EVALUATION OF FACTORS ASSOCIATED WITH POOR NUTRITIONAL STATUS AMONG UNDER FIVE CHILDREN IN NIGERIA USING LINEAR, QUANTILE AND LOGISTIC REGRESSION

BY

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CERTIFICATION

I certify that this work titled "Evaluation of Factors Associated with Poor Nutritional Status among under Five Children in Nigeria Using Linear, Quantile and Logistic Regression" was carried out by Akinsanya, Olabisi Tolu in the Department of Epidemiology and Medical Statistics, Faculty of Public Health, University of Ibadan under my supervision.

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DEDICATION

To every Nigerian child who is suffering from malnutrition.

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LIST OF ACRONYMS

OLS	Ordinary Least Square
QR	Quantile Regression
BMI	Body Mass Index
NDHS	Nigeria Demographic and Health Survey
WHO	World Health Organization
CED	Chronic Energy Deficiency
SE	Standard Error
LRM	Linear Regression Model
QRM	Quantile Regression Model
MAC	Mid Arm Circumference
MAMC	Mid Arm Muscle Circumference
GLM	Generalized Linear Models
GAMLSS	Generalized Additive Models for Location, Scale and Shape
LMS	Lambda-Mu-Sigma
EA	Enumeration Area
LR	Logistic Regression

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ABSTRACT

Childhood is a time of active growth in terms of physical size, mental, emotional and psychological development. Normal growth is dependent on adequate nutrition and encompasses major transformations from birth to adulthood. Quantile regression does not restrict attention to the conditional mean and therefore it permits to approximate the whole conditional distribution of a response variable. This study aim to evaluate the performance of parametric Ordinary Least Square (OLS) and non-parametric regression (quantile function) method, also to use logistics regression to determine factors affecting nutritional status of under five children in Nigeria.

A representative sample of 24,505 under five children (0-59 months) within households in communities was obtained from the Nigeria Demographic and Health Survey (NDHS 2013). For the over-nutritional status (overweight and obese), the body mass index for-age z-scores was used as the outcome variable, also for the under-nutritional status; height-for-age, weight-for-height and weight-for-age was respectively used while the explanatory variables include child's age, wealth index, sex of child, size of child at birth, maternal age, mother's educational level, breastfeeding duration, working status of mother, mother's BMI, region, antenatal visits. The outcome variables (under nutrition) were further classified as dichotomous variable as stunted, wasted and underweight or not, using their cut-off. Ordinary Least Square regression was used to determine the average effect of factors of the nutritional status while QR was used to determine how a particular/corresponding percentile of the distribution was associated with covariates. Lastly, logistic regression was carried out to also determine factors affecting under nutrition status of under-five children.

Quantile regression was able to detect the amount of under estimation and over estimation by the Ordinary Least Square regression. The QR result showed that child's age (24 to 35 months), sex, size of the child at birth, maternal education and region significantly contributed to under-nutrition while child's age (between 24 to 47 months), breastfeeding duration, mother's BMI, maternal working status, size of the child at birth and wealth index contributed significantly to overweight. The logistic regression identified maternal age, child's age, wealth index (those in richer and richest categories), sex, size of child at birth, mother's education (at least secondary), working mothers, all the regions (except south west), mother's BMI (overweight and obese) as factors significantly related to under-nutrition.

The quantile regression can be used to model specific parts of the distribution of the nutritional indices and should be preferred to OLS regression if the original scale of the outcome variable was continuous with a non-normal distribution. Attention should be paid to some factors which have contributed to the mal-nutritional status (either over-nutrition or under-nutrition) of the under five children. The factors which include child's age, size of the child birth, antenatal clinic visits and region.

Key words: Under nutrition, Overweight, Quantile Regression, Linear Regression, Logistic Regression. Word Count: 461

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND

Nutrition is the intake of food, considered in relation to the body's dietary needs. Good nutrition, well balanced diet combined with regular physical activity- is a cornerstone of good health. Poor nutrition can lead to reduced immunity, increased susceptibility to disease, impaired physical and mental development, and reduced productivity.

Child under-nutrition is a major public health problem in Nigeria like in other Sub-Saharan African countries. Malnutrition is a direct or indirect cause of 54% of all childhood death. In addition to this mortality risk, there is early growth retardation with delayed motor development and impaired cognitive function and school performance. In Africa, almost two out of five children are stunted, an estimated total of 60million children. Nigeria alone accounts for 11 million of these children. Report from the Nigerian Demographic Health Survey (NDHS) 2008 indicated that 41% of children under five years are chronically malnourished (i.e. stunted), and 23% of children suffer from severe stunting. Fourteen percent of children under-five in Nigeria are wasted and 7% are severely wasted, an increase from 11% wasting and 4% severe wasting obtained in 2003 NDHS. The importance of care giving behaviors was recognized by UNICEF in its conceptual model of factors that determine children's risks of malnutrition, death and disability. More specifically, successful nutritional and feeding practices requires not only that foods of adequate energy and nutrient quality be available, but also a range of appropriate behaviors by the caregiver.

Nutritional status of children is measured by medical and social history, diet history and intake, clinical examination, anthropometrics and biochemical data. The three most frequently used indicators of the nutritional status of children are based on weight and height measurements; weight for age, height for age and weight for height. The interpretation and transformation of these indicators for determining the prevalence of weight deficiency, stunting, wasting and obesity, and thus for classifying populations according to their degree of risk of under and over-nutrition are described in detail in (WHO 1995).

Under-nutrition among children is a common problem in developing nations. It may turn out from a broad range of aspects like prenatal under-nutrition, deficiencies of macro and micronutrient, infection and possibly socioeconomic conditions (PCD, 2013). United nation for children's fund (Dangour, 2013) reported that more than 200 million school-age children were stunted by the year 2000. In the same report, it was pointed out that the proportion of stunted school children with impaired physical and mental development will grow up to 1 billion by the year 2020 unless a tangible action is undertaken. The economic cost of under-nutrition is highly substantial. According to the World Health Organization, under-weight is the largest risk factor contributing to the global burden of disease in the developing world. It leads to nearly 15 percent of the total disability-adjusted life years (DALY) losses in country with high children mortality (Ezzati, 2002).

World Health Organization (WHO) and United Nation Children's Fund (UNICEF) have advocated for increased commitment to appropriate feeding practices for all infants and young children in order to achieve optimal growth, development and health (UNICEF and WHO,2011). As global public health recommendations, international guidelines stress that infants should be exclusively breastfed for six months, then frequent and on demand breastfeeding should continue to 24 months and should be coupled with the gradual introduction of complementary feeding adapted to the child's requirements (WHO, 2015). This recommendation also applies to Africa. Infants and young children need special attention in order to attain their nutritional requirement as the period of complementary feeding is particularly vulnerable to nutritional deficiencies due to rapid growth (WHO MGRSG, 2006).

According to a UNICEF report, five infectious diseases (pneumonia, diarrhea, malaria, measles and AIDS) account for more than one-half of all deaths in children aged <5 years, most of whom are undernourished(UNICEF statistics, 2006). Moreover malnutrition increases the risk of mortality from diarrheal and acute lower respiratory infection in children <2 years of age (Yoon PW et al, 1997). About 53% of under-five mortality is attributed to malnutrition (Bryce et al, 2005). Inadequate nutrition during the first two years of life may lead to childhood morbidity and mortality, as well as inadequate brain development (WHO, 2000). Infants are at increased risk of malnutrition starting from six months, when breast milk alone is no longer sufficient to meet all the nutritional requirements of infants. Children living in most developing countries are introduced directly to the regular household diet made of cereal or starchy root crops which is a major cause for the high incidence of child malnutrition, morbidity and mortality (Dewey 2003, Nancy 2002, Brown et al, 1998).

Regression analysis enables one to investigate the various factors associated with the problem of malnutrition among children under five years of age.

Linear regression is an approach for modeling the relationship between a scalar dependent variable *y* and one or more explanatory (or independent variables) denoted *x*. The case of one explanatory variable is called simple linear regression, for more than one explanatory variable, the process is called multiple linear regressions. Linear regression was the first type of regression analysis to be studied rigorously, and to be used extensively in practical applications. This is because models which depend linearly on their unknown parameters are easier to fit than models which are non-linearly related to their parameters and because the statistical properties of the resulting estimators are easier to determine.

Linear regression models are often fitted using the least square approach, but they may also be fitted in other ways, such as by minimizing the "lack of fit" in some other norm(as with least absolute deviations regression), or by minimizing a penalized version of the least squares loss function as in ridge regression (L2-norm penalty) and lasso (L1-norm penalty). Conversely, the least squares approach can be used to fit models that are not linear models. Thus, although the terms "least squares" and "linear model" are closely linked, they are not synonymous. Linear regression requires the residuals to be normally distributed and homoscedastic (Ho et al., 2006; Adams, 2008) but the normality assumption may perhaps not hold especially when a dependent variable has a heavy-tailed distribution (Hao and Naiman, 2007). Failing to meet these modeling assumptions may result in biased estimates and misleading conclusions.

Quantiles are cutpoints dividing the range of probability distribution into contiguous intervals with equal probabilities, or dividing the observations in a sample in the same way. Quantile regression (QR) was introduced in 1978 by Koenker and Bassett (Hao and Naiman, 2007), models conditional quantiles as functions of predictors. The quantile regression model is an extension of the linear-regression model. It is one of the statistical analyses used in medicine and public health (Austin et al., 2005) which is capable of identifying more effects than the conventional OLS methods. It does not restrict attention to the conditional mean, permits estimation of the whole conditional distribution of a response variable, and approximates for the high incidence of child malnutrition, morbidity and mortality (Dewey 2003, Nancy 2002, Brown et al, 1998).

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Quantile regression is desired if conditional quantile functions are of interest. One advantage of quantile regression, relative to the ordinary least squares regression, is that the quantile regression estimates are more robust against outliers in the response measurements. However, the main attraction of quantile regression goes beyond that. Different measures of central tendency and statistical dispersion can be useful to obtain a more comprehensive analysis of the relationship between variables. The Quantile Regression Model (QRM) and Linear Regression Model (LRM) are similar in certain aspects, as both models deal with a continuous response variable that is linear in unknown parameters, but they model different quantities and rely on different assumptions about error terms.

The advantages of quantile regression over traditional approaches (OLS) are: flexibility in dealing with non-normally distributed errors, robustness against outliers, and ability to detect heterogeneity (Koenker 2005). Quantile regression has this capability to analyse the whole distribution whereas ordinary regression merely considers the central distribution (Cizek, 2011; Gannoun et al, 2003; Hao and Naiman, 2007). OLS alone could not help since the effect of skewness can be assessed only through the evaluation of different quantiles. By focusing on the mean as a measure of central location, information about the tails of the distribution is lost (Montenegro, 2001).

In quantile regression, a real valued random variable Y of the distribution function $F(y) = Pr(Y \leq y)$ can be defined as $Q(\tau) = \inf\{y: F(y) \geq \tau\}$. The median is a special quantile, one that describes the central location of a distribution. Conditional median regression is a special case of quantile regression in which the conditional 0.5th quantile is modeled as a function of covariates. Non central positions of the dependent variable can be described by other quantiles. The "quantile" concept takes a broad view of specific terms like quartile, quintile, decile, and percentile (Hao and Naiman, 2007). QR partitions the whole distribution into quantiles and estimates the conditional quantiles as functions of explanatory variables Equal-sized partitioning of a distribution are called quantiles. For example, quintile partitions the data into five equally-sized groups.

1.2 PROBLEM STATEMENT

The World Health Organization estimates that approximately 150 million children younger than 5 years in developing countries are underweight and an additional 200 million children are stunted. Recent data in Nigeria showed that 37 percent of children under age 5 are stunted, 18 percent are wasted, and 29 percent are underweight (WHO, 2013).

Malnutrition remains a major public health problem and it appears to be getting worse in selected settings. Poverty, ignorance and disease appear to be the heart of the problem of childhood malnutrition in Nigeria, and until there is significant improvement in the socio-economic status of the vast majority of Nigerians, malnutrition will continue to pose a serious threat to the growth and development of Nigerian children and to future national development.

Poor feeding practices have been identified in the developing world to arise from ignorance about adequate breastfeeding and appropriate weaning practices. All these are closely related to the socioeconomic status and sizes of families. These factors are most expectedly prominent in the rural, under-developed settings where finances and knowledge about food choices are alarmingly poor.

Studies by Islam M.Z et al (2003) and Kamal et al (2005) amongst many others on nutritional status have either used an Ordinary Least Squares (OLS) framework or have focused on specific groups.

The techniques of parameter estimation have led to several problems in the realm of regression analysis such as underestimation and overestimation of parameters and some are imprecise (Green et al, 1994). These differences in the distribution make the use of quantile regression more compelling than OLS, which has the shortcoming of assuming the same effects across the entire distribution.

Linear regression requires the residuals to be normally distributed and homoscedastic (Ho et al., 2006; Adams, 2008) but the normality assumption may not hold particularly when a dependent variable has a heavy-tailed distribution (Hao and Naiman, 2007). Failure to meet these modeling assumptions may result in biased estimates and confusing conclusions. To address these issues, quantile regression method (non-parametric method) can be used.

1.3 JUSTIFICATION

Malnutrition among children is a critical problem because its effects are long lasting and go beyond child-hood. It has both short- and long-term consequences. For instance, malnourished as compared to non-malnourished children are physically, emotionally and intellectually less productive and suffer more from chronic illnesses and disabilities. Malnutrition among children depends on complex interactions of various factors reflecting socio-demographic, environmental, reproductive, institutional, cultural, political and regional factors (Islam et al, 2013, Ahmed et al, 2009, Jesmin et al, 2011).

Results from the 2013 NDHS showed that under-five mortality declined by 31 percent from 185 deaths per 1,000 live births to 128 deaths per 1,000 live births (WHO, 2013). Infant and under-5 mortality rates in the past five years are 69 and 128 deaths per 1,000 live births, respectively. At these mortality levels, one in every 15 Nigerian children die before reaching age 1, and one in every eight do not survive to their fifth birthday. Infant mortality has declined by 26 percent over the last 15 years, while under-5 mortality has declined by 31 percent over the same period. There is need to improve more on this decline.

Many research works done, to mention a few, Sangeetha et al, 2010 used logistic regression, Reed et al, 2012 used linear regression, also Roland et al, 2009 used ANOVA to assess the bivariate association between the explanatory factors and nutritional status, multilevel analysis were undertaken to estimate the net effect of both household and community factors. Sangeetha et al, 2010 used logistic regression to identify factors associated with compromised nutrition, and also compared observed height for age and weight for age with an accepted international standard published by the United States National Centre for Health Statistics.

There is need to perform quantile regression at different quantiles in order to assess the differences that occur in the relationship between the dependent and explanatory variable. It gives a more comprehensive picture of the effect of the predictors on the response variable. It specifies changes in the quantiles of the response.

Amongst others, Sakiko (2014) found the determinants of child malnutrition in Tanzania using a quantile regression approach alone to study height-for-age z-scores (HAZ) and hemoglobin. Also, Oyedapo (2015), compared linear and quantile regression methods for determining factors associated with nutritional status of women of reproductive age in Nigeria using their BMI which had a markedly skewed distribution.

This study intends to evaluate over-nutrition using the BMI-for-age z-scores by examining the quantiles (75^{th} and 90^{th} percentiles) that approximates the reference cut-offs of +2 (corresponding to overweight) and +3 (corresponding to obesity) of the under-five children, also to examine the 10^{th} percentile of the height-for-age, weight-for-height and weight-for-age which approximates the reference cut-offs of under-nutrition

1.4 OBJECTIVES

1.4.1 Main Objective: To determine factors influencing the nutritional status of under five children in Nigeria using quantile regression approach.

1.4.2 Specific Objectives:

The specific objectives of this study are to:

- To determine the factors associated with overweight and obesity (excessive fat accumulation) and under-nutrition: stunting (inadequate length or height relative to age), wasting (inadequate weight relative to length or height) and underweight (inadequate weight relative to age) among under five children using quantile regression approach
- To compare the results from quantile regression with the more popular OLS approach
- To determine factors associated with stunting (height-for-age), wasting (weight-for-height) and underweight (weight-for-age) using logistic regression approach.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Anthropometric measurement

Anthropometry is the most common technique used to assess the presence and degree of protein-energy malnutrition. It is the measurement of body parameters to indicate nutritional status. It can be used to measure an individual to determine if he or she needs nutrition intervention or it can be used to measure many individuals to determine if malnutrition is a problem in a population. Some common anthropometric measurements include: height or length, weight, mid-upper arm circumference (MUAC), demi-span or arm span, knee height, sitting height, skin fold thickness, and head circumference. Height (or length) and weight are the most common anthropometric measures used to indicate protein-energy nutritional status in emergencies, which is used in this study.

Anthropometric measurement was used to determine if children were underweight (weight-for age), wasting (weight-for-height) and stunting (height-for-age) based on reference data from the National Center for Health Statistics (NCHS/World Health Organization) (Nguyen and Sin, 2008). Sangeetha and Nicholas (2007), in their study have also used height for age and weight for age because they have been associated with long-term and short-term nutritional nutritional stress respectively,

2.2 Morbidity and Mortality Due to Malnutrition

Malnutrition is an important public health problem and a threat to proper living which can be in two forms-under nutrition and over nutrition. Underweight, obesity and even overweight are considered as unhealthy and abnormal status which can be traced to several mortalities and morbidities (Flegal et al., 2007). A local Nigerian newspaper described obesity as "a new killer in town" which also joins the ranks of HIV/AIDS and malaria; this was reported by Ogundipe and Obinna, 2010.

Ezzati et al., 2002 evaluated diverse causes of mortality and morbidity which revealed that malnutrition is the single leading cause of ill health worldwide. The poor are exposed to greater risk of health problem which leads to a heightened risk of disease (WHO, 2013).

Nearly half of all deaths in children under 5 are attributable to under nutrition. This translates into the unnecessary loss of about 3 million young lives a year. Under nutrition puts children at greater risk of dying from common infections, increases the frequency and severity of such infections, and contributes to delayed recovery. In addition, the interaction between under nutrition and infection can create a potentially lethal cycle of worsening illness and deteriorating nutritional status. Poor nutrition in the first 1,000 days of a child's life can also lead to stunted growth, which is irreversible and associated with impaired cognitive ability and reduced school and work performance. (UNICEF, 2016)

Leading causes of death in under-5 children are preterm birth complications, pneumonia, birth asphyxia, diarrhoea and malaria. About 45% of all child deaths are linked to malnutrition. Children in sub-Saharan Africa are more than 14 times more likely to die before the age of 5 than children in developed regions. More than half of these early child deaths are due to conditions that could be prevented or treated with access to simple, affordable interventions. (WHO, 2016)

2.3 Factors Affecting the Nutritional Status of Under Five Children

2.3.1 Child's Age

Ibidapo et al, 2016 reported that child's age was associated with stunting. Studies done in both Nigeria and worldwide have documented similar findings. Studies by (Adekanbi, 2013) using 2008 NDHS data revealed that age above 11 months was associated with stunting. Ojofeitimi (2003) in Ife, Uthman (2008) using NDHS 2003 and Mustafa (2011) in Bangladesh. This result is plausible considering that many of the younger children are still being breastfed, and chronic malnutrition sets in only after weaning.

2.3.2 Wealth Index

Rathavuth (2006) investigated and concluded that economic inequality is strongly associated with chronic childhood undernutrition; and reducing economic inequalities and making services more accessible to the poor will be key to improving the health and nutritional status of children in Ghana. Children in poorer households are at a much greater risk of being chronically undernourished than children in better-off households.

2.3.3 Sex of child

Child's sex and birth weight, and access to care (fully immunized) all have statistically significant effects, but these effects are generally small (Rathavuth, 2006). Studies by Olwedo et al (2008) in Uganda, Emina et al (2009) in the Demographic Republic of Congo and Irena et al (2011) in Zambia have suggested that under-nutrition is more prevalent among boys than among girls. Chukwuma et al, 2015 reported in their study that higher proportion of under-weight, stunted and wasted among males when compared to females.

2.3.4 Size of child at birth

Low birth weight was found to be a risk factor, significant predictor, of child malnutrition in a study conducted by Hui et al, 2014. Low birth weight infants were more likely to develop into stunted children than children of normal birth weight and above normal birth weight (Baby 2 See, 2010). Birth weight (Aklima et al, 2011) was also reported to be positively associated with nutritional status.

2.3.5 Mother's age at birth

Gilbert (2015) reported that the association between age of the mother at the birth of a child and nutritional status (stunting) of the child was not statistically significant at 5% level of significance. On contrary to this, the study conducted in Dhankuta District of Nepal found maternal age more than 35 years at pregnancy, was a risk factor for stunting and underweight in children at 10% level of significance (Sapkota, 2009)

2.3.6 Mother's Education Level

Christiaensen and Alderman (2004) and Glewwe (1999) have investigated the mechanisms through which education results in better child nutrition and concluded that parental education, especially mother's education, is a key element in improving children's nutritional status. It was reported by Nguyen et al (2008) that the educational level of the mother was found to be one of the most important factors of malnutrition. Mother's education level is associated with more efficient management of limited household resources, greater utilization of available health care services, better health promoting behaviors, lower fertility and more child-centered caring practices, all of which are associated with better child health and nutrition (Felice 1999, Shah et al 2003)

2.3.7 Duration of breastfeeding

The World Health Organization (WHO) recommended that infants be exclusively breastfed for the first six months of life, after which complementary foods (any fluid or food other than breast milk) should be introduced (WHO, 2001). The risk of malnutrition increases with age, children in the youngest age group, 0-11 months, had a significantly lower risk of being underweight, stunting and wasting than children in the older age groups. Also the highest risk of stunting was among children aged 12-23 months (Nguyen and Kam 2008)

2.3.8 Working Status of Mother

Zemede (2005)reported that when economically inactive members in a household increases relative to the number of economically active members of a household, the limited available food resources will be depleted without satisfying the required nutrition. Maternal occupation emerged a significant factor that could be associated with under five stunting Gilbert (2015)

2.3.9 Mothers' BMI

Sakiko (2014) concluded that mother's height and BMI have strong significant effects on HAZ, which indicates that the nutritional status cresses from one generation to another. Women who are undernourished are more likely to give birth to low birth weight children, grow poorly, and remain malnourished throughout their childhood. In addition, the mother having small BMI could not be able to care for her children adequately (Smith et al, 2003). Also Oyedapo (2015) showed that women's BMI was significantly influenced by the level of education for both OLS and QR.

2.3.10 Region

The results of a study conducted in Malaysia reported that the prevalence of underweight and stunting were high among children in poor rural areas (Khor et al, 2003). Children in rural areas are more likely to be stunted than those in urban areas and the pattern is similar for severe stunting. The North West has the highest proportion of children who are stunted, followed by the

North East and North Central. At the state level, Kebbi has the highest proportion of stunted children while Enugu has the lowest proportion (WHO report, 2013)

2.3.11 Antenatal Visits

Mothers of underweight and stunted children did not have more antenatal visit and also mothers of wasted children did not visit health institutions when they had been caught by diseases than their counterpart. Households having wasted and underweight children reside far from health institutions than those households who have normal children (Rabia et al, 2013)

2.4 Issues on Nutritional Status of under five children in Sub-Sahara Africa

Mother's educational status wasn't found significant to predict under nutrition (Dilaram et al, 2013), but some of the studies carried out in North America and Africa found significant association between them (Antonieta et al, 2002). Similarly the study conducted in under five years children to assess the nutritional status of Oranfe, a semi-rural community in Ife East Local Government Area of Osun State, found that mother's educational status level, age, types of family and children's immunization status of U5 children (Ojofeitimi et al, 2003)

Ozor et al (2014) reported that males were more under-weight and wasted than female, which also agrees with the study by Dutta et al. (2009) but contradicts a meta-analysis of 16 demographic and health survey carried out in Sub-Sahara Africa by Wamani et al (2007)

2.5 Robustness in Linear and Quantile Regression Analysis

Robustness refers to insensitivity to outliers and the violation of model assumptions concerning the dependent variable. The Linear Regression Model (LRM) estimates can be sensitive to outliers while Quantile Regression Model (QRM) estimates are not sensitive to outliers (Lingxin, 2007). Robustness is studying phenomena of highly skewed distributions e.g. health outcomes like obesity.

2.6 Empirical Application of Quantile Regression

Quantile regression has been applied to a broad range of studies. Quantile regression also spread to medicine and public health (Austin et al., 2005). Alexander et al., 2011 demonstrated that studying the coefficients and their uncertainty for different percentiles generates new insights, especially for non-normally distributed data. A small number of recent applications to explaining variations in BMI (Beyerlein et al., 2008; Terry et al., 2007; Sturm et al., 2005) have demonstrated the value added by QR methods in this setting. Abreveya, 2002 in his study "Demographics impact on infant birth weight" showed that the quantile regression estimates signify that several factors have higher impact at lower quantiles while lower impact at higher quantiles.

The vast majority of applications of quantile regression in the field of health have focused on geographically defined contexts such as countries (Shankar, 2010), states, and neighborhood (Hill et al. 2014; Hoss and Fischbeck, 2014, Ramokolo et al., 2015).

Empirical researchers took advantage of quantile regression's ability to examine the impact of predictor variables on the response distribution. Two of the earliest empirical papers by economists (Hao and Naiman, 2007) provided practical examples of how to apply quantile regression to the study of wages. Quantile regression allowed them to examine the entire conditional distribution of wages and determine if the returns to schooling, and experience and the effects of union membership differed across wage quantiles. The use of quantile regression to analyze wages increased and expanded to address additional topics such as changes in wage distribution (Machado and Mata, 2005; Melly, 2005), wage distributions within specific industries (Budd and McCall, 2001), and educational attainment and wage inequality (Lemieux, 2006).

The use of quantile regression also expanded to address the quality of schooling (Bedi and Edwards, 2002; Eide et al. 2002) which showed a strong positive effect on the labor earnings distribution with the strongest impact occurring at the lower quartile. Quantile regression also spread to other fields, notably sociology, ecology and environmental sciences. Vundi et al. 2015, also used quantile regression to examine the effects of growth velocity and breastfeeding on over-weight and obesity of infants and children.

2.7 Comparison of Linear and Quantile Regression Methods of Estimation

Ouyang et al, 2015 used the lambda-mu-sigma (LMS) method to describe the changes in the BMI distribution of adults. He also investigated the changes in the BMI distribution over time using a separate sex stratified longitudinal quantile regression analysis.

Asirvatham, 2009 studied the differences between eating habits and BMI. He compared the quantile regression results to the OLS results. He demonstrated that to fully understand the behavior of the relationships across the conditional distribution of the dependent variables: energy intake, Healthy Eating Index, and BMI, quantile regression will be more appropriate.

Beyerlein et al., 2008 in their research work used different approaches to predict childhood BMI which were Generalized Linear Models (GLM), Quantile Regression (QR), and Generalized Additive Models for Location, Scale and Shape (GAMLSS). He compared GLM, GAMLSS and QR models among BMI data to identify the best method for the risk factors of obesity.

2.8 Determinant of Nutritional Status of Under Five Children

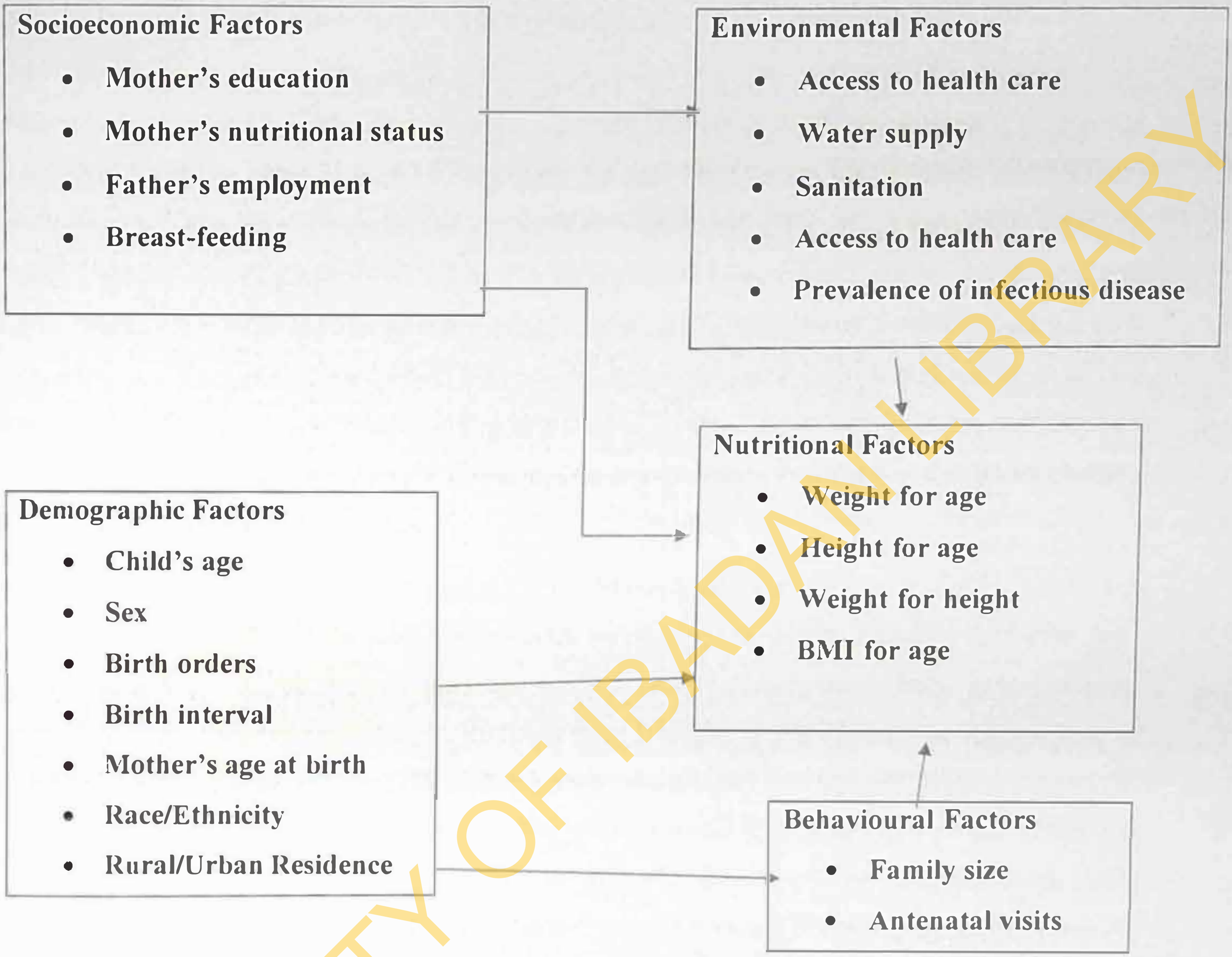

Figure 2.1: Conceptual Framework for Determinants of Nutritional Status of under five children

Rathavuth, 2006 and Gilbert 2015 in their studies examined the determinants of nutritional status of under five children. The customized conceptual framework builds on existing knowledge to analyze the socio-economic and demographic factors associated to nutritional status among under five children in Nigeria. Environmental factors and father's employment, birth order and birth interval were not used in this study.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study Area

Nigeria is one of the Sub-Saharan African countries located in the West African region which came into existence as a nation in 1914 through the amalgamation of the Northern and Southern protectorates. The British established a crown settlement type of government after the amalgamation. The dealings of the colonial administration were carried out by the British until 1942, when a few Nigerians became involved. In the early 1950s, Nigeria achieved partial self-government with a parliament in which the majority of the members were elected into an executive council of which most were Nigerians. Nigerians became fully independent in October 1960 as an alliance of three regions (Northern, Western, and Eastern) under a constitution that provided for a parliamentary system of governance.

Nigeria is in the West African sub region, lying between latitudes 4°16′ and 13°53′ north and longitudes 2°40′ and 14°41′ east. It is surrounded by Niger in the North, Chad in the North east, Cameroon in the East, and Benin in the west. To the South, Nigeria is bordered by approximately 850 kilometres of the Atlantic Ocean, stretching from Badagry in the West to the Rio del Rey in the East. It covers a total area of 923,768 kilometer square and it is the 14th largest country in Africa and the world's 32nd largest country. Nigeria comprises of 36 states and a Federal Capital Territory(FCT), these states are grouped into six geopolitical zones; North Central, North East, North West, South East, South-South And South West. There are 774 local government areas in the country. According to the 2006 National Census estimate, the population of the country was 140,431,790 with an annual growth rate of 3.2 percent. Nigeria is the most populous country in Africa; it has an estimate of 374 ethnic groups. The major ethnic groups are Hausa/Fulani, Yoruba and Igbo which account for 68 percent, Edo, Ijaw, Ibibio, Kanuri, Ebira, Nupe And Tiv make up 27%, other minority ethnic groups make up 5%.

3.2 Study Design

Data was obtained from the Nigeria Demographic and Health Survey (NDHS 2013) and was used to answer the study objectives. The survey made use of a cross-sectional population based study design. This study explores the factors affecting nutritional status of under five children.

3.2.1 Sampling Frame and Technique

NDHS 2013 is a nationally representative sample. The 36 states in Nigeria and the Federal Capital Territory were divided into Local Government Areas (LGA) and each LGA was further divided into smaller localities. The 36 states were regrouped by geopolitical locality into six zones and using the 2006 population census implementation, each locality was subdivided into Enumeration Areas (EAs). A complete list of the EAs served as the sample frame for the survey. The sampling technique for the 2013 NDHS was a stratified sample, selected at random in three stages from the sampling frame. The first stage; each state was stratified into urban and rural areas; this resulted in a list of localities. Second stage; one enumeration area was selected at random from a selected locality with equal probability of selection, the resulting list of households served as sampling frame for the selection of households in the third stage. The third stage; fixed number of 45 households were selected in every urban and rural cluster through probability systematic sampling using the household listing.

3.3 Study Population

The study made use of National Demography Health Survey 2013 dataset. The study population (children under five in Nigeria) was obtained as subsamples from the samples of children interviewed in the survey of the year 2013. Measurements of height and weight were obtained for children born in the five years preceding the survey (i.e born in January 2008 or later) in all of the selected households. Children under age 2 were measured lying down on the board (recumbent length), and standing height was measured for all other children.

3.4 Inclusion Criteria

Children under five years of age.

3.5 Exclusion Criteria

1. Excludes children whose mothers were not interviewed
2. Children whose mothers were not weighed and measured.
3. Children whose mothers were pregnant or gave birth within the preceding 2 months.

3.6 Sample size

A representative sample of 40,320 households was selected for the NDHS 2013 survey. A total number of 31,482 children under age five were sampled and eligible for anthropometric measurement. The analysis focused on 24,505 children that have complete information (Date of birth, weight, height), 4672 were flagged because they were dead and 2305 were not weighed at all.

3.7 Study variables

The following variables were used in the study;

3.7.1 Dependent Variable

The Body Mass Index (BMI) is a person's weight in kilograms divided by the square of height in meters. For children and teens, BMI is age and sex specific, calculated by using BMI calculator for children which requires the birth date, date of measurement, sex, height and weight, it is often referred to as BMI-for-age. The nutritional status was assessed by anthropometric data on height and weight collected in the 2013 NDHS. The data allowed the calculation of the nutritional indices of under five children. Height-for-age (stunting): reflects chronic malnutrition, it is inadequate length or height relative to age. Stunting is moderate if the z-score is $-3 \leq z < -2$, and severe if the z-score is <-3. Weight-for-height (wasting): reflects acute malnutrition, it is inadequate weight relative to length or height. It is moderate if the z-score is $-3 \leq z < -2$ and severe if the z-score <-3. Weight-for-age (underweight): reflects both chronic malnutrition and acute malnutrition, it is inadequate weight relative to age. It is moderate if the z-scores is $-3 \leq z < -2$ and severe when the z-score <-3. Weight-for-height (BMI-for-age): is an excessive fat accumulation that presents a risk to health. It is an overweight if the z-score is $>+2$ and $\leq+3$, and obese if $>+3$.

The BMI-for-age z-score was specified as the dependent variable for the over-weight and obese while height-for-age, weight-for-age and weight-for-height was used for the under-nutrition in the OLS and QR. Stunting, underweight and wasting were respectively specified as the dependent variable in the multiple logistic regression.

3.7.2 Independent Variables

The choice of explanatory variables was based on findings of "An investigation on factors associated with malnutrition among under five children in Nakaseke and Nakasongola districts" (Gilbert 2015), and on those of "Nutritional status and the characteristics related to malnutrition in children under five years of age in Nghean, Vietnam" (Nguyen et al, 2008). It consists of Sex of the child, Age of child, Age of mother at birth (years), Mother's educational level, Region, Mother's BMI, Weight at birth, Duration of breastfeeding. The explanatory variables that are categorical were dummy coded to explain differences across variables given in Table 3.1 below.

