

**THE DOUBLE BURDEN OF UNDER- AND OVER-NUTRITION
AMONG SCHOOL-AGED CHILDREN AND ADOLESCENTS IN
TWO NIGERIAN STATES**

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**A Thesis submitted to the
Faculty of Health Sciences, University of the Witwatersrand, Johannesburg,
in fulfilment of the requirements for the degree of
Doctor of Philosophy**

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DECLARATION

I, Adeleye Abiodun Adeomi, declare that this thesis is my own, unaided work. It is being submitted for the degree of Doctor of Philosophy in Public Health at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



Adeleye A. Adeomi

13th day of April, 2022

DEDICATION

I dedicate this work to the loving memory of my father and mother

Chief Adegbola Adigun Adeomi (1944 – 2009)

Mrs. Deborah Ajitoni Adeomi (1948 – 2018).

PRESENTATIONS ARISING FROM THIS RESEARCH PROJECT

The presentations arising from this project include;

1. The double burden of under- and over-nutrition among school-aged children and adolescents in two Nigerian states. Joint Academic Seminar 3 of the Consortium for Advanced Research Training in Africa (CARTA), Ibadan, Nigeria, February, 2021 (Oral presentation)
2. Double burden of malnutrition among school-aged children and adolescents: evidence from a community-based cross-sectional survey in two Nigerian States. 8th Annual Joint Advanced Seminar (JAS4) Conference (Virtual), 23 – 24th September, 2021
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4. Food security, dietary diversity, dietary patterns and the double burden of malnutrition among school-aged children and adolescents in two Nigerian States. 13th Faculty week and scientific conference of the faculty of clinical sciences, Obafemi Awolowo University, Ile-Ife, Nigeria (30th November to 2nd December, 2021)

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1. **Adeomi, A.**, Fatusi, A., & Klipstein-Grobusch, K. (2022). ‘Children eat all things here’: a qualitative study of mothers’ perceptions and cultural beliefs about underweight and overweight children and adolescents in selected communities in two Nigerian states. *BMJ Open*. 12:e059020. <http://dx.doi.org/10.1136/bmjopen-2021-059020>
2. **Adeomi A.A.**, Fatusi A., Klipstein-Grobusch K (2021). Double burden of malnutrition among school-aged children and adolescents: evidence from a community-based cross-sectional survey in two Nigerian States. *AAS Open Research*; 4:38 <https://doi.org/10.12688/aasopenres.13257.1>
3. **Adeomi, A.**, Fatusi, A., & Klipstein-Grobusch, K. (2022). Individual and contextual factors associated with under- and over-nutrition among school-aged children and adolescents in two Nigerian states: A multi-level analysis. *Public Health Nutrition*, 1-13. doi:10.1017/S1368980022000258
4. **Adeomi, A.**, Fatusi, A., & Klipstein-Grobusch, K. (2022) Food Security, Dietary Diversity, Dietary Patterns and the Double Burden of Malnutrition among School-Aged Children and Adolescents in Two Nigerian States. *Nutrients*, 14 (4): 789; <https://doi.org/10.3390/nu14040789>

ABSTRACT

Introduction: Little data exists on the double burden of malnutrition (DBM) among school-aged children and adolescents in Nigeria, despite some evidence for its existence. This research explored mothers' perceptions and cultural beliefs about the concept, causes, and community experience of under- and over-weight children and adolescents and measured the prevalence rates of thinness, underweight, stunting, overweight, obesity to investigate the existence of the DBM. In addition, the research identified individual and contextual correlates of the DBM including food security, dietary diversity and dietary patterns among school-aged children and adolescents in the two Nigerian states.

Methods: The study was a community-based study, carried out in Osun and Gombe States in Nigeria. The study used a mixed-methods design, with a sequential exploratory approach. This involved a qualitative study using focus group discussions among 76 women in 8 randomly selected communities in the two Nigerian states, and a subsequent quantitative cross-sectional study carried out among 1,200 (600 in each state) 6 – 19 year olds and their mothers, who were selected using multi-stage sampling technique. Individual (child), household and community level data were collected using structured pre-tested questionnaire, while anthropometric data (weight and height) were collected using weighing scales and stadiometers. Thinness and overweight/obesity, measured using the BMI-for-age Z-scores from the World Health Organization (WHO) growth reference values for 5 – 19 year olds, were used as the indicators for under- and over-nutrition, respectively. Additionally, dietary diversity (DD) was assessed using a 24-hour dietary recall and dietary patterns (DPs) were determined by principal component analysis using a 30-day food frequency questionnaire. Multi-variable analyses were used to identify determinants, while multi-level analyses were performed to understand the influence of the community, and community-level factors on under- and over-nutrition among school-aged children and adolescents in the two selected states.

Results: Mothers from the qualitative study expressed perceptions on the concepts, causes and community experience of under- and overweight children and adolescents. Majority of the women reported no known food taboo or restrictions, and no cultural practices relating to the nutrition of children and adolescents.

The mean age of the respondents of the cross-sectional study was 11.6 ± 3.8 years. The overall prevalence rate of stunting was 34.9%, underweight was 13.5%, thinness was 10.3% and overweight/obesity was 11.4%, which typifies the DBM at population level. Four percent were both stunted and overweight/obese, typifying individual level DBM. The rates for the indicators

of under- and over-nutrition differed significantly across demographic, socio-economic and household/family characteristics ($p < 0.05$).

The random effects of the multilevel analysis showed that the full models accounted for about 82% and 39% of the odds of under-nutrition and over-nutrition across the communities respectively, as explained by the proportional change in variance (PCV). Also, 21.6% and 28.5% of the variation in the odds for under-nutrition and over-nutrition were attributable to community level variables respectively, and these were statistically significant ($p < 0.001$). The fixed effects showed that household size was positively associated with under-nutrition, while the upper wealth index was inversely associated with under-nutrition. Age, exclusive breastfeeding, physical activity and the upper wealth index were inversely associated with over-nutrition, while residing in Osun State, female gender and screen time > 2 hours/day were positively associated with over-nutrition.

Two DPs were identified. The diversified DP had positive loadings for all food groups indicating a varied diet, while the traditional DP had positive loading for starchy foods/cereals, legumes and sugars. The traditional DP was positively associated with both under- and over-nutrition, while the diversified DP was inversely related with under-nutrition.

Conclusions: Gaps and misconceptions exist in the perceptions of mothers on under- and overweight children and adolescents. Food taboos, food restrictions and other cultural beliefs or practices were not reported by majority of the mothers. The study found evidence of DBM at individual and population levels, and the DBM was significantly influenced by the community and individual-level factors. A traditional DP was positively associated with the DBM, while the diversified DP was inversely associated with under-nutrition. Educational programmes for mothers and school-aged children and adolescents should target identified gaps and misconceptions and promote the importance of healthy/diversified dietary patterns. There is a need to explore the possibilities of community-based interventions to combat the double burden of malnutrition.

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NOMENCLATURE

AIC	-	Akaike Information Criteria
BIC	-	Bayesian Information Criteria
BMI	-	Body Mass Index
CDC	-	Centre for Disease Control and Prevention
CI	-	Confidence Interval
DBM	-	Double burden of malnutrition
DD	-	Dietary Diversity
DDS	-	Dietary Diversity Score
EA	-	Enumeration Area
EST	-	Ecological systems theory
FAO	-	Food and Agricultural organization
FFQ	-	Food Frequency Questionnaire
FGD	-	Focus Groups Discussion
FIVIMS	-	Food Insecurity and Vulnerability Information and Mapping Systems
HFIAS	-	Household Food Insecurity Access Scale
ICC	-	Intra-Class Correlation
IOTF	-	International Obesity Task Force
IRB	-	Institutional Review Board
KMO	-	Kaiser-Meyer-Olkin
LGA	-	Local Government Area
LMIC	-	Low and Middle-Income Countries
MICS	-	Multiple Indicator Cluster Survey
NCD	-	Non-communicable disease
NCHS	-	National Center for Health Statistics
NDHS	-	Nigeria Demographic and Health Survey
OR	-	Odds Ratio
PCA	-	Principal Component Analysis
PCV	-	Proportional Change in Variance
QFFQ	-	Quantitative Food Frequency Questionnaire

SSA	-	sub-Saharan Africa
UNICEF	-	United Nations Children Fund
VPC	-	Variance Partition Coefficient
WHO	-	World Health Organization

PREFACE

The thesis is structured according to the “divided block” of the Faculty of Health Sciences in University of the Witwatersrand. As shown in Figure 1.1, the thesis comprises of seven chapters. Chapters one and two are for the introduction and methodology respectively. Chapters 3-6 present the study results, followed by an integrated discussion in chapter 7.

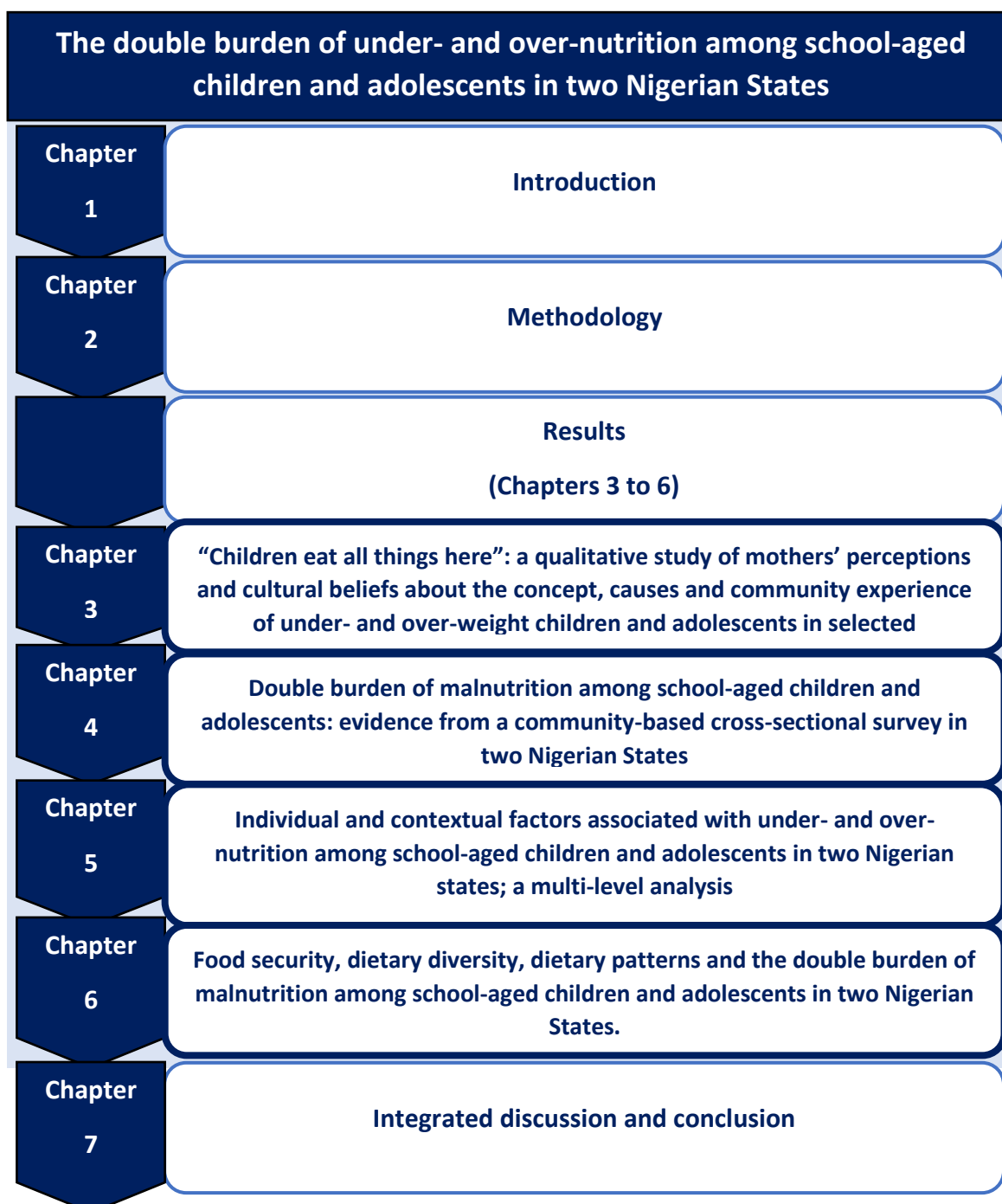


Figure 1.1: Overview of the thesis

The double burden of malnutrition (DBM) is the co-existence of under- and over-nutrition, which could be at individual, household and population levels. The DBM is due to the rising prevalence of overweight/obesity globally, while the prevalence of under-nutrition, especially in low- and middle-income countries (LMIC), is still high. Nigeria, like many other LMIC, may also be experiencing the DBM, especially among school-aged children and adolescents, but there is very little data on DBM and its determinants in Nigeria.

The introduction (chapter one) gives background information for the double burden of malnutrition, including the epidemiology, research problems, research gap, conceptual framework, research questions and objectives. Chapter two describes the general methodology of the study, including the methodology for the qualitative and quantitative studies. Since the specific methodological considerations for each of the empirical studies are included in the appropriate chapters, the emphasis in chapter two was on the generic methodological issues to avoid unnecessary repetition. Therefore, methodological issues that had been explained in greater detail in the empirical studies were only briefly explained in Chapter two. However, some repetition could not be avoided, but this was reduced to the barest minimum.

Chapter three describes the qualitative study which answered the first objective which was to explore mothers' perceptions and cultural beliefs about the concept, causes, and community experience of under- and over-weight children and adolescents in two Nigerian States. Hence, chapter three is titled ““Children eat all things here”: a qualitative study of mothers' perceptions and cultural beliefs about the concept, causes and community experience of under- and over-weight children and adolescents in selected communities in two Nigerian States.” The second objective, which is to estimate the prevalence and distribution of under- and over-nutrition among school-aged children and adolescents in two Nigerian States, was addressed in chapter four. Chapter four is titled “Double burden of malnutrition among school-aged children and adolescents: evidence from a community-based cross-sectional survey in two Nigerian States.”

The third objective is to identify individual and contextual factors associated with under- and over-nutrition among school-aged children and adolescents in two Nigerian States. At the proposal level, it was conceptualized that this objective would be addressed using multi-level analysis. However, in the course of running the multi-level analysis, two issues arose that resulted in the modification of the initial concept. Firstly, the independent variables to be adjusted for in the multi-level model were many including child characteristics, household/family characteristics, diet-related characteristics and community level factors, and this resulted in a number of the variables having high variance inflation factor (VIF) when multi-collinearity diagnostics were undertaken. Secondly, there was a need to do more dilation

and analysis of the diet-related factors, than could be allowed when everything was incorporated into the multi-level models. Hence, the diet-related factors were investigated separately to allow for a detailed analysis of food security, dietary diversity and dietary patterns in relation to thinness and overweight/obesity. Therefore, the association between other individual and community level factors with the DBM using the multi-level analysis is described in Chapter five which is titled “individual and contextual factors associated with under- and over-nutrition among school-aged children and adolescents in two Nigerian states; a multi-level analysis.”

Diet-related factors, including food insecurity, dietary diversity and the dietary patterns, and their relationship with the double burden of malnutrition were addressed separately in Chapter 6, which is titled “Food security, dietary diversity, dietary patterns and the double burden of malnutrition among school-aged children and adolescents in two Nigerian States.”

Chapter seven integrates the findings from the qualitative and quantitative studies in a overall discussion to complement, explain and enrich each other in what is considered a concurrent triangulation approach. The chapter also includes policy implications and directions for further research.

CHAPTER ONE: Introduction and Literature Review

1.1 Background

Many years ago, childhood undernutrition was the major nutritional problem but today there is the pandemic of overweight/obesity and its accompanying non-communicable diseases (NCDs).¹ This rising prevalence of overweight/obesity is in addition to the challenge of undernutrition, which remains a big problem in many parts of low and middle income (LMIC).² This coexistence of under- and over-nutrition is what has been called the double burden of malnutrition,³ and has been described by a number of researchers including the World Health Organization (WHO).⁴⁻⁶

DBM can occur at the individual, household and population levels. It occurs at the individual level when an overweight or obese person is stunted at the same time, or when a person develops both undernutrition or overweight at different points in a lifetime.^{5,6} This is common in many developing countries with a high prevalence of stunted children who later become overweight/obese as older children or adults.⁷ In high income countries (HIC), the common pattern is when overweight/obese people have some micro-nutrient deficiencies.⁴⁻⁶ The occurrence of both types of malnutrition (i.e. under- or over-nutrition) by different members of the same family describes the household-level, while occurrence of this at community, regional or National levels have been referred to as the DBM at population level.^{5,6}

DBM is a global challenge, but seems to affect the low-and middle-income (LMIC) countries more.^{4,5} Some reasons that have been deduced for the DBM include nutrition transition, demographic transition and the epidemiological transition, which are related with each other and are occurring in different countries.^{5,8} The nutrition transition is a shift from a tradition dietary pattern, to more westernized patterns which are higher in sugar, saturated fat and refined foods but lower in fibre, and with a reduction in physical activity as a result of technological advancements.⁹ The epidemiological transition describes a change in the predominance of communicable diseases to the increasing prevalence of non-communicable diseases (NCD).⁵ Demographic transition is the change in the structure of populations from high birth and death rates having high population of young people, to low birth and death rates with increasing population of older people who are more at risk of NCDs.⁵ These transitions are occurring more in LMIC, especially Latin America¹⁰ and may be the reason why these countries seem to be having a higher burden of DBM. There is also evidence for a nutrition transition in sub-Saharan Africa, with a rising prevalence of overweight/obesity among children, while still having a high burden of childhood undernutrition.²

Nigeria, like many LMIC, may already be experiencing the double burden of malnutrition. The prevalence of overweight and obesity among Nigerian children is rising, with some researchers reporting rates close to the global average,¹¹ but the problem of undernutrition is still far from over. United Nations Children Fund's (UNICEF) estimates that 33% of Nigerian children are stunted,¹² with many Nigerian studies reporting even higher rates.^{13–17} Popkin et al¹⁸ defined country-level DBM as having “a prevalence of wasting of >15%, stunting of >30%, and thinness in women of >20%, and an adult or child overweight prevalence of >20%, >30%, or >40%”, and hence grouped Nigeria as having DBM at >30% overweight/obesity.

1.2 Nutritional Status of School-Aged Children and Adolescents

1.2.1 Global epidemiology

There has been a steady rise in the prevalence of overweight and obesity among children in all regions of the world. Prevalence rates in the range of 10 – 40% for overweight/obesity were reported in selected high income countries among 15-year-old adolescents.¹⁹ The World Health Organization (WHO) reports that 340 million school-aged children and adolescents (aged 5 – 19 years) were overweight/obese globally in 2016.²⁰ Low- and middle-income countries have also experienced significant rise in the prevalence of overweight/obesity with highest prevalence rates recorded in the Middle East, North Africa, Latin America and the Caribbean.^{19,21} The rates of increase in childhood overweight and obesity in sub-Saharan Africa have been rather modest, but some researchers argue that this may actually be due to shortage of recent representative data.²²

Despite the rising prevalence of overweight/obesity in sub-Saharan Africa, the prevalence of underweight children still remains high. In a study that assessed the worldwide trend in the nutritional status of 24.1 million children between the ages of 5–17 years from 1975 to 2016, the prevalence of underweight reduced in almost all regions, but not in south Asia, central, east and west Africa.²⁰ UNICEF reports that 34% and 36% of children and adolescents in sub-Saharan and south Asia were chronically malnourished (stunted) respectively.

1.2.2 The Nigerian epidemiology

There is no nationally representative data on the nutritional status of school-aged children and adolescents in Nigeria. A number of scattered studies have been done on the subject in Nigeria, which suggest the existence of the double burden of malnutrition (Appendix 17). A number of studies in Nigeria report stunting rates in excess of 50%,^{13,16,23,24} which is higher than the 33%

estimated by UNICEF. Despite the prevalence of undernutrition, a number of existing studies reported prevalence rates of overweight/obesity higher than 10%,^{11,25–30} which was the reported global average in 2004.³¹ This pattern strongly suggests the double burden of malnutrition; rising prevalence of overweight/obesity, while undernutrition is still a big problem. There are a number of scattered studies on the nutritional status of children in Nigeria, generalizing the findings has however been a major challenge because of different methodological approaches to these studies.^{2,32} The poor quality and heterogeneity of study methodologies has been a problem. These include differences in the study populations, sample sizes, sampling methods, data collection methods, the growth reference values used for assessing the nutritional status of the children and data management methods.³² This complicates the comparability of research findings among the existing studies. It may not be surprising therefore, that most researchers who have carried out systemic reviews on this subject in Nigeria^{2,22,32–34} have had this as a major limitation. It may also be the reason why no meta-analysis on the nutritional status of school-aged children and adolescents in Nigeria could be found even after a diligent literature search.

Comparability between findings has been particularly challenging because many of the existing studies used differing criteria for defining under- and over-nutrition among school-aged children and adolescents.^{32,33} Globally, there have been strong debates about the appropriate method to use for the assessment of the nutritional status of older children (older than 5 years).^{22,31,35–38} Earlier methods include the National Centre for Health Statistics (NCHS)/World Health Organization (WHO)³⁹ and the Centre for Disease Control and Prevention (CDC) international growth references,⁴⁰ but these have been shown to have several drawbacks,^{22,31,35–37} some of which have been earlier explained. More recent international growth references from the WHO³⁵ and the International Obesity Task Force (IOTF)^{37,41} have been more widely accepted. However, many existing studies in Nigeria used the NCHS/WHO and the CDC references,^{42–46} while very few used the 2007 WHO and the IOTF references,^{47–51} and others used other unconventional or poorly defined methods.^{24,52–58} The unconventional methods used include the use of adults' BMI or waist hip ratio values to define under-or over-nutrition in school-aged children or adolescents.^{52,53,59} The others with poorly defined reference values either did not state the reference values used in their study or described methods that are difficult to understand.^{17,55,56,60} The use of differing reference values/charts by the exiting studies in Nigeria has made it difficult to have a national perspective on the nutritional status of school-aged children and adolescents in Nigeria.

The conflicting results reported by the existing studies in Nigeria is another cause of concern. While some researchers reported stunting rates higher than 50% as above, others reported rates lower than 5%.^{56,58,60–65} These differences are hard to explain, and it is difficult to conclude that these the differences are real or are due to the heterogeneity of research methods or the differing growth references used in assessing the nutritional status.

A systemic review by Ejike on the subject sought to give a national perspective on the subject.³² However, the study was not very helpful in filling this gap because of some limitations, as reported by the researcher. Some of the limitations were poor quality of the studies, limited number of studies, limited subjects, heterogeneity of methodologies and differences in the reference values used to diagnose overweight/obesity.

1.2.3 Growth references

Monitoring the epidemiology and trends in nutritional status is greatly dependent on the adequacy of the growth reference used.⁶⁶ A growth reference is a statistical or graphical summary of the anthropometric measurements of a reference group of children, which is usually presented as a range of values or charts at different ages and for different sexes.⁶⁷ Growth references describe the growth and nutritional status of children, and these references establish whether or not the anthropometric measurements of children are typical of the reference group.^{35,67}

Growth references have been considered one of the most valuable tools for assessing, not just the health and well-being of individuals, but also the families and communities in which they live.⁶⁸ The fact that children are a vulnerable group in the society makes their growth assessment and subsequently their growth references even more reflective of the well-being of the families and communities in which they live.⁶⁸

Defining a single standard for children and adolescents has been more difficult than that of adults. Earlier efforts at developing a single international growth reference was by the National Centre for Health Statistics (NCHS)/World Health Organization (WHO)³⁹ and the Centre for Disease Control and Prevention (CDC) international growth references.⁴⁰ Early researchers used these, and many other growth references for children and adolescents. All these methods have however been shown to have several drawbacks.^{22,31,35–37} Some of these drawbacks include the fact that the earlier growth references were developed from data from American children (all races) alone, and in fact some of the data were from only white middle class American children.³⁶

Furthermore, the growth references used arbitrary cut-off points (percentiles) to define under- and over-nutrition, and these had no scientific basis.^{37,68}

The drawbacks of the different reference curves led to the establishment of expert committees by the WHO and the International Obesity Taskforce (IOTF), which developed reference values that have become widely accepted. The two growth references by the WHO and IOTF used representative data of children and adolescents from different countries of the world.^{35,69} These two reference values have improved on most of the limitations and drawbacks of the earlier growth reference values, hence have been the more appropriate reference for the nutritional status of 5 to 19 years age group.^{35,37,67,70}

1.3 Correlates of the Nutritional Status of School-Aged Children and Adolescents

The correlates of the nutritional status of school-aged children and adolescents in Nigeria have not been the focus of most research efforts on the subject.^{28,52,54,71-75} The interest of most researchers in this field in Nigeria has been the assessment and description of the nutritional status, and only few have aimed to identify the most important correlates.^{13,16,25,76-78} Identifying the correlates is important, not only in improving the understanding about the subject, but especially in planning appropriate nutrition interventions for the children.

Most of the research efforts targeted at identifying the correlates of the nutritional status of school-aged children and adolescents have focused mainly at the individual (i.e. child) factors alone. A number of studies have studied and reported significant relationship between nutritional status and such factors as age and gender of the child,^{15,50,51,79} residence,^{62,80-82} physical activity^{43,83} and feeding patterns^{49,81,84} of the older children. However, little evidence exists in Nigeria about the relationship between the nutritional status and diet related factors such as household food security, dietary diversity and the dietary patterns of this group of children. Household food security refers to a household's access to sufficient quantity and quality of food,⁸⁵ dietary diversity assesses diet quality,⁸⁶ while dietary patterns describes the grouping of people based on the food or nutrient groups they usually consume.⁸⁷ These diet-related factors have been shown to be associated with under- and over-nutrition among school-aged children and adolescents,^{88,89} but very little data exists in this in Nigeria. The few existing studies^{60,90-94} that worked on the relationship between these diet-related factors and the nutritional status of school-aged children and/or adolescents have methodological limitations that make the comparison of the results difficult.

Furthermore, very little evidence could be found on the relationship between nutritional status of school-aged children and adolescents and the contextual units within which they live (i.e., household- and community-level factors). Understanding the contextual correlates of nutritional status would help in developing wholesome interventions to curb malnutrition among them. Multi-level modelling has been used to highlight the importance of the child's community to nutrition and survival of under-five children, but not those 6 – 19 years old in Nigeria.^{95,96} Highlighting the influence of contextual factors on both under- and over-nutrition among older children in Nigeria is important in designing effective and contextualized interventions for them.

Another important, yet under-studied correlate of the nutritional status of children is the perception and understanding of malnutrition by the parents. The understanding of mothers, especially, about malnutrition and the associated health risk have been shown to affect their child feeding practices.^{97,98} It has been found that mothers who perceived their children as overweight used food control and monitoring more.^{97,98} It has also been found that some mothers could not correctly classify the nutritional status of their children and hence would not know if or when to adopt appropriate measures.^{99–101} The information about the perception of mothers of older children in Nigeria would be important in designing and implementing nutrition interventions that work among these children.

Studies on maternal perception on under- or over-weight children or adolescents in Nigeria is very scarce. The few ones available used quantitative designs,^{102,103} which generally lack the ability to provide a deeper understanding of the perception, experiences and context of the study population. Also, the studies on cultural beliefs and their association with nutrition in Nigeria have targeted mainly pregnant women,^{104–106} with none found that was focused on cultural beliefs relating to the nutrition of school-aged children and adolescents in Nigeria.

Different studies on under- and/or over-nutrition and their determinants/correlates among children and adolescents have however been done in other countries. Qualitative studies from other countries on the perception of mothers on the nutrition or nutritional status of their children or adolescents have reported different gaps and misconceptions among the mothers. An important gap in knowledge that has been reported is the mothers' inability to correctly classify the nutritional status of their children or adolescents leading to misclassification of the nutritional status of such children.^{99–101} Other gaps include little knowledge about the use of growth reference charts by mothers and the love for moderately overweight or chubby children/adolescents by some mothers.¹⁰¹ Similarly, quantitative studies from other countries

have shown evidence for the double burden of malnutrition among children and/or adolescents,^{107–113} and associated factors including geographical regions,^{110,111} socio-economic factors,^{109,111} diet related factors^{109,114} and contextual factors.¹¹⁴

1.4 Theoretical and Conceptual Framework

1.4.1 Ecological systems theory

Ecological systems are the contextual factors within which individuals are nested.^{115,116} These ecological systems are the external influences that have been shown to affect the development of children within the family. However, only little data exist in the literature on the interplay of the different ecological systems on the nutritional status of children.¹¹⁷

Ecological systems theory (EST) was proposed by Bronfenbrenner as a model to be adopted in order to understand child nutrition processes.¹¹⁸ While the ecological systems theory recognizes the impact of the child's individual factors in affecting development, it conceptualizes that these factors are just one group out of many others.^{115,119} In the original work on the ecological systems theory, four different inter-related environments called micro-, meso, exo- and macro-systems, were pointed out. The micro-system is the most proximal level, followed by the meso-system, the exo-system and the macro-system levels in that order. While the most proximal levels reflect individual and intra-familial processes, the outermost system reflects the cultural, religious and socio-economic organization of the community.^{115,119}

The theory was later revised to bio-ecological systems theory to emphasize the important role the individual plays in the development process.¹¹⁶ It was hypothesized that human development was the result of the interplay among four processes which are the person, context, process and time. He explained “person” factors to mean individual characteristics, the “context” refers to the external factors described in the original work on the EST, the “process” refers to the interaction between the person and the context and this development must be understood with reference to “time”.^{116,119}

1.4.2 Conceptual framework

The conceptual framework for this study was adapted from the Food and Agricultural organization (FAO) and the Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS) Framework.¹²⁰ The framework depicts the interactions of different types and dimensions of factors, operating at different levels of affectation, and resulting ultimately in the

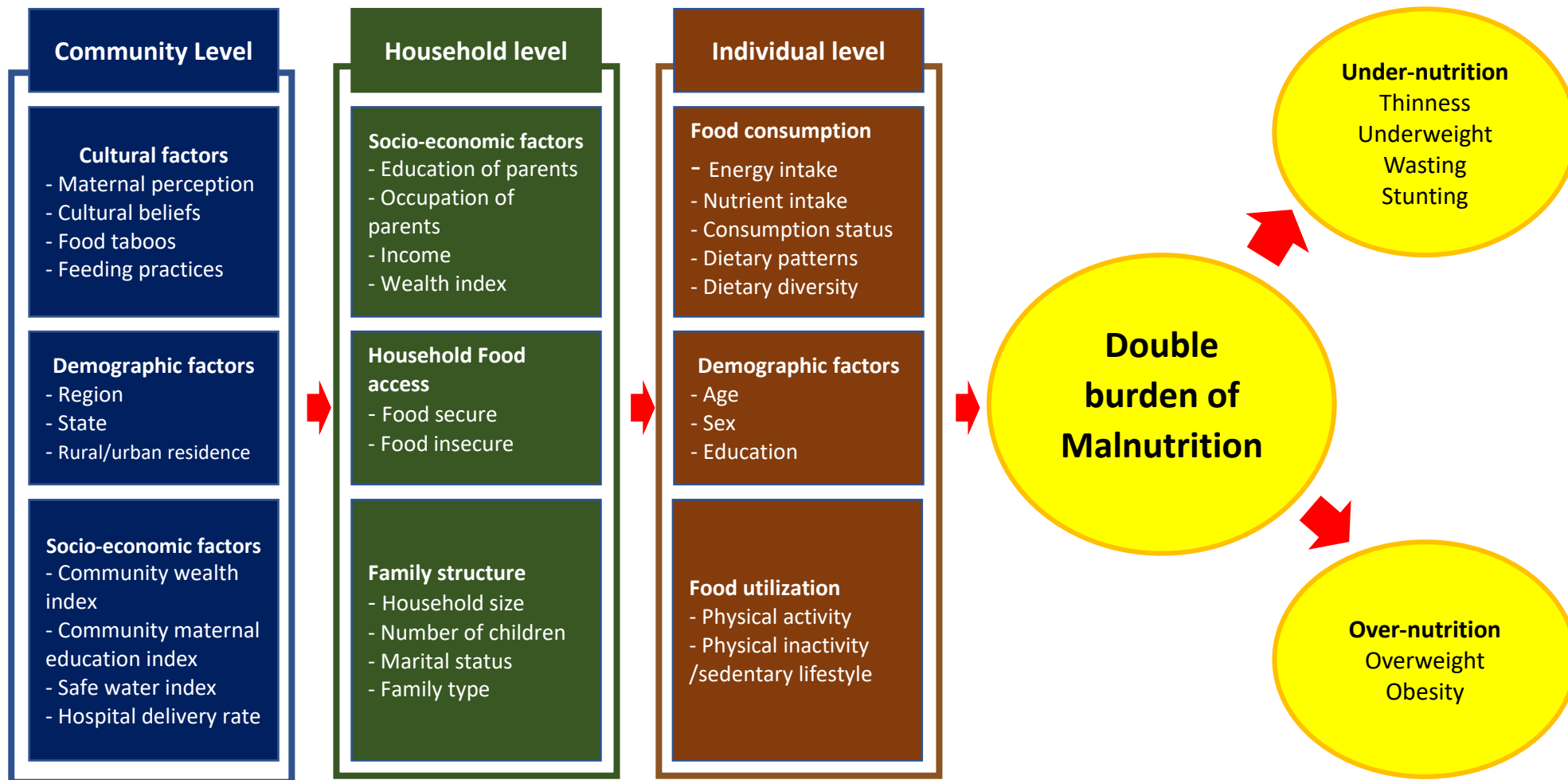


Figure 1.2: Conceptual framework adapted from the Food and Agricultural organization (FAO) and Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS) framework

nutritional status.^{120,121} This conceptual framework was used for the present study because it models the concept that the nutritional status of a child is determined by a complex interplay of different levels of contextual factors (i.e. individual, household and community factors), as expressed by the objectives of this study.

1.5 Research Gap and Justification for the Study

School aged-children and adolescents form a substantial portion of the population, and hence their health should be given great consideration. According to UNICEF, school-aged children and adolescents form about 22% of the current world population, which in actual numbers is nearly 2 billion.¹² The Nigerian story is even more graphic; the most recent National census showed that school-aged children and adolescents formed 36.35% (51,040,749) of the entire population of 140,431,790.¹²² UNICEF in the 2019 state of the world children (SOWC) estimates school-aged children and adolescents (6 – 18 years) in Nigeria to be more than 65 million.¹²³ The health of this substantial proportion of the population should therefore be of great concern to all stakeholders. However, while much emphasis has been on under-five children, not much emphasis has been on school-aged children and adolescents in terms of nutritional surveys and interventions.¹²⁴ This is corroborated by Nigeria Health and Demographic survey (NDHS) data reporting the nutritional status of under-five children, but not school-aged children and adolescents.¹²⁵ Additionally, the Lancet series on adolescent nutrition also reports that the nutritional health of adolescents has been overlooked by many National governments and non-governmental organizations.¹²⁶

In Nigeria, there is no nationally representative data on the burden, distribution and determinants of the nutritional status of school age children and adolescents.³² Although, some studies have been done on the subject, but these studies have limited usefulness for various reasons. First of all, the Nigeria Demographic and Health Survey (NDHS), the Multiple Indicator Cluster Survey (MICS) and the Nutrition and Health Survey, which all have nationally representative data on the nutritional status of children in Nigeria include only under-five children.^{125,127,128} There is no other nationally representative survey available for the nutritional status of school-aged children and adolescents in Nigeria.^{32,34} Secondly, generalizing the findings from existing studies in Nigeria has been difficult because of the different methodological approaches of the studies.^{2,32} Another challenge with the existing data is the different criteria used to define the nutritional status of school-aged children and adolescents.^{32,33}

Another reason why the existing data in Nigeria has limited usefulness is the geographical imbalance in the study locations, with most studies focusing on richer areas of the country. Most of the existing studies have been done in the urban areas and in the Southern part of Nigeria, while majority of Nigerians live in rural areas and in the Northern part of the country.^{122,129} This is corroborated by a systematic review in Nigeria which found that only 14% and 24% of the existing studies on nutritional status of children were carried out in rural and northern parts of Nigeria respectively.³² More than half of the studies included in the systematic review were in the south-west geo-political zone alone (which is just one of the six geo-political zones in Nigeria), with the north-east contributing just 2% of the total study population.³² Similar to this is the narrow and restricted geographical spread of the existing studies. Most of the existing studies were carried out in just one town/city/village,^{13,71,72,76,130–133} very few at State level,^{26,29,53,81,84,134,135} and none crossed a geo-political zone.³²

Furthermore, nearly all of the existing studies in Nigeria have been school-based studies. The problem with this is that a particular demography of out-of-school children, especially those from poor and disadvantaged backgrounds has been excluded. Additionally, the data that can be collected from such studies is limited. This may explain why the focus has mainly been on individual factors (e.g. age and sex), and very little on contextual factors like the household and community factors as determinants. There is growing evidence of transgenerational risk from obese mothers to their offspring,¹³⁶ for instance, and other associations with family/household and community factors, and it is important that these associations be explored in the Nigerian context.

1.6.1 Impact and policy implications

The lack of adequate data on the nutritional status of school-aged children and adolescents in Nigeria has global implications, because nearly 5% of the school-aged children and adolescents in the world are Nigerians.¹³⁷ This problem is part of a wider problem in sub-Saharan Africa (SSA) where more than 20% school-aged children and adolescents live,¹³⁷ and yet generally lacks nationally representative data on this group of children.^{2,22,31,32,37} This dearth of nationally representative data in SSA may be the reason why it is believed that the prevalence of childhood overweight/obesity is low in SSA,^{22,31} and this may not necessarily be so.

Nigeria, and indeed SSA is usually poorly represented in international researches or considerations that require nationally representative data. In developing an international growth reference for children and adolescents by the IOTF for example, data from Nigeria, and all SSA

was not included because no nationally representative data with large enough sample size could be found.³⁷ Also when studying worldwide trends in overweight and obesity among children, estimates of projected prevalence rates could not be made for Africa because of insufficient data. This lack of nationally representative data has made studying the trend of the nutritional status of school-aged children and adolescents in SSA very challenging.^{2,22,31,33} This knowledge gap in Nigeria and SSA will also make understanding international trends and comparisons very difficult.

Planning appropriate nutrition intervention programmes for school-aged children and adolescents in Nigeria by policy makers without nationally representative and reliable data will therefore be difficult or even impossible. This may be the reason why there has not been a significant improvement in the nutritional status of children in Nigeria, despite the various intervention programmes by governmental and non-governmental organizations over the years.^{125,127,138,139} Understanding the magnitude of the problem, and its distribution according to who is affected and where they live is fundamental to planning appropriate public health interventions.¹⁴⁰

A recent example of a nutrition intervention programme for Nigerian children is the home grown feeding programme. The federal government of Nigeria and some state governments are investing heavily in the feeding of school children with one meal per day.¹⁴¹ The planning and implementation of the programme was however not informed by appropriate data on the nutritional status and needs of the children. While the investment in school feeding programme is good and laudable, evaluation of its effectiveness and contribution to the improving the health and nutritional status of school-going children will be difficult.^{140,141} There is yet no scientific evaluation of the effectiveness of the programme that has been done so far, and this is because of the lack of representative data either at the state or national levels.

A major barrier to obtaining representative data is that the nutritional health of school-aged children and adolescents has been overlooked by government and non-government organizations.¹²⁶ A major way of overcoming this is by drawing attention to the issues/challenges with school-aged children/adolescent nutrition, as were the objectives of this study. This study therefore aimed to provide information on the perception of mothers and the cultural beliefs about the concept, causes and community experience of under- and over-nutrition, to determine the prevalence rates of the various indicators of under- and over-nutrition and establish the existence of the double burden of malnutrition. Additionally, the study aimed to identify

individual (including household and diet-related factors) and contextual factors associated with the DBM among school-aged children and adolescents in the selected states.

1.8 Research Questions

1. What are the mothers' perceptions and cultural beliefs about the concept, causes, and community experience of under- and over-weight children and adolescents in two Nigerian States?
2. What are the prevalence rates and distribution of underweight, stunting, thinness, overweight/obesity, and do these indicate the DBM among school-aged children and adolescents in two Nigerian States?
3. What are the individual and contextual determinants of under- and over-nutrition among school-aged children and adolescents in two Nigerian States?

1.9 Objectives

1. To explore mothers' perceptions and cultural beliefs about the concept, causes, and community experience of under- and over-weight children and adolescents in two Nigerian States;
2. To estimate the prevalence rates and distribution of underweight, stunting, thinness, overweight/obesity, and establish the existence of DBM among school-aged children and adolescents in two Nigerian States; and
3. To identify individual (including household and diet-related factors) and contextual factors associated with under- and over-nutrition among school-aged children and adolescents in two Nigerian States.

CHAPTER TWO: Methodology

2.1 Study Setting

The study was carried out in two randomly selected States from the Federal Republic of Nigeria, which is usually just referred to as Nigeria. Nigeria is a west African country which lies between latitudes 4°16' and 13°53' north and longitudes 2°40' and 14°41' east. It occupies approximately 923,768 square kilometers of land extending from the Gulf of Guinea on the Atlantic coast in the south to the fringes of the Sahara Desert in the North. Nigeria shares boundaries with Benin Republic in the west, Chad and Cameroon in the east, and Niger in the north. Its coast in the south lies on the Gulf of Guinea in the Atlantic Ocean. Nigeria is the most populous country in Africa, with a population of 140,431,790 according to the 2006 census,¹²² but new projections put Nigeria population at 211.4 million.¹⁴² According to recent data from the World Bank, 48% of Nigerians live in rural communities, while the remaining 52% live in urban communities.¹⁴³

Nigeria has a tropical climate with wet and dry seasons. Its climate is influenced by the rain-bearing southwesterly winds and the cold, dry, and dusty northeasterly winds, commonly referred to as the Harmattan. The dry season occurs from October to March with a spell of cool, dry, and dusty Harmattan wind felt mostly in the north in December and January. The wet season occurs from April to September. The temperature in Nigeria oscillates between 25°C and 40°C, and rainfall ranges from 2,650 millimeters in the southeast to less than 600 millimeters in some parts of the north, mainly on the fringes of the Sahara Desert. The vegetation that results from these climatic differences consists of mangrove swamp forest in the Niger Delta and Sahel grassland in the north. With its variety of climatic, vegetation, and soil conditions, Nigeria possesses the potential for growing a wide range of agricultural produce.

Nigeria became fully independent in October 1960 as a federation of three regions (Northern, Western, and Eastern) under a constitution that provided for a parliamentary system of governance. The Lagos area became the Federal Capital Territory (FCT). Nigeria became a republic on October 1, 1963, with different administrative structures. Later, the FCT was moved to Abuja where it remains till today. Within the boundaries of Nigeria are many social groups with distinct cultural traits; there are about 374 identifiable ethnic groups, with the Hausa, Yoruba, Fulani and Igbo as the major groups.

Nigeria has 36 states with the Capital, Federal Capital Territory, and it is divided broadly into the Southern and Northern parts with 6 geo-political zones; 3 zones in the North and 3 in the South. The geo-political zones in are North-Central/Middle belt (with Benue, Kogi, Kwara,

Nasarawa, Niger and Plateau states, and the Federal Capital Territory), North-East (Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe states), North-West (Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto and Zamfara states), South-East (Abia, Anambra, Ebonyi, Enugu and Imo states), South-South (Akwa-Ibom, Cross-River, Bayelsa, Rivers, Delta and Edo states) and South-West (Ekiti, Lagos, Ogun, Ondo, Osun and Oyo states). Each State has three senatorial districts and there are 774 constitutionally recognized local government areas (LGAs) in the country.

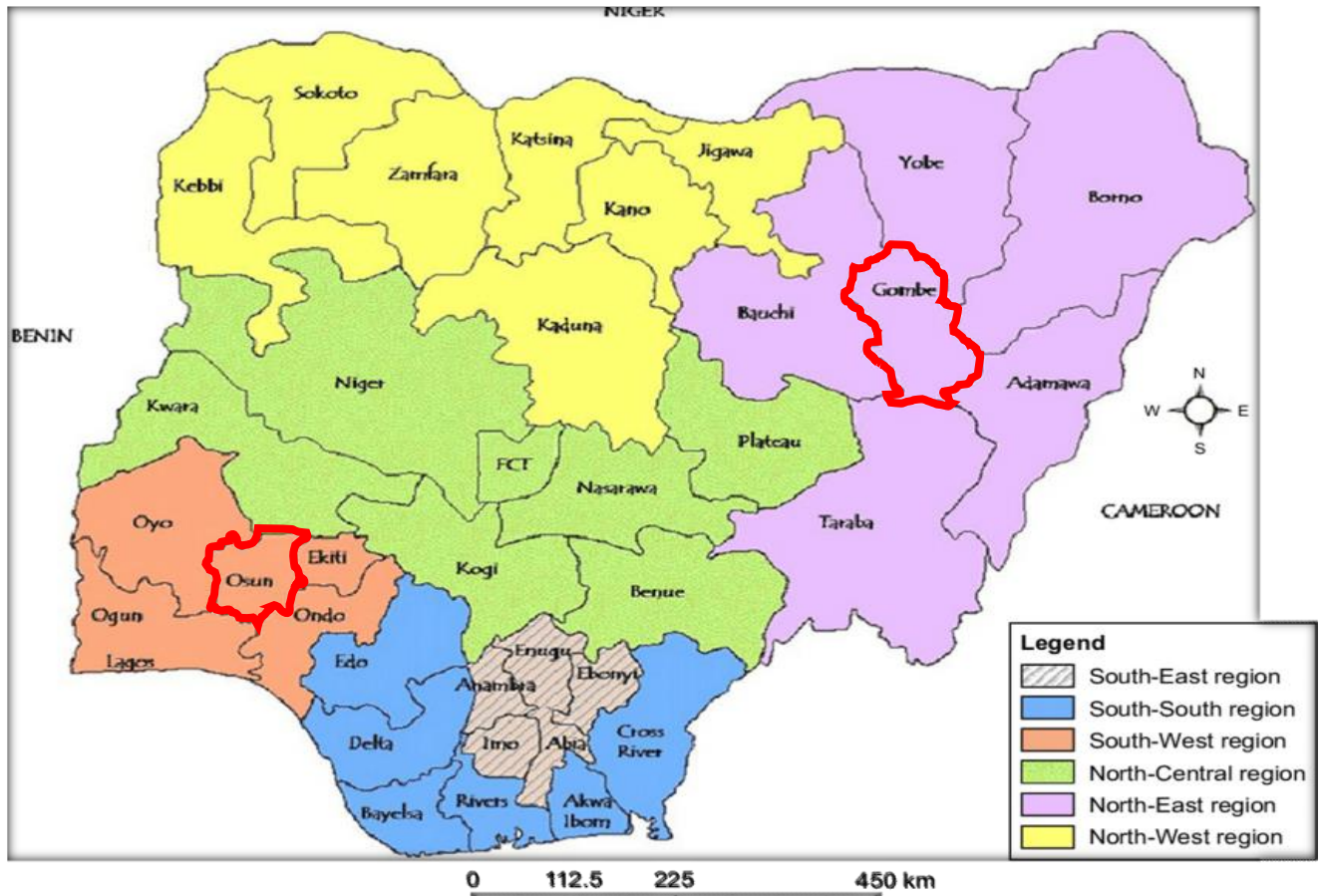


Figure 2.1: Map of Nigeria showing the geo-political zones, with Gombe and Osun States highlighted

2.2 Study Design

This was a mixed methods study, using the exploratory sequential design. It was a two-phased design, involving the collection of qualitative data using focus group discussion (FGDs) (phase 1) and a quantitative cross-sectional study (phase 2). Rapid analysis of the transcripts from the qualitative data was done to generate the main themes and sub-themes which helped to inform the development of some sections of the questionnaire used for quantitative data collection. The second phase was the quantitative data collection and analysis. Combining the quantitative and

qualitative methods for this study is important because the results of the qualitative study helped to explore aspects of the possible community and cultural factors that may affect the nutritional status of children, so as to inform the design of the quantitative instrument. Combining the methods also helped to provide a more holistic perspective to a complex problem like the double burden of malnutrition, and this is important in designing appropriate and effective nutrition interventions for addressing the problem.

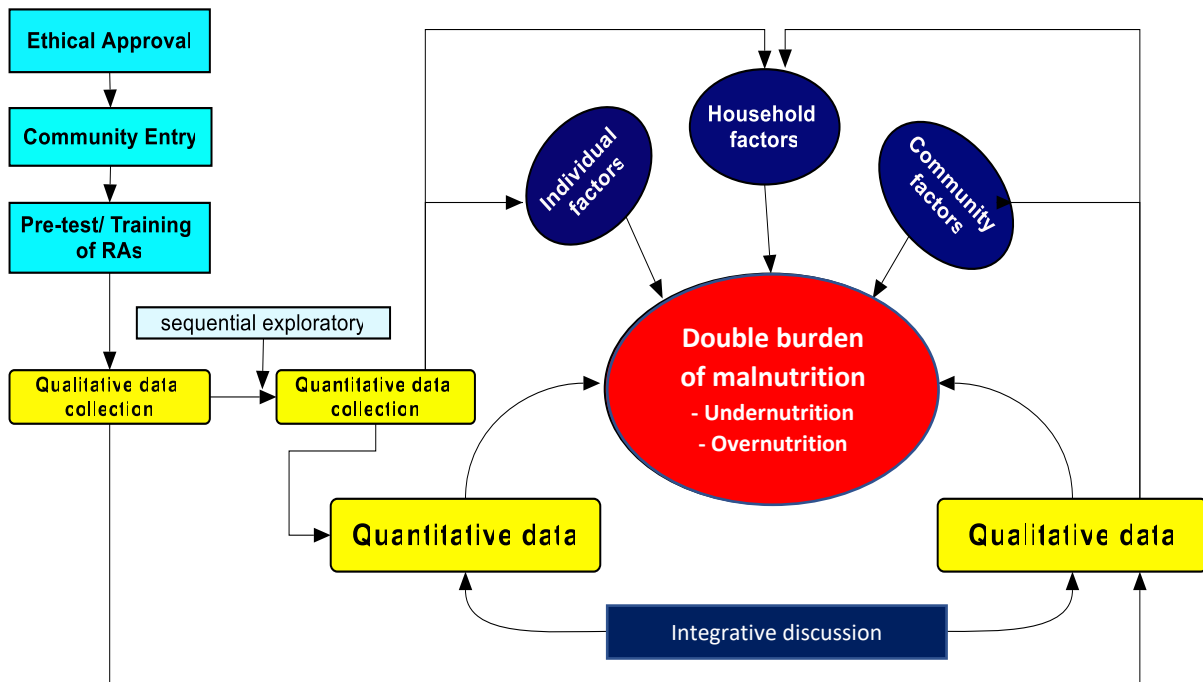


Figure 2.2: Flow chart for the study

2.3 Qualitative Study

2.3.1 Study population

The study population for the qualitative study were mothers of children 6 – 19 years, living in the selected communities. The inclusion criteria included that they were usually resident in the area, currently had a child between 6 and 19 years of age, had no speech or hearing defect, were at least averagely expressive and also gave consent.

2.3.2 Sample size

A total of 8 focus group discussion (FGD) sessions were held, and this was determined by the time data saturation was reached. Four FGD sessions were held in each of the selected States,

with a minimum of one in each LGA. Each FGD session consisted of 8 to 10 discussants, and there were a total of 76 women who participated in the 8 FGDs.

2.3.3 Sampling technique

The discussants for the FGD sessions were selected purposively from the women in the community who met the inclusion criteria. These communities were the same communities used for the quantitative aspect of the present study, and were selected using multi-stage sampling technique. Details of the multi-stage sampling technique are explained in section 2.4.3 below, under the quantitative study. One community (enumeration area) was randomly selected among the five enumeration areas selected in each ward, making a total of eight communities from the eight selected wards in the two states. The women leaders in each of the communities were approached and briefed about the study and the required study population. The women leaders then led the candidate (or designated trained research assistant) to the houses of women who had children between 6 to 19 years of age. The candidate (or the designated trained research assistant) had very brief discussions with the women, and the women who freely provided information with little or no promptings were considered “expressive” or “averagely expressive” as the case may be. Eight to ten women were then purposively selected from each community based on the inclusion criteria. The study was explained to focus group discussants, and their questions about the study were addressed. Those who consented were then included in the FGDs.

2.3.4 Data collection and analysis

The FGD guide (Appendix 6) was used for qualitative data collection for the FGD sessions. Qualitative data were collected before the collection of the quantitative data and this was so as to give insight into possible cultural and child feeding practices that could affect the nutritional status of the children. Each FGD session was conducted within a timeframe of 90 to 120 minutes, with 8 – 10 discussants per group using a pre-prepared FGD guide (Appendix 6). The sessions were moderated by the researcher (Ph.D. candidate) and recorded on tape after seeking the consent of the discussants to do so. The supervisors for each of the States were trained as note takers for the FGD sessions. The venues for the FGDs were places that provided comfortable sitting and privacy, and with little or no disturbances, and they varied from community to community. The recordings were initially transcribed verbatim analyzed using NVivo version 11 software (QSR International Pty Ltd, Doncaster, Australia). Direct quotations from the discussants that most clearly represent each theme were chosen to be included in the manuscript in italics.

2.4 Quantitative Study

2.4.1 Study population

School-aged children, adolescents and their mothers living in the selected communities formed the study population for the quantitative aspect of the present study. School-aged children are usually defined as those 6 to 11 years of age,¹⁴⁴ or 5 to 14 years,¹⁴⁵ while adolescents are those from 10 – 19 years of age.¹⁴⁵ In the present study, school-aged children and adolescents are taken as those from 6 to 19 years of age. Households were picked from rural and urban communities in two Nigerian states (one each from Northern and Southern Nigeria).

Inclusion criteria: Children and adolescents, within the age range of 6 and 19 years as at the time of data collection, and residing within the selected study areas were included in the study. The mothers of the selected school-aged children and adolescents were also included in the study.

Exclusion criteria: The exclusion criteria included;

- Children and adolescents within the age range of 6 and 19 years with chronic diseases that can affect their weight (like sickle cell diseases and cancers). These clarifications were made by the past medical history obtained from the mothers/care-givers.
- Acutely ill children or those on hospital admission, and those with disabilities that made them unable to stand were excluded.
- Those not usual residents of the selected communities were also excluded from the study. Children of other Nationalities living in the selected areas were excluded from the study.
- Children whose mothers were not available even after a revisit on another day during the time of the survey
- Lagos and Kano States were excluded because they are highly cosmopolitan, with high proportion of people from different parts of the country.
- Borno, Yobe, Zamfara, Kaduna and Plateau States were excluded because of security issues.

2.4.2 Sample size determination

The sample size was calculated to get an absolute precision of $\pm 5\%$ using STATCALC on the Epi-Info software. The variables used include;

Proportion of expected outcome	=	33% (0.33)
Design effect	=	1.5
Acceptable margin of error	=	5%

Calculated sample size = 510

The prevalence of stunting among Nigerian children according to UNICEF (33%)¹² was used as the expected outcome. The design effect is the increase of sample size because of the hierarchical sampling model, which was taken as 1.5 for this study. After correcting for an anticipated non-response rate of 10%, the sample size came to 561 and was rounded off to 600. This sample size was doubled to give a total of 1,200 (i.e. 600 for each state) so that the findings can be generalized to the states.

2.4.3 Sampling technique

The respondents for the quantitative aspect of the present study were selected using multi-stage sampling.

2.4.3.1 First stage: Selection of two (2) states in Nigeria; one in the North and one in the South

Firstly, the geo-political zones with the lowest and highest wealth index, as published by the NDHS,¹²⁵ were selected, and these were the North-east and South-west zones respectively. Subsequently, one out of the six states in each of the selected geo-political zones (i.e. North-East and South-West) was selected using simple random sampling technique (Balloting method). Gombe and Osun States were selected from the North-eastern and South-western parts of the country respectively.

2.4.3.2 Second stage: Selection of Local Government Areas

The lists of all the local government areas (LGAs), according to their groupings into rural and urban LGAs were obtained from the Local Government Commissions of the selected states. Two LGAs each were selected from the 2 selected States (one from rural and one from urban LGAs) using simple random sampling technique (Balloting method). This gave a total of 4 LGAs; 2 LGAs per State.

2.4.3.3 Third Stage: Selection of wards

The lists of the wards in each of the selected LGAs were obtained from the headquarters of the respective LGAs. From the lists, two (2) wards each were selected from each LGA using simple random sampling technique (balloting method). This gave a total of 8 wards; 4 per State.

2.4.3.4 Fourth stage: Selection of enumeration areas

In each of the selected Wards, enumeration areas (EAs) as demarcated by the National Population Commission for 2006 population census were used as the primary sampling units.

