telephonically and asked to answer a few questions with regards to the food your child eats. The questions are summarized below:

- Information about all foods, beverages and possibly dietary supplements your child consumed in the past 24 hours (from midnight to midnight the previous day). You will also be asked about the type and amount (portion size) of all food and beverages consumed as well as preparation/cooking method and time of day the food was consumed.
- Questions about the availability/accessibility of foods and beverages for your household.

The questions will be asked by trained volunteers and all answers will be strictly confidential, no one outside the group will see the answer sheets. You and your child will get a number and your names will not appear in any reports, you will be kept anonymous. It will take approximately 30 minutes to complete the questions and there will be no cost to you. If we phone on an inconvenient time, we can reschedule to a time that better suits you. It is your choice whether to have your child participate or not. If you choose not to give consent, all school services for your child will continue and nothing will change. You may also choose to change your mind later and stop participating, even if you agreed earlier. You can stop by telling us that you do not want to go further and then the questionnaire will be destroyed and your data will not be used.

Please note that the data collected will be kept for a maximum of five years should it be necessary to plan follow-up studies or interventions.

If you agree to participate via a telephone interview (at no cost to you) and in order for us to contact you, please provide us with the following information and consent:

Print name and surname of parent or guardian:	
Contact number:	
Preferred time of call:	Morning / Afternoon / Evening Weekday / Weekend
Signature of parent or guardian:	
Date:	

Any complaints or concerns can be expressed to the following authorities:

Researcher – Madeleine Nienaber

0761941764

[Madeleine.Nienaber@mandela.ac.za](mailto:Madeleine.Nienaber@mandela.ac.za)

or the supervisor – Annelie Gresse ([Annelie.gresse@mandela.ac.za](mailto:Annelie.gresse@mandela.ac.za)) or the Research Ethics Committee (Human) of Nelson Mandela University ([rd@mandela.ac.za](mailto:rd@mandela.ac.za))

[Should you have concerns, you may also address it with the](mailto:nhrec@health.gov.za) National Health Research Ethics Council ([nhrec@health.gov.za](mailto:nhrec@health.gov.za)). See also the newsletter attached.

## Addendum J: Child Informed Assent Form

Dear Learner

Your parent/guardian has given permission for you to take part in a study called: The effect of COVID-19 on food security and dietary diversity in low-income households in a selected area of Nelson Mandela Bay, Eastern Cape. The approval number from the Research Ethics Committee (Human) is **H22-HEA-DIET-007**. Your parent/guardian will be called on the phone and asked to answer a few questions about the food you eat. The questions are summarized below:

- Information about all foods, drinks you had in the past 24 hours (from midnight to midnight the previous day).
- Questions about if you had enough food and drinks for the people living with you in the house.

Your parent/guardian has received a letter and has been told about the study. Nobody will know that you were in the study, and we will not list your name on any of the reports. Taking part in the study is your choice and you can stop being a part of the study at any time without getting in trouble just by telling your parent that you do not want to participate before the researchers phone your parents. You can stop by telling us that you do not want to go further and then the questionnaire will be destroyed and your data will not be used.

Please note that the information collected will be kept for a maximum of five years should it be necessary to plan follow-up studies or interventions.

Do you understand this study and are you willing to participate?	Yes / No
Name and Surname of Child:	
Signature of child:	
Date:	

Any complaints or concerns can be expressed to the following authorities:

Researcher – Madeleine Nienaber

0761941764

[Madeleine.Nienaber@mandela.ac.za](mailto:Madeleine.Nienaber@mandela.ac.za)

or the supervisor – Annelie Gresse ([Annelie.gresse@mandela.ac.za](mailto:Annelie.gresse@mandela.ac.za)) or the Research Ethics Committee (Human) of Nelson Mandela University ([rd@mandela.ac.za](mailto:rd@mandela.ac.za))

Should you have concerns, you may also address it with the National Health Research Ethics Council ([nhrec@health.gov.za](mailto:nhrec@health.gov.za)). See also the newsletter attached.