Table 3.1: Variables Definition

Variables	Subcategories	Definitions/Dummy Code
Maternal Age	<20 yrs	if <20 years,=0
	20-35yrs	if 20-35 years,=1
	36 and above	if 36 and above,=2
Mother's educational status	None	if no education,=0
	Primary	if primary,=1
	Secondary and higher	if secondary and higher,=3
Size of child at birth	Large	if 'very large' and 'larger than average',=1
	Average	if average,=2
	Small	if 'smaller than average' and 'very small',=3
Antenatal Visits	Yes	if 1-30 weeks,=Yes
	No	if 'don't know' or 'no visits',=No
Sex of child	Male	if Male,=1
	Female	if Female,=2
Mother's BMI	Underweight	if <18.5kg/m2
	Normal	if => 18.5-24.9kg/m2
	Overweight	if => 25-29.9kg/m2
	Obese	if=>30kg/m2

Table 3.1 Variable Definition
(ctd)

Variables	SubCategories	Definition/Dummy Codes
Region	North Central	if North Central,=1
	North East	if North East,=2
	North West	if North West,=3
	South East	if South East,=4
	South South	if South South,=5
	South West	if South West,=6
Wealth Index	Poorest	if Poorest,=1
	Poorer	if Poorer,=2
	Middle	if Middle,=3
	Richer	if Richer,=4
	Richest	if Richest,=5
Working status of mother	No	if not working,=0
	Yes	if working,=1
Breastfeeding Duration	Ever breastfed,not currently breastfeeding	if ever breastfed,not currently breastfeeding,=0
	Never breastfed	if never breastfed,=1
	Still breastfeeding	if still breastfeeding,=2
Child's Age	0-11 months	if 0-11 months,=0
	12-23 months	if 12-23 months,=1
	24-35 months	if 24-35 months, =2
	36-47 months	if 36-47 months,=3
	48-59 months	if 48-59 months,=4

Table 3.1 Variable Definition (ctd)

Variables	SubCategories	Definition/Dummy Codes
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	Richer	if Richer,=4
	Richest	if Richest,=5
Working status of mother	No	if not working,=0
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	24-35 months	if 24-35 months, =2
	36-47 months	if 36-47 months.=3
	48-59 months	if 48-59 months.=4

3.8 Data Management

SPSS version 20 was used for extraction of relevant variables from the NDHS 2013 dataset and was also used for data cleaning, 4672 children that was flagged and 2305 children who were not weighed was excluded from the analysis.

3.8.1 Statistical Analysis

Quantiles are cutpoints dividing the range of a probability distribution into contiguous intervals with equal probabilities, or dividing the observations in a sample in the same way. Quintiles are any of the quantiles which divide an ordered sample population into five equally numerous subsets.

Descriptive statistics were carried out where the variables in classes were presented as frequencies (percentages) and continuous data were presented as mean (standard deviation) for normally distributed data while median and range were presented for skewed data.

The selected percentiles for this study evaluates over-nutrition using the BMI-for-age z-scores by examining the quantiles (75^{th} and 90^{th} percentiles) that approximates the reference cut-offs of +2 (corresponding to overweight) and +3 (corresponding to obesity) of the under-five children, also to examine the 10^{th} percentile of the height-for-age, weight-for-height and weight-for-age respectively which approximates the reference cut-offs of under-nutrition. A logistic regression was also carried out on stunting, wasting and underweight respectively with the explanatory variables in order to know which of these variables was associated with under nutrition.

STATA version 12 was used for fitting the two regression models (quantile regression and multiple linear regression), the graphs were plotted using R console. Adjusted R-square was employed to assess the goodness of fit in linear regression while pseudo R^2 was used to assess quantile regression. Two hundred bootstrap replications were performed in the quantile equations to compute the standard errors of the estimates and also to obtain unbiased estimates (Asirvatham, 2009). The 95% confidence intervals were derived from standard errors generated from 200 bootstrap replications.

3.9 Statistical Models, Assumptions and Specifications

The statistical models used in the study include the following:

3.9.1 Linear Regression

A linear regression is a statistical method used for analyzing dataset with one or more independent variable(s) determining an outcome. The outcome variable is continuous. Ordinary Least Square is the typical method for regular linear regression.

The linear regression function which is:

$$Y = \beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\ldots\ldots + \beta_pX_p+ \varepsilon_i \qquad \varepsilon_i \sim N(0,\sigma^2)$$

where Y is the value of the response variable,

β_0 is the intercept of the model that is, the effect of Body Mass Index when all the explanatory variables are zero,

β_p is the slope of the model that is the effect of each explanatory variable on the Body Mass Index.

X_s are the explanatory variables in which the variables in classes once were dummy coded as "1" to be presence of the class of variable and "0" as absence of that class.

ε_i is a random error term that is assumed to normally independent and identically distributed with mean $(E(\varepsilon_i))=0$ and variance σ^2.

The least squares method is a common method in linear regression and it is used to find a function that best fits a given set of data (Barnes, 2001). The strength of the least square method is that it minimizes the sum of the n squared errors (SSE) of the predicted values on the fitted line ($\hat{y}_i$) and the observed value(y).

$$\sum_i^n (y_i - \hat{y}_i)^2$$

3.9.2 Assumptions:

a. Relationship between independent and dependent variable is linear.

b. $E(\varepsilon_i)=0$.

c. Errors are normally distributed i.e. $\varepsilon_i \sim N(0,\sigma^2)$.

d. Error terms:
   $Var(\varepsilon)= \sigma^2$, or homoskedastic errors. $E(r_{\varepsilon_i,\varepsilon_j}) = 0$, or no autocorrelation.

3.9.3 Quantile Regression

Quantile regression is a statistical technique that provides a more detailed analysis of the relationship between the dependent variable and its independent variables because it provides conditional regression coefficients for each quantile. QR is also necessary because it identifies the lower and upper extremes of the BMI for-age z-score distribution. Its methodology is also necessary because it helps in understanding the relationship between variables outside of the mean of the data.

For a random response variable Y with probability distribution function:

$$F(y) = \text{Prob}\ (Y \leq y),$$

The τ^{th} quantile of Y is defined as the inverse function:

$$Q(\tau) = \inf \{y : F(y) \geq \tau\} \text{ where } 0 < \tau < 1.$$

Let $X = (x_1, \ldots, x_n)$ denote the matrix consisting of n observed vectors of the random vector X, and $Y = (y_1, \ldots, y_n)$ denote the n observed responses.

The model for linear quantile regression in this study is given by:

$$Y_i = \alpha_\tau + \beta_{i\tau} X_i + \varepsilon_i$$

where $\beta_\tau = (\beta_{1\tau}, \ldots, \beta_{p\tau})$ is the unknown p-dimensional vector of parameters and

$\varepsilon = (\varepsilon_1, \ldots, \varepsilon_n)$ is the n dimensional vector of unknown errors

(Assumption: the τ^{th} quantile of ε_i is zero).

The β_τ is a solution of:

$$\min_{\beta\tau \in R^P}\left[\sum_{i \in \{i: yi \leq \alpha\tau + xi\beta\tau\}} \tau |yi - \alpha\tau - xi\beta\tau| + \sum_{i \in \{i: yi \leq \alpha\tau + xi\beta\tau\}} (1-\tau)\, |yi - \alpha\tau - xi\beta\tau|\right]$$

3.9.4 Logistic Regression

Logistic regression is an analysis used to describe data and explain the relationship between one dependent binary variable and one or more independent variable. It is the appropriate regression analysis to conduct when the dependent variable is dichotomous (binary), like all regression analysis, the logistic regression is a predictive analysis. The goal of logistic regression is to find the best fitting (yet biologically reasonable) model to describe the relationship between the dichotomous characteristic of interest (dependent variable=response or outcome variable) and a set of independent (predictor or explanatory) variables. Logistic regression generates the coefficients (and its standard errors and significance levels) of a formular to predict a logit transformation of the probability of presence of the characteristic of interest.

$$\text{Logit}(p) = b_0+b_1X_1+b_2X_2+b_3X_3+\ldots+b_kX_k$$

Where p is the probability of presence of the characteristic of interest. The logit transformation is defined as the logged odds:

Odds= p/(1-p) = (probability of presence of characteristic)/(probability of absence of characteristics) and logit (p) = ln {p/(1-p)}

The major assumption are:

- The outcome must be discrete (dichotomous in nature)
- There should be no high intercorrelations (multicollinearity) among the predictors.
- The error terms need to be independent
- It assumes linearity of independent variables and log odds
- It requires quite large sample sizes

In this study, children whose height-for-age z-score was <-2 were categorized as stunted (i.e 1) while others were not stunted (i.e 0). Children whose weight-for-age z-score was <-2 were categorized as underweight (i.e 1) while others were not underweight (i.e 0). Also, those children whose weight-for-height z-score was <-2 was wasted (i.e 1) while others were not wasted (i.e 0).

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3.10 Assessing the Goodness of Fit for Linear and Quantile Regression

R^2 also known as the coefficient of variation is a quantitative measure of how well the independent variables account for the dependent variable(s). The R^2 indicates how much a dependent variable can be accounted for by having knowledge of the independent variables instead of assuming that each one had the mean value on the dependent variable.

After fitting the linear model to the data set, an assessment was made for the adequacy of fit. The assessment of goodness of fit for the QR model exploited the general idea leading to the typical R^2 goodness of fit index in classical regression analysis (Koenker, 2005). In linear regression models, the goodness of fit was measured by the adjusted R-squared (the coefficient of determination) method:

$$R^2 = \frac{\sum_i (Y_i - \bar{y})^2}{\sum_i (Y_i - \bar{y})^2}$$

Pseudo R^2 measures the relative success of the corresponding quantile regression models at a specific quantile in terms of an appropriately weighted sum of absolute residuals. The obtained pseudo R^2 was considered as an index comparing the residual absolute sum of weighted differences using the selected model with the residual absolute sum of weighted differences using a model with only the intercept. The obtained pseudo R^2 ranges between 0 and 1.

It is worth noting that the index cannot be considered a measure of the goodness of fit of the whole model because it is related to a given quantile. In practice, for each considered quantile, the corresponding pseudo R^2 was evaluated at a local level, thereby indicating whether the presence of the covariates influences the considered quantile. The pseudoR^2 was be used to assess the model with the best goodness of fit between nested models.

3.11 Bootstrap Method for Regression Models

Bootstrapping is a nonparametric approach to statistical inference that substitutes computation for more traditional assumptions and asymptotic results. Bootstrap is the most suitable resampling method in QR analysis (Davino et al. 2014, He and Hu 2002, Kocherginsky 2003, Kocherginsky et al., 2005).

Bootstrapping offers precise inferences when the data are not well behaved. Also, it is also applied to data with sampling distributions difficult to derive. Furthermore, it is useful for complex stratified and clustered samples.

The bootstrap approach can be used to estimate standard errors without requiring any assumption of the error distribution. Finally, the capabilities of bootstrap methods are also explored to estimate standard errors in QR.

CHAPTER FOUR

4.0 RESULTS

This study involved analysis of the 2013 NDHS dataset children aged 0-59 months. The total number of children used for this study was 24,505, however sample weights were applied.

4.1 SOCIO DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

4.1.1 Continuous variables

Characteristics of the sample were depicted in Table 4.1. The child's mean age was 28.48 months (17.27) with median 28 months (IQR=30). The mean BMI for the mothers was 23.15kg/m² (4.29) while the median was 22.37kg/m² (IQR=4.83).

Table 4.1: Descriptive statistics of continuous variable

Variables	N	Mean	Standard Deviation	Median	Interquartile Range
BMI for age	24505	-0.47	1.59	-0.37	1.93
Child's Age(months)	24505	28.48	17.27	28.00	30.00
Maternal's BMI	24505	23.15	4.29	22.37	4.83
Stunting	24505	-1.34	2.00	-1.34	2.54
Underweight	24505	-1.20	1.39	-1.16	1.81
Wasting	24505	-0.60	1.54	-0.51	1.85

According to WHO report 2013 (page 176), a mean z-score of less than zero suggests that the distribution of an index has shifted downward and that most if not all children in the population suffer from under nutrition relative to the reference population.

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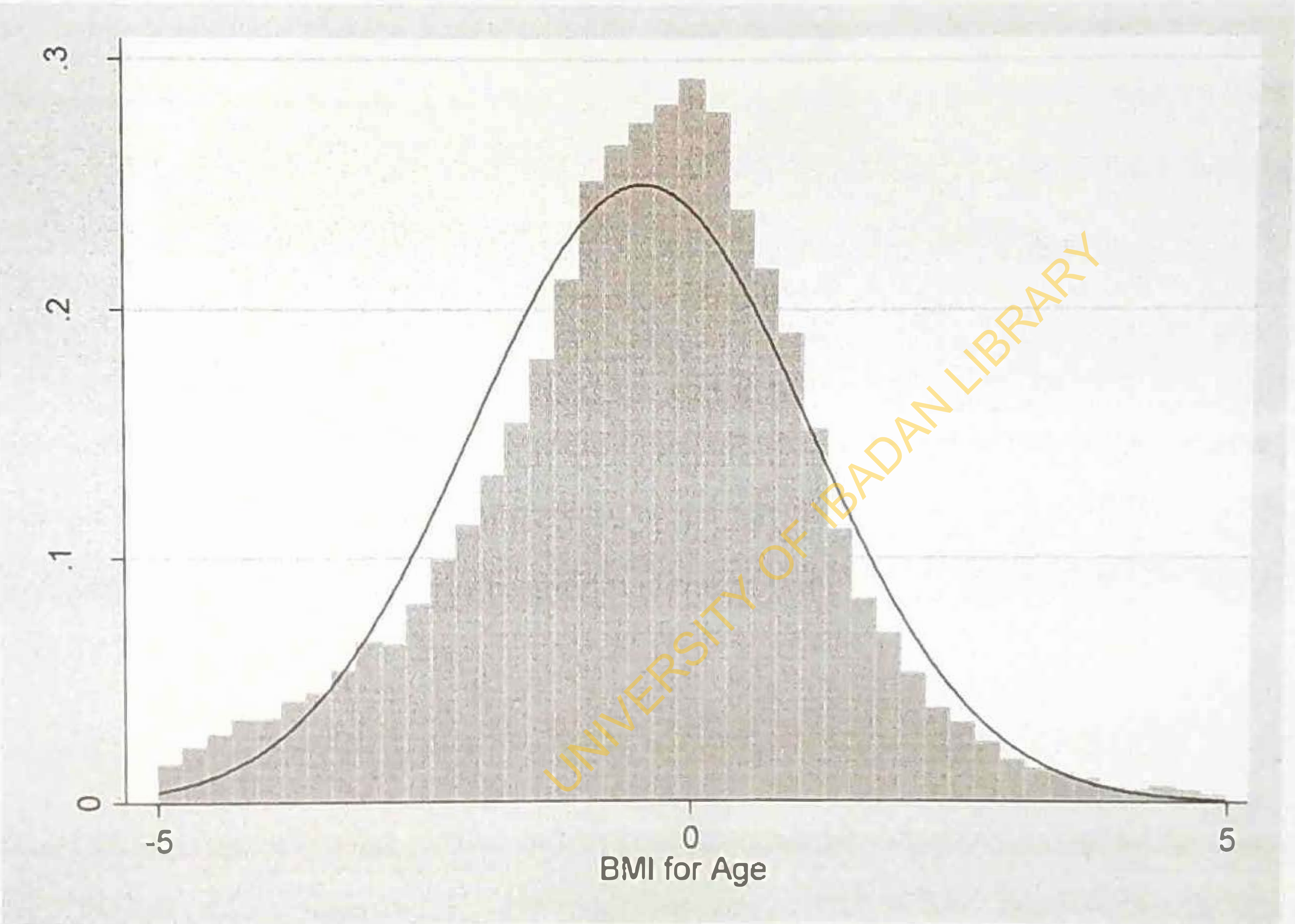
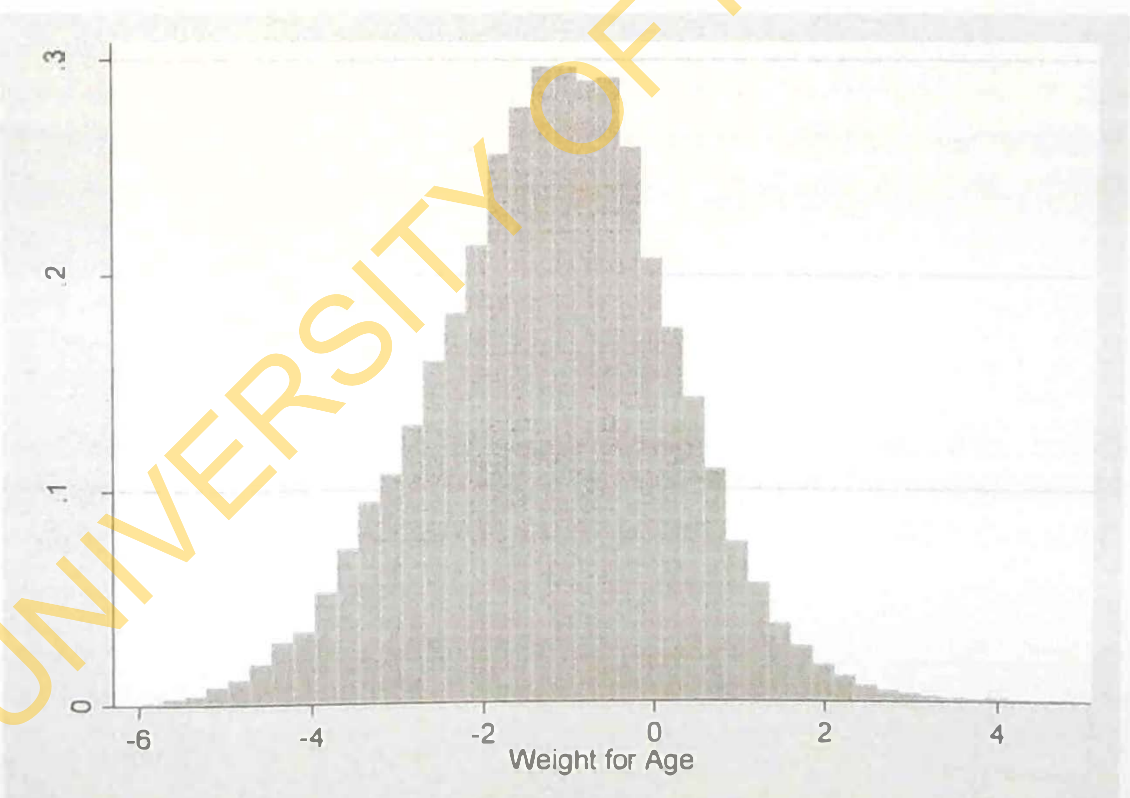
According to WHO report 2013 (page 176), a mean z-score of less than zero suggests that the distribution of an index has shifted downward and that most if not all children in the population suffer from under nutrition relative to the reference population.

4.1.2 Distribution of z-scores of the nutritional measures

Fig, 4.1 showed the distribution of z-scores of the nutritional measures, the z-scores indicates how far and in what direction (positive vs. negative) a measured value deviates from the population mean, expressed in units of the population standard deviation. These z-scores were obtained using the statistical software developed by the WHO and US Centers for Disease Control and Prevention.




0
.05
.1
.15
.2
-5
0
5
Height- for- Age


0
.1
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.3
-6
-4
-2
0
2
4
Weight for Age

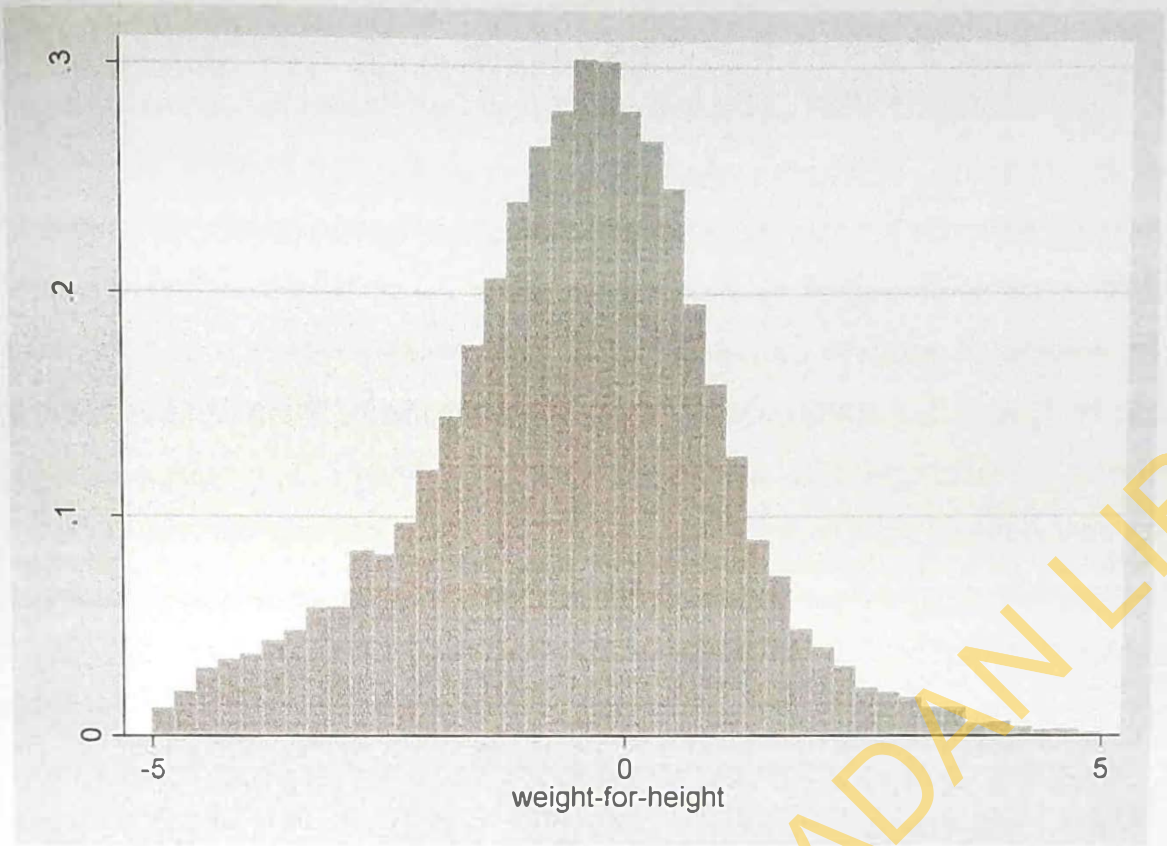

Figure 4.1: Body Mass Index for Age Z-Scores, Height-for-age z-score, Weight-for-age z-score, And Weight-for-height z-score Distribution of Children under five

Shappiro Wilk's test was used to further test for normality of the BMI-for-age z-scores, height-for-age z-scores, weight-for-age z-scores and weight-for-height z-scores, despite that it's the standardized value, but the result showed with p-value (<0.001) that they were not coming from a normal distribution.

4.1.3 Categorical Variables

The distributions for variables in classes are presented in Table 4.2. Mothers aged 20-35 years were 74.7%. Mothers with at least primary education were 56.7%. Children with large size at birth had a proportion of 44.8%. Mothers who went for antenatal visits during pregnancy were 31.8%. The proportion of the sex of the children were approximately average. North West geopolitical zone had the highest proportion of children 29.1%. The distribution of children in terms of wealth quintile revealed that the lowest wealth quintile had the highest percentage of children i.e poorest (20.9%) while the highest wealth quintile had the lowest proportion i.e richest 17.1%. Mothers who were working had proportion of 70%. Mothers who had ever breastfed but not currently breastfeeding were 64.3%.

Table 4.2: Frequency Distribution of categorical variables

Variables	Frequency	%
Maternal Age Group		
<20 years	2702	11
20-35 years	18311	74.7
36 and above	3492	14.3
Mother's educational status		
None	10851	44.3
Primary	5181	21.1
Secondary and higher	8473	34.6
Size of child at birth		
Large	10808	44.8
Average	9992	41.4
Small	3354	13.9
Antenatal Visits		
Yes	5017	31.8
No	10771	68.2
Sex of child		
Male	12259	50
Female	12246	50

Table 4.2: Frequency Distribution of categorical variables(ctd)

Region		
North Central	3819	15.6
North East	4900	20
North West	7141	29.1
South East	2287	9.33
South South	3042	12.41
South West	3316	13.53
Wealth Index		
Poorest	5117	20.9
Poorer	5482	22.4
Middle	4968	20.3
Richer	4754	19.4
Richest	4184	17.1
Working status of mother		
No	7253	29.7
Yes	17146	70.3
Breastfeeding Duration		
Ever breastfed, not currently breastfeeding	15524	64.3
Never breastfed	267	1.1
Still breastfeeding	8372	34.7

4.1.4 Distribution of Over-weight Children by Socio Demographic Variables

Table 4.3 showed the distribution of children who were over-weight and obese. Among the children who were overweight and obese, children whose mothers were 20-35 years had proportion of 73.5%. Of these children, only 18.3% of their mothers had primary education, 24.2% had at least secondary education while majority had no education. About 51% of these children were considered to be large sized at birth.

Of these children who were overweight and obese, 57.3% of their mothers attended antenatal clinic. Male children were 51.4% while female were 48.6%. Children from the North West were 43.7% and those from poorer category of the wealth index were 27.4%, closely followed by those in the poorest category with 26.9%.

Overweight and obese children whose mothers were working had a proportion of 60.8%. Those who had ever breastfed but not currently breastfeeding were 69.8%. Children aged 24-35 months had the highest percentage of 25.7% followed by children aged 36-47 months old with 21.9%. Of the children who were overweight and obese, those whose mothers had normal Body Mass Index had 64.6%.

Table 4.3: Summary Statistics of Over-weight Children by Socio Demographic Variables

Variables	Frequency (%)
Maternal Age	
<20 years	164(13.4)
20-35 years	898(73.5)
36 and above	159(13.1)
Mother's educational status	
None	702(57.5)
Primary	223(18.3)
Secondary and higher	296(24.2)
Size of child at birth	
Large	610(50.9)
Average	411(34.3)
Small	178(14.8)
Antenatal Visits	
Yes	451(57.3)
No	336(42.7)
Sex of child	
Male	627(51.4)
Female	594(48.6)
Region	
North Central	177(14.5)
North East	242(19.8)
North West	534(43.7)
South East	54(4.4)
South South	130(10.6)
South West	84(6.9)
Wealth Index	
Poorest	328(26.9)
Poorer	334(27.4)
Middle	241(19.7)
Richer	177(14.5)
Richest	141(11.5)

Table 4.3: Summary Statistics of Over-weight Children by Socio Demographic Variables

Variables	Frequency (%)
Maternal Age	
<20 years	164(13.4)
20-35 years	898(73.5)
36 and above	159(13.1)
Mother's educational status	
None	702(57.5)
Primary	223(18.3)
Secondary and higher	296(24.2)
Size of child at birth	
Large	610(50.9)
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Sex of child	
Male	627(51.4)
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Region	
North Central	177(14.5)
North East	242(19.8)
North West	534(43.7)
South East	54(4.4)
South South	130(10.6)
South West	84(6.9)
Wealth Index	
Poorest	328(26.9)
Poorer	334(27.4)
Middle	241(19.7)
Richer	177(14.5)
Richest	141(11.5)

Table 4.3 Summary Statistics of Over-weight Children by Socio Demographic Variables

Working status of mother	
No	476(39.2)
Yes	738(60.8)
Breastfeeding Duration	
Ever breastfed, not currently breastfeeding	832(69.8)
Never breastfed	8(0.7)
Still breastfeeding	352(29.5)
Child's Age (months)	
0-11	199(16.3)
12-23	242(19.8)
24-35	314(25.7)
36-47	267(21.9)
48-59	199(16.3)
Maternal BMI	
Underweight	82(6.8)
Normal	784(64.6)
Overweight	251(20.7)
Obese	97(8.0)

Table 4.3 Summary Statistics of Over-weight Children by Socio Demographic Variables

Working status of mother	
No	476(39.2)
Yes	738(60.8)
Breastfeeding Duration	
Ever breastfed, not currently breastfeeding	832(69.8)
Never breastfed	8(0.7)
Still breastfeeding	352(29.5)
Child's Age (months)	
0-11	199(16.3)
12-23	242(19.8)
24-35	314(25.7)
36-47	267(21.9)
48-59	199(16.3)
Maternal BMI	
Underweight	82(6.8)
Normal	784(64.6)
Overweight	251(20.7)
Obese	97(8.0)

4.1.5 Distribution of Stunted Children by Socio Demographic Variables

Table 4.4 showed the distribution of children who were stunted. Among the children who were stunted, children whose mothers were 20-35 years had proportion of 71.3%. Of these children, only 19.5% of their mothers had primary education, 19.1% had at least secondary education while majority had no education. About 42.2% of these children were considered to be averagely sized at birth and 41% were large sized at birth.

Of these children who were stunted, 44.1% of their mothers attended antenatal clinic. Male children were 52.5% while female were 47.5%. Children from the North West were 44.6% and those from poorest category of the wealth index were 31.3%, closely followed by those in the poorer category with 28.1%.

Stunted children whose mothers were working had a proportion of 66.5%. Those who had ever breastfed but not currently breastfeeding were 70.3%. Children aged 36-47 months had the highest percentage of 23.5% followed by children aged 24-35 months old with 23.3%. Of the children who were stunted, those whose mothers had normal Body Mass Index had 70.9%.

Table 4.4: Summary Statistics of Stunted Children by Socio Demographic Variables

Variables	Frequency (%)
Maternal Age	
<20 years	1272(14.4)
20-35 years	6305(71.3)
36 and above	1265(14.3)
Mother's educational status	
None	5432(61.4)
Primary	1725(19.5)
Secondary and higher	1685(19.1)
Size of child at birth	
Large	3566(41.0)
Average	3667(42.2)
Small	1464(16.8)
Antenatal Visits	
Yes	2388(44.1)
No	3033(55.9)
Sex of child	
Male	4641(52.5)
Female	4201(47.5)
Region	
North Central	1097(12.4)
North East	2146(24.3)
North West	3944(44.6)
South East	334(3.8)
South South	612(6.9)
South West	709(8.0)
Wealth Index	
Poorest	2767(31.3)
Poorer	2482(28.1)
Middle	1736(19.6)
Richer	1172(13.3)
Richest	685(7.7)

Table 4.4 Summary Statistics of Stunted Children by Socio Demographic Variables

Working status of mother	
No	2945(33.5)
Yes	5856(66.5)
Breastfeeding Duration	
Ever breastfed, not currently breastfeeding	6110(70.3)
Never breastfed	94(1.1)
Still breastfeeding	2486(28.6)
Child's Age (months)	
0-11	1043(11.8)
12-23	1873(21.2)
24-35	2057(23.3)
36-47	2075(23.5)
48-59	1794(20.3)
Maternal BMI	
Underweight	964(11.0)
Normal	6230(70.9)
Overweight	1240(14.1)
Obese	352(4.0)

Table 4.4 Summary Statistics of Stunted Children by Socio Demographic Variables

Working status of mother	
No	2945(33.5)
Yes	5856(66.5)
Breastfeeding Duration	
Ever breastfed, not currently breastfeeding	6110(70.3)
Never breastfed	94(1.1)
Still breastfeeding	2486(28.6)
Child's Age (months)	
0-11	1043(11.8)
12-23	1873(21.2)
24-35	2057(23.3)
36-47	2075(23.5)
48-59	1794(20.3)
Maternal BMI	
Underweight	964(11.0)
Normal	6230(70.9)
Overweight	1240(14.1)
Obese	352(4.0)

4.1.6 Distribution of Underweight Children by Socio Demographic Variables

Table 4.5 showed the distribution of children who were underweight. Among the children who were underweight, children whose mothers were 20-35 years had proportion of 71.5%. Of these children, only 18.1% of their mothers had primary education, 18.7% had at least secondary education while majority had no education. About 44.4% of these children were considered to be averagely sized at birth, followed by 36.9% who were large sized.

Of these children who were underweight, 44.9% of their mothers attended antenatal clinic. Male children were 52.7% while female were 47.3%. Children from the North West were 49.5% and those from poorest category of the wealth index were 32.1%, closely followed by those in the poorer category with 27.7%.

Underweight children whose mothers were working had a proportion of 66.6%. Those who had ever breastfed but not currently breastfeeding were 63.4%. Children aged 12-23 months had the highest percentage of 22.4% followed by children aged 24-35 months old with 21.3%. Of the children who were underweight, those whose mothers had normal Body Mass Index had 71.1%.

Table 4.5: Summary Statistics of Underweight Children by Socio Demographic Variables

Variables	Frequency (%)
Maternal Age	
<20 years	929(14.1)
20-35 years	4704(71.5)
36 and above	949(14.4)
Mother's educational status	
None	4159(63.2)
Primary	1192(18.1)
Secondary and higher	1231(18.7)
Size of child at birth	
Large	2392(36.9)
Average	2877(44.4)
Small	1218(18.7)
Antenatal Visits	
Yes	1936(44.9)
No	2379(55.1)
Sex of child	
Male	3466(52.7)
Female	3116(47.3)
Region	
North Central	671(10.2)
North East	1550(23.5)
North West	3256(49.5)
South East	252(3.8)
South South	393(6.0)
South West	460(7.0)
Wealth Index	
Poorest	2111(32.1)
Poorer	1826(27.7)
Middle	1197(18.2)
Richer	890(13.5)
Richest	558(8.5)

Table 4.5: Summary Statistics of Underweight Children by Socio Demographic Variables

Variables	Frequency (%)
Maternal Age	
<20 years	929(14.1)
20-35 years	4704(71.5)
36 and above	949(14.4)
Mother's educational status	
None	4159(63.2)
Primary	1192(18.1)
Secondary and higher	1231(18.7)
Size of child at birth	
Large	2392(36.9)
Average	2877(44.4)
Small	1218(18.7)
Antenatal Visits	
Yes	1936(44.9)
No	2379(55.1)
Sex of child	
Male	3466(52.7)
Female	3116(47.3)
Region	
North Central	671(10.2)
North East	1550(23.5)
North West	3256(49.5)
South East	252(3.8)
South South	393(6.0)
South West	460(7.0)
Wealth Index	
Poorest	2111(32.1)
Poorer	1826(27.7)
Middle	1197(18.2)
Richer	890(13.5)
Richest	558(8.5)

Table 4.5: Summary Statistics of Underweight Children by Socio Demographic Variables

Variables	Frequency (%)
Maternal Age	
<20 years	929(14.1)
20-35 years	4704(71.5)
36 and above	949(14.4)
Mother's educational status	
None	4159(63.2)
Primary	1192(18.1)
Secondary and higher	1231(18.7)
Size of child at birth	
Large	2392(36.9)
Average	2877(44.4)
Small	1218(18.7)
Antenatal Visits	
Yes	1936(44.9)
No	2379(55.1)
Sex of child	
Male	3466(52.7)
Female	3116(47.3)
Region	
North Central	671(10.2)
North East	1550(23.5)
North West	3256(49.5)
South East	252(3.8)
South South	393(6.0)
South West	460(7.0)
Wealth Index	
Poorest	2111(32.1)
Poorer	1826(27.7)
Middle	1197(18.2)
Richer	890(13.5)
Richest	558(8.5)

Table 4.5: Summary Statistics of Underweight Children by Socio Demographic Variables

Variables	Frequency (%)
Maternal Age	
<20 years	929(14.1)
20-35 years	4704(71.5)
36 and above	949(14.4)
Mother's educational status	
None	4159(63.2)
Primary	1192(18.1)
Secondary and higher	1231(18.7)
Size of child at birth	
Large	2392(36.9)
Average	2877(44.4)
Small	1218(18.7)
Antenatal Visits	
Yes	1936(44.9)
No	2379(55.1)
Sex of child	
Male	3466(52.7)
Female	3116(47.3)
Region	
North Central	671(10.2)
North East	1550(23.5)
North West	3256(49.5)
South East	252(3.8)
South South	393(6.0)
South West	460(7.0)
Wealth Index	
Poorest	2111(32.1)
Poorer	1826(27.7)
Middle	1197(18.2)
Richer	890(13.5)
Richest	558(8.5)

Table 4.5 Summary Statistics of Underweight Children by Socio Demographic Variables

Working status of mother	
No	2188(33.4)
Yes	4359(66.6)
Breastfeeding Duration	
Ever breastfed, not currently breastfeeding	4118(63.4)
Never breastfed	57(0.9)
Still breastfeeding	2317(35.7)
Child's Age (months)	
0-11	1165(17.7)
12-23	1477(22.4)
24-35	1403(21.3)
36-47	1318(20.1)
48-59	1219(18.5)
Maternal BMI	
Underweight	836(12.8)
Normal	4642(71.1)
Overweight	845(12.9)
Obese	212(3.2)

4.1.7 Distribution of Wasted Children by Socio Demographic Variables

Table 4.6 showed the distribution of children who were wasted. Among the children who were wasted, children whose mothers were 20-35 years had proportion of 74.8%. Of these children, only 18.7% of their mothers had primary education, 26.2% had at least secondary education while majority had no education. About 43% of these children were considered to be averagely sized at birth.