Five (5) EAs were selected in each of the selected wards using systematic random sampling, giving a total of 40 EAs from the 8 selected wards in both States.

2.4.3.5 Fifth stage: Selection of households

After mapping and listing the households in the EAs, thirty (30) households were drawn in each of the selected EAs using systematic sampling technique.

2.4.3.6 Sixth stage: Selection of respondents

At the household level, one school-age child or adolescent who met the inclusion criteria was included in the study. If a household had more than one school-aged child or adolescent who met the inclusion criteria, one was randomly selected from all the children and/or adolescents such that not more than one school-aged child or adolescent was selected from each household. This is because children within the same household would have very similar exposures, especially at this level and it may confound the associations at this level. The mother-child pair was then interviewed.

2.4.4 Research Instruments

2.4.4.1 Questionnaire

The quantitative data were collected using a structured questionnaire on general characteristics, diet, physical activity of the child and information on the family and household characteristics (Appendix 5). The questionnaire was also translated to the native languages of the different study locations (Yoruba and Hausa languages) and back translated to English by Ph.D. students in the Department of Nigerian Languages in Obafemi Awolowo University, Ile-Ife, Nigeria. The back translation was to ensure the original meaning was intact. The questionnaire had the following sections;

Section A: General characteristics of the child: The section was adapted from the NDHS.¹²⁵ These included demographic characteristics of the child and other questions about health related history of the child including place of birth, breastfeeding, immunization status etc. Puberty staging was assessed using the Tanner 5-point pubertal self-rating scale,¹⁴⁶ (Figure 2.3) which had been used in the similar age group in Nigeria.¹⁴⁷

Section B: Food consumption of the child: Food consumption was assessed using a 30-day food frequency questionnaire (FFQ) consisting of 92 different food items. The FFQ was adapted from the one used among school-aged children in Ghana¹⁴⁸ and further modified after pre-testing

the research instrument. Dietary diversity was assessed using fourteen (14) food groups,⁸⁶ by use of a 24-hour dietary recall.

Section C: Activity patterns of the child: This was assessed using the physical activity questionnaire for older children and adolescents by Kowalski et al¹⁴⁹, which has been validated and used among similar age group in Nigeria.¹⁵⁰

Section D: Household/family characteristics: Some items in this section were adapted from the NDHS.¹²⁵ The Household food security was assessed using the household Food Insecurity Access Scale (HFIAS).¹⁵¹

Section E: Anthropometric measurements: The weight and height of the school-aged children and adolescents, and their mothers were measured, and used to assess the nutritional status of the respondents and their mothers.

2.4.4.2 Instruments for anthropometric measurement

A OMRON digital bathroom weighing scale (Intellisense technology, Japan) was used for measuring weight in 0.1 kilograms (kg). Height was measured to the nearest 0.1 meter using the stadiometer (Leceister® Height Measure, Seca, UK).

2.4.4.3 Pre-testing of research instruments

Research instruments were pre-tested with 5% (60) of the sample size in communities outside of the selected ones, but within the selected States. This was done to detect difficult or ambiguous questions, verify the duration to complete the questionnaires, build confidence in data collectors and also to uncover possible problems in the field procedure.

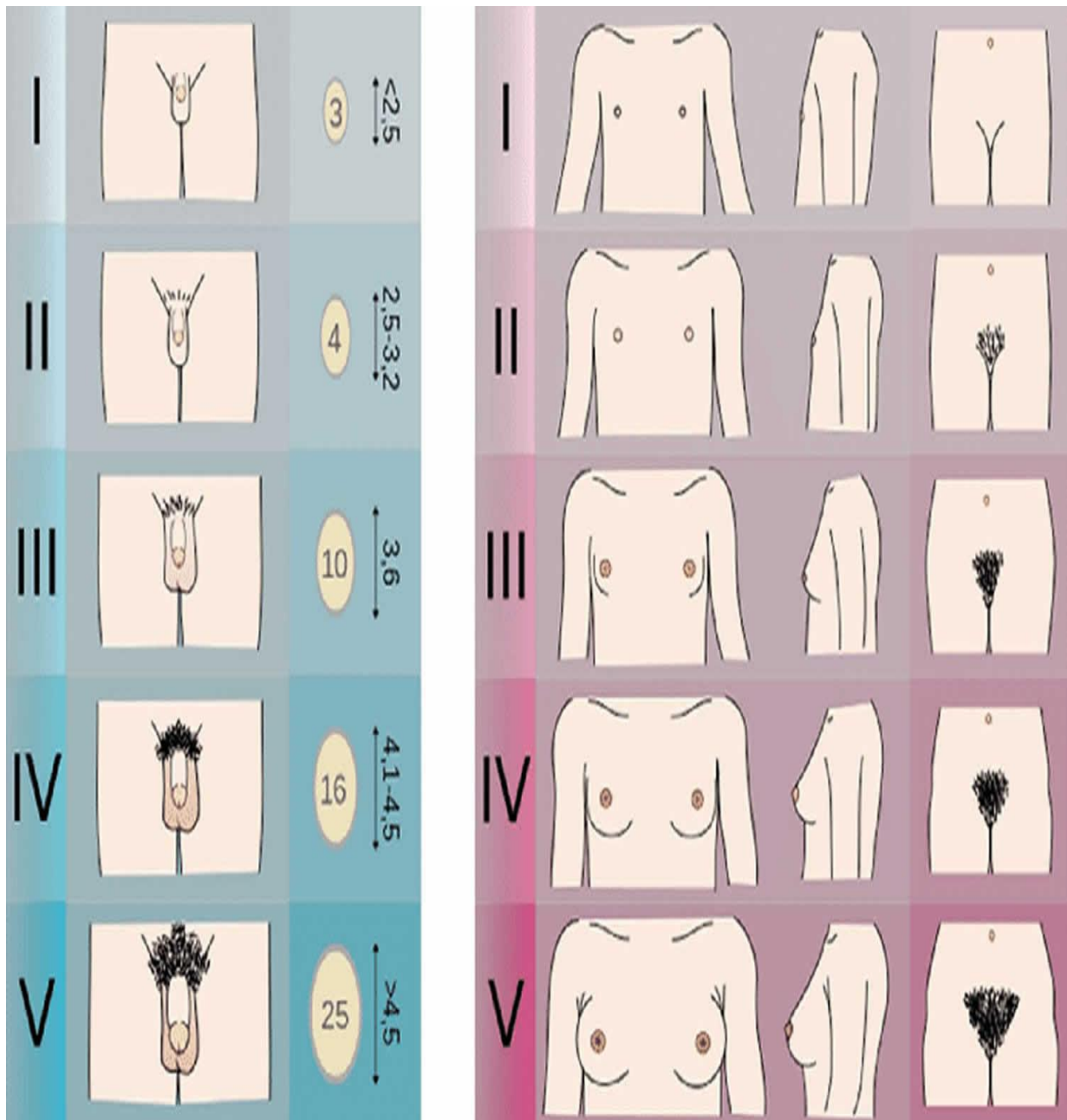


Figure 2.3: Tanner stages¹⁴⁶

Children/adolescents were given above chart to choose which stage best corresponds to their experience as touching the genitalia and pubis hair for boys, breasts and pubic hair for females.

Table 2.1: Matrix showing the instrument of data collection and measurement of specific objectives of the study

	Specific Objectives	Questionnaire	FGD guide	Weighing scale	Stadiometer	HFIAS	FFQ	14-food DD scale
1	To explore mothers' perceptions and cultural practices relating to under- and over-weight children and adolescents in two Nigerian States		X					
2	To estimate the prevalence and distribution of underweight, stunting, thinness, overweight/obesity, and the existence of DBM among school-aged children and adolescents in two Nigerian States	X		X	X			
3	To identify individual (including household and diet-related factors) and contextual factors that are associated with under- and over-nutrition among school-aged children and adolescents in two Nigerian States	X		X	X	X	X	X

FGD – focus group discussion; HFIAS – household food insecurity access scale; FFQ – food frequency questionnaire; DD – dietary diversity

2.4.5 Data Collection Methods

2.4.5.1 Recruitment and training of research assistants

Ten research assistants (five males and five females) and one field supervisor were recruited and trained in each of the selected States. They were people with background in health sciences and sufficient experience in studies of this nature. They were fluent in both the native (Yoruba or Hausa language) and English languages, and they were very familiar with the terrain of the study locations. The research assistants in each of the selected states were trained for five days (for two hours daily) by the principal researcher (Ph.D. candidate). They were introduced to the research concept, issue of confidentiality, objectives and the instruments. The meaning and

measurement of every item on the instrument were properly explained to the research assistants. Training methods included training sessions, role plays, questions and answers and field trials. After the training, measurements were taken by the researcher and each of the research assistants on the same set of subjects to ensure minimal or no inter-tester and intra-tester errors. This exercise was repeated at intervals during the entire study to further assure strict quality control.

2.4.5.2 Data collection with the questionnaire

The questionnaires were administered with RedCap¹⁵² on tablets using interviewer method. The respondents were school-aged children and adolescents, and their mothers in selected households. The mothers were the respondents for the sections on general characteristics of the child and household/family characteristics. The school-aged children or adolescents responded to the sections on the dietary patterns, pubertal staging, 24-hour dietary recall and physical activity patterns of the child.

2.4.5.3 Anthropometric data collection

The anthropometric measurements of the child or adolescent and the mother were taken according to standard protocols recommended by the International Society for the Advancement of Kinanthropometry.¹⁵³ Every morning before taking measurements, the weighing scales were standardized using known weights.

2.4.6 Dependent and independent variables

The primary outcome/dependent variable is the Nutritional status, which was assessed using the BMI-for-age reference, of the WHO growth reference.³⁵ It was categorized into (1) thinness (2) normal (3) overweight/obese for bivariate and multinomial analysis. For the multilevel analysis, two separate analyses were done for under-nutrition and over-nutrition. The dependent variables were expressed as binary outcomes which were (1) thinness (0) otherwise, and (1) overweight/obesity (0) otherwise. Hence, the two-level multilevel binary logistic regression analyses were done to identify the contextual determinants for both under- and over-nutrition. The variables used were selected after a careful review of relevant literature, and are as listed in Table 2.2 below.

Table 2.2 Definitions for independent variables

Independent Variables	Description
Individual level factors	
Child factors	
Age of child (years)	Expressed as a continuous variable
Sex of child	Categorized into (1) male (2) female
Birth order	Categorized into (1) 1 (2) 2 – 4 (3) > 4
Education	Categorized into (1) currently in school (2) previously in school (3) never in school
Birth weight	Categorized into (1) low < 2.5kg (2) normal 2.5 – 4 kg (3) > 4 kg
Breastfeeding duration	Expressed as a continuous variable (months)
Immunization status	Categorized into (1) complete (0) incomplete
Birth place	Categorized into (1) others (2) hospital
Exclusively breastfeeding	Categorized into (1) yes (0) no
Puberty stage	Categorized into stages 1 to 5 using Tanner staging
Dietary and Activity patterns	
Dietary diversity	Expressed as continuous variable (scores)
Dietary pattern 1	Categorized into quartiles (Q1,2,3 and 4)
Dietary pattern 2	Categorized into quartiles (Q1,2,3 and 4)
Sleeping time	Expressed as continuous variable
Screen time	Expressed as continuous variable (hours)
Physical activity scores	Expressed as continuous variable (scores)
Household/family factors	
Household size	Expressed as continuous variable
Number of children	Expressed as continuous variable
Maternal age	Expressed as continuous variable (in years)
Household wealth index	Categorized into (1) poorest (2) poorer (3) middle (4) richer (5) richest
Ethnicity	Categorized into (1) Yoruba (2) Igbo (3) Hausa (4) Fulani (5) minorities
Marital status	Categorized into (1) single (2) married (3) previously married
Family type	Categorized into (1) monogamous (2) polygamous
HFIA categories	Categorized into (1) food secure (2) mildly food insecure (3) moderately food insecure (4) severely food insecure
Maternal education	Categorized into (1) less than secondary (2) secondary or more
Mother's unemployment	Categorized into (1) employed (2) unemployed
Mother's BMI	Categorized into (1) underweight (2) normal (3) overweight/obesity
Community level factors	
State	Categorized into (1) Osun (2) Gombe
Residence	Categorized into (1) rural (2) urban
Community poverty level	Categorized into (1) low (2) high
Community maternal education level	Proportion of women who had a minimum of secondary education in each community was used to categorize them into (1) low (2) high, depending on the median value
Community hospital delivery level	Proportion of children who were delivered in the hospital in each of the communities was used to categorized them into (1) low (2) high, depending on the median value
Safe water	Categorized into (1) low (2) high

2.4.7 Measurement of variables

2.4.7.1 Nutritional status of school-aged children and adolescents and their parents

The nutritional status of the school-aged children and adolescents was assessed with the WHO (2007 reference),³⁵ using the body mass index (BMI)-for-age, weight-for-age and height-for-age reference values.

For the BMI-for-age reference values, the BMI was first calculated by dividing the weight in kg by the height in m² (i.e. BMI = kg/m²), and the BMI of the school-aged children and adolescents were read across the age of the child on the BMI-for-age reference tables for ages 5 to 19 years as published by the WHO³⁵ to get the z-scores. The z-scores derived from the BMI-for-age reference tables were then used to define the different indicators as follows;³⁵

Thinness	-	< -2 standard deviation (SD)
Normal	-	≥ -2 SD to ≤ +1 SD
Overweight	-	> +1 SD to +2 SD
Obesity	-	> +2 SD

Weight-for-age (WFA) z-scores were used to define underweight as follows:

Severe underweight	-	< -3 SD
Moderate underweight	-	< -2 SD to -3 SD
Underweight (moderate and severe)	-	< -2 SD
Normal	-	≥ -2 SD to ≤ +2 SD

Height-for-age (HFA) z-scores were used to define stunting as follows;

Severe stunting	-	< -3 SD
Moderate stunting	-	< -2 SD to -3 SD
Stunted (moderate and severe)	-	< -2 SD
Normal	-	≥ -2 SD to ≤ +2 SD

The nutritional status of the mothers was assessed using the BMI (i.e. weight in kg by the height in m²), which were categorized using the WHO classification¹⁵⁴ into underweight (less than 18.5 kg/m²), normal (18.5 kg/m² to 24.9 kg/m²), overweight (25.0 kg/m² to 29.9 kg/m²) and obesity (30.0 kg/m² and above).

2.4.7.2 Dietary diversity

Dietary diversity was assessed using dietary diversity scores (DDS).⁸⁶ A scale of fourteen (14) food groups which includes cereals, vitamin A vegetables and tubers, white tubers, dark green

leafy vegetables, other vegetables, vitamin A fruits, other fruits, organ meat, flesh meat, egg, fish, legumes/nuts/seeds, milk/milk products and oils/fats; was used in assessing the DDS for each of the children and adolescents.^{86,93} A one-time 24-hour dietary recall was done, where the child/adolescent recalled all food and drinks taken in the last 24 hours preceding data collection. Using the information collected from the 24-hour dietary recall, a point was awarded to each food group consumed, and the sum of all the points awarded was the DDS for each child. Hence the DDS ranged from a minimum of 0 (if no food from the 14 food groups was consumed) and 14 (if food from all 14 food groups were consumed).

2.4.7.3 Activity patterns of the respondents

This was assessed using the physical activity questionnaire for older children and adolescents by Kowalski et al.¹⁴⁹ The responses to each item were scored from 1 to 5. The mean of all the variables was calculated, so that a composite score of 1 to 5 was derived for them. The higher the score, the more active the child/adolescent was, with 1 representing the option with least or no activity and 5 being the option with most activity.

2.4.7.4 Household food insecurity

Household food security was measured using the household Food Insecurity Access Scale (HFIAS).¹⁵¹ The HFIAS has nine (9) occurrence questions with a recall period of four weeks (30 days), and these are followed by three frequency-of-occurrence questions to determine whether the condition happened rarely (once or twice), sometimes (three to ten times) or often (more than ten times) in the past four weeks. A response of “No” to the occurrence questions will be scored 0, while rarely, sometimes and often will be scored 1, 2 and 3 respectively. The household food security scores ranged from 0 (minimum) to 27 (maximum). The households were categorized into four groups as shown below;¹⁵¹

Food secure: if [(Q1a=0 or Q1a=1) and Q2=0 and Q3=0 and Q4=0 and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]

Mildly food insecure: if [(Q1a=2 or Q1a=3 or Q2a=1 or Q2a=2 or Q2a=3 or Q3a=1 or Q4a=1) and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]

Moderately food insecure: if [(Q3a=2 or Q3a=3 or Q4a=2 or Q4a=3 or Q5a=1 or Q5a=2 or Q6a=1 or Q6a=2) and Q7=0 and Q8=0 and Q9=0]

Severely Food insecure: if [Q5a=3 or Q6a=3 or Q7a=1 or Q7a=2 or Q7a=3 or Q8a=1 or Q8a=2 or Q8a=3 or Q9a=1 or Q9a=2 or Q9a=3]

For inferential statistics, the four categories were re-categorized into two; food secure and food insecure. The food secure and mildly food insecure were re-categorized as food secure, while the moderately and severely food insecure were re-categorized as food insecure.

2.4.7.5 Household wealth index

Household wealth index was calculated using ownership of some household possessions, as it was used by the NDHS.¹²⁵ Possession of different household assets was scored and used to generate wealth scores for the households. Principal component analysis was used to produce a common factor score (also known as wealth index score) for each household. The scores were divided into quintiles to categorize the households into poorest, poorer, middle, richer and richest households for the smallest to the highest wealth index score respectively. For inferential statistics, the scores categorized into 3; poor, middle and rich for the households with the lowest to the highest wealth index score respectively. The proportion of households in the community that belonged to the lowest quintile was obtained and used to divide the communities into those with low and high poverty levels.

2.4.7.6 Dietary patterns

Information on the frequency of consumption of 92 different food types from 15 food groups including cereals and grain products, starchy fruits, roots and tubers, grain legumes and products, nuts and seeds, vegetables and products, fruits, sugars and syrups, meat and poultry, egg and products, fish and products, milk and milk products, fats and oils, condiments and spices, sweetened drinks and desserts and snacks was assessed by FFQ. Principal component analysis was used to determine the number of patterns which best represented the food intake of the population based on the Scree plot (Figure 2.4) as well as the eigenvalues values and corresponding statistical tests (Kaiser-Meyer-Olkin and Bartlett's sphericity test) as shown in Table 2.3. Two components (i.e. patterns) were identified, with absolute loadings above 0.4 considered, and these explained 56% of the variance. The component matrix for the PCA is shown on the radar chart in Figure 2.5). The first dietary pattern showed positive loadings greater than 0.4 for all food groups indicating a varied diet and hence was described as "*Diversified dietary pattern*". The second pattern showed positive loadings greater than 0.4 for starchy foods/cereals, legumes and sugars and negative loadings greater than -0.4 for fish, desserts and snacks, and was described as the "*Traditional dietary pattern*", because the typical traditional diet in Nigeria is dominated by cereals/starchy foods and legumes. The pattern scores generated for each respondent by PCA were categorized into quartiles for the statistical analysis.

Table 2.3: Principal Component Analysis to determine the dietary patterns among the children and adolescents

Test	Measure	Statistics	
Kaiser-Meyer-Olkin (KMO)	Sampling adequacy	^a 0.923	
Bartlett's	Sphericity	$\chi^2 = 8559.593$ df = 105 p < 0.001*	
Total Variance explained			
Component	Eigenvalues	% of variance	Cumulative %
1	6.619	44.125	44.125
2	1.725	11.500	55.625

* Statistically significant ^a Sample is adequate

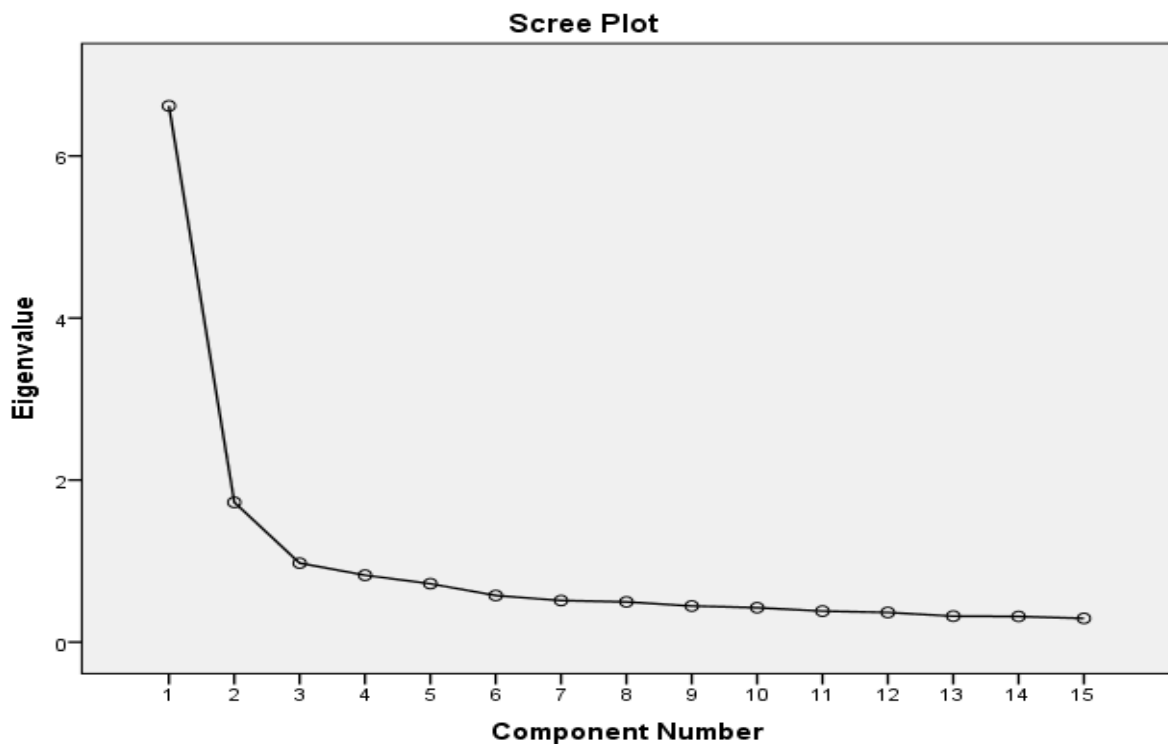


Figure 2.4: Scree plot to determine the number of components for Principal Component Analysis

2.4.8 Data analysis

The data were analyzed using Stata version 15.1 (Stata Corporation, College station, Texas, USA). Level of significance was set with p-value less than 0.05. The results were reported as estimates of the effect, corresponding to 95% confidence interval and associated p values. All p values were reported to three decimal places, with those less than 0.001 reported as $p < 0.001$. Descriptive analysis was done at the univariate level. Categorical and continuous variables were expressed as absolute numbers (percentages) and median (interquartile range) respectively. The anthropometric variables i.e. the weight and height, were described using means and standard deviation and for different ages and the two sexes. The proportions of undernourished (i.e. underweight, thinness and stunted) and over-nourished (i.e. overweight and obese) school-aged children and adolescents were described generally.

The bivariate associations of between the dependent and the independent variables were examined. Pearson chi-square test was used as the test of association for categorical variables, while, Mann Whitney U and Kruskal-Wallis (non-parametric) tests were used for the continuous variables that had 2 or more independent groups respectively. The non-parametric tests were used because the continuous variables were not normally distributed. The distributions of the various indicators of under- and over-nutrition according to the socio-demographic and socio-economic variables were done.

Using the three categories of nutritional status (i.e., thinness, normal and overweight/obesity) as the dependent/outcome variable, multinomial logistic regression analysis (with “normal” being the base outcome) was used to identify socio-demographic and socio-economic characteristics associated with under- and over-nutrition.

Subsequently, the nutritional status was re-categorized into binary outcomes (i.e., thinness or otherwise and overweight/obesity or otherwise). Two-level multi-level binary logistic regression analyses were done to investigate the extent to which the individual and community level factors explained the variation in under- and over-nutrition in the two Nigerian States. Two separate multi-level analyses were done to identify the contextual factors associated with both under-nutrition and over-nutrition. Six models each (total of 12 models) were fitted in all, generating the fixed and random effects for under- and over-nutrition. Multi-collinearity diagnostics were done and variables with high variance inflation factor (VIF) were not included in the models.

Binary logistic regression analysis was used to determine the relationship between DBM and the diet-related factors. Four models each were fitted for food insecurity, dietary diversity, diversified food pattern and the traditional food pattern, and their relationships with thinness and overweight/obesity. Model 0 was the empty model showing crude/unadjusted rates, while Model 1 adjusted for age and sex. Model 2 adjusted for State of residence and household wealth index in addition to Model 1, and Model 3 was the full model that adjusted for physical activity scores in addition to Model 2. More details about the data analysis, especially as it relates to the different objectives is shown in Table 2.4 (data analysis matrix) below.

2.5 Synthesis of Quantitative and Qualitative data

The sequential exploratory approach was used, and this was with the intention that the findings from the qualitative data collection were to be used to improve the instrument for quantitative data collection. During the integrative discussion, the quantitative and qualitative data were integrated, allowing each set of findings to deepen, enrich, and complement the other. This is considered the concurrent triangulation approach, where the findings from qualitative will help to explain the findings from the quantitative data, and vice versa.¹⁵⁵

Table 2.4: Data analysis matrix

Objective	What to examine	How it was examined	Instruments/tools	Outcomes
Objective 1 1. To explore mothers' perceptions and cultural beliefs about the concept, causes, and community experience of under- and over-weight children and adolescents in two Nigerian States	Mothers' perceptions about the nutritional status of children and adolescents	Probe for mothers' perceptions about the concept and causes of underweight and overweight	FGD for women using the FGD guide	Perceptions of women about the concept and causes of nutritional disorders in children and adolescents
	Cultural/traditional beliefs	Probe for food beliefs, practices, restrictions and taboos that exist in the community for children	FGD for women using the FGD guide	Feeding practices, food beliefs, restrictions and taboos that exist for children/adolescents
Objective 2 2. To estimate the prevalence rates and distribution of underweight, stunting, thinness, overweight/obesity, and establish the existence of DBM among school-aged children and adolescents in two Nigerian States	Weight & height	Direct measurement by trained research assistants	OMRON digital bathroom weighing scale and the stadiometer	The anthropometric values for the children/ adolescents according to ages and sex
	Prevalence of the indicators of undernutrition	Using the WHO reference - Thinness: BMI-for-age Z score - Underweight: weight for age Z score - Wasting: weight for height Z score - Stunting: height for age Z score	WHO (2007) growth reference for 5 – 19 years The cut-off is Z score < -2	Prevalence of - Thinness - Underweight - Wasting (only for children 6 – 10 years) - stunting
	Prevalence of the indicators of over-nutrition	Using WHO reference BMI-for-age references, using z-scores	WHO (2007) growth reference for 5 – 19 years	Prevalence of - Overweight - Obesity
	Spread of malnutrition	Distribution of malnutrition according to age-groups, sex, residence, region by cross-tabulating these variables with under- and over-nutrition using the chi-squared test	WHO (2007) references	- Prevalence in different age groups, males/females, rural/urban, Osun/Gombe etc. - statistical significance at $p < 0.05$
	Double burden of malnutrition	At individual level Co-existence of overweight/obesity & stunting At household level Co-existence of an overweight/obese mother & a stunted child in the same household At population level Similarity between prevalence rates of the indicators of under- and over-nutrition in the population	WHO (2007) references	- Confirm the existence of DBM at individual, household & population levels - Prevalence of DBM at individual & household levels
Objective 3:	Relationship between thinness and	Categorical Variables - Chi-square test will be used	IBM SPSS & STATA	Statistically significant associations ($p < 0.05$) between under- and over-

To identify individual (including household and diet-related factors) and contextual factors that are associated with under- and over-nutrition among school-aged children and adolescents in two Nigerian States	overweight/obesity and the independent variables	- Cross tabulation between nutritional status and categorical independent variables		nutrition and selected categorical variables
		Continuous variables Since they were not normally distributed - Mann Whitney U & Kruskal-Wallis tests were used for 2 or >2 categories respectively	IBM SPSS & STATA	Statistically significant associations ($p < 0.05$) between under- and over-nutrition and selected continuous variables
	Association between socio-demographic & socio-economic characteristics and nutritional status	- Multinomial regression analysis (when 3 categories were used i.e. thinness/normal/overweight/obesity) - “normal” category was the base outcome	STATA	- OR (95% CI) of under- & over-nutrition by selected independent variables
	Multi-level predictors of thinness and overweight/obesity	- Two 2-level multi-level models for thinness and overweight/obesity - each model had 6 models	STATA	Fixed effects: OR (95% CI) of under- & over-nutrition by selected independent variables Random effects: community level variance, VPC/ICC, PCV, log likelihood and AIC for the different models
	Associations between food insecurity, dietary diversity, dietary patterns and the DBM	- Separate binary logistic regression analyses for each of the diet-related factors and thinness/overweight/obesity - each had 4 models	STATA	- Adjusted OR (95% CI) of under- & over-nutrition by selected diet-related factors

2.6 Ethical Considerations

Ethical approval was obtained from the Human Research Ethics Committee of the University of the Witwatersrand (certificate No: M190514) (Appendix 2) and relevant institutional review boards (IRB) in Osun (certificate No: OSHREC/PRS/569T/155) (Appendix 3) and Gombe (certificate No: MOH/ADM/621/1/142) (Appendix 4) States.

2.6.1 Ethical considerations for the qualitative study

The participants' information sheet (Appendix 8), which was prepared for participants in the qualitative study, was read and explained to all the intending participants. The purpose and nature of the study were highlighted in the information sheet, and the participants were allowed to ask any questions they had, which were all addressed. Afterwards, written informed consent was obtained from the mothers (Appendix 10), which included their agreement to be included in the FGD sessions, that the researchers may use anonymous quotes in their report, that the interview may be audio recorded and that pictures could be taken.

2.6.2 Ethical considerations for the quantitative study

Different age-appropriate information sheets were prepared for younger children (6 – 11 years) (Appendix 11), the other adolescents (12 – 19 years) (Appendix 13) and their mothers (Appendix 7), which highlighted the purpose and nature of the study. The information sheets were read and explained to the intending participants, after which written informed consent was obtained from the parents and adolescents who were 16 years and above (Appendix 9), while assent was obtained from those less than 16 years (Appendices 12 and 14). All severely malnourished children, with BMI-for-age, weight-for-age or height-for-age Z-score less than -3, were referred to the nearby public health facilities for nutritional counselling and further management.

2.7 Community Entry and Engagement

All the communities selected had very organized community leaders' forums who took decisions on behalf of the communities. Additionally, the communities had expanded forums where all the heads of households were members, called the Landlords' association. The initial step was to obtain the phone numbers of the community heads or the chairmen of the community leaders' forums and to introduce the study, its purpose and nature, and to seek their permission to carry out the study in their community. The initial reception in almost all the communities was not very positive. The community leaders were initially reluctant to allow any "strangers" in form

of the research team to be visiting their households, and this was because of the state of insecurity in Nigeria at the time. One of the community leaders said;

“the country is very hard now, we cannot allow people to be going to our houses especially because we men are not usually at home” (Community leader, Osun urban 1)

In one of the communities in Gombe State, the community leader was very receptive, because he also had a child who was carrying out such research work for his undergraduate degree. This community leader then helped to convince other community leaders in his community, and even helped in convincing community leaders from other communities in Gombe State.

In other communities a meeting was arranged with other community leaders, where questions were asked about the researchers and the research, and about all that it would entail. In all the communities, except one, permission to carry out the study was given after speaking with the community leaders. In one of the urban communities in Osun State however, another meeting was organized with all the heads of households in the community where similar questions were asked. While there were people with very negative attitude in the meetings, some others especially those who were, or had been involved in some postgraduate programmes, understood and convinced others to permit the study. Some of the notable voices that supported, and convinced others to support the research were noted, and some were contacted afterwards to help in convincing community leaders from other communities.

A common practice in all the communities after giving permission for the study was to appoint a member of the community that would be monitoring the conduct of the study, and in some of the communities the research team was mandated to pay these people some daily allowance for this task. In all, the community entry and engagement took about three months, but eventually all the selected communities gave permission to carry out the study and were generally supportive.

2.7 Funding

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CHAPTER THREE: “Children eat all things here”: a qualitative study of mothers’ perceptions and cultural beliefs about under- and over-weight children and adolescents in selected communities in two Nigerian States

Table 3.1: Journal information and publication status of Paper 1

Journal	BMJ Open
Manuscript number	bmjopen-2021-059020
Manuscript type	Research article
Authors	Adeleye Abiodun Adeomi; Adesegun Fatusi; Kerstin Klipstein-Grobusch
Corresponding author	Adeleye Abiodun Adeomi
Publication status	Published
Citation	Adeomi, A., Fatusi, A., & Klipstein-Grobusch, K. (2022). ‘Children eat all things here’: a qualitative study of mothers’ perceptions and cultural beliefs about underweight and overweight children and adolescents in selected communities in two Nigerian states. <i>BMJ Open</i> . 12:e059020. http://dx.doi.org/10.1136/bmjopen-2021-059020

3.1 Abstract

Introduction: The perception of mothers about causes of under- and over-weight among children or adolescents and associated cultural beliefs may influence nutritional status. However, data from qualitative studies on this subject and regarding age 6 -19 are scarce in Nigeria.

Objective: This study aimed to explore mothers' perceptions and cultural beliefs about under- and over-weight children and adolescents in selected communities in a northern and a southern Nigerian state.

Design: This was a qualitative study using focus group discussions. Eight focus group discussion (FGD) sessions were held. The interviews were transcribed verbatim, and the transcripts were coded and analyzed using NVivo version 11, and direct quotations representing the themes generated from the perspectives were cited as appropriate.

Setting: The study was carried out in eight randomly selected rural and urban communities in Gombe and Osun States of Nigeria.

Participants: Seventy-six mothers of children and adolescents aged 6 – 19 years.

Results: The mothers identified concepts, causes, and community experience of under- and overweight children and adolescents, however, some gaps and misconceptions were observed. These included perspectives that suggest a limited understanding of the concepts of mild and moderate malnutrition and stunting and citing of “witches and wizards” as causes of malnutrition. The mothers observed that being underweight was more prevalent in rural communities of Osun and Gombe States, while overweight was more prevalent in urban communities in Osun State. The majority of the women reported no known food taboo or restrictions, and no cultural beliefs relating to the nutrition of children and adolescents.

Conclusion: Gaps and misconceptions exist in the perceptions of mothers on under- and overweight children and adolescents. Food taboos, food restrictions and other cultural beliefs were not reported by majority of the mothers. Educational programmes for mothers on child/adolescent nutrition should target identified gaps and misconceptions.

3.2 Introduction

, the global community is battling with the epidemic of overweight/obesity as the incidence and prevalence of overweight/obesity are on the increase in various parts of the world.¹⁸ However, for many low- and middle-income countries (LMIC) the nutritional challenge goes beyond just

overweight/obesity, as they are also confronted with the persisting problem of under-nutrition.^{2,156} This paradoxical coexistence of under- and over-nutrition is what has been called the double burden of malnutrition (DBM).³

Nigerian researchers had made a fair attempt to understand the determinants of under- and over-nutrition among children and adolescents in Nigeria, however almost all of these studies used a quantitative study approach. A number of existing quantitative studies have reported determinants of under- and over-nutrition among Nigerian children and/or adolescents to include household and socioeconomic factors such as household income, parental education, and occupation, nutritional status of the parents, family type, and maternal characteristics.^{56,58,82,157–159} Qualitative methods allow for a deeper understanding of the perceptions, experiences and context.¹⁶⁰ This is important because people's "realities" are actually their realities, which cannot be "measured" because they are socially constructed. People's realities are diverse and its existence is based on the people's perceptions and peculiar experiences.^{160,161} The qualitative approach will therefore be helpful, especially because of the complex nature of the determinants of childhood and adolescent nutrition.^{115,116}

Mothers' perception and cultural beliefs are important, yet under-studied, determinants of the nutritional status of children and/or adolescents. In some high income countries (HIC), the understanding of mothers about malnutrition have been shown to affect their child feeding practices.^{97,98} It has also been found that some mothers in Europe and Asia could not correctly classify the nutritional status of their children and hence would not know if or when to adopt appropriate measures.^{99–101} The effect of cultural beliefs, on the nutritional status of children and adolescents has also not been well explored. Food taboos, food restrictions and food beliefs have been reported among pregnant women in Nigeria.^{104–106} However, only little research-based information could be found in the literature on the cultural beliefs relating to child/adolescent nutrition in Nigeria. The information about mothers' perception and cultural beliefs, and how these relate to the nutrition of children and adolescents in Nigeria would be important in designing and implementing effective nutritional interventions among these children and/or adolescents. Qualitative methods are particularly important in exploring and understanding issues relating to perception and cultural beliefs about nutritional issues, but there are gaps in the literature regarding the Nigerian situation both in terms of the study approach and the thematic issues. This study, therefore, aimed to explore mothers' perceptions and cultural beliefs about the concept, causes and community experience of under- and over-weight children and

adolescents in selected communities in two Nigerian states using qualitative study approach to address the existing gaps.

3.3 Methods

3.3.1 Study setting and design

This qualitative study was carried out in two states in Nigeria – one from the northern part and the other from the southern part of the country. Thus, this study setting takes cognisance of the broad division of Nigeria into two parts – the south and the north. Nigeria is a highly diverse and heterogeneous country in terms of ethnic, socio-cultural, and religious setting and the southern part has better socio-economic rating compared to the north. Politically, Nigeria has 36 states, which are organised into 6 geo-political zones with 3 zones in the North and 3 in the South., Each geo-political zone is generally homogenous in sociocultural attributes and fairly distinct from other geo-political zones. Many ethnic groups within each zone share a common ancestry and have a high degree of similarities in terms of cultural beliefs as well as socio-religious characteristics, and economic indicators.

The selection of the states used for the present study was guided by the wealth level of each geo-political zone as published by the 2018 Nigeria Demographic and Health Survey (NDHS).¹²⁵ One state each was selected from the two zones with lowest (North-East) and highest wealth index (South-West) using simple random sampling technique (Balloting method). Gombe State and Osun State were thereby randomly selected from the North-East and South-West zones respectively.

3.3.2 Participants and procedure

The study population for the qualitative study were mothers of children and adolescents aged 6 – 19 years living in selected communities in Osun and Gombe States. A total of 8 focus group discussion (FGD) sessions were held, determined by the time data saturation was reached. The 8 FGDs were carried out in 8 different communities, with 4 communities selected in each of the two states (two rural and two urban communities per state). To select the communities, two local government areas (LGAs) were selected in each of the two states (one rural and one urban LGA). The list of the communities in each LGA was obtained from the LGA headquarters, and two communities in each LGA were selected using simple random sampling technique (balloting method), making a total of 8 communities. Each FGD session consisted of 8 to 10 discussants, who were women usually resident in the community, currently had at least one child between 6 and 19 years of age, had no speech or hearing defect, were at least averagely expressive and gave

informed written consent. In all, a total of 76 women who met the study criteria were selected purposively and were included in the study only after the study objectives and processes had been explained to them, their questions and concerns addressed, and they voluntarily gave their consents to participate in the FGDs.

3.3.3 Data collection

A guide was developed and used for qualitative data collection for the FGD sessions (Supplementary file). The FGD guide was initially in English language, but translated to the native languages of the different study locations (Yoruba and Hausa languages) and back translated to English to ensure the original meaning was intact. The translations were done by Ph.D. students in the Department of Nigerian Languages in Obafemi Awolowo University, Ile-Ife, Nigeria. Each FGD session was conducted within a time frame of 90 to 120 minutes, and sessions were facilitated by one of the authors (moderator) and a research assistant (note-taker) trained for that purpose. The discussions were done in the native languages of Osun and Gombe States, which were Yoruba and Hausa languages respectively. In Gombe State, where the researcher was not fluent in the native language (Hausa language), there was an interpreter who was fluent in both English and Hausa languages. The sessions were audio-recorded after obtaining the consent of the discussants to do so.

3.3.4 Data analysis

The audio-recordings were initially transcribed verbatim in Yoruba and Hausa Languages, and later translated to English language. The moderator, the note taker and the interpreter checked the transcripts to make sure that they matched the recordings. The English transcripts were carefully reviewed and a set of codes were developed to describe groups of words or categories with similar meanings. Initial broad coding was done according to major themes from the FGD guide (deductive), but new codes and themes were also developed as they emerged from the data (inductive). Fine codes were developed under each of the initial broad codes. To increase reliability, 20% of the transcripts were double coded by a senior qualitative expert. The definitions of both the broad and fine codes were put together in a code book. Once the code book was established, transcripts were coded using NVivo version 11 software (QSR International Pty Ltd, Doncaster, Australia). Direct quotations from the discussants that most clearly represent each theme were chosen to be included in the manuscript in italics.

3.3.5 Trustworthiness

Trustworthiness is a crucial requirement for all qualitative studies and this was ensured in many ways in the present study, and is here presented using Guba's criteria.^{162,163}

Credibility: The FGDs used for the present study were taken from eight randomly selected sites, with representation of the two major regions in the country (North and South) and also the rural and urban communities. To further ensure the credibility of the findings, all the authors independently read and commented on the findings, while a senior qualitative expert who was not involved in the study checked the themes and quotations to ensure they emerged from the original materials. The use of voice recordings and notes from the note taker, and the checking of the final transcripts by the moderator and note-taker all ensured that the discussions were accurately captured, and hence improving the credibility of the findings. Furthermore, only one person moderated all the FGDs and he was also the one who conducted the analysis hence he could easily make references to nuances in the transcripts.

Transferability: To ensure transferability, some background information about the study subject and context was given. Also, the details about the number of participants, how they were recruited and the data collection methods (FGD) were given. Additionally, the number and duration of the FGD sessions and other details about the FGD sessions were provided.

Dependability: The detailed information about the research methods and process provided in this study is also intended to improve the dependability of the research findings, such that a future researcher could repeat and get a similar result.

Confirmability: Triangulation through data sources was done in the present study, which was to recruit a wide range of women for the study. These were women from different states, residences (i.e. rural and urban dwellers) and backgrounds.

3.3.6 Ethical considerations

Ethical clearance was obtained from the Human Research Ethics Committee of University of the Witwatersrand (certificate No: M190514) as well as the Ministry of Health in Osun State (certificate No: OSHREC/PRS/569T/155) and Gombe State (certificate No: MOH/ADM/621/1/142). Written consent was obtained from the mothers, which included their agreement to participate in the FGD and that the interview may be audio-recorded and that the researchers may use anonymous quotes in their report.

3.4 Results

A total of 76 women participated in the FGDs, and they were between 29 and 55 years of age, with a mean age of 32.4 ± 4.5 years. Forty-six (60.5%) of them were Christians, while the remaining 30 (39.5%) were Muslims. Each of them had at least a child/adolescent who was 6 – 19 years of age.

3.4.1 Concept of under- and over-weight

3.4.1.1 Concept of underweight

The perception of the discussants about underweight children/adolescents was expressed through 4 sub-themes as described below;

Sub-theme 1: Body parts disproportion

Many of the mothers perceived that underweight children/adolescents have disproportionately sized body parts such as those with disproportionately big heads, protruding or big abdomen, thin arms, legs or thin waist such that clothes do not size. One mother noted,

“you know some child(ren), if you see them they are looking somehow, you’ll see the children they are slim, some you will see big head, and will also have long (repeats “long”) legs...” (Discussant 8: Gombe, Urban 1)

Sub-theme 2: Sickly appearance

Some of the discussants perceived that underweight children/adolescents have sickly appearances, even when they are not apparently sick. Some mothers noted that underweight children or adolescents have uncomely or pale skin appearances. A mother reported,

“from the eyes (repeats “from the eyes”) of the child, you can easily see that this child is not really looking well.” (Discussant K2: Gombe rural 1)

Another mother simply said,

“the child will not be attractive” (Discussant K4: Osun Urban 2)

Sub-theme 3: Weak or Sickly Children

Another opinion expressed by the mothers about underweight children is that they are weak, sickly and usually having different infections. A mother opined,

“the moment he’s playing with his colleague, from there you can know, because the moment they push him small (a little), he will fall down, he’s not that strong. (Discussant K1: Gombe Rural 1)

According to another mother,

“some of such children with abnormal weight always have incessant cough, face swelled up and dry lips. Some can have swollen body with hidden illnesses.”

(Discussant K7: Gombe Rural 2)

Sub-theme 4: Growth less than children of same age

Some of the women perceived underweight children/adolescents as those whose growth is less than the growth of other children of same age. According to one mother,

“such a child will not grow very well among children of same age”(Discussant R3: Osun Rural 1)

3.4.1.2 Concept of Overweight/Obesity

The perceptions of mothers on childhood/adolescent overweight/obesity were captured by 2 sub-themes;

Sub-theme 1: Bigger than Age-mates

Majority of the discussants perceived an overweight child/adolescent as one whose physical body is bigger than the body size of most of his/her age mates. Some of the mothers opined that overweight/obese children/adolescents appear big, but from their behaviour it will be obvious that they are younger than how they look. The mothers opined that,

“first sighting will make you see the child being very big with a young face structure. Weight will be too much for the age of the child.” (Discussant R7: Osun Urban 2)

“the fatness will not be OK. The weight is too much for the age of the child (and) we would know that such is not normal. From seeing the child, you will know that the weight of the child is too much for the age.” (Discussant R7: Osun Urban 1)

Sub-theme 2: Moderate chubbiness is good

Some of the women expressed an opinion that favoured chubby children or adolescents. They felt that a moderately chubby child is beautiful, and that it only becomes a problem if the chubbiness is excessive. This view was more prevalent among women in urban communities of Osun State. One of the mothers opined,

“we like chubby children, but when it is too much it is different, the child can’t carry himself” (Discussant 3: Osun Urban 1)

3.4.2 Community experience of under- and over-weight children and adolescents

The researchers sought to know which of under – or over-weight children and adolescents were perceived by the discussants to be predominant in each of the communities, and based on the responses of the discussants, three sub-themes emerged.

Sub-theme 1: Overweight children and adolescents are predominant

This sub-theme emerged exclusively from the two FGD sessions conducted in urban communities in Osun State. Some of the mothers opined that overweight was the predominant nutritional disorder in their community, and some of them were of the view that there was no underweight child or adolescent in their communities. One mother added,

“in my own opinion I think overweight is more prevalent in this area” (Discussant 4: Osun Urban 2)

Another mother noted,

“I have not seen very slim children in this area” (Discussant 2: Osun Urban 1)

Sub-theme 2: Underweight children and adolescents are predominant

This sub-theme emerged from the FGD sessions in rural communities, both in Osun and Gombe States. The mothers expressed the view that the prominent nutritional disorder among children/adolescents in their communities was underweight. In the words of one of the mothers,

“we do not have overweight children here but we have a lot of underweight children”
(Chorused by majority of the discussants, Gombe rural 2)

Sub-theme 3: Both under- and over-weight in the community

Some mothers across different discussion groups opined that there were both under- and over-weight children/adolescents in their communities, and did not think any was more predominant than the other. A mother opined,

“in my area, the population of overweight is the same as those of underweight”
(Discussant 7: Osun Urban 2)

Another mother noted,

“there are those with less weight (underweight), and there are those overweight. The most common, the skinny children, hmm (thinks for some time)... no, it's interwoven”
(Discussant 7: Osun Urban 1)

3.4.3 Perceived causes of under- and over-weight

The opinions expressed by the mothers about the causes of under- and over-weight are shown in Table 3.2. There were seven sub-themes for the perceived causes of under-weight, which include poor feeding, poverty, hereditary, sickness or ill-health, parental/family factors, witches and wizards and environmental factors. For the perceived causes of overweight, four sub-themes emerged namely; eating habits, hereditary, sickness and sedentary lifestyle.

Table 3.2: Perceived causes of under- and over-weight according to the mothers

UNDERWEIGHT			
Sub-theme	Definition	Illustrative Quotations	Discussant
1	Poor feeding	<i>“the quality of the food.... well, most of the time, he eats only one type of food. No change of food, always only one type of food,(repeats “always only one type”). That will also cause a child not to reach the normal weight”</i>	Discussant 7: Gombe Rural 1
2	Poverty	<i>“yes, we have people that don’t have much money in this area, even some of us here just packaged ourselves in this country. Some that gave birth and don't have much will not be able to give such a child the right diet and this could cause underweight.”</i>	Discussant 6: Osun rural 1
3	Hereditary	<i>“for some of them, (it is) lack of food, (for)some (it) is sick(ness) or sometimes you know the parents are thin. Both the parents are thin, so the child will come like that (will also be thin)”</i>	Discussant 8: Gombe urban 1
4	Sickness or ill-health	<i>“The first is that it could be stomach worms’ problem, or a kind of sickness or that it is the gene in his/her body. Though eating (adequately, but) not getting fat, but it will show that he/she is eating good food”</i>	Discussant 6: Osun Rural 2
5	Parental and family factors	<i>“you cannot compare a child brought up in the rural area and another whose parents are learned”</i>	Discussant 5: Osun rural 1
6	Witches and wizards	<i>“It is witches and wizards (that cause underweight), but to the glory of God, there is no such thing in this community, in my own view”</i>	Discussant 7: Osun urban 2
7	Environmental factors	<i>“some, it’s from the environment (environmental factors), (for example) if the environment is not clean, it will be affecting them to be thin”</i>	Discussant 1: Gombe urban 1
OVERWEIGHT			
1	Eating habits	<i>“yes. food like carbohydrate, like swallows (starchy food), yam, garri (cassava flakes), pounded yam, semo (maize meal). When carbohydrate is too much on (in) a diet, it can lead to overweight. if it’s taken all the time. It can cause overweight”</i>	Discussant 7: Osun Urban 2
2	Hereditary	<i>“even I, I have mummy (a mother that is) very big, that is why I am also fat, it is hereditary or genetic”</i>	Discussant 5: Gombe Urban 2
3	Sickness	<i>“(for) some it could be sickness that caused overweight, and some are just naturally endowed with stature by God”</i>	Discussant 7: Osun Rural 1
4	Sedentary lifestyle	<i>“what about excessive comfortability, where a child does nothing, only the house maid that does all the work while the child is lazing around, could lead to overweight., the child is just watching films, just waking up and sleeping, not doing any work. Because there are plenty of those people in this area”</i>	Discussant 7: Osun Urban 2

3.4.4 Cultural beliefs and practices relating to the nutrition of children and adolescents

Two sub-themes emerged concerning the views of discussants about cultural beliefs relating to the nutrition of children and adolescents.

Sub-theme: No known cultural belief

Majority of the mothers did not know of any cultural belief or practice concerning the nutrition of children/adolescents in their families or communities. Even when the discussants were probed for food taboos or restrictions for children and adolescents, majority of them reported no food taboo or restriction for children and/or adolescents. This was the major finding in most of the discussion groups. Below are some quotations from the mothers,

“none, we do not have anything like that in this community”

(Discussant 2: Osun Urban 2)

“it's in the olden days that we have heard that a child does not eat meat and the likes, but now such is not common anymore. It is just how much (money) you have that determines what you give to the child nowadays”

(Discussant 4: Osun Urban 1)

“in our culture there is no food that a child cannot eat, if egg is available you (give the child to) eat, if it's not (available), you will eat other things”

(Discussant 2: Osun Rural 1)

“Children eat all things here”

(Discussant 5: Gombe Urban 2)

Sub-theme: Restriction for snails

Few of the mothers from Gombe State reported that restrictions for snails existed in their families and/or tribes. Other women from Gombe State, however, noted that snail eating was not popular in the North because snails were scarce in the North, which may indicate that snail was not really a taboo. A mother noted,

“we no dey (do not) eat snail, even the adult don't eat it”

(Discussant 8: Gombe Urban 1)

Another mother from the same discussion group however added,

“yes, because we, we are not used to snail here. We don't eat it”

(Discussant 1: Gombe Urban 1)

3.5 Discussion

The focus of the second Sustainable Development Goal (SDG 2) is to “end hunger, achieve food security and improve nutrition, and promote sustainable agriculture”. As the “Power of Nutrition” organisation notes, “ending hunger, food insecurity and malnutrition for all will require continued and focused efforts, especially in Asia and Africa.”¹⁶⁴ This study, to the best of our knowledge, is the first to examine the perception of mothers and cultural beliefs about under- and over-weight children and adolescents in two ethnically-different states in Nigeria. Understanding the perspectives of mothers, as primary care givers, is particularly important for developing effective interventions for under- and over-nutrition among children and adolescents.

Mothers’ Perceptions about the concept, causes and community experience of under- and over-weight children

The mothers in the present study expressed some perceptions about underweight children/adolescents, including physical features such as protruding abdomen, big heads, thin limbs, poor growth, and weak and sickly appearances among underweight children and adolescents. However, the mothers also exhibited some gaps in their knowledge in that most of the perspectives shared reflects severely underweight children. The mothers seemed not to understand the possibility of mild to moderate under-nutrition, which may only be known after objective assessment with some instruments. This is important as only a low proportion of under-nutrition are severe, and relevant actions need to be focused early on addressing mild and moderate cases, which constitute the majority of malnutrition problems among children/adolescent. This gap in perception could be the reason for misclassification of malnourished children at community levels as normal as reported by various authors.^{165–167}

Another gap in the mothers’ knowledge is that no reference was made to stunting (i.e. short for age) as a form of under-nutrition. Yet, stunting is the most prevalent form of under-nutrition in Nigeria, with the United Nations Children Fund (UNICEF) reporting that a third of Nigerian children under 18 years are stunted.¹²³ Therefore, if the mothers, who are principally responsible for feeding or controlling the feeding of children or adolescents are ignorant of stunting, they may be taking little or no action to address such. Furthermore, the mothers based their perception of underweight on the weight of other children of same age. Such judgement is highly subjective, and may lead to incorrect conclusion regarding perceived nutritional status, particularly in a community with a high prevalence of undernutrition. Similar findings have previously been

reported from a qualitative study among mothers in Vietnam¹⁰¹ and could be associated with mother's misjudgement of the weight of their children or their nutritional status.¹⁶⁵⁻¹⁶⁷

The perception of majority of the mothers about overweight was also mixed. The subjectivity of basing the classification of a child/adolescent's weight on that of other children as earlier noted for underweight also applies to the perception of overweight. Another point of concern is the fact that some of the mothers favoured chubby children. Mothers in Vietnam similarly expressed their love for chubby children.¹⁰¹ The preference for chubby children may not be unconnected with the fact that underweight has been associated with poverty; thus, community members may tend to view chubby children as indication of wellbeing or affluence. The challenge with this perspective is that it would be objectively difficult to draw a line between "chubby" and "overweight".

Mothers living in urban communities reported that overweight children were more prevalent, while those from rural communities reported the predominance of underweight children. This pattern is expected, and corroborates the findings of other researchers in Nigeria that have reported that overweight/obesity is predominant in the richer urban areas, while the less resourced rural areas have a high burden of under-nutrition.^{81,129,168,169} The NDHS also reports that all the indicators of under-nutrition are two-times higher in rural, compared to urban communities in Nigeria.¹²⁹ While the high burden of overweight children/adolescents in the urban communities should be discouraged, the higher burden of underweight in rural communities reflects the well-documented socio-economic inequity and inequalities between rural and urban communities in Nigeria,¹⁷⁰ – a persistent gap that needs to be urgently bridged.

Many of the factors that have been reported as determinants of under- and over-nutrition among children and adolescents by previous authors were also mentioned by the mothers when asked about the causes of under-and over-nutrition.^{11,81,83,157} These include dietary/feeding habits, physical activity patterns, sickness/disease, environmental factors, socio-economic factors and household/parental factors. This level of understanding among the mothers is encouraging, because high health literacy among mothers is needed for the prevention and/or control of under-and over-weight among children and adolescents. On the other hand, it is also important to recognise some major misconceptions recorded among mothers regarding the causes of under-and over-weight among children and adolescents, such as "witches and wizards". Although, a number of misconceptions have been reported among mothers about the nutritional status of their children,^{165-167,171} previous authors have not specifically reported witches and wizards, although

the role of the “spiritual forces” or the “supernatural” as causes of mortality and morbidity is known to have been prevalent in local communities across Nigeria, particularly in the past. It is disturbing that these opinions were not only expressed in the rural areas, but also in the urban communities where mothers would be expected to be better educated and more enlightened. Misconceptions relating to the role of the supernatural forces pose a challenge to efforts aimed at encouraging mothers to take actions to prevent or control malnutrition since they are associated with the belief that addressing the cause is out of their reach.