## Addendum K: Phase One Questionnaire

### 24-hour Dietary Recall Form

Date:

Participant ID:

Meal time	Food consumed	Quantity
Before Breakfast		
Breakfast		
Snack		
Lunch		
Snack		
Dinner		
Snack		

## Food Intake Checklist

FG1 cereal	x		x		x
Cereals: Baby/infant cereal		Cereals: Sorghum, whole grain		Cereals: Cake flour	
Cereals: Noodles, other		Cereals: Ugali, based on corn meal		Cereals: Couscous	
Cereals: Nshima		Cereals: Wheat		Cereals: Maize	
Cereals: Oats, flakes, breakfast cereals		Cereals: White bread/bread rolls		Cereals: Maize Porridge	
Cereals: Rice		Cereals: Brown, whole wheat bread		Cereals: Mealie rice & samp	
Cereals: Sorghum-meal flour		Cereals: Other bread		Cereals: Millet	
Cereals: Sorghum porridge		Cereals: Other cereal products		Cereals: Noodles, instant 2-min.	

FG2 white roots	x		x		x
White roots and tubers: Amaranth		White roots and tubers: Amadumbe		White roots and tubers: Sweet potato, leaves	
White roots and tubers: Other foods made from roots		White roots and tubers: Potato			

FG3 vit A vegetables	x		x		x
Vegetables: Butternut		Vegetables: Pepper, red		Vegetables: Pumpkin	
Vegetables: Carrot					

FG4 dark leafy green veg	x		x		x
Vegetables: Broccoli		Vegetables: Kale		Vegetables: Morogo	
Vegetables: Imifino		Vegetables: Lettuce		Vegetables: Spinach	

FG5 other vegetables	x		x		x
Vegetables: Baby vegetable purees		Vegetables: Celery		Vegetables: Cabbage	
Vegetables: Squash		Vegetables: Chilli		Vegetables: Cauliflower	
Vegetables: Tomato		Vegetables: Green mealies		Vegetables: Beetroot	
Vegetables: Other fresh vegies		Vegetables: Onion		Vegetables: Pepper, others	

FG6 vit A fruit	x		x		x
Fruits: Apricot		Fruits: Mango		Fruits: Peach	
Fruits: Cantaloupe		Fruits: Papaya			

FG7 other fruit	x		x		x
Fruits: Apple		Fruits: Other fruit		Fruits: Naartjie	
Fruits: Pear		Fruits: Baby fruit purees		Fruits: Orange	
Fruits: Strawberries		Fruits: Banana		Fruits: Other citrus fruit	
Fruits: Sweet melon		Fruits: Cherries		Fruits: Lemon	
Fruits: Water melon		Fruits: Dried fruit			
Fruits: Wild fruits		Fruits: Grapes			

FG8 organ meat	x		x		x
Organ meat: Heart or other organ meats		Organ meat: Liver/ chicken liver		Organ meat: Meat pastes	
Organ meat: Kidney					

FG9 flesh meat	x		x		x
Flesh meat: Baby beef or chicken puree		Flesh meat: Sausages, boerewors		Flesh meat: Chicken	
Flesh meat: Insects		Flesh meat: Other birds		Flesh meat: Cold meats, vienna, russian sausage	
Flesh meat: Lamb		Flesh meat: Other meats		Flesh meat: Cured meat	
Flesh meat: Mutton		Flesh meat: Other sausages		Flesh meat: Duck	
Flesh meat: Pork		Flesh meat: Bacon		Flesh meat: Goat	
Flesh meat: Poultry, other		Flesh meat: Beef and veal			
Flesh meat: Rabbit		Flesh meat: Biltong, dried sausages			

FG10 eggs	x		x		x
Eggs: Eggs					

FG11 fish and seafood	x		x		x
Fish: Dried fish		Fish: Shelfish		Fish: Other fish	
Fish: Fresh fish (Salmon, tuna)		Fish: Tinned fish, pilchard			

FG12 legumes nuts seeds	x		x		x
Legumes, nuts and their products: Beans, dried or tinned		Legumes, nuts and their products: Hummus		Legumes, nuts and their products: Cashew	
Legumes, nuts and their products: Peas, split/ dried		Legumes, nuts and their products: Lentils		Legumes, nuts and their products: Coconut	
Legumes, nuts and their products: Sesame seeds		Legumes, nuts and their products: Melon seeds		Legumes, nuts and their products: Groundnut	
Legumes, nuts and their products: Shea nut		Legumes, nuts and their products: Palm nuts		Legumes, nuts and their products: Peanut, peanut butter	