Of these children who were wasted, only 37.9% of their mothers attended antenatal clinic. Male children were 52.2% while female were 47.8%. Children from the North West were 44.2% and those from poorest category of the wealth index were 26.2%, closely followed by those in the poorer category with 24.9%.

Wasted children whose mothers were working had a proportion of 66.7%. Those who had ever breastfed but not currently breastfeeding were 49.3%, closely followed by those who were still breastfeeding 50.1%. Children aged 0-11 months had the highest percentage of 32% followed by children aged 12-23 months old with 26.1%. Of the children who were wasted, those whose mothers had normal Body Mass Index had 69.4%.

Table 4.6: Summary Statistics of Wasted Children by Socio Demographic Variables

Variables	Frequency (%)
Maternal Age	
<20 years	484(11.9)
20-35 years	3043(74.8)
36 and above	542(13.3)
Mother's educational status	
None	2243(55.1)
Primary	760(18.7)
Secondary and higher	1066(26.2)
Size of child at birth	
Large	1580(39.2)
Average	1731(43.0)
Small	715(17.8)
Antenatal Visits	
Yes	1161(37.9)
No	1901(62.1)
Sex of child	
Male	2123(52.2)
Female	1946(47.8)
Region	
North Central	434(10.5)
North East	873(21.5)
North West	1798(44.2)
South East	276(6.8)
South South	344(8.5)
South West	344(8.5)
Wealth Index	
Poorest	1068(26.2)
Poorer	1012(24.9)
Middle	765(18.8)
Richer	693(17.0)
Richest	531(13.1)

Table 4.6 Summary Statistics of Wasted Children by Socio Demographic Variables

Working status of mother	
No	1350(33.3)
Yes	2703(66.7)
Breastfeeding Duration	
Ever breastfed, not currently breastfeeding	1984(49.3)
Never breastfed	25(0.6)
Still breastfeeding	2019(50.1)
Child's Age (months)	
0-11	1304(32.0)
12-23	1062(26.1)
24-35	636(15.6)
36-47	576(14.2)
48-59	491(12.1)
Maternal BMI	
Underweight	449(11.1)
Normal	2802(69.4)
Overweight	642(15.9)
Obese	145(3.6)

Table 4.6 Summary Statistics of Wasted Children by Socio Demographic Variables

Working status of mother	
No	1350(33.3)
Yes	2703(66.7)
Breastfeeding Duration	
Ever breastfed, not currently breastfeeding	1984(49.3)
Never breastfed	25(0.6)
Still breastfeeding	2019(50.1)
Child's Age (months)	
0-11	1304(32.0)
12-23	1062(26.1)
24-35	636(15.6)
36-47	576(14.2)
48-59	491(12.1)
Maternal BMI	
Underweight	449(11.1)
Normal	2802(69.4)
Overweight	642(15.9)
Obese	145(3.6)

4.2 GOODNESS OF FIT/MODEL FIT

The goodness of fit of a statistical model describes how well it fits a set of observations. The measures summarize the discrepancy between observed values and the values expected under the model.

The adjusted R-squared compares the explanatory power of regression models that contain different numbers of predictors. It is a modified version of R-squared that has been adjusted for the number of predictors in the model.

There was a correlation between the dependent variable and the explanatory variables in the results of the analysis shown from tables 4.5 to 4.8. The adjusted R^2 showed that 22%, 18%, 4% and 6% variations respectively was observed in the height-for age (stunting), weight-for-age (underweight), weight-for-height (wasting) and BMI-for-age(overweight)

Also the pseudo R^2 of 0.15, 0.13 and 0.07 showed that 15%, 13% and 7% of the variation in the values of height-for age (stunting), weight-for-age (underweight) and weight-for-height (wasting) can be explained respectively.

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4.3 Factors associated with stunting of under five children using quantile regression

The regression coefficients are presented in Table with their p-values to identify the factors associated with stunting. Children whose height-for-age z-scores is <-2SD (stunted) and <-3SD (severely stunted) from the median of the WHO reference population are considered short for their age (stunted).The 10^{th} percentile of the height-for-age z-scores data represented the corresponding quantile for this analysis.

The quantile regression showed that child's age, sex, size of child at birth, maternal education (at least secondary level), antenatal visits, and region (North East, North West and South East) are all having a significant influence on stunting while maternal age, working status and mother's BMI are not contributing to the stunting status of the children.

Children in other groups from 12 months upwards were likely to be stunted compared with children between 0-11 months old, though the result showed that children aged 24-35 months were more likely to be stunted among other age groups. Children who were in the poorer, middle, richer and richest categories of the wealth index showed not to be stunted as likely as those in the poorer category. This significantly showed among children who were in the richer and richest categories of the wealth index.

The result of this study showed that children with average and small birth weight were significantly likely to be stunted compared to children with large birth size. Maternal education significantly showed that children whose mothers attained secondary and higher level of education were not likely to be stunted than children whose mothers had no education.

The study significantly showed that children living in the North East part of the country were likely to be more stunted than those in the North Central while children living in the South East region were not likely to be stunted compared to those in the North Central. Children whose mothers attended antenatal clinic were not likely to be stunted compared to the children whose mothers did not attend antenatal clinics. Female children were not as likely to be stunted as male children. Maternal working status, maternal. Children who were still breastfeeding are not as likely to be stunted as those who were not currently breastfeeding.

4.4 Factors associated with underweight of under five children using quantile regression

The regression coefficients are presented in Table with their p-values to identify the factors associated with under-weight. Children whose weight-for-age z-scores is <-2SD and <-3SD from the median of the WHO reference population are considered to be underweight and severely underweight respectively. The 10^{th} percentile of the weight-for-age z-scores data represented the corresponding quantile for this analysis.

The quantile regression showed that child's age (except 48-59months), sex, size of child at birth, maternal education (at least secondary level), antenatal visits, mother's BMI and region (North East, North West and South East) were all having a significant influence on underweight while wealth index, maternal age, working status, breastfeeding status and are not contributing to the underweight status of the children.

This study clearly pointed out children in age category 24-35 months as those who are more likely among other groups to be underweight compared to the reference category. Female children were not as likely to be underweight as male children. Average and small sized children at birth showed to be significantly more underweight compared to large sized children at birth. Children whose mothers attained at least primary education were not likely to be underweight compared to those children whose mothers were without education. Children whose mothers had normal weight, overweight and obese were not significantly as likely to be underweight as those children whose mothers were underweight.

Also, this study showed a significant result that children from the North East and North West region of the country were likely to be underweight compared with those in the North Central while children from other geo-political zones were not likely to be as underweight as those in the North Central. Children whose mothers attended antenatal clinic were not likely to be underweight as those who did not attend.

4.5 Factors associated with wasting of under five children using quantile regression

The regression coefficients are presented in Table with their p-values to identify the factors associated with wasting. Children whose weight-for-height z-scores is <-2SD and <-3SD from the median of the WHO reference population are considered to be wasted and severely wasted respectively. The 10^{th} percentile of the weight-for-height z-scores data represented the corresponding quantile for this analysis.

The quantile regression showed that child's age, sex, size of child at birth, maternal education, wealth index (middle and richest), mother's BMI (obese) and region (North East, North West and South West) were all having a significant influence on wasting while maternal age, maternal working status, breastfeeding status and antenatal visits were not contributing to the wasting status of the children.

The QR result showed that as age increases, children were less likely to be wasted. Children in the middle and richest category of the wealth index are significantly likely to be wasted while other categories like poorer and richer, though likely to be wasted but not significant. Female children were not likely to be wasted compared to male children. Average and small sized children at birth were significantly likely to be wasted compared to those with large size at birth.

Children whose mothers had basic education were not likely to be wasted than those children whose mothers had no education at all. Children from obese mothers were significantly not likely to be wasted. Children in the North East and North West region of the country were significantly likely to be wasted while the result also showed that children in the South West were significantly not likely to be wasted.

4.6 Factors associated with over weight of under five children using quantile regression

The regression coefficients are presented in Table 4.5 with their p-values to facilitate the identification of significant effects of factors. It should be remembered that BMI-for-age z scores ≤+3 and >+2 indicates problems associated with being overweight and >+3 indicates more problems with being obese. For this study 75th and 90th percentiles represented overweight and obese respectively.

The QR result showed that child's age is significantly associated with overweight/obesity of under five children, it identified age groups 24-35 months and 36-47 months as those who were more likely to be overweight/obese compared to others. Children in the richer and richest categories of the wealth index are those who were significantly likely to be overweight and also identified those in the richest category alone as those who were significantly likely to be obese.

The result showed that children with average and small size at birth were not likely to be overweight and obese. Children whose mothers are working were not likely to be overweight and obese compared to those whose mothers were not working. The QR result showed that children living in the South East region of the country were significantly not likely to be overweight, those in the South West and South East were not likely to be obese and only those in the North West were significantly likely to be obese.

Children who never breastfed and those still breastfeeding were significantly not likely to be overweight while only those who never breastfed were significantly not likely to be obese. Mothers BMI contributed significantly to both the overweight and obesity. This also showed that children who were overweight and obese also have mother's BMI to be on the high side, the higher the mother's BMI, the more likely it is for a child to be overweight /obese.

Children whose mothers did not attend antenatal clinics were significantly not likely to be obese, same result holds for overweight children though insignificant. Maternal age, sex of the child and maternal education level were not seen to be associated with overweight and obesity.

4.7 Comparison of Results of the Ordinary Least Square and Quantile Regression Analysis for stunted children

The OLS result showed that maternal age significantly contributed to the under nutrition status (stunting) of under five children as children whose mothers were >= 20 years old were not likely to be stunted. The OLS showed that maternal working status significantly contributed to this study as children of working class mothers were not likely to be stunted compared to those children whose mothers were not working. Ordinary least square result showed that mother's BMI contributed significantly to this study, as children whose mothers had normal, overweight and obese BMI were not likely to be stunted compared to children whose mothers were underweight.

In the QR, antenatal visits contributed significantly to stunting while the OLS result showed that antenatal visit did not contribute significantly to the study. The results of both the OLS and QR were similar, though the QR had increased unit, but OLS included children in the South South region as part of those children who were not likely to be stunted.

4.8 Comparison of Results of the Ordinary Least Square and Quantile Regression Analysis for underweight children

The OLS result showed that all the age groups significantly contributed to the underweight status of children under five and also showed that 24-35 months old children were more likely among other groups to be underweight compared with children who were 0-11 months old. The OLS showed that only children in the richer and richest categories of the wealth index were significantly not likely to be underweight while others were also not likely but insignificant. The sex of child, size of child at birth and maternal education level showed similar results in OLS as QR. The OLS result showed that children whose mothers are >= 36 years were significantly not likely to be underweight.

The QR result showed that breastfeeding duration did not significantly contribute to underweight while the OLS result showed that children who were still breastfeeding were significantly likely to be underweight. The OLS result included children in the South West region as those who were likely to be underweight but not significant. The result was similar with the QR results in the other regions. Antenatal visits did not contribute significantly in the OLS result as it showed that children whose mothers attended antenatal clinic were likely to be underweight. Both OLS and QR showed similar results in the sex of child, size of child at birth, maternal education status, maternal working status and maternal BMI.

4.9 Comparison of Results of the Ordinary Least Square and Quantile Regression Analysis for wasted children

The OLS result was similar to the QR as both showed that child's age was associated with wasting but OLS specified children aged 12-23 months as those who were likely to be wasted, though not significant. Ordinary least square result showed that children in all the categories of the wealth index were significantly likely to be wasted except children in poorer category which was not significant as compared with those in the poorest category.

Both the QR and OLS results were similar as regards the sex of child, the size of child at birth, maternal age, maternal education and antenatal visit. The OLS result showed that children who were still breastfeeding were significantly likely to be wasted compared to those who had ever breastfed but not currently breastfeeding.

Children whose mothers were working are significantly likely to be wasted compared to those whose mothers were not working. It was also seen in the OLS result that children living in North East, North West and South East region of Nigeria were significantly likely to be wasted compared with those in the North Central.

4.10 Comparison of Results of the Ordinary Least Square and Quantile Regression Analysis for overweight and obese children

On the contrary, maternal age showed to be associated with overweight/obesity in OLS, the result showed that children whose mothers were between 20-35 years were not likely to be overweight and obese while those aged 36 and above were likely to be. The OLS result significantly specified only 12-36 months and 24-35 months as those who are likely to be overweight and obese. This result is similar to the QR result, children in age group 24-35 months showed to be at high risk of being overweight and obese compared to others.

The OLS result showed that increase in wealth is likely to increase the BMI of children. Female children were more likely to be overweight than male, significance of this result was seen only in the OLS. Similar result which showed that an average or small sized children at birth were not likely to be overweight and obese, this was significantly seen in both the QR and OLS.

Ordinary least square result significantly showed that mother's education level is very important, as children of educated mothers are likely to be overweight and obese. Both OLS and QR showed that children of working mothers were not likely to be overweight and obese. It was evident, though not significant, that mother's BMI contributed a lot to their children's BMI.

Table 4.11 Regression coefficients and p-value of the linear regression and quantile regression using height-for-age z-scores

Variables	OLS β(p-value)	10th percentile β(p-value)
Child's age (months)		
0-11[c]		
12-23	-1.14(<0.001)	-0.91(<0.001)
24-35	-1.78(<0.001)	-1.42(<0.001)
36-47	-1.65(<0.001)	-1.29(<0.001)
48-59	-1.41(<0.001)	-0.96(<0.001)
Wealth Index		
Poorest[c]		
Poorer	0.06(0.18)	0.04(0.56)
Middle	0.12(0.02)	0.01(0.92)
Richer	0.30(<0.001)	0.30(0.01)
Richest	0.53(<0.001)	0.46(<0.001)
Sex of child		
Male[c]		
Female	0.26(<0.001)	0.27(<0.001)
Size of child at birth		
Large[c]		
Average	-0.21(<0.001)	-0.14(0.01)
Small	-0.39(<0.001)	-0.43(<0.001)
Maternal Age (years)		
<20[c]		
20-35	0.14(0.01)	0.08(0.28)
≥36	0.19(0.002)	0.15(0.14)
Maternal Education		
None[c]		
Primary	0.04(0.35)	0.11(0.15)
Secondary and Higher	0.22(<0.001)	0.38(<0.001)
Breastfeeding Duration		
Ever breastfed[c]		
Never breastfed	0.25(0.24)	-0.39(0.48)
Still breastfeeding	-0.16(<0.001)	-0.19(0.02)

Table 4.11 ctd

Variables	OLS	10^{th} percentile
Maternal Working Status		
No[c]		
Yes	0.07(0.04)	0.09(0.10)
Mother's BMI		
Underweight[c]		
Normal	0.13(0.01)	0.05(0.60)
Overweight	0.25(<0.001)	0.14(0.22)
Obese	0.32(<0.001)	0.19(0.19)
Region		
North Central[c]		
North East	-0.35(<0.001)	-0.49(<0.001)
North West	-0.98(<0.001)	-1.29(<0.001)
South East	0.40(<0.001)	0.62(<0.001)
South South	0.23(<0.001)	0.16(0.11)
South West	-0.06(0.25)	0.08(0.41)
Antenatal Visits		
No[c]		
Yes	0.04(0.34)	0.16(0.02)
Constant	-0.48(<0.001)	-2.86(<0.001)
Adjusted R^2	0.22	
Pseudo R^2		0.15

Table 4.12 Regression coefficients and p-value of the linear regression and quantile regression using weight-for-age z-scores

Variables	OLS β(p-value)	10^{th} percentile β(p-value)
Child's age (months)		
0-11[c]		
12-23	-0.48(<0.001)	-0.35(<0.001)
24-35	-0.71(<0.001)	-0.48(<0.001)
36-47	-0.60(<0.001)	-0.25(0.001)
48-59	-0.54(<0.001)	-0.08(0.34)
Wealth Index		
Poorest[c]		
Poorer	0.03(0.32)	-0.06(0.34)
Middle	0.02(0.66)	-0.11(0.09)
Richer	0.08(0.05)	0.05(0.50)
Richest	0.17(<0.001)	0.04(0.66)
Sex of child		
Male[c]		
Female	0.18(<0.001)	0.28(<0.001)
Size of child at birth		
Large[c]		
Average	-0.31(<0.001)	-0.25(<0.001)
Small	-0.50(<0.001)	-0.59(<0.001)
Maternal Age (years)		
<20[c]		
20-35	0.04(0.25)	0.05(0.39)
≥36	0.13(0.003)	0.08(0.25)
Maternal Education		
None[c]		
Primary	0.08(0.01)	0.11(0.05)
Secondary and Higher	0.22(<0.001)	0.32(<0.001)

Table 4.12 (ctd)

Variables	OLS	10th percentile
Breastfeeding Duration		
Ever breastfed[c]		
Never breastfed	-0.03(0.84)	-0.08(0.76)
Still breastfeeding	-0.21(<0.001)	-0.08(0.12)
Maternal working status		
No[c]		
Yes	-0.03(0.18)	-0.04(0.34)
Mother's BMI		
Underweight[c]		
Normal	0.25(<0.001)	0.21(0.001)
Overweight	0.45(<0.001)	0.41(<0.001)
Obese	0.61(<0.001)	0.47(<0.001)
Region		
North Central[c]		
North East	-0.33(<0.001)	-0.40(<0.001)
North West	-0.84(<0.001)	-1.02(<0.001)
South East	0.13(0.004)	0.28(0.001)
South South	0.06(0.03)	0.14(0.04)
South West	-0.05(0.18)	0.15(0.03)
Antenatal Visits		
No[c]		
Yes	-0.01(0.66)	0.11(0.04)
Constant	-0.77(<0.001)	-2.68(<0.001)
Adjusted R^2	0.18	
Pseudo R^2		0.13

Table 4.13 Regression coefficients and p-value of the linear regression and quantile regression for weight-for-height children

Variables	OLS β(p-value)	10th percentile β(p-value)
Child's age (months)		
0-11[c]		
12-23	-0.06(0.10)	0.19(0.002)
24-35	0.16(0.001)	0.40(<0.001)
36-47	0.30(<0.001)	0.76(<0.001)
48-59	0.23(<0.001)	0.69(<0.001)
Wealth Index		
Poorest[c]		
Poorer	-0.01(0.80)	-0.08(0.30)
Middle	-0.10(0.03)	-0.23(0.02)
Richer	-0.16(0.002)	-0.17(0.09)
Richest	-0.19(0.001)	-0.21(0.05)
Sex of child		
Male[c]		
Female	0.10(<0.001)	0.13(0.004)
Size of child at birth		
Large[c]		
Average	-0.26(<0.001)	-0.26(<0.001)
Small	-0.39(<0.001)	-0.35(<0.001)
Maternal Age (years)		
<20[c]		
20-35	-0.05(0.20)	-0.08(0.39)
≥36	0.05(0.36)	0.07(0.47)
Maternal Education		
None[c]		
Primary	0.09(0.02)	0.13(0.05)
Secondary and Higher	0.12(0.003)	0.19(0.02)

Table 4.13 (ctd)

Variables	OLS	10th percentile
Breastfeeding Duration		
Ever breastfed[c]		
Never breastfed	-0.22(0.23)	0.05(0.86)
Still breastfeeding	-0.20(<0.001)	-0.09(0.21)
Maternal working status		
No[c]		
Yes	-0.10(0.001)	-0.02(0.75)
Mother's BMI		
Underweight[c]		
Normal	0.26(<0.001)	-0.03(0.66)
Overweight	0.43(<0.001)	0.10(0.26)
Obese	0.61(<0.001)	0.41(<0.001)
Region		
North Central[c]		
North East	-0.20(<0.001)	-0.44(<0.001)
North West	-0.39(<0.001)	-1.21(<0.001)
South East	-0.13(0.01)	0.02(0.88)
South South	-0.02(0.73)	0.02(0.83)
South West	-0.02(0.67)	0.15(0.04)
Antenatal Visits		
No[c]		
Yes	-0.06(0.08)	-0.01(0.93)
Constant	-0.52(<0.001)	-2.35(<0.001)
Adjusted R^2	0.04	
Pseudo R^2		0.07

Table 4.14: Regression Coefficients and p-values of the Linear Regression and Quantile Regression for using BMI-for-age z-scores

Variables	OLS β (p-value)	75th percentile β (p-value)	90th percentile β (p-value)
Maternal Age			
<20 years[c]			
20-35 years	-0.05(0.04)	-0.05(0.459)	-0.11(0.176)
36 and above	0.03(0.05)	0.01(0.866)	-0.11(0.215)
Child's Age			
0-11 months[c]			
12-23 months	0.27(0.03)	0.29(<0.001)	0.23(0.001)
24-35 months	0.59(0.05)	0.60(<0.001)	0.48(<0.001)
36-47 months	0.66(0.06)	0.60(<0.001)	0.35(0.001)
48-59 months	0.50(0.07)	0.34(<0.001)	0.22(0.052)
Wealth Index			
Poorest[c]			
Poorer	-0.01(0.04)	-0.06(0.337)	0.03(0.687)
Middle	-0.09(0.05)	-0.06(0.348)	-0.07(0.404)
Richer	-0.17(0.05)	-0.20(0.002)	-0.14(0.099)
Richest	-0.25(0.06)	-0.26(<0.001)	-0.22(0.028)
Sex of Child			
Male[c]			
Female	0.06(0.03)	0.01(0.846)	-0.05(0.242)
Size of Child at Birth			
Large[c]			
Average	-0.26(0.03)	-0.25(<0.001)	-0.26(<0.001)
Small	-0.39(0.04)	-0.43(<0.001)	-0.35(<0.001)
Mother's Educational Level			
None[c]			
Primary	0.07(0.04)	0.04(0.388)	-0.05(0.493)
Secondary	0.10(0.04)	0.08(0.081)	-0.04(0.637)
Working Status of Mother			
Not Working[c]			
Working	-0.11(0.03)	-0.14(<0.001)	-0.22(<0.001)

Table 4.14 (ctd)

	OLS β(p-value)	75th percentile β(p-value)	90th percentile β(p-value)
Region			
North Central[c]			
North East	-0.17(0.05)	-0.02(0.703)	-0.06(0.448)
North West	-0.35(0.04)	0.05(0.353)	0.21(0.011)
South East	-0.17(0.06)	-0.21(0.001)	-0.26(0.002)
South South	-0.08(0.05)	-0.09(0.125)	-0.12(0.195)
South West	-0.03(0.05)	-0.10(0.066)	-0.16(0.022)
Breastfeeding Duration			
Ever breastfed,not currently breastfeeding[c]			
Never breastfed	-0.25(0.18)	-0.48(<0.001)	-0.73(0.003)
Still Breastfeeding	-0.17(0.04)	-0.20(<0.001)	-0.14(0.065)
Mother's BMI			
Underweight[c]			
Normal	0.24(0.05)	0.36(<0.001)	0.31(<0.001)
Overweight	0.41(0.05)	0.57(<0.001)	0.60(<0.001)
Obese	0.57(0.07)	0.67(<0.001)	0.78(<0.001)
Antenatal Visits			
Yes[c]			
No	-0.05(0.03)	-0.05(0.194)	-0.16(0.018)
Constant	-0.61(0.09)	0.25(0.038)	1.44(<0.001)
Adj. R^2	0.06		
Pseudo R^2		0.04	0.03

SE=Bootstrapped Std Error with 200 reps   c=reference

Table 4.15 Regression coefficients and standard error of the linear regression and quantile regression using height-for-age

Variables	OLS β(SE)	10th percentile β(SE)
Child's age (months)		
0-11[c]		
12-23	-1.14(0.04)	-0.91(0.06)
24-35	-1.78(0.06)	-1.42(0.10)
36-47	-1.65(0.07)	-1.29(0.11)
48-59	-1.41(0.08)	-0.96(0.13)
Wealth Index		
Poorest[c]		
Poorer	0.06(0.05)	0.04(0.07)
Middle	0.12(0.05)	0.01(0.09)
Richer	0.30(0.06)	0.30(0.11)
Richest	0.53(0.07)	0.46(0.11)
Sex of child		
Male[c]		
Female	0.26(0.03)	0.27(0.05)
Size of child at birth		
Large[c]		
Average	-0.21(0.03)	-0.14(0.05)
Small	-0.39(0.05)	-0.43(0.07)
Maternal Age (years)		
<20[c]		
20-35	0.14(0.05)	0.08(0.07)
≥36	0.19(0.06)	0.15(0.10)
Maternal Education		
None[c]		
Primary	0.04(0.05)	0.11(0.08)
Secondary and Higher	0.22(0.05)	0.38(0.08)

Table 4.15 (ctd)

Variables	**OLS**	**10th percentile**
Breastfeeding Duration		
Ever breastfed[c]		
Never breastfed	0.25(0.21)	-0.39(0.55)
Still breastfeeding	-0.16(0.05)	-0.19(0.08)
Maternal working status		
No[c]		
Yes	0.07(0.03)	0.09(0.06)
Mother's BMI		
Underweight[c]		
Normal	0.13(0.05)	0.05(0.10)
Overweight	0.25(0.06)	0.14(0.11)
Obese	0.32(0.08)	0.19(0.14)
Region		
North Central[c]		
North East	-0.35(0.05)	-0.49(0.10)
North West	-0.98(0.05)	-1.29(0.09)
South East	0.40(0.06)	0.62(0.10)
South South	0.23(0.06)	0.16(0.10)
South West	-0.06(0.06)	0.08(0.09)
Antenatal Visits		
No[c]		
Yes	0.04(0.04)	0.16(0.07)
Constant	-0.48(0.10)	-2.86(0.18)
Adjusted R^2	0.22	
Pseudo R^2		0.15

Table 4.16 Regression coefficients and standard error of the linear regression and quantile regression using weight-for-age

Variables	OLS β(SE)	10th percentile β(SE)
Child's age (months)		
0-11[c]		
12-23	-0.48(0.03)	-0.35(0.05)
24-35	-0.71(0.04)	-0.48(0.07)
36-47	-0.60(0.05)	-0.25(0.08)
48-59	-0.54(0.05)	-0.08(0.08)
Wealth Index		
Poorest[c]		
Poorer	0.03(0.03)	-0.06(0.07)
Middle	0.02(0.04)	-0.11(0.07)
Richer	0.08(0.04)	0.05(0.07)
Richest	0.17(0.05)	0.04(0.09)
Sex of child		
Male[c]		
Female	0.18(0.02)	0.28(0.04)
Size of child at birth		
Large[c]		
Average	-0.31(0.02)	-0.25(0.04)
Small	-0.50(0.03)	-0.59(0.06)
Maternal Age (years)		
<20[c]		
20-35	0.04(0.04)	0.05(0.05)
≥36	0.13(0.04)	0.08(0.07)
Maternal Education		
None[c]		
Primary	0.08(0.03)	0.11(0.06)
Secondary and Higher	0.22(0.03)	0.32(0.06)

Table 4.16 (ctd)

Variables	**OLS**	**10th percentile**
Breastfeeding Duration		
Ever breastfed[c]		
Never breastfed	-0.03(0.15)	-0.08(0.25)
Still breastfeeding	-0.21(0.03)	-0.08(0.05)
Maternal working status		
No[c]		
Yes	-0.03(0.02)	-0.04(0.04)
Mother's BMI		
Underweight[c]		
Normal	0.25(0.04)	0.21(0.06)
Overweight	0.45(0.04)	0.41(0.08)
Obese	0.61(0.06)	0.47(0.10)
Region		
North Central[c]		
North East	-0.33(0.04)	-0.40(0.07)
North West	-0.84(0.04)	-1.02(0.06)
South East	0.13(0.05)	0.28(0.09)
South South	0.06(0.04)	0.14(0.07)
South West	-0.05(0.04)	0.15(0.07)
Antenatal Visits		
No[c]		
Yes	-0.01(0.03)	0.11(0.06)
Constant	-0.77(0.07)	-2.68(0.13)
Adjusted R^2	0.18	
Pseudo R^2		0.13

Table 4.17 Regression coefficients and standard error of the linear regression and quantile regression using weight-for-height

Variables	OLS β(SE)	10th percentile β(SE)
Child's age (months)		
0-11[c]		
12-23	-0.06(0.03)	0.19(0.06)
24-35	0.16(0.05)	0.40(0.11)
36-47	0.30(0.06)	0.76(0.11)
48-59	0.23(0.06)	0.69(0.12)
Wealth Index		
Poorest[c]		
Poorer	-0.01(0.04)	-0.08(0.08)
Middle	-0.10(0.04)	-0.23(0.10)
Richer	-0.16(0.05)	-0.17(0.10)
Richest	-0.19(0.06)	-0.21(0.11)
Sex of child		
Male[c]		
Female	0.10(0.02)	0.13(0.05)
Size of child at birth		
Large[c]		
Average	-0.26(0.03)	-0.26(0.05)
Small	-0.39(0.04)	-0.35(0.07)
Maternal Age (years)		
<20[c]		
20-35	-0.05(0.04)	-0.08(0.09)
≥36	0.05(0.05)	0.07(0.10)
Maternal Education		
None[c]		
Primary	0.09(0.04)	0.13(0.07)
Secondary and Higher	0.12(0.04)	0.19(0.08)

Table 4.17 (ctd)

Variables	OLS	10th percentile
Ever breastfed[c]		
Never breastfed	-0.22(0.18)	0.05(0.30)
Still breastfeeding	-0.20(0.04)	-0.09(0.07)
Maternal working status		
No[c]		
Yes	-0.10(0.03)	-0.02(0.06)
Mother's BMI		
Underweight[c]		
Normal	0.26(0.05)	-0.03(0.06)
Overweight	0.43(0.05)	0.10(0.09)
Obese	0.61(0.07)	0.41(0.10)
Region		
North Central[c]		
North East	-0.20(0.04)	-0.44(0.08)
North West	-0.39(0.04)	-1.21(0.08)
South East	-0.13(0.05)	0.02(0.10)
South South	-0.02(0.05)	0.02(0.08)
South West	-0.02(0.05)	0.15(0.07)
Antenatal Visits		
No[c]		
Yes	-0.06(0.03)	-0.01(0.06)
Constant	-0.52(0.09)	-2.35(0.16)
Adjusted R^2	0.05	
Pseudo R^2		0.07

Table 4.18 Regression coefficients and standard error of the linear regression and quantile regression using BMI-for-age

Variables	OLS Regression β(SE)	75th Quantile β (SE)	90th Quantile β (SE)
Maternal Age			
<20 years[c]			
20-35 years	-0.05(0.04)	-0.05(0.06)	-0.11(0.08)
36 and above	0.03(0.05)	0.01(0.08)	-0.11(0.09)
Child's Age			
0-11 months[c]			
12-23 months	0.27(0.03)	0.29(0.04)	0.23(0.07)
24-35 months	0.59(0.05)	0.60(0.06)	0.48(0.10)
36-47 months	0.66(0.06)	0.60(0.07)	0.35(0.11)
48-59 months	0.50(0.07)	0.34(0.07)	0.22(0.11)
Wealth Index			
Poorest[c]			
Poorer	-0.01(0.04)	-0.06(0.06)	0.03(0.08)
Middle	-0.09(0.05)	-0.06(0.07)	-0.07(0.08)
Richer	-0.17(0.05)	-0.20(0.07)	-0.14(0.08)
Richest	-0.25(0.06)	-0.26(0.07)	-0.22(0.10)
Sex of Child			
Male[c]			
Female	0.06(0.03)	0.01(0.03)	-0.05(0.05)
Size of Child at Birth			
Large[c]			
Average	-0.26(0.03)	-0.25(0.03)	-0.26(0.05)
Small	-0.39(0.04)	-0.43(0.04)	-0.35(0.08)
Mother's Educational Level			
None[c]			
Primary	0.07(0.04)	0.04(0.05)	-0.05(0.07)
Secondary	0.10(0.04)	0.08(0.04)	-0.04(0.08)
Working Status of Mother			
Not Working[c]			
Working	-0.11(0.03)	-0.14(0.04)	-0.22(0.06)

Table 4.18 (ctd)

Variables	OLS β(SE)	75th percentile β(SE)	90th percentile β(SE)
North Central[c]			
North East	-0.17(0.05)	-0.02(0.05)	-0.06(0.08)
North West	-0.35(0.04)	0.05(0.06)	0.21(0.08)
South East	-0.17(0.06)	-0.21(0.06)	-0.26(0.09)
South South	-0.08(0.05)	-0.09(0.06)	-0.12(0.09)
South West	-0.03(0.05)	-0.10(0.05)	-0.16(0.07)
Breastfeeding Duration			
Ever breastfed,not currently breastfeeding[c]			
Never breastfed	-0.25(0.18)	-0.48(0.13)	-0.73(0.24)
Still Breastfeeding	-0.17(0.04)	-0.20(0.05)	-0.14(0.07)
Mother's BMI			
Underweight[c]			
Normal	0.24(0.05)	0.36(0.06)	0.31(0.08)
Overweight	0.41(0.05)	0.57(0.08)	0.60(0.09)
Obese	0.57(0.07)	0.67(0.08)	0.78(0.10)
Antenatal Visits			
Yes[c]			
No	-0.05(0.03)	-.05(0.04)	-0.16(0.07)
Constant	-0.61(0.09)	0.25(0.12)	1.44(0.15)
Adj. R^2	0.06		
Pseudo R^2		0.04	0.03

4.11 Graphical presentation of the effects of demographic factors on nutritional status

Figures 4.2 to 4.45 illustrate graphically the effects of each of the demographic factors on height-for-age, weight-for-age, weight-for-height and BMI-for-age. In each figure and in each panel, the solid line represents estimates of the coefficient from the quantile regression while the shaded area represents the 95% confidence interval. Superimposed on the plot is a dashed line representing the ordinary least squares (OLS) estimate of the regression co-efficient. The coefficient estimates of the indicator or dummy variables reported in the tables are relative to the reference category.

Figures 4.2 showed the quantile regression models demonstrating effects of explanatory variables on height-for-age z-scores.

Figures 4.3 showed the quantile regression models demonstrating effects of explanatory variables on weight-for-age z-scores.

Figures 4.4 showed the quantile regression models demonstrating effects of explanatory variables on weight-for-height z-scores.

Figures 4.5 showed the quantile regression models demonstrating effects of explanatory variables on BMI-for-age z-scores.