Cultural beliefs relating to the nutrition of children and adolescents

Studies in Nigeria and several other African communities have reported food restrictions and taboos as prevalent among women and children,^{106,172–174} but the finding of the present study is different. Majority of the women who participated in this study, across the different socio-demographic locations, knew no food restriction nor taboo for children and adolescents. Furthermore, majority of the women reported no cultural beliefs relating to child or adolescent nutrition that they knew of. A study carried out in Kano State, Nigeria that aimed to describe the nutritional taboos among pregnant women also similarly found that food taboos were not much reported among the women.¹⁷⁵ The Nigerian studies that reported food taboos are rather old,^{172–174} while the more recent studies that reported restrictions/taboo did so among pregnant women.^{104,106} The finding of this present study probably reflects the present reality in Nigeria that food taboo has reduced significantly, which may be associated with increased education and health awareness among the population.¹⁷⁶

The findings of this study, however, may not be generalizable to children, adolescents or the mothers to the whole of Nigeria for some reasons. Firstly, the study was carried out in two out of the 36 states in Nigeria. Secondly, even in the two selected states, discussants were recruited from only four out the total of 41 local government areas (LGAs). Lastly, the sample size (76) may not be representative, as it was not scientifically determined. It is also difficult to establish causality with the qualitative research design. The nature of the focus group discussion used, also creates artificiality, since the discussion was arranged, and it is not occurring naturally.

This study has, however, provided new and important qualitative data on perception of mothers and cultural beliefs about under- and over-weight children and adolescents that have not been previously reported, especially because most previous studies used quantitative approaches. These findings could be used to generate some important research ideas which could be pursued using both qualitative or quantitative methods. An important research idea, for instance, is the

“prevalence of the gaps and/or mis-conceptions noticed among a larger population of mothers, and their associations with dietary practices/patterns and nutritional status of children”, and this could be pursued using a quantitative study. Additionally, the findings of this study would be important in designing nutritional education for mothers on child/adolescent nutrition, especially in the study area. This is because the study has made known some concepts and perceptions that could be built on, and important gaps and misconceptions that need to be addressed.

3.6 Conclusion

The mothers identified concepts, causes and community experience of under- and overweight children and adolescents, but some gaps and misconceptions still exist among them, one of which is the perception that underweight is caused by witches and wizards. Food taboos, food restrictions and other cultural beliefs were not reported by majority of the mothers. Educational programmes for mothers on child/adolescent nutrition should target identified gaps and misconceptions.

CHAPTER FOUR: Double Burden of Malnutrition among School-Aged Children and Adolescents: Evidence from a Community-Based Cross-Sectional Survey in two Nigerian States

Table 4.1: Journal information and publication status of Paper 2

Journal	AAS Open Research
Manuscript number	aasopenres-13242
Manuscript type	Research article
Authors	Adeleye Abiodun Adeomi; Adesegun Fatusi; Kerstin Klipstein-Grobusch
Corresponding author	Adeleye Abiodun Adeomi
Publication status	Published
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4.1 Abstract

Background: Double burden of malnutrition (DBM) is the co-existence of overweight/obesity and undernutrition. Rising prevalence rates of childhood overweight/obesity in Nigeria have been reported, whilst undernutrition continues to be prevalent. This study aimed to estimate the prevalence and distribution of underweight, stunting, thinness, overweight/obesity, and DBM among school-aged children and adolescents in two Nigerian States.

Methods: This was a community-based cross-sectional study carried out in Osun and Gombe States. A total of 1,200 children aged 6 – 19 years were recruited using multi-stage sampling technique. Weight, height and data on demographic, socio-economic, household/family characteristics of the children were collected using structured interviewer administered questionnaires. Nutritional status was calculated using the WHO 2007 reference values using BMI-for-age (thinness, overweight/obesity), height-for-age (stunting) and weight-for-age (underweight). DBM was described at the population and individual levels.

Results: The mean age of the respondents was 11.6 ± 3.8 years. The overall prevalence rate of stunting was 34.9%, underweight was 13.5%, thinness was 10.3% and overweight/obese was 11.4% and 4.0% had individual level DBM, which typifies the DBM at individual and population levels. These rates differed significantly across demographic, socio-economic and household/family characteristics ($p < 0.05$). Gombe State, which is in the Northern part of Nigeria, had significantly higher burden of stunted, underweight and thin children than Osun State, while Osun State, in the Southern part of Nigeria, had a significantly higher burden of overweight/obesity.

Conclusions: The study found evidence of DBM both at population and individual levels. The overall prevalence rates of stunting, underweight, thinness and overweight/obesity in this study were high compared to previous reports, and they differed significantly across the demographic, socio-economic and household/family characteristics. There is the need for government and all other stakeholders to design nutrition educational programmes that will target both under- and over-nutrition among older children in the different contexts.

4.2 Introduction

Decades ago, the world faced the devastating burden of undernutrition among children, such that the term malnutrition was used almost exclusively to mean undernutrition.¹⁷⁷ In recent years, there has been a steady rise in the prevalence of overweight and obesity among children and adolescents in all parts of the world, and the rate is increasing faster in low- and middle-income countries (LMIC) compared to high-income countries.¹⁵⁶ According to the World Health Organization (WHO), the prevalence of overweight and obesity among school-aged children and adolescents increased from 4% in 1975 to 18% in 2016, and doubled between 2006 and 2016, with 340 million of them being overweight/obese by 2016.¹⁷⁸ Yet, undernutrition remains a major challenge in many LMICs; as such, many LMICs face a double burden of malnutrition (DBM) problems in terms of the co-existence of undernutrition and over-nutrition (overweight/obesity).^{2,137} The increasing incidence of overweight/obesity in LMICs has been attributed mainly to nutrition transition with changes in dietary patterns from a traditional to a westernized diet – “a diet high in saturated fat, sugar, and refined foods and low in fibre”⁹ and a reduction in energy expenditure fueled by increasing sedentary activity patterns.⁸ The double burden of malnutrition significantly and negatively impact population health and well-being as well as economic development in LMICs.¹⁷⁹

Nigeria, like many other LMICs, is currently undergoing nutritional transition.^{180,181} with some researchers already reporting rising prevalence rates of overweight/obesity close to the global average of 18% among adolescents.^{11,75,156} On the other hand, the United Nations Children Fund (UNICEF) estimates that 33% of Nigerian children are stunted, and this has been corroborated by other studies.^{13,14,85,182} Few studies in Nigeria are already reporting the existence of the double burden of malnutrition,^{183–185} but these studies are scattered, limited in geographical distribution and mainly school based. There is, to date, no nationally representative community-based data on the nutritional status of children 6 – 14 years in Nigeria. The Nigeria Demographic and Health Survey (NDHS), the Multiple Indicator Cluster Survey (MICS) and the Nutrition and Health Survey, which all have nationally representative data on the nutritional status of children in Nigeria include only under-five children, and those 15 years and older.^{125,127,128}

Also, although several studies have been carried out in Nigeria on the nutritional status of school-aged children and adolescents, many of the studies have the challenge of small sample size and comparability between survey findings has been challenging as different anthropometric indicators, reporting systems, cut-off points and reference values have been used.³² Another

challenge is the geographical imbalance in the study locations of existing studies, with majority of the studies reported in settings with higher socio-economic status (ie the Southern and urban parts of Nigeria).³² Furthermore, most of the existing studies in Nigeria have been school-based studies and out-of-school children, who are from economically poorer and more disadvantaged backgrounds, are thereby excluded. This study aims to address some of the existing shortcomings and research gaps relating to DBM among children and adolescents in Nigeria. Specifically, this study aimed to estimate the prevalence and distribution of under- and over-nutrition among school-aged children and adolescents in two Nigerian States from the northern and southern parts of the country, using a community-based approach.

4.3 Methods

4.3.1 Study design, population and size

This community-based cross-sectional study was carried out in Osun and Gombe States, located in the southern and northern parts of Nigeria respectively. The selection of the states was based on the wealth index as published by the NDHS.¹⁹ The wealth index was categorized according to geo-political zones. Therefore, one state each from the zones with lowest (North-East; Gombe State) and highest wealth (South-West; Osun State) index were selected randomly. The study population were school-aged children and adolescents aged between 6 and 19 years living in selected communities in the study locations. The mothers of the selected school-aged children and adolescents were also included in the study. Acutely ill children, those with chronic diseases that can affect their weight (like sickle cell diseases and cancers), those living with disabilities that affect their abilities to stand properly, and children whose mothers were not available even after a revisit on another day during the time of the survey were excluded from the study. The sample size was calculated using STATCALC on Epi-Info software.¹⁸⁶ The prevalence of stunting among Nigerian children according to UNICEF (33%)¹³⁷ was used as the expected outcome, the acceptable margin of error was set at 5%, and the design effect was taken as 1.5. The design effect is the increase of sample size because of the hierarchical sampling model used in this study. After correcting for an anticipated non-response rate of 10%, the sample size came to 561 and was rounded off to 600 for each state, making a total of 1,200.

4.3.2 Sampling technique

The 1,200 respondents were selected using a multi-stage sampling. Four Local Government Areas (LGAs), 8 wards and 40 enumeration areas (EAs) were selected in the first, second and

third stages using simple random sampling technique (balloting method). At the fourth stage, 30 households were selected from each of the EAs using systematic random sampling technique, making a total of 1,200 households. At the household level (fifth stage), only one child/adolescent was randomly selected (using balloting) from all the eligible children and/or adolescents in the household. This is because children within the same household would probably have very similar exposures, especially at this level, potentially confounding the associations.

4.3.3 Data collection

Ten research assistants and one field supervisor were recruited and trained in each of the 2 states. They were fluent in both the native and English languages and familiar with the sociocultural and geographical terrains of the study locations. The assistants and supervisors were trained for five days by the one of the authors (AAA). The training for research assistants included introduction to the research concept, issue of confidentiality, objectives and the instruments. The meaning and measurement of every item on the instrument were properly explained to the research assistants. Training methods included training sessions, role plays, questions and answers and field trials. After the training, measurements were taken by the researcher and each of the research assistants on the same set of subjects to ensure minimal or no inter-tester and intra-tester errors. This exercise was repeated at intervals during the entire study to further assure quality control. Data collection was undertaken between November, 2019 and March, 2020

The questionnaires were interviewer-administered by use of REDCap.¹⁵² The questionnaire collected information on demographic, socio-economic and household/family characteristics, using relevant questions that were adapted from the NDHS.¹²⁵ Anthropometric measurements of children/adolescents were taken according to standard protocols recommended by the International Society for the Advancement of Kinanthropometry.¹⁵³ Weight was measured in 0.1 kilograms by the use of an Omron® electronic bathroom weighing scale. Height was measured to the nearest 0.1 meter using a stadiometer. Weighing scales were routinely standardized by use of known weights.

4.3.4 Measurement of the outcome and explanatory variables

The outcome variable ,nutritional status of the school-aged children and adolescents, was assessed using WHO 2007 reference values.³⁵ Those with BMI-for-age Z-scores $< -2SD$, $-2SD$ to $1SD$, $> 1SD$ to $2SD$ and $> 2SD$ were classified as thinness, normal, overweight and obesity respectively. Weight-for-age and height-for-age Z scores $< -2SD$ were also used to assess

underweight and stunting. Population level DBM signified communities with both under- and over-nutrition, while individual DBM was defined as children who were both stunted and overweight/obese.

The explanatory variables were States (Osun/Gombe), residence (rural/urban), sex (male/female), ethnic groups (Yoruba/Igbo/Hausa/Fulani/Minorities), household wealth index (poorest/poorer/middle/richer/richest), family type (monogamous/polygamous), mother's education (less than secondary/secondary or more) and mother's occupation (unemployed/employed). Age was categorized into pre-adolescents (6 – 9 years), early adolescents (10 – 13 years), middle adolescents (14 – 16 years) and late adolescents (17 – 19 years). The wealth index was calculated using ownership of some household possessions, as was used by the NDHS ¹²⁵. Principal component analysis was used to produce a common factor score for each household. The scores were divided into quintiles to categorize the households into poorest, poorer, middle, richer and richest households. The wealth index was later re-grouped into three categories (poorest/middle/richest) for the multi-variate analysis.

4.3.5 Data analysis

The data were analyzed using STATA version 15.1. The level of significance was set with a two-sided p-value less than 0.05. The distribution of thinness, underweight, stunting, overweight/obesity and individual DBM according to the demographic, socio-economic and household/family characteristics was done. Pearson's chi-square test was used to test for associations at the bivariate level. The multinomial logistic regression was used to identify predictors of under-and over-nutrition at the population level, using the BMI-for-age categories as the dependent variable (i.e. (1) underweight (2) normal (3) overweight/obesity) with the comparator being the "normal" category. Two models were fitted for this; the empty and full models, and all the explanatory variables considered in this study were entered into the models. The empty model contained crude/unadjusted odds ratios (OR) for the explanatory variables with their 95% confidence intervals (CI), while the full model adjusted for all the explanatory variables considered, and hence generated adjusted odds ratios (aOR) with the 95% CI.

4.3.6 Ethical considerations

Ethical clearance was obtained from the Human Research Ethics Committee of the University of the Witwatersrand (certificate No: M190514) and relevant institutional review boards (IRB) in Osun (certificate No: OSHREC/PRS/569T/155) and Gombe (certificate No:

MOH/ADM/621/1/142) States. Community entry was undertaken with advocacy visits to leaders and gate-keepers in selected communities. Participation was voluntary and the information volunteered was confidential as all questionnaires were coded. Participants were free to opt-out at any time in the study. Written consent was obtained from the parents and adolescents who were 18 years and above, while assent was obtained from those less than 18 years. All severely malnourished children, with BMI-for-age, weight-for-age or height-for-age Z-score less than -3, were referred to the nearby public health facilities for nutritional counselling and further management.

4.4 Results

A total of 1200 school-aged children and adolescents – 601 (50.1%) males and 599 (49.9%) females – participated in the study, giving a male-to-female ratio of approximately 1:1. The mean age of the respondents was 11.6 ± 3.8 years.

Table 4.2 shows the prevalence and distribution of the nutritional status of the respondents according to their age and sex. Among the males, the prevalence of thinness was highest among those 15 years old (16.4%), followed by those 6 or 9 years in age (11.9%). The prevalence of overweight and obesity was highest among the younger male children with the highest prevalence being 23.5% (9 years) and 31.6% (8 years) for overweight and obesity respectively. Beyond the age of 13 years, nearly no male child was overweight nor obese. For the females, the prevalence of thinness was highest among the 6- and 10-year-old children (12.5%), while prevalence of overweight and obesity were highest among 11- and 7-year old children (20.6% and 33.3%) respectively. Unlike the males however, there were overweight females after the age of 13 years. On the whole, the prevalence of malnutrition was significantly different between males and females; 11.1% of males compared to 9.3% of females had thinness, while 5.7% of males and 10.5% of females were overweight and 3.2% of males and 3.5% of males were obese. The overall prevalence of malnutrition was 10.2% for thinness, 8.1% for overweight and 3.3% for obesity.

Table 4.2: Age and sex distribution of the prevalence of thinness, overweight and obesity

Age	Males (%)				Females (%)				Total (%)			P -value	
	^a n	Thinness	Over-weight	Obese	^a n	Thinness	Over-weight	Obese	^a N	Thinness	Over-weight		Obese
6	46 (7.7)	8 (11.9)	4 (11.8)	1 (5.3)	58 (9.7)	7 (12.5)	2 (3.2)	2 (9.5)	104 (8.7)	15 (12.2)	6 (6.2)	3 (7.5)	^b 0.540
7	41 (6.8)	4 (6.0)	4 (11.8)	3 (15.8)	47 (7.8)	8 (14.3)	1 (1.6)	7 (33.3)	88 (7.3)	12 (9.8)	5 (5.2)	10 (25.0)	^b 0.209
8	58 (9.7)	6 (9.0)	6 (17.6)	6 (31.6)	43 (7.2)	1 (1.8)	10 (15.9)	1 (4.8)	101 (8.4)	7 (5.7)	16 (16.5)	7 (17.5)	^b 0.049*
9	53 (8.8)	4 (6.0)	8 (23.5)	1 (5.3)	61 (10.2)	6 (10.7)	11 (17.5)	2 (9.5)	114 (9.5)	10 (8.1)	19 (19.6)	3 (7.5)	^b 0.872
10	72 (12.0)	8 (11.9)	4 (11.8)	1 (5.3)	56 (9.3)	7 (12.5)	5 (7.9)	3 (14.3)	128 (10.7)	15 (12.2)	9 (9.3)	4 (10.0)	^b 0.479
11	33 (5.5)	2 (3.0)	0 (0.0)	4 (21.1)	44 (7.3)	2 (3.6)	13 (20.6)	1 (4.8)	77 (6.4)	4 (3.3)	13 (13.4)	5 (12.5)	^b < 0.001*
12	59 (9.8)	3 (4.5)	4 (11.8)	2 (10.5)	52 (8.7)	5 (8.9)	1 (1.6)	3 (14.3)	111 (9.3)	8 (6.5)	5 (5.2)	5 (12.5)	^b 0.437
13	44 (7.3)	3 (4.5)	2 (5.9)	1 (5.3)	44 (7.3)	2 (3.6)	1 (1.6)	2 (9.5)	88 (7.3)	5 (4.1)	3 (3.1)	3 (7.5)	^b 0.827
14	41 (6.8)	4 (6.0)	0 (0.0)	0 (0.0)	38 (6.3)	5 (8.9)	5 (7.9)	0 (0.0)	79 (6.6)	9 (7.3)	5 (5.2)	0 (0.0)	^b 0.017
15	43 (7.2)	11 (16.4)	1 (2.9)	0 (0.0)	42 (7.0)	4 (7.1)	4 (6.3)	0 (0.0)	85 (7.1)	15 (12.2)	5 (5.2)	0 (0.0)	^b 0.066
16	23 (3.8)	2 (3.0)	0 (0.0)	0 (0.0)	24 (4.0)	4 (7.1)	2 (3.2)	0 (0.0)	47 (3.9)	6 (4.9)	2 (2.1)	0 (0.0)	^b 0.160
17	39 (6.5)	7 (10.4)	0 (0.0)	0 (0.0)	42 (7.0)	2 (3.6)	2 (3.2)	0 (0.0)	81 (6.8)	9 (7.3)	2 (2.1)	0 (0.0)	^b 0.047*
18	30 (5.0)	4 (6.0)	1 (2.9)	0 (0.0)	32 (5.3)	2 (3.6)	5 (7.9)	0 (0.0)	62 (5.2)	6 (4.9)	6 (6.2)	0 (0.0)	^b 0.172
19	19 (3.2)	1 (1.5)	0 (0.0)	0 (0.0)	16 (2.7)	1 (1.8)	1 (1.6)	0 (0.0)	35 (2.9)	2 (1.6)	1 (1.0)	0 (0.0)	^b 0.443
Total	601 (50.1)	67 (11.1)	34 (5.7)	19 (3.2)	599 (49.9)	56 (9.3)	63 (10.5)	21 (3.5)	1200 (100.0)	123 (10.2)	97 (8.1)	40 (3.3)	0.016*

* Statistically significant

⁺The WHO BMI-for-age classification was used such that those with < -2, -2 to 1, > 1 to 2 and > 2 were categorized as thinness, normal, overweight and obesity respectively

^a - number in the group

^b test of association between male and female rates (Pearson chi-square test)

The distribution of the indicators of under- and over-nutrition according to States, residence, age groups, sex, ethnicity groups, household wealth index, family types, mother's education and occupation is shown in Table 4.3. The overall prevalence rate of stunting was 34.9%, underweight was 13.5%, thinness was 10.3%, overweight/obese was 11.4% and 4.0% had individual level DBM in the study. Stunting was significantly associated with all the explanatory variables considered ($p < 0.01$), except residence ($p = 0.672$). Underweight was significantly associated with all explanatory variables, except residence ($p = 0.227$) and sex ($p = 0.554$), while BMI-for-age categories (thinness, normal and overweight/ obesity) were significantly associated with all the considered explanatory variables ($p < 0.05$), except family type ($p = 0.667$). Individual DBM was significantly associated with the State, residence, ethnicity, family type and mother's occupation ($p < 0.05$).

Table 4.4 shows the factors associated with under-nutrition (thinness) and over-nutrition (overweight/obesity) after controlling for all the explanatory variables using multinomial regression analysis. The odds for thinness were significantly higher among minority ethnic groups (OR: 2.63, $p = 0.040$, 95% CI: 1.04 to 6.62) and children with unemployed mothers (OR: 1.64, $p = 0.047$, 95% CI: 1.01 to 2.68), and lower among those from middle (OR: 0.55, $p = 0.016$, 95% CI: 0.34 to 0.89) and richest households (OR: 0.25, $p = 0.002$, 95% CI: 0.10 to 0.60). Urban dwellers (OR: 2.63, $p < 0.001$, 95% CI: 1.68 to 4.61) and females (OR: 1.63, $p = 0.011$, 95% CI: 1.12 to 2.45) had increased odds for being overweight/obese, while those in the middle wealth index category (OR: 0.56, $p = 0.045$, 95% CI: 0.32 to 0.99), age groups 10 – 13 years (OR: 0.61, $p = 0.020$, 95% CI: 0.40 to 0.90), 14 – 16 years (OR: 0.32, $p = 0.001$, 95% CI: 0.17 to 0.63) and 17 – 19 years (OR: 0.31, $p = 0.002$, 95% CI: 0.15 to 0.64) had lower odds of being overweight/obese.

Table 4.3: Indicators of under- and over-nutrition and the associated factors

	Height-for-Age		‡Weight-for-Age		Thinness	BMI-for-Age		Individual DBM	
	Stunted	Otherwise	Under-weight	Otherwise		Normal	Overweight/Obesity	Present	Otherwise
Overall Total	419 (34.9)	781 (65.1)	72 (13.5)	463 (86.5)	123 (10.3)	940 (78.3)	137 (11.4)	48 (4.0)	1152 (96.0)
State									
Osun	136 (22.7)	464 (77.3)	22 (7.4)	275 (92.6)	40 (6.7)	464 (77.3)	96 (16.0)	36 (6.0)	564 (94.0)
Gombe	283 (47.2)	317 (52.8)	50 (21.0)	188 (79.0)	83 (13.8)	476 (79.3)	41 (6.8)	12 (2.0)	588 (98.0)
	p < 0.001*		p < 0.001*			p < 0.001*		p < 0.001	
Residence									
Rural	206 (34.3)	394 (65.7)	38 (15.4)	209 (84.6)	77 (12.8)	481 (80.2)	42 (7.0)	16 (2.7)	584 (97.3)
Urban	213 (35.5)	387 (64.5)	34 (11.8)	254 (88.2)	46 (7.7)	459 (76.5)	95 (15.8)	32 (5.3)	568 (94.7)
	p = 0.672		p = 0.227			p < 0.001*		p = 0.018*	
Age groups									
6 – 9 years	45 (11.1)	362 (88.9)	41 (10.1)	366 (89.9)	44 (10.8)	294 (72.2)	69 (17.0)	12 (2.9)	395 (97.1)
10 – 13 years	177 (43.8)	227 (56.2)	31 (24.2)	97 (75.8)	32 (7.9)	325 (80.4)	47 (11.6)	20 (5.0)	384 (95.0)
14 – 16 years	109 (51.7)	102 (48.3)			30 (14.2)	169 (80.1)	12 (5.7)	11 (5.2)	200 (94.8)
17 – 19 years	88 (49.4)	90 (50.6)			17 (9.6)	152 (85.4)	9 (5.1)	5 (2.8)	173 (97.2)
	p < 0.001*		p < 0.001*			p < 0.001*		p = 0.309	
Sex									
Male	251 (41.8)	350 (58.2)	34 (12.6)	236 (87.4)	67 (11.1)	481 (80.0)	53 (8.8)	18 (3.0)	583 (97.0)
Female	168 (28.0)	431 (72.0)	38 (14.3)	227 (85.7)	56 (9.3)	459 (76.6)	84 (14.0)	30 (5.0)	569 (95.0)
	p < 0.001*		p = 0.554			p = 0.014*		p = 0.075	
Ethnicity									
Yoruba	165 (25.8)	474 (74.2)	22 (7.2)	283 (92.8)	41 (6.4)	506 (79.2)	92 (14.4)	37 (5.8)	602 (94.2)
Igbo	12 (31.6)	26 (68.4)	0 (0.0)	18 (100.0)	2 (5.3)	34 (89.5)	2 (5.3)	1 (2.6)	37 (97.4)
Hausa	73 (48.7)	77 (51.2)	12 (22.6)	41 (77.4)	15 (10.0)	127 (84.7)	8 (5.3)	3 (2.0)	147 (98.0)
Fulani	72 (49.0)	75 (51.0)	22 (33.3)	44 (66.7)	27 (18.4)	106 (72.1)	14 (9.5)	3 (2.0)	144 (98.0)
Minorities	97 (42.9)	129 (57.1)	16 (17.2)	77 (82.8)	38 (16.8)	167 (73.9)	21 (9.3)	4 (1.8)	222 (98.2)
	p < 0.001*		p < 0.001*			p < 0.001*		p = 0.022*	
Household wealth index									
Poorest	113 (47.1)	127 (52.9)	26 (25.5)	76 (74.5)	45 (18.8)	169 (70.4)	26 (10.8)	13 (5.4)	227 (94.6)
Poorer	83 (34.4)	158 (65.6)	19 (16.2)	98 (83.8)	28 (11.6)	180 (74.7)	33 (13.7)	10 (4.1)	231 (95.9)
Middle	80 (32.1)	169 (67.9)	15 (13.4)	97 (86.6)	18 (7.2)	208 (83.5)	23 (9.2)	6 (2.4)	243 (97.6)

Richer	73 (30.9)	163 (69.1)	11 (10.0)	99 (90.0)	24 (10.2)	191 (80.9)	21 (8.9)	12 (5.1)	224 (94.9)
Richest	70 (29.9)	164 (70.1)	1 (1.1)	93 (98.9)	8 (3.4)	192 (82.1)	34 (14.5)	7 (3.0)	227 (97.0)
	p < 0.001*		p < 0.001*		p < 0.001*			p = 0.373	
Family type									
Monogamous	346 (32.5)	718 (67.5)	54 (11.2)	427 (88.8)	107 (10.1)	833 (78.3)	124 (11.7)	45 (4.2)	1019 (95.8)
Polygamous	73 (53.7)	63 (46.3)	18 (33.3)	36 (66.7)	16 (11.8)	107 (78.7)	13 (9.6)	3 (2.2)	133 (97.8)
	p < 0.001*		p < 0.001*		p = 0.667			p < 0.001*	
Mother's education									
< Secondary	155 (41.4)	219 (58.6)	40 (24.5)	123 (75.5)	61 (16.3)	283 (75.7)	30 (8.0)	12 (3.2)	362 (96.8)
≥ Secondary	264 (32.0)	562 (68.0)	32 (8.6)	340 (91.4)	62 (7.5)	657 (79.5)	107 (13.0)	36 (4.4)	790 (95.6)
	p = 0.001*		p < 0.001*		p < 0.001*			p = 0.346	
Mother's Occupation									
Unemployed	105 (42.9)	140 (57.1)	26 (23.4)	85 (76.6)	47 (19.2)	178 (72.7)	20 (8.2)	3 (1.2)	242 (98.8)
Employed	314 (32.9)	641 (67.1)	46 (10.8)	378 (89.2)	76 (8.0)	762 (79.8)	117 (12.3)	45 (4.7)	910 (95.3)
	p = 0.003*		p = 0.001*		p < 0.001*			p = 0.013*	

*statistically significant

Table 4.4: Factors associated with malnutrition among school-aged children and adolescents in two Nigerian states using multinomial logistic regression analysis

^aTHINNESS								
Variables	Empty Model				Full Model			
	OR	p-value	95% CI		aOR	p-value	95% CI	
			Lower	Upper			Lower	Upper
State								
Gombe (R)								
Osun	0.49	0.001*	0.33	0.74	1.05	0.910	0.42	2.62
Residence								
Rural (R)								
Urban	0.63	0.018*	0.43	0.92	0.79	0.280	0.51	1.22
Age groups								
6 – 9 years (R)								
10 – 13 years	0.66	0.089	0.41	1.07	0.66	0.104	0.40	1.09
14 – 16 years	1.19	0.504	0.72	1.96	1.15	0.612	0.67	1.96
17 – 19 years	0.75	0.336	0.41	1.35	0.65	0.178	0.35	1.22
Sex								
Male (R)								
Female	0.88	0.491	0.60	1.28	0.91	0.619	0.61	1.34
Ethnicity								
Yoruba (R)								
Igbo	0.76	0.714	0.18	3.29	1.01	0.996	0.21	4.64
Hausa	1.47	0.226	0.79	2.75	0.99	0.988	0.34	2.92
Fulani	3.25	<0.001*	1.92	5.50	1.61	0.381	0.56	4.65
Minorities	2.82	<0.001*	1.75	4.55	2.63	0.040*	1.04	6.62
Wealth index								
Poorest (R)								
Middle	0.45	<0.001*	0.30	0.69	0.55	0.016*	0.34	0.89
Richest	0.16	<0.001*	0.07	0.34	0.25	0.002*	0.10	0.60
Family type								
Monogamous (R)								
Polygamous	1.16	0.597	0.66	2.04	0.82	0.508	0.45	1.49
Mother's education								
< Secondary (R)								
≥ Secondary	0.44	<0.001*	0.30	0.64	0.77	0.294	0.47	1.26
Mother's Occupation								
Employed (R)								
Unemployed	2.51	<0.001*	1.68	3.74	1.64	0.047*	1.01	2.68
^aOVERWEIGHT								
State								
Gombe (R)								
Osun	2.40	<0.001*	1.63	3.54	2.30	0.057	0.98	5.11
Residence								
Rural (R)								
Urban	2.37	<0.001*	1.61	3.48	2.63	<0.001*	1.68	4.61
Age groups								
6 – 9 years (R)								
10 – 13 years	0.62	0.018*	0.41	0.92	0.61	0.020*	0.40	0.90
14 – 16 years	0.30	<0.001*	0.16	0.57	0.32	0.001*	0.17	0.63
17 – 19 years	0.25	<0.001*	0.12	0.52	0.31	0.002*	0.15	0.64
Sex								
Male (R)								

Female	1.66	0.007*	1.15	2.40	1.63	0.011*	1.12	2.45
Ethnicity								
Yoruba (R)								
Igbo	0.47	0.219	0.14	1.56	0.58	0.405	0.16	2.09
Hausa	0.28	0.002*	0.13	0.62	0.66	0.496	0.20	2.17
Fulani	0.53	0.056	0.27	1.02	0.80	0.707	0.25	2.56
Minorities	0.58	0.042*	0.35	0.98	1.35	0.536	0.52	3.48
Wealth index								
Poorest (R)								
Middle	0.86	0.549	0.54	1.39	0.56	0.045*	0.32	0.99
Richest	1.15	0.617	0.66	2.00	0.61	0.151	0.31	1.20
Family type								
Monogamous (R)								
Polygamous	0.82	0.511	0.45	1.50	1.35	0.386	0.68	2.68
Mother's education								
< Secondary (R)								
≥ Secondary	11.54	0.049*	1.00	2.36	1.05	0.869	0.61	1.81
Mother's Occupation								
Employed (R)								
Unemployed	0.63	0.087	0.37	1.07	0.98	0.937	0.53	1.80

*Statistically significant OR – odds ratio; aOR – adjusted odds ratio; CI – confidence interval; R – reference value

^a Base outcome or comparator was the “normal” category

4.5 Discussion

The findings of the present study show that the overall prevalence rates for under- and over-nutrition were relatively high compared to what had been previously reported in Nigeria.^{123,137} The prevalence rate for overweight/obesity (11.4%) was similar to prevalence rates for underweight (13.5%) and thinness (10.3%) in the same population, typifying the DBM at the population level. The DBM was also found at the individual level, with 4% of the children being stunted and overweight/obese at the same time. Although, much attention has not been given to DBM in Nigeria previously, recent studies have similarly reported the DBM at population and individual levels among different Nigerian populations^{183–185}. This is important because most nutrition interventions for Nigerian children before now have focused on undernutrition alone¹⁴¹, but with the current knowledge, attention must be paid to both under- and over-nutrition. The DBM has also been reported in several other African countries, and in nearly all regions of the continent^{114,187,188}. The rate of nutritional shift, and the DBM in Africa has become so alarming that the WHO has constituted a committee to develop a strategic plan to reduce the DBM in the Africa region.¹⁸⁹

Using the BMI-for-age categories, undernutrition (thinness) and over-nutrition (overweight/obesity) rates were 10.2% and 11.4% respectively. Most of the previous studies carried out in Nigeria that used BMI-for-age categories, especially those carried out more than 5 years ago, reported thinness being considerably higher than overweight/obesity^{71,76,80,134}. Omigbodun *et al.*⁸⁰ who conducted a similar study among adolescents in southwestern Nigeria in 2010, for example, reported 18.9% and 2.3% as prevalence rates for thinness and overweight/obesity respectively, while Fetuga *et al.*⁷⁶ reported 22.2% and 3.5% respectively for a similar study among school-aged children in 2011. The present study however, is reporting a slightly higher prevalence of overweight/obesity than that of thinness, with about a fifth of children in Osun State, urban dwellers and school-aged children being overweight/obese. These results are in line with recent Nigerian studies by Asiegbu *et al.* in 2017¹⁹⁰, Onoja *et al.* in 2019¹⁹¹ and Olasinde *et al.* in 2020¹⁹² all reporting higher rates of overweight/obesity than thinness among children 6 – 19 years.

The prevalence of childhood overweight/obesity has been increasing globally, and Nigeria is not exempted. UNICEF reported increases from 2% to 8% for Nigeria within 2 years from 2017¹³⁷ to 2019¹²³. The overall prevalence of overweight/obesity in this study (11.4%) is higher than what UNICEF reported for Nigeria and sub-Sahara Africa¹²³. The prevalence rates in Osun State

for children 6 – 19 years old and those from the wealthiest households are already nearing the global average of 18% among adolescents ¹²³. Similarly, recent Nigerian studies by Otuneye *et al.* ¹¹ Omisore *et al.* ²⁹ and Bello *et al.* ¹⁹³ carried out among children 6 – 19 years from different parts of the country reported prevalence rates between 10.4% to 15.4% for overweight/obesity. This increasing prevalence of overweight/obesity among older children in Nigeria and other LMIC has been attributed to nutrition transition, with increased adoption of westernized diets and reduced energy expenditure ^{180,181}. Urbanization, shifts in occupational structure and globalization, e.g. changing food environments, have been reported as the root cause for the nutrition transition ¹⁸⁰.

On the other hand, the present study shows persistent under-nutrition among school-aged children and adolescents in the study population, and possibly in Nigeria as a whole. More than a third of the children in this study were stunted, which is more than the 33% reported by UNICEF ¹². Particularly alarming is the prevalence rate of stunting, reaching nearly 50% in Gombe State, among older adolescents, in Hausa and Fulani ethnic groups and in the poorest households. The prevalence of underweight, measured using WFA reference values, was also a concern, with a third of Fulani children and a quarter of younger adolescents and children from the poorest wealth index being underweight. This paradoxical co-existence of overweight/obesity and undernutrition in the present study typifies the DBM (i.e. under- and over-nutrition) ³.

After controlling for possible confounding variables using the multivariate analysis, older children from the minority tribes had 3 times higher likelihood of thinness compared to those from the Yoruba ethnic group. Regional and ethnic variation in malnutrition among Nigerian children has been reported by previous researchers ^{184,194}. Similarly, those whose mothers were unemployed had 2 times higher likelihood for thinness compared to those with employed mothers. School-aged children and adolescents in the middle wealth index group had 45% less likelihood while those in the riches wealth index group had 75% less likelihood of thinness than those in the poorest wealth index group. This finding further underscores the importance of socio-economic and household factors in the nutritional status of the child, as has been previously reported by other studies in Nigeria and sub-Saharan Africa ^{81,125,195,196}.

Concerning the predictors of overweight/obesity, urban dwellers were 3 times more likely to be overweight/obese than rural dwellers. Urban-rural differentials in childhood malnutrition has been previously established ^{29,191,195}. Urbanization has been associated with nutrition transition,

and hence with increasing prevalence of overweight/obesity^{180,181}. Furthermore, females were 2 times more likely to be overweight/obese than boys, and the likelihood for overweight/obesity reduced with increasing age groups of the children and adolescents. The pattern of distribution of over-nutrition (overweight/obesity) across sex and age groups seems to be consistent in most of the studies, with overweight/obesity higher in the girls and younger age groups^{192,197-199}. The findings of the present study corroborated this pattern, with the children 6 – 9 years and girls having significantly higher prevalence rates of overweight/obesity.

A limitation of this study is that it cannot not be generalized to all of Nigeria, because only 2 out of 36 states were involved in the study. The cross-sectional nature of the study also means that causality cannot be determined in this study. Lastly, this study did not set out to exhaust the many complex explanatory factors for both under-nutrition and over-nutrition among school-aged children and adolescents. Possible area for further research would be to explore the determinants of the double burden of malnutrition, using both qualitative and quantitative approaches.

4.6 Conclusion

The study found evidence of DBM both at population and individual levels. The overall prevalence rate of stunting was 34.9%, underweight was 13.5%, thinness was 10.3%, overweight/obese was 11.4% and 4.0% had individual level DBM in the study. These rates differed significantly across the demographic, socio-economic and household/family characteristics. There is the need for government and all other stakeholders to design nutrition educational programmes that will target both under- and over-nutrition among older children in the different contexts.

CHAPTER FIVE: Individual and Contextual Factors associated with Under- and Over-Nutrition among School-Aged Children and Adolescents in two Nigerian States; A Multi-Level Analysis

Table 5.1: Journal information and publication status of Paper 3

Journal	Public Health Nutrition
Manuscript number	PHN-RES-2021-0891
Manuscript type	Research article
Authors	Adeleye Abiodun Adeomi; Adesegun Fatusi; Kerstin Klipstein-Grobusch
Corresponding author	Adeleye Abiodun Adeomi
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5.1 Abstract

Objective: This study aimed to identify individual and contextual factors that are associated with under- and over-nutrition among school-aged children and adolescents in two Nigerian states

Design: Community-based cross-sectional study

Setting: The study was carried out in rural and urban communities of Osun and Gombe States in Nigeria.

Participants: A total of 1,200 school-aged children and adolescents

Results: Multilevel analysis showed that the full models accounted for about 82% and 39% of the odds of thinness or overweight/obese across the communities respectively. Household size (aOR 1.10; $p = 0.001$; 95% CI 1.04 to 1.16) increased the odds, while the upper wealth index (aOR 0.43; $p = 0.016$; 95% CI 0.22 to 0.86) decreased the odds of thinness. Age (aOR 0.86; $p < 0.001$; 95% CI 1.26 to 8.70), exclusive breastfeeding (aOR 0.46; $p = 0.010$; 95% CI 0.25 to 0.83), physical activity (aOR 0.55; $p = 0.001$; 95% CI 0.39 to 0.78) and the upper wealth index (aOR 0.47; $p = 0.018$; 95% CI 0.25 to 0.88) were inversely related with overweight/obesity, while residing in Osun State (aOR 3.32; $p = 0.015$; 95% CI 1.26 to 1.70), female gender (aOR 1.73; $p = 0.015$; 95% CI 1.11 to 2.69) and screen time > 2 hours/day (aOR 2.33; $p = 0.005$; 95% CI 1.29 to 4.19) were positively associated with overweight/obesity.

Conclusions: The study shows that selected community and individual-level factors are strongly associated with thinness and overweight/obesity among school-aged children and adolescents.

5.2 Introduction

Obesity is a global challenge, and the prevalence of overweight and obesity is increasing at a faster rate in low- and middle-income countries as compared to high income countries (HIC).⁵ At the same time, the challenge of undernutrition persists still in many low- and middle-income countries¹³⁷. Thus, many low and middle-income countries (LMIC) are confronted with a double burden of malnutrition (DBM),¹⁸ with co-existing high level of undernutrition and an increasing level of over-nutrition.³ Several factors are associated with malnutrition, and the ecological systems model has been proposed to understand child nutrition processes.¹¹⁸ Ecological systems are the contextual factors within which individuals are nested,^{115,116}.

While the ecological systems theory recognizes the impact of the child's individual factors in affecting development, it conceptualizes that these factors are just one group out of many others.^{115,119} In the original work on the ecological systems theory, four different inter-related environments are identified, with the microsystem as the most proximal level, followed by the mesosystem, the exosystem, and the macrosystem level. While the most proximal level reflects individual and intrafamilial processes, the outermost system reflects the cultural, religious and socio-economic organization of the community.^{115,119} The chronosystem is the fifth and final level of Bronfenbrenner's ecological systems theory; it encompasses the concept of time and consists of the environmental changes and transitions that occur over the lifetime and influence the child's development. The theory was later updated to emphasize the important role the individual plays in the development process.¹¹⁶ It was hypothesized that human development was the result of the interplay among four processes: person, context, process and time, with "person" factors to mean individual characteristics, the "context" to refer to the external factors described in the original work on the ecological systems theory, the "process" to refer to the interaction between the person and the context and this development to be understood with reference to "time".^{116,119}

Most of the research efforts targeted at identifying the determinants of the nutritional status of school-aged children and adolescents have focused mainly at the individual factors alone. A number of studies have reported a significant relationship between nutritional status and such factors as age and gender of the child,^{15,50,51,79} residence,^{62,80-82} physical activity,^{43,83} and feeding patterns^{49,81,84} of children. However, there is little evidence on the relationship between the nutritional status of school-aged children and adolescents and the communities within which the children live. Little or no evidence exists in Nigeria about the relationship between the nutritional

status of this group of children and community level factors, and very few studies have explored ecological factors as determinants of child nutrition beyond the individual factors.

There is a need to focus on the determinants of the nutritional status of school-aged children and adolescents in Nigeria, because identifying the determinants has not been the focus of most research efforts on the subject in Nigeria.^{72,74,75} The interest of majority of the researchers in this field in Nigeria has been the assessment and description of the nutritional status. Identifying the determinants is important, not only in improving the understanding about the subject, but especially in planning appropriate nutrition interventions for the children.

Identifying the individual and contextual determinants, using multi-level modelling however, has added advantages. Firstly, conventional regression models assume the units of analysis are not dependent, and this is not usually true. This error may then lead to over-estimation of statistical significance.²⁰⁰ Designing interventions based on erroneous evidence may lead to ineffectiveness of such interventions. Additionally, identifying the contextual determinants will help to understand the dynamics of the influence of the contextual units,²⁰⁰ and especially the potentials they hold for reducing the burden of a complex health challenge such as the double burden of under- and over-nutrition.

While multi-level modelling has been used to explain the determinants of the nutritional status of children under the age of five years in Nigeria,^{95,194} to date, data are lacking for school-aged children and adolescents in Nigeria. This study, therefore, aimed to identify individual and contextual factors that are associated with either under- or over-nutrition among both school-aged children and adolescents in two Nigerian states.

5.3 Materials and Methods

5.3.1 Study design and setting

This community-based cross-sectional study was carried out in two Nigerian states. School-aged children and adolescents aged between 6 and 19 years and their mothers formed the study population. The sample size was calculated to get an absolute precision of $\pm 5\%$ for prevalence estimates using STATCALC on the Epi-Info software,¹⁸⁶ and a design effect of 1.5, which is an adjustment for the sampling technique (multi-stage) used. After correcting for an anticipated non-response rate of 10%, the sample size came to 561 and was rounded off to 600 for each state, making a total of 1,200.

The classification of Nigeria's six geo-political zones in Nigeria according to their wealth index by the NDHS¹²⁵ was used in selecting the states for this study. One state each from the zones with the lowest (North-east zone) and the highest wealth index (South-west zone) were selected using simple random sampling technique (balloting method). Selection of states were done according to wealth index and geo-political zones because these were the two most consistent factors that were significantly associated with malnutrition from previous similar studies in Nigeria.^{95,194,201} Gombe and Osun States were selected from the North-east and the South-west zones respectively. The 1,200 children 6-19 years old and their mothers who constituted the study population were then selected using the multi-stage sampling technique.

5.3.2 Data collection

Data collection was carried out with interviewer-administered pre-tested structured questionnaires using REDCap,¹⁵² a data collection software installed on electronic tablets. The mothers were the respondents for the sections on general characteristics of the child, household/family characteristics and community factors. The school-aged children or adolescents responded to the sections on the dietary diversity, physical activity patterns and pubertal staging. Anthropometric measurements of the children and mothers were taken according to standard protocols recommended by the International Society for the Advancement of Kinanthropometry.¹⁵³ Weight was measured in 0.1 kilograms by use of a Omron® electronic bathroom weighing scale. Height was measured to the nearest 0.1 meter using a stadiometer. Weighing scales were routinely standardized by the use of known weights.

Screen time was the time in hours that the child spent with television, computer, video games or phones per day. The physical activity was assessed using the physical activity questionnaire for older children and adolescents by Kowalski et al,¹⁴⁹ from which a composite score of 1 to 5 was derived (higher scores represent higher physical activity levels).

5.3.3 Statistical analyses

5.3.3.1 Measures

The primary outcome/dependent variable was the nutritional status, which was assessed using the BMI-for-age according to WHO reference values.³⁵ It was categorized into (1) thinness (2) normal (3) overweight/obese. The independent variables used were those that had been previously reported from similar studies^{95,194} and are presented in Table 5.2. The independent variables consist of three groups of variables: individual, household, and community level

factors, but the individual and household level factors were collapsed into the individual level factors for the multi-level analysis. Communities were taken as those who shared a common enumeration area, which served as the primary sampling unit. Household wealth index was calculated using ownership of some household possessions, as it was used by the NDHS.¹²⁵ Principal component analysis was then used to produce a common factor score (household wealth index score) for each household. These scores were used to categorize wealth index into three (1) poor (2) middle (3) rich. The community wealth index was calculated by finding the median wealth index score for each community, and these were then categorized into (1) low and (2) high using the median value. Pubertal staging was assessed using the Tanner pubertal self-rating scale²⁰²

5.3.3.2 Data analysis

The data were analyzed by use of STATA version 15.1.²⁰³ At the bivariate level, cross-tabulations were done using Pearson's chi-squared test for the categorical variables. The Mann-Whitney U and Kruskal-Wallis tests (non-parametric) were used to test for association among the continuous variables with 2 and more than 2 independent variables respectively. These tests were used because the continuous variables were not normally distributed.

Two-level multi-level binary logistic regression analysis was done to investigate the extent to which the individual and community level factors explained the variation in under- and over-nutrition in the two Nigerian states. This involved 1,200 school-aged children and adolescents (level 1) nested within 40 communities (level 2). Enumeration areas (EAs), as demarcated by the National Population Commission for 2006 population census in Nigeria,¹²⁹ were used as communities in this study, and a total of 40 EAs were selected (20 in each of the two states). Two separate multi-level analyses identified the individual and contextual factors associated with either under- or over-nutrition. Hence, the nutritional status of the school-aged children and adolescents, which was initially categorized into (1) thinness (2) normal (3) overweight/obese, was recoded to form 2 different dependent variables which were thinness (categorized as (1) thinness (0) otherwise) and overweight/obesity (categorized as (1) overweight/obese (0) otherwise). Firstly, thinness was retained as "thinness", while normal and overweight/obesity were merged as "otherwise" (1 - Thinness, 0 - otherwise). For the second dependent variable, overweight/obesity were retained as such, while normal and thinness were merged as "otherwise" (1 – overweight/obesity, 0 - otherwise). Six models each (total of 12 models) were fitted in all. The first model (Model 0) was the empty model, and the second model (Model 1)

considered only the states (Osun and Gombe States), while the third model (Model 2) incorporated the child characteristics to Model 1. The fourth model (Model 3) incorporated the household/family characteristics into the first model. The community level factors alone were considered in the fifth model (Model 4), while the sixth model (Model 5) is the full model that incorporated all factors into the multi-level analysis. Ethnicity was not included because of a high variance inflation factor (VIF) when multi-collinearity diagnostics were done.

The fixed effects were used as the measures of association and expressed as adjusted odds ratio (aOR) with the 95% confidence intervals and the p-values. The random effects, which measured variations, were intra-class correlation (ICC) or the variance partition coefficient (VPC) and the proportional change in variance (PCV). Akaike information criteria (AIC) were used to determine the goodness of fit of the models, where a lower value indicated a better fit.²⁰⁴ The covariance structure applied in the analysis was the independent structure, which is the default for the STATA software.

5.3.4 Ethics

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Human Research Ethics Committee of University of the Witwatersrand (certificate No: M190514), and the ministry of health in Osun (certificate No: OSHREC/PRS/569T/155) and Gombe (certificate No: MOH/ADM/621/1/142) States. Written informed consent was obtained from all subjects/patients.

Table 5.2: Definitions for independent variables

Independent Variables	Description
Individual level factors	
Age of child (years)	Expressed as a continuous variable
Sex of child	Categorized into (1) male (2) female
Birth order	Categorized into (1) 1 (2) 2 – 4 (3) > 4
Education	Categorized into (1) currently in school (2) previously in school (3) never in school
Birth weight	Categorized into (1) low < 2.5kg (2) normal 2.5 – 4 kg (3) > 4 kg
Breastfeeding duration	Expressed as a continuous variable (months)
Immunization status	Categorized into (1) complete (2) incomplete
Birth place	Categorized into (1) others (2) hospital
Exclusively breastfed for 6 months	Categorized into (1) yes (2) no
Child's health	This is the mother's perception of the child's health and it was categorized into (1) very good (2) good (3) not too good
Puberty stage	Categorized into stages 1 to 5 (Tanner staging)
Screen time (in hours)	Categorized as (1) < 2 hours (2) ≥ 2 hours
Physical activity	Expressed as continuous variable (scores)
Household/family factors	
Household size	Expressed as continuous variable
Number of children	Expressed as continuous variable
Wealth index	Categorized into (1) Poor (2) Middle (3) Rich
Marital status	Categorized into (1) single (2) married (3) previously married
Family type	Categorized into (1) monogamous (2) polygamous
Maternal education	Categorized into (1) less than secondary (2) secondary or more
Father's education	Categorized into (1) less than secondary (2) secondary or more
Mother's unemployment	Categorized into (1) employed (2) unemployed
Community level factors	
State	Categorized into (1) Gombe (2) Osun
Residence	Categorized into (1) rural (2) urban
Community wealth index	Categorized into (1) low (2) high, using the median of the community wealth index scores as reference
Maternal education	Categorized into (1) low (2) high, using the median as reference
Safe water	Categorized into (1) low (2) high, using the median as reference

5.4 Results

The prevalence rates of thinness and overweight/obesity were 10.3% and 11.4% respectively, while 21.7% had one form of malnutrition or the other (Figure 5.1). Gombe State has a higher prevalence of thinness (13.8% vs. 6.7%) and lower prevalence of overweight/obesity (6.8% vs. 16.0%). The prevalence rate of malnutrition (under- and over-nutrition) was 22.7% for Osun State, 20.6% for Gombe State. The distribution of the individual and community level factors according to the two States (i.e. Gombe and Osun States) are shown in Table 5.2 below.

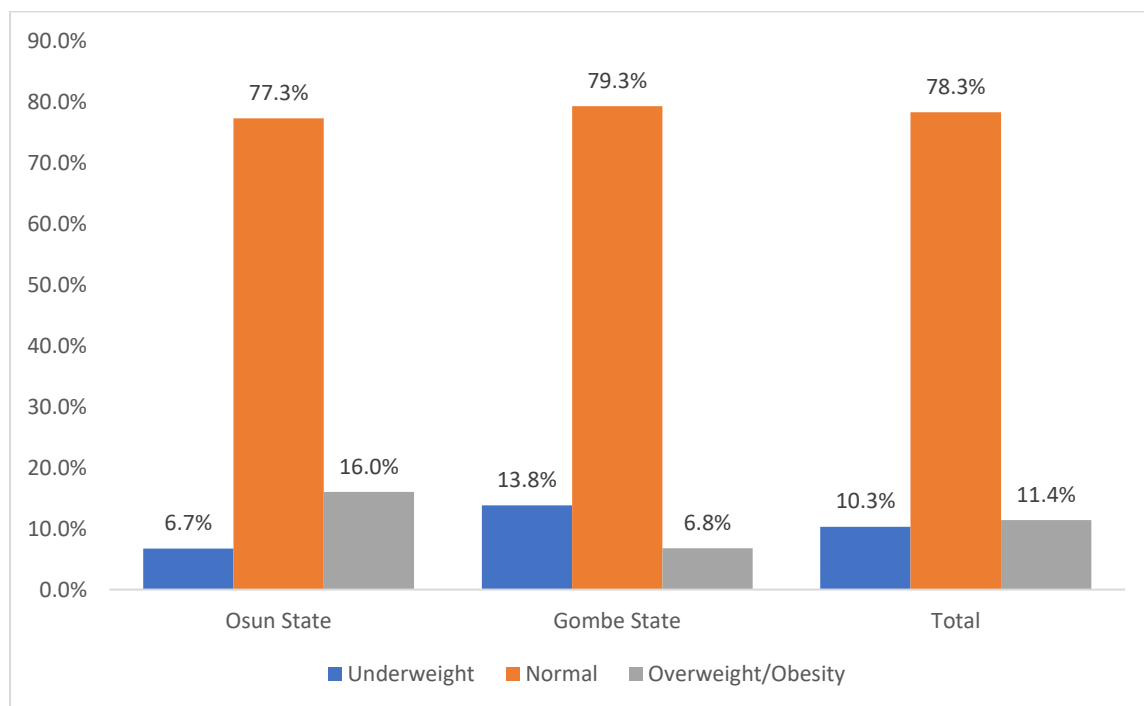


Figure 5.1: Distribution of the nutritional status among school-aged children and adolescents by state

Table 5.3: Distribution of individual and community level factors by States

Variables	State (%)		
	Osun (n = 600)	Gombe (n = 600)	Total (N = 1200)
INDIVIDUAL LEVEL FACTORS – Child characteristics			
Age of the child (IR)	11.0 (5.0)	12.0 (7.0)	11.0 (6.0)
Breastfeeding duration (months)(IR)	18.0 (8.0)	18.0 (3.0)	18.0 (9.0)
Sex			
Male	278 (46.3)	323 (53.8)	601 (50.1)
Female	322 (53.7)	277 (46.2)	599 (49.9)
Child education			
Currently in-school	576 (96.0)	530 (88.3)	1106 (92.2)
Previously in-school	23 (3.8)	34 (5.7)	57 (4.8)
Never attended school	1 (0.2)	36 (6.0)	37 (3.1)
Birth weight of the Child			
Small (< 2.5kg)	56 (9.3)	111 (18.5)	167 (13.9)
Normal (2.5 – 4kg)	415 (69.2)	417 (69.5)	832 (69.3)
Big (> 4kg)	129 (21.5)	72 (12.0)	201 (16.8)
Birth place of the Child			
Others	91 (15.2)	128 (21.3)	219 (18.3)
Hospital	509 (84.8)	472 (78.7)	981 (81.8)
Exclusively breastfed for 6 months			
No	90 (15.0)	406 (67.7)	496 (41.3)
Yes	510 (85.0)	194 (32.3)	704 (58.7)
Immunization status of Child			
Complete	550 (91.7)	422 (70.3)	972 (81.0)
Incomplete	50 (8.3)	178 (29.7)	228 (19.0)
Birth Order of the Child			
1	321 (53.5)	275 (45.8)	596 (49.7)
2 – 4	257 (42.8)	215 (35.8)	472 (39.3)
> 4	22 (3.7)	110 (18.3)	132 (11.0)
Screen time (IR)	3.3 (3.0)	2.0 (3.3)	2.6 (3.0)
Physical activity scores (IR)	2.4 (1.1)	2.1 (1.0)	2.2 (1.0)
Child's health			
Very good	352 (58.7)	147 (24.5)	499 (41.6)
Good	237 (39.5)	350 (58.3)	587 (48.9)
Not too good	11 (1.8)	103 (17.2)	114 (9.5)
Pubertal Staging			
Stage 1	141 (23.5)	189 (31.5)	330 (27.5)
Stage 2	214 (35.7)	190 (31.7)	404 (33.7)
Stage 3	167 (27.8)	160 (26.7)	327 (27.3)
Stage 4	66 (11.0)	50 (8.3)	116 (9.7)
Stage 5	12 (2.0)	11 (1.8)	23 (1.9)
INDIVIDUAL LEVEL FACTORS –Household/ Family level factors			
Household size (IR)	5.0 (2.0)	7.0 (6.0)	6.0 (3.0)
Children in the household (IR)	3.0 (2.0)	4.0 (3.0)	4.0 (2.0)
Household wealth index			
Poor	195 (32.5)	205 (34.2)	400 (33.3)
Middle	211 (35.2)	189 (31.5)	400 (33.3)
Rich	194 (32.3)	206 (34.3)	400 (33.3)
Marital status			
Single	5 (0.8)	3 (0.5)	8 (0.7)
Married	558 (93.0)	567 (94.5)	1125 (93.8)

Previously married	37 (6.2)	30 (5.0)	67 (5.6)
Family type			
Monogamous	561 (93.5)	503 (83.8)	1064 (88.7)
Polygamous	39 (6.5)	97 (16.2)	136 (11.3)
Maternal education			
Less than secondary	144 (24.0)	230 (38.3)	374 (31.2)
Secondary or more	456 (76.0)	370 (61.7)	826 (68.8)
Father's education			
Less than secondary	109 (18.2)	122 (20.3)	231 (19.3)
Secondary or more	491 (81.8)	478 (79.7)	969 (80.8)
Mother's Employment			
Employed	573 (95.5)	382 (63.7)	955 (79.6)
Unemployed	27 (4.5)	218 (36.3)	245 (20.4)
COMMUNITY LEVEL FACTORS			
Residence			
Rural	300 (50.0)	300 (50.0)	600 (50.0)
Urban	300 (50.0)	300 (50.0)	600 (50.0)
Community wealth index			
Low	300 (50.0)	300 (50.0)	600 (50.0)
High	300 (50.0)	300 (50.0)	600 (50.0)
Maternal education			
Low	240 (40.0)	360 (60.0)	600 (50.0)
High	360 (60.0)	240 (40.0)	600 (50.0)
Safe water			
Low	210 (35.0)	270 (45.0)	480 (40.0)
High	390 (65.0)	330 (55.0)	720 (60.0)

IR, interquartile range; Screen time, time spent watching television, with phone, computer or computer

The description of all individual and community level factors according to the states is shown in Supplementary Table 1. As Table 5.4 shows, all the child characteristics had a statistically significant association with the nutritional status of the respondents ($p < 0.05$) at the bivariate analysis level, except education ($p = 0.86$), birth order ($p = 0.06$) and pubertal staging ($p = 0.06$). All the household/family factors had a statistically significant association with the nutritional status of the older children ($p < 0.05$), except marital status ($p = 0.61$) and family type ($p = 0.67$). All the community level factors had a statistically significant association with the nutritional status of the children ($p < 0.001$).