FG13 milk and milk products	x		x		x
Milk, milk products: Buttermilk		Milk, milk products: Other milk products		Milk, milk products: Sourmilk	
Milk, milk products: Cheese		Milk, milk products: Ice crême		Milk, milk products: Soymilk	
Milk, milk products: Milk, cow		Milk, milk products: Milk, other		Milk, milk products: Yogurt	
Milk, milk products: Milk, other					

FG14 oils and fats	x		x		x
Oils and fats: Butter		Oils and fats: Other oils		Oils and fats: Shea butter	
Oils and fats: Coconut oil		Oils and fats: Margarine		Oils and fats: Sunflower-, vegetable oil	
Oils and fats: Ghee		Oils and fats: Mayonnaise			

FG15 sweets	x		x		x
Sweets: Cake, doughnuts, tarts		Sweets: Chocolates		Sweets: Sweetened juice drinks, concentrated	
Sweets: 100% fruit juice		Sweets: Cookies, biscuits		Sweets: Candies, lollipops	
Sweets: Soft drinks		Sweets: Crisps/ packet of chips		Sweets: Pies	
Sweets: Sweetened ice tea		Sweets: Honey		Sweets: Sugar	
Sweets: Sweetened, flavoured milk beverages		Sweets: Jam, Syrup			

FG16 spice condiments beverages	x		x		x
Beverages: Tea					
Beverages: Water					

## Household Hunger Scale

**In the past 30 days, did all of your household members have access to enough food on every day?**

- Yes  No

**On how many days did all of your household members have access to enough food in the past 30 days?**

- 0 days  1-2 days  3-10 days  
 more than 10 days
- 

**In the past 30 days, did you or any household member go to sleep at night hungry because there was not enough food?**

- Yes  No

**On how many days did this happen in the past 30 days?**

- 0 days  1-2 days  3-10 days  
 more than 10 days
- 

**In the past 30 days, did you or any household member go a whole day and night without eating anything at all because there was not enough food?**

- Yes  No

**On how many days did this happen in the past 30 days?**

- 0 days  1-2 days  3-10 days  
 more than 10 days
- 

## COVID-19 impact

**Did Covid-19 have an influence on the diet of your child, for example, was their less food in the house so the child got less food to eat?**

- Yes  No

**If yes, please explain**

**Did Covid-19 have an influence on the food security in the house, for example was there less money to buy food with?**

- Yes  No

**If yes, please explain**

**Thank you for your time!**

## **Addendum L: Invitation to Nutrition Experts to Participate in the Research Project**

South Campus  
Department of Human Nutrition and Dietetics  
Faculty of Health Sciences  
Tel . +27 (0)41 5042048  
s218202873@mandela.ac.za

Invitation to Nutrition Experts to participate in the research project

Madeleine Nienaber  
Primary investigator  
Nelson Mandela University  
Date: 09 August 2024

Dear [Recipient's Name],

I would like to extend an invitation for your esteemed participation in a critical phase of our research project titled: **A household food security index to identify household food security, dietary diversity, and nutritional status of children in Nelson Mandela Bay, Eastern Cape**. This project aims to develop a comprehensive household food security index, employing the dietary diversity score (DDS), household hunger scale (HHS), and nutritional status as key indicators for measuring household food security. The study is undertaken as part of my PhD degree and is conducted under the supervision of Prof Annelie Gresse, Head of the Department of Human Nutrition and Dietetics. The proposal for the envisaged research has also received ethics approval from the Nelson Mandela University Research Ethics Committee (REC-H number: H23-HEA-DIET-010)

As a recognized authority in the field of food security, your expertise and insights are highly valued, and we believe your involvement in Step 1 – defining the theoretical framework, Step 2 – model specification, and Step 4 – model evaluation will contribute significantly to our collective effort in developing a robust and accurate index. The data collection will employ the Delphi research method, which involves gathering and refining expert opinions through multiple rounds of feedback to achieve consensus.

This phase is set to commence in September 2024 and will continue for approximately one month.