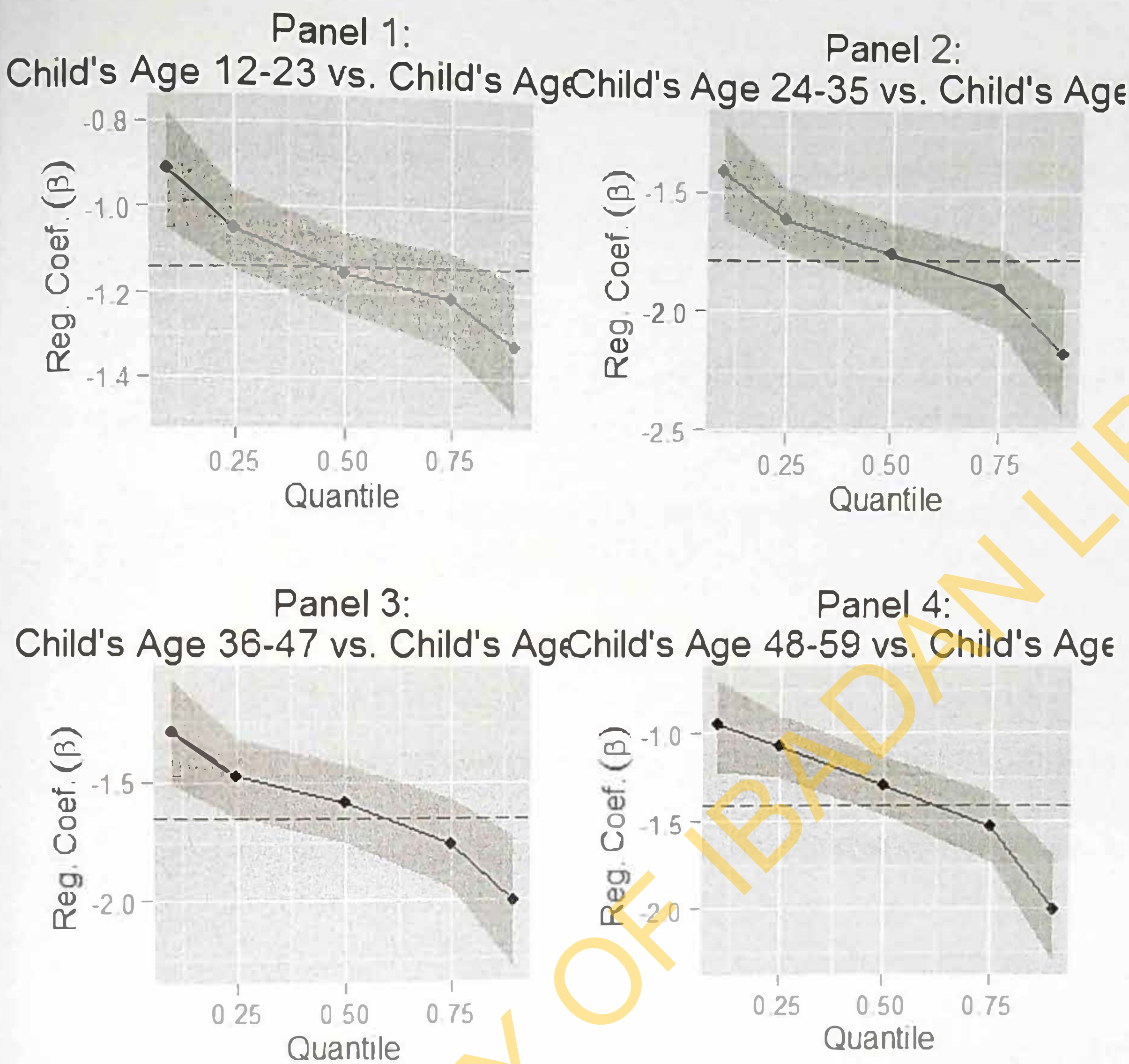

Figure 4.2.1: Quantile regression models demonstrating effects of child's age (compared with 0-11 months) on height-for-age z-scores.

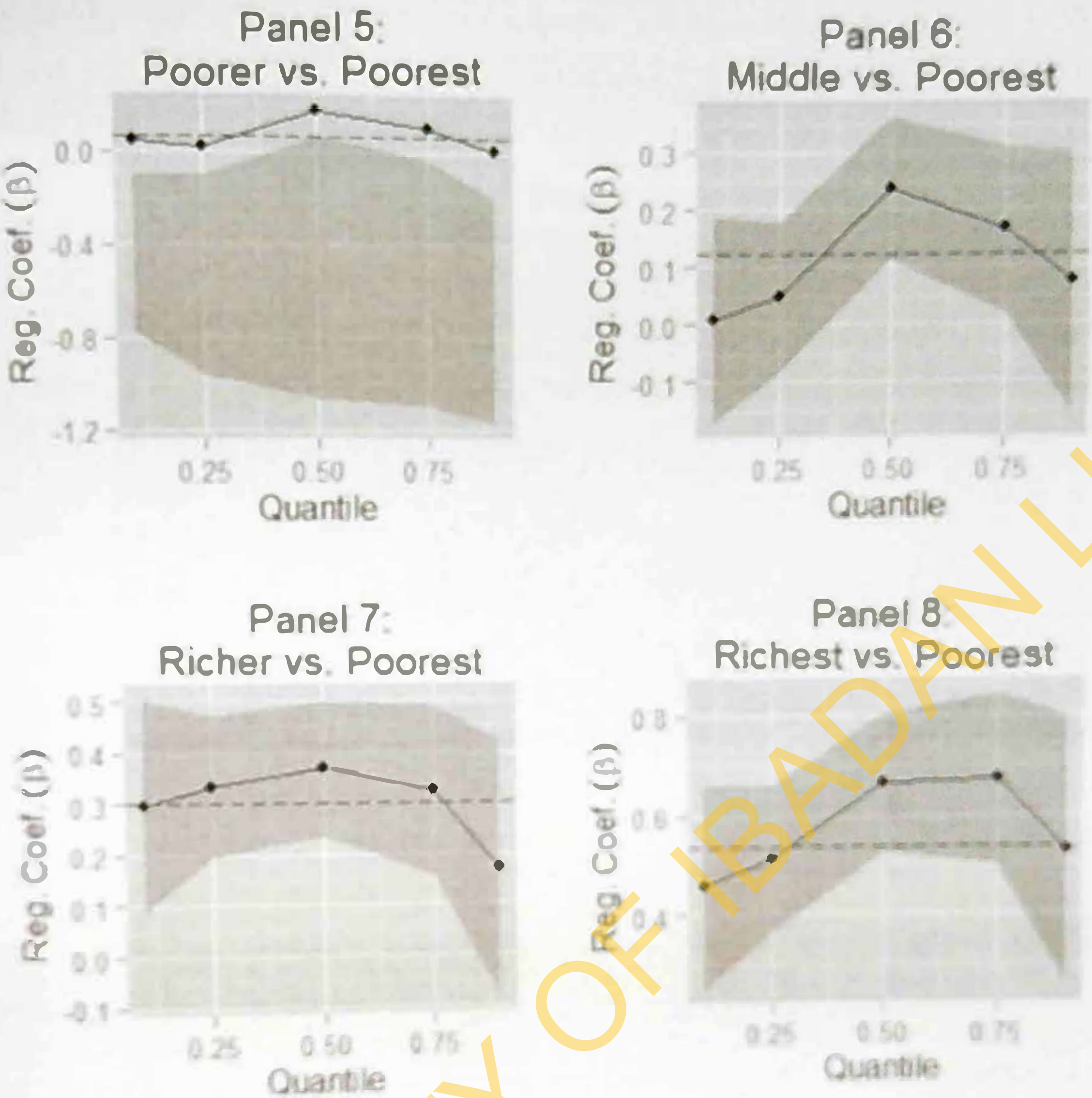

Figure 4.2.2: Quantile regression models demonstrating effects of wealth index (compared with poorest category) on height-for-age z-scores.

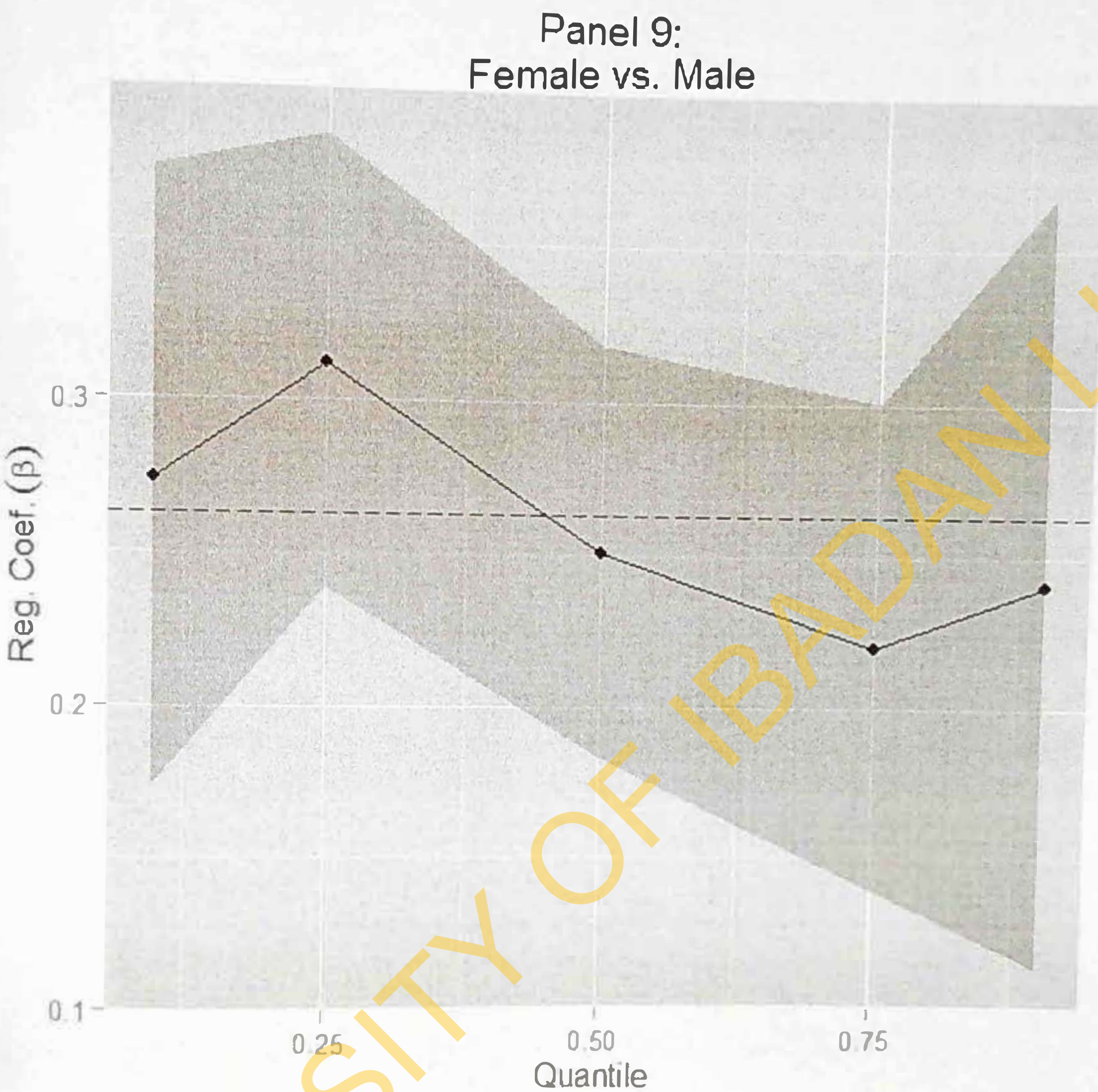

Figure 4.2.3: Quantile regression models demonstrating effects of child's sex (compared with male) on height-for-age z-scores.

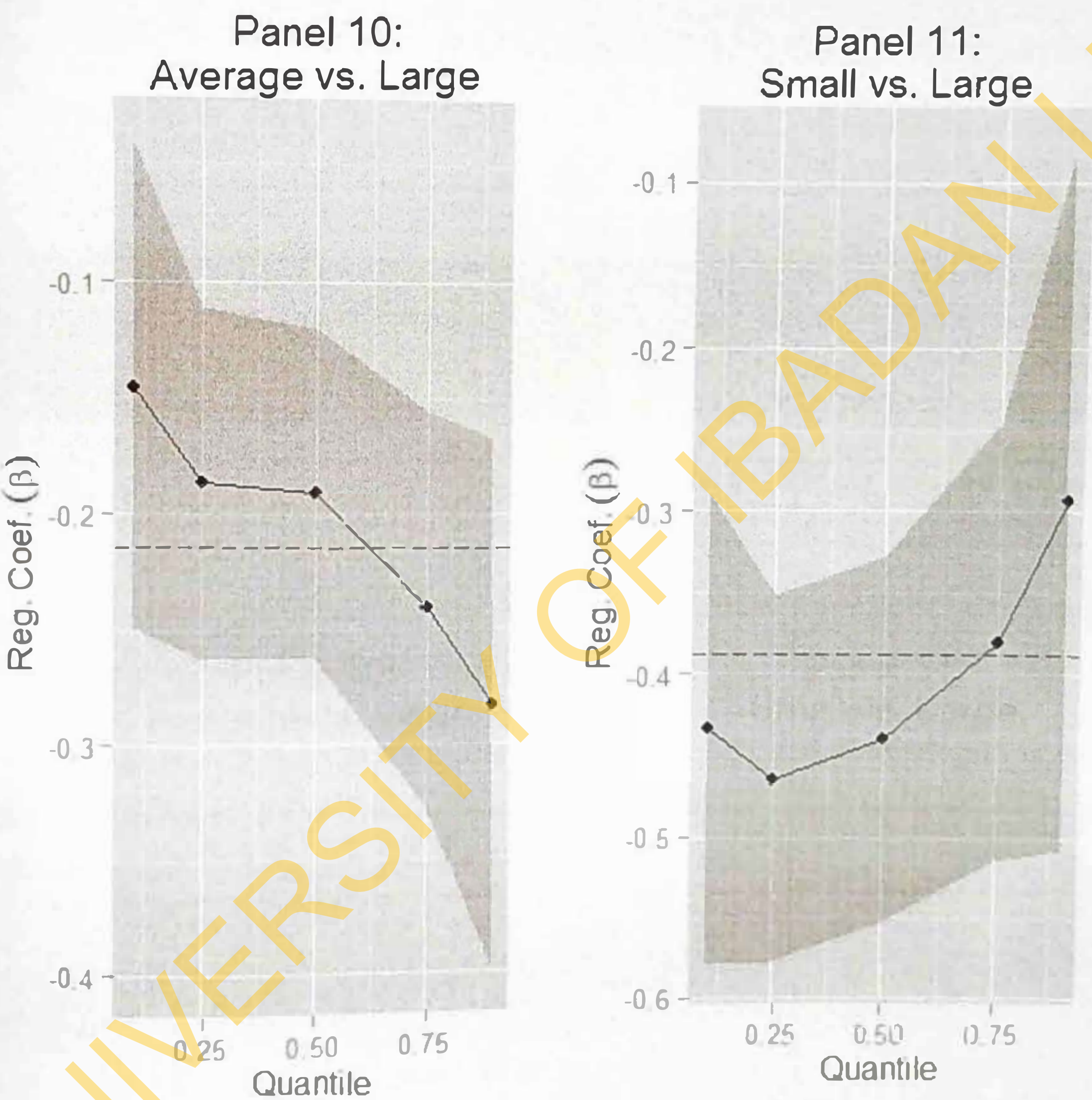

Figure 4.2.4: Quantile regression models demonstrating effects of child's size at birth (compared with large size) on height-for-age z-scores.

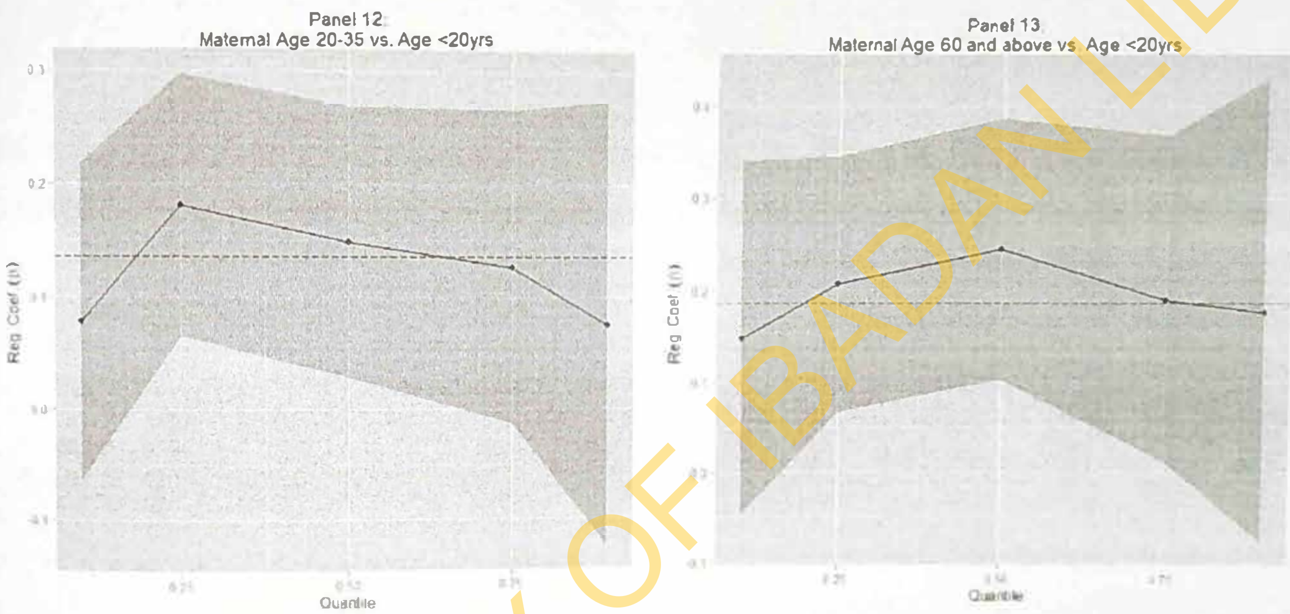

Figure 4.2.5: Quantile regression models demonstrating effects of maternal age (compared with <20 years) on height-for-age z-scores.

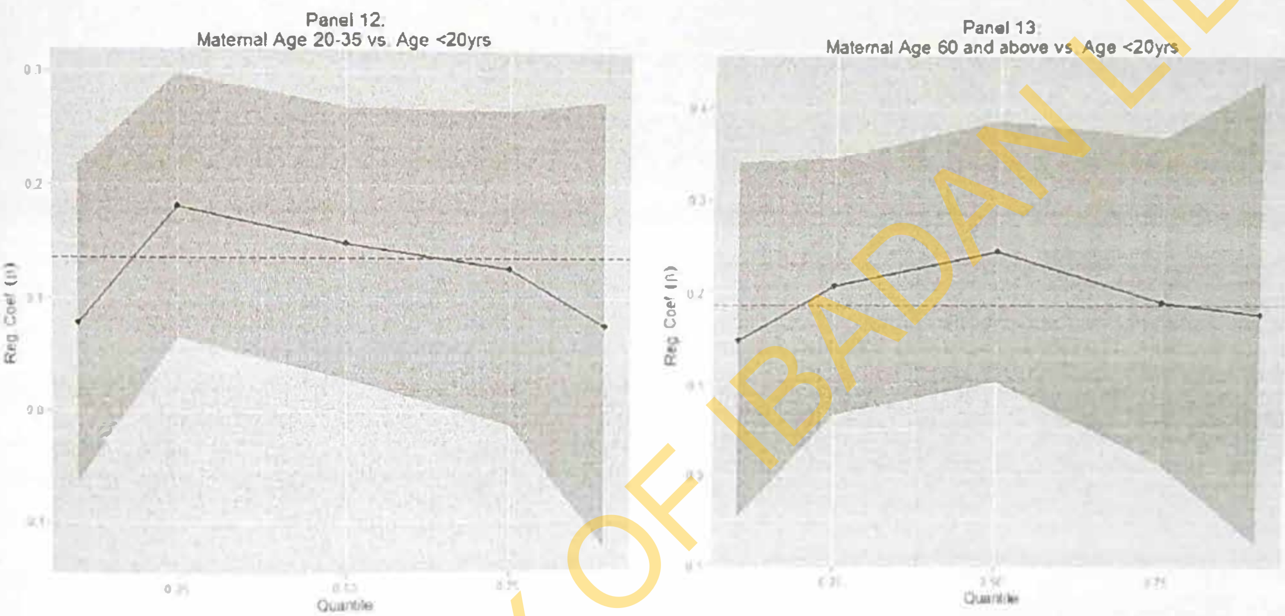

Figure 4.2.5: Quantile regression models demonstrating effects of maternal age (compared with <20 years) on height-for-age z-scores.

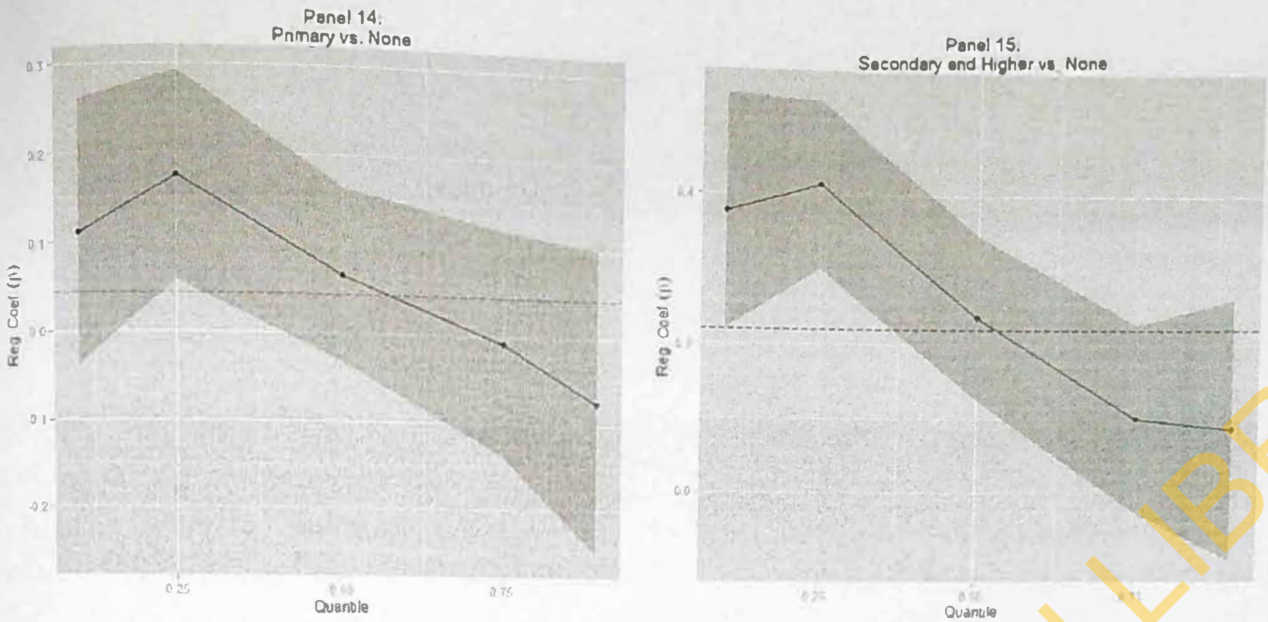

Figure 4.2.6: Quantile regression models demonstrating effects of maternal education level (compared with no education) on height-for-age z-scores.

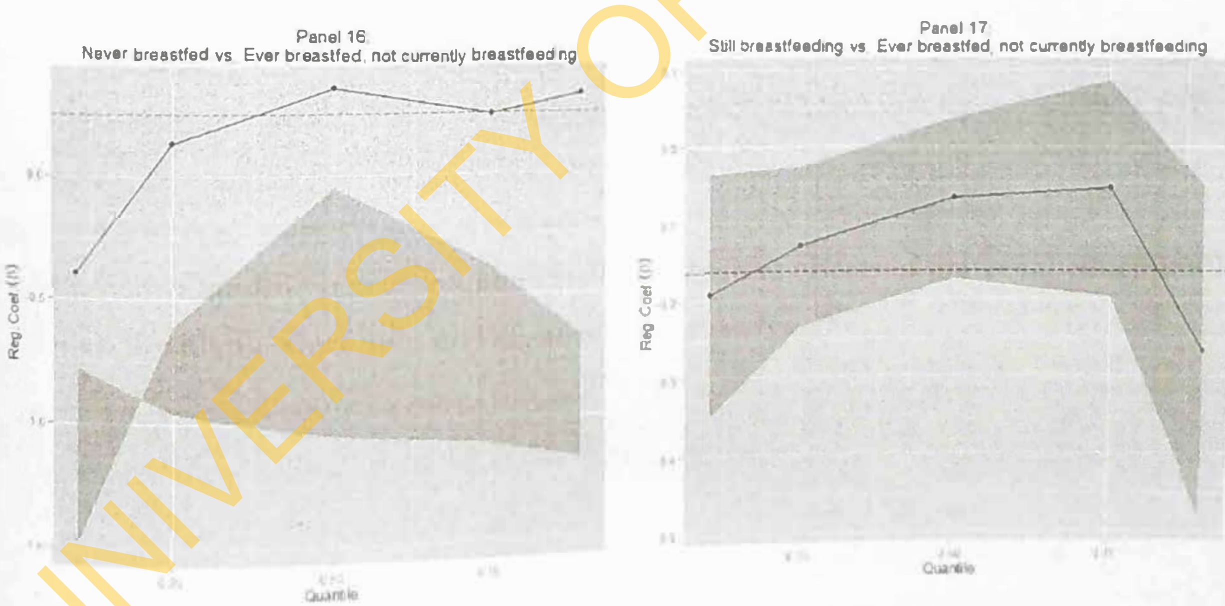

Figure 4.2.7: Quantile regression models demonstrating effects of breastfeeding duration (compared with ever breastfed) on height-for-age z-scores.

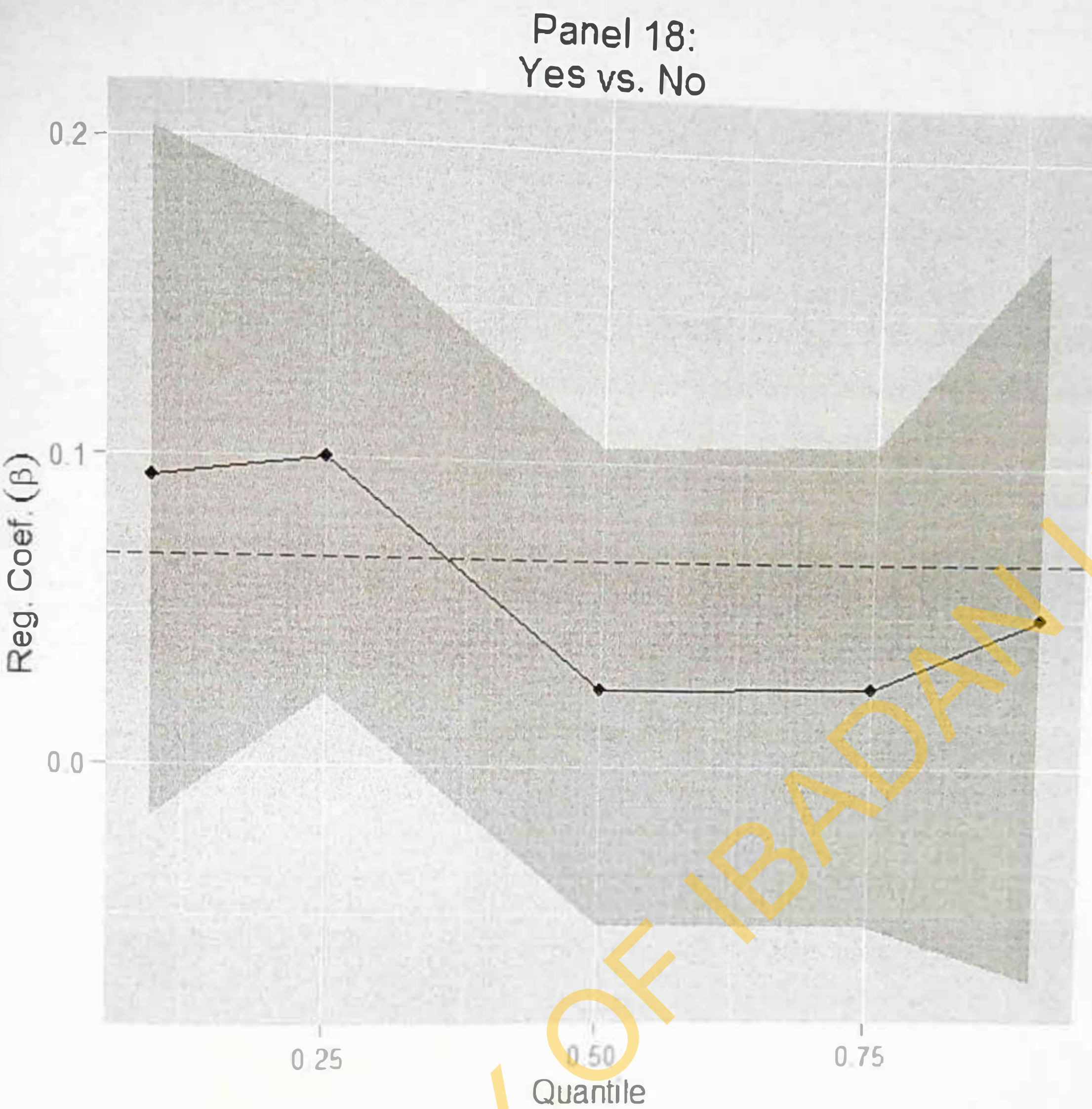

Figure 4.2.8: Quantile regression models demonstrating effects of mother's working status (compared with 'not workimg') on height-for-age z-scores.

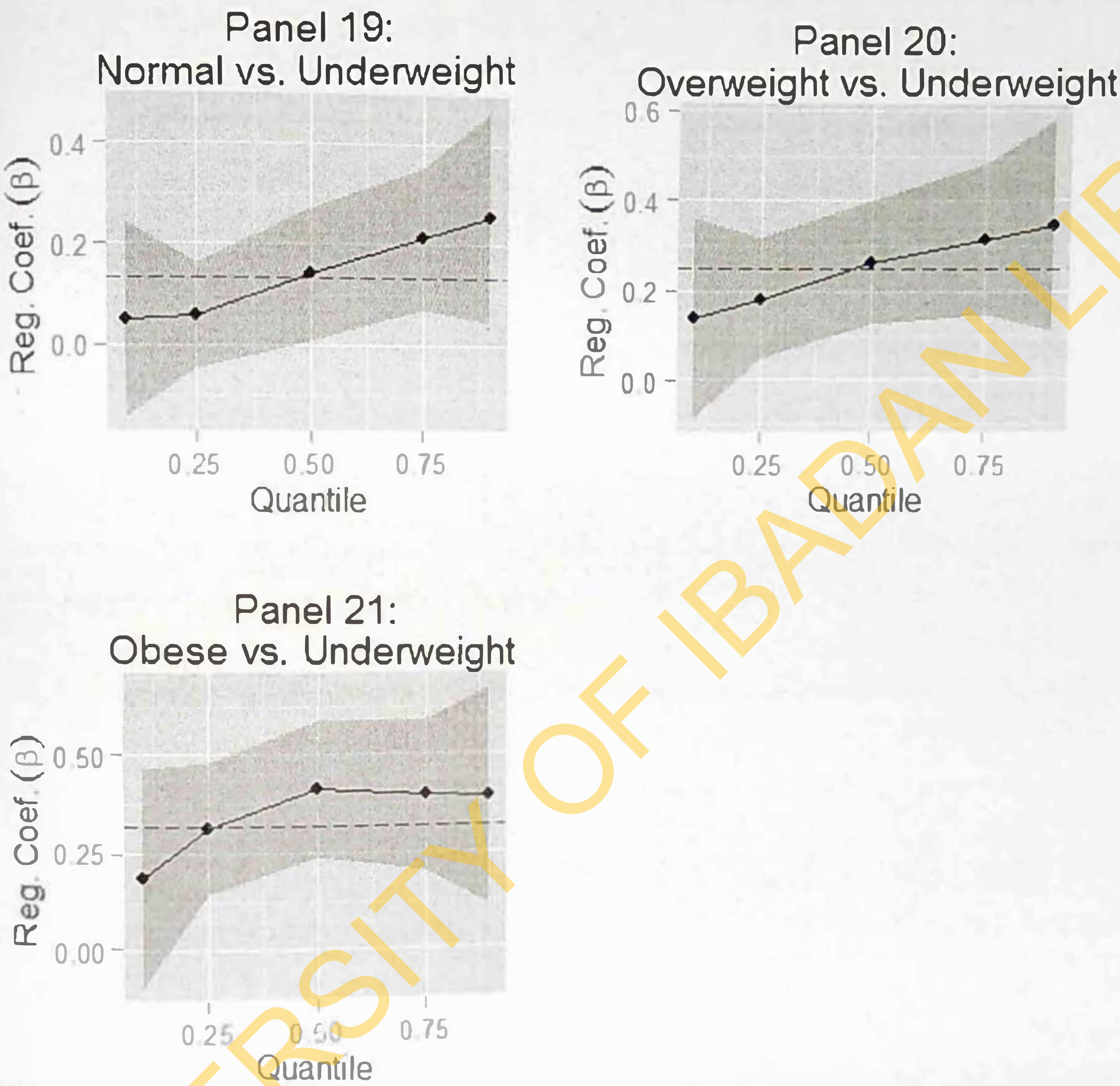

Figure 4.2.9: Quantile regression models demonstrating effects of mother's BMI (compared with underweight) on height-for-age z-scores.

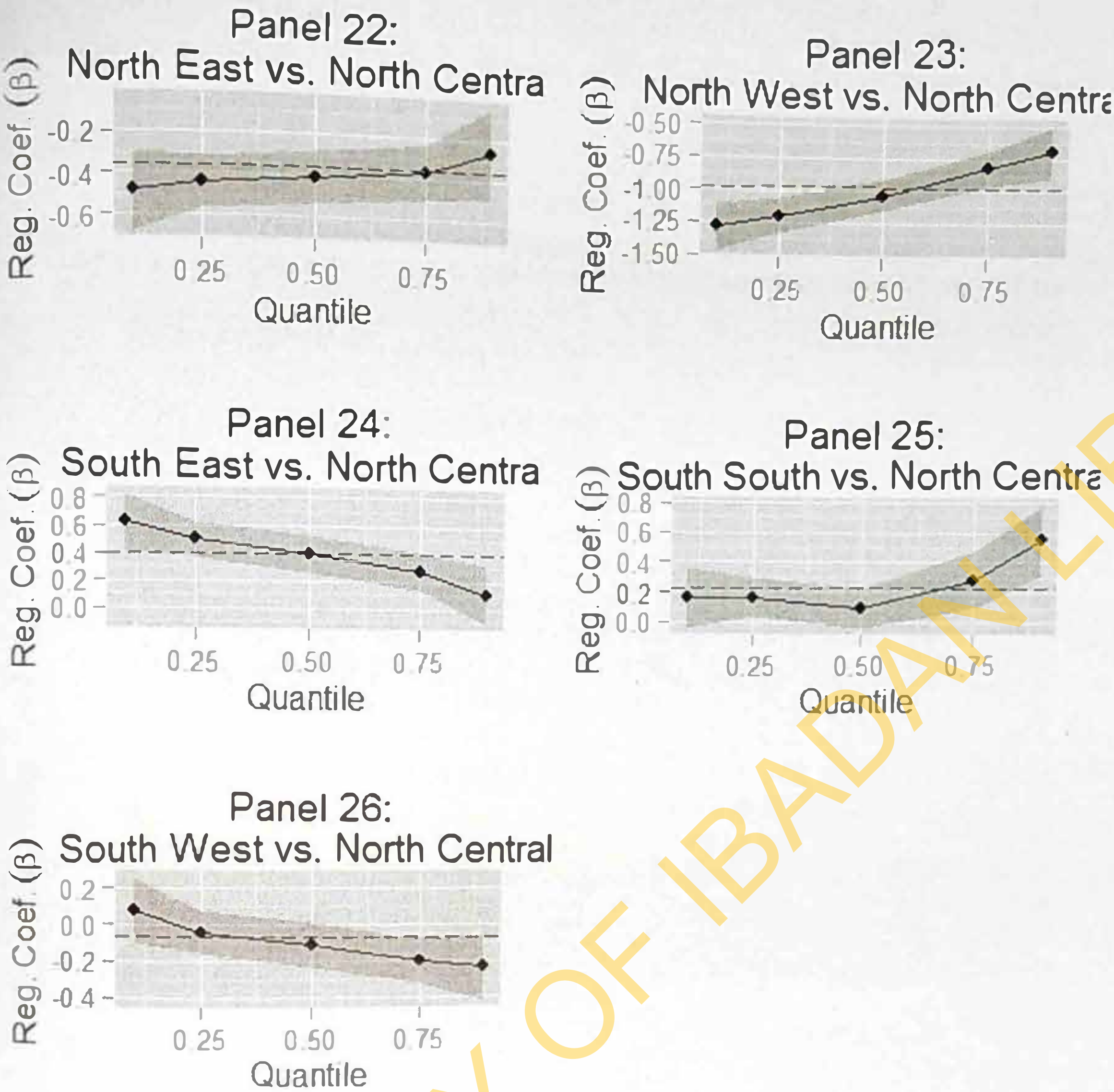

Figure 4.2.10: Quantile regression models demonstrating effects of region (compared with North Central) on height-for-age z-scores.