Tables 5.5 shows the results of the multi-level analyses for thinness (under-nutrition), highlighting the fixed and random effects. The full model shows that household size (aOR 1.10; $p = 0.001$; 95% CI 1.04 to 1.16) and the uppermost wealth index (rich) (aOR 0.43; $p = 0.016$; 95% CI 0.22 to 0.86) had significant positive and inverse associations with thinness respectively. Concerning the measures of variations for thinness, as shown with the random effects on Table 3, the ICC for the intercept only model (i.e. no explanatory variable) was 21.6%. This implies that 21.6% of the variation in the odds of thinness were attributable to community level variables, and this was statistically significant ($p < 0.001$). The Models 1, 2, 3, 4 and 5 account for about 22.1%, 51.8%, 41.2%, 56.7% and 80.2% in the odds of under-nutrition across the communities, as explained by the PCV. The model with the best fit is Model 3, which controlled for State and the Household/family characteristics, with AIC of 740.41 compared with 753.3 for the empty model (Model 0).

Table 5.6 shows the results of the multi-level analysis for overweight/obesity (over-nutrition). Age (aOR 0.86; $p < 0.001$; 95% CI 1.26 to 8.70), exclusive breastfeeding (aOR 0.46; $p = 0.010$; 95% CI 0.25 to 0.83), physical activity (aOR 0.55; $p = 0.001$; 95% CI 0.39 to 0.78) and the rich wealth index (aOR 0.47; $p = 0.018$; 95% CI 0.25 to 0.88) had an inverse relationship with overweight/obesity, while residing in Osun State (aOR 3.32; $p = 0.015$; 95% CI 1.26 to 1.70), female gender (aOR 1.73; $p = 0.015$; 95% CI 1.11 to 2.69) and screening time > 2 hours/day (aOR 2.33; $p = 0.005$; 95% CI 1.29 to 4.19) were positively associated with overweight/obesity. The empty model (Model 0) shows a statistically significant variation in the odds of childhood overweight/obesity across the communities ($p < 0.001$). As indicated by the ICC, 28.5% of the variance in the odds of overweight/obesity among the children could be ascribed to community level factors. The Models 1, 2, 3, 4 and 5 account for about 23.4%, 35.3%, 18.2%, 48.1% and 39.2% in the odds of over-nutrition across the communities, as explained by the PCV. The statistically significant variation across communities persisted even after controlling for all the

variables ($p < 0.001$). Model 2, which controlled for the state and child characteristics had the best fit with AIC of 752.76. (Table 4)

Table 5.4: Association between the individual and community level factors and nutritional status at bivariate analysis level

Variables	Nutritional status (%)			Statistics
	Thinness	Normal	Overweight/ Obesity	
INDIVIDUAL LEVEL FACTORS – Child characteristics				
Age of the child (IR)	12.0 (7.0)	12.0 (6.0)	10.0 (4.0)	$\dagger p < 0.001^*$
Breastfeeding duration (months)(IR)	18.0 (8.0)	18.0 (9.0)	18.0 (8.0)	$\dagger p = 0.046^*$
Sex				
Male	67 (11.1)	481 (80.0)	53 (8.8)	$p = 0.014^*$
Female	56 (9.3)	459 (76.6)	84 (14.0)	
Child education				
Currently in-school	116 (10.5)	866 (78.3)	124 (11.2)	$p = 0.855$
Previously in-school	4 (7.0)	45 (78.9)	8 (14.0)	
Never attended school	3 (8.1)	29 (78.4)	5 (13.5)	
Birth weight of the Child				
Small (< 2.5kg)	17 (10.2)	135 (80.8)	15 (9.0)	$p = 0.003^*$
Normal (2.5 – 4kg)	91 (10.9)	629 (75.6)	112 (13.5)	
Big (> 4kg)	15 (7.5)	176 (87.6)	10 (5.0)	
Birth place of the Child				
Others	32 (14.6)	167 (76.3)	20 (9.1)	$p = 0.042^*$
Hospital	91 (9.3)	773 (78.8)	117 (11.9)	
Exclusively breastfed				
No	65 (13.1)	385 (77.6)	46 (9.3)	$p = 0.006^*$
Yes	58 (8.2)	555 (78.8)	91 (12.9)	
Immunization status of Child				
Not immunized	6 (28.6)	13 (61.9)	2 (9.5)	$p = 0.012^*$
Partially immunized	26 (16.5)	116 (73.4)	16 (10.1)	
Fully immunized	86 (8.8)	773 (79.5)	113 (11.6)	
Not sure	5 (10.2)	38 (77.6)	6 (12.2)	
Birth Order of the Child				
1	58 (9.7)	460 (77.2)	78 (13.1)	$p = 0.063$
2 – 4	53 (11.2)	366 (77.5)	53 (11.2)	
> 4	12 (9.1)	114 (86.4)	6 (4.5)	
Screen time (hours)(IR)	2.0 (3.0)	2.8 (3.2)	3.0 (3.0)	$\dagger p < 0.001^*$
Physical activity scores (IR)	2.0 (1.1)	2.3 (1.0)	2.1 (0.8)	$\dagger p < 0.001^*$
Child's health				
Very good	39 (7.8)	391 (78.4)	69 (13.8)	$p < 0.001^*$
Good	57 (9.7)	473 (80.6)	57 (9.7)	
Not too good	27 (23.7)	76 (66.7)	11 (9.6)	
Pubertal Staging				
Stage 1	32 (9.7)	268 (81.2)	30 (9.1)	$p = 0.061$
Stage 2	37 (9.2)	328 (81.2)	39 (9.7)	
Stage 3	35 (10.7)	238 (72.8)	54 (16.5)	
Stage 4	16 (13.8)	89 (76.7)	11 (9.5)	
Stage 5	3 (13.0)	17 (73.9)	3 (13.0)	
INDIVIDUAL LEVEL FACTORS –Household/Family Characteristics				
Household size (IR)	7.0 (5.0)	6.0 (3.0)	5.0 (2.0)	$\dagger p < 0.001^*$
Children in the household (IR)	5.0 (3.0)	4.0 (2.0)	3.0 (1.0)	$\dagger p < 0.001^*$

Household wealth index				
Poor	61 (15.3)	294 (73.5)	45 (11.3)	p < 0.001*
Middle	44 (11.0)	312 (78.0)	44 (11.0)	
Rich	18 (4.5)	334 (83.5)	48 (12.0)	
Marital status				
Single	1 (12.5)	5 (62.5)	2 (25.0)	p = 0.606
Married	117 (10.4)	879 (78.1)	129 (11.5)	
Previously married	5 (7.5)	56 (83.6)	6 (9.0)	
Family type				
Monogamous	107 (10.1)	833 (78.3)	124 (11.7)	p = 0.667
Polygamous	16 (11.8)	107 (78.7)	13 (9.6)	
Mother's education				
Less than secondary	61 (16.3)	283 (75.7)	30 (8.0)	p < 0.001*
Secondary or more	62 (7.5)	657 (79.5)	107 (13.0)	
Father's education				
Less than Secondary	35 (15.2)	170 (73.6)	26 (11.3)	p = 0.023*
Secondary or more	88 (9.1)	770 (79.5)	111 (11.5)	
Mother's Employment				
Employed	77 (8.1)	759 (79.5)	119 (12.5)	p < 0.001*
Unemployed	46 (18.8)	181 (73.9)	18 (7.3)	
COMMUNITY LEVEL FACTORS				
State				
Gombe	83 (13.8)	476 (79.3)	41 (6.8)	p < 0.001*
Osun	40 (6.7)	464 (77.3)	96 (16.0)	
Residence				
Rural	77 (12.8)	481 (80.2)	42 (7.0)	p < 0.001*
Urban	46 (7.7)	459 (76.5)	95 (15.8)	
Community wealth index				
Low	79 (13.2)	477 (79.5)	44 (7.3)	p < 0.001*
High	44 (7.3)	463 (77.2)	93 (15.5)	
Mother's education				
Low	85 (14.2)	472 (78.7)	43 (7.2)	p < 0.001*
High	38 (6.3)	468 (78.0)	94 (15.7)	
Safe water				
Low	69 (14.4)	370 (77.1)	41 (8.5)	p < 0.001*
High	54 (7.5)	570 (79.2)	96 (13.3)	

IR, interquartile range; Screen time, time spent watching television, with phone, computer or computer

* Statistically significant

† Kruskal-Wallis test (Non-parametric) was used because the variables were not normally distributed

Table 5.5: Individual and contextual factors associated with thinness among school-aged children and adolescents in two Nigerian states using a two-level multi-level analysis

Variables	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5
	Odds Ratio (95% Confidence interval)					
States						
Gombe ®						
Osun		*0.499 (0.25, 0.99)	0.521 (0.25, 1.09)	0.576 (0.29, 1.14)	0.620 (0.33, 1.16)	0.696 (0.33, 1.48)
INDIVIDUAL LEVEL FACTORS – Child characteristics						
Age			0.977 (0.92, 1.04)			0.976 (0.91, 1.04)
Breastfeeding (months)			1.031 (0.99, 1.08)			1.029 (0.98, 1.08)
Gender						
Male ®						
Female			0.933 (0.61, 1.43)			0.914 (0.59, 1.42)
Birth weight						
Small (< 2.5kg) ®						
Normal (2.5 – 4kg)			1.248 (0.67, 2.31)			1.081 (0.58, 2.02)
Big (> 4kg)			0.836 (0.37, 1.91)			0.603 (0.26, 1.42)
Hospital Birth						
No ®						
Yes			0.950 (0.55, 1.65)			1.284 (0.71, 2.31)
Child education						
Currently in-school ®						
Previously in school			0.649 (0.21, 1.97)			0.613 (0.19, 1.97)
Never in school			0.341 (0.09, 1.29)			0.379 (0.10, 1.43)
Immunization						
Not immunized ®						
Partially immunized			0.786 (0.23, 2.71)			1.063 (0.26, 4.28)
Fully immunized			0.566 (0.16, 1.97)			0.958 (0.23, 3.99)
Not sure			0.559 (0.12, 2.58)			0.508 (0.09, 2.78)
Birth Order						
1 ®						
2 – 4			1.017 (0.65, 1.59)			1.022 (0.64, 1.63)
> 4			0.737 (0.36, 1.53)			0.537 (0.22, 1.32)
Exclusive BF						
No ®						
Yes			0.828 (0.49, 1.39)			0.895 (0.52, 1.54)
Screen time						
< 2 hours ®						

≥ 2 hours	0.677 (0.43, 1.08)	0.805 (0.49, 1.32)
Physical activity scores	1.072 (0.80, 1.45)	0.963 (0.71, 1.30)
Child's health		
Very good ®		
Good	1.079 (0.64, 1.83)	0.951 (0.55, 1.65)
Not too good	1.458 (0.63, 3.38)	1.127 (0.46, 2.76)
Puberty stage		
1 ®		
2	1.193 (0.67, 2.11)	1.282 (0.71, 2.30)
3	1.179 (0.63, 2.20)	1.463 (0.77, 2.78)
4	1.937 (0.87, 4.32)	1.506 (0.65, 3.48)
5	2.602 (0.70, 9.68)	2.350 (0.60, 9.19)
INDIVIDUAL LEVEL FACTORS – Household/Family characteristics		
Household size	**1.076 (1.02, 1.13)	***1.097 (1.04, 1.16)
Children in the household	0.936 (0.85, 1.03)	0.972 (0.86, 1.10)
Wealth index		
Poor ®		
Middle	0.827 (0.51, 1.33)	0.921 (0.55, 1.53)
Rich	***0.350 (0.19, 0.66)	*0.432 (0.22, 1.86)
Marital status		
Single ®		
Married	0.596 (0.06, 5.56)	0.449 (0.05, 4.32)
Previously married	0.408 (0.04, 4.58)	0.351 (0.03, 4.25)
Family type		
Monogamous ®		
Polygamous	0.519 (0.25, 1.07)	0.452 (0.20, 1.02)
Maternal education		
< secondary ®		
Secondary or more	0.775 (0.45, 1.32)	0.796 (0.44, 1.44)
Father's education		
< Secondary ®		
Secondary or more	1.042 (0.60, 1.80)	1.204 (0.67, 2.17)
Mother's Employment		
Employed ®		
Unemployed	1.111 (0.66, 1.87)	1.397 (0.81, 2.41)
COMMUNITY LEVEL FACTORS		
Residence		
Rural ®		
Urban	1.873 (0.63, 5.55)	1.677 (0.62, 4.53)

Community wealth index						
Low ®						
High					0.553 (0.28, 1.07)	0.592 (0.32, 1.10)
Maternal education						
Low						
High ®					*0.332 (0.12, 1.92)	0.459 (0.18, 1.19)
Safe water						
Low ®						
High					0.637 (0.33, 1.21)	0.733 (0.41, 1.32)
RANDOM EFFECTS						
Community level	***0.905 (0.34)	***0.705 (0.29)	***0.436 (0.23)	***0.532 (0.25)	***0.392 (0.21)	0.179 (0.19)
Variance (SE)						
VPC = ICC (%)	21.57%	17.65%	11.69%	13.91%	10.64%	5.16%
Explained variation (ie PCV in %)	Reference	22.10%	51.82%	41.22%	56.69%	80.22%
Log likelihood	-374.65	-372.85	-356.26	-357.20	-367.15	-337.18
Model fit statistics (AIC)	753.30	751.70	762.51	740.41	748.31	752.35

OR, odds ratio; R, reference value; Screen time, time spent watching television, with phone, computer or computer games; SE, standard error; VPC, variance partition coefficient; ICC, intra-class correlation; PCV, proportional change in variance; AIC, Akaike Information Criteria; BIC, Bayesian Information Criteria;

* Statistically significant; *p < 0.05; **p < 0.010; ***p < 0.001

Table 5.6: Individual and contextual factors associated with over-nutrition among school-aged children and adolescents in two Nigerian states using a two-level multi-level analysis

Variables	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5
Odds Ratio (95% Confidence interval)						
States						
Gombe ®						
Osun		*2.499 (1.16, 5.38)	**3.930 (1.61, 9.57)	2.138 (0.93, 4.91)	**2.543 (1.23, 5.28)	* 3.317 (1.26, 8.70)
INDIVIDUAL LEVEL FACTORS – Child characteristics						
Age			***0.864 (0.81, 0.93)			*** 0.861 (0.80, 0.92)
Breastfeeding (months)			0.986 (0.95, 1.03)			0.990 (0.95, 1.03)
Gender						
Male ®						
Female			*1.748 (1.13, 2.70)			* 1.731 (1.11, 2.69)
Birth weight						
Small (< 2.5kg) ®						
Normal (2.5 – 4kg)			1.143 (0.57, 2.29)			1.180 (0.57, 2.45)
Big (> 4kg)			0.491 (0.19, 1.29)			0.552 (0.21, 1.48)
Hospital Birth						
No ®						
Yes			1.138 (0.61, 2.14)			0.993 (0.51, 1.92)
Child education						
Currently in-school ®						
Previously in school			2.057 (0.82, 5.16)			2.023 (0.79, 5.16)
Never in school			1.309 (0.35, 4.87)			1.177 (0.30, 4.57)
Immunization						
Not immunized ®						
Partially immunized			1.035 (0.17, 6.20)			1.143 (0.19, 6.75)
Fully immunized			0.682 (0.12, 3.88)			0.752 (0.13, 4.23)
Not sure			1.171 (0.16, 8.47)			1.553 (0.22, 11.18)
Birth Order						
1 ®						
2 – 4			1.068 (0.69, 1.64)			1.129 (0.72, 1.78)
> 4			0.562 (0.21, 1.48)			0.615 (0.20, 1.91)
Exclusive BF						
No ®						
Yes			*0.514 (0.29, 0.91)			** 0.455 (0.25, 0.83)
Screen time						
< 2 hours ®						

≥ 2 hours	**2.159 (1.23, 3.78)	** 2.329 (1.29, 4.19)
Physical activity scores	***0.551 (0.39, 0.77)	*** 0.550 (0.39, 0.78)
Child's health		
Very good ®		
Good	0.725 (0.42, 1.25)	0.712 (0.41, 1.24)
Not too good	1.822 (0.65, 5.08)	1.924 (0.65, 5.66)
Puberty stage		
1 ®		
2	1.073 (0.61, 1.89)	1.090 (0.61, 1.93)
3	1.272 (0.67, 2.42)	1.283 (0.67, 2.46)
4	1.028 (0.43, 2.46)	1.082 (0.44, 2.65)
5	0.560 (0.06, 4.96)	0.601 (0.07, 5.41)
INDIVIDUAL LEVEL FACTORS – Household/Family characteristics		
Household size	1.003 (0.93, 1.08)	0.997 (0.91, 1.09)
Children in the household	0.937 (0.82, 1.07)	0.991 (0.85, 1.16)
Wealth index		
Poor ®		
Middle	0.760 (0.46, 6.15)	0.686 (0.39, 1.20)
Rich	0.589 (0.34, 5.05)	* 0.472 (0.25, 0.88)
Marital status		
Single (R)		
Married	0.933 (0.14, 6.15)	1.108 (0.13, 9.63)
Previously married	0.644 (0.08, 5.05)	0.677 (0.07, 6.98)
Family type		
Monogamous (R)		
Polygamous	1.440 (0.67, 3.12)	1.646 (0.69, 3.90)
Maternal education		
Less than secondary (R)		
Secondary or more	1.730 (0.93, 3.23)	2.052 (0.98, 4.32)
Father's education		
Less than Secondary (R)		
Secondary or more	0.617 (0.33, 1.15)	0.622 (0.32, 1.21)
Mother's Employment		
Employed (R)		
Unemployed	0.923 (0.49, 1.75)	0.731 (0.36, 1.47)
COMMUNITY LEVEL FACTORS		
Residence		
Rural (R)		
Urban	2.275 (0.55, 9.48)	1.195 (0.24, 5.89)

Community wealth index						
Low (R)						
High					1.696 (0.78, 3.71)	1.565 (0.65, 3.76)
Maternal education						
Low						
High (R)					0.936 (0.26, 3.40)	1.612 (0.37, 7.05)
Safe water						
Low (R)						
High					0.698 (0.31, 1.58)	0.731 (0.30, 1.80)
RANDOM EFFECTS						
Community level	***1.311 (0.48)	***1.005 (0.39)	***0.848 (0.37)	***1.073 (0.43)	***0.681 (0.30)	***0.796 (0.36)
Variance (SE)						
VPC = ICC (%)	28.50%	23.40%	20.49%	24.60%	17.14%	19.48%
Explained variation (ie PCV in %)	Reference	23.34%	35.32%	18.15%	48.05%	39.21%
Log likelihood	-391.56	-389.07	-351.01	-384.50	-385.41	-343.87
Model fit statistics (AIC)	787.11	784.15	752.03	795.00	784.82	765.73

OR, odds ratio; R, reference value; Screen time, time spent watching television, with phone, computer or computer games; SE, standard error; VPC, variance partition coefficient; ICC, intra-class correlation; PCV, proportional change in variance; AIC, Akaike Information Criteria; BIC, Bayesian Information Criteria;

* Statistically significant; *p < 0.005; **p < 0.010; ***p < 0.001

5.5 Discussion

This study, to the best of our knowledge, is the first attempt to simultaneously consider the influence of individual and community level factors as predictors of under- and over-nutrition among school-aged and adolescents in Nigeria. Most previous studies have focused on various indicators of undernutrition among categories of under-five children. It is also the first study that used multilevel analysis to identify the predictors of overweight/obesity among any group of children or adolescents in Nigeria. Furthermore, the present study controlled for a wide range of independent variables, making it one of the most comprehensive studies on the determinants of nutritional status of any category of children and/or adolescents in Nigeria.

The ecological systems theory has underscored the importance of, not only the compositional factors (i.e. the individual level factors), but also the contextual factors (i.e. community level factors) in trying to understand a complex and highly important process like child nutrition.^{115,116} The multi-level analysis that was done in this study therefore helped to account for the variations in under- and over-nutrition of older children across the different contextual units, as well as to identify the compositional and contextual factors that were associated with under- and over-nutrition among the older children in the two Nigerian States.

A major finding of this study is the importance of community variation and community level factors in the prevalence of thinness and overweight/obesity among children 6-19 years old in the two Nigerian states. As indicated by the ICC of the intercept only model (i.e. no explanatory variable incorporated), about 22% and 29% of the variance in the odds for thinness and overweight/obesity among the children could be ascribed to community level factors respectively. Apart from the full model that included all explanatory variables, the model which consisted of community level factors only (these factors include the state, residence, wealth index, maternal education and safe water), accounted for the highest variation observed for children that were thin (57%) and overweight/obese (48%). This suggests that school-aged children and adolescents from the same communities are influenced by common factors, and hence the potential for community level interventions.

The present study found the odds for thinness increased by 10% for every unit increase in household size. Not many studies among children have explored the relationship between under-nutrition and household size, but some studies have however looked at other variables that could serve as proxy for the household size. For example, Nnebue et al⁵⁶ found a statistically significant relationship between under-nutrition and the number of siblings a child has. This finding further

underscores the need for increased efforts in promoting family planning in Nigeria, because a larger number of children may put a household at higher risk of poverty and hence of undernutrition. The household wealth index was also significantly associated with thinness, such that those in the “rich” category had 57% lesser odds of being thin than those in the “poor” category. Furthermore, wealth index had a statistically significant association with household size, such that those from richer households significantly had a lower household size. Hence, large family size, which increased the likelihood of thinness, may be a proxy for poverty. The relationship between poverty and under-nutrition, especially in LMICs has been well established.²⁰⁵ Therefore, effective interventions for thinness (under-nutrition) in these two states and Nigeria as a whole, may be interventions against poverty.

The present study found that for every unit increase in age, the odds of being overweight/obese reduced by 14%. The association between age and over-weight/obesity may not be unconnected with the pubertal staging of the respondents. Although the pubertal stage was not significantly associated with overweight/obesity, it had a strong statistically significant association with age ($p < 0.001$). Females were also found to have 2 times higher odds of being overweight/obese than males. The relationship between overweight/obesity, age and sex of school-aged children and adolescents has been similarly reported by other studies within and outside Nigeria.^{190,192,199} Screen time (i.e. time spent with television, computers, video games and phones) of 2 hours or more daily had 2 times higher odds of being overweight/obese, while the odds of being overweight/obese reduced by 45% with a unit increase in physical activity. This finding is in line with previous studies linking overweight/obesity to reducing physical activity and increasing sedentary lifestyle, of which screen time plays a major role.^{29,49,81,83}

Increasing screen time has also been associated with higher consumption of snacks, which also has been reported to significantly increase the likelihood of overweight/obesity in children.⁸² Exclusive breastfeeding was found to significantly reduce the odds of being overweight/obesity by as much as 54% in line with the results of previous studies²⁰⁶⁻²⁰⁸. This finding is important as it underscores the importance of exclusive breastfeeding in reducing, not only childhood undernutrition and mortality,^{95,96} but also overweight/obesity. An interesting finding was that being part of a rich household reduced the odds of overweight/obesity by 53%. This is different from what previous researchers in Nigeria have reported,^{29,192} but similar to the finding in the high-income countries.²⁰⁹ This may be due to community level factors which were probably not assessed in this study, since 30% of the variance in the odds for overweight/obesity in this study is attributable to community level factors. Community level factors such as availability,

accessibility and proximity to fast-food shops and recreational facilities or programmes in communities have been shown to influence the nutritional status of children and adolescents.^{210–212} Another plausible reason for this is that, by reason of exposure, the richest households in Nigeria are already adopting the lifestyle and values of the rich in developed countries where emphasis is placed on healthy food, exercises and a slim figure.

The school-aged children and adolescents living in Osun State had 3 times higher odds of being overweight/obese than those from Gombe State, and this may be a reflection of the higher socio-economic status and urbanization of Osun State and the southwestern part of Nigeria compared to the northeastern part of the country where Gombe State is located.²¹³ In the present study, although the wealth index was not significantly different between the two states, Osun state did significantly better for almost all other indices of better socio-economic status than Gombe state, including household size, number of children in the family, family type, mother's education, father's education and mother's employment.

Comparing the findings of the present study with those from previous multi-level analyses in Nigeria is challenging. Firstly, the previous studies were undertaken for under-five children, and they also focused on under-nutrition alone. Furthermore, no previous research effort has used multi-level modelling to understand the determinants of overweight/obesity among any group of children/adolescents in Nigeria.^{95,194,201} Additionally, the reference values used in the present study is different from those used by other previous studies. Previous studies used height-for-age (for stunting),^{95,194} weight-for-age (for underweight)²⁰¹ and weight-for-height (for wasting)²⁰¹ reference values, which are all indicators of under-nutrition. The present study used the BMI-for-age reference values, which has the advantage of measuring both under-nutrition (measured as thinness) and over-nutrition (measured as overweight and obesity).³⁵

A limitation of this study is that the findings of this study may not be generalizable to all of Nigeria, because only 2 out of 36 states were involved in the study. Another limitation is that, as to date, there was no data about the contextual determinants of overweight/obesity among older children in Nigeria using multi-level analysis, hence making comparison of the findings of the present study and others challenging. The cross-sectional nature of the study also makes it impossible to establish causality.

5.6 Policy Implications

The findings of this study has some important policy implications. The present study observed that the community-level factors contributed significantly to the odds of under- and over-

nutrition, indicating the need to explore community-based nutrition interventions for school-aged children and adolescents. There is also a need to review current interventions to assess whether/how they could be scaled-up and targeted at reducing socio-economic inequalities, and especially poverty among households in the study location. The food systems approach of the Food and Agriculture Organization to create an enabling environment for improved nutrition.²¹⁴ can guide governance for improved nutrition, evidence-based policies and programmes and financial investment to facilitate changes in food systems. The findings of the present study underscore the importance of reduced physical activity and prolonged screen time in increasing the odds for overweight/obesity among the school-aged children and adolescents. There is a need, therefore, for the development of recreational, sports or games centres and programmes for children and adolescents in different communities that will increase engagement in physical activity and reduce screen time among them.

5.7 Conclusion

This study showed that Nigeria faces the challenge of a double burden of malnutrition among its school-aged and adolescents (6-19 years), with over a fifth experiencing either undernutrition or over nutrition. The study showed thinness and overweight/obesity among school-aged children and adolescents were strongly influenced by their communities, individual-level factors and their residence. Predictors of thinness in this study were household size and household wealth index. Over-weight/obesity was significantly associated with the age, sex, exclusive breastfeeding, physical activity and household wealth index. Policy makers and stakeholders should therefore plan community-based educational programs to address, especially, socio-economic status, physical activity patterns among the children and the control of family/household size in the two Nigerian states.

CHAPTER SIX: Food Security, Dietary Diversity, Dietary Patterns and the Double Burden of Malnutrition among School-Aged Children and Adolescents in two Nigerian States

Table 6.1: Journal information and publication status of Paper 4

Journal	Nutrient
Manuscript number	nutrients-1432767
Manuscript type	Research article
Authors	Adeleye Abiodun Adeomi; Adesegun Fatusi; Kerstin Klipstein-Grobusch
Corresponding author	Adeleye Abiodun Adeomi
Publication status	Published
Citation	Adeomi A.A. , Fatusi A., Klipstein-Grobusch K (2021). Food security, dietary diversity, dietary patterns and the double burden of malnutrition among school-aged children and adolescents in two Nigerian States. <i>Nutrients</i> , 14 (4): 789; https://doi.org/10.3390/nu14040789

6.1 Abstract

Background: Little evidence exists on the relationship between diet-related factors and child/adolescent malnutrition in Nigeria. This study aimed to assess the associations between household food insecurity (HFI), dietary diversity (DD), and dietary patterns (DP) with double burden of malnutrition (DBM) among 6–19 year olds in two Nigerian States.

Methods: This community-based cross-sectional study was carried out among 1,200 respondents (6 – 19 years in age) in Gombe and Osun States of Nigeria. HFI was assessed using the HFI access scale. DD was assessed using a 24-hour dietary recall. DP were determined by principal component analysis using a 30-day food frequency questionnaire. DP scores were categorized into quartiles (Q) for statistical analysis. Diet-related predictors of DBM were assessed using logistic regression.

Results: HFI was experienced by 568 (47.3%) respondents. The median DD score was 7.0 (maximum of 14). Two DPs were identified, diversified DP (DDP) and traditional DP (TDP). TDP was significantly associated with both thinness (Q4: OR: 2.91; 95%CI: 1.52-5.55; P_{trend} : 0.002) and overweight/obesity (Q4: OR: 2.50; 95%CI: 1.43-4.35; P_{trend} : 0.007), while DDP was inversely related with thinness (Q4: OR: 0.36; 95%CI: 0.21-0.61; P_{trend} : 0.008) as compared to Q1.

Conclusion: TDP increased the odds for DBM, while the DDP reduced the odds.

6.2 Introduction

There has been a steady rise in the prevalence of overweight and obesity among children in all regions of the world. Prevalence rates in the range of 10 – 40% for overweight/obesity were reported in selected high income countries among 15-year-old adolescents.¹⁹ The World Health Organization (WHO) reports that 340 million school-aged children and adolescents (aged 5 – 19 years) were overweight/obese globally in 2016.²⁰ Low- and middle-income countries have also experienced significant rise in the prevalence of overweight/obesity with highest prevalence rates recorded in the Middle East, North Africa, Latin America and the Caribbean.^{19,21}

Despite the rising prevalence of overweight/obesity in sub-Saharan Africa, the prevalence of underweight children still remains high. In a study that assessed the worldwide trend in the nutritional status of 24.1 million children between the ages of 5–17 years from 1975 to 2016, the prevalence of underweight was observed to have been reduced in virtually all regions, except for South Asia, Central Africa, East Africa, and West Africa.²⁰ Thus, most countries in sub-Saharan Africa, including Nigeria, are experiencing what has been termed as “double burden of malnutrition”, which is the co-existence of both under- and over-nutrition.^{18,184}

Identifying the determinants of under- and over-nutrition is important not only in improving the understanding about the subject, but also critical for planning appropriate nutrition interventions for affected children. However, to date, most of the research efforts targeted at identifying the determinants of the nutritional status of school-aged children and adolescents in Nigeria have focused at socio-demographic factors.^{15,50,51,79} Little evidence could be found in the literature on the relationship between the nutritional status of school-aged children and adolescents and key factors such as food security, dietary diversity and dietary patterns in Nigeria. Thus, a significant evidence gap exists with regards to determinants of nutritional status of school children and adolescents in Nigeria, particularly as diet has been reported as an important factor in the epidemiology of childhood and adolescent malnutrition.^{180,215,216}

Household food security, dietary diversity and dietary patterns are methods that have been used to describe the diet and food consumption at individual and household levels. Household food security refers to situations when a household has access to sufficient quantity and quality of food for all members of the household for a given period.⁸⁵ Dietary diversity qualitatively measures access and consumption of varieties of food types as a proxy for nutrient/diet adequacy and quality at individual and household levels.⁸⁶ Dietary patterns, on the other hand, describe a broader and more comprehensive conceptualization of food consumption as against the

traditional method of finding the frequency of consumption of individual food types or nutrients.⁸⁷ Each of these three elements has been shown to be associated with nutritional status and studies have also shown relationships between them.^{88,89}

Few studies have assessed household food insecurity in Nigeria,^{91,92} and fewer still have directly linked household food insecurity to the nutritional status of school-aged children or adolescents. Likewise, dietary diversity and its relation to under- and over-nutrition among school-aged children or adolescents has only been assessed in few Nigerian studies.^{60,93,94} Data on the dietary patterns of school-aged children and adolescents in Nigeria is even more scarce. Previous reports from Nigeria who attempted to describe the dietary patterns of children and/or adolescents only described the frequency of consumption of different food groups or the dietary habits of the children or adolescents.^{46,217,218} Only one recently published article described the dietary patterns of a small sample of out-of-school adolescents⁹⁰ in Nigeria using dietary pattern analysis.⁸⁷

The present study aims to address the evidence gap highlighted above: it aimed to assess household food security, dietary diversity and dietary patterns in relation to under- and over-nutrition among school-aged children and adolescents in two selected states in Nigeria located in two different parts of the country (North and South).

6.3 Materials and Methods

6.3.1 Study location

The study was carried out in two randomly selected states in Nigeria. Nigeria has 36 states and is a multi-ethnic nation with significant socio-economic and cultural differences between its two broad geographical areas – the north and the south. The dominant ethnic groups in the north are the Hausa and Fulani ethnic groups, while the dominant groups in the southern part of Nigeria are Yoruba and Igbo ethnic groups. Nigeria is politically structured into 6 geo-political zones that are equally distributed between the northern and southern parts of the country. For this study, the geo-political zones with the lowest (North-East) and highest (South-West) wealth index based on the 2018 Nigeria Demographic and Health Survey (NDHS)¹²⁹ were selected, and Gombe and Osun States were randomly selected from the two zones respectively.

6.3.2 Study design, population and size

A community-based cross-sectional study was carried out among 1,200 school-aged children and adolescents aged 6 – 19 years (600 from each of the selected states). School-aged children are

usually defined as those 6 to 11 years of age,¹⁴⁴ or 5 to 14 years,¹⁴⁵ while adolescents are those from 10 – 19 years of age.¹⁴⁵ In the present study, school-aged children and adolescents are taken as those from 6 to 19 years of age. The sample size was determined using STATCALC on the Epi-Info software,¹⁸⁶ to get an absolute precision of $\pm 5\%$. The proportion of expected outcome was taken as 33%, which is the prevalence of stunted children in Nigeria,¹³⁷ and a design effect of 1.5 was used because of the hierarchical sampling model. The calculated sample size for each of the states was 510, and after correcting for an anticipated 10% non-response, the same sample became 561, which was rounded off to 600 for each of the states (making a total of 1,200). The sample size determination has been previously described in detail in another study.²¹⁹

6.3.3 Sampling technique

Respondents were selected using multi-stage sampling technique. At the first stage, two local government areas (LGAs) were selected from each of the two selected states (one from rural and one from urban LGAs) using simple random sampling technique (Balloting method). Two wards/districts each were randomly selected from each LGA at the second stage. In each of the selected wards/districts, five enumerations areas (EAs), as demarcated by the National Population Commission for the 2006 population census, were randomly selected for the third stage. At the fourth stage, the listing of households in the EAs was first done, then 30 households were drawn in each of the selected EAs using systematic sampling technique. At the household level, one school-age child or adolescent was selected. If a household had more than one school-aged child or adolescent who met the inclusion criteria, only one was randomly selected.

6.3.4 Data collection

Ten research assistants (five males and five females) and one field supervisor were recruited and trained to collect data in each of the two states. The questionnaires were administered with RedCap¹⁵² and the anthropometric measurements i.e. weight and height of the children/adolescents were taken using standard protocols recommended by the International Society for the Advancement of Kinanthropometry.¹⁵³

6.3.5 Outcome variable

The primary outcome/dependent variable is the Nutritional status, which was assessed with the WHO 2007 reference values,³⁵ using the BMI-for-age Z-scores and categorized into (1) thinness (2) normal (3) overweight/obese for BMI-for-age Z-scores < -2 , -2 to 1 , > 1 respectively. This

was re-categorized into two different outcome variables for under-nutrition (i.e. (1) thinness (0) otherwise) and over-nutrition (i.e. (1) overweight/obese (0) otherwise).

6.3.6 Explanatory variables

6.3.6.1 Household food insecurity

Household food security was measured using the household Food Insecurity Access Scale (HFIAS).¹⁵¹ The HFIAS has nine (9) occurrence questions with a recall period of four weeks (30 days), and these are followed by three frequency-of-occurrence questions to determine whether the condition happened rarely (once or twice), sometimes (three to ten times) or often (more than ten times) in the past four weeks. A response of “No” to the frequency-of-occurrence questions was scored 0, while rarely, sometimes and often were scored 1,2 and 3 respectively. The households were then categorized into “food secure”, “mildly food insecure”, “moderately food insecure” and “severely food insecure”, using the responses to these questions and based on extant literature.¹⁵¹ These four categories were re-categorized into “food secure” (food secure and mildly food insecure) and “food insecure” (moderately and severely food insecure) households for data analysis.

6.3.6.2 Dietary diversity (DD)

A scale of 14 food groups including the following was used in assessing the DD score for each of the children and adolescents.^{86,93}: cereals, vitamin A vegetables and tubers, white tubers, dark green leafy vegetables, other vegetables, vitamin A fruits, other fruits, organ meat, flesh meat, egg and egg products, fish, legumes/nuts/seeds, milk/milk products and oils/fats. DD classification was based on a one-time 24-hour dietary recall. This involved the respondents listing all the foods and drinks they had taken in the 24 hours preceding the data collection. Using the information collected from the 24-hour dietary recall, a point was awarded to each food group consumed out of the 14 food groups, and the sum of all the points awarded was the DD score for each child. Hence the DD score ranged from a minimum of 0 (if no food from the 14 food groups was consumed) and 14 (if food from all 14 food groups was consumed). The DD score lower than the median score of 7 were grouped as “low”, while others (≥ 7) were regarded as high.

6.3.6.3 Dietary patterns (DP)

A 30-day food frequency questionnaire (FFQ) was used to collect information on the frequency and amount of 92 different food items consumed in the last 30 days preceding the study. The FFQ was adapted from the one used among school-aged children in Ghana¹⁴⁸ and further modified after pre-testing the research instrument. For the present study, the 92 different food

items were collapsed into 15 food groups, based on their nutritional profile. (Supplementary table 1) Principal component analysis (PCA) with Varimax rotation was used to determine the dietary patterns which best represented the food intake of the population. The number of patterns was determined using the Scree plot and eigenvalues values greater than 1.0. Two components (i.e. patterns) explained 56% of the total variance and were retained. Food groups with absolute loadings greater or equal to 0.4 were used to name the retained principal components/patterns (Figure 1).

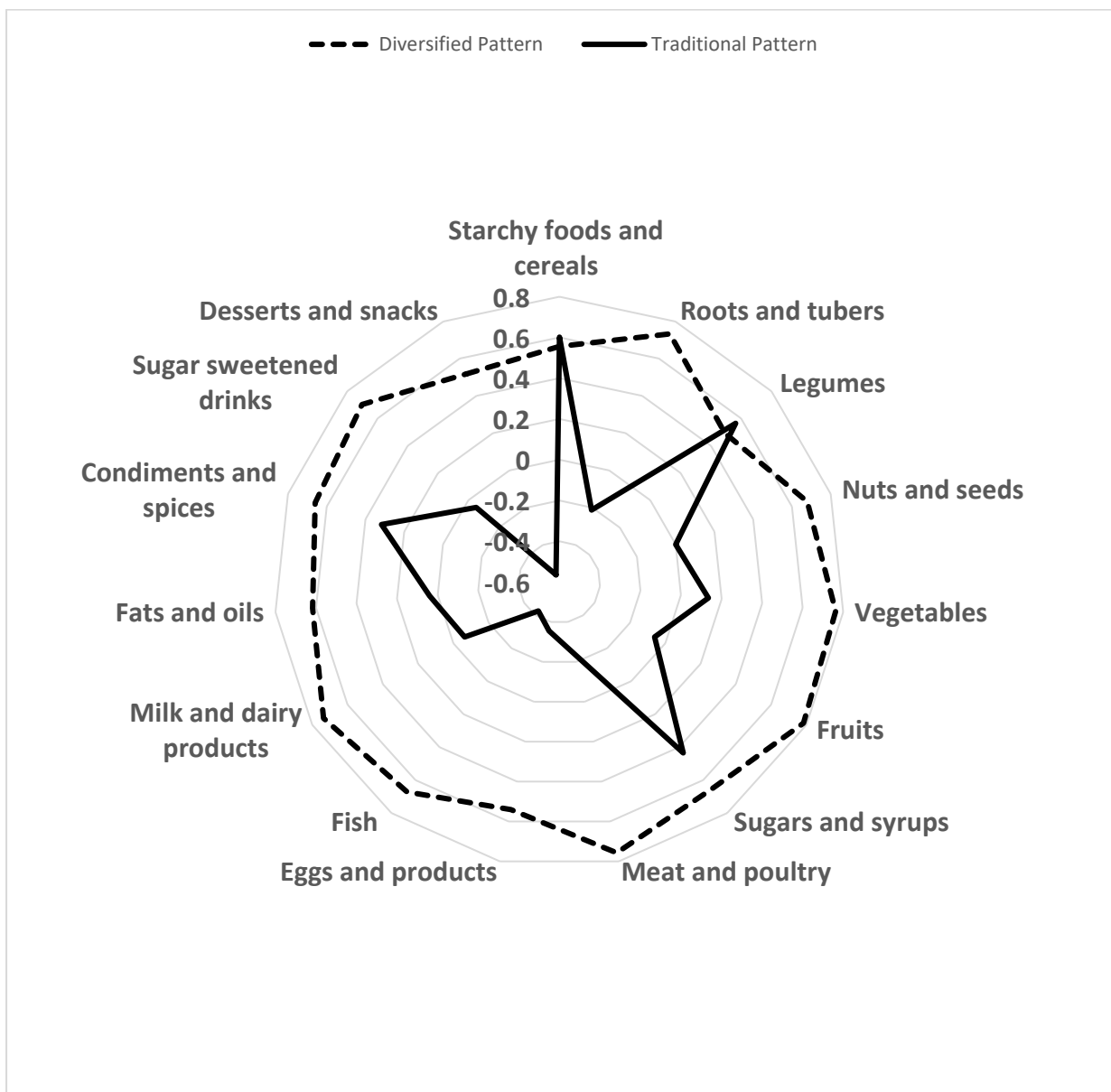


Figure 6.1: Radar chart showing the two dietary patterns, the 15 food groups and their factor loadings among school-aged children and adolescents in two States in Nigeria

The first pattern showed positive loadings greater than 0.4 for all food groups and hence was described as “*Diversified dietary pattern*”. The second pattern showed positive loadings greater than 0.4 for starchy foods/cereals, legumes and sugars and negative loadings for fish, desserts and snacks, and was described as the “*Traditional dietary pattern*”, because the typical traditional diet in Nigeria is dominated by cereals/starchy foods and legumes. The pattern scores generated for each respondent by PCA were categorized into quartiles for the statistical analysis.

6.3.6.4 Other explanatory variables

Socio-demographic characteristics, which include age, sex, household wealth index, residence, state and ethnicity, were included in the variables for the analysis. The household wealth index was calculated using household possessions through PCA, and categorized into tertiles (1) High (2) middle and (3) low, as earlier explained in another article.²¹⁹ Pubertal staging was assessed using the Tanner pubertal self-rating scale.²⁰² The scale has a score range of 1-5, and the respondents were grouped into early puberty (Tanner stage 2 and below) and mid-puberty (> Tanner stage 2). Physical activity was assessed using the physical activity questionnaire for older children and adolescents by Kowalski et al,¹⁴⁹ which was measured as scores from 1 to 5. The higher the score, the more active the respondent was, with 1 representing the option with least or no activity and 5 being the option with most activity.

6.3.7 Data analysis

Data from RedCap database were exported and analysed using Stata version 15. All the dependent and independent variables were initially described, after which Pearson chi-square was used to test for associations for categorical variables at bivariate level. Kruskal Wallis test was used to test the associations between nutritional status and continuous variables at bivariate level, because the variables were not normally distributed. Four models each were fitted for food insecurity, dietary diversity, diversified food pattern and the traditional food pattern, and their relationships with thinness and overweight/obesity using binary logistic regression analysis. Model 0 was the empty model showing crude/unadjusted rates, while Model 1 adjusted for age and sex. Model 2 adjusted for State of residence and household wealth index in addition to Model 1, and Model 3 was the full model that adjusted for physical activity scores in addition to Model 2. Variables with high variance inflation factor (VIF) when multi-collinearity diagnostics were done were not included in the models. Therefore, pubertal staging, residence and ethnicity were not included to prevent redundancy. Level of significance was set at $p < 0.05$.

6.3.8 Ethical considerations

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Human Research Ethics Committee of the University of the Witwatersrand, South Africa (certificate No: M190514, approved on 25/09/2019), and the Ministry of Health in Osun State (certificate No: OSHREC/PRS/569T/155, approved on 24/06/2019) and Gombe State (certificate No: MOH/ADM/621/1/142, approved on 26/07/2019) in Nigeria. Informed consent was obtained from all subjects involved in the study. Written consent was obtained from adolescents who were 18 years and above, and the parents of children less than 18 years, while assent was obtained in addition from children less than 18 years. All severely malnourished children were referred to the nearby public health facilities for further management.

6.3 Results

The distribution of the dependent and independent variables by state of residence is shown in Table 6.2. The prevalence rate of thinness was 10.3% and overweight/obesity was 11.4%. At bivariate level, thinness (under-nutrition) had statistically significant associations with ethnicity ($p < 0.001$), household wealth index ($p < 0.001$), State of residence ($p < 0.001$), residence (rural/urban) ($p = 0.0013$), diversified dietary pattern ($p < 0.001$) and traditional dietary pattern ($p = 0.0013$). Overweight/obesity had significant statistical relationships with age ($p < 0.001$), gender ($p < 0.001$), ethnicity ($p < 0.001$), State of residence ($p < 0.001$), residence (rural/urban) ($p < 0.001$) and physical activity ($p = 0.001$).

Figure 1 shows the diversified and traditional dietary patterns, and their rotated factor loadings using a radar chart. The diversified dietary pattern was characterised by high intake (i.e. factor loading ≥ 0.4) of all listed food groups, while the traditional pattern had high intake of starchy foods/cereals, legumes and sugars, and very low intake (i.e. factor loading ≤ 0.4) of fish, desserts and snacks. The diversified dietary pattern explained 44.1% of the variance, while the traditional dietary pattern explained 11.5% of the variance.

The socio-demographic characteristics, physical activity, food insecurity and dietary diversity across the quartiles of the two dietary patterns is presented in Table 6.3. All the considered variables, except age ($p = 0.926$) and sex ($p = 0.571$), had statistically significant association with the diversified dietary pattern ($p \leq 0.001$). The traditional dietary pattern had a statistically significant association with all the considered variables ($p < 0.05$) except pubertal staging ($p = 0.637$) and food insecurity (0.403)

Table 6.2: Description of the study population in Gombe and Osun states (N = 1200)

Variables	States		
	^f Gombe n (%)	^f Osun n (%)	Total n (%)
Age of the child (IR)	12.0 (7.0)	11.0 (5.0)	11.0 (6.0)
^aBMI-for-age			
Thinness	83 (13.8)	40 (6.7)	123 (10.3)
Normal	476 (79.3)	464 (77.3)	940 (78.3)
Overweight/obesity	41 (6.8)	96 (16.0)	137 (11.4)
Sex			
Male	323 (53.8)	278 (46.3)	601 (50.1)
Female	277 (46.2)	322 (53.7)	599 (49.9)
Pubertal Staging			
Early puberty	379 (63.2)	355 (59.2)	734 (61.2)
Mid puberty	221 (36.8)	245 (40.8)	466 (38.8)
Ethnicity			
Yoruba	65 (10.8)	574 (95.7)	639 (53.3)
Igbo	23 (3.8)	15 (2.5)	38 (3.2)
Hausa	150 (25.0)	0 (0.0)	150 (12.5)
Fulani	144 (24.0)	3 (0.5)	147 (12.3)
Minorities	218 (36.3)	8 (1.3)	226 (18.8)
^bHousehold wealth index			
Low	205 (34.2)	195 (32.5)	400 (33.3)
Middle	189 (31.5)	211 (35.2)	400 (33.3)
High	206 (34.3)	194 (32.3)	400 (33.3)
Residence			
Rural	300 (50.0)	300 (50.0)	600 (50.0)
Urban	300 (50.0)	300 (50.0)	600 (50.0)
^cFood security			
Food secure	320 (53.3)	312 (52.0)	632 (52.7)
Food insecure	280 (46.7)	288 (48.0)	568 (47.3)
^dDietary diversity			
Low	244 (41.1)	341 (57.0)	585 (49.1)
High	350 (58.9)	257 (43.0)	607 (50.9)
^eDiversified dietary pattern			
Quartile 1	249 (41.5)	52 (8.7)	301 (25.1)
Quartile 2	150 (25.0)	149 (24.8)	299 (24.9)
Quartile 3	112 (18.7)	188 (31.3)	300 (25.0)
Quartile 4	89 (14.8)	211 (35.2)	300 (25.0)
^eTraditional dietary pattern			
Quartile 1	32 (5.3)	268 (44.7)	300 (25.0)
Quartile 2	165 (27.5)	135 (22.5)	300 (25.0)
Quartile 3	195 (32.5)	105 (17.5)	300 (25.0)
Quartile 4	208 (34.7)	92 (15.3)	300 (25.0)

IR – Interquartile range; BMI – Body mass index ^aCategorized using BMI-for-Age Z-scores; thinness (<-2), normal (-2 to 1) and overweight/obesity (> 1) ^bHousehold wealth index scores were derived from scoring the possession of household commodities using principal component analysis, which were then categorized into three (low/middle/high) ^cMeasured using HFIAS, “food secure” represents those that were food secure and mildly food insecure, while “food insecure” represents moderately and severely food insecure)

^dThose with a dietary diversity score lower than the median score of 7 were grouped as “low”, while others (≥ 7) were regarded as high. ^eDietary pattern scores derived using principal component analysis were categorized into quartiles. ^fThe number of respondents in each of Gombe and Osun States is 600

Table 6.3: Demographic variables, physical activity, food insecurity and dietary diversity across the quartiles of the two dietary patterns

Variables	Diversified dietary pattern				p-value	Traditional dietary pattern				p-value
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4	
^a Age	11.0 (6.0)	11.0 (5.0)	12.0 (7.0)	12 (6.0)	0.926	10.0 (5.0)	11.0 (6.0)	11.5 (6.0)	12.0 (6.0)	<0.001*
^a Physical activity scores	2.1 (1.0)	2.0 (1.0)	2.4 (1.1)	2.6 (0.9)	<0.001*	2.2 (1.2)	2.4 (1.0)	2.2 (1.1)	2.3 (0.9)	0.034*
Sex										
Male	152 (25.3)	159 (26.5)	143 (23.8)	147 (24.5)	0.571	121 (20.1)	158 (26.3)	151 (25.1)	171 (28.5)	<0.001*
Female	149 (24.9)	140 (23.4)	157 (26.2)	153 (25.5)		179 (29.9)	142 (23.7)	149 (24.9)	129 (21.5)	
Pubertal Staging										
Early puberty	211 (28.7)	184 (25.1)	168 (22.9)	171 (23.3)	0.001*	187 (25.5)	187 (25.5)	186 (25.3)	174 (23.7)	0.637
Mid puberty	90 (19.3)	115 (24.7)	132 (28.3)	129 (27.7)		113 (24.2)	113 (24.2)	114 (24.5)	126 (27.0)	
Ethnicity										
Yoruba	65 (10.2)	159 (24.9)	203 (31.8)	212 (33.2)	<0.001*	264 (41.3)	139 (21.8)	125 (19.6)	111 (17.4)	<0.001*
Igbo	3 (7.9)	11 (28.9)	9 (23.7)	15 (39.5)		7 (18.4)	18 (47.4)	2 (5.3)	11 (28.9)	
Hausa	62 (41.3)	35 (23.3)	28 (18.7)	25 (16.7)		12 (8.0)	51 (34.0)	37 (24.7)	50 (33.3)	
Fulani	83 (56.5)	25 (17.0)	23 (1.6)	16 (10.9)		7 (4.8)	42 (28.6)	48 (32.7)	50 (34.0)	
Minorities	88 (38.9)	69 (30.5)	37 (16.4)	32 (14.2)		10 (4.4)	50 (22.1)	88 (38.9)	78 (34.5)	
Household Wealth index										
Low	170 (42.5)	68 (17.0)	75 (18.8)	87 (21.8)	<0.001*	75 (18.8)	125 (31.3)	94 (23.5)	106 (26.5)	<0.001*
Middle	88 (22.0)	115 (28.7)	116 (29.0)	81 (20.3)		116 (29.0)	86 (21.5)	122 (30.5)	76 (19.0)	
High	43 (10.8)	116 (29.0)	109 (27.3)	132 (33.0)		109 (27.3)	89 (22.3)	84 (21.0)	118 (29.5)	
State										
Gombe	249 (41.5)	150 (25.0)	112 (18.7)	89 (14.8)	<0.001*	32 (5.3)	165 (27.5)	195 (32.5)	208 (34.7)	<0.001*
Osun	52 (8.7)	149 (24.8)	188 (31.3)	211 (35.2)		268 (44.7)	135 (22.5)	105 (17.5)	92 (15.3)	
Residence										
Rural	109 (18.2)	123 (20.5)	181 (30.2)	187 (31.2)	<0.001*	174 (29.0)	135 (22.5)	129 (21.5)	162 (27.0)	<0.001*
Urban	192 (32.0)	176 (29.3)	119 (19.8)	113 (18.8)		126 (21.0)	165 (27.5)	171 (28.5)	138 (23.0)	
Food security										
Food secure	291 (26.3)	259 (23.4)	271 (24.5)	286 (25.8)	<0.001*	280 (25.3)	278 (25.1)	279 (25.2)	270 (24.4)	0.403
Food insecure	10 (10.8)	40 (43.0)	29 (31.2)	14 (15.1)		20 (21.5)	22 (23.7)	21 (22.6)	30 (32.3)	
Dietary diversity										
Low	198 (33.8)	153 (26.2)	130 (22.2)	104 (17.8)	<0.001*	175 (29.9)	171 (29.2)	150 (15.6)	89 (15.2)	<0.001*
High	97 (16.0)	146 (24.1)	168 (27.7)	196 (32.3)		125 (20.6)	127 (20.9)	144 (23.7)	211 (34.8)	
^a Dietary diversity score	5.0 (4.0)	6.0 (3.0)	7.0 (4.0)	8.0 (7.0)	<0.001*	6.0 (3.0)	6.0 (4.0)	6.0 (5.0)	9.0 (6.0)	<0.001*

Q – quartiles; * - statistically significant ^aKruskal Wallis test was used because the variables were not normally distributed, and median (inter-quartile range) was used to describe the data

Table 6.4 shows adjusted odds ratios and 95% CIs from the associations of food insecurity and dietary diversity, with thinness (under-nutrition) and overweight/obesity (over-nutrition) among the respondents. There were no statistically significant associations across all the models for both food insecurity and dietary diversity.