For each of the steps mentioned above, you will get an initial questionnaire where you will give your opinion. Thereafter you will receive a questionnaire to rate statements in order to determine the consensus amongst panel members. Should there not be sufficient consensus after the first rating questionnaire, it may be followed up with a second rating round, with results from the first rating round. Thereafter, it will be accepted that consensus cannot be reached.

Your participation will remain anonymous and help to ensure that the conceptual model accurately reflects the complex and nuanced relationships among the variables relevant to household food security, enhancing the quality and validity of the household food security index's development as well as evaluating the model's alignment with real-world data. Your expert opinion and insights will help us fine-tune the model and strengthen the validity of our approach.

If you are willing to participate, please respond to the email confirming your availability, and we shall provide you with further details. We extend our heartfelt appreciation for considering this request and look forward to the prospect of working together to make a meaningful contribution to the field of household food security.

Yours sincerely



Primary Investigator: Madeleine Nienaber

Cell: 0761941764

[s218202873@mandela.ac.za](mailto:s218202873@mandela.ac.za)



Supervisor: Prof A Gresse

[Annelie.Gresse@mandela.ac.za](mailto:Annelie.Gresse@mandela.ac.za)

## **Addendum M: Theoretical Framework of Study to Nutrition Experts**

### **Theoretical Framework for Creating a Household Food Security Index (HFSI) for Low-income Households in Nelson Mandela Bay (NMB), South Africa**

#### **Introduction**

Food security, as defined by the Food and Agriculture Organization (FAO), involves the availability, access, utilisation, and stability of food at multiple levels—individual, household, regional, and national. At the household level, the utilisation and access dimensions determine consistent access to sufficient, safe, and nutritious food for an active and healthy life (FAO, 2006). Regional and national food security are influenced by broader systemic factors like food availability and policy (Fanzo et al., 2022). Figures 1-3 illustrate the different levels and dimensions of food security, as well as their interactions. To assess food security at household level, three key measures, Household Dietary Diversity Score (HDDS), Nutritional Status, and the Household Hunger Scale (HHS), have been selected. These measures are chosen for their practicality, ease of implementation in clinical settings, and their ability to provide a comprehensive view of food security at household level. In addition to their ability to capture critical aspects of food security that can be directly addressed through interventions. The HDDS and Nutritional Status focus on individual and household levels, assessing dietary quality and health outcomes within a home, while the HHS reflects household-level access to food.

#### **Dimensions of Food Security**

##### **1. Availability**

Refers to the presence of sufficient quantities of food within a region, influenced by factors such as agricultural production and distribution networks, and international trade policies (Frongillo et al., 2022).

## 2. **Access**

Involves the ability of households to acquire adequate food through economic, social, and physical means, including income, prices, and access to markets. This dimension includes both economic and physical access to food (Leroy et al., 2015).

## 3. **Utilisation**

Refers to the proper biological use of food, focusing on diet quality and the body's ability to absorb nutrients. It is closely linked to health and sanitation, as the ability to absorb and metabolize nutrients is impacted by disease, hygiene, and food preparation practices (Abbade, 2017).

## 4. **Stability**

Stability ensures that the other three dimensions are consistently met over time. It involves the reliability of food availability, access, and utilisation, even during adverse conditions like economic crises, climate shocks, or seasonal food shortages (Fanzo et al., 2022).

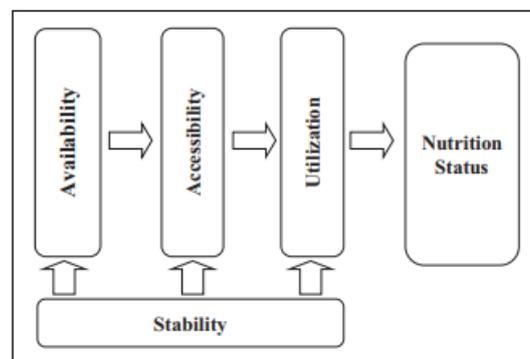


Figure 1: The relationship among the categorical elements of framework of food and nutrition security (Göttingen et al., 2009).