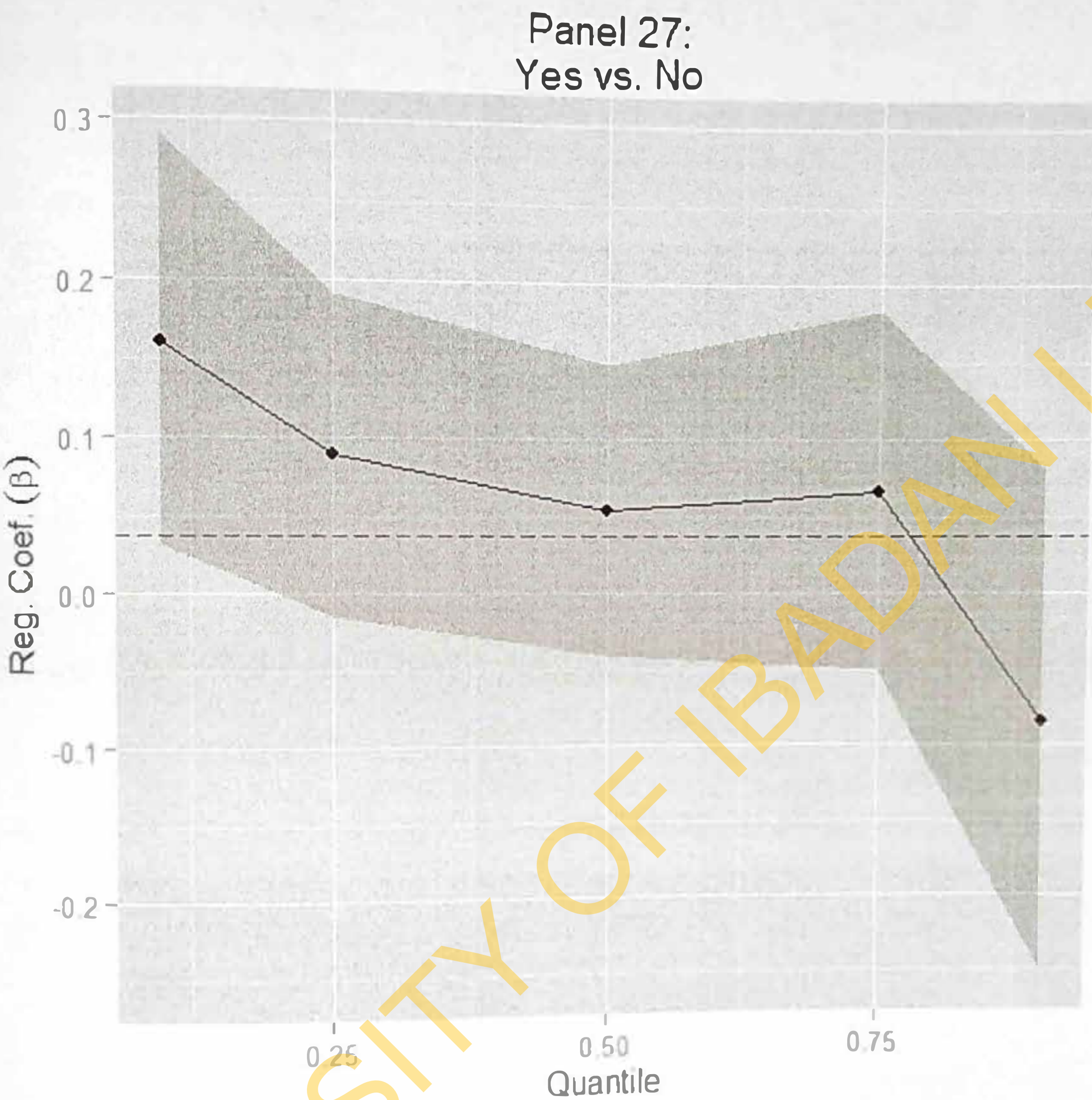

Figure 4.2.11: Quantile regression models demonstrating effects of antenatal visit (compared with 'No visit') on height-for-age z-scores.

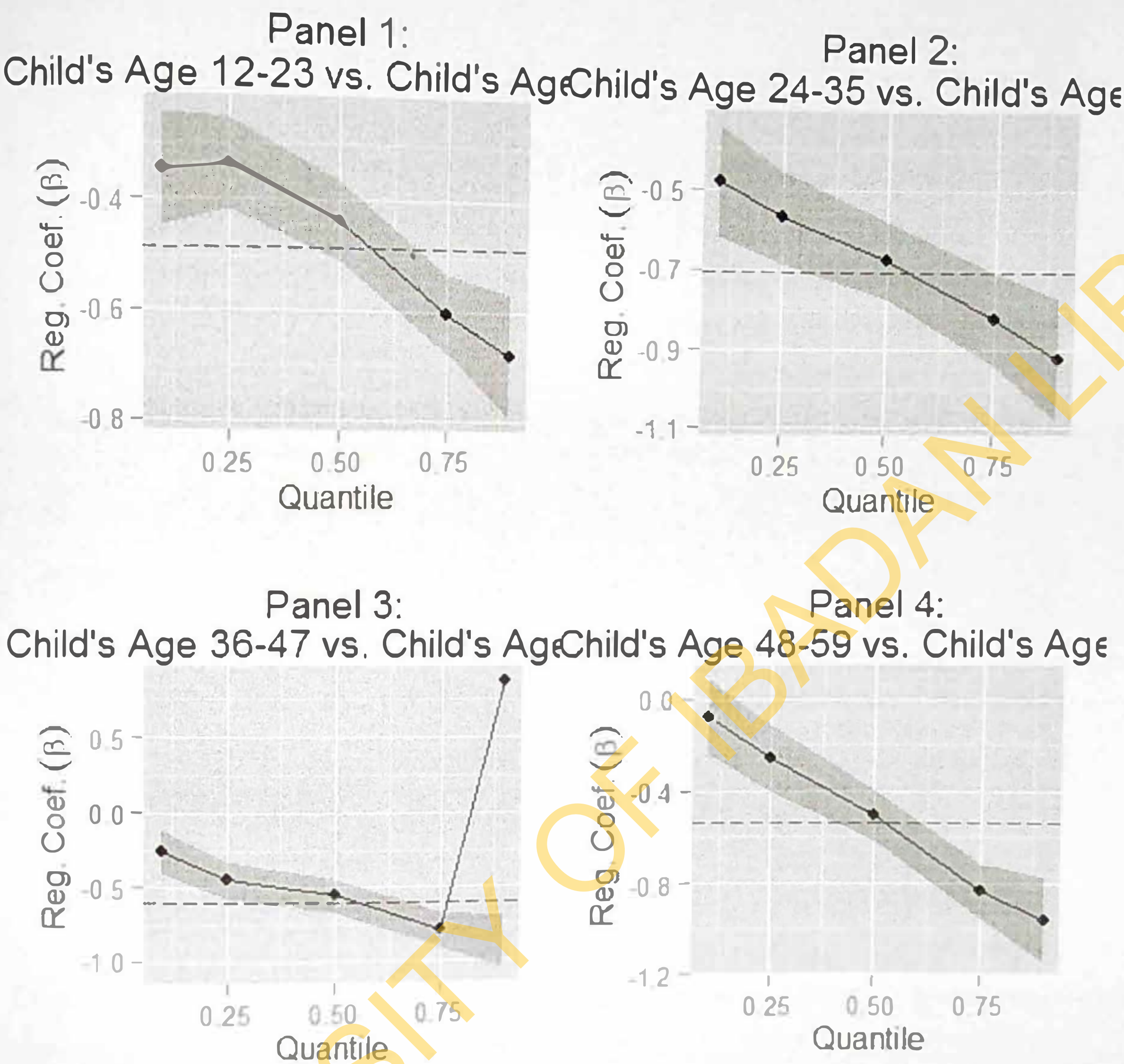

Figure 4.3.1: Quantile regression models demonstrating effects of child's age (compared with age group 0-11 months) on weight-for-age z-scores.

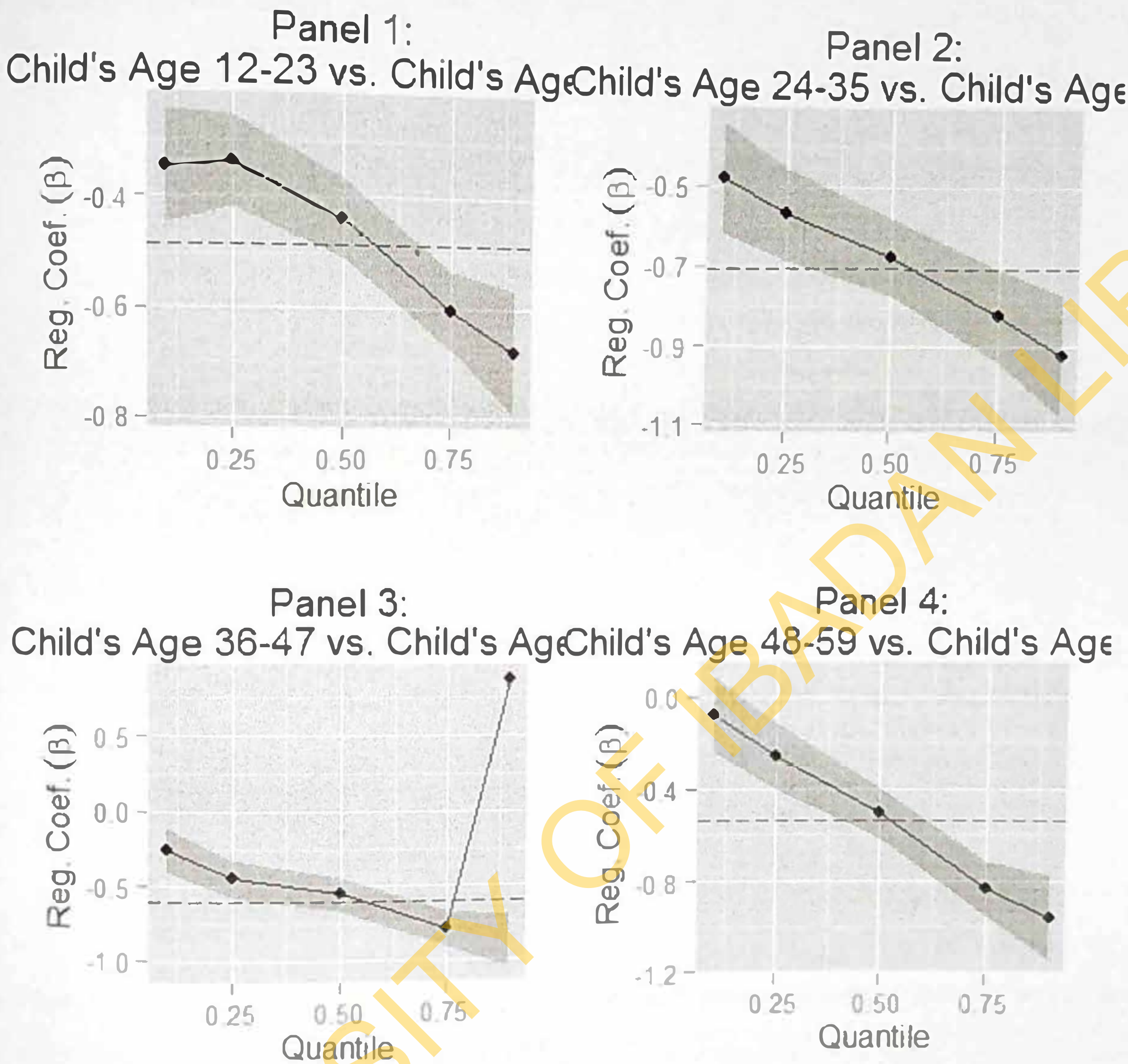

Figure 4.3.1: Quantile regression models demonstrating effects of child's age (compared with age group 0-11 months) on weight-for-age z-scores.

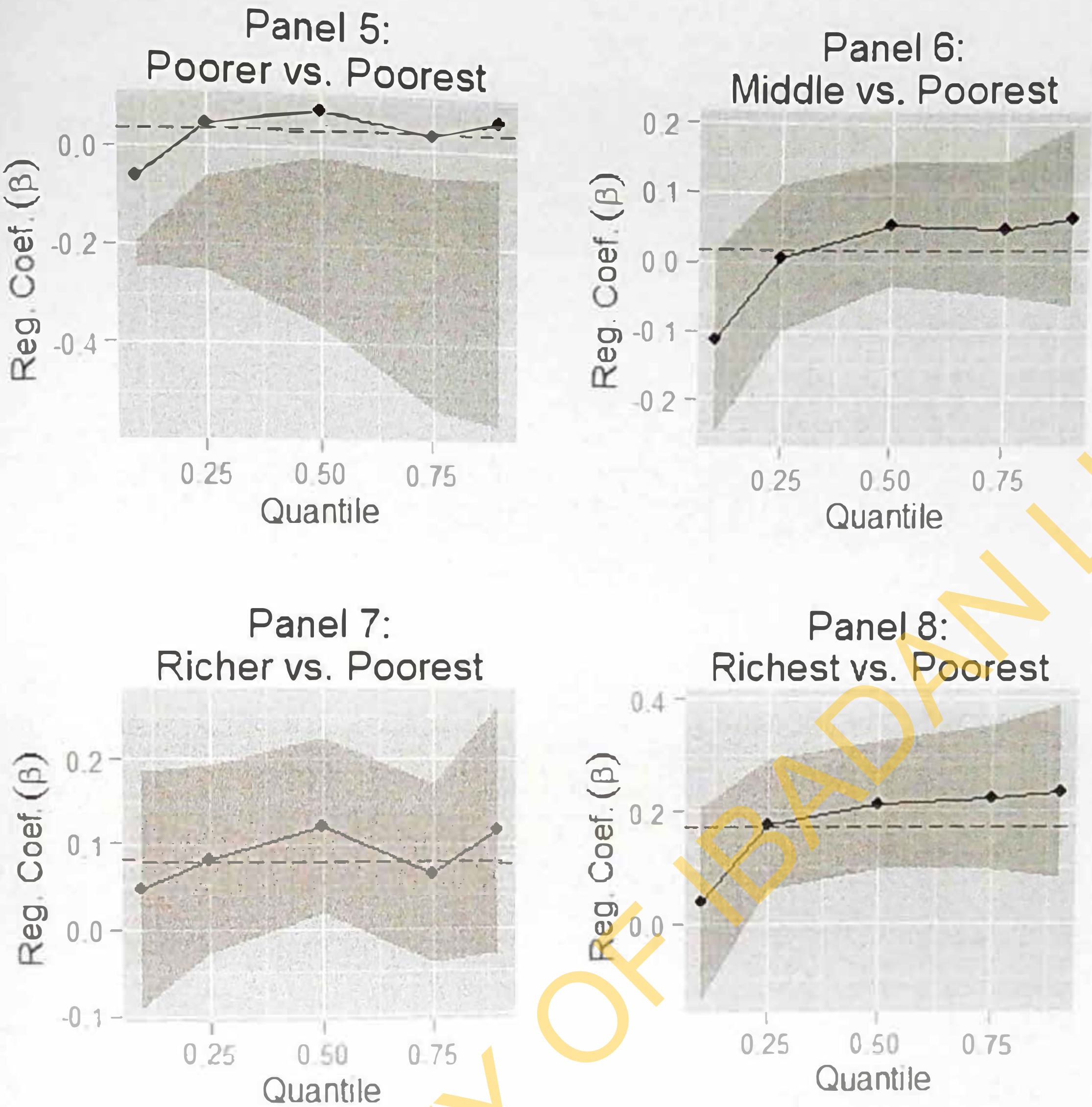

Figure 4.3.2: Quantile regression models demonstrating effects of wealth index (compared with poorest) on weight-for-age z-scores.

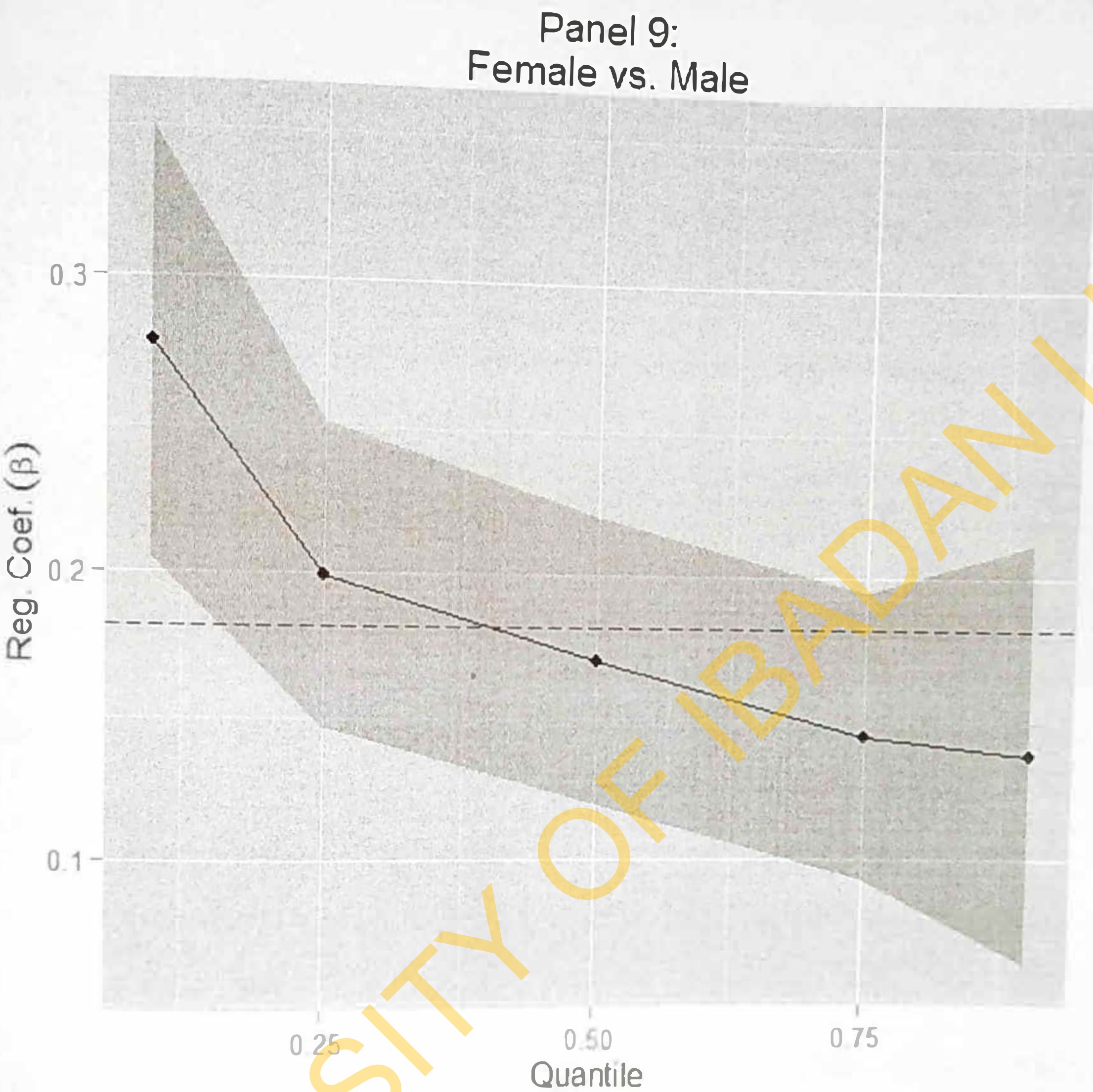

Figure 4.3.3: Quantile regression models demonstrating effects of child's sex (compared with male) on weight-for-age z-scores.

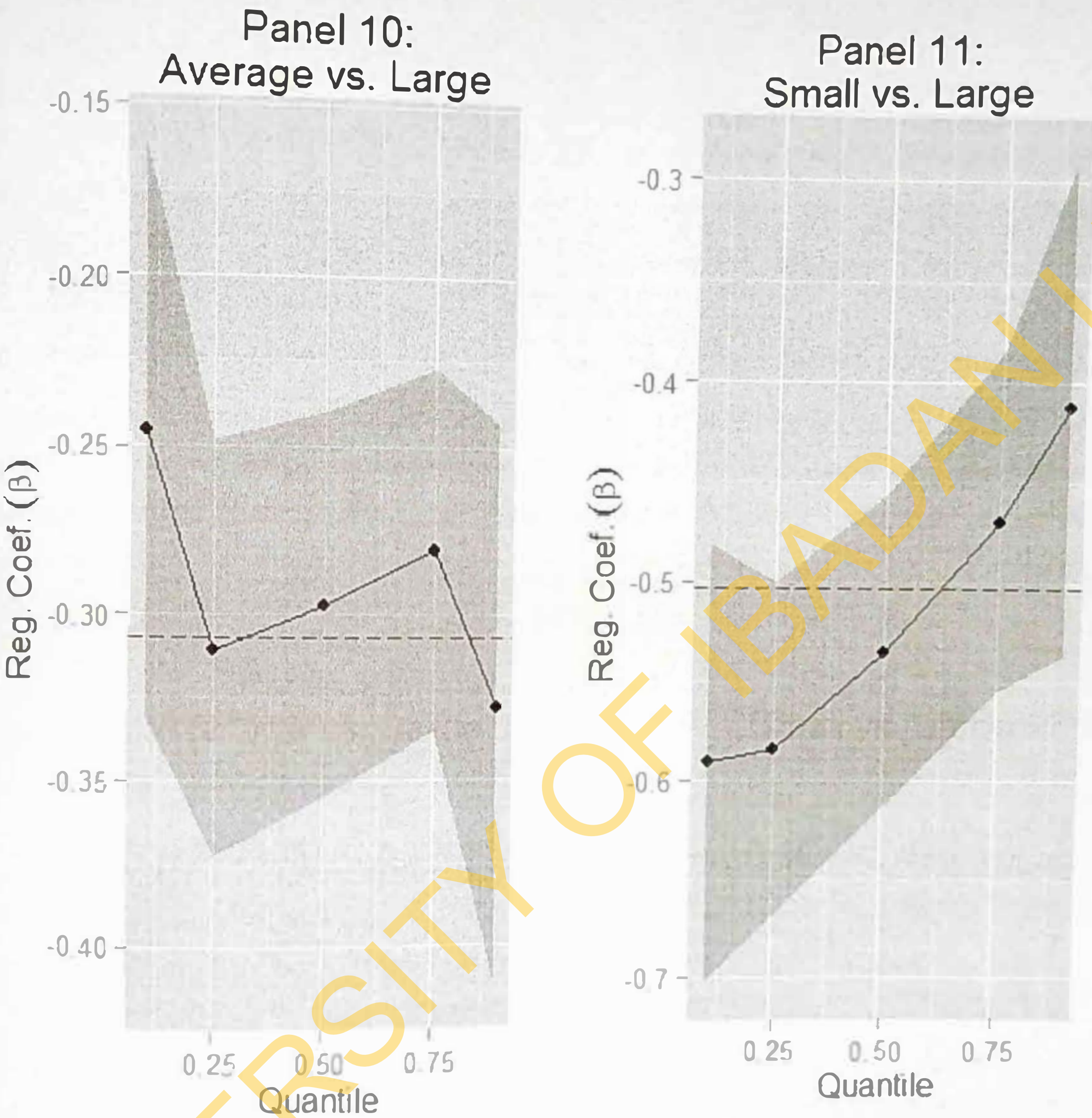

Figure 4.3.4: Quantile regression models demonstrating effects of child's size at birth (compared with large) on weight-for-age z-scores.

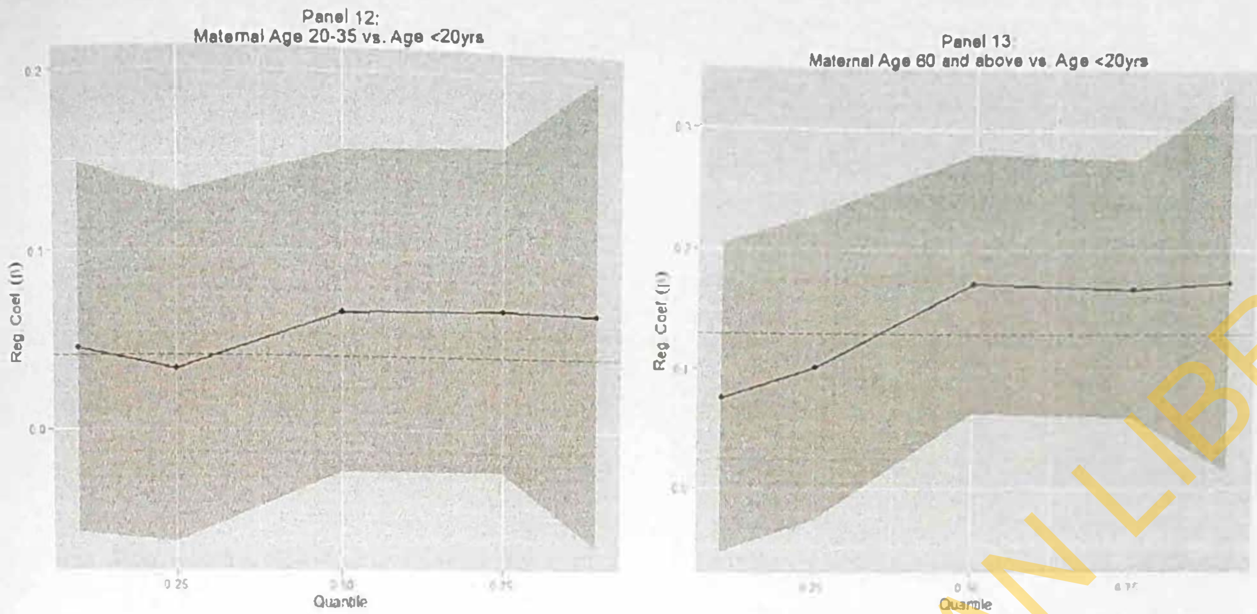

Figure 4.3.5: Quantile regression models demonstrating effects of maternal age (compared with <20 years) on weight-for-age z-scores.

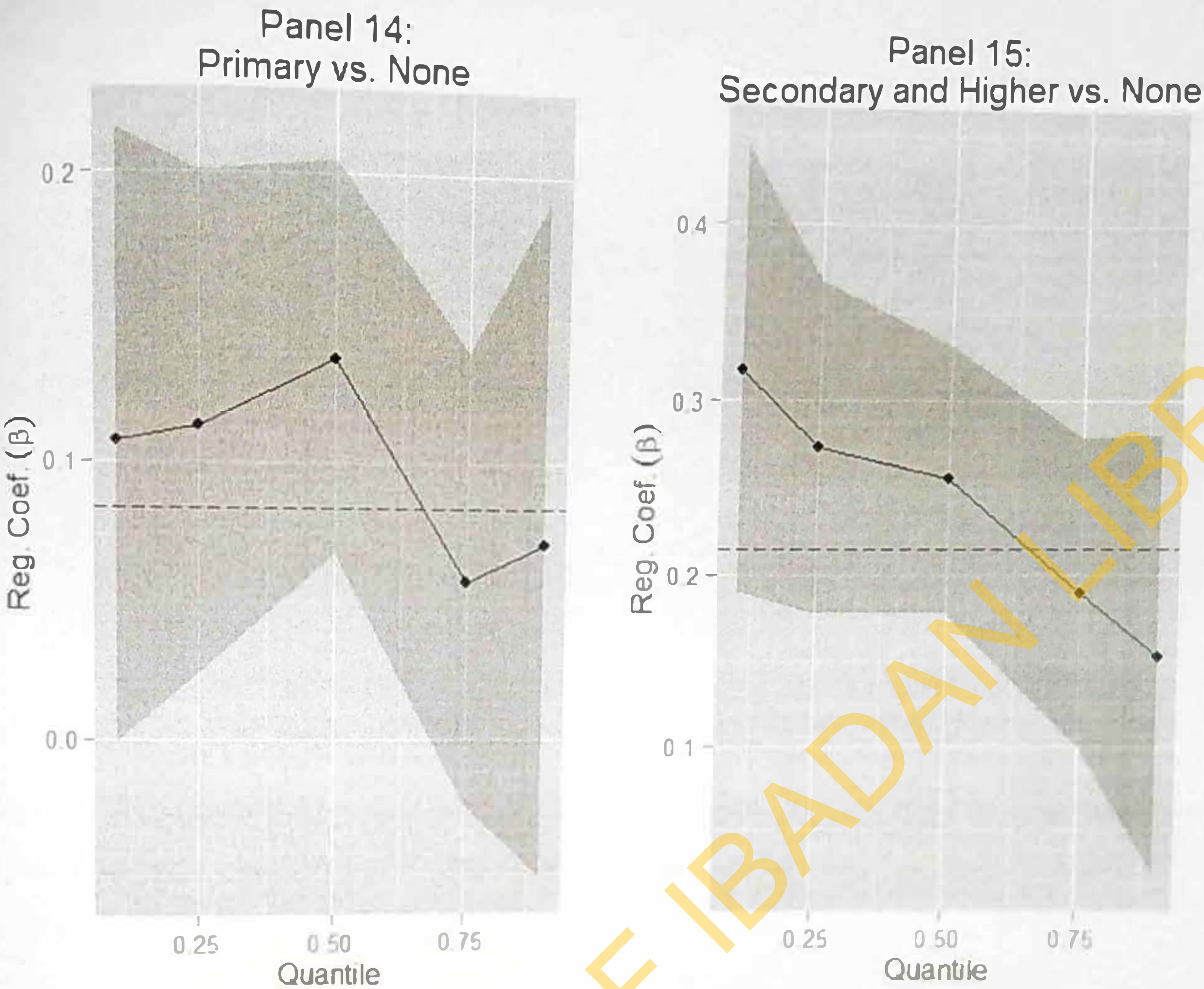

Figure 4.3.6: Quantile regression models demonstrating effects of mother's education level (compared with 'no education') on weight-for-age z-scores.

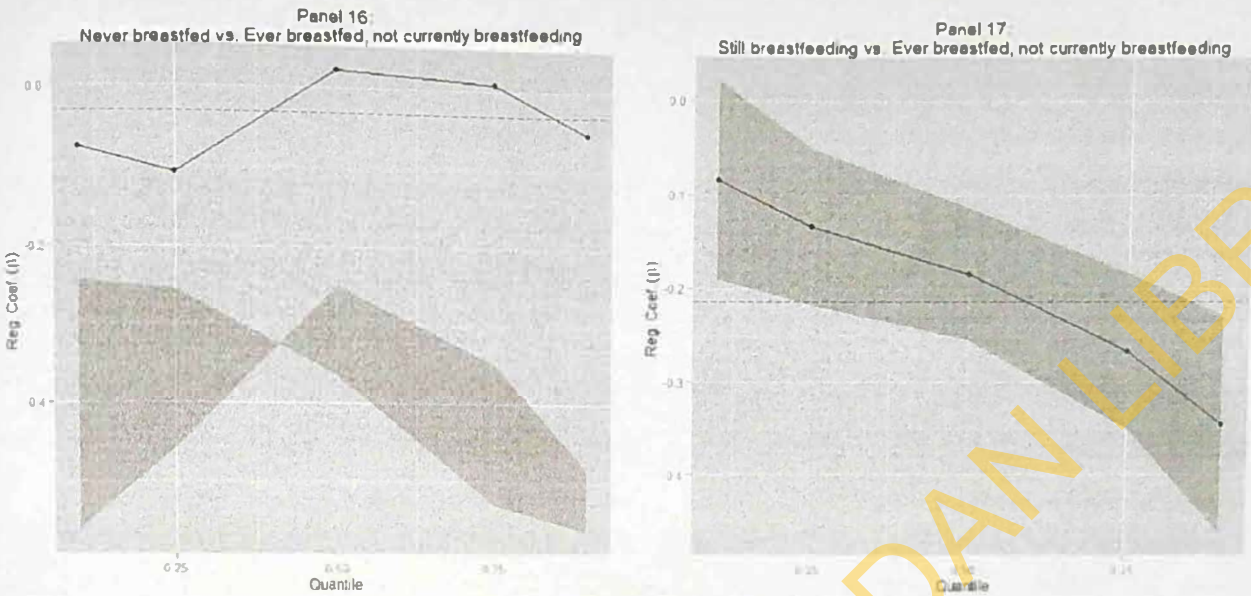

Figure 4.3.7: Quantile regression models demonstrating effects of breastfeeding duration (compared with 'ever breastfed') on weight-for-age z-scores.

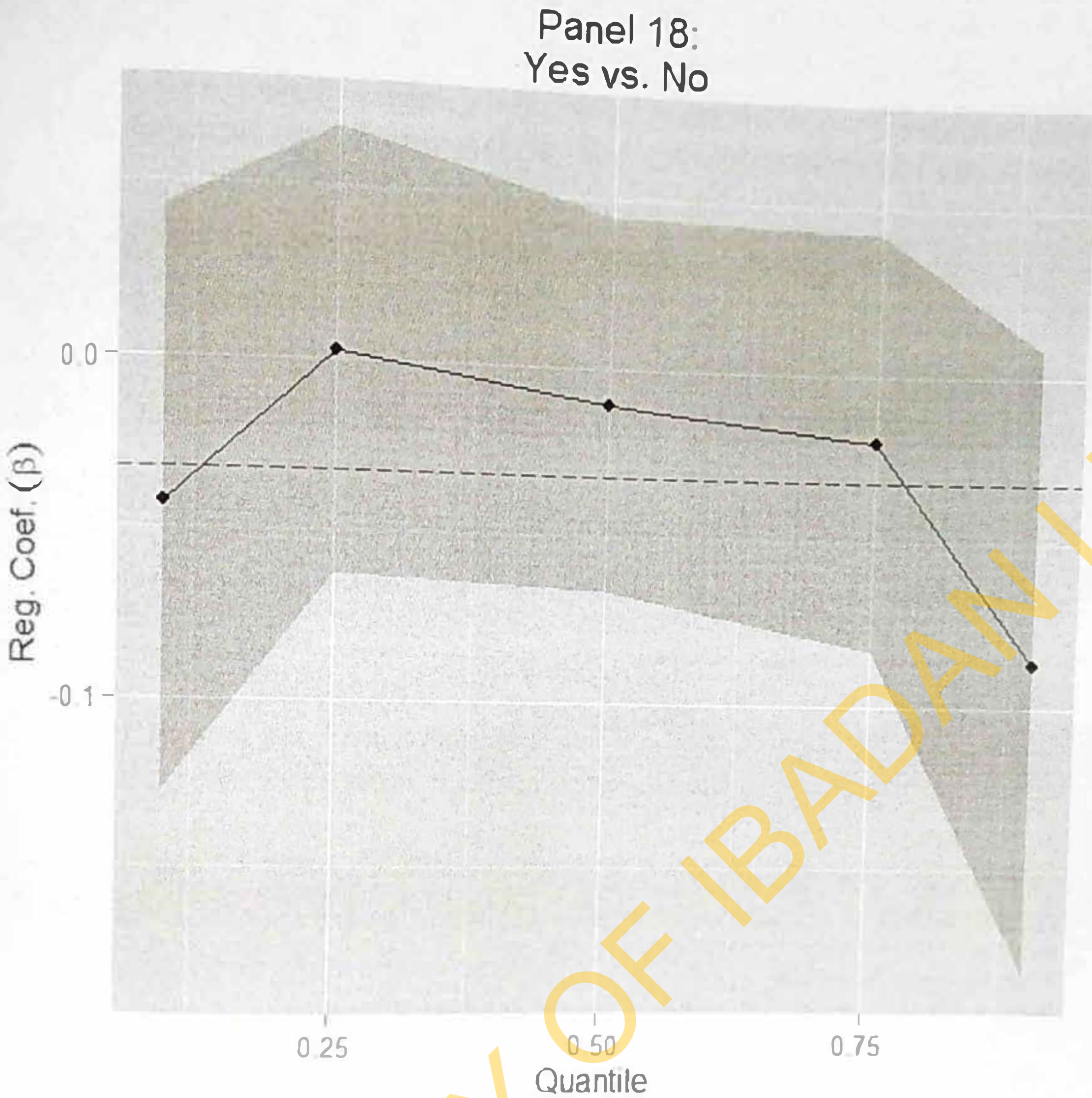

Figure 4.3.8: Quantile regression models demonstrating effects of maternal working status (compared with 'not working') on weight-for-age z-scores.