Table 6.4: The associations of food insecurity and dietary diversity, with thinness (under-nutrition) and overweight/obesity (over-nutrition) among school-aged children and adolescents in two Nigerian states, using binary logistic regression (N = 1200)

^a Models	^b Ref	OR	95% CI	p-value
Food insecurity				
Model 0 (Empty/Crude)	1.00	1.33	0.71, 2.51	0.381
Model 1	1.00	1.35	0.72, 2.57	0.351
Model 2	1.00	1.34	0.70, 2.58	0.377
Model 3	1.00	1.34	0.70, 2.57	0.382
Dietary diversity				
Model 0 (Empty/Crude)	1.00	0.85	0.58, 1.23	0.378
Model 1	1.00	0.83	0.57, 1.21	0.324
Model 2	1.00	0.91	0.61, 1.36	0.645
Model 3	1.00	0.91	0.61, 1.35	0.637
<hr/>				
Food insecurity				
Model 0 (Empty/Crude)	1.00	0.71	0.34, 1.51	0.376
Model 1	1.00	0.70	0.33, 1.50	0.358
Model 2	1.00	0.79	0.37, 1.70	0.546
Model 3	1.00	0.73	0.33, 1.60	0.433
Dietary diversity				
Model 0 (Empty/Crude)	1.00	1.04	0.73, 1.49	0.822
Model 1	1.00	1.23	0.85, 1.77	0.275
Model 2	1.00	1.31	0.90, 1.92	0.158
Model 3	1.00	1.34	0.91, 1.96	0.134

OR – odds ratio; CI – confidence interval; * statistically significant

^aModel 1 – adjusted for age and sex; Model 2: Model 1 + household wealth index and State; Model 3: full model (ie Model 2 + physical activity scores) ^brepresents the food secure category and the category with low dietary diversity which served as reference values for food insecurity and dietary diversity respectively.

Table 6.5: The associations of the diversified and traditional dietary patterns, with thinness (under-nutrition) and overweight/obesity (over-nutrition) among school-aged children and adolescents in two Nigerian states, using binary logistic regression (N = 1200)

^a Models	Q1	Q2			Q3			Q4			p-trend
	(Ref)	OR	p-value	95% CI	OR	p-value	95% CI	OR	p-value	95% CI	
THINNESS											
Diversified dietary pattern											
Model 0 (Empty/Crude)	1.00	0.28	< 0.001 *	0.16, 0.49	0.51	0.006 *	0.31, 0.82	0.36	< 0.001 *	0.21, 0.61	0.009 *
Model 1	1.00	0.27	< 0.001 *	0.15, 0.48	0.51	0.006 *	0.32, 0.82	0.36	< 0.001 *	0.21, 0.61	0.008 *
Model 2	1.00	0.44	0.007 *	0.24, 0.80	0.89	0.675	0.52, 1.53	0.72	0.285	0.40, 1.31	0.915
Model 3	1.00	0.44	0.007 *	0.24, 0.80	0.91	0.737	0.53, 1.57	0.75	0.343	0.41, 1.37	0.827
Traditional dietary pattern											
Model 0 (Empty/Crude)	1.00	2.96	0.001 *	1.57, 5.59	2.61	0.004 *	1.37, 4.97	2.87	0.001 *	1.52, 5.44	0.002 *
Model 1	1.00	2.98	0.001 *	1.57, 5.63	2.63	0.003 *	1.38, 5.04	2.91	0.001 *	1.52, 5.55	0.002 *
Model 2	1.00	1.94	0.059	0.97, 3.86	1.63	0.177	0.80, 3.32	1.95	0.065	0.96, 3.96	0.114
Model 3	1.00	1.99	0.051	1.00, 3.98	1.64	0.171	0.81, 3.98	1.98	0.059	0.97, 4.03	0.106
OVERWEIGHT/OBESITY											
Diversified dietary pattern											
Model 0 (Empty/Crude)	1.00	1.01	0.978	0.60, 1.70	1.42	0.166	0.86, 2.32	1.08	0.781	0.64, 1.81	0.871
Model 1	1.00	1.01	0.957	0.60, 1.73	1.39	0.193	0.84, 2.30	1.09	0.742	0.65, 1.85	0.935
Model 2	1.00	0.66	0.164	0.36, 1.19	0.83	0.529	0.47, 1.48	0.60	0.100	0.33, 1.10	0.100
Model 3	1.00	0.62	0.119	0.34, 1.13	0.92	0.780	0.51, 1.65	0.78	0.421	0.42, 1.44	0.581
Traditional dietary pattern											
Model 0 (Empty/Crude)	1.00	0.97	0.901	0.59, 1.58	0.70	0.188	0.42, 1.19	1.00	1.00	0.61, 1.63	0.865
Model 1	1.00	1.14	0.606	0.69, 1.88	0.83	0.488	0.49, 1.41	1.31	0.290	0.79, 2.17	0.444
Model 2	1.00	1.70	0.048 *	1.01, 2.87	1.33	0.316	0.76, 2.34	2.14	0.006 *	1.24, 3.67	0.017 *
Model 3	1.00	2.06	0.009 *	1.20, 3.55	1.50	0.169	0.84, 2.66	2.50	0.001 *	1.43, 4.35	0.007 *

Ref - reference value; OR –odds ratio; CI – confidence interval; * statistically significant

Q – represent quartiles, which were derived from the principal component analysis scores for both the diversified and traditional dietary patterns

^aModel 1 – adjusted for age and sex; Model 2: Model 1 + household wealth index and State; Model 3: full model (ie Model 2 + physical activity scores)

The adjusted odds ratios and 95% CIs from the associations of the diversified and traditional dietary patterns with thinness (under-nutrition) and overweight/obesity (over-nutrition) among the respondents is shown in Table 6.5. With respondents in the first quartile being the reference, respondents in all other quartiles had a statistically significant association with under-nutrition (thinness) at the crude/empty model level; the diversified dietary pattern was inversely associated ($p_{\text{trend}} = 0.009$) while the traditional dietary pattern was positively associated ($p_{\text{trend}} = 0.002$). However, only those in the second quartile of the diversified dietary pattern retained the statistical significant association after controlling for all the independent variables (ie in the full model/Model 3) (OR: 0.44; $p = 0.007$; 95% CI: 0.24 to 0.80). For the association between dietary patterns and over-nutrition (overweight/obesity), there was no significant associations at the crude model level, but the full models of Quartile 2 (OR: 2.06; $p = 0.009$; 95% CI: 1.20 to 3.55) and 4 (OR: 2.50; $p = 0.001$; 95% CI: 1.43 to 4.35) of the traditional dietary pattern showed statistical significant positive association. The P_{trend} was 0.007, which indicates a statistically significant linear association.

6.5 Discussion

Few scattered small-scale studies exist regarding diet-related factors among school-aged children and adolescents in Nigeria, but no study was found that considered these factors together and related them to under- and over-nutrition among older children. Addressing these factors together is important so as to assess and control for any potential confounding effects in explaining the associations between the explanatory and outcome variables. Existing studies also have methodological limitations of unrepresentative study populations and/or unconventional methodologies that make comparison of the results difficult. The current study has the advantage of avoiding these limitations: in particular, it was based on representative populations from two states of Nigeria that are diverse geographically, socio-culturally, and economically, and used well established approaches, with rigorous analysis in addressing the association of diet related factors with under- and over-nutrition.

Nearly half of the households were moderately or severely food insecure. Previous studies on household security in Nigeria have similarly reported rates of moderate/severe food insecurity in excess of 50%.^{53,91} These findings are disturbing, especially as this was found to be significantly associated with the nutritional status of the children or adolescents living in such households.⁵³ The median DD score for the present study was 7 out of a total possible score of 14, with two-thirds of the respondents scoring 7 or below. Other previous studies on dietary patterns among

children or adolescents reported similar findings with the mean/median DD score being about half of the total DD score.^{60,94,220} The present study found that half of the respondents had dietary diversity scores less than 7, which is just half of the maximum value of 14. This indicates sub-optimum dietary diversity among half of the respondents.

Two dietary patterns were identified in the present study, which were named diversified and traditional DP. The only other study on dietary pattern among adolescents in Nigeria using the principal component analysis/factor analysis, had very similar findings. The authors reported two patterns also, with one characterized by high intake of all the food groups that were considered while the other was characterized by high intake of roots/tubers and legumes, and they called these the healthy and unhealthy DPs respectively.⁹⁰ A study from Ghana also reported two DPs, but with very different food group loadings from the present study and the previous Nigerian study⁹⁰. The DPs described for adolescents from other countries^{221,222} outside Africa were also quite different from those found among school-aged children or adolescents in Nigeria and Ghana.^{90,223}

The diversified dietary pattern had an inversely significant association with thinness, even after adjusting for all independent variables, i.e showing a 56% lower odds of thinness of those in the fourth as compared to those in the first quartile. The inverse relationship between the diversified dietary pattern and thinness is expected, because the diversified diet reflects a healthier dietary pattern. Even though not statistically significant, it may be important to also note that the diversified dietary pattern was also inversely related to overweight/obesity. This underscores the importance of a healthy or diversified dietary pattern for better health (i.e. lower odds for thinness and overweight/obesity).

The traditional dietary pattern had a positively significant association with overweight/obesity, such that those in the second and fourth quartiles of the traditional dietary pattern had 2 times higher odds of being overweight/obese than those in the first quartile. The traditional dietary pattern also had a positive association with thinness, although the relationship was only statistically significant in the crude model. Overall, the traditional dietary pattern seems to increase the odds of thinness and overweight/obesity, therefore contributing to the double burden of malnutrition. This may not be unexpected because the traditional dietary pattern is characterized by higher intake of starchy foods/cereals and sugars. This finding further underscores the importance of a healthy dietary pattern in combating the double burden of

malnutrition among school-aged children and adolescents in these two States, and probably the whole of Nigeria.

Similarly, different studies carried out in other countries have reported associations between dietary patterns and under- or over-nutrition,^{221,222,224} though the pattern of association has been inconsistent. The most diversified DP in a study among Spanish adolescents had lower odds for overweight/obesity,²²² while a study carried out in Bangladesh found that the diversified DPs were significantly and positively associated with overweight/obesity.²²¹ Alangea et al²²³ in Ghana found a significant association between the energy-dense DP and childhood overweight/obesity. Meanwhile, studies by Abizari et al²²⁵ and Samuel et al⁹⁰ in Ghana and Nigeria respectively, found no association between the dietary patterns and nutritional status of the adolescents. This lack of consensus on the nature of the relationship between dietary patterns and body mass index has been previously noted.²²² This may not be un-expected because of the multi-factorial and complex nature of the determinants of nutritional status. The role cultural, ethnic and religious factors,^{115,119,226,227} and influence of contextual factors like household level and community level factors^{95,194} cannot be ruled out. Furthermore, the role of indirect associations can also not be ruled out, in the present study as an example, the indirect association with food insecurity and dietary diversity are also important. More research is therefore needed to understand the mechanism underlying the associations.

The relationships between food insecurity, dietary diversity and thinness and overweight/obesity were not statistically significant. However, indirect associations cannot be ruled out because of the significant associations that existed between the dietary patterns and both food insecurity and dietary diversity at the bivariate analysis level. School-aged children and adolescents who came from food insecure homes, and those who had low dietary diversity were significantly less likely to have a diversified dietary pattern, while a third of those in the fourth quartile, and more than half of those in the third and fourth quartiles of the traditional dietary pattern were food insecure. This shows a possible relationship between food insecurity and the unhealthy (i.e. traditional) dietary pattern which had a positive association with the double burden of malnutrition.

Thinness and overweight/obesity among the school-aged children and adolescents in this present study were significantly associated with variables that were not diet-related. The variables who had significant associations with both dietary patterns in this study were ethnicity, household wealth index, State and residence. These relationships underscore the importance of the social determinants of health. Social determinants have a major influence on health and health related

behaviour, and especially on diet and/or nutrition of people.^{2,80,228} Religion, for instance, dictates some food that are to be eaten, and others that should be avoided, and this is irrespective of other variables including the wealth index of such households. Similarly, previous researchers have found that ethnicity, culture and other social determinants influence dietary patterns.^{226,227} In the present study, those in the high household wealth index category, for example, were more likely to have a diversified diet, and this may indicate that household financial means determines affordability of food and hence determines dietary patterns.

While the present study involved a representative sample from two states, the findings may not be generalizable to the entire country of 36 states, particularly granted the social diversity, cultural plurality, and multi-ethnic nature of Nigeria. Also, the assessment of dietary diversity and dietary patterns was dependent on the recall of food taken in the last 24 hours and the last 30 days respectively, which makes them prone to recall bias. The aetiology of under- and over-nutrition is complex, and this study could not assess all possible explanatory variables, hence the possibility of residual confounding could not be ruled out.

6.6 Conclusion

A traditional dietary pattern (containing mainly cereals/starchy food and legumes) significantly increased the odds for both thinness and overweight/obesity, while a diversified dietary pattern (containing all food groups) significantly reduced the odds for thinness in school-aged children and adolescents in Nigeria. Dietary patterns were the only diet-related factors that had direct associations with under- and over-nutrition, while food insecurity and dietary diversity had indirect associations. DBM was also associated with socio-demographic and socio-economic variables, underscoring the importance of the social determinants of health. Nutrition education programmes to promote a healthy diversified dietary pattern that will reduce the burden of under- and over-nutrition among age 6-19 years needs to be intensified in Nigeria for school-aged children, adolescents and their parents.

CHAPTER SEVEN: Integrated Discussion and Conclusion

7.1 Summary of Findings

This study aimed, firstly, to explore mothers' perceptions and cultural practices relating to under- and over-weight children and adolescents. Secondly, the study aimed to estimate the prevalence and distribution of underweight, stunting, thinness, overweight/obesity, and the existence of DBM and lastly to identify individual and contextual factors associated with under- and over-nutrition among school-aged children and adolescents in two Nigerian States. The findings of this study, according to the objectives, chapters and empirical studies are presented in Table 7.1 below.

7.2 Integrated Discussion

The qualitative data produced novel data on the perception of mothers and cultural beliefs and practices relating to under- and over-weight children and adolescents in the two Nigerian states. Generally, mothers' perceptions agreed with the concept of under- and over-weight children and adolescents. There were however some gaps and misconceptions in the perceptions of the mothers. Firstly, most of the perceptions expressed by the mothers about the concept of under- and over-weight referred to severe cases of under- or over-weight, which in reality are not as common as mild and moderate cases. This is corroborated by the quantitative aspect of the present study where, of the 13.5% underweight respondents, only 4.1% were severe, and only 2.7% of the 10.3% with thinness were severe cases.

Another gap in the mothers' perception, was that none of the mothers expressed any perception about stunting. None of the participants in the qualitative study mentioned anything about stunting or shortness as a feature of undernutrition. This is important because stunting is the most prevalent form of under-nutrition in Nigeria.¹²³ The quantitative aspect of the present study corroborated this, with 34.9% of the children/adolescents being stunted. The present study further showed that the stunting rate was as high as nearly 50% in Gombe State, and in some communities, yet it was not mentioned at all in the discussions. If the mothers do not perceive stunting to be a form of under-nutrition, then they would likely misclassify stunted children as not under-nourished¹⁶⁵⁻¹⁶⁷ and would probably do little to address it.

Table 7.1: Summary of the findings according to the objectives, chapters and empirical studies

Objective	Chapter	Paper	Findings
To explore mothers' perceptions and cultural practices relating to under- and over-weight children and adolescents in two Nigerian States	3	1	<ul style="list-style-type: none"> - Mothers expressed perceptions on the concept, causes and community experiences of under- and over-weight among children and adolescents - Gaps and misconceptions were, however, observed in the perception of the mothers - Food taboos, food restrictions and other cultural beliefs or practices were not reported by majority of the mothers.
To estimate the prevalence and distribution of underweight, stunting, thinness, overweight/obesity, and the existence of DBM among school-aged children and adolescents in two Nigerian States	4	2	<ul style="list-style-type: none"> - The mean age of the respondents was 11.6 ± 3.8 years. - Prevalence rate of stunting was 34.9%, underweight was 13.5%, thinness was 10.3% and overweight/obesity was 11.4%, which typifies the DBM at population level - 4% were both stunted and overweight/obese, representing DBM at individual level - Prevalence rates for under- and over-nutrition differed significantly across demographic, socio-economic and household/family characteristics ($p < 0.05$).
To identify individual and contextual factors that are associated with under- and over-nutrition among school-aged children and adolescents in two Nigerian States	5	3	<p>Findings for under-nutrition (using thinness)</p> <ul style="list-style-type: none"> - Household size and the uppermost wealth index (rich) had significant positive and inverse associations with thinness respectively - 21.6% of the variation in the odds for thinness were attributable to community level variables (i.e. ICC for empty model = 21.6%) - The model that controlled for State and the Household/family characteristics had the best fit (AIC = 740.4) <p>Findings for over-nutrition (using overweight/obesity)</p> <ul style="list-style-type: none"> - Residing in Osun State, female gender and screen time > 2 hours/day were positively associated with overweight/obesity. - Age, exclusive breastfeeding, physical activity and the highest wealth index (rich) had an inverse relationship with overweight/obesity - 28.5% of the variation in the odds for overweight/obesity were attributable to community level variables (i.e. ICC for empty model = 28.5%) - The model that controlled for state and child characteristics had the best fit (AIC = 752.8)

6	4	<ul style="list-style-type: none">- 47.3% of the households reported food insecurity, while 49.1% of the respondents reported low dietary diversity- Two dietary patterns (DPs), which are combination of different foods and drinks that are usually consumed by people, were identified;- Diversified DP (DDP) had positive loadings ≥ 0.4 for all food groups- Traditional DP (TDP) had positive loadings ≥ 0.4 for starchy foods/cereals, legumes and sugars and negative loadings for fish, desserts and snacks- TDP was significantly associated with both thinness and overweight/obesity, while DDP was inversely related with thinness- Food insecurity and dietary diversity had no direct statistically significant relations with under- and over-nutrition, but were significantly associated with the DPs
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Another gap is the fact that many of the mothers perceived a child/adolescent to be under- or over-weight by comparing the child/adolescent's weight with that of the age mates. The quantitative aspect of the present study showed that about three-quarters of the school-aged children and adolescents in the study had at least one form of under- or over-nutrition, therefore comparing a child to another in such a population could be misleading. This gap in the perceptions of the mothers could lead to misclassification of the children/adolescents, which ultimately will affect the response of the mothers to under- or over-weight children/adolescents.

The mothers correctly noted some causes of under- and over-weight. Some of the factors expressed by the mothers, which are eating habits, physical activity patterns, poor feeding, parental factors and poverty were corroborated by the quantitative aspect of the present study that showed that they had statistically significant associations with under- and over-nutrition. Some of the factors raised by the mothers were not assessed by the present study, but other studies have shown they are significantly associated with under- and over-nutrition. A major misconception, however is the belief that witches and wizards cause under-weight in children and adolescents.

Concerning the community experience of under- and over-weight, it was interesting that mothers from different communities noted the existence of the double burden of malnutrition in their communities. These were the mothers who noted that both under- and over-weight were in their communities. The quantitative aspect of the present study, which objectively assessed the prevalence of the different indicators of under- and over-nutrition found the existence of the double burden of malnutrition in these communities, and so it was important that some mothers perceived this. Understanding this puts them in a better place to respond appropriately.

The perception by some mothers in the urban communities in Osun State that there were no under-weight children in their community may not be completely true. The quantitative aspect of the present study showed that, even in urban Osun State, 21.7% were stunted and 5.7% had thinness. This is probably due to the reasons discussed earlier which could generally lead to misclassification.

The conceptual framework used for this study indicated the role of cultural beliefs and practices in influencing the nutritional status. This, therefore, informed the sequential exploratory approach used in this research, because it was conceptualized that the findings on the qualitative study on the cultural beliefs and practices will help to develop some aspects on the questionnaire used for quantitative data collection and to subsequently assist in interpretation of the findings.

This became necessary because the concept of how cultural beliefs and cultural practices affect the nutritional status of children and adolescents was not well formed in the existing literature. However, the findings of the qualitative study showed that cultural beliefs and practices were no longer a prominent thing in many of these communities, hence this was not considered as one of the factors to be assessed in the quantitative aspect of the present study. This finding probably indicates that cultural beliefs and practices may be playing decreasing roles in the nutritional status of children and adolescents in Nigeria. The significant associations of dietary patterns, physical activity scores and screen time with under- and over-nutrition in the quantitative aspect of the present study underscores the influence of lifestyle factors on the double burden of malnutrition, as has been earlier reported.^{5,8} Previous studies from Nigeria, and other developing countries have similarly reported significant associations between diet, physical activity and malnutrition (i.e. under- and over-nutrition).^{49,81,228,229} Findings from the qualitative study of the present study also corroborate this finding, according to some mothers;

“There is a lot of ijekuje (junk food) in this area like tea, Sweet, Coke, Lacofa-sweet, chewing gum, soft drinks, ice cream, burger, sweet, coke, minerals, Bobo. These are not good at all, Meat eating excessively, flour products. All these cause excessive fatness”
(Discussant 2: Osun Urban 1)

“What about excessive comfortability, where a child does nothing, only the house maid that does all the work while the child is lazing around, could lead to overweight., the child is just watching films, just waking up and sleeping, not doing any work. Because there are plenty of those people in this area” (Discussant 7: Osun Urban 2)

This information is important in the designing and content development for individual-level health education programmes for school-aged children and adolescents in the two states selected for this study, and possibly for other states in Nigeria.

The quantitative aspect of the present study also produced evidence for the existence of the double burden of malnutrition in Nigeria at both the individual and population levels. This is especially important because most nutrition interventions in the past have targeted under-nutrition, with little or no attention to over-nutrition. This study also shows socio-economic inequalities between the rural and urban communities, and between Osun and Gombe States, and these were responsible for the significant differences in the distribution of under- and over-nutrition across socio-economic variables.

Concerning the distribution of under- and over-nutrition across age categories, the present study found that overweight/obesity was inversely associated with age categories, such that the younger age groups had higher odds of being overweight/obese compared to older age groups. This finding is similar to what other Nigerian authors found among school-aged children and adolescents,^{81,191,192,198} but it is different from what has been reported in other countries.^{230,231} This difference in the distribution of overweight/obesity across age categories may be a reflection of different stages of the nutrition transition. These countries may be more advanced than Nigeria in the nutrition transition, hence their pattern is reflecting more what happens in high income countries.^{232,233}

The inequality in the distribution of under- and over-nutrition in Gombe and Osun State is another point of concern. The findings from this study showed that the distribution of all the indicators of under- and over-nutrition assessed in this study were significantly different in the two states, with Gombe State having a significantly higher burden of under-nutrition and Osun State having a significantly higher burden of over-nutrition. Prevalence rates for stunting and thinness in Gombe State were a more than double the rates in Osun State, while the prevalence rate of underweight was three times higher in Gombe State. On the other hand, the prevalence rate for overweight/obesity in Osun State was much more than double the rate in Gombe State. Additionally, this study found that the distribution of almost all socio-economic indicators assessed in this study differed significantly between Gombe and Osun States. Studies carried out on malnutrition among under-five children in Nigeria^{95,194,201} and the NDHS¹²⁹ also corroborate the inequalities that exist between regions and States in Nigeria. This inequality cannot however be justified and needs to be addressed.

The quantitative aspect of the present study produced novel data on the dietary patterns of school-aged children and adolescents in two states in Nigeria, and also the associations between food insecurity, dietary diversity, dietary patterns and the double burden of malnutrition. The study found that the traditional dietary pattern consisting of increased the odds for both under- and over-nutrition, while the diversified dietary pattern, reflecting a varied diet, reduced the odds for under-nutrition. Only one other study in Nigeria among adolescents identified dietary patterns using a similar methodology, and the study reported no association with either under- or over-nutrition. Although the study used a very small sample size, and was carried out among out-of-school adolescents alone. A similar study among university students in Nigeria and another among adults in Ghana reported significant associations between dietary patterns and over-nutrition.^{224,234} Food insecurity and dietary diversity were also found to have indirect associations

with under- and over-nutrition. These findings were corroborated by the qualitative study. The mothers noted that poor feeding and eating habits could cause under- and over-nutrition respectively. More specifically, the mothers expressed opinions that pointed more directly to food insecurity, dietary diversity and dietary patterns being determinants of under- and over-nutrition. For example, a mother noted

“the quality of the food.... well, most of the time, he eats only one type of food. No change of food, always only one type of food, always only one type. That will also cause a child not to reach the normal weight” (Discussant 7: Gombe Rural 1)

Another mother noted that

“for some of them, (it is) lack of food...” (Discussant 8: Gombe urban 1)

This understanding by the mothers is important because they are usually responsible for making food choices in homes, and this in part depends on the availability and accessibility of food choices.

The quantitative aspect of the present study showed that community level influenced the variance in the odds of both under- and over-nutrition. The qualitative study also showed some variation in the understanding and experience of under- and over-nutrition across the different communities. The influence of the community on the odds for under- and over-nutrition among school-aged children and adolescents is a novel finding from this research work. This is important in designing and planning nutrition interventions for school-aged children and adolescents in these two Nigerian states. Most large-scale interventions for school-aged children and adolescents in Nigeria have been school-based. While the school environment is an important setting for interventions in these age groups, the findings of this research shows that it may be important to consider community-based nutrition interventions for them.

7.3 Considerations when assessing Validity of Results

The study limitations have been discussed under each empirical paper (i.e. in chapters 3 to 6), however a summary of the limitations are discussed below;

A limitation of the qualitative study, as with all other qualitative studies,²³⁵ is that the findings may not be generalizable.

The lack of nationally representative data on the burden of under- and over-nutrition among school-aged children and adolescents in Nigeria was one of the research gaps considered when

conceptualizing this research. However, the findings of the present research carried out in only two states, may not be generalizable to the entire country with 36 states, even though the present study involved a representative sample from the two states. This is particularly so because of the social diversity, cultural plurality, and the multi-ethnic nature of Nigeria. This limitation notwithstanding, it is important to note the value of these findings to similar settings in Nigeria, Africa and other LMIC, and its value in the comparison between urban and rural communities.

The cross-sectional nature of the study also means that causality cannot be determined in this study. What this study identified were the factors that were significantly associated with under- and over-nutrition. The multi-variable analyses done helped to control for confounding, but could still not be said to establish causality. Additionally, this study did not set out to exhaust the many complex explanatory factors for both under-nutrition and over-nutrition among school-aged children and adolescents.

Another limitation is the possibility of recall bias associated with dietary assessment among the respondents. The assessment of dietary diversity and dietary patterns was dependent on the recall of foods consumed in the last 24 hours and the last 30 days respectively, which makes them prone to recall bias.²³⁶

The validity of the research instruments was however ensured throughout the research process. The questionnaire was developed with validated instruments, and was pre-tested among a similar population living in similar communities to those in the study. To further ensure their validity, the questionnaires were translated to the native languages and back translated to English to ensure the original meanings were intact.

To ensure the validity of the anthropometric measurements (weight and height), known weights were used on the weighing scales every morning. Furthermore, intra and inter-tester errors were minimized by ensuring proper training of research assistants, engaging very experienced supervisors for the data collection processes and taking multiple measurements of same and different subjects by the researcher and the research assistants during the training of research assistants and also randomly during data collection.

7.3 Future Research

This research has identified different areas for further research, which should include;

- Exploring the perception of school-aged children and adolescents about the concepts, causes and community experience of under- and overweight children and adolescents.

The perception of the children/adolescents is important as it could affect their nutritional habits and food choices, as has been among teenage and adolescent girls in developed countries.

- Investigating of the existence, pattern, distribution and determinants of the double burden of under- and over-nutrition in the remaining four geo-political zones in Nigeria, so as to have a national perspective on the subject.
- Development of context-specific interventions, in co-creation with respective stakeholders, including children / adolescents and their parents.
- Evaluating of the effectiveness of community-based nutrition intervention programmes in improving energy balance-related behaviours among school-aged children and adolescents in Nigeria. The present study has shown the importance of the community in the odds for both under- and over-nutrition, hence the need to evaluate community-based interventions.
- Identifying the individual and conceptual factors associated with stunting among school-aged children and adolescents. The present study used thinness as the indicator for under-nutrition, which is appropriate because the reference values used (i.e. BMI-for-age) reflects both under- and over-nutrition (double burden of malnutrition) which is the focus of the present study. However, stunting is the most prevalent indicator of malnutrition in the present study, with more than a third of the respondents being stunted. Hence the need for this proposed study.

7.4 Implications

- The efforts of state and federal governments in addressing malnutrition in the two states and similar LMIC settings is duly noted. However, the governments and all other stakeholders need to evaluate nutrition intervention programmes (including school feeding programmes) and policies to target both under- and over-nutrition among age 6 - 19 years, and not just under-nutrition alone as it is presently done.
- Nutrition education programmes need to be intensified in the two states and similar LMIC settings for school-aged children, adolescents and their mothers to promote healthy/diversified dietary pattern and improvement of other energy balance-related behaviours. Educational programmes for mothers should also target identified gaps and misconceptions in their perceptions about under- and overweight children/adolescents.
- Stakeholders in the two states and similar LMIC settings should plan health education for children/adolescents and their parents to include information on physical activity and

the harmful effect of too much screen time. These health education programmes should use individual, household and community level education approaches.

- Policy makers and stakeholders in the two states and similar LMIC settings need to plan community-based nutrition intervention programmes to address under- and over-nutrition, and their determinants among children 6 – 19 years of age
- There is a need for the government and policy makers in Nigeria and other similar LMIC to address the socio-economic inequalities that exist between states and regions in Nigeria

7.5 Conclusion

The study concluded that the double burden of under- and over-nutrition exists among school-aged children and adolescents in the two Nigerian States, and these were associated with socio-demographic, socio-economic, dietary patterns and the contextual unit (communities) where the respondents lived.

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Appendices

Appendix 1: Co-authors' agreement

I declare that I contributed adequately towards research findings published in the articles stated below which are included in my thesis.

Signature of Student: 

Date: 20th December 2021

Name of Primary Supervisor: Prof. Kerstin Klipstein-Grobusch K

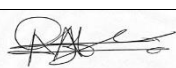
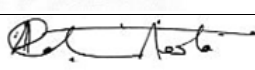
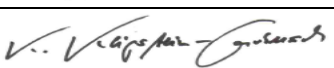
Signature of Primary Supervisor:

Date: 20th December 2021

Agreement by co-authors

By signing this declaration, the co-authors listed below agree to the use of the article (s) by the student as part of his Thesis.

Article 1: Title: Double burden of malnutrition among school-aged children and adolescents: evidence from a community-based cross-sectional survey in two Nigerian States. AAS Open Research (2021); 4:38 <https://doi.org/10.12688/aasopenres.13257.1>

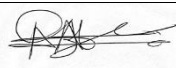
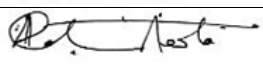
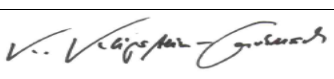
Authors	Name	Signature	Date
1 st Author	Adeomi A.A.		20/12/2021
2 nd Author	Fatusi A.		20/12/2021
3 rd Author	Klipstein-Grobusch K		20/12/2021

Comments by primary supervisor:

N/A.....
.....
...

Article 2: Title: Individual and contextual factors associated with under- and over-nutrition among school-aged children and adolescents in two Nigerian states; a multi-level analysis. Public Health Nutrition (2021);

Authors	Name	Signature	Date
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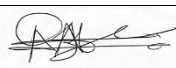
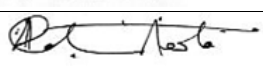
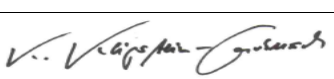
1 st Author	Adeomi A.A.		20/12/2021
2 nd Author	Fatusi A.		20/12/2021
3 rd Author	Klipstein-Grobusch K		20/12/2021

Comments by primary supervisor:

N/A.....

 ...

Article 3: Title: Food security, dietary diversity, dietary patterns and under- and over-nutrition among school-aged children and adolescents in two Nigerian States. Nutrients


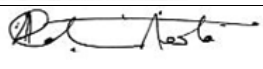
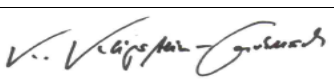
Authors	Name	Signature	Date
1 st Author	Adeomi A.A.		20/12/2021
2 nd Author	Fatusi A.		20/12/2021
3 rd Author	Klipstein-Grobusch K		20/12/2021

Comments by primary supervisor:

N/A.....

 ...

Article 4: Title: “Children eat all things here”: a qualitative study of mothers’ perceptions and cultural beliefs about the concept, causes and community experience of under- and over-weight children and adolescents in selected communities in two Nigerian States.

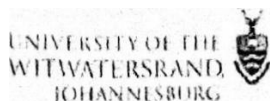
Authors	Name	Signature	Date
1 st Author	Adeomi A.A.		20/12/2021
2 nd Author	Fatusi A.		20/12/2021
3 rd Author	Klipstein-Grobusch K		20/12/2021

Comments by primary supervisor:

N/A.....

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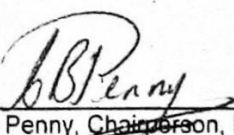
Appendix 2: Ethical clearance from University of the Witwatersrand



R14/49 Dr. AA Adeomi

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL) CLEARANCE CERTIFICATE NO. M190514

NAME: (Principal Investigator)	Dr AA Adeomi
DEPARTMENT:	School of Public Health Medical School University of the Witwatersrand
PROJECT TITLE:	The double burden of under- and over- nutrition amongst school-aged children and adolescents In two Nigerian States
DATE CONSIDERED:	2019/05/31
DECISION: CONDITIONS:	Approved unconditionally
SUPERVISOR:	Dr K Klipstein-Grobusch


Dr CB Penny, Chairperson, HREC (Medical)

APPROVED BY: _____

DATE OF APPROVAL: 2019/09/25

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and ONE COPY returned to the Research Office Secretary on the 3rd Floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to submit details to the Committee. I agree to submit a yearly progress report. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in May and Will therefore reports and re-certification will be due early in the month of May each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).



Principal Investigator Signature

30/09/2019

Date

PLEASE QUOTE THE CLEARANCE CERTIFICATE NUMBER IN ALL ENQUIRIES

Appendix 3: Ethical clearance from Osun State



MINISTRY OF HEALTH
HEALTH PLANNING, RESEARCH & STATISTICS DEPARTMENT
PRIVATE MAIL BAG NO. 4421 OSOGBO, OSUN STATE OF NIGERIA

Your Ref. No.....

*All Communications should be addressed to
The Permanent Secretary quoting*

Our Ref. No: OSHREC/PRS/569T/155

24th June, 2019

Dr Adeleye Abiodun Adeomi
Department of Community Health
Obafemi Awolowo University
Ile-Ife.

THE DOUBLE BURDEN OF UNDER - AND- OVER- NUTRITION AMONG SCHOOL - AGED CHILDREN AND ADOLESCENTS IN NIGERIA.

I wish to inform you that the Osun State Health Research Ethics Committee (OSHREC) has granted you an approval to proceed on the above exercise.

The approval lasts one year spanning June, 24th, 2019 and June, 23th 2020
You are to inform the Committee the starting date of the exercise and if there is any delay in starting, kindly inform the Committee to enable it adjust the date accordingly which will allow for monitoring by designated representative of the Committee. A copy of the outcome of the research must be made available to the Committee.

Regard this letter as Certificate of OSHREC approval.

Thank you.

A handwritten signature in black ink, appearing to read 'Gbenga Oyebode'.

Gbenga Oyebode.

For: Chairman.
(OSHREC)

Appendix 4: Ethical clearance from Gombe State

SECRET

GOMBE STATE OF NIGERIA

**MINISTRY OF
HEADQUARTERS**

HEALTH

All correspondence to be: -State
Addressed to the Hon.
042 Gombe Gombe State.



072-220244

Secretariat
Commissioner P.M.B

222988

our Ref: MOH/ADM/621/VOL.I/142
Adeleye Abiodun Adeomi
School of Public Health,
The University of the Witwatersrand,
South Africa.

Date: 26TH July, 2019

■ ETHICAL APPROVAL: THE DOUBLE BURDEN OF UNDER-AND OVER-NUTRITION

AMONG SCHOOL AGED CHILDREN AND ADOLESCENT IN NIGERIA

I am directed to inform you that, approval has been granted for the above subject matter.

Please, comply with the institutional guidelines, rules, regulation and tenets of the code for Health Research. The state committee reserves the right to visit your site without prior notification.

Pharm. Titunuw S. Dogonbaya FOR: STATE COMMITTEE ON HEALTH RESEARCH AND ETHICS

Appendix 5: Questionnaire

GENERAL INTRODUCTORY DETAILS		
01	Serial Number	
02	State	
03	Local Government Area	
04	Ward	
05	Enumeration area	
06	Date of interview	
07	Interviewer's code	
08	Supervisor's code	
09	Residence	a. Rural [] b. Urban []
SECTION A: GENERAL CHARACTERISTICS OF THE CHILD/ADOLESCENT <i>(Respondent for this section – Mother)</i>		
A01	Do you know the date of birth of the child	a. Yes [] b. No []
A02	If yes, what is the date of Birth	
A03	If No, what is the age	
A04	Gender	a. Male [] b. Female []
A05	Has this child ever attended school?	a. Yes, and the child is currently in-school [] b. Yes, but now out-of-school [] <i>Skip to A08</i> a. No [] <i>Skip to A08</i>
A06	If yes, level of schooling “ completed ”	b. None [] c. Primary [] d. Secondary [] e. Tertiary [] f. Post-graduate []
A07	If yes (a or b), school type	a. Public [] b. Private []
A08	If yes and currently in-school, what is the class in school	a. Primary [] b. Junior secondary [] c. Senior secondary [] d. Tertiary []
A09	What is total number of children in the family?	
A10	What is the position of the child (Birth order) in the family?	
A11	Birth space between the child and the immediate older sibling? (in months)	
A12	Where was this child born?	a. Hospital [] b. Clinic or primary health centre [] c. Home [] d. Traditional birth attendant []

		e. Mission home [] f. Don't know []	
A13	What was the weight of the child at birth?	a. Small (< 2.5kg) [] b. Normal (2.5 – 4kg) [] c. Big (>4kg) []	
A14	Was child breastfed?	a. Yes [] b. No [] <i>Skip to A16</i>	
A15	How long was the child breastfed in months?		
A16	Was the child exclusively breastfed? (<i>given just breastmilk without any other food or water after birth</i>)?	a. Yes [] b. No [] <i>Skip to A16</i>	
A17	How long in months was the child exclusively breastfed?		
A18	What is the immunization status of the child/adolescent, concerning the NPI schedule for children?	a. Not immunized [] b. Partially immunized [] c. Fully immunized [] d. Not sure []	
A19	Overall, how do you perceive the child's health?	a. Very good [] b. Good [] c. Fair [] d. Poor [] e. Very poor []	
A20	Has the child been sick/ill or needed to be given drugs or treatment for an illness in the last one month?	a. Yes [] b. No []	
A21	If yes, what is the nature of the illness/sickness		
SECTION B: DIETARY PATTERNS, PUBERTAL STAGING AND BODY IMAGE PREFERENCES OF THE CHILD/ADOLESCENT (<i>Respondent for this section – Child or Adolescent</i>)			
B01	What is the number of times you took a serving (not just a bite) of these food types in the last one month?		
	SN	Food types	Number of times in the last one month
		Cereals and Grain products	
	1.	White rice	
	2.	Brown/local rice	
	3.	Maize	
	4.	Millet	
	5.	Sorghum/Guinea corn	
	6.	Bread	
	7.	Spaghetti/macaroni	
	8.	Wheat	
		Starchy fruits, roots and tubers	
	9.	Cassava	
	10.	Yam	

11.	Potato	
12.	Cocoyam	
13.	Plantain	
	Grain legumes & products	
14.	Beans	
15.	Soybean	
	Nuts & seeds	
16.	Groundnut	
17.	Cashew nuts	
18.	Coconut	
	Vegetables and products	
19.	Cabbage	
20.	Carrot	
21.	Cucumber	
22.	Waterleaf (Gbure)	
23.	Mushroom	
24.	Tomato	
25.	Amaranthus leaves	
26.	Pumpkin leaves (ugu)	
27.	Bitter leaves	
28.	Scent leaves	
29.	Okra	
30.	Ewedu	
31.	Eggplant (efo igba)	
32.	Moringa leaves	
33.	Efo worowo/Amunututu (spinach)	
34.	Other vegetables (specify)	
	Fruits	
35.	Apple	
36.	Avocado	
37.	Citrus fruits (e.g. orange, tangerine)	
38.	Guava	
39.	Mango	
40.	Pawpaw	
41.	Pineapple	
42.	Watermelon	
43.	African star apple (agbalumo)	
44.	banana	
45.	Other fruits (specify)	
	Sugars and syrups	
46.	Honey	
47.	Sugar	
48.	Sugar cane	
	Meat & poultry	
49.	Beef (cow meat)	
50.	organ meat	
51.	Cow skin	
52.	Chicken	
53.	Turkey	
54.	Goat	
55.	Guinea fowl	
56.	Pork	

	57.	Sheep/lamb	
	58.	Rabbit	
	59.	Snail	
	60.	Duck	
	61.	Bush meat	
		Egg & products	
	62.	Chicken egg	
	63.	Duck egg	
	64.	Quail egg	
	65.	Turkey egg	
	66.	Guinea fowl egg	
		Fish & products	
	67.	Catfish	
	68.	Crab	
	69.	Crayfish	
	70.	Periwinkle	
	71.	Other types of fish (titus, sower, tilapia etc)	
		Milk and related products	
	72.	Powdered milk	
	73.	Evaporated milk	
	74.	Yoghurt	
	75.	Traditional (fura) milk	
	76.	Soymilk	
		Fats and oils	
	77.	Butter/Bama	
	78.	Vegetable/groundnut oil	
	79.	Palm oil	
		Condiments and spices	
	80.	Garlic	
	81.	Ginger	
	82.	Locust beans	
	83.	Onions	
	84.	Dried pepper	
		Drinks	
	85.	Homemade fruit juice	
	86.	Kunu drink	
	87.	Sweetened drinks (coke etc)	
		Desserts and snacks	
	88.	Chips or pop corn	
	89.	Cakes or muffins	
	90.	Pastry & pies	
	91.	Doughnut	
	92.	Candy	
B02	List all the foods and drinks you have taken in the last 24-hours	Type	List of foods and drinks
		Breakfast	
		Between breakfast and lunch	

		Lunch		
		Between lunch and dinner		
		Dinner		
		After dinner		
B03	What is the dietary diversity score of the child, using the 24-hour dietary recall above (to be calculated by research assistant)			
SN	Food groups			Score Yes = 1 No = 0
1	Cereals (corn/maize, rice, wheat, sorghum, millet or other grains or foods made from them eg bread, noodles, porridge or other grain products)			
2	Vitamin A vegetables & tubers (pumpkin, carrot, squash, or sweet potato that are orange inside + other locally available vitamin A rich vegetables)			
3	White tubers (white potatoes, white yam, white cassava, or other foods made from roots)			
4	Dark green leafy vegetables (dark green leafy vegetables, including wild forms) + locally available vitamin A rich leaves such as amaranth, spinach			
5	Other vegetables (other vegetables (e.g. tomato, onion, eggplant) + other locally available vegetables)			
6	Vitamin A rich fruits (ripe mango, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + other locally available vitamin A rich fruits)			
7	Other fruits (other fruits, including wild fruits and 100% fruit juice made from these)			
8	Organ meat (liver, kidney, heart or other organ meats or blood-based foods)			
9	Flesh meat (beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects)			
10	Egg (eggs from chicken, duck, guinea fowl or any other egg)			
11	Fish (fresh or dried fish or shellfish)			
12	Legumes, nuts & seeds (dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg. hummus, peanut butter))			
13	Milk & milk products (milk, cheese, yogurt or other milk products)			
14	Oils & fats (oil, fats or butter added to food or used for cooking)			
B04	Pubertal stage (using the diagram in Appendix 13) indicate the stage that best describes your experience	a. Stage 1 [] b. Stage 2 [] c. Stage 3 [] d. Stage 4 [] e. Stage 5 []		
SECTION C: PHYSICAL ACTIVITY PATTERNS OF THE CHILD <i>(Respondent for this section – Child or Adolescent)</i>				
C01	Estimated time (in minutes) playing games on computers/mobile phones or on internet/ computer daily or other indoor games that do not require mobility			
C02	Average hours spent watching television/ video/satellite daily			
C03	Average hours spent sleeping daily			

C04	Physical activity in your spare time: Have you done any of the following activities in the past 7 days (last week)? If yes, how many times? (Mark only one circle per row.)		No	1-2	3-4	5-6	≥ 7	
		Skipping						
		Walking for exercise						
		Bicycling						
		Jogging/running						
		Swimming						
		Vigorous Dance						
		Football/soccer						
		Tennis/badminton						
		Volleyball						
		Basketball						
		Skateboarding						
		Farming						
		Cultural play/activity like buru, tete, suwe etc						
Other vigorous activity/exercise								
	In the last 7 days, during your physical education (PE) classes, how often were you very active (running, jumping, juggling, throwing)? (Check one only)	a. I don't do PE [] b. Hardly ever [] c. Sometimes [] d. Quite often [] e. Always []						
	In the last 7 days, what did you do most of the time at recess? (Check one only) Sat	a. Sat down (talking, reading, doing schoolwork) [] b. Stood around or walked around [] c. Ran or played a little bit [] d. Ran around and played quite a bit [] e. Ran and played hard most of the time []						
	In the last 7 days, what did you normally do at lunch (besides eating lunch)? (Check one only)	a. Sat down (talking, reading, doing schoolwork) [] b. Stood around or walked around [] c. Ran or played a little bit [] d. Ran around and played quite a bit [] e. Ran and played hard most of the time []						
	In the last 7 days (excluding weekends), on how many days right after school/work, did you do sports, dance, or play games in which you were very active? (Check one only.)	a. None [] b. 1 time last week [] c. 2 or 3 times last week [] d. 4 times last week [] e. 5 times last week []						
	In the last 7 days (excluding weekends), on how many evenings did you do sports, dance, or play games in which you were very active? (Check one only.)	a. None [] b. 1 time last week [] c. 2 or 3 times last week [] d. 4 or 5 times last week [] e. 6 or 7 times last week []						
	On the last weekend, how many times did you	a. None [] b. 1 time []						

	do sports, dance, or play games in which you were very active? (Check one only.)	c. 2 or 3 times [] d. 4 or 5 times [] e. 6 or more times []	
	Which one of the following describes you best for the last 7 days? Read all five statements before deciding on the one answer that describes you.	a. All or most of my free time was spent doing things that involve little physical effort [] b. I sometimes (1 — 2 times last week) did physical things in my free time (e.g. played sports, went running, swimming, bike riding, did aerobics) [] c. I often (3 — 4 times last week) did physical things in my free time [] d. I quite often (5 — 6 times last week) did physical things in my free time [] e. I very often (7 or more times last week) did physical things in my free time []	
	Mark how often you did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day last week.		

	None	Little bit	Medium	Often	Very often
Monday					
Tuesday					
Wednesday					
Thursday					
Friday					
Saturday					
Sunday					

SECTION D: HOUSEHOLD/FAMILY CHARACTERISTICS

(Respondent for this section – Mother)

D01	Household type	a. One Nuclear family alone [] b. > 1 nuclear family [] c. One extended family [] d. >1 extended family []	
D02	Who owns the house you reside in?	a. Rented apartment [] b. Owned by a member of the household [] c. Owned by a family member, who is not a part of the household [] d. Others (specify) _____	
D03	Family setting (of parents)	a. Monogamous [] <i>Skip to B11</i> b. Polygamous []	
D04	If polygamous, how many wives		
D05	What is the marital status of the parent(s)	a. Never married [] b. Married, living together [] c. Married, living separately [] d. Separated [] e. Divorced [] f. Widowed []	
D06	Religion	a. Christianity [] b. Islam [] c. Traditional [] d. Others (specify)	

D07	What is the family size, including all the parents and all the children?																																																							
D08	What is your tribe?	a. Yoruba [] b. Igbo [] c. Hausa [] d. Fulani [] e. Others (Specify) _____																																																						
D09	What is the level of education completed by the Mother?	a. None [] b. Primary [] c. Secondary [] d. Tertiary [] e. Post-graduate []																																																						
D10	What is the level of education completed by the Father?	a. None [] b. Primary [] c. Secondary [] d. Tertiary [] e. Post-graduate []																																																						
D11	Mother's occupational status	a. Nil/housewife [] b. Student/apprentice [] c. Unskilled workers (maids, guards, petty traders etc) [] d. Farmers [] e. Teachers/civil servants [] f. Professionals (doctors, lawyers, accountants, engineers etc) [] g. Large scale entrepreneurs []																																																						
D12	Father's occupational status	a. Nil/housewife [] b. Student/apprentice [] c. Unskilled workers (maids, guards, petty traders etc) [] d. Farmers [] e. Teachers/civil servants [] f. Professionals (doctors, lawyers, accountants, engineers etc) [] g. Large scale entrepreneurs []																																																						
D13	Father's average monthly income																																																							
D14	Mother's average monthly income																																																							
D15	What is the main material used for the roof and the walls of the main dwelling?	<table border="1"> <thead> <tr> <th></th> <th>Type of material</th> <th>Roof</th> <th>Walls</th> </tr> </thead> <tbody> <tr><td>1</td><td>Bricks</td><td>2</td><td>7</td></tr> <tr><td>2</td><td>Cement block/concrete</td><td>2</td><td>7</td></tr> <tr><td>3</td><td>Corrugated iron/zinc</td><td>2</td><td>3</td></tr> <tr><td>4</td><td>Wood</td><td>2</td><td>4</td></tr> <tr><td>5</td><td>Plastic</td><td>1</td><td>2</td></tr> <tr><td>6</td><td>Cardboard</td><td>1</td><td>1</td></tr> <tr><td>7</td><td>Mixture of mud and cement</td><td>1</td><td>6</td></tr> <tr><td>8</td><td>Wattle and daub</td><td>1</td><td>3</td></tr> <tr><td>9</td><td>Tiles</td><td>2</td><td>8</td></tr> <tr><td>10</td><td>Mud</td><td>1</td><td>5</td></tr> <tr><td>11</td><td>Thatching</td><td>1</td><td>3</td></tr> <tr><td>12</td><td>Asbestos/cement roof sheeting</td><td>2</td><td>0</td></tr> </tbody> </table>		Type of material	Roof	Walls	1	Bricks	2	7	2	Cement block/concrete	2	7	3	Corrugated iron/zinc	2	3	4	Wood	2	4	5	Plastic	1	2	6	Cardboard	1	1	7	Mixture of mud and cement	1	6	8	Wattle and daub	1	3	9	Tiles	2	8	10	Mud	1	5	11	Thatching	1	3	12	Asbestos/cement roof sheeting	2	0		
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1	Radio																																																							
2	Television																																																							

		3	Mobile telephone			
		4	Non-mobile telephone			
		5	Refrigerator/freezer			
		6	Canoe	2		
		7	Bicycle	2		
		8	Motorcycle	3		
		9	Animal-drawn cart	1		
		10	Car/truck	4		
		11	Boat with a motor	3		
		12	Electricity			
		13	Cable TV			
		14	Generating set			
		15	Computer/Laptop			
D17	What is the household's main source of water? <i>Please tick just one option as appropriate</i>		Water source	Yes	No	
		1	Piped tap water in dwelling	6		
		2	Piped tap water on site or in yard	3		
		3	Public tap	2		
		4	Water-Carrier/tanker	3		
		5	Borehole on site	5		
		6	Borehole off site/communal	2		
		7	Rain-water tank on site	2		
		8	Flowing water/stream	1		
		9	Dam/pool/stagnant water	1		
		10	Well	4		
		11	Spring	1		
		12	Other (specify)			
D18	Does this household have electricity?	a. Yes, and it is currently connected [] b. Yes, but it is NOT currently connected [] c. No []				
D19	Household Food security (Children should also answer this section)					
No	Question	Response			Code	
1	In the past four weeks, did you worry that your household would not have enough food?	a. Yes b. No (<i>skip to Q2</i>)				
1a	How often did this happen?	a. Rarely b. Sometimes c. Often				
2	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	a. Yes b. No (<i>skip to Q3</i>)				
2a	How often did this happen?	a. Rarely b. Sometimes c. Often				
3	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	a. Yes b. No (<i>skip to Q4</i>)				
3a	How often did this happen?	a. Rarely b. Sometimes c. Often				
4	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	a. Yes b. No (<i>skip to Q5</i>)				
4a	How often did this happen?	a. Rarely b. Sometimes c. Often				
5	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	a. Yes b. No (<i>skip to Q6</i>)				
5a	How often did this happen?	a. Rarely b. Sometimes c. Often				

6	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	a. Yes b. No (<i>skip to Q7</i>)	
6a	How often did this happen?	a. Rarely b. Sometimes c. Often	
7	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	a. Yes b. No (<i>skip to Q8</i>)	
7a	How often did this happen?	a. Rarely b. Sometimes c. Often	
8	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	a. Yes b. No (<i>skip to Q9</i>)	
8a	How often did this happen?	a. Rarely b. Sometimes c. Often	
9	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	a. Yes b. No (<i>Finished</i>)	
9a	How often did this happen?	a. Rarely b. Sometimes c. Often	
SECTION F: ANTHROPOMETRIC MEASUREMENTS			
F01	Child/adolescent	a. Weight _____ (Kg) b. Height _____ (m)	
F02	Mother	a. Weight _____ (Kg) b. Height _____ (m)	

Appendix 6: Focus group discussion guide

- 1) Arrival and welcoming of discussants
- 2) Introduction of researcher/moderator and recorder/note taker.
- 3) Introduction of project topic and briefly explaining the rationale for the study
- 4) **Questions for discussion**
 - a. What do you understand by an underweight child or adolescent?
 - b. What do you understand by an overweight child or adolescent?
 - c. Which, in your opinion, is more common in your community
 - d. Why do you think causes some children/adolescents to be under- or overweight?
 - e. What beliefs exist in your culture that relate to the diet/nutrition/feeding of children?
 - f. What food restrictions or taboos exist for children in your community?
NB: Depending on the response, further probing will be done to understand the restrictions/taboo
- 5) Appreciate the discussants and disperse them

Appendix 7: Participant information sheet for mothers (quantitative study)

Dear Ma

My name is Adeleye Abiodun and I am a PhD student in Public Health at Wits University in Johannesburg. As part of my studies, I have to undertake a research project, and I am investigating the double burden of under- and over-nutrition among school-aged children and adolescents in Nigeria. The aim of this research project is to investigate the burden, distribution and determinants of malnutrition among school-aged children and adolescents in Nigeria.

I would like to invite you to take part in this study. Your participation involves you and/or your child answering a set of questions in the questionnaire. This will also involve the measurement of your weight, height, waist & hip circumferences and will take around 45 minutes to 1 hour.

You will not receive any direct benefits from participating in this study, and there are no disadvantages or penalties for not participating. You may withdraw at any time or not answer any question if you do not want to. The responses to the questionnaire and your measurements will be completely confidential and anonymous as I will not be asking for your name or any identifying information, and the information you give to me will be held securely in a computer only accessible to me and will not be disclosed to anyone else. If you experience any distress or discomfort, we will stop the interview or resume another time. If you need some support or counselling services following answering the questionnaire, these are available free of charge. I will also refer to the nearest hospital if I find any appalling measurements.

If you have any questions afterwards about this research, feel free to contact me on the details listed below. This study will be written up as research manuscripts/report. If you wish to receive a summary of this report, I will be happy to send it to you upon request. If you have any queries, concerns or complaints regarding the ethical procedures of this study, you are welcome to contact;

- The University Human Research Ethics Committee (Medical), telephone +27 11 717 2656, email hrec-medical.researchoffice@wits.ac.za
- The Health Planning, Research and Statistics Department, Ministry of Health, P.O.Box 4421, Osun State Secretariat, Osogbo, Osun State; telephone +2348067712241

Yours sincerely,

Principal Investigator: Adeleye Abiodun Adeomi, leyeadeomi@yahoo.com, +2348036535077
Supervisor: Kerstin Klipstein-Grobusch, Kerstin.Klipstein-Grobusch@wits.ac.za,
k.klipstein-grobusch@umcutrecht.nl

Appendix 8: Participant information sheet for mothers (qualitative study)

Dear Ma

My name is Adeleye Abiodun and I am a PhD student in Public Health at Wits University in Johannesburg. As part of my studies I have to undertake a research project, and I am investigating the double burden of under- and over-nutrition among school-aged children and adolescents in Nigeria. The aim of this research project is to investigate the burden, distribution and determinants of malnutrition among school-aged children and adolescents in Nigeria.

I will like to invite you to take part in this study. Your participation involves you taking part in a focus group discussion. This activity will involve joining a group of 6 – 10 women in your community to discuss on issues related to the research and will take around 60 to 90 minutes. With your permission, I would also like to record the discussion using a digital device.

You will not receive any direct benefits from participating in this study, and there are no disadvantages or penalties for not participating. You may withdraw at any time or not answer any question if you do not want to. Your views/contributions in the focus group discussion will not be completely confidential. I will be using a pseudonym (false name) to represent your participation, in my final research report. If you experience any distress or discomfort, we will stop the interview or resume another time. If you need some support or counselling services following the focus group discussion session, these are available free of charge.