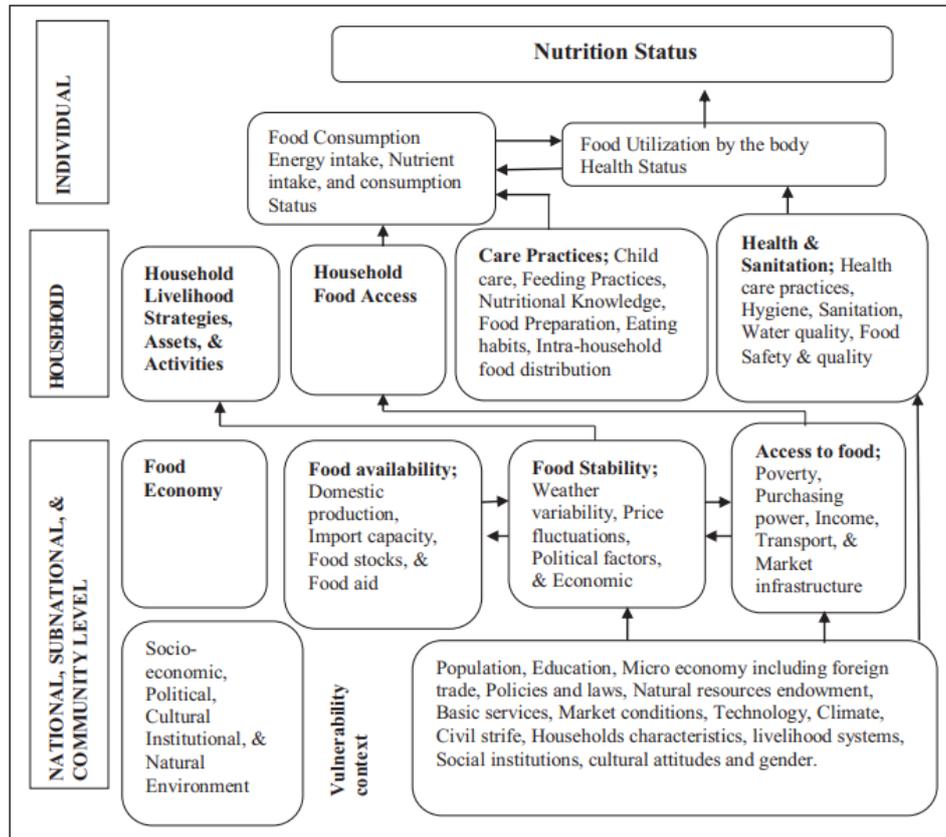


Figure 2: The Food and Agricultural Organization-Vulnerability Information and Mapping Systems (FAO-FIVIMS) framework (FAO, 2008).

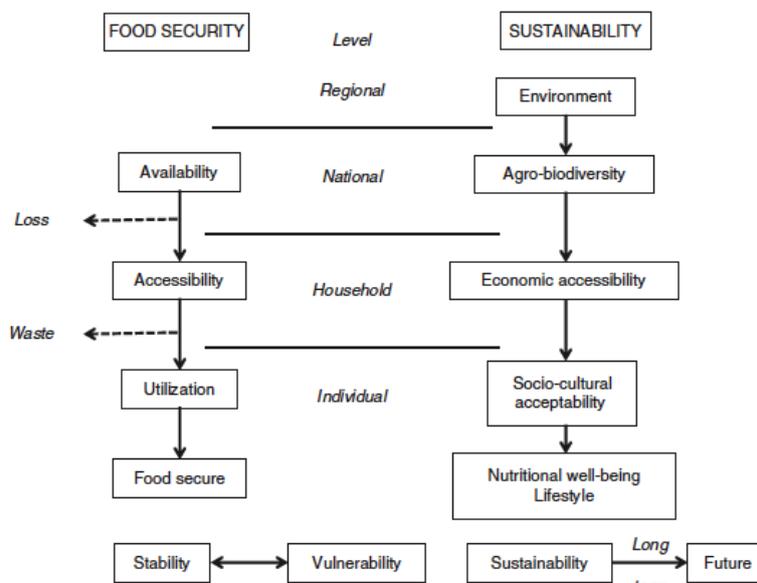


Figure 3: Dimensions and associated levels of food security (Berry et al., 2015).