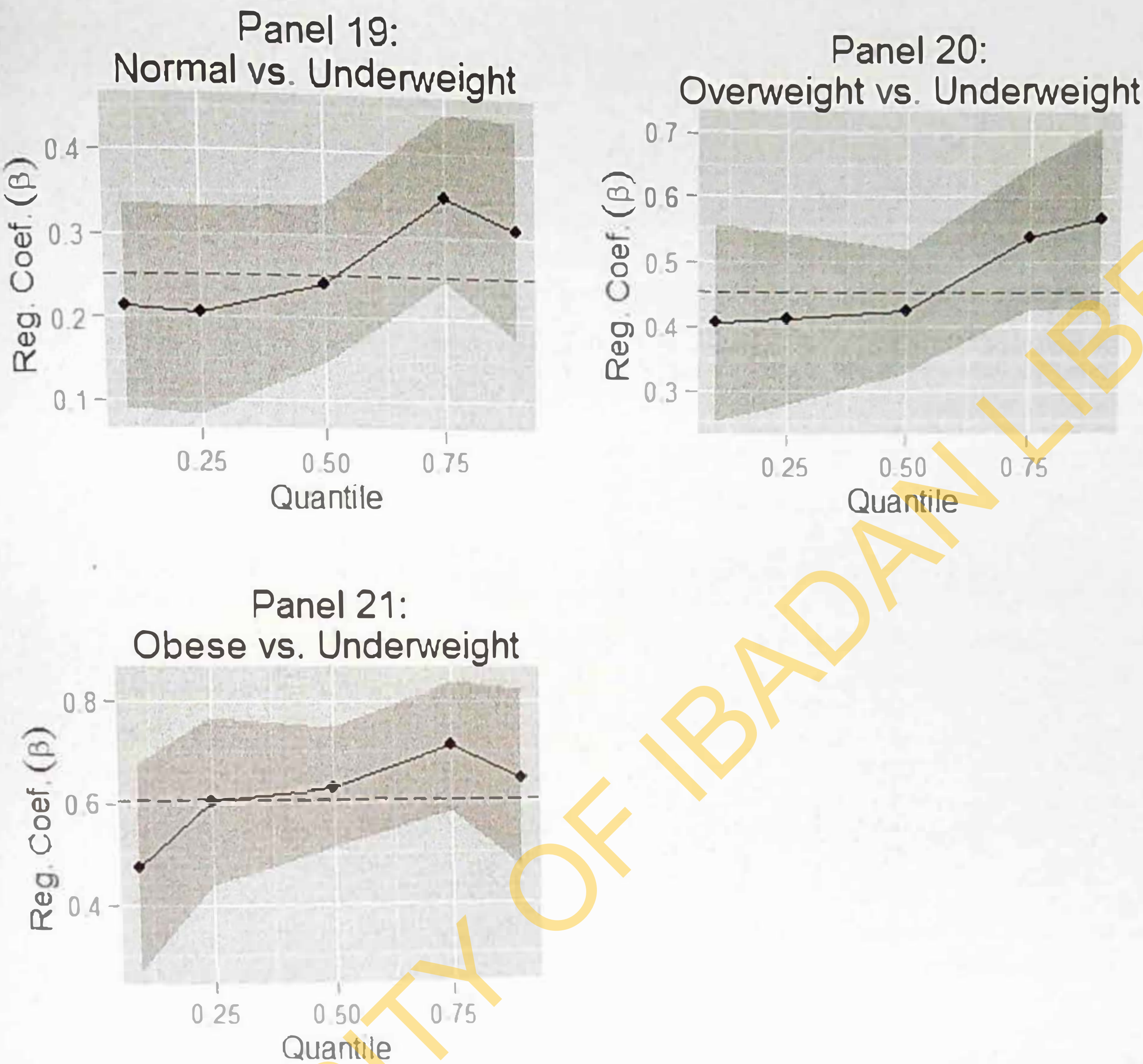

Figure 4.3.9: Quantile regression models demonstrating effects of maternal BMI (compared with 'underweight') on weight-for-age z-scores.

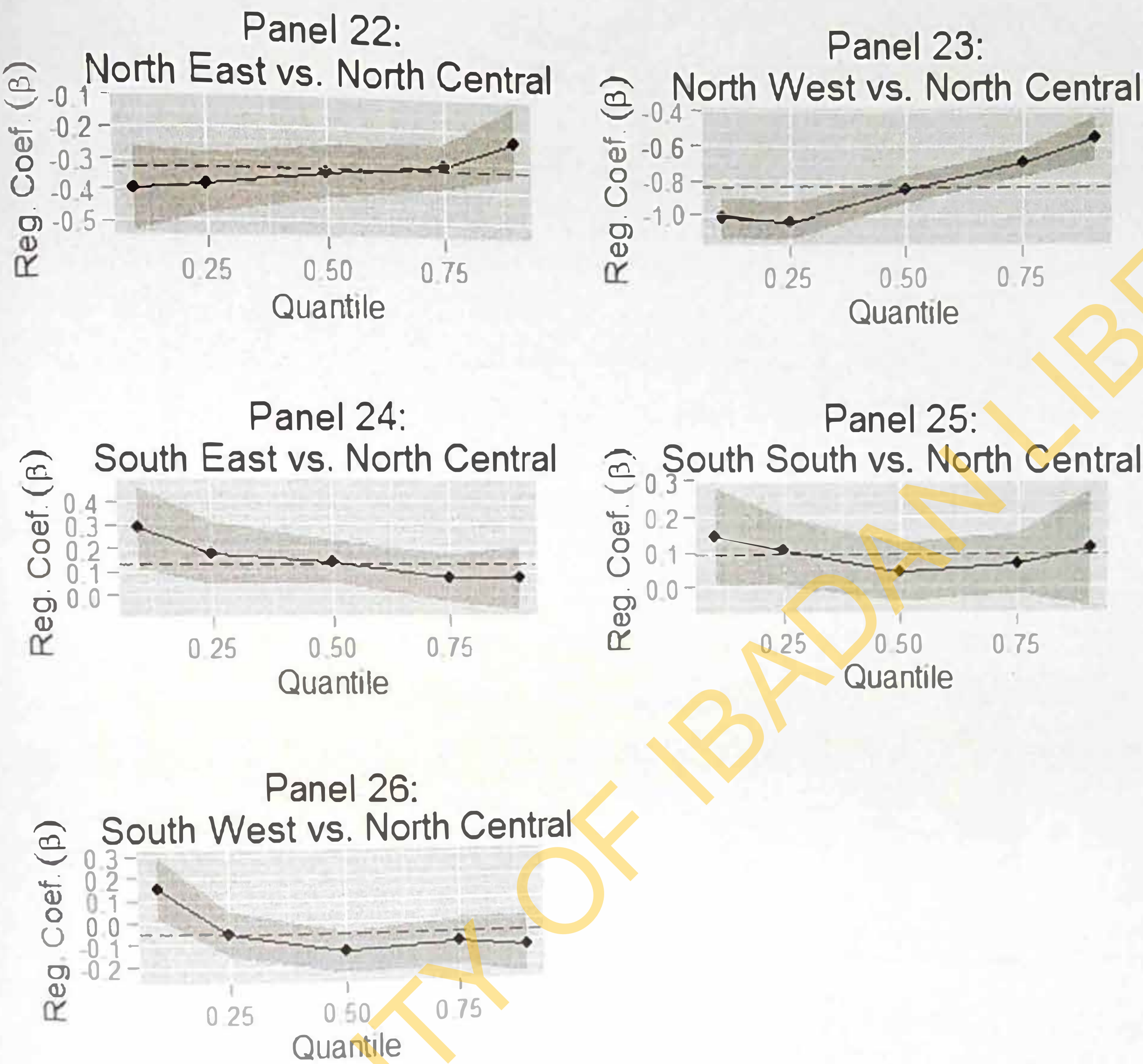

Figure 4.3.10: Quantile regression models demonstrating effects of region (compared with North Central) on weight-for-age z-scores.

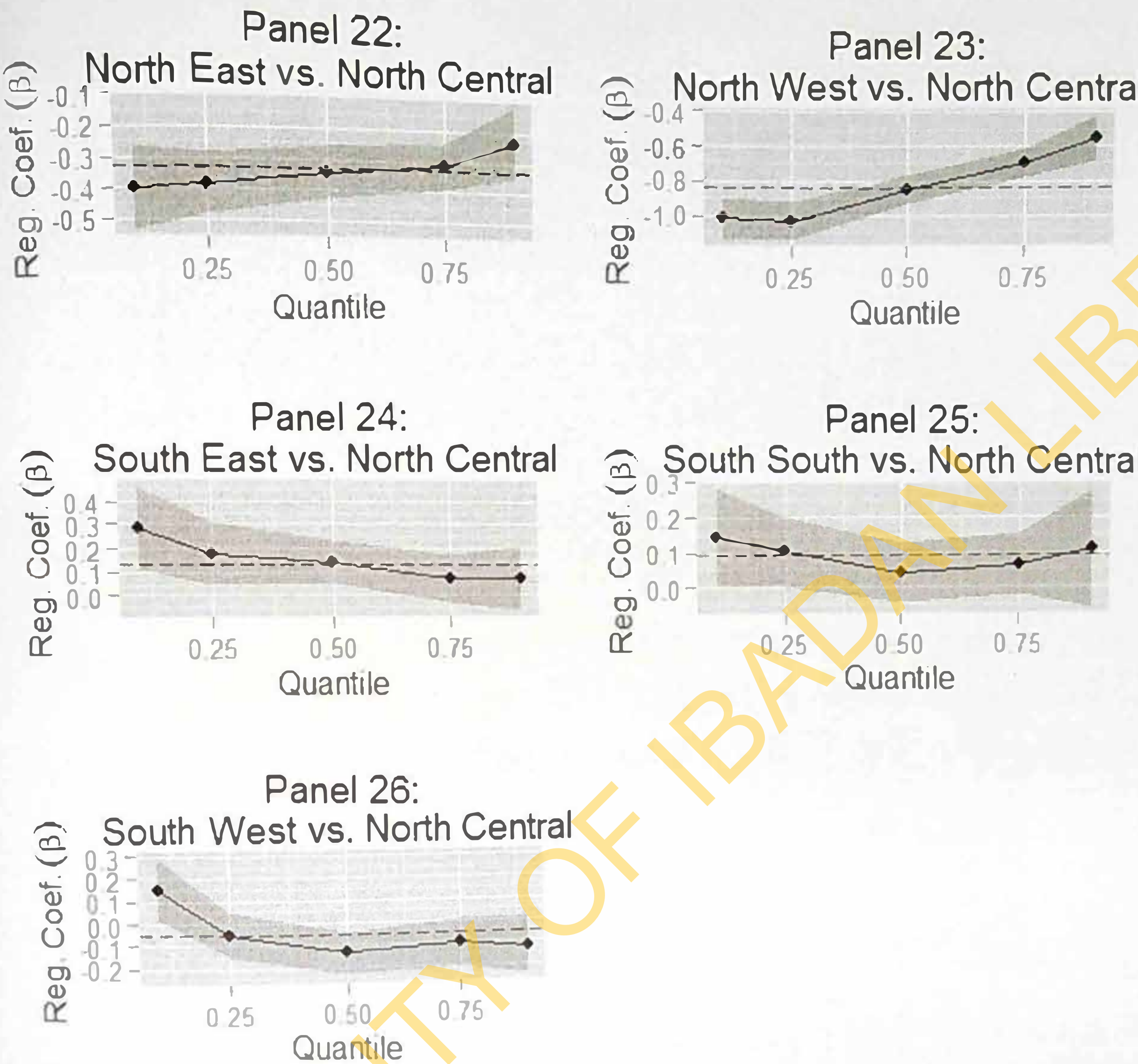

Figure 4.3.10: Quantile regression models demonstrating effects of region (compared with North Central) on weight-for-age z-scores.

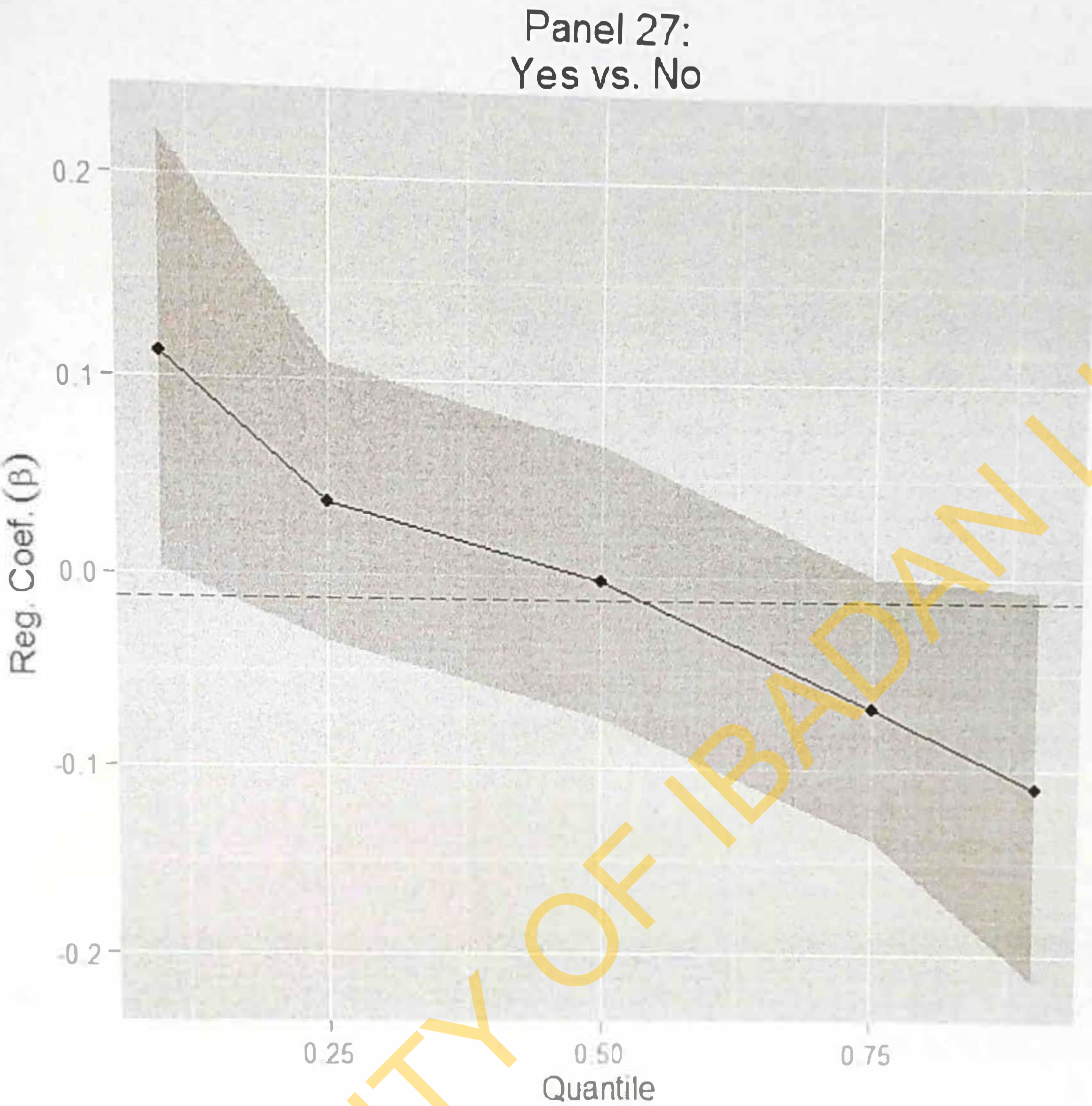

Figure 4.3.11: Quantile regression models demonstrating effects of antenatal visit (compared with 'no visit') on weight-for-age z-scores.

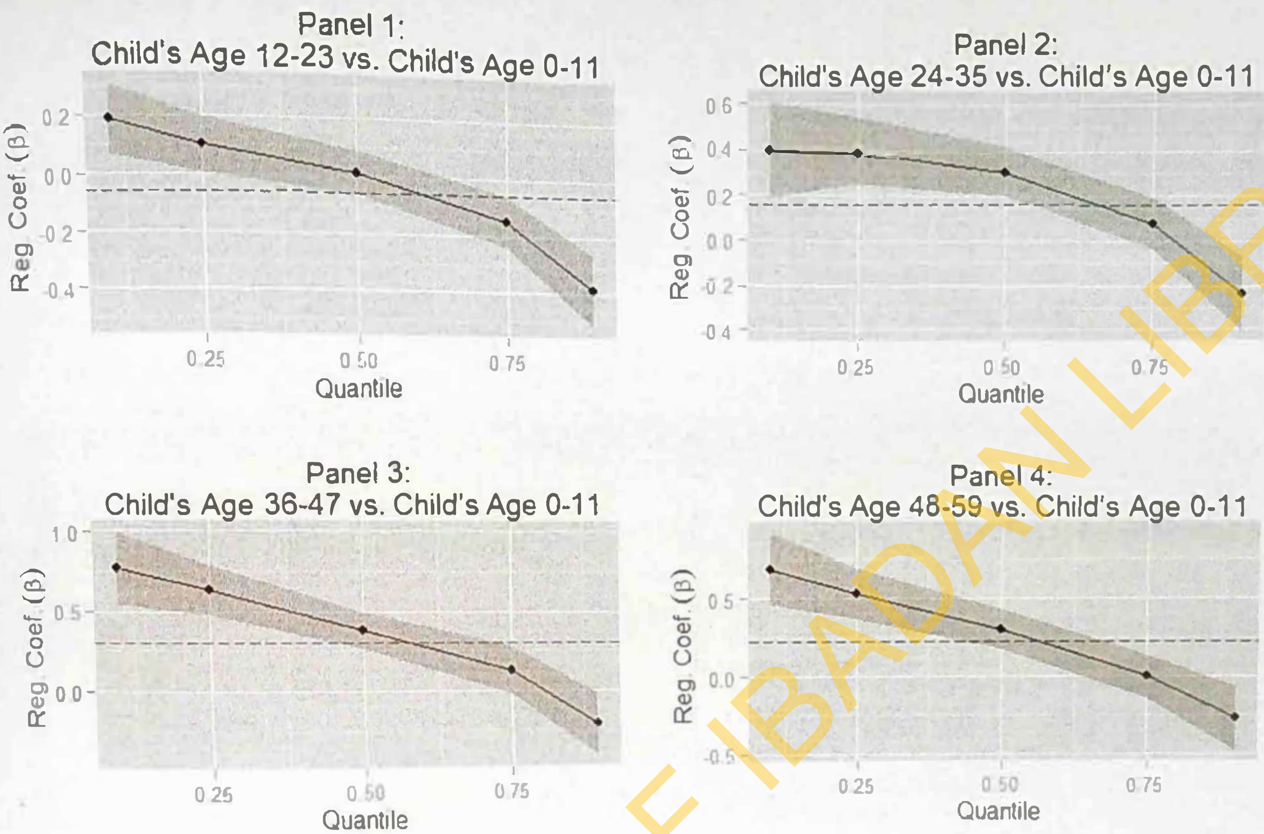

Figure 4.4.1: Quantile regression models demonstrating effects of child's age (compared with 0-11 months) on weight-for-height z-scores.

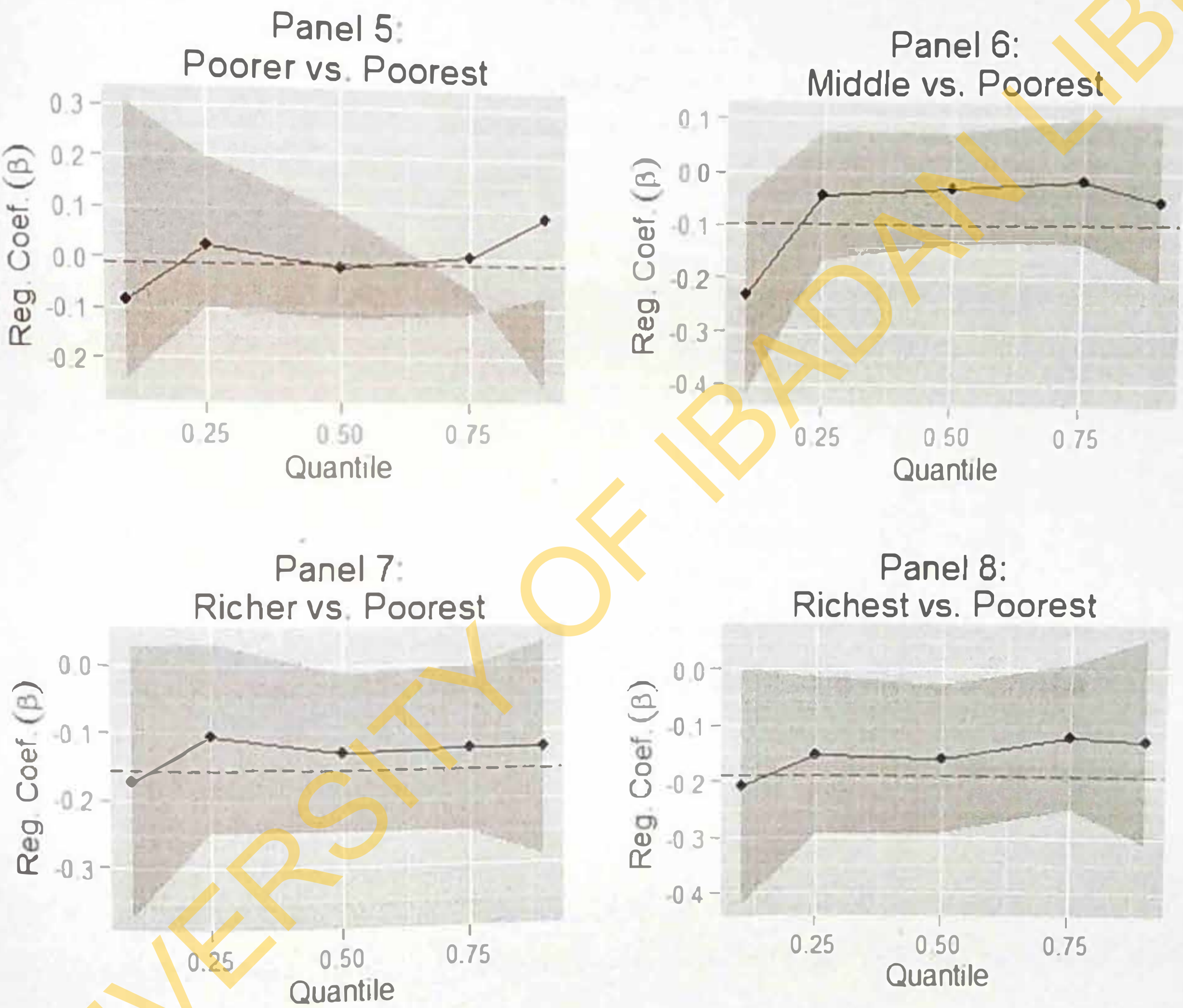

Figure 4.4.2: Quantile regression models demonstrating effects of wealth index (compared with poorest) on weight-for-height z-scores.

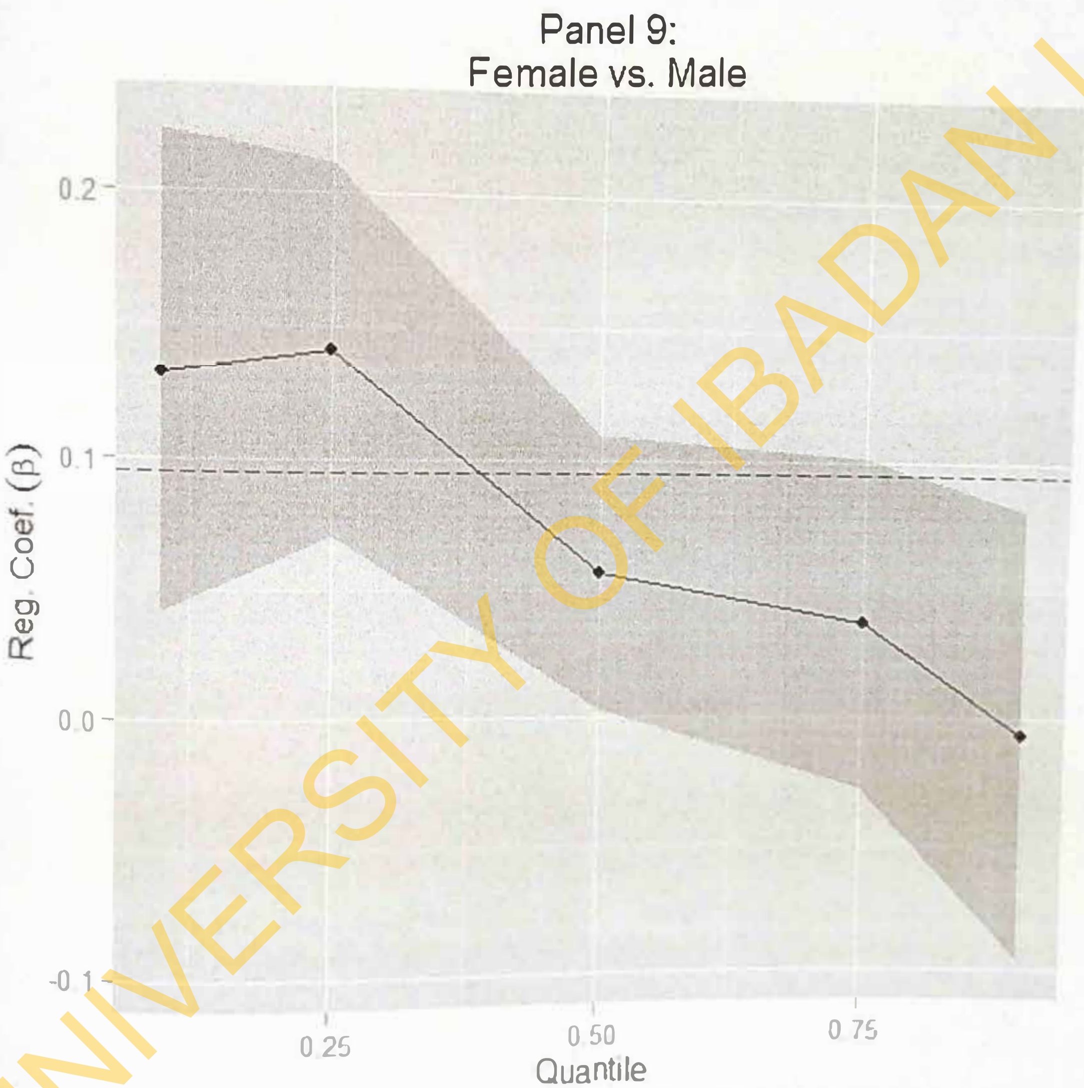

Figure 4.4.3: Quantile regression models demonstrating effects of sex (compared with male) on weight-for-height z-scores.

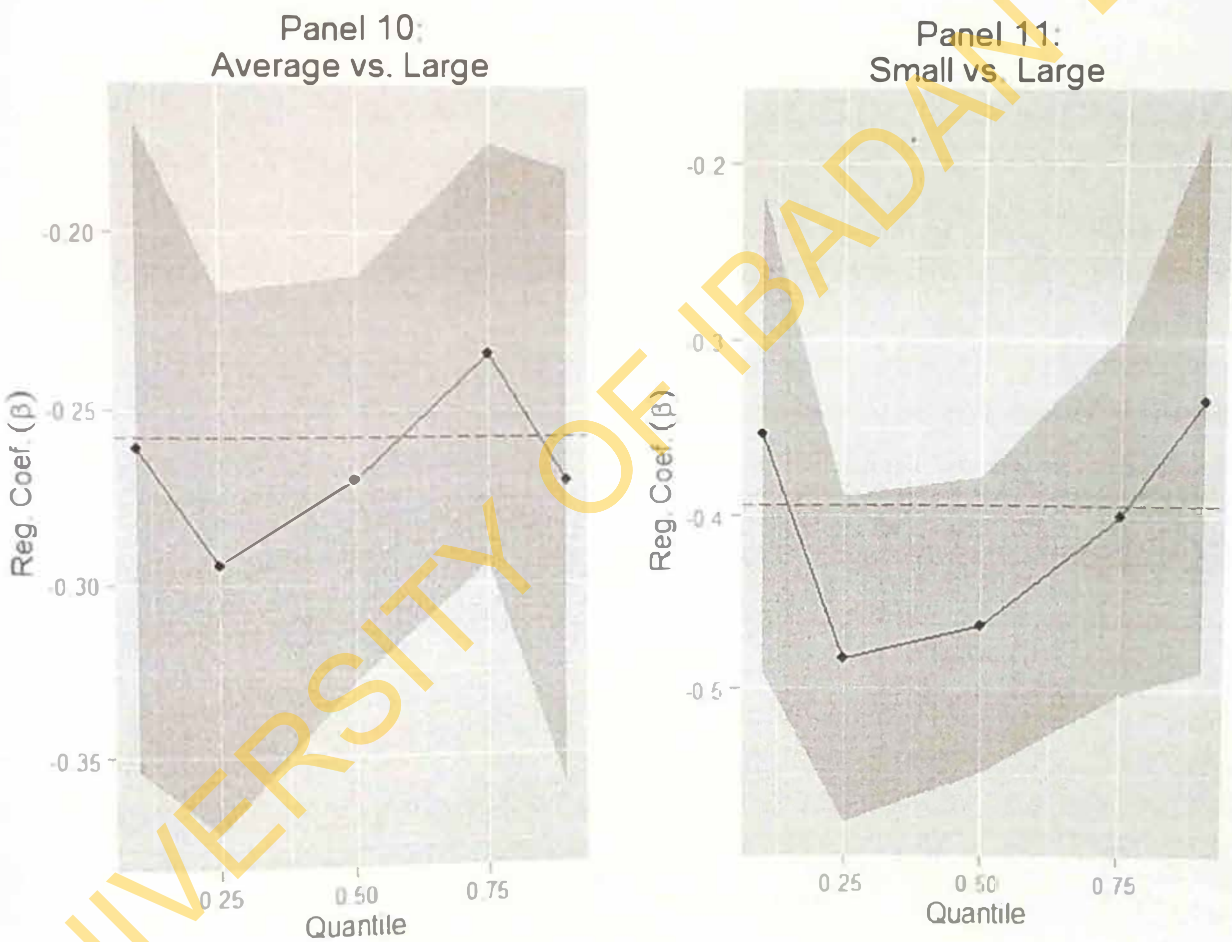

Figure 4.4.4: Quantile regression models demonstrating effects of size of child at birth (compared with large) on weight-for-height z-scores.

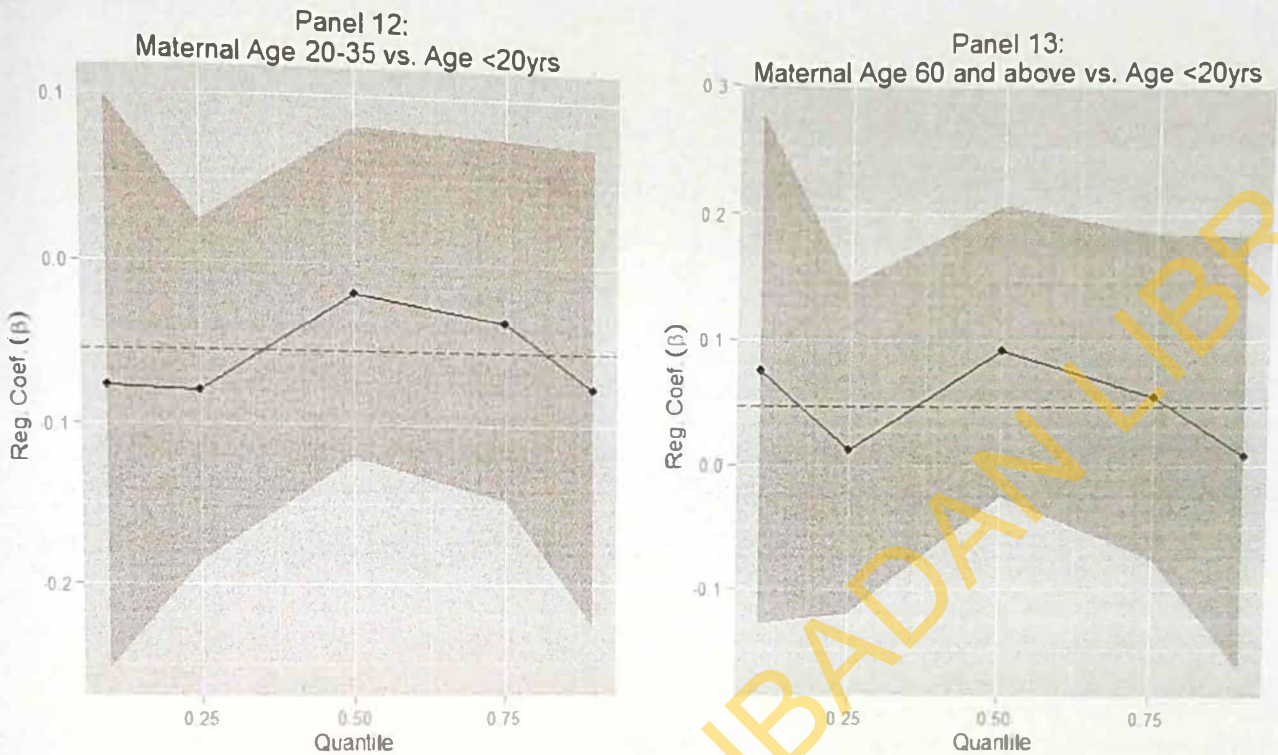

Figure 4.4.5: Quantile regression models demonstrating effects of maternal age (compared with age <20 years) on weight-for-height z-scores.

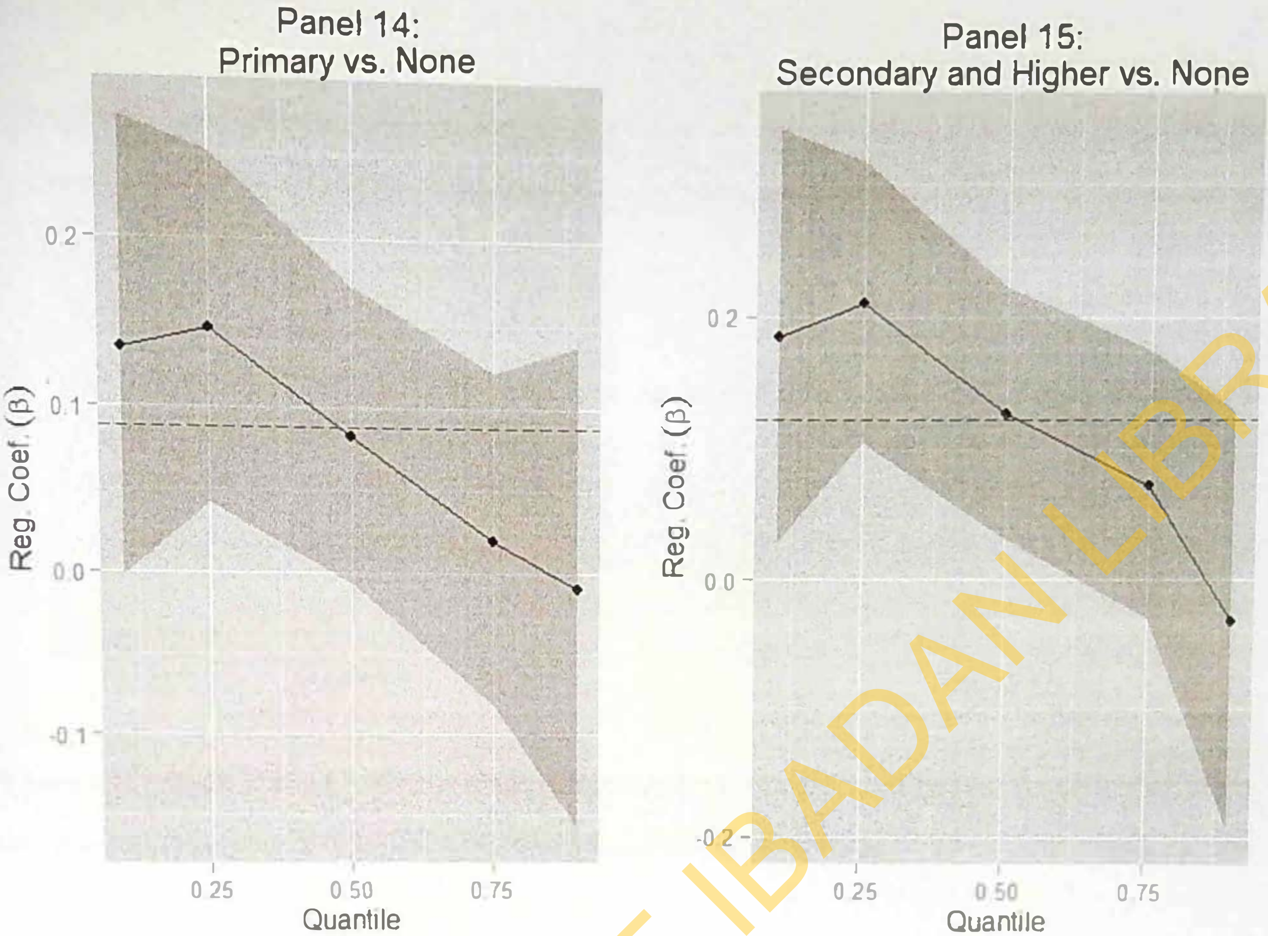

Figure 4.4.6: Quantile regression models demonstrating effects of maternal educational level (compared with 'no education') on weight-for-height z-scores.