If you have any questions afterwards about this research, feel free to contact me on the details listed below. This study will be written up as research manuscripts/report. If you wish to receive a summary of this report, I will be happy to send it to you upon request. If you have any queries, concerns or complaints regarding the ethical procedures of this study, you are welcome to contact;

- The University Human Research Ethics Committee (Medical),
- telephone +27 11 717 2656, email hrec-medical.researchoffice@wits.ac.za
- The Health Planning, Research and Statistics Department, Ministry of Health, P.O.Box 4421, Osun State Secretariat, Osogbo, Osun State; telephone +2348067712241

Yours sincerely,

Principal Investigator: Adeleye Abiodun Adeomi, leyeadeomi@yahoo.com, +2348036535077

Supervisor: Kerstin Klipstein-Grobusch, Kerstin.Klipstein-Grobusch@wits.ac.za,
k.klipstein-grobusch@umcutrecht.nl

Appendix 9: Consent form for mothers (quantitative study)

Title of project: The double burden of under- and over-nutrition among school-aged children and adolescents in Nigeria

Name of researcher: Adeleye Abiodun Adeomi

I (Name of participant) agree to participate in this research project. The research has been explained to me and I understand what my participation will involve.

(please circle Yes or No as it will be appropriate)

I agree to be involved in answering questionnaires YES NO

I agree that my anthropometric measurements will be taken YES NO

I agree that the researcher can write up research manuscripts/report from information collected YES NO

I know that participation is not mandatory and I will withdraw from the study whenever I choose to YES NO

I agree that the researcher might refer my child to a near-by hospital based on certain findings YES NO

Participant:	<i>Name</i>	<i>Signature/thumb print</i>	<i>Date</i>
Witness:	<i>Name</i>	<i>Signature/thumb print</i>	<i>Date</i>
Researcher:	<i>Name</i>	<i>Signature</i>	<i>Date</i>

Appendix 10: Consent form for mothers participating in Focus Group Discussions

Title of project: The double burden of under- and over-nutrition among school-aged children and adolescents in Nigeria

Name of researcher: Adeleye Abiodun Adeomi

I (Name of participant) agree to participate in this focus group discussion. The research has been explained to me and I understand what my participation will involve.

(please circle Yes or No as it will be appropriate)

I agree to be involved in focus group discussion YES NO

I agree that the researcher may use anonymous quotes in his research report YES NO

I agree that the interview may be audio recorded YES NO

I agree that the researcher may use pseudonym (false name) to represent me in the final research report YES NO

I agree that the researcher can write up research manuscripts/report from information collected YES NO

I know that participation is not mandatory and I will withdraw from the study whenever I choose to YES NO

Participant: _____
Name _____ _____
Signature/thumb print *Date*

Witness: _____
Name _____ _____
Signature/thumb print *Date*

Researcher: _____
Name _____ _____
Signature *Date*

Appendix 11: Information sheet for younger children (6 – 11 years)



TITLE OF THE RESEARCH PROJECT: *The double burden of under- and over-nutrition among school-aged children and adolescents in Nigeria*

RESEARCHERS NAME/CONTACT(S): I am Adeleye Abiodun Adeomi, and the name of my school is University of Witwatersrand, Johannesburg, South Africa

What is RESEARCH?

Research is something we do to know something new about the way things (and people) work. We use research projects or studies to help us find out more about disease or illness. Research also helps us to know better ways of helping, or treating children who are sick.

What is this research project all about?

This research is to know something new about how children in different parts of Nigeria grow, and to find out more about why children grow the way they grow.

Why have I been invited to take part in this research project?

This project involves children between 6 and 19 years of age, and who live in some communities in Nigeria. You have been invited because you are within this age group and you are living in one of the communities in Nigeria.

What will happen to me in this study?

You will answer some questions and we will find out what your weight and how tall you are. No pain, harm or any other bad thing will happen to you. And you are free to have any adult you trust (not necessarily a parent) with you when being asked questions.

What if I do not want to do this? And is there any benefit?

If you do not want to do this, there will be no problem or bad thing that will happen to you. Although, no direct benefit may come to you, but overall this study will help to know how children in Nigeria grow and will generally be of benefit to children in Nigeria. And you may be advised to visit a hospital for better care based on certain findings.

At this point, you can ask questions for better understanding...

Yours sincerely,

Adeleye Abiodun Adeomi, leyeadeomi@yahoo.com, +2348036535077

Appendix 12: Assent form for younger children (6 – 11 years)



Title of project: The double burden of under- and over-nutrition among school-aged children and adolescents in Nigeria

Name of researcher: Adeleye Abiodun Adeomi

I (Name of participant) agree to participate in this research. The research has been explained to me and I understand what my participation will involve.

(please circle Yes or No as it will be appropriate)

Do you understand this research study and are you willing to take part in it? YES NO

Have all your questions about this project been answered? YES NO

Do you understand that you can pull out of the study at any time? YES NO

Do you understand that you may be advised to visit a hospital for better care based on certain findings YES NO

Do you understand that you are free to have any adult you trust (not necessarily a parent) with you when being asked questions YES NO

Participant: _____
Name Signature/thumb print Date

Witness: _____
Name Signature/thumb print Date

Researcher: _____
Name Signature Date

Appendix 13: Information sheet form for adolescents (12 – 19 years)



TITLE OF THE RESEARCH PROJECT: *The double burden of under- and over-nutrition among school-aged children and adolescents in Nigeria*

RESEARCHERS NAME/CONTACT(S): I am Adeleye Abiodun Adeomi, a student of the University of Witwatersrand, Johannesburg, South Africa

What is RESEARCH?

Research is something we do to find new knowledge about the way things (and people) work. We use research projects or studies to help us find out more about disease or illness. Research also helps us to find better ways of helping, or treating children who are sick.

What is this research project all about?

The project is to find out new knowledge about how children in different parts of Nigeria grow, and to find out more about why children grow the way they grow.

Why have I been invited to take part in this research project?

This project involves children between 6 and 19 years of age, and who live in selected communities in Nigeria. You have been invited because you are within this age group and you are living in one of the selected communities.

What will happen to me in this study?

You will answer some questions and your weight and height will be measured. No pain, harm or any other bad thing will happen to you. And you are free to have any adult you trust (not necessarily a parent) with you when being asked questions.

What if I do not want to do this? And is there any benefit?

If you do not want to do this, there will be no consequence or negative thing that will happen to you. Although, no direct benefit may come to you, but overall this study will help to know how children in Nigeria grow and will generally be of benefit to children in Nigeria. And you may be advised to visit a hospital for better care based on certain findings.

At this point, you can ask questions for better understanding...

Yours sincerely,

Adeleye Abiodun Adeomi, leyeadeomi@yahoo.com, +2348036535077

(please circle Yes or No as it will be appropriate)

Appendix 15: Confidentiality forms for research assistants

Title of project: The double burden of under- and over-nutrition among school-aged children and adolescents in Nigeria

Name of researcher: Adeleye Abiodun Adeomi

Confidential information relating to human subjects in this research study may include, but is not limited to Name, date of birth, age, sex, educational and occupational records, ethnic or racial origin, family/household characteristics, nutritional history, child characteristics etc.

As a research assistant, you will have access to confidential information pertaining to the research study. Many participants will reveal information to you because the principal investigator has assured them that every effort will be made to maintain confidentiality. That is why it is of the utmost importance to maintain full confidentiality when conducting a research study

In order to maintain confidentiality, I agree to:

1. Keep all research information that is shared with me (e.g. flash drives, notes, transcripts, data, etc.) confidential by not discussing or sharing this information verbally or in any format with anyone other than the principal investigator of this study;
2. Ensure the security of research information while it is in my possession. This may include:
 - Keeping all documents and/or data related to the research study on a password protected computer with password protected files;
 - Closing any programs, documents, or data files related to the research study when away from the computer;
 - Keeping any printed documents and/or data related to the research study in a secure location such as a locked filing cabinet;
 - Permanently deleting any digital communication containing documents and/or data related to the research study.
3. Not make copies of documents and/or data related to the research study unless specifically instructed to do so by the principal investigator;
4. Give all research information/data and research participant information/data back to the principal investigator upon completion of my duties as a research assistant;
5. After discussing it with the principal investigator, erase or destroy all research information that cannot be returned to the principal investigator upon completion of my duties as a research assistant.

By signing this form, I acknowledge that I have reviewed, understand, and agree to adhere to the expectations for a research assistant described above. I agree to maintain confidentiality while performing my duties as a research assistant and recognize that failure to comply with these expectations may result in disciplinary action.

Research assistant:

Name

Signature/Date

Researcher:

Name

Signature/Date

Appendix 16: Confidentiality form for translators and transcribers

Title of project: The double burden of under- and over-nutrition among school-aged children and adolescents in Nigeria

Name of researcher: Adeleye Abiodun Adeomi

Confidential information relating to human subjects in this research study may include, but is not limited to Name, date of birth, age, sex, educational and occupational records, ethnic or racial origin, family/household characteristics, nutritional history, child characteristics etc.

As a translator/transcriber, you will have access to confidential information pertaining to the research study. That is why it is of the utmost importance to maintain full confidentiality when conducting a research study

In order to maintain confidentiality, I agree to:

1. Keep all research information that is shared with me (e.g. flash drives, notes, transcripts, data, etc.) confidential by not discussing or sharing this information verbally or in any format with anyone other than the principal investigator of this study;
2. Ensure the security of research information while it is in my possession. This may include:
 - Keeping all documents and/or data related to the research study on a password protected computer with password protected files;
 - Closing any programs, documents, or data files related to the research study when away from the computer;
 - Keeping any printed documents and/or data related to the research study in a secure location such as a locked filing cabinet;
 - Permanently deleting any digital communication containing documents and/or data related to the research study.
3. Not make copies of documents and/or data related to the research study unless specifically instructed to do so by the principal investigator;
4. Give all research information/data and research participant information/data back to the principal investigator upon completion of my duties as a translator/transcriber;
5. After discussing it with the principal investigator, erase or destroy all research information that cannot be returned to the principal investigator upon completion of my duties as a translator/transcriber.

By signing this form, I acknowledge that I have reviewed, understand, and agree to adhere to the expectations for a research assistant described above. I agree to maintain confidentiality while performing my duties as a translator/transcriber and recognize that failure to comply with these expectations may result in disciplinary action.

Translator/transcriber: _____
Name *Signature/Date*

Researcher: _____
Name **Signature/Date**

Appendix 17: Table showing previous studies in Nigeria

SN	Authors Year	Location/ State/Region	Population/ Sample size	Nutritional status	Measure	Associated factors
1.	Ijarotimi et al, 2003	Akure/ Ondo/SW	10-18 years/ 606	Not clear	W/H, H/A (undefined reference) and Adult BMI	Not considered
2.	Grew et al, 2003	Jos/ Plateau/NC	1-16 years/ 340	Stunting (girls) – 46%/ Stunting (boys) – 57%	NCHS	Not considered
3.	Ijarotimi et al, 2005	Ondo/SW	10-18 years/ 1427	Underweight - 69.3%/ Overweight – 0.5%/ Stunting – 48.9%	Adult BMI Classification/ H/A (undefined reference)	Household food security
4.	Nwokoro et al, 2006	Benin city/ Edo/SS	10-20 years/ 2012	Not clearly stated	NCHS/WHO/MUAC	Not considered
5.	Oninla et al, 2007	Ile-Ife/Osun/ SW	2.5-18 years/749	Underweight - 61.2%/ Wasting - 16.8%/ Stunting - 27.6%	NCHS (using W/A, H/A, W/H)/ Wellcome classification	Age, gender, residence (rural & urban)
6.	Ben-Bassey et al, 2007	Eti-Osa/ Lagos/SW	10-19 years/ 1504	Underweight -14.3%/ Overweight - 3.4%/ Obesity - 0.2%	NCHS (using BMI-for-age percentiles)	Age, school type, gender, residence, socio-economic status
7.	Ijarotimi et al, 2007	Akure/Ondo/ SW	10 – 15 years/402	Wasting - 50.2%/ Stunting -50.0%	W/A, H/A; but reference values not stated	Age, gender, socio-economic status
8.	Ukegbu et al, 2007	Umuhia/ Abia/SE	15-18 years/ 190	Underweight - 58.4%/ Stunting - 62.5%/ Overweight -3%	NCHS 1977 using W/A, H/A AND BMI-for-age/ MUAC/Skin fold thickness	Age, gender
9.	Olumakaiye, 2008	Osun/SW	10-19 years/ 401	Underweight -20.1%/ Overweight - 3.2%/ Obesity - 0.7%	NCHS/ WHO using BMI-for-age percentiles	Age, gender, household type, hours spent outside the home, frequency of travelling
10.	Ekpo et al, 2008	Ogun, Oyo and Kwara/ SW	6 months – 15 years/ 331	Stunting – 38.7%/ Wasting – 13.6%/ Underweight – 38.7%	NCHS/WHO using H/A, W/H AND W/A	Age, gender
11.	Ansa et al, 2008	Calabar/ Cross-River/SS	10-20 years/ 1000	Overweight – 6.8%/ Obesity – 1.7%	IOTF	Soft drink consumption
12.	Amuta et al, 2008	Makurdi/ Benue/NC	10-18 years/ 569	Prevalence of malnutrition – 72.6%	BMI	Intestinal parasitic infections
13.	Amuta et al, 2009	Makurdi/ Benue/NC	6-17 years/ 600	Undernutrition - 50.7%	NCHS/WHO using BMI percentiles	Residence, school type, gender, age

14.	Akinyemi et al, 2009	Lagos/SW	10-19 years/ 40	Not clearly stated	Adult BMI classification	Not considered
15.	Ayoola et al, 2009	Ibarapa/Oyo/ SW	5-20 years/ 623	Stunting – 50%/ Underweight – 30%	NCHS using HFA and BMI-for-age	Not considered
16.	Omigbodun et al, 2010	Ibadan/Oyo/ SW	10-19 years/ 1799	Stunting - 15.7%/ Underweight -18.9%/ Overweight - 2.3%	WHO 2007 (using H/A & BMI-for-age)	Gender, residence, school type, age, onset of puberty, mother's occupation, number of children in family
17.	Olumakaiye et al, 2010	Osun/SW	10-19 years/ 401	Underweight - 20.1%/ Overweight - 3.2%/ Obesity - 0.6%	NCHS/WHO using BMI-for-age percentiles	Food consumption pattern
18.	Goon et al, 2010	Tarka/Benue/ NC	12-18 years/ 722/Girls only	Underweight - 5%/ Overweight & Obesity -9.9%	WHO 1995 (using BMI-for-age percentiles)	Not considered
19.	Odenigbo et al, 2010	Ikwuano/ Abia/SE	6-12 years/ 119	Underweight – 29.41%/ Stunting - 10.08%/ Overweight – 6.72%/ Obesity – 0.84%	CDC 2000 using W/A, H/A and BMI-for-age	Birth weight
20.	Akor et al, 2010	Jos/Plateau /NC	5-12 years/ 764	Underweight -10.3%/ Stunting -11.1%/ Wasting - 2.4%	NCHS/WHO using W/A, H/A and W/H	Age, gender, school type
21.	Senbanjo et al, 2010	Abeokuta/ Ogun/SW	10-19 years/ 570	Underweight -28.6%/ Overweight & obesity -1.9%	NCHS/WHO using BMI-for-age percentiles	Socio-demographic characteristics/ socio-economic status/ physical activity
22.	Ejike et al, 2010	Ajaokuta/ Kogi/NC	10-19 years/ 625	Undernutrition - 19.4%/ Stunting - Overweight/Obesity - 13.12%	NCHS using H/A, BMI-for-age	Age, gender
23.	Goon et al, 2010	Makurdi/ Benue/NC	9-12 years/ 2015	CDC/Underweight -83.4%/ Overweight - 2.1%/ IOTF/Overweight - 1.7%	CDC/ IOTF using BMI-for-age	Age, gender
24.	Opera et al, 2010	Uyo/ Akwa-Ibom/SS	31-150 months/ 985	Underweight - 33.3%/ Stunting - 21.2%/ Obesity - 5.7%	WHO 1995 using H/A & BMI-for-age	Age, school type, food preferences, maternal education, socio-economic status
25.	Oninla et al, 2010	Ile-Ife/Osun/ SW	3-19 years/ 749	Prevalence of malnutrition of all kinds – 62.1%	NCHS/ Welcome classification	Helminthic infection
26.	Opara et al, 2010	Uyo/ Akwa Ibom/ SS	2.5-14 years/ 985	Underweight – 33.4%/ stunting – 21.2%/ Overweight/Obesity – 5.7%	WHO 2003 reference	Age, gender, food preferences, school type, socio-economic status

27.	Goon et al, 2011	Makurdi/ Benue/NC	9–12 years/ 2015	Underweight – 43.4%/ stunting – 52.7%/ Thinness – 77.3%	NCHS (using W/A, H/A)/ IOTF using BMI-for-age	Gender
28.	Senbanjo et al, 2011	Abeokuta/ Ogun/SW	5-19 years/ 570	Stunting - 17.4%	WHO 1995 (using H/A)	School type, family type, maternal education,
29.	Fetuga et al, 2011	Sagamu/ Ogun/SW	6-10 years/ 1016	Underweight-25.5%/ Stunting - 14.2%/ Thinness - 22.2%/ Overweight - 3.0%/ Obesity -0.5%	WHO 2007 (using W/A, H/A and BMI-for-age)	Age, gender
30.	Senbanjo et al, 2011	Abeokuta/ Ogun/SW	5-19 years/ 570	Underweight - 24.7%/ Stunting -17.4%/ Overweight - 1.7%/ Obesity - 2.6%	NCHS/WHO using W/A & H/A	Age, sex, socio-economic status
31.	Fetuga et al, 2011	Sagamu/ Ogun/SW	6-16 years/ 1690	Underweight - 33.4/30.2/ Stunting - 17.7/16.9/ Overweight - 1.8/3.8	CDC/WHO 2007 using W/A, H/A AND BMI-for-age	Not considered
32.	Bamidele et al, 2011	Osogbo/ Osun/SW	15–19 years/ 497	Underweight – 41.3%/ Overweight – 3.8%	NCHS/WHO using BMI-for- age	Age, gender, occupation and education of parents
33.	Adesina et al, 2012	Port-Harcourt/ Rivers/SS	10-19 years/ 960	Underweight-6.4%/ Overweight-6.3%/ Obesity-1.8% Stunting-5.4%	NCHS (using BMI-for-age percentiles)	Age, gender, socio-economic class, maternal education, television watching
34.	Musa et al, 2012	Benue/NC	9-16 years/ 3240	Overweight - 9.7%/ Obesity - 1.8%	IOTF (using BMI-for-age)	Age, gender and residence
35.	Falade et al, 2012	Ile-Ife/Osun/ SW	3-15 years/ 160	Underweight - 14%/ Overweight - 3%	WHO 1995 (using BMI-for- age percentiles)/MUAC	Age, gender
36.	Okoh et al, 2012	Port-Harcourt/ Rivers/SS	6-12 years/ 1302	Underweight -11.7%/ Overweight - 5.7%/ Obesity - 5.9%	CDC using BMI-for-age	Not considered
37.	Ene-Obong et al, 2012	Lagos/ Port-Harcourt/ Nsukka/Aba	5-18 years/ 1599	Overweight - 11.4%/ Obesity - 2.8% Thinness - 13.0%	IOTF using BMI-for-age	Gender, age, residence, socio- economic status, city, income level
38.	Olanipekun et al, 2012	Ibadan/Oyo/ SW	5 – 10 years/ 300	Stunting – 38.3%/ Underweight – 35%/ Wasting – 32%	NCHS/WHO using W/H, H/A, W/A and BMI-for-age	School- type
39.	Oduwole et al, 2012	Lagos/SW	10-17 years/ 885	Overweight – 13.8%/ Obesity – 9.4%	CDC using BMI-for-age	Not considered


40.	Opera et al, 2012	Akwa-Ibom/ SS	2.9 – 14 years/ 405	Stunting (rural Vs urban) – 42.3% Vs 29.7%/ Underweight (rural Vs urban) – 43.2% Vs 29.6%/ Wasting (rural Vs urban) – 10.9% Vs 6.4%	NCHS	Intestinal parasitic infections
41.	Chinedu et al, 2012	Ota/Ogun/ SW	2-19 years/ 926	Underweight – 9.0%/ Overweight – 9.1%/ Obesity – 4.3%	CDC	Not considered
42.	Mustapha et al, 2013	Ondo/SW	10-19 years/ 2031	Underweight -16.3%/ Overweight - 5.8%/ Obesity -1.1%	WHO-Anthro-plus (using BMI-for-age percentiles)	Age, gender and residence
43.	Senbanjo et al, 2013	Abeokuta/ Ogun/SW	5-19 years/ 570	Overweight - 1.8%/ Obesity - 0.2%	WHO, 1995 (BMI-for-age percentiles)/ Skinfold ratio/ Waist-Height ratio	Age, gender, socio-economic status
44.	Ahmad et al, 2013	Sokoto/ Sokoto/NW	10–18 years/180	Overweight – 3.3%/ Obesity – 1.4%	IOTF using BMI-for-age	Age, gender
45.	Ndukwu et al, 2013	Onitsha/ Anambra/SE	6-12 years/ 788	Not defined	Not defined	Residence
46.	Olumakaiye, 2013	Ile-Ife/Osun/ SW	6 – 11 years/ 600	Underweight – 1.7%/ Stunting – 5.0%/ Wasting – 4.2%/ Overweight/obese – 5.8%	CDC/WHO 2007 using BMI- for-age, W/A, H/A AND W/H	Food diversity, school type,
47.	Yusuf et al, 2013	Kano/Kano/ NW	13-19 years/ 718	Overweight – 1.98%/ Obesity – 0.84%	IOTF using BMI-for-age	Age, gender, social status
48.	Onyiriuka et al, 2013	Benin City/ Edo/SS	12-19 years/ 2,097	Overweight – 7.9%/ Obesity – 1.8%	NCHS	Eating habits
49.	Sabageh et al, 2013	Ile-Ife/Osun/ SW	10-19 years/ 500	Using BMI - Obesity – 4.2%/ Using WHR –obesity -37.2%	BMI/WHR	Gender
50.	Olumakaiye, 2013	Ile-Ife/Osun/ SW	6-11 years/ 600	Underweight – 11.7%/ Stunting – 5.0%/ Thinness – 4.2% Overweight/Obesity – 5.8%	Not clear	Age, dietary diversity
51.	Akinpelu et al, 2014	Ojo/Lagos/ SW	1-10 years/ 1903	WHO/Underweight - 43.2%/ Overweight - 4.1%/ Obesity - 3.6%/ IOTF/Underweight - 42.9%/ Overweight - 2.6%/ Obesity - 1.2%	WHO 2007 using BMI-for- age, H/A & W/A/ IOTF using BMI-for-age	Age, gender

52.	Senbanjo et al, 2014	Abeokuta/ Ogun/SW	5-19 years/ 570	Wasting - 9.1%/ Stunting- 17.4%	WHO 1995 using H/A, W/H, BMI-for-age/MUAC/ Triceps skinfold thickness	Age, gender
53.	Omobuwa et al, 2014	Ibadan/ Oyo/SW	13 – 19 years/93	Underweight – 6.4%/ Overweight – 5.4%/ Obesity – 2.2%	CDC/NCHS/WHO using BMI- for-age	Gender
54.	Nto et al, 2014	Ebonyi/SE	5-18 years/ 1,620	Not reported as prevalence	CDC using BMI-for-age	Age, gender, residence
55.	Ilechukwu et al, 2014	Enugu/Enugu/ SE	1-10 years/ 460	Wasting – 1.3%/ Stunting – 0.2%	NCHS/WHO using H/A, W/H	Helminthic infection
56.	Adeomi et al, 2015	Osun/SW	6-12 years/ 600	Underweight -41.0%/ Overweight - 2.3%/ Obesity - 1.5%	IOTF (using BMI-for-age)	Residence, age, family setting, socio-economic status, physical activity,
57.	Alkali et al, 2015	Gombe/Gombe/ NE	5-18 years/ 450	Overweight - 4% Obesity - 2.8%	CDC using BMI-for-age	Age, gender, school type, socio- economic status, lifestyle parameters
58.	Nwabueze et al, 2015	Anambra/SE	4 – 15 years/365	Underweight – 10.7% Stunting – 1.9%/ Overweight – 4.1%	W/A (undefined reference)	Residence, educational status of parents
59.	Ukegbu, 2015	Orunmba/ Anambra/SE	6 – 11 years/ 358	Underweight – 15.9%/ Stunting – 27.4%/ Wasting – 20.7%	WHO 2007 using W/A, H/A AND W/H	Breakfast consumption
60.	Esimai et al, 2015	Port Harcourt/ Rivers/SS	10-16 years/ 182	Underweight – 46.2%/ Overweight – 6.6%/ Stunting – 36.3%	WHO 2007	Age, gender
61.	Ayogu et a, 2016	Nsukka/Enugu/ SE	12-18 years/ 400	Stunting-33.3%/ Thinness -31.0%	WHO 2007 (using BMI-for- age, H/A)	Age, household income
62.	Oyeyemi et al, 2016	Maiduguri/ Bornu/NE	11-18 years/ 1006	Underweight - 41.0%/ Overweight - 2.3%/ Obesity -1.5%	IOTF using BMI-for-age	Physical activity
63.	Jaja et al, 2016	Port-Harcourt/ Rivers/SS	10-19 years/ 1320/ Girls only	Obesity; CDC: 8.02%/ WHO: 5.22%/ IOTF: 2.75%	CDC/ WHO 2007/ IOTF using BMI-for-age	Not considered
64.	Lateef et al, 2016	Kwara/NC	10-19 years/ 515	Underweight – 29.1%/ Overweight – 4.7%/ Obesity – 0.2%	WHO 2007 (Anthro-plus)	Physical activity level, food consumption pattern,
65.	Bello et al, 2016	Lagos/SW	6-12 years/ 529	Underweight – 32.3%/ Stunting – 10.6%/ Obesity – 0.2%	NCHS/WHO using W/A, H/A and W/H	Dietary patterns, residence

				Wasting – 3.4%/ Overweight/obese – 5.8%		
66.	Nnebue et al, 2016	Owerri/Imo/SE	5-12 years/ 300	Underweight – 6.0%/ Stunting – 2.6%/ Wasting – 12.7%/ Overweight/obese – 3.4%	Not defined	Age, gender, Feeding practices, family characteristics
67.	Akinola et al, 2016	Onigbongbo/ Lagos/SW	10-19 years/ 1100	Overweight – 5.8%/ Obesity – 1.7%	CDC using BMI-for-age	School type, age, gender
68.	Adam et al, 2017	Benin city/ Edo/SS	6-12 years/ 195	Underweight-1.8%/ Over-weight -7.7%/ Obesity -3.1%	WHO 2007 (using BMI-for-age)	Gender
69.	Otuneye et al, 2017	AMAC/ FCT/NC	10-19 years/ 1550	Stunting -11.2%/ Wasting -1.7%/ Over-weight -12.6%/ Obesity -2.8%	WHO 2007 (using BMI-for-age)	Dietary habits
70.	Nwoke et al, 2017	Aba/Abia/ SE	10 – 19 years/600	Underweight – 23.3%/ Stunting – 8.67%/	WHO/NCHS using H/A and BMI-for-age	School type, gender,
71.	Sadoh et al, 2017	Benin City/ Edo/SS	Primary school children/ 1,466	Underweight – 7.6%/ Overweight – 7.1%/ Obesity – 5.7%	CDC using BMI-for-age	School type
72.	Eze et al, 2017	Enugu/Enugu/ SE	6-12 years/ 2,616	Wasting – 9.3%/ Stunting – 0.5%/ Underweight – 1.2%/ Overweight – 6.3%/ Obesity – 4.5%	WHO Anthro-plus using W/H, H/A, W/A and BMI-for-age	Age, gender,
73.	Abah et al, 2017	Jos/Plateau/NC	6-12 years/ 358	Stunting – 10.34%/ Overweight/obesity – 4.47%/ Thinness – 1.39%	WHO 2007	Age, gender
74.	Igbokwe et al, 2017	Enugu/Enugu/ SE	6-12 years/ 348	Stunting – 0.8%/ Wasting – 3.3%/ Underweight – 3.3%/ Overweight – 8.5%/ Obesity – 4.1%	WHO 2007 using H/A, W/H, W/A and BMI-for age	Socio-economic class, education of parents
75.	Kola-Raji et al, 2017	Ibadan/Oyo/ SW	10-18 years/ 490	Stunting – 2.5%/ Underweight – 39.3%/ Overweight – 8.0%/ Obesity – 0.8%	BMI/HFA but reference value used not stated	School type

76.	Asiegbu et al, 2017	Abakalilki/ Ebonyi/SE	6-12 years/ 804	Underweight – 5.6% Overweight – 6.2% Obesity – 3.0%	WHO 2007 reference	Age, gender, socio-economic status, school type
77.	Omisore et al, 2018	Osun/SW	10-19 years/ 1000	Overweight -7.7% Obesity - 3.0%	IOTF using BMI-for-age	Residence, gender, socio-economic status, physical activity, education of parents
78.	Bello et al, 2018	Ilorin/ Kwara/ NC	6–12 years/ 480	Underweight – 15.7%/ stunting – 11.5%/ Thinness – 15.4% Overweight – 7.3% Obesity – 3.1%	WHO 2007 reference	Gender, school type
79.	Uwakwe et al, 2019	Uzo-Uwani/ Enugu/SE	10–19 years/ 840	Underweight – 3.0%/ stunting – 9.1%/ Thinness – 14.4% Overweight/Obesity – 3.1%	WHO 2007 reference	Gender, residence
80.	Olasinde et al, 2020	Ilorin/ Kwara/ NC	6–12 years/ 480	Underweight – 3.0%/ stunting – 5.0%/ Thinness – 4.4% Overweight – 7.3% Obesity – 1.0%	WHO 2007 reference	Age, sex, school type, socio-economic status
81.	Wariri et al, 2020	Gombe & Uyo/ SS & NE	10 – 18 years	Thinness – 6.8% Overweight/obesity – 12.4% Individual DBM – 8.02%	WHO Anthroplus	Age, sex, religion, ethnicity, family setting. Socio-economic status

BMJ Open 'Children eat all things here': a qualitative study of mothers' perceptions and cultural beliefs about underweight and overweight children and adolescents in selected communities in two Nigerian states

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ABSTRACT

Introduction The perception of mothers about causes of underweight and overweight among children or adolescents and associated cultural beliefs may influence nutritional status. However, data from qualitative studies on this subject and regarding age 6–19 are scarce in Nigeria.

Objective This study aimed to explore mothers' perceptions and cultural beliefs about underweight and overweight children and adolescents in selected communities in a northern and a southern Nigerian state.

Design This was a qualitative study using focus group discussions (FGD). Eight FGD sessions were held. The interviews were transcribed verbatim, and the transcripts were coded and analysed using NVivo V.11, and direct quotations representing the themes generated from the perspectives were cited as appropriate.

Setting The study was carried out in eight randomly selected rural and urban communities in Gombe and Osun states of Nigeria.

Participants Seventy-six mothers of children and adolescents aged 6–19 years.

Results The mothers identified concepts, causes and community experience of underweight and overweight children and adolescents, however, some gaps and misconceptions were observed. These included perspectives that suggest a limited understanding of the concepts of mild and moderate malnutrition and stunting and citing of 'witches and wizards' as causes of malnutrition. The mothers observed that being underweight was more prevalent in rural communities of Osun and Gombe states, while overweight was more prevalent in urban communities in Osun state. The majority of the women reported no known food taboo or restrictions, and no cultural beliefs relating to the nutrition of children and adolescents.

Conclusion Gaps and misconceptions exist in the perceptions of mothers on underweight and overweight children and adolescents. Food taboos, food restrictions and other cultural beliefs were not reported by majority of the mothers. Educational programmes for mothers on

Strengths and limitations of this study

- This study, to the best of our knowledge, is the first to examine the perception of mothers on cultural beliefs and causes of both undernutrition and overnutrition among age 6–19 years as a group in the two ethnically different states in Nigeria.
- Unlike many other studies on the nutritional status of children and adolescents, this study used a qualitative design which are particularly important in exploring and understanding issues relating to perception and cultural beliefs.
- The findings of this study, however, may not be generalisable to children, adolescents or the mothers to the whole of Nigeria. Additionally, it is difficult to establish causality with the qualitative research design. The nature of the focus group discussion used, also creates artificiality, since the discussion was arranged, and it is not occurring naturally.

child/adolescent nutrition should target identified gaps and misconceptions.

INTRODUCTION

Nutritionally, the global community is battling with the epidemic of overweight/obesity as the incidence and prevalence of overweight/obesity are on the increase in various parts of the world.¹ However, for many low-income and middle-income countries the nutritional challenge goes beyond just overweight/obesity, as they are also confronted with the persisting problem of undernutrition.^{2,3} This paradoxical coexistence of undernutrition and overnutrition is what has been called the double burden of malnutrition.⁴

Nigerian researchers had made a fair attempt to understand the determinants of



undernutrition and overnutrition among children and adolescents in Nigeria, however, almost all of these studies used a quantitative study approach. A number of existing quantitative studies have reported determinants of undernutrition and overnutrition among Nigerian children and/or adolescents to include household and socioeconomic factors such as household income, parental education and occupation, nutritional status of the parents, family type and maternal characteristics.^{5–10} Qualitative methods allow for a deeper understanding of the perceptions, experiences and context.¹¹ This is important because people's 'realities' are actually their realities, which cannot be 'measured' because they are socially constructed. People's realities are diverse and its existence is based on the people's perceptions and peculiar experiences.^{11–12} The qualitative approach will, therefore, be helpful, especially because of the complex nature of the determinants of childhood and adolescent nutrition.^{13–14}

Mothers' perception and cultural beliefs are important, yet understudied, determinants of the nutritional status of children and/or adolescents. In some high-income countries, the understanding of mothers about malnutrition have been shown to affect their child feeding practices.^{15–16} It has also been found that some mothers in Europe and Asia could not correctly classify the nutritional status of their children and hence would not know if or when to adopt appropriate measures.^{17–19} The effect of cultural beliefs, on the nutritional status of children and adolescents has also not been well explored. Food taboos, food restrictions and food beliefs have been reported among pregnant women in Nigeria.^{20–22} However, only little research-based information could be found in the literature on the cultural beliefs relating to child/adolescent nutrition in Nigeria. The information about mothers' perception and cultural beliefs, and how these relate to the nutrition of children and adolescents in Nigeria would be important in designing and implementing effective nutritional interventions among these children and/or adolescents. Qualitative methods are particularly important in exploring and understanding issues relating to perception and cultural beliefs about nutritional issues, but there are gaps in the literature regarding the Nigerian situation both in terms of the study approach and the thematic issues. This study, therefore, aimed to explore mothers' perceptions and cultural beliefs about the concept, causes and community experience of underweight and overweight children and adolescents in selected communities in two Nigerian states using qualitative study approach to address the existing gaps.

METHODS

Study setting and design

This qualitative study was carried out in two states in Nigeria—one from the northern part and the other from the southern part of the country. Thus, this study setting takes cognisance of the broad division of Nigeria into two parts—the south and the north. Nigeria is a highly diverse and heterogeneous country in terms of ethnic, sociocultural and religious setting

and the southern part has better socio-economic rating compared with the north. Politically, Nigeria has 36 states, which are organised into 6 geopolitical zones with 3 zones in the North and 3 in the South. Each geopolitical zone is generally homogeneous in sociocultural attributes and fairly distinct from other geopolitical zones. Many ethnic groups within each zone share a common ancestry and have a high degree of similarities in terms of cultural beliefs as well as socioreligious characteristics and economic indicators.

The selection of the states used for this study was guided by the wealth level of each geo-political zone as published by the 2018 Nigeria Demographic and Health Survey (NDHS).²³ One state each was selected from the two zones with lowest (North-East) and highest wealth index (South-West) using simple random sampling technique (Balloting method). Gombe State and Osun State were thereby randomly selected from the North-East and South-West zones, respectively.

Participants and procedure

The study population for the qualitative study were mothers of children and adolescents aged 6–19 years living in selected communities in Osun and Gombe States. A total of eight focus group discussion (FGD) sessions were held, determined by the time data saturation was reached. The eight FGDs were carried out in eight different communities, with four communities selected in each of the two states (two rural and two urban communities per state). To select the communities, two local government areas (LGAs) were selected in each of the two states (one rural and one urban LGA). The list of the communities in each LGA was obtained from the LGA headquarters, and two communities in each LGA were selected using simple random sampling technique (balloting method), making a total of eight communities. Each FGD session consisted of 8–10 discussants, who were women usually resident in the community, currently had at least one child between 6 and 19 years of age, had no speech or hearing defect, were at least averagely expressive and gave informed written consent. In all, a total of 76 women who met the study criteria were selected purposively and were included in the study only after the study objectives and processes had been explained to them, their questions and concerns addressed, and they voluntarily gave their consents to participate in the FGDs.

Data collection

A guide was developed and used for qualitative data collection for the FGD sessions (online supplemental file). The FGD guide was initially in English language, but translated to the native languages of the different study locations (Yoruba and Hausa languages) and back translated to English to ensure the original meaning was intact. The translations were done by Ph.D. students in the Department of Nigerian Languages in Obafemi Awolowo University, Ile-Ife, Nigeria. Each FGD session was conducted within a time frame of 90–120 min, and sessions were facilitated by one of the authors (moderator) and a research assistant (note-taker) trained for that purpose. The discussions were done in the native languages of Osun and Gombe States, which were Yoruba and Hausa

languages respectively. In Gombe state, where the researcher was not fluent in the native language (Hausa language), there was an interpreter who was fluent in both English and Hausa languages. The sessions were audiorecorded after obtaining the consent of the discussants to do so.

Data analysis

The audiorecordings were initially transcribed verbatim in Yoruba and Hausa Languages, and later translated to English language. The moderator, the note taker and the interpreter checked the transcripts to make sure that they matched the recordings. The English transcripts were carefully reviewed and a set of codes were developed to describe groups of words or categories with similar meanings. Initial broad coding was done according to major themes from the FGD guide (deductive), but new codes and themes were also developed as they emerged from the data (inductive). Fine codes were developed under each of the initial broad codes. To increase reliability, 20% of the transcripts were double coded by a senior qualitative expert. The definitions of both the broad and fine codes were put together in a code book. Once the code book was established, transcripts were coded using NVivo V.11 software (QSR International, Doncaster, Australia). Direct quotations from the discussants that most clearly represent each theme were chosen to be included in the manuscript in italics.

Trustworthiness

Trustworthiness is a crucial requirement for all qualitative studies and this was ensured in many ways in this study, and is here presented using Guba's criteria.^{24,25}

Credibility

The FGDs used for this study were taken from eight randomly selected sites, with representation of the two major regions in the country (North and South) and also the rural and urban communities. To further ensure the credibility of the findings, all the authors independently read and commented on the findings, while a senior qualitative expert who was not involved in the study checked the themes and quotations to ensure they emerged from the original materials. The use of voice recordings and notes from the note taker, and the checking of the final transcripts by the moderator and note-taker all ensured that the discussions were accurately captured, and hence improving the credibility of the findings. Furthermore, only one person moderated all the FGDs and he was also the one who conducted the analysis hence he could easily make references to nuances in the transcripts.

Transferability

To ensure transferability, some background information about the study subject and context was given. Also, the details about the number of participants, how they were recruited and the data collection methods (FGD) were given. Additionally, the number and duration of the FGD sessions and other details about the FGD sessions were provided.

Dependability

The detailed information about the research methods and process provided in this study is also intended to improve the dependability of the research findings, such that a future researcher could repeat and get a similar result.

Confirmability

Triangulation through data sources was done in this study, which was to recruit a wide range of women for the study. These were women from different states, residences (ie, rural and urban dwellers) and backgrounds.

Patient and public involvement statement

The study participants and the public were not involved in the conceptualisation, design and recruitment to and conduct of the study. However, they will be involved in the plans to, and the actual dissemination of the study results by choosing when, where and in what form the dissemination should be.

RESULTS

A total of 76 women participated in the FGDs, and they were between 29 and 55 years of age, with a mean age of 32.4±4.5 years. Forty-six (60.5%) of them were Christians, while the remaining 30 (39.5%) were Muslims. Each of them had at least a child/adolescent who was 6–19 years of age.

Concept of underweight

The perception of the discussants about underweight children/adolescents was expressed through four subthemes as described below;

Subtheme 1: body parts disproportion

Many of the mothers perceived that underweight children/adolescents have disproportionately sized body parts such as those with disproportionately big heads, protruding or big abdomen, thin arms, legs or thin waist such that clothes do not size. One mother noted,

you know some child(ren), if you see them they are looking somehow, you'll see the children they are slim, some you will see big head, and will also have long (repeats "long") legs... (Discussant 8: Gombe, Urban 1)

Subtheme 2: sickly appearance

Some of the discussants perceived that underweight children/adolescents have sickly appearances, even when they are not apparently sick. Some mothers noted that underweight children or adolescents have uncomely or pale skin appearances. A mother reported,

from the eyes (repeats "from the eyes") of the child, you can easily see that this child is not really looking well. (Discussant K2: Gombe rural 1)

Another mother simply said,

the child will not be attractive (Discussant K4: Osun Urban 2)

Subtheme 3: weak or sickly children

Another opinion expressed by the mothers about underweight children is that they are weak, sickly and usually having different infections. A mother opined,

the moment he's playing with his colleague, from there you can know, because the moment they push him small (a little), he will fall down, he's not that strong. (Discussant K1: Gombe Rural 1)

According to another mother,

some of such children with abnormal weight always have incessant cough, face swelled up and dry lips. Some can have swollen body with hidden illnesses. (Discussant K7: Gombe Rural 2)

Subtheme 4: growth less than children of same age

Some of the women perceived underweight children/adolescents as those whose growth is less than the growth of other children of same age. According to one mother,

such a child will not grow very well among children of same age (Discussant R3: Osun Rural 1)

Concept of Overweight/Obesity

The perceptions of mothers on childhood/adolescent overweight/obesity were captured by two subthemes:

Subtheme 1: bigger than Age-mates

Majority of the discussants perceived an overweight child/adolescent as one whose physical body is bigger than the body size of most of his/her age mates. Some of the mothers opined that overweight/obese children/adolescents appear big, but from their behaviour it will be obvious that they are younger than how they look. The mothers opined that,

first sighting will make you see the child being very big with a young face structure. Weight will be too much for the age of the child. (Discussant R7: Osun Urban 2)

the fatness will not be OK. The weight is too much for the age of the child (and) we would know that such is not normal. From seeing the child, you will know that the weight of the child is too much for the age. (Discussant R7: Osun Urban 1)

Subtheme 2: moderate chubbiness is good

Some of the women expressed an opinion that favoured chubby children or adolescents. They felt that a moderately chubby child is beautiful, and that it only becomes a problem if the chubbiness is excessive. This view was more prevalent among women in urban communities of Osun State. One of the mothers opined,

we like chubby children, but when it is too much it is different, the child can't carry himself (Discussant 3: Osun Urban 1)

Community experience of underweight and overweight children and adolescents

The researchers sought to know which of underweight or overweight children and adolescents were perceived by the discussants to be predominant in each of the communities, and based on the responses of the discussants, three subthemes emerged.

Subtheme 1: overweight children and adolescents are predominant

This subtheme emerged exclusively from the two FGD sessions conducted in urban communities in Osun State. Some of the mothers opined that overweight was the predominant nutritional disorder in their community, and some of them were of the view that there was no underweight child or adolescent in their communities. One mother added,

in my own opinion I think overweight is more prevalent in this area (Discussant 4: Osun Urban 2)

Another mother noted,

I have not seen very slim children in this area (Discussant 2: Osun Urban 1)

Subtheme 2: underweight children and adolescents are predominant

This subtheme emerged from the FGD sessions in rural communities, both in Osun and Gombe states. The mothers expressed the view that the prominent nutritional disorder among children/adolescents in their communities was underweight. In the words of one of the mothers,

we do not have overweight children here but we have a lot of underweight children (Chorused by majority of the discussants, Gombe rural 2)

Subtheme 3: both underweight and overweight in the community

Some mothers across different discussion groups opined that there were both underweight and overweight children/adolescents in their communities, and did not think any was more predominant than the other. A mother opined,

in my area, the population of overweight is the same as those of underweight (Discussant 7: Osun Urban 2)

Another mother noted,

there are those with less weight (underweight), and there are those overweight. The most common, the skinny children, hmm (thinks for some time)... no, it's interwoven (Discussant 7: Osun Urban 1)

Table 1 Perceived causes of underweight and overweight according to the mothers

Underweight			
Subtheme	Definition	Illustrative Quotations	Discussant
1	Poor feeding	<i>'the quality of the food.... well, most of the time, he eats only one type of food. No change of food, always only one type of food,(repeats 'always only one type'). That will also cause a child not to reach the normal weight'</i>	Discussant 7: Gombe Rural 1
2	Poverty	<i>'yes, we have people that don't have much money in this area, even some of us here just packaged ourselves in this country. Some that gave birth and don't have much will not be able to give such a child the right diet and this could cause underweight.'</i>	Discussant 6: Osun rural 1
3	Hereditary	<i>'for some of them, (it is) lack of food, (for)some (it) is sick(ness) or sometimes you know the parents are thin. Both the parents are thin, so the child will come like that (will also be thin)'</i>	Discussant 8: Gombe urban 1
4	Sickness or ill-health	<i>'The first is that it could be stomach worms' problem, or a kind of sickness or that it is the gene in his/her body. Though eating (adequately, but) not getting fat, but it will show that he/she is eating good food'</i>	Discussant 6: Osun Rural 2
5	Parental and family factors	<i>'you cannot compare a child brought up in the rural area and another whose parents are learned'</i>	Discussant 5: Osun rural 1
6	Witches and wizards	<i>'It is witches and wizards (that cause underweight), but to the glory of God, there is no such thing in this community, in my own view'</i>	Discussant 7: Osun urban 2
7	Environmental factors	<i>'some, it's from the environment (environmental factors), (for example) if the environment is not clean, it will be affecting them to be thin'</i>	Discussant 1: Gombe urban 1
Overweight			
1	Eating habits	<i>'yes, food like carbohydrate, like swallows (starchy food), yam, garri (cassava flakes), pounded yam, semo (maize meal). When carbohydrate is too much on (in) a diet, it can lead to overweight, if it's taken all the time. It can cause overweight'</i>	Discussant 7: Osun Urban 2
2	Hereditary	<i>'even I, I have mummy (a mother that is) very big, that is why I am also fat, it is hereditary or genetic'</i>	Discussant 5: Gombe Urban 2
3	Sickness	<i>'(for) some it could be sickness that caused overweight, and some are just naturally endowed with stature by God'</i>	Discussant 7: Osun Rural 1
4	Sedentary lifestyle	<i>'what about excessive comfortability, where a child does nothing, only the house maid that does all the work while the child is lazing around, could lead to overweight., the child is just watching films, just waking up and sleeping, not doing any work. Because there are plenty of those people in this area'</i>	Discussant 7: Osun Urban 2

Perceived causes of underweight and overweight

The opinions expressed by the mothers about the causes of underweight and overweight are shown in table 1. There were seven subthemes for the perceived causes of underweight, which include poor feeding, poverty, hereditary, sickness or ill health, parental/family factors, witches and wizards and environmental factors. For the perceived causes of overweight, four subthemes emerged namely; eating habits, hereditary, sickness and sedentary lifestyle.

Cultural beliefs relating to the nutrition of children and adolescents

Two subthemes emerged concerning the views of discussants about cultural beliefs relating to the nutrition of children and adolescents.

Subtheme: no known cultural belief

Majority of the mothers did not know of any cultural belief or practice concerning the nutrition of children/adolescents in their families or communities. Even when the discussants were probed for food taboos or restrictions for children and adolescents, majority of them reported no food taboo or restriction for children and/or adolescents. This was the major finding in most of the

discussion groups. Below are some quotations from the mothers,

none, we do not have anything like that in this community (Discussant 2: Osun Urban 2)

it's in the olden days that we have heard that a child does not eat meat and the likes, but now such is not common anymore. It is just how much (money) you have that determines what you give to the child nowadays (Discussant 4: Osun Urban 1)

in our culture there is no food that a child cannot eat, if egg is available you (give the child to) eat, if it's not (available), you will eat other things (Discussant 2: Osun Rural 1)

Children eat all things here (Discussant 5: Gombe Urban 2).

Subtheme: restriction for snails

Few of the mothers from Gombe State reported that restrictions for snails existed in their families and/or tribes. Other women from Gombe state, however, noted that snail eating was not popular in the North because snails were scarce in the North, which may indicate that snail was not really a taboo. A mother noted,

we no dey (do not) eat snail, even the adult don't eat it (Discussant 8: Gombe Urban 1)

Another mother from the same discussion group however added,

yes, because we, we are not used to snail here. We don't eat it (Discussant 1: Gombe Urban 1).

DISCUSSION

The focus of the second Sustainable Development Goal 2 is to 'end hunger, achieve food security and improve nutrition, and promote sustainable agriculture'. As the 'Power of Nutrition' organisation notes, 'ending hunger, food insecurity and malnutrition for all will require continued and focused efforts, especially in Asia and Africa'.²⁶ This study, to the best of our knowledge, is the first to examine the perception of mothers and cultural beliefs about underweight and overweight children and adolescents in two ethnically different states in Nigeria. Understanding the perspectives of mothers, as primary care givers, is particularly important for developing effective interventions for undernutrition and overnutrition among children and adolescents.

Mothers' perceptions about the concept, causes and community experience of underweight and overweight children

The mothers in this study expressed some perceptions about underweight children/adolescents, including physical features such as protruding abdomen, big heads, thin limbs, poor growth, and weak and sickly appearances among underweight children and adolescents. However, the mothers also exhibited some gaps in their knowledge in that most of the perspectives shared reflects severely underweight children. The mothers seemed not to understand the possibility of mild to moderate undernutrition, which may only be known after objective assessment with some instruments. This is important as only a low proportion of undernutrition are severe, and relevant actions need to be focused early on addressing mild and moderate cases, which constitute the majority of malnutrition problems among children/adolescent. This gap in perception could be the reason for misclassification of malnourished children at community levels as normal as reported by various authors.²⁷⁻²⁹

Another gap in the mothers' knowledge is that no reference was made to stunting (ie, short for age) as a form of undernutrition. Yet, stunting is the most prevalent form of undernutrition in Nigeria, with the UNICEF reporting that a third of Nigerian children under 18 years are stunted.³⁰ Therefore, if the mothers, who are principally responsible for feeding or controlling the feeding of children or adolescents are ignorant of stunting, they may be taking little or no action to address such. Furthermore, the mothers based their perception of underweight on the weight of other children of same age. Such judgement

is highly subjective, and may lead to incorrect conclusion regarding perceived nutritional status, particularly in a community with a high prevalence of undernutrition. Similar findings have previously been reported from a qualitative study among mothers in Vietnam¹⁹ and could be associated with mother's misjudgement of the weight of their children or their nutritional status.²⁷⁻²⁹

The perception of majority of the mothers about overweight was also mixed. The subjectivity of basing the classification of a child/adolescent's weight on that of other children as earlier noted for underweight also applies to the perception of overweight. Another point of concern is the fact that some of the mothers favoured chubby children. Mothers in Vietnam similarly expressed their love for chubby children.¹⁹ The preference for chubby children may not be unconnected with the fact that underweight has been associated with poverty; thus, community members may tend to view chubby children as indication of well-being or affluence. The challenge with this perspective is that it would be objectively difficult to draw a line between 'chubby' and 'overweight'.

Mothers living in urban communities reported that overweight children were more prevalent, while those from rural communities reported the predominance of underweight children. This pattern is expected, and corroborates the findings of other researchers in Nigeria that have reported that overweight/obesity is predominant in the richer urban areas, while the less resourced rural areas have a high burden of undernutrition.³¹⁻³⁴ The NDHS also reports that all the indicators of undernutrition are two-times higher in rural, compared with urban communities in Nigeria.³¹ While the high burden of overweight children/adolescents in the urban communities should be discouraged, the higher burden of underweight in rural communities reflects the well-documented socioeconomic inequity and inequalities between rural and urban communities in Nigeria,³⁵—a persistent gap that needs to be urgently bridged.

Many of the factors that have been reported as determinants of undernutrition and overnutrition among children and adolescents by previous authors were also mentioned by the mothers when asked about the causes of undernutrition and overnutrition.^{5 34 36 37} These include dietary/feeding habits, physical activity patterns, sickness/disease, environmental factors, socioeconomic factors and household/parental factors. This level of understanding among the mothers is encouraging, because high health literacy among mothers is needed for the prevention and/or control of underweight and overweight among children and adolescents. On the other hand, it is also important to recognise some major misconceptions recorded among mothers regarding the causes of underweight and overweight among children and adolescents, such as 'witches and wizards'. Although, a number of misconceptions have been reported among mothers about the nutritional status of their children,^{27-29 38} previous authors have not specifically reported witches and wizards, although the role of the 'spiritual forces' or the 'supernatural' as causes

of mortality and morbidity is known to have been prevalent in local communities across Nigeria, particularly in the past. It is disturbing that these opinions were not only expressed in the rural areas, but also in the urban communities where mothers would be expected to be better educated and more enlightened. Misconceptions relating to the role of the supernatural forces pose a challenge to efforts aimed at encouraging mothers to take actions to prevent or control malnutrition since they are associated with the belief that addressing the cause is out of their reach.

Cultural beliefs relating to the nutrition of children and adolescents

Studies in Nigeria and several other African communities have reported food restrictions and taboos as prevalent among women and children,^{22, 39–41} but the finding of this study is different. Majority of the women who participated in this study, across the different sociodemographic locations, knew no food restriction nor taboo for children and adolescents. Furthermore, majority of the women reported no cultural beliefs relating to child or adolescent nutrition that they knew of. A study carried out in Kano State, Nigeria that aimed to describe the nutritional taboos among pregnant women also similarly found that food taboos were not much reported among the women.⁴² The Nigerian studies that reported food taboos are rather old,^{39–41} while the more recent studies that reported restrictions/taboo did so among pregnant women.^{30, 22} The finding of this study probably reflects the present reality in Nigeria that food taboo has reduced significantly, which may be associated with increased education and health awareness among the population.⁴³

The findings of this study, however, may not be generalisable to children, adolescents or the mothers to the whole of Nigeria for some reasons. First, the study was carried out in 2 out of the 36 states in Nigeria. Second, even in the two selected states, discussants were recruited from only four out of the total of 41LGAs. Lastly, the sample size (76) may not be representative, as it was not scientifically determined. It is also difficult to establish causality with the qualitative research design. The nature of the FGD used, also creates artificiality, since the discussion was arranged, and it is not occurring naturally.

This study has, however, provided new and important qualitative data on perception of mothers and cultural beliefs about underweight and overweight children and adolescents that have not been previously reported, especially because most previous studies used quantitative approaches. These findings could be used to generate some important research ideas which could be pursued using both qualitative or quantitative methods. An important research idea, for instance, is the 'prevalence of the gaps and/or misconceptions noticed among a larger population of mothers, and their associations with dietary practices/patterns and nutritional status of children', and this could be pursued using a quantitative study. Additionally, the findings of this study would be important in

designing nutritional education for mothers on child/adolescent nutrition, especially in the study area. This is because the study has made known some concepts and perceptions that could be built on, and important gaps and misconceptions that need to be addressed.

CONCLUSION

The mothers identified concepts, causes and community experience of underweight and overweight children and adolescents, but some gaps and misconceptions still exist among them, one of which is the perception that underweight is caused by witches and wizards. Food taboos, food restrictions and other cultural beliefs were not reported by majority of the mothers. Educational programmes for mothers on child/adolescent nutrition should target identified gaps and misconceptions.

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Contributors All the authors were involved in the conceptualisation of the research idea and topic, the design of the methodology and the proposal. AAA carried out the study as part of his PhD work, and he is the one responsible for the overall content as guarantor. AF and KK-G supervised, provided useful suggestions and the mentorship that helped to shape the study into the present form. All the authors read and approved the final version of the manuscript.

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Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

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RESEARCH ARTICLE

Double burden of malnutrition among school-aged children and adolescents: evidence from a community-based cross-sectional survey in two Nigerian States [version 1; peer review: 2 approved]

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Abstract

Background: Double burden of malnutrition (DBM) is the co-existence of overweight/obesity and undernutrition. Rising prevalence rates of childhood overweight/obesity in Nigeria have been reported, whilst undernutrition continues to be prevalent. This study aimed to estimate the prevalence and distribution of underweight, stunting, thinness, overweight/obesity, and DBM among school-aged children and adolescents in two Nigerian States.