## Conceptual Justification of the HFSI

### 1. Household Dietary Diversity Score (HDDS)

- **Dimension:** Access and Utilisation
- **Level:** Individual & Household
- **Focus population:** Household
- **Rationale:** HDDS is an indicator of the quality and variety of a diet, reflecting the access to a diverse range of foods necessary for adequate nutrition. Dietary diversity is closely linked to micronutrient adequacy and is often used as a proxy for nutrient sufficiency in resource-limited settings (Kennedy et al., 2011). In South Africa, where dietary patterns are influenced by socio-economic disparities, HDDS can provide insights into food utilisation at the household level, particularly for vulnerable populations.
- **Importance:** HDDS measures the variety of foods consumed, serving as a proxy for the access to sufficient, nutritious food. Dietary diversity is critical for ensuring that all essential nutrients are consumed, which supports good health and overall wellbeing. HDDS is closely tied to food security, as households with higher dietary diversity are more likely to meet their nutritional needs. A diverse diet ensures that households consume an array of essential nutrients, which are crucial for maintaining health and preventing malnutrition. Furthermore, HDDS helps identify households at risk of poor nutrition, especially in settings where food insecurity and poverty limit access to diverse food options (Hoddinott & Yohannes, 2002).
- **Motivation and practicality:** HDDS is simple to assess through a dietary recall, making it a practical tool for evaluating dietary quality during routine clinic visits. It provides immediate feedback on the variety and quality of foods available to and consumed by the household, offering actionable insights for nutritional counselling and interventions such as nutritional supplementation and social grant application.

### 2. Nutritional Status

- **Dimension:** Utilisation (Health Impact)
- **Level:** Individual
- **Focus population:** Children

- **Rationale:** Nutritional status, often measured through anthropometric indicators such as stunting and wasting, reflects the cumulative effects of food intake and health status on individuals. It is a critical outcome of food security, capturing the physiological impacts of both undernutrition and overnutrition. Given South Africa's triple burden of malnutrition — where undernutrition coexists with rising obesity rates — nutritional status is a vital measure for assessing the effectiveness of food security interventions in low-income households (FAO et al., 2023).
- **Importance:** Nutritional status, typically assessed through indicators such as child growth measures (stunting/wasting), reflects the health impacts of food security. It captures the effectiveness of food utilisation in meeting the body's nutritional needs, providing direct evidence of the outcomes of food security in terms of physical health (Bhutta et al., 2020).
- **Motivation and practicality:** Assessing nutritional status is a standard practice in clinics, making it a readily available and reliable measure. It offers critical information on the physical health consequences of food insecurity, helping clinicians identify at-risk individuals and tailor interventions, such as nutritional supplements, dietary advice and interventions.

### 3. Household Hunger Scale (HHS)

- **Dimension:** Access
- **Level:** Household
- **Focus population:** Household
- **Rationale:** The HHS is a direct measure of food deprivation within households, capturing the severity and frequency of hunger experienced by household members. It is a robust indicator of access to food, particularly in low-income settings where food insecurity is prevalent. In the South African context, where economic inequality influences food access, HHS provides critical insights into the severity of food insecurity and its impact on household well-being (Coates et al., 2007).
- **Importance:** HHS measures the severity of hunger experienced by households, capturing whether they have consistent access to adequate food. It directly addresses the access dimension of food security by assessing the frequency and

severity of food shortages and highlights whether households can consistently obtain adequate food (Ballard et al., 2011).

- **Motivation and practicality:** The HHS is a simple, self-reported measure that can be quickly administered during a clinic visit. It provides an immediate snapshot of a household's food access situation, enabling healthcare providers to identify those in urgent need of food assistance or other support services.

## Significance of the HFSI

### Holistic household-specific approach

While food availability and stability are influenced by broader systemic factors such as national policies and economic conditions, the proposed index focuses on access and utilisation, dimensions that can be directly impacted at the household level. This targeted approach enables the identification of at-risk households and facilitates the design of interventions that yield immediate, tangible benefits. The inclusion of the HDDS, nutritional status, and HHS ensures that no critical aspect of household food security is overlooked. The HDDS provides insights into dietary diversity and a household's ability to access a variety of foods, linking directly to food access and utilisation. Nutritional status reflects the long-term health outcomes of food security, assessing whether food access and utilisation translate into positive health effects. The HHS captures the immediate experience of hunger, highlighting a household's ability to secure sufficient food. Together, these indicators provide a robust framework for identifying vulnerable households and tailoring interventions accordingly.