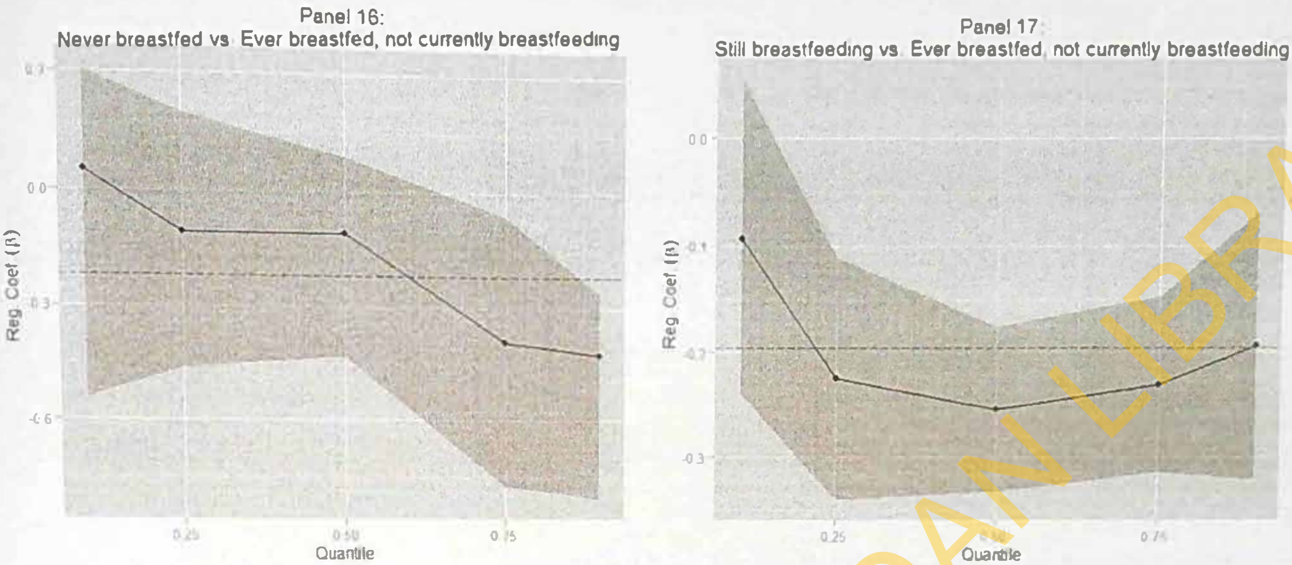

Figure 4.4.7: Quantile regression models demonstrating effects of breast feeding duration (compared with 'ever breastfed') on weight-for-height z-scores.

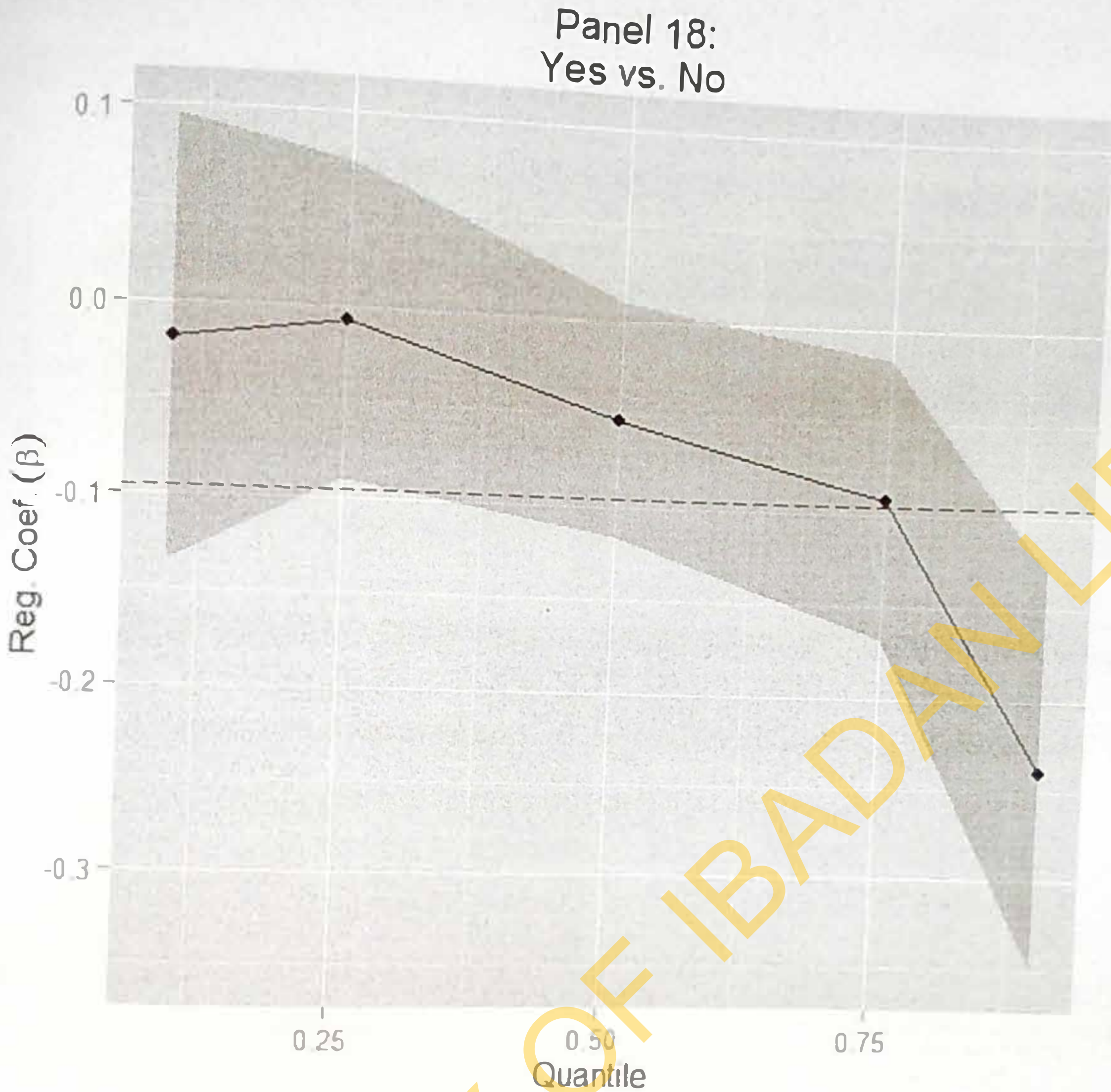

Figure 4.4.8: Quantile regression models demonstrating effects of maternal working status (compared with 'not working') on weight-for-height z-scores.

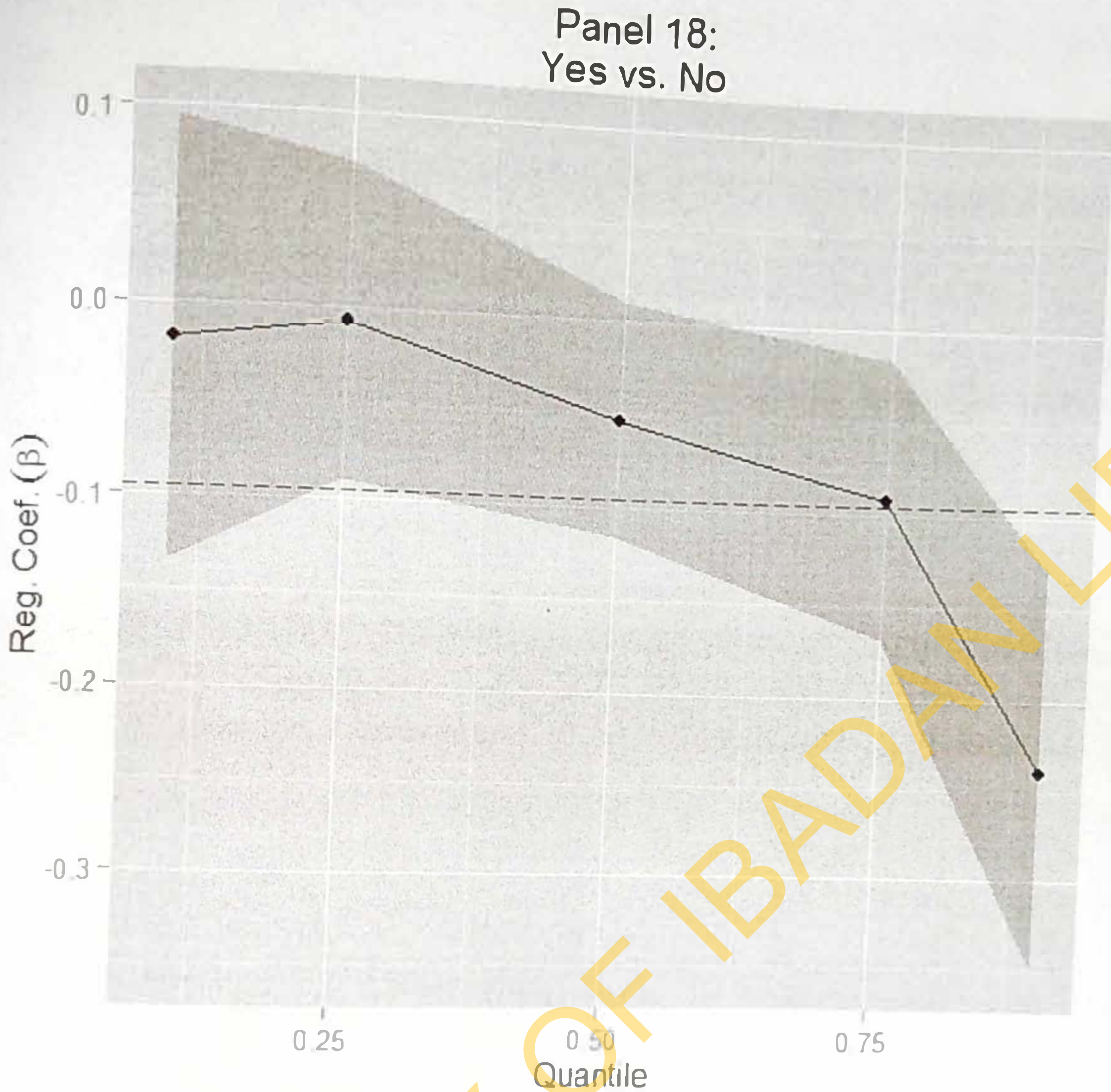

Figure 4.4.8: Quantile regression models demonstrating effects of maternal working status (compared with 'not working') on weight-for-height z-scores.

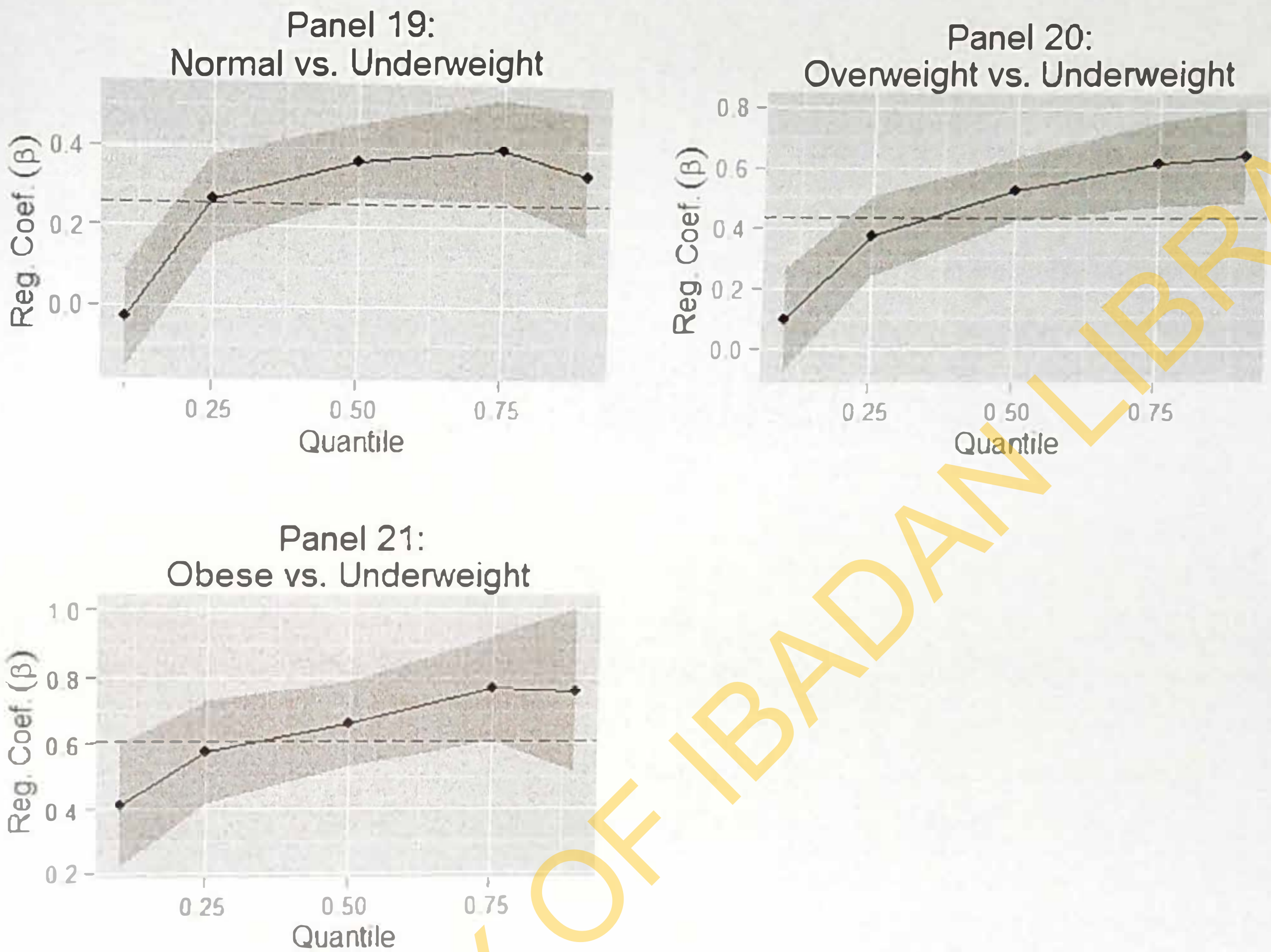

Figure 4.4.9: Quantile regression models demonstrating effects of maternal BMI (compared with underweight) on weight-for-height z-scores.

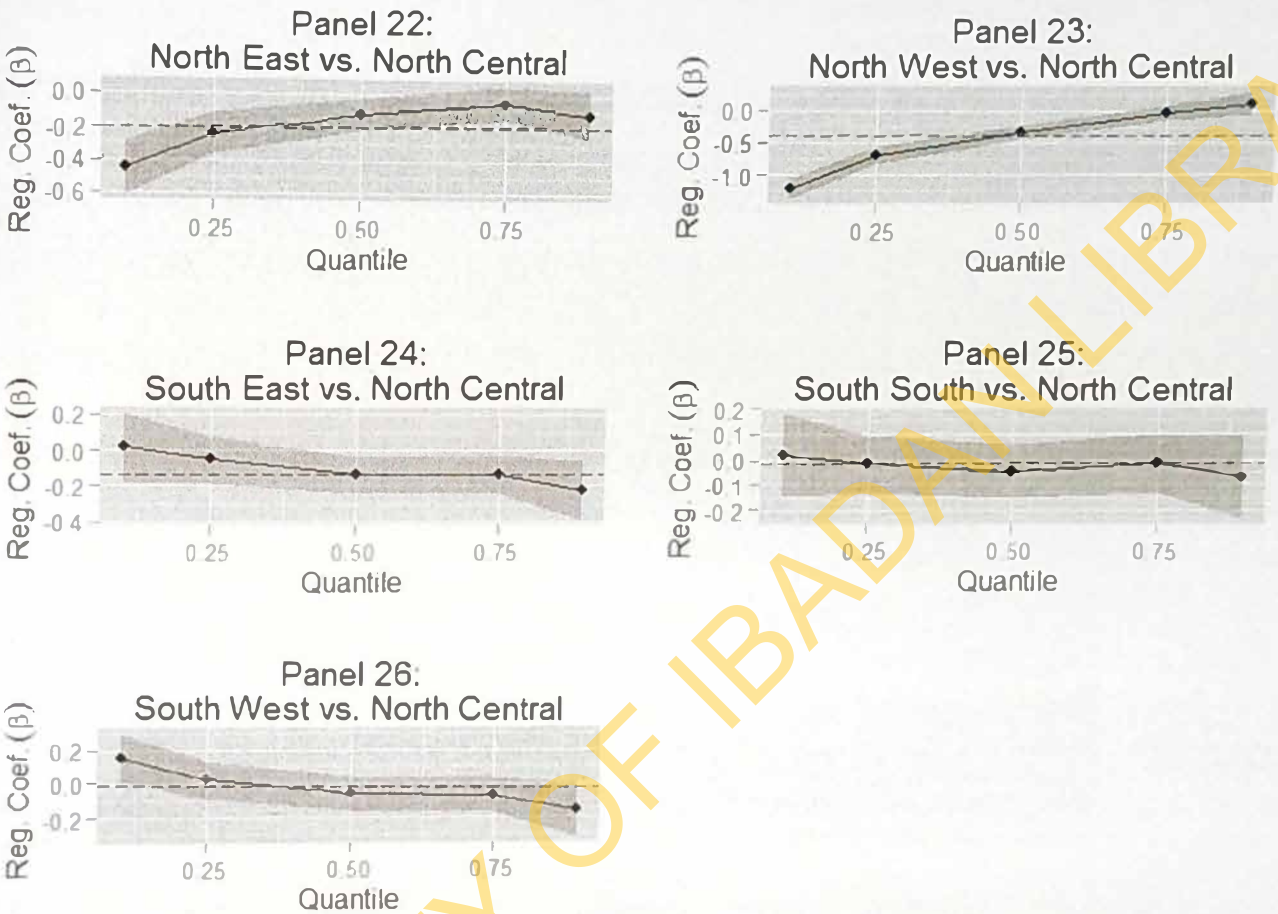

Figure 4.4.10: Quantile regression models demonstrating effects of region (compared with North Central) on weight-for-height z-scores.

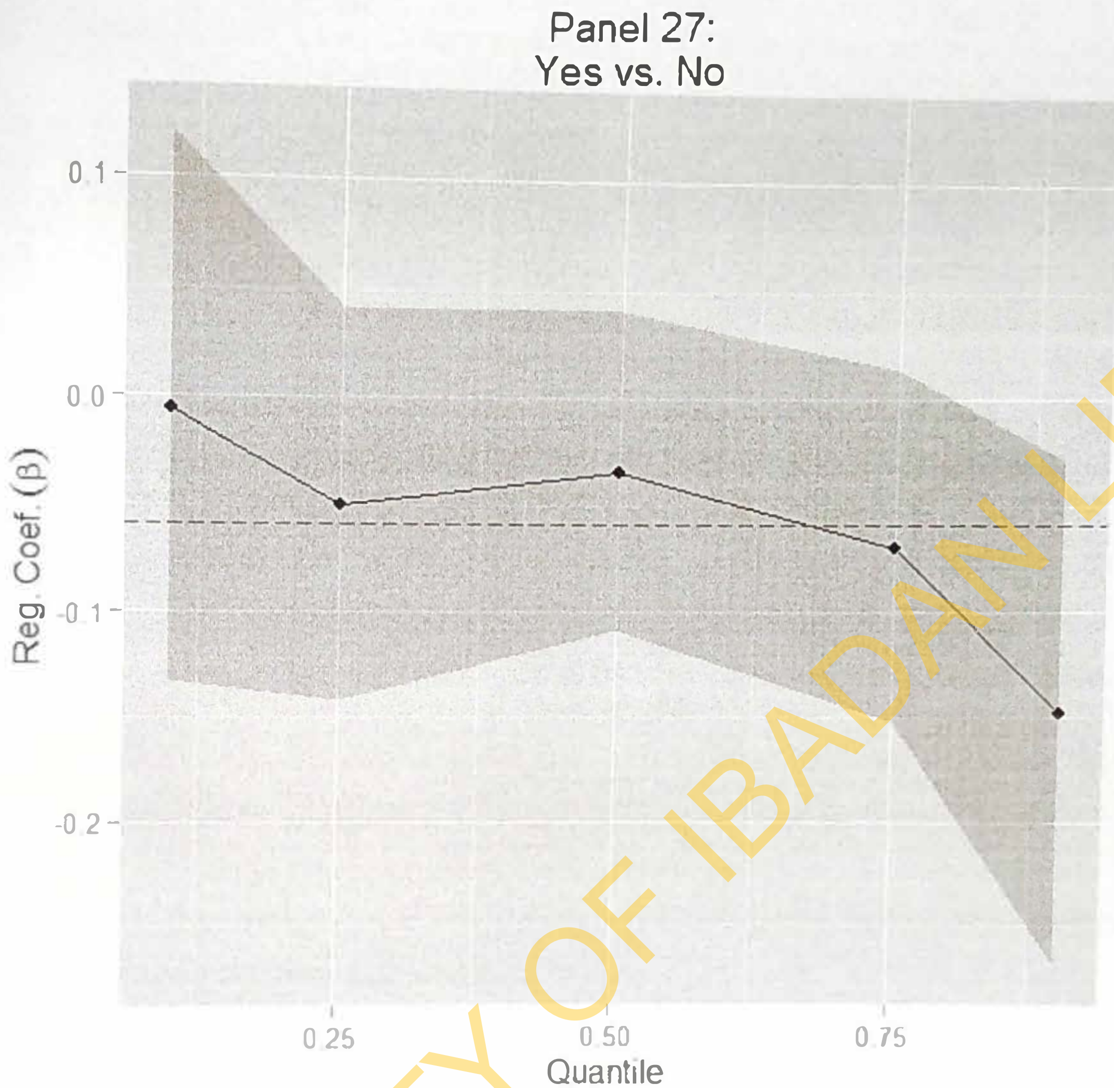

Figure 4.4.11: Quantile regression models demonstrating effects of antenatal visits (compared with 'no antenatal visit') on weight-for-height z-scores.

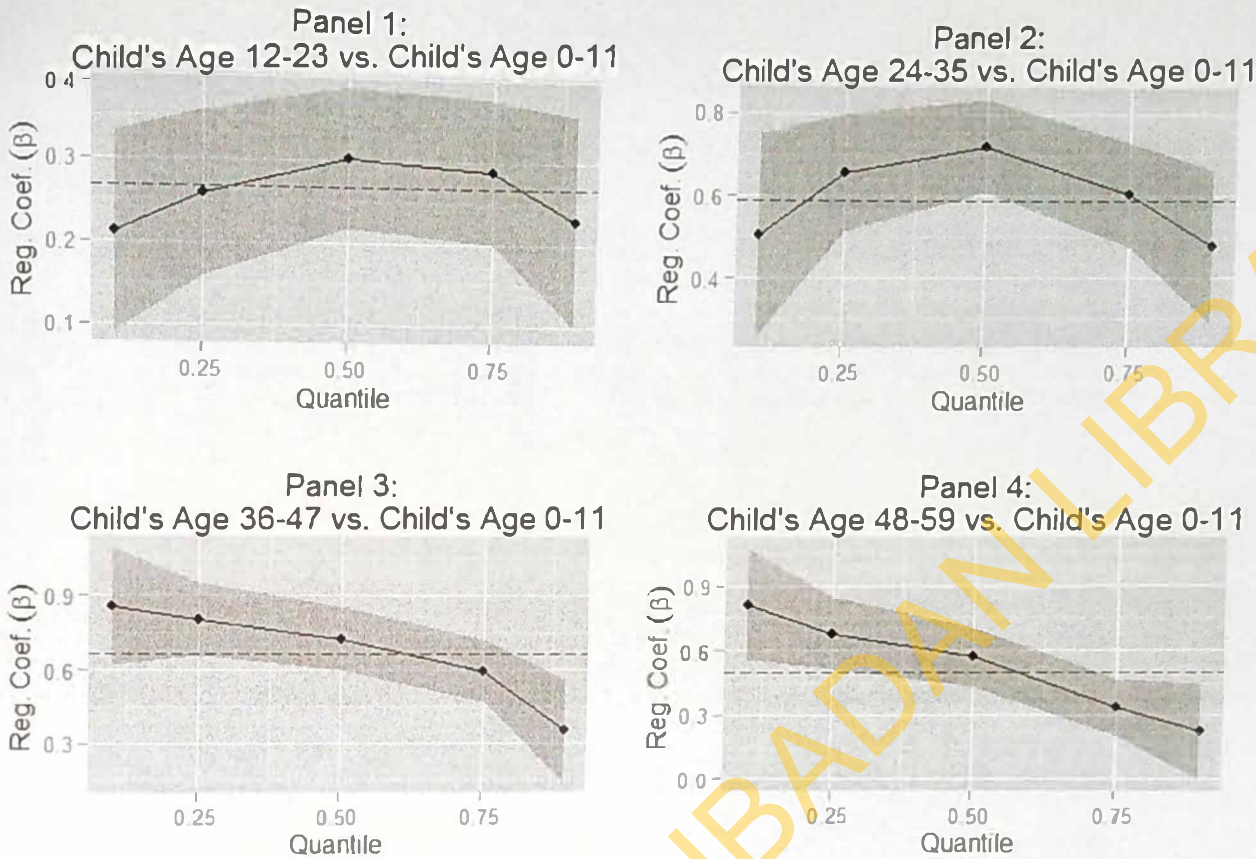

Figure 4.5.1: Quantile regression models demonstrating effects of child's age (compared with 0-11 months) on BMI-for-age z-scores.

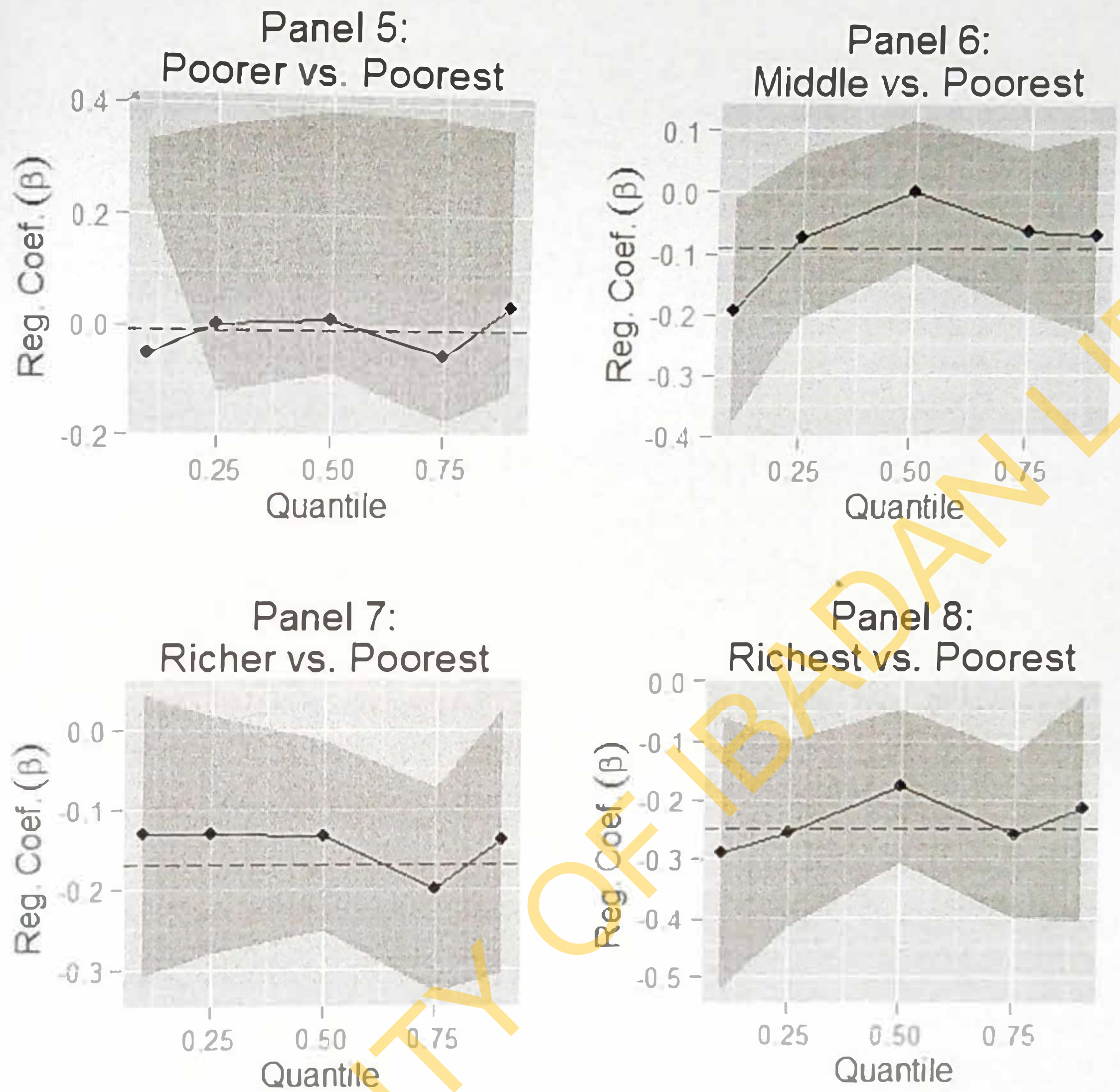

Figure 4.5.2: Quantile regression models demonstrating effects of wealth index (compared with the poorest category) on BMI-for-age z-score

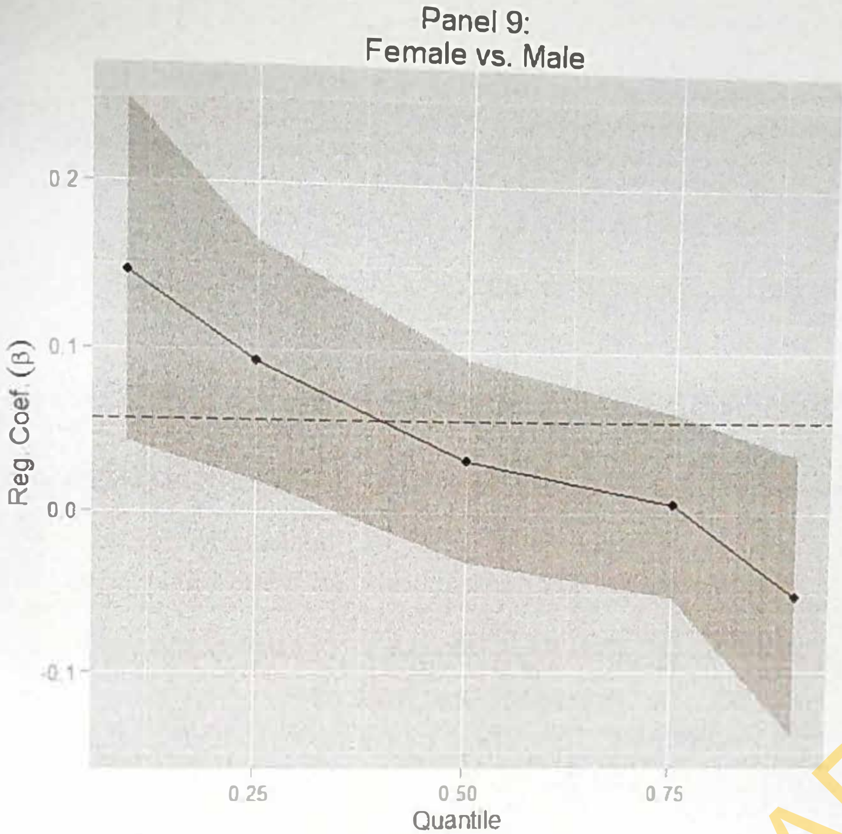

Figure 4.5.3: Quantile regression models demonstrating effects of child's sex (compared with male) on BMI-for-age z-score

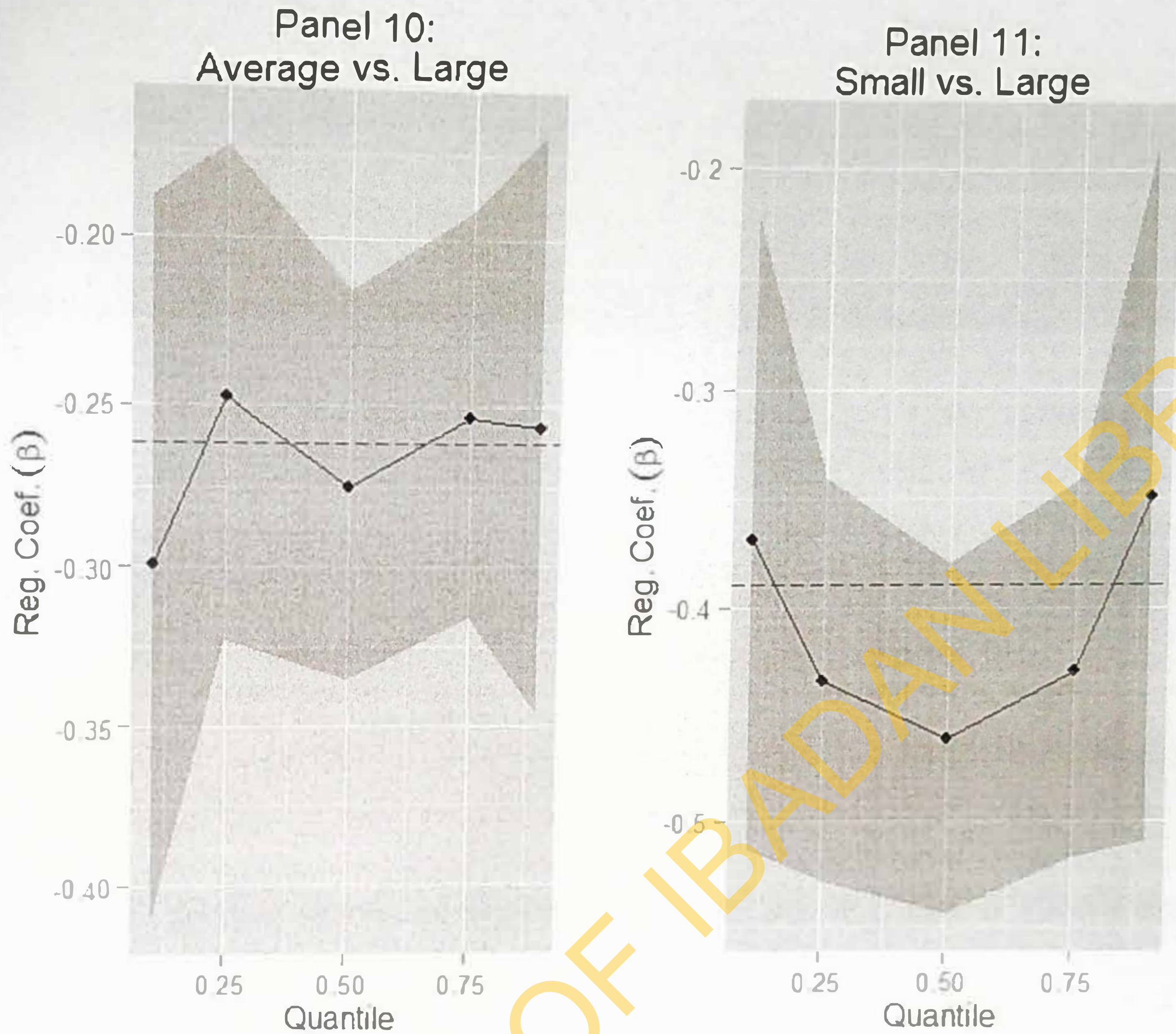

Figure 4.5.4: Quantile regression models demonstrating effects of child's size at birth (compared with large) on BMI-for-age z-score

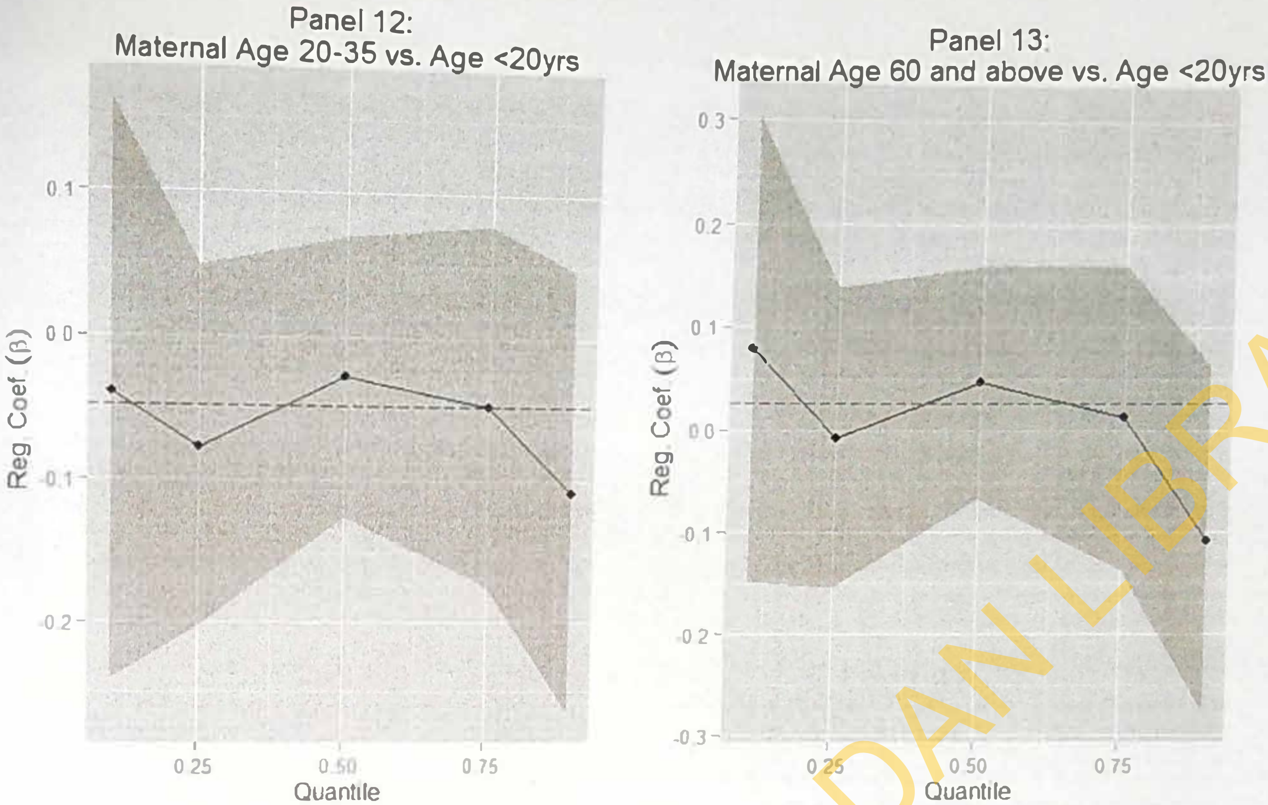

Figure 4.5.5: Quantile regression models demonstrating effects of mother's age (compared with age <20 years) on BMI-for-age z-score.