Methods: This was a community-based cross-sectional study carried out in Osun and Gombe States. A total of 1,200 children aged 6 – 19 years were recruited using multi-stage sampling technique. Weight, height and data on demographic, socio-economic, household/family characteristics of the children were collected using structured interviewer administered questionnaires. Nutritional status was calculated using the WHO 2007 reference values using BMI-for-age (thinness, overweight/obesity), height-for-age (stunting) and weight-for-age (underweight). DBM was described at the population and individual levels.


Results: The mean age of the respondents was 11.6 ± 3.8 years. The overall prevalence rate of stunting was 34.9%, underweight was 13.5%, thinness was 10.3% and overweight/obese was 11.4% and 4.0% had individual level DBM, which typifies the DBM at individual and population levels. These rates differed significantly across demographic, socio-economic and household/family characteristics ($p < 0.05$). Gombe State, which is in the Northern part of Nigeria, had significantly higher burden of stunted, underweight and thin children

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than Osun State, while Osun State, in the Southern part of Nigeria, had a significantly higher burden of overweight/obesity.

Conclusions: The study found evidence of DBM both at population and individual levels. The overall prevalence rates of stunting, underweight, thinness and overweight/obesity in this study were high, and they differed significantly across the demographic, socio-economic and household/family characteristics. There is the need for government and all other stakeholders to design nutritional educational programmes that will target both under- and over-nutrition among older children in the different contexts.

Keywords

Under-nutrition, Over-nutrition, Double burden of Malnutrition, School-aged children, Adolescents, Stunting, Underweight, Thinness



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Introduction

Decades ago, the world faced the devastating burden of undernutrition among children, such that the term malnutrition was used almost exclusively to mean undernutrition¹. In recent years, there has been a steady rise in the prevalence of overweight and obesity among children and adolescents in all parts of the world, and the rate is increasing faster in low- and middle-income countries (LMIC) compared to high-income countries². Yet, undernutrition remains a major challenge in many LMICs; as such, many LMICs face a double burden of malnutrition (DBM) problems in terms of the co-existence of undernutrition and over-nutrition (overweight/obesity)^{3,4}. The increasing incidence of overweight/obesity in LMICs has been attributed mainly to nutrition transition with changes in dietary patterns from a traditional to a westernized diet – “a diet high in saturated fat, sugar, and refined foods and low in fibre” –⁵ and a reduction in energy expenditure fuelled by increasing sedentary activity patterns⁶. DBM significantly and negatively impact population health and well-being as well as economic development in LMICs⁷.

Nigeria, like many other LMICs, is currently undergoing nutritional transition^{8,9}, with some researchers already reporting rising prevalence rates of overweight/obesity close to the global average of 18% among adolescents^{10,11}. On the other hand, the United Nations Children Fund (UNICEF) estimates that 33% of Nigerian children are stunted, and this has been corroborated by other studies^{12–15}. Few studies in Nigeria are already reporting the existence of the double burden of malnutrition^{16–18}, but these studies are scattered, limited in geographical distribution and mainly school based. There is, to date, no nationally representative community-based data on the nutritional status of children 6 – 14 years in Nigeria. The Nigeria Demographic and Health Survey (NDHS), the Multiple Indicator Cluster Survey (MICS) and the Nutrition and Health Survey, which all have nationally representative data on the nutritional status of children in Nigeria include only under-five children, and those 15 years and older^{19–21}.

Also, although several studies have been carried out in Nigeria on the nutritional status of school-aged children and adolescents, many of the studies have the challenge of small sample size and comparability between survey findings has been challenging as different anthropometric indicators, reporting systems, cut-off points and reference values have been used²². Another challenge is the geographical imbalance in the study locations of existing studies, with majority of the studies reported in settings with higher socio-economic status (ie the Southern and urban parts of Nigeria)²³. Furthermore, most of the existing studies in Nigeria have been school-based studies and out-of-school children, who are from economically poorer and more disadvantaged backgrounds, are thereby excluded. This study aims to address some of the existing shortcomings and research gaps relating to DBM among children and adolescents in Nigeria. Specifically, this study aimed to estimate the prevalence and distribution of under- and over-nutrition among school-aged children and adolescents in

two Nigerian States from the northern and southern parts of the country, using a community-based approach.

Methods

Study design, population and size

This community-based cross-sectional study was carried out in Osun and Gombe States, located in the southern and northern parts of Nigeria respectively. The selection of the states was based on the wealth index as published by the NDHS¹⁹. The wealth index was categorized according to geo-political zones. Therefore, one state each from the zones with lowest (North-East; Gombe State) and highest wealth (South-West; Osun State) index were selected randomly. The study population were school-aged children and adolescents aged between 6 and 19 years living in selected communities in the study locations. The mothers of the selected school-aged children and adolescents were also included in the study. Acutely ill children, those with chronic diseases that can affect their weight (like sickle cell diseases and cancers), those living with disabilities that affect their abilities to stand properly, and children whose mothers were not available even after a revisit on another day during the time of the survey were excluded from the study. The sample size was calculated using STATCALC on Epi-Info software²⁴. The prevalence of stunting among Nigerian children according to UNICEF (33%)⁴ was used as the expected outcome, the acceptable margin of error was set at 5%, and the design effect was taken as 1.5. The design effect is the increase of sample size because of the hierarchical sampling model used in this study. After correcting for an anticipated non-response rate of 10%, the sample size came to 561 and was rounded off to 600 for each state, making a total of 1,200.

Sampling technique

The 1,200 respondents were selected using a multi-stage sampling. Four Local Government Areas (LGAs), 8 wards and 40 enumeration areas (EAs) were selected in the first, second and third stages using simple random sampling technique (balloting method). At the fourth stage, 30 households were selected from each of the EAs using systematic random sampling technique, making a total of 1,200 households. At the household level (fifth stage), only one child/adolescent was randomly selected (using balloting) from all the eligible children and/or adolescents in the household. This is because children within the same household would probably have very similar exposures, especially at this level, potentially confounding the associations.

Data collection

Ten research assistants and one field supervisor were recruited and trained in each of the 2 states. They were fluent in both the native and English languages and familiar with the socio-cultural and geographical terrains of the study locations. The assistants and supervisors were trained for five days by the one of the authors (AAA). After the training, measurements were taken by the researcher and each of the research assistants on the same set of subjects to ensure minimal or

no inter-tester and intra-tester errors. This exercise was repeated at intervals during the entire study to further assure quality control.

The questionnaires were interviewer-administered by use of REDCap²⁴. The questionnaire collected information on demographic, socio-economic and household/family characteristics, using relevant questions that were adapted from the NDHS¹⁹. Anthropometric measurements of children/adolescents were taken according to standard protocols recommended by the International Society for the Advancement of Kinanthropometry²⁵. Weight was measured in 0.1 kilograms by the use of an Omron® electronic bathroom weighing scale. Height was measured to the nearest 0.1 meter using a stadiometer. Weighing scales were routinely standardized by use of known weights.

Measurement of the outcome and explanatory variables

The outcome variable, nutritional status of the school-aged children and adolescents, was assessed using WHO 2007 reference values²⁶. Those with BMI-for-age Z-scores <-2, -2 to 1, > 1 to 2 and > 2 were classified as thinness, normal, overweight and obesity respectively. Weight-for-age and height-for-age Z scores < -2 were also used to assess underweight and stunting. Population level DBM signified communities with both under- and over-nutrition, while individual DBM was defined as children who were both stunted and overweight/obese.

The explanatory variables were States (Osun/Gombe), residence (rural/urban), age groups in years (6 – 9/10 – 13/14 – 16/17 – 19 years), sex (male/female), ethnic groups (Yoruba/Igbo/Hausa/Fulani/Minorities), household wealth index (poorest/poorer/middle/richer/richest), family type (monogamous/polygamous), mother's education (less than secondary/secondary or more) and mother's occupation (unemployed/employed). The wealth index was calculated using ownership of some household possessions, as was used by the NDHS¹⁹. Principal component analysis was used to produce a common factor score for each household. The scores were divided into quintiles to categorize the households into poorest, poorer, middle, richer and richest households. The wealth index was later re-grouped into three categories (poorest/middle/richest) for the multi-variate analysis.

Data analysis

The data were analyzed using STATA version 15.1. The level of significance was set with a two-sided p-value less than 0.05. The distribution of thinness, underweight, stunting, overweight/obesity and individual DBM according to the demographic, socio-economic and household/family characteristics was done. Pearson's chi-square test was used to test for associations at the bivariate level. The multinomial logistic regression was used to identify predictors of under- and over-nutrition at the population level, using the BMI-for-age categories as the dependent variable (i.e. (1) underweight (2) normal (3) overweight/obesity) with the comparator being the "normal" category.

Ethical considerations

Ethical clearance was obtained from the Human Research Ethics Committee of the University of the Witwatersrand (certificate No: M190514) and relevant institutional review boards (IRB) in Osun (certificate No: OSHREC/PRS/569T/155) and Gombe (certificate No: MOH/ADM/621/1/142) States. Community entry was undertaken with advocacy visits to leaders and gate-keepers in selected communities. Participation was voluntary and the information volunteered was confidential as all questionnaires were coded. Participants were free to opt-out at any time in the study. Written consent was obtained from the parents and adolescents who were 18 years and above, while assent was obtained from those less than 18 years. All severely malnourished children, with BMI-for-age, weight-for-age or height-for-age Z-score less than -3, were referred to the nearby public health facilities for nutritional counselling and further management.

Results

A total of 1200 school-aged children and adolescents – 601 (50.1%) males and 599 (49.9%) females – participated in the study, giving a male-to-female ratio of approximately 1:1. The mean age of the respondents was 11.6 ± 3.8 years.

Table 1 shows the prevalence and distribution of the nutritional status of the respondents according to their age and sex. Among the males, the prevalence of thinness was highest among those 15 years old (16.4%), followed by those 6 or 9 years in age (11.9%). The prevalence of overweight and obesity was highest among the younger male children with the highest prevalence being 23.5% (9 years) and 31.6% (8 years) for overweight and obesity respectively. Beyond the age of 13 years, nearly no male child was overweight nor obese. For the females, the prevalence of thinness was highest among the 6- and 10-year-old children (12.5%), while prevalence of overweight and obesity were highest among 11- and 7-year old children (20.6% and 33.3%) respectively. Unlike the males however, there were overweight females after the age of 13 years. On the whole, the prevalence of malnutrition was significantly different between males and females; 11.1% of males compared to 9.3% of females had thinness, while 5.7% of males and 10.5% of females were overweight and 3.2% of males and 3.5% of females were obese. The overall prevalence of malnutrition was 10.2% for thinness, 8.1% for overweight and 3.3% for obesity.

The distribution of the indicators of under- and over-nutrition according to States, residence, age groups, sex, ethnicity groups, household wealth index, family types, mother's education and occupation is shown in Table 2. The overall prevalence rate of stunting was 34.9%, underweight was 13.5%, thinness was 10.3%, overweight/obese was 11.4% and 4.0% had individual level DBM in the study. Stunting was significantly associated with all the explanatory variables considered ($p < 0.01$), except residence ($p = 0.672$). Underweight was significantly associated with all explanatory variables, except residence ($p = 0.227$) and sex ($p = 0.554$), while

Table 1. Age and sex distribution of the prevalence of thinness, overweight and obesity*:

Age	Males (%)			Females (%)			Total (%)			P-value			
	n	Thinness	Over-weight	Obese	n	Thinness	Over-weight	Obese	n		Thinness	Over-weight	Obese
6	46 (7.7)	8 (11.9)	4 (11.8)	1 (5.3)	58 (9.7)	7 (12.5)	2 (3.2)	2 (9.5)	104 (8.7)	15 (12.2)	6 (6.2)	3 (7.5)	0.540
7	41 (6.8)	4 (6.0)	4 (11.8)	3 (15.8)	47 (7.8)	8 (14.3)	1 (1.6)	7 (33.3)	88 (7.3)	12 (9.8)	5 (5.2)	10 (25.0)	0.209
8	58 (9.7)	6 (9.0)	6 (17.6)	6 (31.6)	43 (7.2)	1 (1.8)	10 (15.9)	1 (4.8)	101 (8.4)	7 (5.7)	16 (16.5)	7 (17.5)	0.049*
9	53 (8.8)	4 (6.0)	8 (23.5)	1 (5.3)	61 (10.2)	6 (10.7)	11 (17.5)	2 (9.5)	114 (9.5)	10 (8.1)	19 (19.6)	3 (7.5)	0.872
10	72 (12.0)	8 (11.9)	4 (11.8)	1 (5.3)	56 (9.3)	7 (12.5)	5 (7.9)	3 (14.3)	128 (10.7)	15 (12.2)	9 (9.3)	4 (10.0)	0.479
11	33 (5.5)	2 (3.0)	0 (0.0)	4 (21.1)	44 (7.3)	2 (3.6)	13 (20.6)	1 (4.8)	77 (6.4)	4 (3.3)	13 (13.4)	5 (12.5)	< 0.001*
12	59 (9.8)	3 (4.5)	4 (11.8)	2 (10.5)	52 (8.7)	5 (8.9)	1 (1.6)	3 (14.3)	111 (9.3)	8 (6.5)	5 (5.2)	5 (12.5)	0.437
13	44 (7.3)	3 (4.5)	2 (5.9)	1 (5.3)	44 (7.3)	2 (3.6)	1 (1.6)	2 (9.5)	88 (7.3)	5 (4.1)	3 (3.1)	3 (7.5)	0.827
14	41 (6.8)	4 (6.0)	0 (0.0)	0 (0.0)	38 (6.3)	5 (8.9)	5 (7.9)	0 (0.0)	79 (6.6)	9 (7.3)	5 (5.2)	0 (0.0)	0.017
15	43 (7.2)	11 (16.4)	1 (2.9)	0 (0.0)	42 (7.0)	4 (7.1)	4 (6.3)	0 (0.0)	85 (7.1)	15 (12.2)	5 (5.2)	0 (0.0)	0.066
16	23 (3.8)	2 (3.0)	0 (0.0)	0 (0.0)	24 (4.0)	4 (7.1)	2 (3.2)	0 (0.0)	47 (3.9)	6 (4.9)	2 (2.1)	0 (0.0)	0.160
17	39 (6.5)	7 (10.4)	0 (0.0)	0 (0.0)	42 (7.0)	2 (3.6)	2 (3.2)	0 (0.0)	81 (6.8)	9 (7.3)	2 (2.1)	0 (0.0)	0.047*
18	30 (5.0)	4 (6.0)	1 (2.9)	0 (0.0)	32 (5.3)	2 (3.6)	5 (7.9)	0 (0.0)	62 (5.2)	6 (4.9)	6 (6.2)	0 (0.0)	0.172
19	19 (3.2)	1 (1.5)	0 (0.0)	0 (0.0)	16 (2.7)	1 (1.8)	1 (1.6)	0 (0.0)	35 (2.9)	2 (1.6)	1 (1.0)	0 (0.0)	0.443
Total	601 (50.1)	67 (11.1)	34 (5.7)	19 (3.2)	599 (49.9)	56 (9.3)	63 (10.5)	21 (3.5)	1200 (100.0)	123 (10.2)	97 (8.1)	40 (3.3)	0.016*

* Statistically significant

† The WHO BMI for-age classification was used such that those with <-2, -2 to 1, > 1 to 2 and > 2 were categorized as thinness, normal, overweight and obesity respectively

n = number in the group

*† test of association between male and female rates (Pearson chi-square test)

Table 2. Indicators of under- and over-nutrition and the associated factors.

	Height-for-Age		Weight-for-Age		BMI-for-Age			Individual DBM	
	Stunted	Otherwise	Under-weight	Otherwise	Thinness	Normal	Overweight/Obesity	Present	Otherwise
Overall Total	419 (34.9)	781 (65.1)	72 (13.5)	463 (86.5)	123 (10.3)	940 (78.3)	137 (11.4)	48 (4.0)	1152 (96.0)
State									
Osun	136 (22.7)	464 (77.3)	22 (7.4)	275 (92.6)	40 (6.7)	464 (77.3)	96 (16.0)	36 (6.0)	564 (94.0)
Gombe	283 (47.2)	317 (52.8)	50 (21.0)	188 (79.0)	83 (13.8)	476 (79.3)	41 (6.8)	12 (2.0)	588 (98.0)
	p < 0.001*		p < 0.001*		p < 0.001*			p < 0.001	
Residence									
Rural	206 (34.3)	394 (65.7)	38 (15.4)	209 (84.6)	77 (12.8)	481 (80.2)	42 (7.0)	16 (2.7)	584 (97.3)
Urban	213 (35.5)	387 (64.5)	34 (11.8)	254 (88.2)	46 (7.7)	459 (76.5)	95 (15.8)	32 (5.3)	568 (94.7)
	p = 0.672		p = 0.227		p < 0.001*			p = 0.018*	
Age groups									
6 – 9 years	45 (11.1)	362 (88.9)	41 (10.1)	366 (89.9)	44 (10.8)	294 (72.2)	69 (17.0)	12 (2.9)	395 (97.1)
10 – 13 years	177 (43.8)	227 (56.2)	31 (24.2)	97 (75.8)	32 (7.9)	325 (80.4)	47 (11.6)	20 (5.0)	384 (95.0)
14 – 16 years	109 (51.7)	102 (48.3)			30 (14.2)	169 (80.1)	12 (5.7)	11 (5.2)	200 (94.8)
17 – 19 years	88 (49.4)	90 (50.6)			17 (9.6)	152 (85.4)	9 (5.1)	5 (2.8)	173 (97.2)
	p < 0.001*		p < 0.001*		p < 0.001*			p = 0.309	
Sex									
Male	251 (41.8)	350 (58.2)	34 (12.6)	236 (87.4)	67 (11.1)	481 (80.0)	53 (8.8)	18 (3.0)	583 (97.0)
Female	168 (28.0)	431 (72.0)	38 (14.3)	227 (85.7)	56 (9.3)	459 (76.6)	84 (14.0)	30 (5.0)	569 (95.0)
	p < 0.001*		p = 0.554		p = 0.014*			p = 0.075	
Ethnicity									
Yoruba	165 (25.8)	474 (74.2)	22 (7.2)	283 (92.8)	41 (6.4)	506 (79.2)	92 (14.4)	37 (5.8)	602 (94.2)
Igbo	12 (31.6)	26 (68.4)	0 (0.0)	18 (100.0)	2 (5.3)	34 (89.5)	2 (5.3)	1 (2.6)	37 (97.4)
Hausa	73 (48.7)	77 (51.2)	12 (22.6)	41 (77.4)	15 (10.0)	127 (84.7)	8 (5.3)	3 (2.0)	147 (98.0)
Fulani	72 (49.0)	75 (51.0)	22 (33.3)	44 (66.7)	27 (18.4)	106 (72.1)	14 (9.5)	3 (2.0)	144 (98.0)
Minorities	97 (42.9)	129 (57.1)	16 (17.2)	77 (82.8)	38 (16.8)	167 (73.9)	21 (9.3)	4 (1.8)	222 (98.2)
	p < 0.001*		p < 0.001*		p < 0.001*			p = 0.022*	
Household wealth index									
Poorest	113 (47.1)	127 (52.9)	26 (25.5)	76 (74.5)	45 (18.8)	169 (70.4)	26 (10.8)	13 (5.4)	227 (94.6)
Poorer	83 (34.4)	158 (65.6)	19 (16.2)	98 (83.8)	28 (11.6)	180 (74.7)	33 (13.7)	10 (4.1)	231 (95.9)
Middle	80 (32.1)	169 (67.9)	15 (13.4)	97 (86.6)	18 (7.2)	208 (83.5)	23 (9.2)	6 (2.4)	243 (97.6)
Richer	73 (30.9)	163 (69.1)	11 (10.0)	99 (90.0)	24 (10.2)	191 (80.9)	21 (8.9)	12 (5.1)	224 (94.9)
Richest	70 (29.9)	164 (70.1)	1 (1.1)	93 (98.9)	8 (3.4)	192 (82.1)	34 (14.5)	7 (3.0)	227 (97.0)
	p < 0.001*		p < 0.001*		p < 0.001*			p = 0.373	
Family type									
Monogamous	346 (32.5)	718 (67.5)	54 (11.2)	427 (88.8)	107 (10.1)	833 (78.3)	124 (11.7)	45 (4.2)	1019 (95.8)
Polygamous	73 (53.7)	63 (46.3)	18 (33.3)	36 (66.7)	16 (11.8)	107 (78.7)	13 (9.6)	3 (2.2)	133 (97.8)
	p < 0.001*		p < 0.001*		p = 0.667			p < 0.001*	
Mother's education									
< Secondary	155 (41.4)	219 (58.6)	40 (24.5)	123 (75.5)	61 (16.3)	283 (75.7)	30 (8.0)	12 (3.2)	362 (96.8)
≥ Secondary	264 (32.0)	562 (68.0)	32 (8.6)	340 (91.4)	62 (7.5)	657 (79.5)	107 (13.0)	36 (4.4)	790 (95.6)
	p = 0.001*		p < 0.001*		p < 0.001*			p = 0.346	

	Height-for-Age		*Weight-for-Age		BMI-for-Age			Individual DBM	
	Stunted	Otherwise	Under-weight	Otherwise	Thinness	Normal	Overweight/Obesity	Present	Otherwise
Mother's Occupation									
Unemployed	105 (42.9)	140 (57.1)	26 (23.4)	85 (76.6)	47 (19.2)	178 (72.7)	20 (8.2)	3 (1.2)	242 (98.8)
Employed	314 (32.9)	641 (67.1)	46 (10.8)	378 (89.2)	76 (8.0)	762 (79.8)	117 (12.3)	45 (4.7)	910 (95.3)
	p = 0.003*		p = 0.001*		p < 0.001*			p = 0.013*	

*statistically significant

BMI-for-age categories (thinness, normal and overweight/obesity) were significantly associated with all the considered explanatory variables ($p < 0.05$), except family type ($p = 0.667$). Individual DBM was significantly associated with the State, residence, ethnicity, family type and mother's occupation ($p < 0.05$).

Table 3 shows the factors associated with under-nutrition (thinness) and over-nutrition (overweight/obesity) after controlling for all the explanatory variables using multinomial regression analysis. The odds for thinness were significantly higher among minority ethnic groups (OR: 2.63, $p = 0.040$, 95% CI: 1.04 to 6.62) and children with unemployed mothers (OR: 1.64, $p = 0.047$, 95% CI: 1.01 to 2.68), and lower among those from middle (OR: 0.55, $p = 0.016$, 95% CI: 0.34 to 0.89) and richest households (OR: 0.25, $p = 0.002$, 95% CI: 0.10 to 0.60). Urban dwellers (OR: 2.63, $p < 0.001$, 95% CI: 1.68 to 4.61) and females (OR: 1.63, $p = 0.011$, 95% CI: 1.12 to 2.45) had increased odds for being overweight/obese, while those in the middle wealth index category (OR: 0.56, $p = 0.045$, 95% CI: 0.32 to 0.99), age groups 10 – 13 years (OR: 0.61, $p = 0.020$, 95% CI: 0.40 to 0.90), 14 – 16 years (OR: 0.32, $p = 0.001$, 95% CI: 0.17 to 0.63) and 17 – 19 years (OR: 0.31, $p = 0.002$, 95% CI: 0.15 to 0.64) had lower odds of being overweight/obese.

Discussion

The findings of the present study show that the overall prevalence rates for under- and over-nutrition were high, typifying the DBM at the population level. The rate for stunting was 34.9%, underweight was 13.5% and thinness was 10.3%, while at the same time 11.4% were overweight/obesity in the same population. The DBM was also found at the individual level, with 4% of the children being stunted and overweight/obese at the same time. Although, much attention has not been given to DBM in Nigeria previously, recent studies have similarly reported the DBM at population and individual levels among different Nigerian populations^{14–16}. This is important because most nutritional interventions for Nigerian children before now have focused on undernutrition alone, but with the current knowledge, attention must be paid to both under- and over-nutrition.

Using the BMI-for-age categories, undernutrition (thinness) and over-nutrition (overweight/obesity) rates were 10.2% and 11.4% respectively. Most of the previous studies carried out in Nigeria that used BMI-for-age categories, especially those carried out more than 5 years ago, reported thinness being considerably higher than overweight/obesity^{27–30}. Omighodun *et al.*²⁸ who conducted a similar study among adolescents in southwestern Nigeria in 2010, for example, reported 18.9% and 2.3% as prevalence rates for thinness and overweight/obesity respectively, while Fetuga *et al.*³⁰ reported 22.2% and 3.5% respectively for a similar study among school-aged children in 2011. The present study however, is reporting a slightly higher prevalence of overweight/obesity than that of thinness, with about a fifth of children in Osun State, urban dwellers and school-aged children being overweight/obese. These results are in line with recent Nigerian studies by Asiegbu *et al.* in 2017¹⁴, Onoja *et al.* in 2019¹⁵ and Olasinde *et al.* in 2020¹⁶ all reporting higher rates of overweight/obesity than thinness among children 6 – 19 years.

The prevalence of childhood overweight/obesity has been increasing globally, and Nigeria is not exempted. UNICEF reported increases from 2% to 8% for Nigeria within 2 years from 2017¹ to 2019³¹. The overall prevalence of overweight/obesity in this study (11.4%) is higher than what UNICEF reported for Nigeria and sub-Saharan Africa¹⁴. The prevalence rates in Osun State for children 6 – 19 years old and those from the wealthiest households are already nearing the global average of 18% among adolescents³¹. Similarly, recent Nigerian studies by Otuneye *et al.*¹⁴, Omisore *et al.*¹⁵ and Bello *et al.*¹⁶ carried out among children 6 – 19 years from different parts of the country reported prevalence rates between 10.4% to 15.4% for overweight/obesity. This increasing prevalence of overweight/obesity among older children in Nigeria may be due to nutrition transition, with increased adoption of westernized diets and reduced energy expenditure, which has been reported in Nigeria³².

On the other hand, the present study shows persistent under-nutrition among school-aged children and adolescents in the study population, and possibly in Nigeria as a whole. More than a third of the children in this study were stunted,

Table 3. Factors associated with malnutrition among school-aged children and adolescents in two Nigerian States using multinomial logistic regression analysis.

*THINNESS								
Variables	Empty Model				Full Model			
	OR	p-value	95% CI		aOR	p-value	95% CI	
			Lower	Upper			Lower	Upper
State								
Gombe (R)								
Osun	0.49	0.001*	0.33	0.74	1.05	0.910	0.42	2.62
Residence								
Rural (R)								
Urban	0.63	0.018*	0.43	0.92	0.79	0.280	0.51	1.22
Age groups								
6 – 9 years (R)								
10 – 13 years	0.66	0.089	0.41	1.07	0.66	0.104	0.40	1.09
14 – 16 years	1.19	0.504	0.72	1.96	1.15	0.612	0.67	1.96
17 – 19 years	0.75	0.336	0.41	1.35	0.65	0.178	0.35	1.22
Sex								
Male (R)								
Female	0.88	0.491	0.60	1.28	0.91	0.619	0.61	1.34
Ethnicity								
Yoruba (R)								
Igbo	0.76	0.714	0.18	3.29	1.01	0.996	0.21	4.64
Hausa	1.47	0.226	0.79	2.75	0.99	0.988	0.34	2.92
Fulani	3.25	<0.001*	1.92	5.50	1.61	0.381	.56	4.65
Minorities	2.82	<0.001*	1.75	4.55	2.63	0.040*	1.04	6.62
Wealth index								
Poorest (R)								
Middle	0.45	<0.001*	0.30	0.69	0.55	0.016*	0.34	0.89
Richest	0.16	<0.001*	0.07	0.34	0.25	0.002*	0.10	0.60
Family type								
Monogamous (R)								
Polygamous	1.16	0.597	0.66	2.04	0.82	0.508	0.45	1.49
Mother's education								
< Secondary (R)								
≥ Secondary	0.44	<0.001*	0.30	0.64	0.77	0.294	0.47	1.26
Mother's Occupation								
Employed (R)								
Unemployed	2.51	<0.001*	1.68	3.74	1.64	0.047*	1.01	2.68
*OVERWEIGHT								
State								
Gombe (R)								
Osun	2.40	<0.001*	1.63	3.54	2.30	0.057	0.98	5.11
Residence								
Rural (R)								
Urban	2.37	<0.001*	1.61	3.48	2.63	<0.001*	1.68	4.61

*OVERWEIGHT								
Variables	Empty Model				Full Model			
	OR	p-value	95% CI		aOR	p-value	95% CI	
			Lower	Upper			Lower	Upper
Age groups								
6 – 9 years (R)								
10 – 13 years	0.62	0.018*	0.41	0.92	0.61	0.020*	0.40	0.90
14 – 16 years	0.30	<0.001*	0.16	0.57	0.32	0.001*	0.17	0.63
17 – 19 years	0.25	<0.001*	0.12	0.52	0.31	0.002*	0.15	0.64
Sex								
Male (R)								
Female	1.66	0.007*	1.15	2.40	1.63	0.011*	1.12	2.45
Ethnicity								
Yoruba (R)								
Igbo	0.47	0.219	0.14	1.56	0.58	0.405	0.16	2.09
Hausa	0.28	0.002*	0.13	0.62	0.66	0.496	0.20	2.17
Fulani	0.53	0.056	0.27	1.02	0.80	0.707	0.25	2.56
Minorities	0.58	0.042*	0.35	0.98	1.35	0.536	0.52	3.48
Wealth index								
Poorest (R)								
Middle	0.86	0.549	0.54	1.39	0.56	0.045*	0.32	0.99
Richest	1.15	0.617	0.66	2.00	0.61	0.151	0.31	1.20
Family type								
Monogamous (R)								
Polygamous	0.82	0.511	0.45	1.50	1.35	0.386	0.68	2.68
Mother's education								
< Secondary (R)								
≥ Secondary	11.54	0.049*	1.00	2.36	1.05	0.869	0.61	1.81
Mother's Occupation								
Employed (R)								
Unemployed	0.63	0.087	0.37	1.07	0.98	0.937	0.53	1.80

*Statistically significant OR – odds ratio; aOR – adjusted odds ratio; CI – confidence interval; R – reference value

*Base outcome or comparator was the 'normal' category

which is more than the 33% reported by UNICEF³⁷. Particularly alarming is the prevalence rate of stunting, reaching nearly 50% in Gombe State, among older adolescents, in Hausa and Fulani ethnic groups and in the poorest households. The prevalence of underweight, measured using WFA reference values, was also a concern, with a third of Fulani children and a quarter of younger adolescents and children from the poorest wealth index being underweight. This paradoxical co-existence of overweight/obesity and undernutrition in the present study typifies the DBM (i.e. under- and over-nutrition)³⁸.

After controlling for possible confounding variables using the multivariate analysis, older children from the minority

tribes had 3 times higher likelihood of thinness compared to those from the Yoruba ethnic group. Regional and ethnic variation in malnutrition among Nigerian children has been reported by previous researchers^{37,39}. Similarly, those whose mothers were unemployed had 2 times higher likelihood for thinness compared to those with employed mothers. School-aged children and adolescents in the middle wealth index group had 45% less likelihood while those in the richest wealth index group had 75% less likelihood of thinness than those in the poorest wealth index group. This finding further underscores the importance of socio-economic and household factors in the nutritional status of the child, as has been previously reported by other studies in Nigeria and sub-Saharan Africa^{39,40,41}.

Concerning the predictors of overweight/obesity, urban dwellers were 3 times more likely to be overweight/obese than rural dwellers. Urban-rural differentials in childhood malnutrition has been previously established^{12,15,40}. Urbanization has been associated with nutrition transition, and hence with increasing prevalence of overweight/obesity⁴¹. Furthermore, females were 2 times more likely to be overweight/obese than boys, and the likelihood for overweight/obesity reduced with increasing age groups of the children and adolescents. The pattern of distribution of over-nutrition (overweight/obesity) across sex and age groups seems to be consistent in most of the studies, with overweight/obesity higher in the girls and younger age groups^{11,42-44}. The findings of the present study corroborated this pattern, with the children 6 – 9 years and girls having significantly higher prevalence rates of overweight/obesity.

A limitation of this study is that it cannot not be generalized to all of Nigeria, because only 2 out of 36 states were involved in the study. The cross-sectional nature of the study also means that causality cannot be determined in this study. Lastly, this study did not set out to exhaust the many complex explanatory factors for both under-nutrition and over-nutrition among school-aged children and adolescents.

Conclusion

The study found evidence of DBM both at population and individual levels. The overall prevalence rate of stunting

was 34.9%, underweight was 13.5%, thinness was 10.3%, overweight/obese was 11.4% and 4.0% had individual level DBM in the study. These rates differed significantly across the demographic, socio-economic and household/family characteristics. There is the need for government and all other stakeholders to design nutritional educational programmes that will target both under- and over-nutrition among older children in the different contexts.

Data availability

Dryad. Double burden of Malnutrition in two Nigerian States. DOI: <https://doi.org/10.5061/dryad.qnk98stf0> (Adeomi, Adeleye (2021)).

Data are available under the terms of the Creative Commons Zero “No rights reserved” data waiver (CC0 1.0 Public domain dedication).

Authors' contributions

All the authors were involved in the conceptualization of the research idea and topic, the design of the methodology and the proposal. AA carried out the study as part of his Ph.D. work, while AF and KK supervised, provided useful suggestions and the mentorship that helped to shape the study into the present form. All the authors read and approved the final version of the manuscript.

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Individual and contextual factors associated with under- and over-nutrition among school-aged children and adolescents in two Nigerian states: a multi-level analysis

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Abstract

Objective: This study aimed to identify individual and contextual factors that are associated with under- and over-nutrition among school-aged children and adolescents in two Nigerian states.

Design: Community-based cross-sectional study.

Setting: The study was carried out in rural and urban communities of Osun and Gombe States in Nigeria.

Participants: A total of 1200 school-aged children and adolescents.

Results: Multi-level analysis showed that the full models accounted for about 82% and 39% of the odds of thinness or overweight/obese across the communities, respectively. Household size (adjusted OR (aOR) 1.10; $P=0.001$; 95% CI (1.04, 1.16)) increased the odds, while the upper wealth index (aOR 0.43; $P=0.016$; 95% CI (0.22, 0.86)) decreased the odds of thinness. Age (aOR 0.86; $P<0.001$; 95% CI (1.26, 8.70)), exclusive breastfeeding (aOR 0.46; $P=0.010$; 95% CI (0.25, 0.83)), physical activity (aOR 0.55; $P=0.001$; 95% CI (0.39, 0.78)) and the upper wealth index (aOR 0.47; $P=0.018$; 95% CI (0.25, 0.88)) were inversely related with overweight/obesity, while residing in Osun State (aOR 3.32; $P=0.015$; 95% CI (1.26, 1.70)), female gender (aOR 1.73; $P=0.015$; 95% CI (1.11, 2.69)) and screen time > 2 h/d (aOR 2.33; $P=0.005$; 95% CI (1.29, 4.19)) were positively associated with overweight/obesity.

Conclusions: The study shows that selected community and individual-level factors are strongly associated with thinness and overweight/obesity among school-aged children and adolescents.

Keywords

Thinness

Overweight

Obesity

Double burden of malnutrition

Nutritional status

Contextual factors

Multi-level analysis

Obesity is a global challenge, and the prevalence of overweight and obesity is increasing at a faster rate in low- and middle-income countries as compared with high-income countries⁽¹⁾. At the same time, the challenge of under-nutrition persists still in many low- and middle-income countries⁽²⁾. Thus, many low and middle-income countries are confronted with a double burden of malnutrition⁽³⁾, with co-existing high level of under-nutrition and an increasing level of over-nutrition⁽⁴⁾. Several factors are associated with malnutrition, and the ecological systems model has been proposed to understand child nutrition processes⁽⁵⁾. Ecological systems are the contextual factors within which individuals are nested^(6,7).

While the ecological systems theory recognises the impact of the child's individual factors in affecting development, it conceptualises that these factors are just one group out of many others^(6,8). In the original work on the ecological systems theory, four different inter-related environments are identified, with the microsystem as the most proximal level, followed by the mesosystem, the exosystem and the macrosystem level. While the most proximal level reflects individual and intrafamilial processes, the outermost system reflects the cultural, religious and socio-economic organisation of the community^(6,8). The chronosystem is the fifth and final level of Bronfenbrenner's ecological systems theory; it

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encompasses the concept of time and consists of the environmental changes and transitions that occur over the lifetime and influence the child's development. The theory was later updated to emphasise the important role the individual plays in the development process⁽⁷⁾. It was hypothesised that human development was the result of the interplay among four processes: person, context, process and time, with 'person' factors to mean individual characteristics, the 'context' to refer to the external factors described in the original work on the ecological systems theory, the 'process' to refer to the interaction between the person and the context and this development to be understood with reference to 'time'^(7,8).

Most of the research efforts targeted at identifying the determinants of the nutritional status of school-aged children and adolescents have focussed mainly at the individual factors alone. A number of studies have reported a significant relationship between nutritional status and such factors as age and gender of the child^(9,10), residence^(11,12), physical activity^(13,14) and feeding patterns^(11,15) of children. However, there is little evidence on the relationship between the nutritional status of school-aged children and adolescents and the communities within which the children live. Little or no evidence exists in Nigeria about the relationship between the nutritional status of this group of children and community-level factors, and very few studies have explored ecological factors as determinants of child nutrition beyond the individual factors.

There is a need to focus on the determinants of the nutritional status of school-aged children and adolescents in Nigeria, because identifying the determinants has not been the focus of most research efforts on the subject in Nigeria^(16–18). The interest of majority of the researchers in this field in Nigeria has been the assessment and description of the nutritional status. Identifying the determinants is important, not only in improving the understanding about the subject, but especially in planning appropriate nutritional interventions for the children.

Identifying the individual and contextual determinants, using multi-level modelling however, has added advantages. Firstly, conventional regression models assume the units of analysis are not dependent, and this is not usually true. This error may then lead to over-estimation of statistical significance⁽¹⁹⁾. Designing interventions based on erroneous evidence may lead to ineffectiveness of such interventions. Additionally, identifying the contextual determinants will help to understand the dynamics of the influence of the contextual units⁽¹⁹⁾, and especially the potentials they hold for reducing the burden of a complex health challenge such as the double burden of under- and over-nutrition.

While multi-level modelling has been used to explain the determinants of the nutritional status of children under the age of 5 years in Nigeria^(20,21), to date, data are lacking for school-aged children and adolescents in Nigeria. This study, therefore, aimed to identify individual and

contextual factors that are associated with either under- or over-nutrition among both school-aged children and adolescents in two Nigerian states.

Materials and methods

Study design and setting

This community-based cross-sectional study was carried out in two Nigerian states. School-aged children and adolescents aged between 6 and 19 years and their mothers formed the study population. The sample size was calculated to get an absolute precision of $\pm 5\%$ for prevalence estimates using STATCALC on the Epi-Info software⁽²²⁾, and a design effect of 1.5, which is an adjustment for the sampling technique (multi-stage) used. After correcting for an anticipated non-response rate of 10%, the sample size came to 561 and was rounded off to 600 for each state, making a total of 1200.

The classification of Nigeria's six geo-political zones in Nigeria according to their wealth index by the Nigeria demographic and health survey⁽²³⁾ was used in selecting the states for this study. One state each from the zones with the lowest (North-east zone) and the highest wealth index (South-west zone) were selected using simple random sampling technique (balloting method). Selection of states was done according to wealth index and geo-political zones because these were the two most consistent factors that were significantly associated with malnutrition from previous similar studies in Nigeria^(20,21,24). Gombe and Osun States were selected from the North-east and the South-west zones, respectively. The 1200 children 6–19 years old and their mothers who constituted the study population were then selected using the multi-stage sampling technique.

Data collection

Data collection was carried out with interviewer-administered pre-tested structured questionnaires using REDCap⁽²⁵⁾, a data collection software installed on electronic tablets. The mothers were the respondents for the sections on general characteristics of the child, household/family characteristics and community factors. The school-aged children or adolescents responded to the sections on the dietary diversity, physical activity patterns and pubertal staging. Anthropometric measurements of the children and mothers were taken according to standard protocols recommended by the International Society for the Advancement of Kinanthropometry⁽²⁶⁾. Weight was measured in 0.1 kg by use of Omron[®] electronic bathroom weighing scale. Height was measured to the nearest 0.1 metre using a stadiometer. Weighing scales were routinely standardised by the use of known weights.

Screen time was the time in hours that the child spent with television, computer, video games or phones/d. The physical activity was assessed using the physical activity



questionnaire for older children and adolescents by Kowalski *et al.*⁽²⁷⁾ from which a composite score of 1 to 5 was derived (higher scores represent higher physical activity levels).

Statistical analyses

Measures

The primary outcome/dependent variable was the nutritional status, which was assessed using the BMI-for-age according to WHO reference values⁽²⁸⁾. It was categorised into: (1) thinness; (2) normal and (3) overweight/obese. The independent variables used were those that had been previously reported from similar studies^(20,21) and are presented in Table 1. The independent variables consist of three groups of variables: individual, household and community-level factors, but the individual and household-level factors were collapsed into the individual-level factors for the multi-level analysis. Communities were taken as those who shared a common enumeration area, which served as the primary sampling unit. Household wealth index was calculated using ownership of some household possessions, as it was used by the Nigeria demographic and health survey⁽²³⁾. Principal component analysis was then used to produce a common factor score (household wealth index score) for each household. These scores were used to categorise wealth index into three: (1) poor; (2) middle and (3) rich. The community wealth index was calculated by finding the median wealth index score for each community, and these were then categorised into: (1) low and (2) high using the median value. Pubertal staging was assessed using the Tanner pubertal self-rating scale⁽²⁹⁾.

Data analysis

The data were analysed by use of STATA version 15.1⁽³⁰⁾. At the bivariate level, cross-tabulations were done using Pearson's chi-squared test for the categorical variables. The Mann-Whitney U and Kruskal-Wallis tests (non-parametric) were used to test for association among the continuous variables with two and more than two independent variables, respectively. These tests were used because the continuous variables were not normally distributed.

Two-level multi-level binary logistic regression analysis was done to investigate the extent to which the individual and community-level factors explained the variation in under- and over-nutrition in the two Nigerian states. This involved 1200 school-aged children and adolescents (level 1) nested within forty communities (level 2). Enumeration areas, as demarcated by the National Population Commission for 2006 population census in Nigeria⁽³¹⁾, were used as communities in this study, and a total of forty enumeration areas were selected (twenty in each of the two states). Two separate multi-level analyses identified the individual and contextual factors associated with either under- or over-nutrition. Hence, the nutritional status of the school-aged children

and adolescents, which was initially categorised into: (1) thinness; (2) normal and (3) overweight/obese, was recoded to form two different dependent variables which were thinness (categorised as (1) thinness (0) otherwise) and overweight/obesity (categorised as (1) overweight/obese (0) otherwise). Firstly, thinness was retained as 'thinness', while normal and overweight/obesity were merged as 'otherwise' (1 – Thinness, 0 – otherwise). For the second dependent variable, overweight/obesity were retained as such, while normal and thinness were merged as 'otherwise' (1 – overweight/obesity, 0 – otherwise). Six models each (total of twelve models) were fitted in all. The first model (Model 0) was the empty model, and the second model (Model 1) considered only the states (Osun and Gombe States), while the third model (Model 2) incorporated the child characteristics to Model 1. The fourth model (Model 3) incorporated the household/family characteristics into the first model. The community-level factors alone were considered in the fifth model (Model 4), while the sixth model (Model 5) is the full model that incorporated all factors into the multi-level analysis. Ethnicity was not included because of a high variance inflation factor when multi-collinearity diagnostics were done.

The fixed effects were used as the measures of association and expressed as adjusted OR (aOR) with the 95% CI and the *P* values. The random effects, which measured variations, were intra-class correlation or the variance partition coefficient and the proportional change in variance. Akaike information criteria were used to determine the goodness-of-fit of the models, where a lower value indicated a better fit⁽³²⁾. The independent structure, which is the default for the STATA software, was used in the present study.

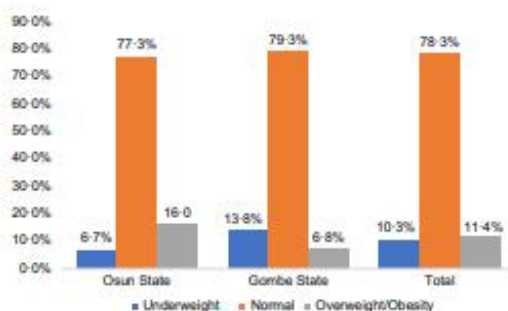
Results

The prevalence rates of thinness and overweight/obesity were 10.3% and 11.4%, respectively, while 21.7% had one form of malnutrition or the other (Fig. 1). Gombe State has a higher prevalence of thinness (13.8% *v.* 6.7%) and lower prevalence of overweight/obesity (6.8% *v.* 16.0%). The prevalence rate of malnutrition (under- and over-nutrition) was 22.7% for Osun State and 20.6% for Gombe State.

The description of all individual- and community-level factors according to the states is shown in Supplemental Table 1. Table 2 shows that all the child characteristics had a statistically significant association with the nutritional status of the respondents ($P < 0.05$) at the bivariate analysis level, except education ($P = 0.86$), birth order ($P = 0.06$) and pubertal staging ($P = 0.06$). All the household/family factors had a statistically significant association with the nutritional status of the older children ($P < 0.05$), except marital status ($P = 0.61$) and family type ($P = 0.67$). All the community-level factors had a statistically significant

Table 1 Definitions for independent variables

Independent variables	Description
Individual-level factors	
Age of child (years)	Expressed as a continuous variable
Sex of child	Categorised into (1) male (2) female
Birth order	Categorised into (1) 1 (2) 2–4 (3) > 4
Education	Categorised into (1) currently in school (2) previously in school (3) never in school
Birth weight	Categorised into (1) low < 2.5 kg (2) normal 2.5–4 kg (3) > 4 kg
Breastfeeding duration	Expressed as a continuous variable (months)
Immunisation status	Categorised into (1) complete (2) incomplete
Birth place	Categorised into (1) others (2) hospital
Exclusively breastfed for 6 months	Categorised into (1) yes (2) no
Child's health	This is the mother's perception of the child's health and it was categorised into (1) very good, (2) good and (3) not too good
Puberty stage	Categorised into stages 1–5 (Tanner staging)
Screen time (in hours)	Categorised as (1) < 2 h (2) ≥ 2 h
Physical activity	Expressed as continuous variable (scores)
Household/family factors	
Household size	Expressed as continuous variable
Number of children	Expressed as continuous variable
Wealth index	Categorised into (1) Poor, (2) Middle and (3) Rich
Marital status	Categorised into (1) single, (2) married and (3) previously married
Family type	Categorised into (1) monogamous and (2) polygamous
Maternal education	Categorised into (1) less than secondary and (2) secondary or more
Father's education	Categorised into (1) less than secondary and (2) secondary or more
Mother's unemployment	Categorised into (1) employed and (2) unemployed
Community-level factors	
State	Categorised into (1) Gombe and (2) Osun
Residence	Categorised into (1) rural and (2) urban
Community wealth index	Categorised into (1) low (2) high, using the median of the community wealth index scores as reference
Maternal education	Categorised into (1) low (2) high, using the median as reference
Safe water	Categorised into (1) low (2) high, using the median as reference

**Fig. 1** Distribution of the nutritional status among school-aged children and adolescents by state

association with the nutritional status of the children ($P < 0.001$).

Table 3 shows the results of the multi-level analyses for thinness (under-nutrition), highlighting the fixed and random effects. The full model shows that household size (aOR 1.10; $P = 0.001$; 95% CI (1.04, 1.16)) and the uppermost wealth index (rich) (aOR 0.43; $P = 0.016$; 95% CI (0.22, 0.86)) had a significant positive and inverse associations with thinness, respectively. Concerning the measures of variations for thinness, as shown with the random effects on Table 3, the intra-class correlation for the intercept-only model (i.e. no explanatory variable) was 21.6%. This implies that 21.6% of the variation in the odds of thinness

was attributable to community-level variables, and this was statistically significant ($P < 0.001$). The Models 1, 2, 3, 4 and 5 account for about 22.1%, 51.8%, 41.2%, 56.7% and 80.2% in the odds of under-nutrition across the communities, as explained by the proportional change in variance. The model with the best fit is Model 3, which controlled for State and the Household/family characteristics, with Akaike information criteria of 740.41 compared with 753.3 for the empty model (Model 0).

Table 4 shows the results of the multi-level analysis for overweight/obesity (over-nutrition). Age (aOR 0.86; $P < 0.001$; 95% CI (1.26, 8.70)), exclusive breastfeeding (aOR 0.46; $P = 0.010$; 95% CI (0.25, 0.83)), physical activity (aOR 0.55; $P = 0.001$; 95% CI (0.39, 0.78)) and the rich wealth index (aOR 0.47; $P = 0.018$; 95% CI (0.25, 0.88)) had an inverse relationship with overweight/obesity, while residing in Osun State (aOR 3.32; $P = 0.015$; 95% CI (1.26, 1.70)), female gender (aOR 1.73; $P = 0.015$; 95% CI (1.11, 2.69)) and screening time > 2 h/d (aOR 2.33; $P = 0.005$; 95% CI (1.29, 4.19)) were positively associated with overweight/obesity. The empty model (Model 0) shows a statistically significant variation in the odds of childhood overweight/obesity across the communities ($P < 0.001$). As indicated by the intra-class correlation, 28.5% of the variance in the odds of overweight/obesity among the children could be ascribed to community-level factors. The Models 1, 2, 3, 4 and 5 account for about 23.4%, 35.3%,



Table 2 Association between the individual- and community-level factors and nutritional status at bivariate analysis level

Variables	Nutritional status (%)						Statistics
	Thinness		Normal		Overweight/obesity		
Individual-level factors – child characteristics							
Age of the child (IR)	12.0	7.0	12.0	6.0	10.0	4.0	† <i>P</i> < 0.001*
Breastfeeding duration (months) (IR)	18.0	8.0	18.0	9.0	18.0	8.0	† <i>P</i> = 0.046*
Sex							
Male	67	11.1	481	80.0	53	8.8	<i>P</i> = 0.014*
Female	56	9.3	459	76.6	84	14.0	
Child education							
Currently in-school	116	10.5	866	78.3	124	11.2	<i>P</i> = 0.855
Previously in-school	4	7.0	45	78.9	8	14.0	
Never attended school	3	8.1	29	78.4	5	13.5	
Birth weight of the child							
Small (< 2.5 kg)	17	10.2	135	80.8	15	9.0	<i>P</i> = 0.003*
Normal (2.5–4 kg)	91	10.9	629	75.6	112	13.5	
Big (> 4 kg)	15	7.5	176	87.6	10	5.0	
Birth place of the child							
Others	32	14.6	167	76.3	20	9.1	<i>P</i> = 0.042*
Hospital	91	9.3	773	78.8	117	11.9	
Exclusively breastfed							
No	65	13.1	385	77.6	46	9.3	<i>P</i> = 0.006*
Yes	58	8.2	555	78.8	91	12.9	
Immunisation status of child							
Not immunised	6	28.6	13	61.9	2	9.5	<i>P</i> = 0.012*
Partially immunised	26	16.5	116	73.4	16	10.1	
Fully immunised	86	8.8	773	79.5	113	11.6	
Not sure	5	10.2	38	77.6	6	12.2	
Birth order of the child							
1	58	9.7	460	77.2	78	13.1	<i>P</i> = 0.063
2–4	53	11.2	366	77.5	53	11.2	
> 4	12	9.1	114	86.4	6	4.5	
Screen time (hours) (IR)	2.0	3.0	2.8	3.2	3.0	3.0	† <i>P</i> < 0.001*
Physical activity scores (IR)	2.0	1.1	2.3	1.0	2.1	0.8	† <i>P</i> < 0.001*
Child's health							
Very good	39	7.8	391	78.4	69	13.8	<i>P</i> < 0.001*
Good	57	9.7	473	80.6	57	9.7	
Not too good	27	23.7	76	66.7	11	9.6	
Pubertal staging							
Stage 1	32	9.7	268	81.2	30	9.1	<i>P</i> = 0.061
Stage 2	37	9.2	328	81.2	39	9.7	
Stage 3	35	10.7	238	72.8	54	16.5	
Stage 4	16	13.8	89	76.7	11	9.5	
Stage 5	3	13.0	17	73.9	3	13.0	
Individual-level factors –household/family characteristics							
Household size (IR)	7.0	5.0	6.0	3.0	5.0	2.0	† <i>P</i> < 0.001*
Children in the household (IR)	5.0	3.0	4.0	2.0	3.0	1.0	† <i>P</i> < 0.001*
Household wealth index							
Poor	61	15.3	294	73.5	45	11.3	<i>P</i> < 0.001*
Middle	44	11.0	312	78.0	44	11.0	
Rich	18	4.5	334	83.5	48	12.0	
Marital status							
Single	1	12.5	5	62.5	2	25.0	<i>P</i> = 0.606
Married	117	10.4	879	78.1	129	11.5	
Previously married	5	7.5	56	83.6	6	9.0	
Family type							
Monogamous	107	10.1	833	78.3	124	11.7	<i>P</i> = 0.667
Polygamous	16	11.8	107	78.7	13	9.6	
Mother's education							
Less than secondary	61	16.3	283	75.7	30	8.0	<i>P</i> < 0.001*
Secondary or more	62	7.5	657	79.5	107	13.0	
Father's education							
Less than Secondary	35	15.2	170	73.6	26	11.3	<i>P</i> = 0.023*
Secondary or more	88	9.1	770	79.5	111	11.5	
Mother's employment							
Employed	77	8.1	759	79.5	119	12.5	<i>P</i> < 0.001*
Unemployed	46	18.8	181	73.9	18	7.3	
Community-level factors							



Table 2 Continued

Variables	Nutritional status (%)						Statistics
	Thinness		Normal		Overweight/obesity		
State							
Gombe	83	13.8	476	79.3	41	6.8	<i>P</i> < 0.001*
Osun	40	6.7	464	77.3	96	16.0	
Residence							
Rural	77	12.8	481	80.2	42	7.0	<i>P</i> < 0.001*
Urban	46	7.7	459	76.5	95	15.8	
Community wealth index							
Low	79	13.2	477	79.5	44	7.3	<i>P</i> < 0.001*
High	44	7.3	463	77.2	93	15.5	
Mother's education							
Low	85	14.2	472	78.7	43	7.2	<i>P</i> < 0.001*
High	38	6.3	468	78.0	94	15.7	
Safe water							
Low	69	14.4	370	77.1	370	77.1	<i>P</i> < 0.001*
High	54	7.5	570	79.2	96	13.3	

IR, Interquartile range; Screen time, time spent watching television, with phone, computer or computer.

*Statistically significant.

†Kruskal-Wallis test (non-parametric) was used because the variables were not normally distributed.

18.2%, 48.1% and 39.2% in the odds of over-nutrition across the communities, as explained by the proportional change in variance. The statistically significant variation across communities persisted even after controlling for all the variables (*P* < 0.001). Model 2, which controlled for the state and child characteristics, had the best fit with Akaike information criteria of 752.76. (Table 4).

Discussion

This study, to the best of our knowledge, is the first attempt to simultaneously consider the influence of individual- and community-level factors as predictors of under- and over-nutrition among school-aged and adolescents in Nigeria. Most previous studies have focussed on various indicators of under-nutrition among categories of under-five children. It is also the first study that used multi-level analysis to identify the predictors of overweight/obesity among any group of children or adolescents in Nigeria. Furthermore, the present study controlled for a wide range of independent variables, making it one of the most comprehensive studies on the determinants of nutritional status of any category of children and/or adolescents in Nigeria.

The ecological systems theory has underscored the importance of not only the compositional factors (i.e. the individual-level factors), but also the contextual factors (i.e. community-level factors) in trying to understand a complex and highly important process like child nutrition^(6,7). The multi-level analysis that was done in this study therefore helped to account for the variations in under- and over-nutrition of older children across the different contextual units, as well as to identify the

compositional and contextual factors that were associated with under- and over-nutrition among the older children in the two Nigerian States.

A major finding of this study is the importance of community variation and community-level factors in the prevalence of thinness and overweight/obesity among children 6–19 years old in the two Nigerian states. As indicated by the intra-class correlation of the intercept-only model (i.e. no explanatory variable incorporated), about 22% and 29% of the variance in the odds for thinness and overweight/obesity among the children could be ascribed to community-level factors, respectively. Apart from the full model that included all explanatory variables, the model which consisted of community-level factors only (these factors include the state, residence, wealth index, maternal education and safe water), accounted for the highest variation observed for children that were thin (57%) and overweight/obese (48%). This suggests that school-aged children and adolescents from the same communities are influenced by common factors, and hence the potential for community-level interventions.