### Practicality and feasibility in clinical settings

The selected indicators, HDDS, nutritional status, and HHS, are designed to be easily administered during routine clinical visits and to give a more holistic picture of household food security, compared to using these indicators in isolation. These indicators require minimal resources and time, making them suitable for use in resource-constrained environments such as South African public health clinics. The HFSI can serve as a practical screening tool for assessing and monitoring household food security, ensuring that healthcare providers can implement timely interventions without additional burden.

## **Conclusion**

The proposed theoretical framework emphasizes the importance of addressing household food security by focusing on the dimensions that are within the control of individual households, access and utilisation. By selecting measures like HDDS, Nutritional Status, and HHS, which are easy to implement and provide valuable information, this framework enables the effective assessment and intervention in food security issues at the household level. Its implementation in clinics can enhance the identification of at-risk households, guide targeted interventions, and support the monitoring and evaluation of food security programmes. By grounding the index in both theoretical and practical considerations, this approach ensures that it is not only scientifically robust but also contextually relevant and actionable.

## **Addendum N: Delphi Questionnaire**

Please complete the following questionnaire related to creating a comprehensive Household Food Security Index (HFSI) for measuring household food security in low-income areas of Nelson Mandela Bay (NMB), South Africa:

### **Relevance of Indicators in Measuring Household Food Security**

Please select the level of relevance for each indicator in measuring household food security:

#### **Household Dietary Diversity Score (HDDS)**

- Very Relevant
- Moderately Relevant
- Not Relevant

#### **Nutritional Status**

- Very Relevant
- Moderately Relevant
- Not Relevant

#### **Household Hunger Scale (HHS)**

- Very Relevant
- Moderately Relevant
- Not Relevant

Please indicate your level of agreement with the following statements:

**Household Dietary Diversity Score (HDDS)** effectively captures the access and utilisation dimension of household food security.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

**Nutritional Status** accurately reflects the utilisation and health outcomes related to food security at the household level.

- Strongly Agree

- Agree
- Neutral
- Disagree
- Strongly Disagree

**Household Hunger Scale (HHS)** adequately addresses the access dimension of food security in households.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

---

## 2. Weighting Considerations of Indicators

Do you believe equal weighting of the indicators would be appropriate?

- Yes
- No

Please elaborate on your response:

Please allocate a weighted percentage to each of the following indicators in the overall index:

HDDS: \_\_\_\_\_ %

Nutritional Status: \_\_\_\_\_ %

HHS: \_\_\_\_\_ %

Total: 100%

Please provide your reasoning for the proposed weighting:

---

## 3. General Assessment of the Index

Please indicate your level of agreement with the following statements:

The three indicators (HDDS, Nutritional Status, and HHS) are reliable for assessing food security in a household setting.

- Strongly Agree
- Agree

- Neutral
- Disagree
- Strongly Disagree

Please provide any concerns or suggestions for improving the reliability:

The inclusion of HDDS, Nutritional Status, and HHS reflects the key dimensions of household food security (access, utilisation) well.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

The proposed Household Food Security Index (HFSI) will be effective in assessing food security at the household level in low-income settings in Nelson Mandela Bay (NMB), South Africa.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Please provide reasoning for your answer:

The time and resources required to administer the index are reasonable for use in clinical settings, particularly in South African clinics.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Please elaborate on any challenges or barriers you foresee:

The proposed index can practically be implemented in routine clinical settings, particularly in South African clinics.

- Strongly Agree

- Agree
- Neutral
- Disagree
- Strongly Disagree

What modifications, if any, would you suggest to improve the practicality of the index:

---

### **Conclusion**

Thank you for your valuable contributions to this study. Your insights are crucial in refining and validating the proposed Household Food Security Index (HFSI). The results from this questionnaire will be analysed using the Delphi technique to reach a consensus on the most effective, reliable, and practical index for assessing household food security in low-income households in NMB, South Africa. We will share the aggregated results with you in the next round for further evaluation.

## Addendum O: Turnitin Results

Thesis 05 December

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ORIGINALITY REPORT

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**21** %  
SIMILARITY INDEX

**18** %  
INTERNET SOURCES

**12** %  
PUBLICATIONS

**7** %  
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