The present study found the odds for thinness increased by 10% for every unit increase in household size. Not many studies among children have explored the relationship between under-nutrition and household size, but some studies have however looked at other variables that could serve as proxy for the household size. For example, Nnebue *et al.*⁽³⁵⁾ found a statistically significant relationship between under-nutrition and the number of siblings a child has. This finding further underscores the need for increased efforts in promoting family planning in Nigeria, because a larger number of children may put a household at higher risk of poverty and hence of under-nutrition. The household wealth index was also significantly associated with



Table 3 Individual and contextual factors associated with thinness among school-aged children and adolescents in two Nigerian states using a two-level multi-level analysis

Variables	Model 0		Model 1		Model 2		Model 3		Model 4		Model 5	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
States												
Gombe ®												
Osun			*0.499	0.25, 0.99	0.521	0.25, 1.09	0.576	0.29, 1.14	0.620	0.33, 1.16	0.696	0.33, 1.48
Individual-level factors – child characteristics												
Age					0.977	0.92, 1.04					0.976	0.91, 1.04
Breastfeeding (months)					1.031	0.99, 1.08					1.029	0.98, 1.08
Gender												
Male ®												
Female					0.933	0.61, 1.43					0.914	0.59, 1.42
Birth weight												
Small (< 2.5 kg) ®												
Normal (2.5–4 kg)					1.248	0.67, 2.31					1.081	0.58, 2.02
Big (> 4 kg)					0.836	0.37, 1.91					0.603	0.26, 1.42
Hospital birth												
No ®												
Yes					0.950	0.55, 1.65					1.284	0.71, 2.31
Child education												
Currently in-school ®												
Previously in school					0.649	0.21, 1.97					0.613	0.19, 1.97
Never in school					0.341	0.09, 1.29					0.379	0.10, 1.43
Immunisation												
Not immunised ®												
Partially immunised					0.786	0.23, 2.71					1.063	0.26, 4.28
Fully immunised					0.566	0.16, 1.97					0.958	0.23, 3.99
Not sure					0.559	0.12, 2.58					0.508	0.09, 2.78
Birth order												
1 ®												
2–4					1.017	0.65, 1.59					1.022	0.64, 1.63
> 4					0.737	0.36, 1.53					0.537	0.22, 1.32
Exclusive breastfeeding												
No ®												
Yes					0.828	0.49, 1.39					0.895	0.52, 1.54
Screen time												
< 2 h ®												
≥ 2 h					0.677	0.43, 1.08					0.805	0.49, 1.32
Physical activity scores					1.072	0.80, 1.45					0.963	0.71, 1.30
Child's health												
Very good ®												
Good					1.079	0.64, 1.83					0.951	0.55, 1.65
Not too good					1.458	0.63, 3.38					1.127	0.46, 2.76
Puberty stage												
1 ®												
2					1.193	0.67, 2.11					1.282	0.71, 2.30
3					1.179	0.63, 2.20					1.463	0.77, 2.78
4					1.937	0.87, 4.32					1.506	0.65, 3.48
5					2.602	0.70, 9.68					2.350	0.60, 9.19

Multi-level determinants of childhood malnutrition

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Table 3 Continued

Variables	Model 0		Model 1		Model 2		Model 3		Model 4		Model 5	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Individual-level factors – household/family characteristics												
Household size							**1.076	1.02, 1.13			***1.097	1.04, 1.16
Children in the household							0.936	0.85, 1.03			0.972	0.86, 1.10
Wealth index												
Poor [®]												
Middle							0.827	0.51, 1.33			0.921	0.55, 1.53
Rich							***0.350	0.19, 0.66			*0.432	0.22, 1.86
Marital status												
Single [®]												
Married							0.596	0.06, 5.56			0.449	0.05, 4.32
Previously married							0.408	0.04, 4.58			0.351	0.03, 4.25
Family type												
Monogamous [®]												
Polygamous							0.519	0.25, 1.07			0.452	0.20, 1.02
Maternal education												
< secondary [®]												
Secondary or more							0.775	0.45, 1.32			0.796	0.44, 1.44
Father's education												
< Secondary [®]												
Secondary or more							1.042	0.60, 1.80			1.204	0.67, 2.17
Mother's employment												
Employed [®]												
Unemployed							1.111	0.66, 1.87			1.397	0.81, 2.41
Community-level factors												
Residence												
Rural [®]												
Urban									1.873	0.63, 5.55	1.677	0.62, 4.53
Community wealth index												
Low [®]												
High									0.553	0.28, 1.07	0.592	0.32, 1.10
Maternal education												
Low												
High [®]									*0.332	0.12, 1.92	0.459	0.18, 1.19
Safe water												
Low [®]												
High									0.637	0.33, 1.21	0.733	0.41, 1.32
Random effects												
Community level	***0.905	0.34	***0.705	0.29	***0.436	0.23	***0.532	0.25	***0.392	0.21	0.179	0.19
Variance (se)												
VPC = ICC (%)	21.57 %		17.65 %		11.69 %		13.91 %		10.64 %		5.16 %	
Explained variation (ie PCV in %)	Reference		22.10 %		51.82 %		41.22 %		56.69 %		80.22 %	
Log likelihood	-374.65		-372.85		-356.26		-357.20		-367.15		-337.18	
Model fit statistics (AIC)	753.30		751.70		762.51		740.41		748.31		752.35	

R, reference value; Screen time, time spent watching television, with phone, computer or computer games; VPC, variance partition coefficient; ICC, intra-class correlation; PCV, proportional change in variance; AIC, Akaike information criteria. Statistically significant: *P < 0.005; **P < 0.010; ***P < 0.001.



Table 4 Individual and contextual factors associated with over-nutrition among school-aged children and adolescents in two Nigerian states using a two-level multi-level analysis

Variables	Model 0		Model 1		Model 2		Model 3		Model 4		Model 5	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
States												
Gombe [®]												
Osun			*2.499	1.16, 5.38	**3.930	1.61, 9.57	2.138	0.93, 4.91	**2.543	1.23, 5.28	*3.317	1.26, 8.70
Individual-level factors – child characteristics												
Age					***0.864	0.81, 0.93					***0.861	0.80, 0.92
Breastfeeding (months)					0.986	0.95, 1.03					0.990	0.95, 1.03
Gender												
Male [®]												
Female					*1.748	1.13, 2.70					*1.731	1.11, 2.69
Birth weight												
Small (< 2.5 kg) [®]												
Normal (2.5–4 kg)					1.143	0.57, 2.29					1.180	0.57, 2.45
Big (> 4 kg)					0.491	0.19, 1.29					0.552	0.21, 1.48
Hospital birth												
No [®]												
Yes					1.138	0.61, 2.14					0.993	0.51, 1.92
Child education												
Currently in-school [®]												
Previously in school					2.057	0.82, 5.16					2.023	0.79, 5.16
Never in school					1.309	0.35, 4.87					1.177	0.30, 4.57
Immunisation												
Not immunised [®]												
Partially immunised					1.035	0.17, 6.20					1.143	0.19, 6.75
Fully immunised					0.682	0.12, 3.88					0.752	0.13, 4.23
Not sure					1.171	0.16, 8.47					1.553	0.22, 11.18
Birth order												
1 [®]												
2–4					1.068	0.69, 1.64					1.129	0.72, 1.78
> 4					0.562	0.21, 1.48					0.615	0.20, 1.91
Exclusive BF												
No [®]												
Yes					*0.514	0.29, 0.91					**0.455	0.25, 0.83
Screen time												
< 2 h [®]												
≥ 2 h					**2.159	1.23, 3.78					**2.329	1.29, 4.19
Physical activity scores					***0.551	0.39, 0.77					***0.550	0.39, 0.78
Child's health												
Very good [®]												
Good					0.725	0.42, 1.25					0.712	0.41, 1.24
Not too good					1.822	0.65, 5.08					1.924	0.65, 5.66
Puberty stage												
1 [®]												
2					1.073	0.61, 1.89					1.090	0.61, 1.93
3					1.272	0.67, 2.42					1.283	0.67, 2.46
4					1.028	0.43, 2.46					1.082	0.44, 2.65
5					0.560	0.06, 4.96					0.601	0.07, 5.41

Multi-level determinants of childhood malnutrition



Table 4 *Continued*

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Variables	Model 0		Model 1		Model 2		Model 3		Model 4		Model 5	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Individual-level factors – household/family characteristics												
Household size							1.003	0.93, 1.08			0.997	0.91, 1.09
Children in the household							0.937	0.82, 1.07			0.991	0.85, 1.16
Wealth index												
Poor [®]												
Middle							0.760	0.46, 6.15			0.686	0.39, 1.20
Rich							0.589	0.34, 5.05			*0.472	0.25, 0.88
Marital status												
Single (R)												
Married							0.933	0.14, 6.15			1.108	0.13, 9.63
Previously married							0.644	0.08, 5.05			0.677	0.07, 6.98
Family type												
Monogamous (R)												
Polygamous							1.440	0.67, 3.12			1.646	0.69, 3.90
Maternal education												
Less than secondary (R)												
Secondary or more							1.730	0.93, 3.23			2.052	0.98, 4.32
Father's education												
Less than Secondary (R)												
Secondary or more							0.617	0.33, 1.15			0.622	0.32, 1.21
Mother's employment												
Employed (R)												
Unemployed							0.923	0.49, 1.75			0.731	0.36, 1.47
Community-level factors												
Residence												
Rural (R)												
Urban									2.275	0.55, 9.48	1.195	0.24, 5.89
Community wealth index												
Low (R)												
High									1.696	0.78, 3.71	1.565	0.65, 3.76
Maternal education												
Low												
High (R)									0.936	0.26, 3.40	1.612	0.37, 7.05
Safe water												
Low (R)												
High									0.698	0.31, 1.58	0.731	0.30, 1.80
Random effects												
Community-level variance (SE)	***1.311	0.48	***1.005	0.39	***0.848	0.37	***1.073	0.43	***0.681	0.30	***0.796	0.36
VPC = ICC (%)	28.50 %		23.40 %		20.49 %		24.60 %		17.14 %		19.48 %	
Explained variation (i.e. PCV in %)	Reference		23.34 %		35.32 %		18.15 %		48.05 %		39.21 %	
Log likelihood	-391.56		-389.07		-351.01		-384.50		-385.41		-343.87	
Model fit statistics (AIC)	787.11		784.15		752.03		795.00		784.82		765.73	

R, reference value; Screen time, time spent watching television, with phone, computer or computer games; VPC, variance partition coefficient; ICC, intra-class correlation; PCV, proportional change in variance; AIC, Akaike information criteria. Statistically significant: **P* < 0.005; ***P* < 0.010; ****P* < 0.001.

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thinness, such that those in the 'rich' category had 57 % lesser odds of being thinner than those in the 'poor' category. Furthermore, wealth index had a statistically significant association with household size, such that those from richer households significantly had a lower household size. Hence, large family size, which increased the likelihood of thinness, may be a proxy for poverty. The relationship between poverty and under-nutrition, especially in low and middle-income countries has been well established⁽³⁰⁾. Therefore, effective interventions for thinness (under-nutrition) in these two states and Nigeria as a whole may be interventions against poverty.

The present study found that for every unit increase in age, the odds of being overweight/obese reduced by 14 %. The association between age and overweight/obesity may not be unconnected with the pubertal staging of the respondents. Although the pubertal stage was not significantly associated with overweight/obesity, it had a strong statistically significant association with age ($P < 0.001$). Females were also found to have two times higher odds of being overweight/obese than males. The relationship between overweight/obesity, age and sex of school-aged children and adolescents has been similarly reported by other studies within and outside Nigeria⁽³⁵⁻³⁷⁾. Screen time (i.e. time spent with television, computers, video games and phones) of 2 h or more daily had two times higher odds of being overweight/obese, while the odds of being overweight/obese reduced by 45 % with a unit increase in physical activity. This finding is in line with previous studies linking overweight/obesity to reducing physical activity and increasing sedentary lifestyle, of which screen time plays a major role^(14,15,38,39).

Increasing screen time has also been associated with higher consumption of snacks, which also has been reported to significantly increase the likelihood of overweight/obesity in children⁽⁴⁰⁾. Exclusive breastfeeding was found to significantly reduce the odds of being overweight/obesity by as much as 54 % in line with the results of previous studies⁽⁴¹⁻⁴³⁾. This finding is important as it underscores the importance of exclusive breastfeeding in reducing, not only childhood under-nutrition and mortality^(21,44), but also overweight/obesity. An interesting finding was that being part of a rich household reduced the odds of overweight/obesity by 53 %. This is different from what previous researchers in Nigeria have reported^(37,39), but similar to the finding in the high-income countries⁽⁴⁵⁾. This may be due to community-level factors which were probably not assessed in this study, since 30 % of the variance in the odds for overweight/obesity in this study is attributable to community-level factors. Community-level factors such as availability, accessibility and proximity to fast-food shops and recreational facilities or programmes in communities have been shown to influence the nutritional status of children and adolescents⁽⁴⁶⁻⁴⁸⁾. Another plausible reason for this is that, by reason of exposure, the richest households in Nigeria are already adopting

the lifestyle and values of the rich in developed countries where emphasis is placed on healthy food, exercises and a slim figure.

The school-aged children and adolescents living in Osun State had three times higher odds of being overweight/obese than those from Gombe State, and this may be a reflection of the higher socio-economic status and urbanisation of Osun State and the southwestern part of Nigeria compared with the northeastern part of the country where Gombe State is located⁽⁴⁹⁾. In the present study, although the wealth index was not significantly different between the two states, Osun state did significantly better for almost all other indices of better socio-economic status than Gombe state, including household size, number of children in the family, family type, mother's education, father's education and mother's employment.

Comparing the findings of the present study with those from previous multi-level analyses in Nigeria is challenging. Firstly, the previous studies were undertaken for under-five children, and they also focussed on under-nutrition alone. Furthermore, no previous research effort has used multi-level modelling to understand the determinants of overweight/obesity among any group of children/adolescents in Nigeria^(20,21,24). Additionally, the reference values used in the present study are different from those used by other previous studies. Previous studies used height-for-age (for stunting)^(20,21), weight-for-age (for underweight)⁽²⁴⁾ and weight-for-height (for wasting)⁽²⁴⁾ reference values, which are all indicators of under-nutrition. The present study used the BMI-for-age reference values, which has the advantage of measuring both under-nutrition (measured as thinness) and over-nutrition (measured as overweight and obesity)⁽²⁸⁾.

A limitation of this study is that the findings of this study may not be generalisable to all of Nigeria, because only two out of thirty-six states were involved in the study. Another limitation is that, as to date, there was no data about the contextual determinants of overweight/obesity among older children in Nigeria using multi-level analysis, hence making the comparison of the findings of the present study and others challenging. The cross-sectional nature of the study also makes it impossible to establish causality.

Policy implications

The findings of this study have some important policy implications. The present study observed that the community-level factors contributed significantly to the odds of under- and over-nutrition, indicating the need to explore community-based nutritional interventions for school-aged children and adolescents. There is also a need to review current interventions to assess whether/how they could be scaled-up and targeted at reducing socio-economic inequalities, and especially poverty among households in the study location. The food systems approach of the Food and Agriculture Organization to create an enabling



environment for improved nutrition⁽⁵⁰⁾ can guide governance for improved nutrition, evidence-based policies and programmes and financial investment to facilitate changes in food systems. The findings of the present study underscore the importance of reduced physical activity and prolonged screen time in increasing the odds for overweight/obesity among the school-aged children and adolescents. There is a need, therefore, for the development of recreational, sports or games centres and programmes for children and adolescents in different communities that will increase engagement in physical activity and reduce screen time among them.

Conclusion

This study showed that Nigeria faces the challenge of a double burden of malnutrition among its school-aged and adolescents (6–19 years), with over a fifth experiencing either under-nutrition or over-nutrition. The study showed thinness and overweight/obesity among school-aged children and adolescents were strongly influenced by their communities, individual-level factors and their residence. Predictors of thinness in this study were household size and household wealth index. Overweight/obesity was significantly associated with the age, sex, exclusive breastfeeding, physical activity and household wealth index. Policymakers and stakeholders should therefore plan community-based educational programs to address, especially, socio-economic status, physical activity patterns among the children and the control of family/household size in the two Nigerian states.

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conceptualisation of the research idea and topic, the design of the methodology and the proposal. A.A. carried out the study as part of his PhD work, while A.F. and K.K. supervised, provided useful suggestions and the mentorship that helped to shape the study into the present form. All the authors read and approved the final version of the manuscript. **Ethics of human subject participation:** The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Human Research Ethics Committee of University of the Witwatersrand (certificate No: M190514) and the ministry of health in Osun (certificate No: OSHREC/PRS/569T/155) and Gombe (certificate No: MOH/ADM/621/1/142) States. Written informed consent was obtained from all subjects/patients.

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Article

Food Security, Dietary Diversity, Dietary Patterns and the Double Burden of Malnutrition among School-Aged Children and Adolescents in Two Nigerian States

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Abstract: Background: Little evidence exists on the relationship between diet-related factors and child/adolescent malnutrition in Nigeria. This study aimed to assess the associations between household food insecurity (HFI), dietary diversity (DD), and dietary patterns (DP) with the double burden of malnutrition (DBM) among 6–19-year-olds in two Nigerian States. Methods: This community-based cross-sectional study was carried out among 1200 respondents (6–19 years in age) in the Gombe and Osun States of Nigeria. HFI was assessed using the HFI access scale. DD was assessed using a 24-h dietary recall. DP were determined by principal component analysis using a 30-day food frequency questionnaire. DP scores were categorized into quartiles (Q) for statistical analysis. Diet-related predictors of DBM were assessed using logistic regression. Results: HFI was experienced by 568 (47.3%) respondents. The median DD score was 7.0 (maximum of 14). Two DPs were identified, diversified DP (DDP) and traditional DP (TDP). TDP was significantly associated with both thinness (Q4:OR: 2.91; 95% CI: 1.52–5.55; P_{trend}: 0.002) and overweight/obesity (Q4:OR: 2.50; 95% CI: 1.43–4.35; P_{trend}: 0.007), while DDP was inversely related with thinness (Q4:OR: 0.36; 95% CI: 0.21–0.61; P_{trend}: 0.008) as compared to Q1. Conclusions: TDP increased the odds for DBM, while the DDP reduced the odds.

Keywords: double burden of malnutrition; under-nutrition; over-nutrition; dietary diversity; dietary patterns; household food insecurity; school-aged children; adolescents; sub-Saharan Africa



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1. Introduction

There has been a steady rise in the prevalence of overweight and obesity among children in all regions of the world. Prevalence rates in the range of 10–40% for overweight/obesity were reported in selected high-income countries among 15-year-old adolescents [1]. The World Health Organization (WHO) reports that 340 million school-aged children and adolescents (aged 5–19 years) were overweight/obese globally in 2016 [2]. Low- and middle-income countries have also experienced significant rise in the prevalence of overweight/obesity with highest prevalence rates recorded in the Middle East, North Africa, Latin America and the Caribbean [1,3].

Despite the rising prevalence of overweight/obesity in sub-Saharan Africa, the prevalence of underweight children still remains high. In a study that assessed the worldwide trend in the nutritional status of 24.1 million children between the ages of 5–17 years from 1975 to 2016, the prevalence of underweight was observed to have been reduced in virtually all regions, except for South Asia, Central Africa, East Africa, and West Africa [2]. Thus,

most countries in sub-Saharan Africa, including Nigeria, are experiencing what has been termed as “double burden of malnutrition”, which is the co-existence of both under- and over-nutrition [4,5].

Identifying the determinants of under- and over-nutrition is important not only in improving the understanding about the subject, but also critical for planning appropriate nutritional interventions for affected children. However, to date, most of the research efforts targeted at identifying the determinants of the nutritional status of school-aged children and adolescents in Nigeria have focused on socio-demographic factors [6–9]. Little evidence could be found in the literature on the relationship between the nutritional status of school-aged children and adolescents and key factors such as food security, dietary diversity and dietary patterns in Nigeria. Thus, a significant evidence gap exists with regards to determinants of nutritional status of school children and adolescents in Nigeria, particularly as diet is reported as an important factor in the epidemiology of childhood and adolescent malnutrition [10–12].

Household food security, dietary diversity and dietary patterns are methods that are used to describe the diet and food consumption at individual and household levels. Household food security refers to situations when a household has access to sufficient quantity and quality of food for all members of the household for a given period [13]. Dietary diversity qualitatively measures access and consumption of varieties of food types as a proxy for nutrient/diet adequacy and quality at individual and household levels [14]. Dietary patterns, on the other hand, describe a broader and more comprehensive conceptualization of food consumption as against the traditional method of finding the frequency of the consumption of individual food types or nutrients [15]. Each of these three elements are shown to be associated with nutritional status and studies have also shown relationships between them [16,17].

Few studies have assessed household food insecurity in Nigeria [18,19], and fewer still have directly linked household food insecurity to the nutritional status of school-aged children or adolescents. Likewise, dietary diversity and its relation to under- and over-nutrition among school-aged children or adolescents has only been assessed in few Nigerian studies [20–22]. Data on the dietary patterns of school-aged children and adolescents in Nigeria is even more scarce. Previous reports from Nigeria who attempted to describe the dietary patterns of children and/or adolescents only described the frequency of consumption of different food groups or the dietary habits of the children or adolescents [23–25]. Only one recently published article described the dietary patterns of a small sample of out-of-school adolescents [26] in Nigeria using dietary pattern analysis [15].

The present study aims to address the evidence gap highlighted above: it aimed to assess household food security, dietary diversity and dietary patterns in relation to under- and over-nutrition among school-aged children and adolescents in two selected states in Nigeria located in two different parts of the country (North and South).

2. Materials and Methods

2.1. Study Location

The study was carried out in two randomly selected states in Nigeria. Nigeria has 36 states and is a multi-ethnic nation with significant socio-economic and cultural differences between its two broad geographical areas: the north and the south. The dominant ethnic groups in the north are the Hausas and Fulanis, while the dominant groups in the southern part of Nigeria are Yorubas and Igbos. Nigeria is politically structured into 6 geo-political zones that are equally distributed between the northern and southern parts of the country. For this study, the geo-political zones with the lowest (North-East) and highest (South-West) wealth index based on the 2018 Nigeria Demographic and Health Survey (NDHS) [27] were selected, and Gombe and Osun States were randomly selected from the two zones, respectively.

2.2. Study Design, Population and Size

A community-based cross-sectional study was carried out among 1200 school-aged children and adolescents aged 6–19 years (600 from each of the selected states). School-aged children are usually defined as those 6 to 11 years of age [28], or 5 to 14 years [29], while adolescents are those from 10–19 years of age [29]. In the present study, school-aged children and adolescents are taken as those from 6 to 19 years of age. The sample size was determined using STATCALC on the Epi-Info software, [30] to get an absolute precision of $\pm 5\%$. The proportion of expected outcome was taken as 33%, which is the prevalence of stunted children in Nigeria [31], and a design effect of 1.5 was used because of the hierarchical sampling model. The calculated sample size for each of the states was 510, and after correcting for an anticipated 10% non-response, the same sample became 561, which was rounded off to 600 for each of the states (making a total of 1200). The sample size determination was previously described in detail in another study [32].

2.3. Sampling Technique

Respondents were selected using multi-stage sampling technique. At the first stage, two local government areas (LGAs) were selected from each of the two selected states (one from rural and one from urban LGAs) using a simple random sampling technique (Balloting method). Two wards/districts each were randomly selected from each LGA at the second stage. In each of the selected wards/districts, five enumerations areas (EAs), as demarcated by the National Population Commission for the 2006 population census, were randomly selected for the third stage. At the fourth stage, the listing of the households in the EAs was first carried out, then 30 households were drawn in each of the selected EAs using systematic sampling technique. At the household level, one school-age child or adolescent was selected. If a household had more than one school-aged child or adolescent who met the inclusion criteria, only one was randomly selected.

2.4. Data Collection

Ten research assistants (five males and five females) and one field supervisor were recruited and trained to collect data in each of the two states. The questionnaires were administered with RedCap [33] and the anthropometric measurements, i.e., the weight and height of the children/adolescents were taken using standard protocols recommended by the International Society for the Advancement of Kinanthropometry [34].

2.5. Outcome Variable

The primary outcome/dependent variable is the nutritional status, which was assessed with the WHO 2007 reference values, [35] using the BMI-for-age Z-scores and categorized into: (1) thinness, (2) normal, and (3) overweight/obese for BMI-for-age Z-scores < -2 , -2 to 1 , > 1 respectively. This was re-categorized into two different outcome variables for under-nutrition (i.e., (1) thinness, (0) otherwise) and over-nutrition (i.e., (1) overweight/obese, (0) otherwise).

2.6. Explanatory Variables

2.6.1. Household Food Insecurity

Household food security was measured using the household food insecurity access scale (HFIAS) [36]. The HFIAS has nine occurrence questions with a recall period of four weeks (30 days), and these are followed by three frequency-of-occurrence questions to determine whether the condition happened rarely (once or twice), sometimes (three to ten times) or often (more than ten times) in the past four weeks. A response of “No” to the frequency-of-occurrence questions was scored 0, while “rarely”, “sometimes”, and “often” were scored 1, 2, and 3 respectively. The households were then categorized into “food secure”, “mildly food insecure”, “moderately food insecure” and “severely food insecure”, using the responses to these questions and based on extant literature [36]. These four categories were re-categorized into “food secure” (food secure and mildly food

insecure) and “food insecure” (moderately and severely food insecure) households for data analysis.

2.6.2. Dietary Diversity (DD)

A scale of 14 food groups including the following was used in assessing the DD score for each of the children and adolescents; [14,21] cereals, vitamin A vegetables and tubers, white tubers, dark green leafy vegetables, other vegetables, vitamin A fruits, other fruits, organ meat, flesh meat, egg and egg products, fish, legumes/nuts/seeds, milk/milk products and oils/fats. DD classification was based on a one-time 24-h dietary recall. This involved the respondents listing all the foods and drinks they had taken in the 24 h preceding the data collection. Using the information collected from the 24-h dietary recall, a point was awarded to each food group consumed out of the 14 food groups, and the sum of all the points awarded was the DD score for each child. Hence the DD score ranged from a minimum of 0 (if no food from the 14 food groups was consumed) and 14 (if food from all 14 food groups was consumed). The DD scores lower than the median score of seven were grouped as “low”, while others (≥ 7) were regarded as high.

2.6.3. Dietary Patterns (DP)

A 30-day food frequency questionnaire (FFQ) was used to collect information on the frequency and amount of 92 different food items consumed in the last 30 days preceding the study. The FFQ was adapted from the one used among school-aged children in Ghana [37] and further modified after pre-testing the research instrument. For the present study, the 92 different food items were collapsed into 15 food groups, based on their nutritional profile (Supplementary Table S1). Principal component analysis (PCA) with Varimax rotation was used to determine the dietary patterns which best represented the food intake of the population. The number of patterns was determined using the Scree plot and eigenvalues values greater than 1.0. Two components (i.e., patterns) explained 56% of the total variance and were retained. Food groups with absolute loadings greater or equal to 0.4 were used to name the retained principal components/patterns (Figure 1). The first pattern showed positive loadings greater than 0.4 for all food groups and hence was described as “*Diversified dietary pattern*”. The second pattern showed positive loadings greater than 0.4 for starchy foods/cereals, legumes and sugars and negative loadings for fish, desserts and snacks, and was described as the “*Traditional dietary pattern*”, because the typical traditional diet in Nigeria is dominated by cereals/starchy foods and legumes. The pattern scores generated for each respondent by PCA were categorized into quartiles for the statistical analysis.

2.6.4. Other Explanatory Variables

Socio-demographic characteristics, which include age, sex, household wealth index, residence, state and ethnicity, were included in the variables for the analysis. The household wealth index was calculated using household possessions through PCA and categorized into tertiles, (1) high, (2) middle, and (3) low, as earlier explained in another article. [32] Pubertal staging was assessed using the Tanner pubertal self-rating scale [38]. The scale has a score range of 1–5, and the respondents were grouped into early puberty (Tanner stage 2 and below) and mid-puberty (>Tanner stage 2). Physical activity was assessed using the physical activity questionnaire for older children and adolescents by Kowalski et al. [39] which was measured as scores from 1 to 5. The higher the score, the more active the respondent was, with 1 representing the option with least or no activity and 5 being the option with most activity.

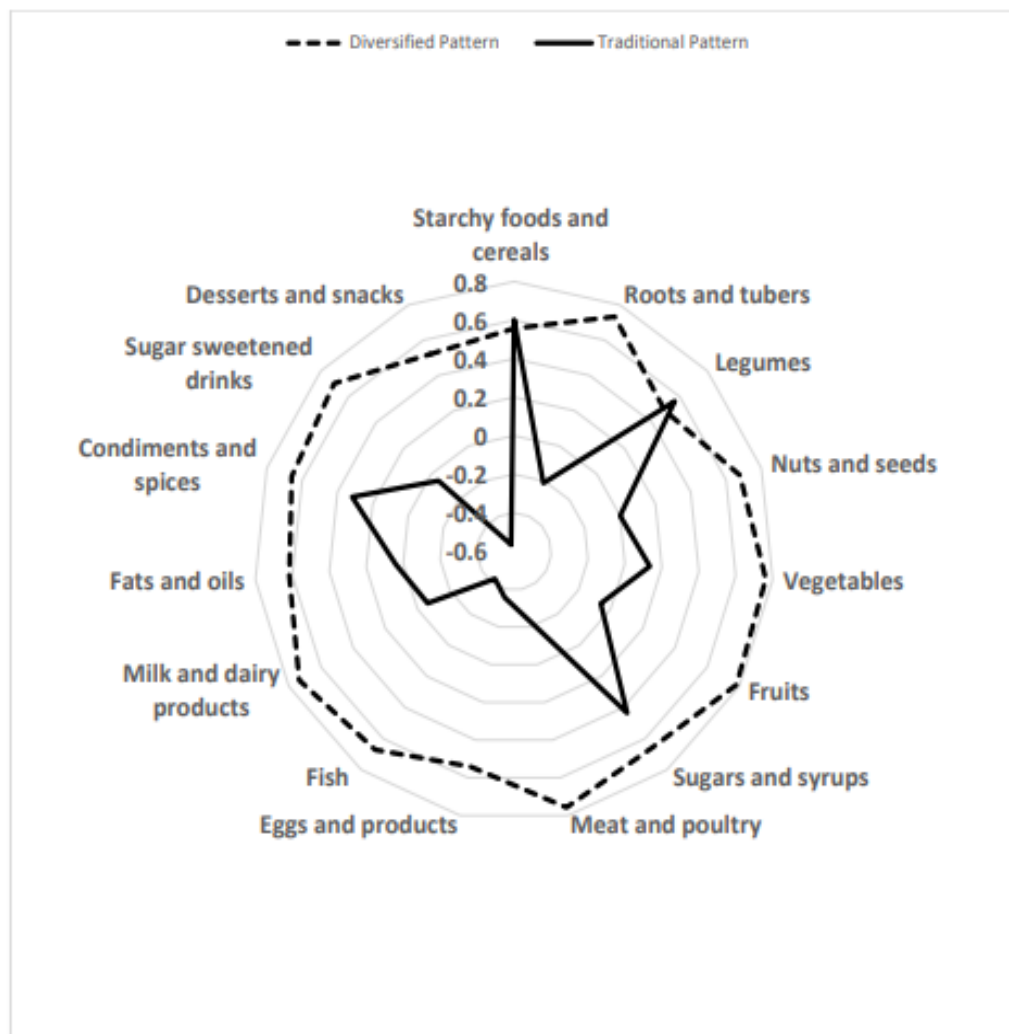


Figure 1. Radar chart showing the two dietary patterns, the 15 food groups and their factor loadings among school-aged children and adolescents in two States in Nigeria.

2.7. Data Analysis

Data from the RedCap database were exported and analyzed using Stata version 15. All the dependent and independent variables were initially described, after which Pearson chi-square was used to test for associations for categorical variables at bivariate level. The Kruskal–Wallis test was used to test the associations between nutritional status and continuous variables at bivariate level, because the variables were not normally distributed. Four models each were fitted for food insecurity, dietary diversity, diversified food pattern and the traditional food pattern, and their relationships with thinness and overweight/obesity using binary logistic regression analysis. Model 0 was the empty model showing crude/unadjusted rates, while Model 1 adjusted for age and sex. Model 2 adjusted for State of residence and household wealth index in addition to Model 1, and Model 3 was the full model that adjusted for physical activity scores in addition to Model 2. Variables with high variance inflation factor (VIF) when multi-collinearity diagnostics were performed were not included in the models. Therefore, pubertal staging, residence and

ethnicity were not included to prevent redundancy. The level of significance was set at $p < 0.05$.

2.8. Ethical Considerations

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Human Research Ethics Committee of the University of the Witwatersrand, South Africa (certificate No: M190514, approved on 25/09/2019), and the Ministry of Health in Osun State (certificate No: OSHREC/PRS/569T/155, approved on 24/06/2019) and Gombe State (certificate No: MOH/ADM/621/1/142, approved on 26/07/2019) in Nigeria. Informed consent was obtained from all subjects involved in the study. Written consent was obtained from adolescents who were 18 years and above, and the parents of children less than 18 years, while assent was obtained in addition from children less than 18 years. All severely malnourished children were referred to the nearby public health facilities for further management.

3. Results

The distribution of the dependent and independent variables by the state of residence is shown in Table 1. The prevalence rate of thinness was 10.3% and overweight/obesity was 11.4%. At bivariate level, thinness (under-nutrition) had statistically significant associations with ethnicity ($p < 0.001$), household wealth index ($p < 0.001$), state of residence ($p < 0.001$), residence (rural/urban) ($p = 0.0013$), diversified dietary pattern ($p < 0.001$) and traditional dietary pattern ($p = 0.0013$). Overweight/obesity had significant statistical relationships with age ($p < 0.001$), gender ($p < 0.001$), ethnicity ($p < 0.001$), state of residence ($p < 0.001$), residence (rural/urban) ($p < 0.001$) and physical activity ($p = 0.001$).

Table 1. Description of the study population in Gombe and Osun States ($n = 1200$).

Variables	States		
	[†] Gombe <i>n</i> (%)	[†] Osun <i>n</i> (%)	Total <i>n</i> (%)
Age of the child (IR)	12.0 (7.0)	11.0 (5.0)	11.0 (6.0)
^a BMI-for-age			
Thinness	83 (13.8)	40 (6.7)	123 (10.3)
Normal	476 (79.3)	464 (77.3)	940 (78.3)
Overweight/Obesity	41 (6.8)	96 (16.0)	137 (11.4)
Sex			
Male	323 (53.8)	278 (46.3)	601 (50.1)
Female	277 (46.2)	322 (53.7)	599 (49.9)
Pubertal staging			
Early puberty	379 (63.2)	355 (59.2)	734 (61.2)
Mid puberty	221 (36.8)	245 (40.8)	466 (38.8)
Ethnicity			
Yoruba	65 (10.8)	574 (95.7)	639 (53.3)
Igbo	23 (3.8)	15 (2.5)	38 (3.2)
Hausa	150 (25.0)	0 (0.0)	150 (12.5)
Fulani	144 (24.0)	3 (0.5)	147 (12.3)
Minorities	218 (36.3)	8 (1.3)	226 (18.8)
^b Household wealth index			
Low	205 (34.2)	195 (32.5)	400 (33.3)
Middle	189 (31.5)	211 (35.2)	400 (33.3)
High	206 (34.3)	194 (32.3)	400 (33.3)
Residence			
Rural	300 (50.0)	300 (50.0)	600 (50.0)
Urban	300 (50.0)	300 (50.0)	600 (50.0)

Table 1. Cont.

Variables	States		
	^f Gombe n (%)	^f Osun n (%)	Total n (%)
^c Food security			
Food secure	320 (53.3)	312 (52.0)	632 (52.7)
Food insecure	280 (46.7)	288 (48.0)	568 (47.3)
^d Dietary diversity			
Low	244 (41.1)	341 (57.0)	585 (49.1)
High	350 (58.9)	257 (43.0)	607 (50.9)
^e Diversified dietary pattern			
Quartile 1	249 (41.5)	52 (8.7)	301 (25.1)
Quartile 2	150 (25.0)	149 (24.8)	299 (24.9)
Quartile 3	112 (18.7)	188 (31.3)	300 (25.0)
Quartile 4	89 (14.8)	211 (35.2)	300 (25.0)
^e Traditional dietary pattern			
Quartile 1	32 (5.3)	268 (44.7)	300 (25.0)
Quartile 2	165 (27.5)	135 (22.5)	300 (25.0)
Quartile 3	195 (32.5)	105 (17.5)	300 (25.0)
Quartile 4	208 (34.7)	92 (15.3)	300 (25.0)

IR—interquartile range; BMI—body mass index. ^a Categorized using BMI-for-age Z-scores; thinness (<-2), normal (-2 to 1) and overweight/obesity (>1) ^b Household wealth index scores were derived from scoring the possession of household commodities using principal component analysis, which were then categorized into three (low/middle/high) ^c Measured using HFIAS, “food secure” represents those that were food secure and mildly food insecure, while “food insecure” represents moderately and severely food insecure ^d Those with a dietary diversity score lower than the median score of 7 were grouped as “low”, while others (≥ 7) were regarded as high. ^e Dietary pattern scores derived using principal component analysis were categorized into quartiles. ^f The number of respondents in each of Gombe and Osun States is 600.

Figure 1 shows the diversified and traditional dietary patterns, and their rotated factor loadings using a radar chart. The diversified dietary pattern was characterized by a high intake (i.e., factor loading ≥ 0.4) of all listed food groups, while the traditional pattern had a high intake of starchy foods/cereals, legumes and sugars, and very low intake (i.e., factor loading ≤ 0.4) of fish, desserts and snacks. The diversified dietary pattern explained 44.1% of the variance, while the traditional dietary pattern explained 11.5% of the variance.

The socio-demographic characteristics, physical activity, food insecurity and dietary diversity across the quartiles of the two dietary patterns is presented in Table 2. All the considered variables, except age ($p = 0.926$) and sex ($p = 0.571$), had statistically significant association with the diversified dietary pattern ($p \leq 0.001$). The traditional dietary pattern had a statistically significant association with all the considered variables ($p < 0.05$) except pubertal staging ($p = 0.637$) and food insecurity (0.403).

Table 3 shows adjusted odds ratios and 95% CIs from the associations of food insecurity and dietary diversity, with thinness (under-nutrition) and overweight/obesity (over-nutrition) among the respondents. There were no statistically significant associations across all the models for both food insecurity and dietary diversity.

Table 2. Demographic variables, physical activity, food insecurity and dietary diversity across the quartiles of the two dietary patterns.

Variables	Diversified Dietary Pattern				p-Value	Traditional Dietary Pattern				p-Value
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4	
^a Age	11.0 (6.0)	11.0 (5.0)	12.0 (7.0)	12 (6.0)	0.926	10.0 (5.0)	11.0 (6.0)	11.5 (6.0)	12.0 (6.0)	<0.001 *
^a Physical Activity Scores	2.1 (1.0)	2.0 (1.0)	2.4 (1.1)	2.6 (0.9)	<0.001 *	2.2 (1.2)	2.4 (1.0)	2.2 (1.1)	2.3 (0.9)	0.034 *
Sex										
Male	152 (25.3)	159 (26.5)	143 (23.8)	147 (24.5)	0.571	121 (20.1)	158 (26.3)	151 (25.1)	171 (28.5)	<0.001 *
Female	149 (24.9)	140 (23.4)	157 (26.2)	153 (25.5)		179 (29.9)	142 (23.7)	149 (24.9)	129 (21.5)	
Pubertal Staging										
Early Puberty	211 (28.7)	184 (25.1)	168 (22.9)	171 (23.3)	0.001 *	187 (25.5)	187 (25.5)	186 (25.3)	174 (23.7)	0.637
Mid Puberty	90 (19.3)	115 (24.7)	132 (28.3)	129 (27.7)		113 (24.2)	113 (24.2)	114 (24.5)	126 (27.0)	
Ethnicity										
Yoruba	65 (10.2)	159 (24.9)	203 (31.8)	212 (33.2)	<0.001 *	264 (41.3)	139 (21.8)	125 (19.6)	111 (17.4)	<0.001 *
Igbos	3 (7.9)	11 (28.9)	9 (23.7)	15 (39.5)		7 (18.4)	18 (47.4)	2 (5.3)	11 (28.9)	
Hausa	62 (41.3)	35 (23.3)	28 (18.7)	25 (16.7)		12 (8.0)	51 (34.0)	37 (24.7)	50 (33.3)	
Fulani	83 (56.5)	25 (17.0)	23 (1.6)	16 (10.9)		7 (4.8)	42 (28.6)	48 (32.7)	50 (34.0)	
Minorities	88 (38.9)	69 (30.5)	37 (16.4)	32 (14.2)		10 (4.4)	50 (22.1)	88 (38.9)	78 (34.5)	
Household Wealth Index										
Low	170 (42.5)	68 (17.0)	75 (18.8)	87 (21.8)	<0.001 *	75 (18.8)	125 (31.3)	94 (23.5)	106 (26.5)	<0.001 *
Middle	88 (22.0)	115 (28.7)	116 (29.0)	81 (20.3)		116 (29.0)	86 (21.5)	122 (30.5)	76 (19.0)	
High	43 (10.8)	116 (29.0)	109 (27.3)	132 (33.0)		109 (27.3)	89 (22.3)	84 (21.0)	118 (29.5)	
State										
Gombe	249 (41.5)	150 (25.0)	112 (18.7)	89 (14.8)	<0.001 *	32 (5.3)	165 (27.5)	195 (32.5)	208 (34.7)	<0.001 *
Osun	52 (8.7)	149 (24.8)	188 (31.3)	211 (35.2)		268 (44.7)	135 (22.5)	105 (17.5)	92 (15.3)	
Residence										
Rural	109 (18.2)	123 (20.5)	181 (30.2)	187 (31.2)	<0.001 *	174 (29.0)	135 (22.5)	129 (21.5)	162 (27.0)	<0.001 *
Urban	192 (32.0)	176 (29.3)	119 (19.8)	113 (18.8)		126 (21.0)	165 (27.5)	171 (28.5)	138 (23.0)	
Food Security										
Food Secure	291 (26.3)	259 (23.4)	271 (24.5)	286 (25.8)	<0.001 *	280 (25.3)	278 (25.1)	279 (25.2)	270 (24.4)	0.403
Food Insecure	10 (10.8)	40 (43.0)	29 (31.2)	14 (15.1)		20 (21.5)	22 (23.7)	21 (22.6)	30 (32.3)	
Dietary Diversity										
Low	198 (33.8)	153 (26.2)	130 (22.2)	104 (17.8)	<0.001 *	175 (29.9)	171 (29.2)	150 (15.6)	89 (15.2)	<0.001 *
High	97 (16.0)	146 (24.1)	168 (27.7)	196 (32.3)		125 (20.6)	127 (20.9)	144 (23.7)	211 (34.8)	
^a Dietary Diversity Score	5.0 (4.0)	6.0 (3.0)	7.0 (4.0)	8.0 (7.0)	<0.001 *	6.0 (3.0)	6.0 (4.0)	6.0 (5.0)	9.0 (6.0)	<0.001 *

Q—quartiles; *—statistically significant; ^a—Kruskal–Wallis test was used because the variables were not normally distributed, and median (inter-quartile range) was used to describe the data.

The adjusted odds ratios and 95% CIs from the associations of the diversified and traditional dietary patterns with thinness (under-nutrition) and overweight/obesity (over-nutrition) among the respondents is shown in Table 4. With respondents in the first quartile being the reference, respondents in all other quartiles had a statistically significant association with under-nutrition (thinness) at the crude/empty model level; the diversified dietary pattern was inversely associated ($p_{\text{trend}} = 0.009$) while the traditional dietary pattern was positively associated ($p_{\text{trend}} = 0.002$). However, only those in the second quartile of the diversified dietary pattern retained the statistically significant association after controlling for all the independent variables (i.e., in the full model/Model 3) (OR: 0.44; $p = 0.007$; 95% CI: 0.24 to 0.80). For the association between dietary patterns and over-nutrition (overweight/obesity), there was no significant associations at the crude model level, but the full models of Quartile 2 (OR: 2.06; $p = 0.009$; 95% CI: 1.20 to 3.55) and 4 (OR: 2.50; $p = 0.001$; 95% CI: 1.43 to 4.35) of the traditional dietary pattern showed statistically significant positive association. The P_{trend} was 0.007, which indicates a statistically significant linear association.

Table 3. The associations of food insecurity and dietary diversity, with thinness (under-nutrition) and overweight/obesity (over-nutrition) among school-aged children and adolescents in two Nigerian states, using binary logistic regression (n = 1200).

^a Models	^b Ref	OR	95% CI	p-Value
Food Insecurity				
Model 0 (Empty/Crude)	1	1.33	0.71, 2.51	0.381
Model 1	1	1.35	0.72, 2.57	0.351
Model 2	1	1.34	0.70, 2.58	0.377
Model 3	1	1.34	0.70, 2.57	0.382
Dietary Diversity				
Model 0 (Empty/Crude)	1	0.85	0.58, 1.23	0.378
Model 1	1	0.83	0.57, 1.21	0.324
Model 2	1	0.91	0.61, 1.36	0.645
Model 3	1	0.91	0.61, 1.35	0.637
Food Insecurity				
Model 0 (Empty/Crude)	1	0.71	0.34, 1.51	0.376
Model 1	1	0.7	0.33, 1.50	0.358
Model 2	1	0.79	0.37, 1.70	0.546
Model 3	1	0.73	0.33, 1.60	0.433
Dietary iversity				
Model 0 (Empty/Crude)	1	1.04	0.73, 1.49	0.822
Model 1	1	1.23	0.85, 1.77	0.275
Model 2	1	1.31	0.90, 1.92	0.158
Model 3	1	1.34	0.91, 1.96	0.134

OR=odds ratio; CI=confidence interval; ^a Model 1=adjusted for age and sex; Model 2: Model 1 + household wealth index and state; Model 3: full model (i.e., Model 2 + physical activity scores); ^b represents the food secure category and the category with low dietary diversity which served as reference values for food insecurity and dietary diversity respectively.

Table 4. The associations of the diversified and traditional dietary patterns, with thinness (under-nutrition) and overweight/obesity (over-nutrition) among school-aged children and adolescents in two Nigerian states, using binary logistic regression (n = 1200).

^a Models	Q1 (Ref)	Q2			Q3			Q4			p-Trend
		OR	p-Value	95% CI	OR	p-Value	95% CI	OR	p-Value	95% CI	
Thinness											
Diversified Dietary Pattern											
Model 0 (Empty/Crude)	1	0.28	<0.001 *	0.16, 0.49	0.51	0.006 *	0.31, 0.82	0.36	<0.001 *	0.21, 0.61	0.009 *
Model 1	1	0.27	<0.001 *	0.15, 0.48	0.51	0.006 *	0.32, 0.82	0.36	<0.001 *	0.21, 0.61	0.008 *
Model 2	1	0.44	0.007 *	0.24, 0.80	0.89	0.675	0.52, 1.53	0.72	0.285	0.40, 1.31	0.915
Model 3	1	0.44	0.007 *	0.24, 0.80	0.91	0.737	0.53, 1.57	0.75	0.343	0.41, 1.37	0.827
Traditional Dietary Pattern											
Model 0 (Empty/Crude)	1	2.96	0.001 *	1.57, 5.59	2.61	0.004 *	1.37, 4.97	2.87	0.001 *	1.52, 5.44	0.002 *
Model 1	1	2.98	0.001 *	1.57, 5.63	2.63	0.003 *	1.38, 5.04	2.91	0.001 *	1.52, 5.55	0.002 *
Model 2	1	1.94	0.059	0.97, 3.86	1.63	0.177	0.80, 3.32	1.95	0.065	0.96, 3.96	0.114
Model 3	1	1.99	0.051	1.00, 3.98	1.64	0.171	0.81, 3.98	1.98	0.059	0.97, 4.03	0.106
Overweight/Obesity											
Diversified Dietary Pattern											
Model 0 (Empty/Crude)	1	1.01	0.978	0.60, 1.70	1.42	0.166	0.86, 2.32	1.08	0.781	0.64, 1.81	0.871
Model 1	1	1.01	0.957	0.60, 1.73	1.39	0.193	0.84, 2.30	1.09	0.742	0.65, 1.85	0.935

Table 4. Cont.

* Models	Q1 (Ref)	Q2			Q3			Q4			p-Trend
		OR	p-Value	95% CI	OR	p-Value	95% CI	OR	p-Value	95% CI	
Model 2	1	0.66	0.164	0.36, 1.19	0.83	0.529	0.47, 1.48	0.6	0.1	0.33, 1.10	0.1
Model 3	1	0.62	0.119	0.34, 1.13	0.92	0.78	0.51, 1.65	0.78	0.421	0.42, 1.44	0.581
Traditional Dietary Pattern											
Model 0 (Empty/Crude)	1	0.97	0.901	0.59, 1.58	0.7	0.188	0.42, 1.19	1	1	0.61, 1.63	0.865
Model 1	1	1.14	0.606	0.69, 1.88	0.83	0.488	0.49, 1.41	1.31	0.29	0.79, 2.17	0.444
Model 2	1	1.7	0.048 *	1.01, 2.87	1.33	0.316	0.76, 2.34	2.14	0.006 *	1.24, 3.67	0.017 *
Model 3	1	2.06	0.009 *	1.20, 3.55	1.5	0.169	0.84, 2.66	2.5	0.001 *	1.43, 4.35	0.007 *

Ref—reference value; OR—odds ratio; CI—confidence interval; *—statistically significant Q—represent quartiles, which were derived from the principal component analysis scores for both the diversified and traditional dietary patterns ^a Model 1—adjusted for age and sex; Model 2—Model 1 + household wealth index and state; Model 3: full model (i.e., Model 2 + physical activity scores).

4. Discussion

Few scattered small-scale studies exist regarding diet-related factors among school-aged children and adolescents in Nigeria, but no study was found that considered these factors together and related them to under- and over-nutrition among older children. Addressing these factors together is important so as to assess and control for any potential confounding effects in explaining the associations between the explanatory and outcome variables. Existing studies also have methodological limitations of unrepresentative study populations and/or unconventional methodologies that make comparisons of the results difficult. The current study has the advantage of avoiding these limitations: in particular, it was based on representative populations from two states of Nigeria that are diverse geographically, socio-culturally, and economically, and used well established approaches, with rigorous analysis in addressing the association of diet related factors with under- and over-nutrition.

Nearly half of the households were moderately or severely food insecure. Previous studies on household security in Nigeria have similarly reported rates of moderate/severe food insecurity in excess of 50% [18,40]. These findings are disturbing, especially as this was found to be significantly associated with the nutritional status of the children or adolescents living in such households. [40] The median DD score for the present study was 7 out of a total possible score of 14, with two-thirds of the respondents scoring 7 or below. Other previous studies on dietary patterns among children or adolescents reported similar findings with the mean/median DD score being about half of the total DD score [20,22,41]. The present study found that half of the respondents had dietary diversity scores less than 7, which is just half of the maximum value of 14. This indicates sub-optimum dietary diversity among half of the respondents.

Two dietary patterns were identified in the present study, which were named diversified and traditional DP. The only other study on dietary pattern among adolescents in Nigeria using the principal component analysis/factor analysis had very similar findings. The authors reported two patterns also, with one characterized by a high intake of all the food groups that were considered while the other was characterized by a high intake of roots/tubers and legumes, and they called these the healthy and unhealthy DPs, respectively [26]. A study from Ghana also reported two DPs, but with very different food group loadings from the present study and the previous Nigerian study [26]. The DPs described for adolescents from other countries [42,43] outside Africa were also quite different from those found among school-aged children or adolescents in Nigeria and Ghana [26,44].

The diversified dietary pattern had an inversely significant association with thinness, even after adjusting for all independent variables, i.e., showing 56% lower odds of thinness in those in the fourth as compared to those in the first quartile. The inverse relationship between the diversified dietary pattern and thinness is expected because the diversified

diet reflects a healthier dietary pattern. Even though not statistically significant, it may be important to also note that the diversified dietary pattern was also inversely related to overweight/obesity. This underscores the importance of a healthy or diversified dietary pattern for better health (i.e., lower odds for thinness and overweight/obesity).

The traditional dietary pattern had a positively significant association with overweight/obesity, such that those in the second and fourth quartiles of the traditional dietary pattern had 2 times higher odds of being overweight/obese than those in the first quartile. The traditional dietary pattern also had a positive association with thinness, although the relationship was only statistically significant in the crude model. Overall, the traditional dietary pattern seems to increase the odds of thinness and overweight/obesity, therefore, contributing to the double burden of malnutrition. This may not be unexpected because the traditional dietary pattern is characterized by higher intake of starchy foods/cereals and sugars. This finding further underscores the importance of a healthy dietary pattern in combating the double burden of malnutrition among school-aged children and adolescents in these two states, and probably the whole of Nigeria.

Similarly, different studies carried out in other countries have reported associations between dietary patterns and under- or over-nutrition [42,43,45], though the pattern of association is inconsistent. The most diversified DP in a study among Spanish adolescents had lower odds for overweight/obesity [43], while a study carried out in Bangladesh found that the diversified DPs were significantly and positively associated with overweight/obesity [42]. Alangea et al. [44] in Ghana found a significant association between the energy-dense DP and childhood overweight/obesity. Meanwhile, studies by Abizari et al. [46] and Samuel et al. [26] in Ghana and Nigeria, respectively, found no association between the dietary patterns and nutritional status of the adolescents. This lack of consensus on the nature of the relationship between dietary patterns and body mass index was previously noted [43]. This may not be unexpected because of the multi-factorial and complex nature of the determinants of nutritional status. The role cultural, ethnic and religious factors [47–50], and influence of contextual factors such as household level and community level factors [51,52] cannot be ruled out. Furthermore, the role of indirect associations can also not be ruled out, in the present study as an example, the indirect association with food insecurity and dietary diversity are also important. More research is thus needed to understand the mechanism underlying the associations.

The relationships between food insecurity, dietary diversity and thinness and overweight/obesity were not statistically significant. However, indirect associations cannot be ruled out because of the significant associations that existed between the dietary patterns and both food insecurity and dietary diversity at the bivariate analysis level. School-aged children and adolescents who came from food insecure homes, and those who had low dietary diversity were significantly less likely to have a diversified dietary pattern, while a third of those in the fourth quartile, and more than half of those in the third and fourth quartiles of the traditional dietary pattern were food insecure. This shows a possible relationship between food insecurity and the unhealthy (i.e., traditional) dietary pattern which had a positive association with the double burden of malnutrition.

Thinness and overweight/obesity among the school-aged children and adolescents in this present study were significantly associated with variables that were not diet-related. The variables who had significant associations with both dietary patterns in this study were ethnicity, household wealth index, state and residence. These relationships underscore the importance of the social determinants of health. Social determinants have a major influence on health and health related behavior, and especially on diet and/or nutrition of people [53–55]. Religion, for instance, dictates some food that are to be eaten, and others that should be avoided, and this is irrespective of other variables including the wealth index of such households. Similarly, previous researchers have found that ethnicity, culture and other social determinants influence dietary patterns [47,48]. In the present study, those in the high household wealth index category, for example, were more likely to

have a diversified diet, and this may indicate that household financial means determines affordability of food and hence determines dietary patterns.

While the present study involved a representative sample from two states, the findings may not be generalizable to the entire country of 36 states, particularly granted the social diversity, cultural plurality, and multi-ethnic nature of Nigeria. Additionally, the assessment of dietary diversity and dietary patterns was dependent on the recall of food taken in the last 24 h and the last 30 days respectively, which makes them prone to recall bias [56,57]. The aetiology of under- and over-nutrition is complex, and this study could not assess all possible explanatory variables, hence the possibility of residual confounding could not be ruled out.

5. Conclusions

A traditional dietary pattern (containing mainly cereals/starchy food and legumes) significantly increased the odds for both thinness and overweight/obesity, while a diversified dietary pattern (containing all food groups) significantly reduced the odds for thinness in school-aged children and adolescents in Nigeria. Dietary patterns were the only diet-related factors that had direct associations with under- and over-nutrition, while food insecurity and dietary diversity had indirect associations. DBM was also associated with socio-demographic and socio-economic variables, underscoring the importance of the social determinants of health. Nutrition education programmes to promote a healthy diversified dietary pattern that will reduce the burden of under- and over-nutrition among age 6–19 years needs to be intensified in Nigeria for school-aged children, adolescents and their parents.

Supplementary Materials: The following are available online at <https://www.mdpi.com/article/10.3390/nu14040789/s1>. Table S1: List of food types and their groups used for the assessment of dietary patterns.

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Informed Consent Statement: Written informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical considerations.

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