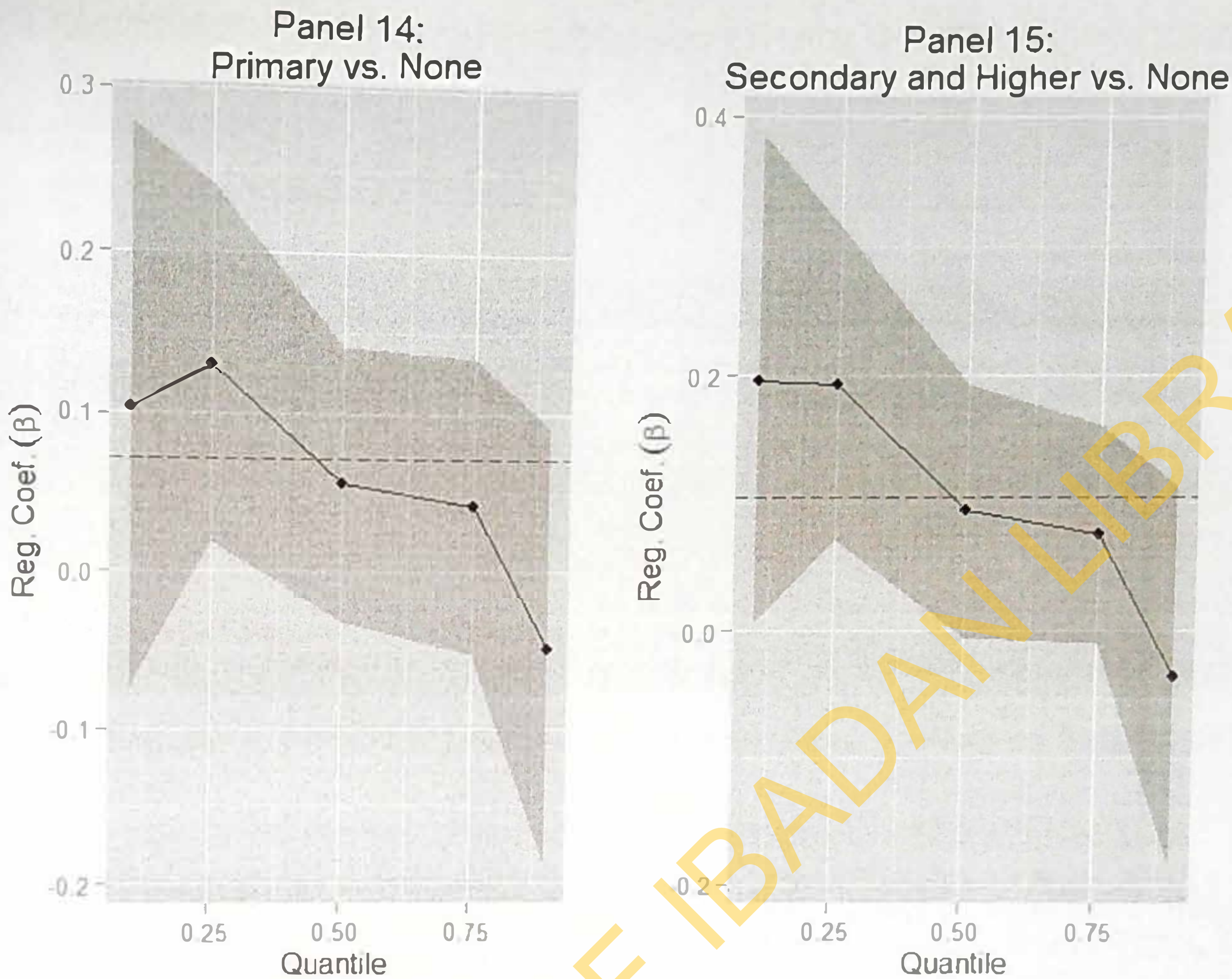

Figure 4.5.6: Quantile regression models demonstrating effects of mother's educational status (compared with no education) on BMI-for-age z-score.

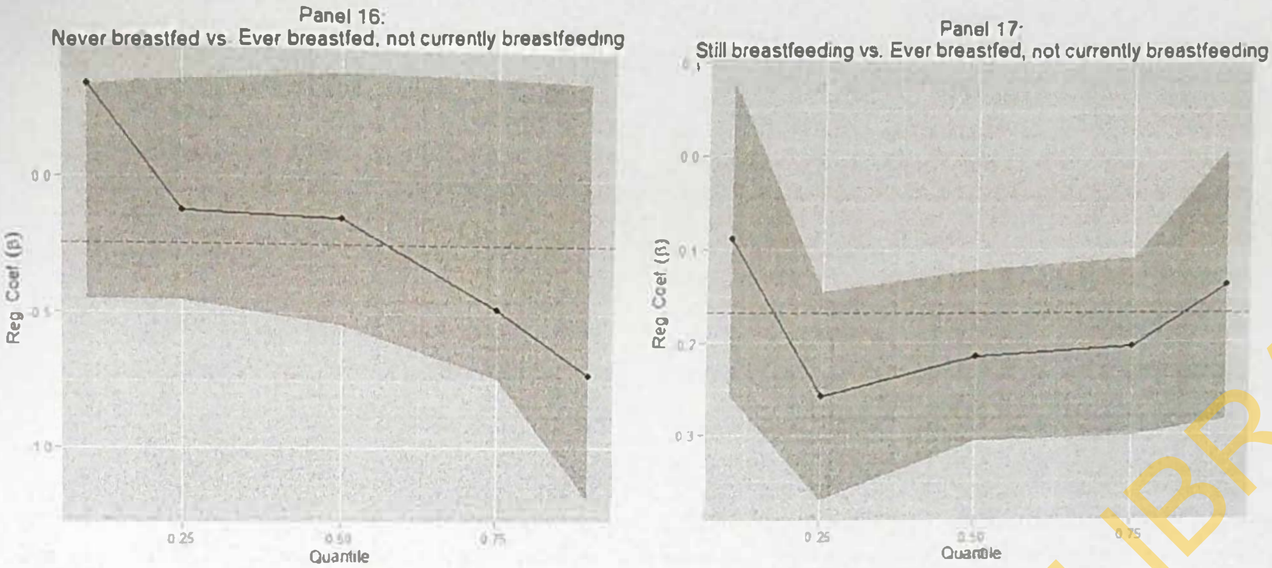

Figure 4.5.7: Quantile regression models demonstrating effects of mother's breastfeeding status (compared with ever breastfed but not currently breastfeeding) on BMI-for-age z-score.

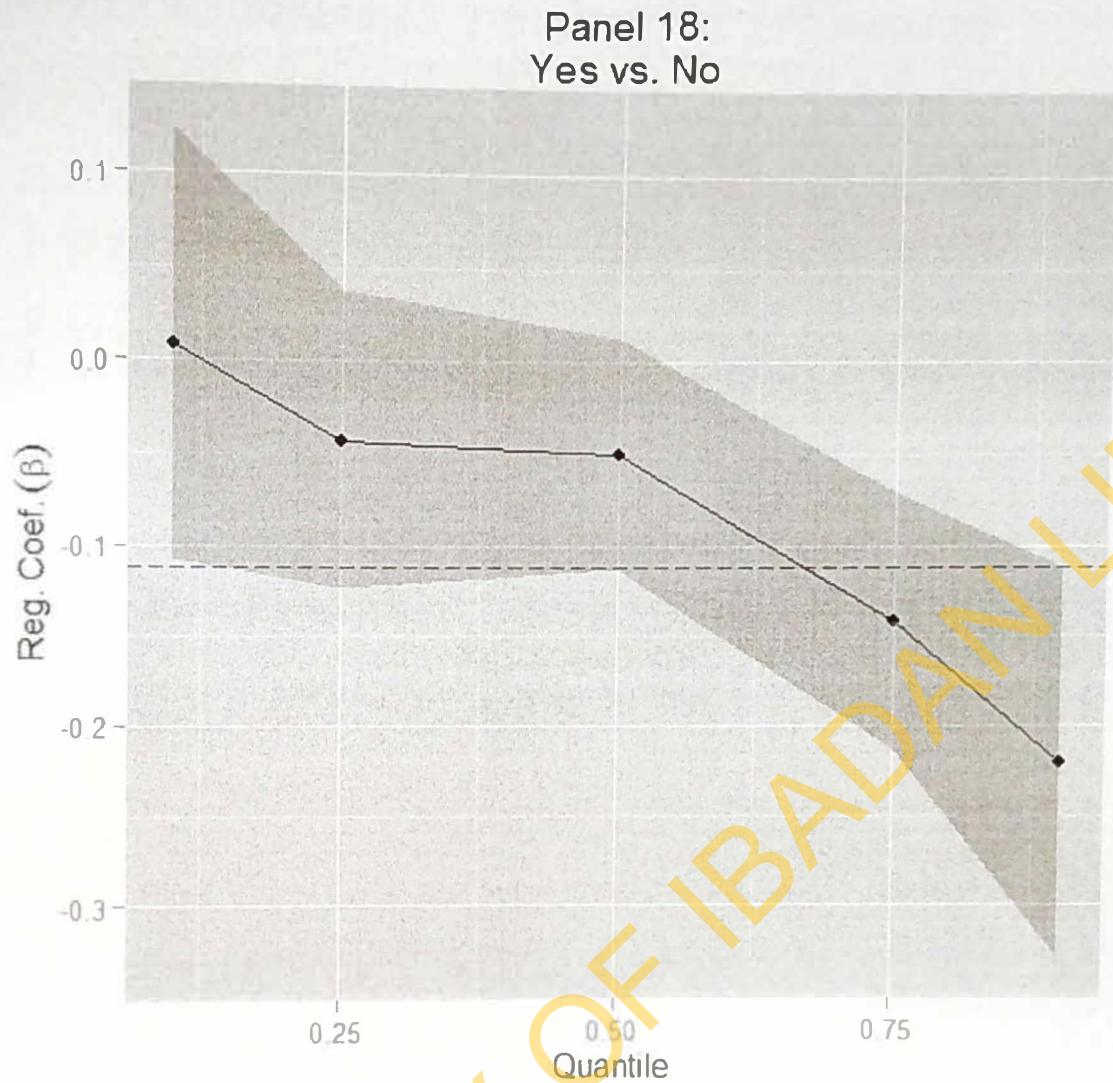

Figure 4.5.8: Quantile regression models demonstrating effects of mother's working status (compared with 'not working') on BMI-for-age z-score.

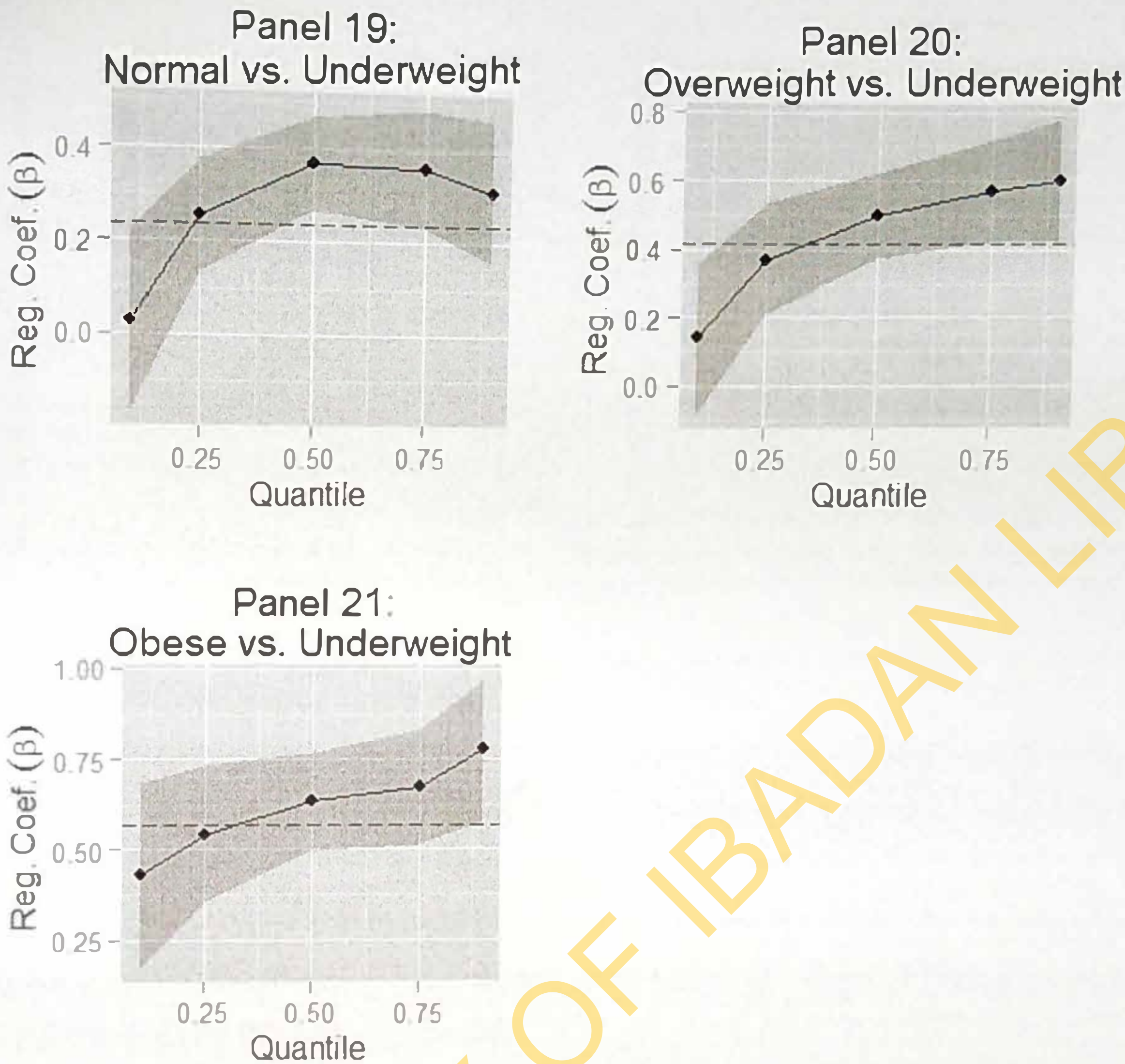

Figure 4.5.9: Quantile regression models demonstrating effects of mother's BMI status (compared with underweight) on BMI-for-age z-score.

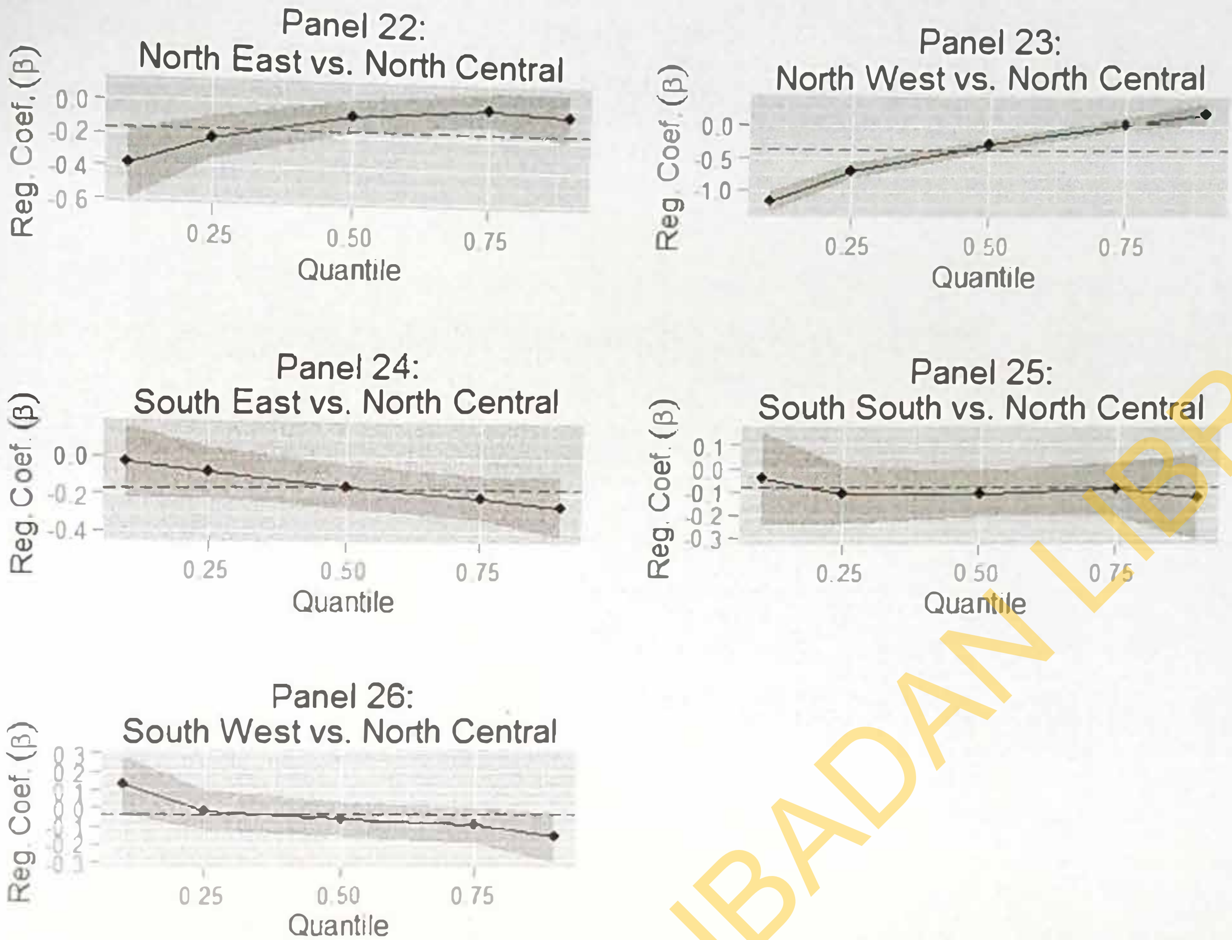

Figure 4.5.10: Quantile regression models demonstrating effects of region (compared with North Central) on BMI-for-age z-score.

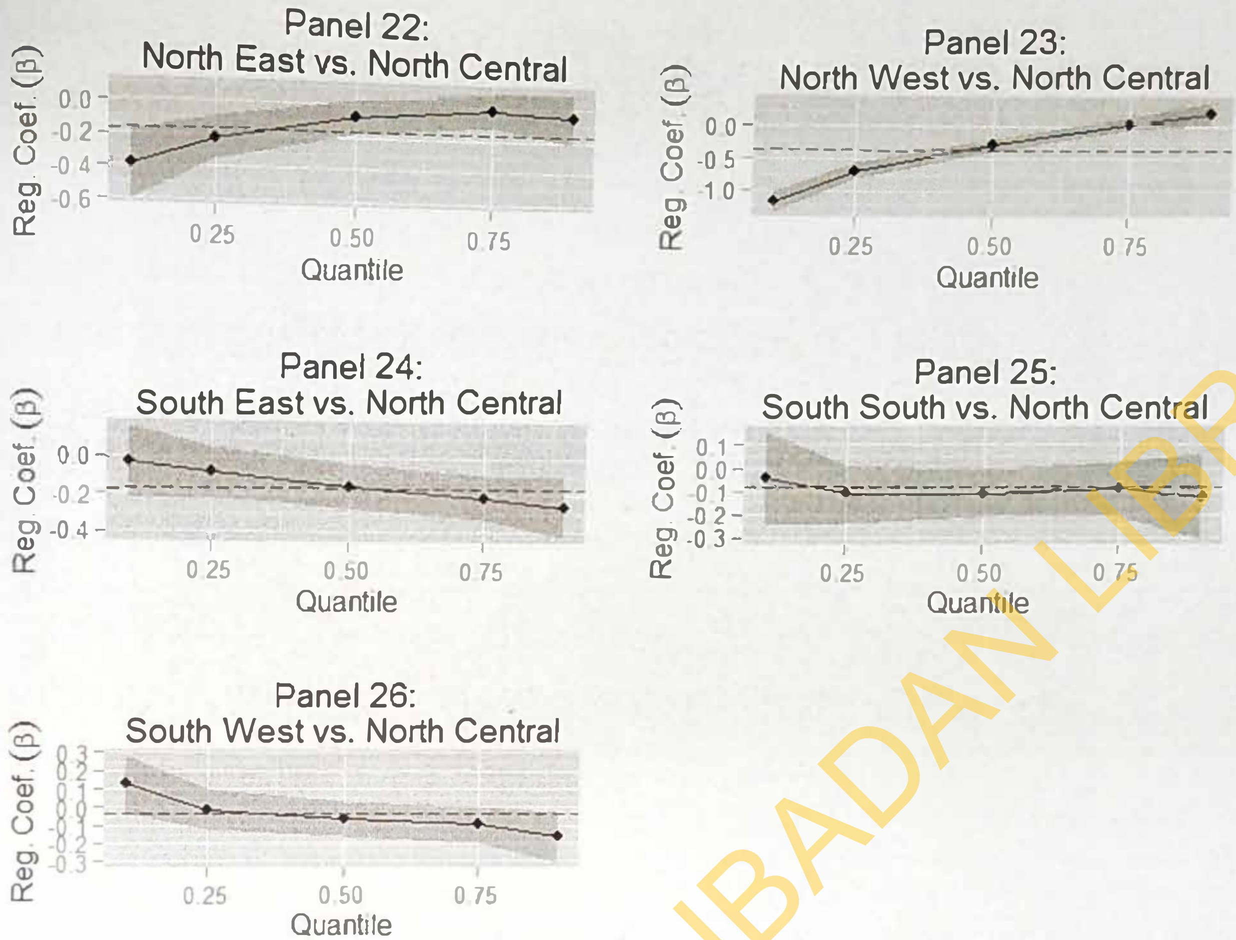

Figure 4.5.10: Quantile regression models demonstrating effects of region (compared with North Central) on BMI-for-age z-score.

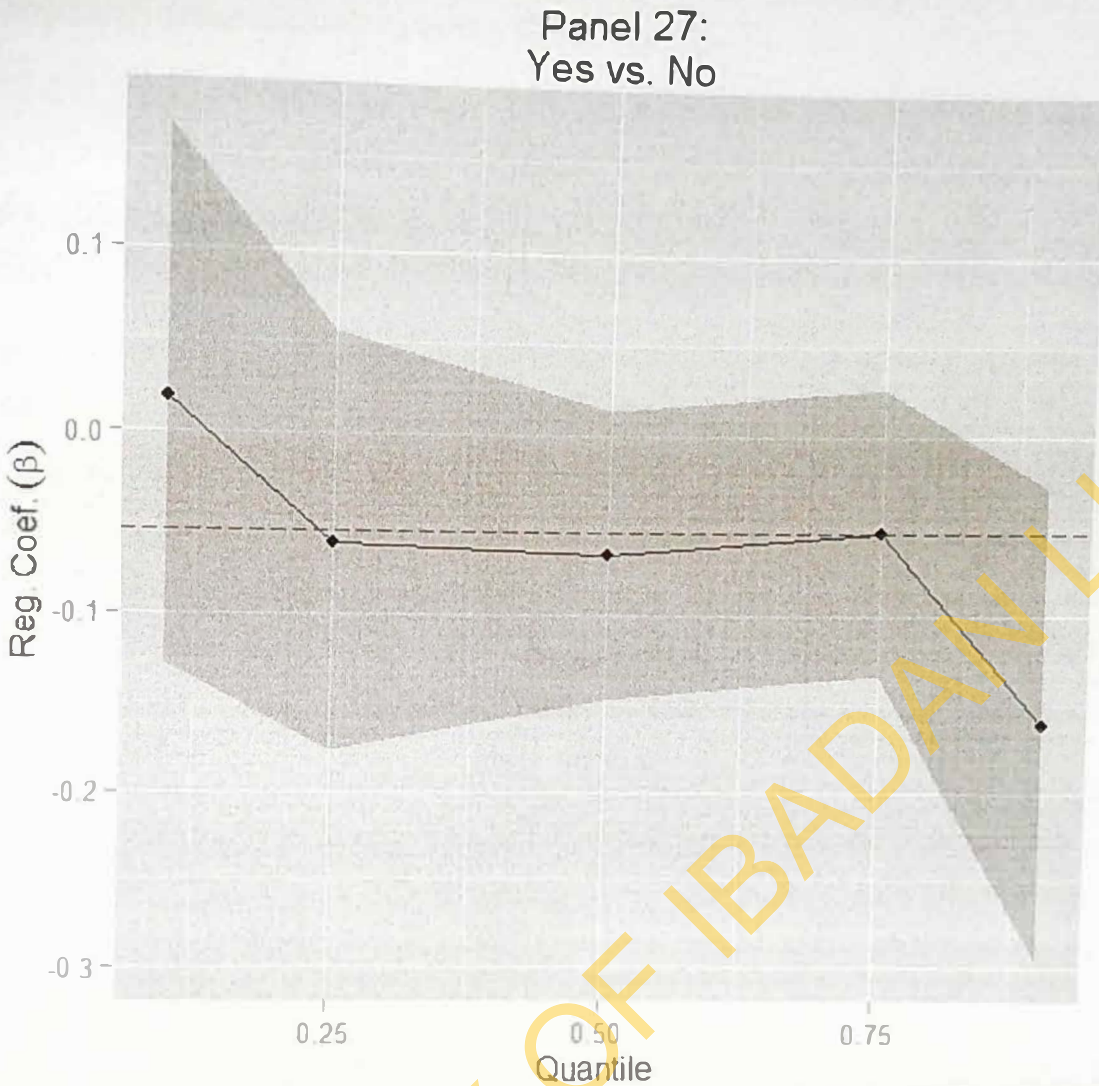

Figure 4.5.11: Quantile regression models demonstrating effects of antenatal visit (compared with 'no antenatal visit') on BMI-for-age z-score.

4.12 Results of the Logistics Regression in determining the factors associated with nutritional status of children under five in Nigeria

Children whose mother's age was 20-25 years were 0.84 times (OR=0.84, p-value= 0.005) as likely to be stunted as children whose mother's aged <20, likewise children whose mother's aged 36 and above were 0.80 times (OR=0.80, p-value=0.002) as likely to be stunted as those children whose mother's age was <20.

Children with age groups (in months) 12-23, 24-35, 36-47 and 48-59 were (2.85, 5.08, 4.36, and 2.98 respectively, all with p-values <0.001) as likely to be stunted as children between the age of 0-11 months. Children with age groups (in months) 12-23, 24-35, 36-47 and 48-59 were (0.9 (p-value=0.038), 0.68, 0.49, and 0.52 times respectively, all with p-values <0.001) as likely to be wasted as children between the age of 0-11 months. Children with age groups (in months) 12-23, 24-35, 36-47 and 48-59 were (1.71, 2.59, 2.07, and 1.64 times respectively, all with p-values <0.001) as likely to be underweight as children between the age of 0-11 months.

Children who were in the categories of richer and richest, were 0.67 and 0.53 times (p-value<0.001 respectively) as likely to be stunted as children who were in poorest category. Children who were in the richest category, were 1.23 (p-value 0.03) times as likely to be wasted as children who were in poorest category. Children who were in the richest category, were 0.8 (p-value 0.0012) times as likely to be wasted as children who were in poorest category.

Female children were 0.75, 0.86, and 0.74 times as likely to be stunted, wasted and underweight respectively, all with p-values <0.001, as male children.

Average sized children at birth were 1.21 (<0.001), 1.33 (<0.001), and 1.49 (<0.001) times as likely to be stunted, wasted and underweight respectively as children who were large sized at birth. Also children who were small sized at birth were 1.51 (<0.001), 1.57 (<0.001) and 1.95 (<0.001) times as likely to be stunted, wasted and underweighted as children who were large sized at birth.

Children whose mother had at least secondary education were 0.71(<0.001), 0.80(<0.001), 0.74(<0.001) times as likely to be stunted, wasted and underweighted respectively.

Children whose their mother were still breastfeeding were 1.21(0.004) times as likely to be wasted as children whose mother ever breastfed but not currently breastfeeding.

Children who lived at the North East and North West part of the country were 1.55(<0.001) and 2.73(<0.001) times as likely to be stunted and 1.44(<0.001), 2.09(<0.001) times as likely to be wasted respectively as those who lived at the North Central, those who lived at the South East and South South part of the country were 0.53(<0.001) and 0.78 (0.002) as likely to be stunted. Also, those children who lived at the North East and North West were 1.71(<0.001), 3.23(<0.001) times as likely to be underweighted respectively as those who lived at the North Central, children who lived at the South East and South South were 0.66 (<0.001) and 0.77 (0.004) times as likely to be underweighted as those who lived at the North Central.

Children whose mother were overweight and obese were 0.81(0.007) and 0.073(0.002) times respectively as likely to be stunted as children whose mothers were underweight. Children whose mother's BMI were normal, overweight and obese were 0.79(0.001), 0.73(<0.001) and 0.47(<0.001) times respectively as likely to be wasted as children whose mothers were underweight. Lastly, children whose mother's BMI were normal, overweight and obese were 0.75(<0.001), 0.56(<0.001) and 0.49(<0.001) times respectively as likely to be underweight.

Table 4.19 Logistics Regression in determining the factors associated with under-nutritional status of children under five in Nigeria

Variables	Stunting		Wasting		Underweight	
	O.R	Pvalue	O.R	Pvalue	O.R	Pvalue
Maternal Age						
<20 years[c]						
20-35 years	0.84	0.005	1.10	0.156	0.92	0.189
36 and above	0.80	0.002	0.99	0.862	0.90	0.17
Child's Age						
0-11 months[c]						
12-23 months	2.85	<0.001	0.90	0.038	1.71	<0.001
24-35 months	5.08	<0.001	0.68	<0.001	2.59	<0.001
36-47 months	4.36	<0.001	0.49	<0.001	2.07	<0.001
48-59 months	2.98	<0.001	0.52	<0.001	1.64	<0.001
Wealth Index						
Poorest[c]						
Poorer	0.93	0.18	1.00	0.99	0.96	0.434
Middle	0.92	0.17	1.10	0.22	0.97	0.627
Richer	0.67	<0.001	1.14	0.11	0.87	0.056
Richest	0.52	<0.001	1.23	0.03	0.80	0.0012
Sex of Child						
Male[c]						
Female	0.75	<0.001	0.86	<0.001	0.74	<0.001
Size of Child at Birth						
Large[c]						
Average	1.21	<0.001	1.33	<0.001	1.49	<0.001
Small	1.51	<0.001	1.57	<0.001	1.95	<0.001

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Average	1.21	<0.001	1.33	<0.001	1.49	<0.001
Small	1.51	<0.001	1.57	<0.001	1.95	<0.001

Mother's Educational Level						
None[c]						
Primary	0.91	0.08	0.89	0.079	0.91	0.098
Secondary	0.71	<0.001	0.80	0.001	0.74	<0.001
Working Status of Mother						
Not Working[c]						
Working	0.92	0.048	1.00	0.93	1.02	0.654
Region						
North Central[c]						
North East	1.55	<0.001	1.44	<0.001	1.71	<0.001
North West	2.73	<0.001	2.09	<0.001	3.23	<0.001
South East	0.53	<0.001	1.06	0.532	0.66	<0.001
South South	0.78	0.002	0.96	0.695	0.77	0.004
South West	0.98	0.79	0.83	0.042	0.88	0.118
Breastfeeding Duration						
Ever breastfed,not currently breastfeeding[c]						
Never breastfed	0.83	0.50	0.76	0.459	1.16	0.67
Still Breastfeeding	1.09	0.16	1.21	0.004	1.29	1.144
Mother's BMI						
Underweight[c]						
Normal	0.96	0.497	0.79	0.001	0.75	<0.001
Overweight	0.81	0.007	0.73	<0.001	0.56	<0.001
Obese	0.73	0.002	0.47	<0.001	0.49	<0.001
Antenatal Visits						
Yes[c]						
No	0.92	0.077	1.04	0.937	0.95	0.302

Mother's Educational Level						
None[c]						
Primary	0.91	0.08	0.89	0.079	0.91	0.098
Secondary	0.71	<0.001	0.80	0.001	0.74	<0.001
Working Status of Mother						
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Mother's BMI						
Underweight[c]						
Normal	0.96	0.497	0.79	0.001	0.75	<0.001
Overweight	0.81	0.007	0.73	<0.001	0.56	<0.001
Obese	0.73	0.002	0.47	<0.001	0.49	<0.001
Antenatal Visits						
Yes[c]						
No	0.92	0.077	1.04	0.937	0.95	0.302

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSION AND RECOMMENDATION

This study examined factors affecting nutritional status of under five children in Nigeria from the National Demographic and Health Survey (NDHS 2013). The study helps in understanding the factors affecting the nutritional status of children under five using the z-scores of all the nutritional indices for both the under-nutrition and over-nutrition.

5.1 QUANTILE REGRESSION

The quantile regression has helped to give a more comprehensive picture of the effect of the predictors on the response variable. It has modeled the relation between the set of predictor variables and specific percentiles of the response variables.

5.1.1 Quantile regression for over-nutrition

It is evident in this study that maternal age is not a factor that determines either a child is overweight or obese, this is in contrary to a study by Andrew Beyerlein et al, 2011 and Schienkiewitz et al, 2006 which concluded that maternal age was known to be slightly positively associated with obesity.

This study showed that mother's BMI is one of the factors responsible for a child being overweight/obese, this corresponds with the study by Whitaker, 2004 which said that infants of obese mothers are likely to be obese than infants of non-obese mothers.

The present study showed that breastfeeding duration is a factor contributing to over-nutrition of a child. This is in line with the study by Huiquan et al. 2014, which found that despite the beneficial effect of breastfeeding to human body, longer duration of breastfeeding played a role in contributing to overweight and obesity.

5.1.2 Quantile regression for under-nutrition

The present study showed that child's age; starting from the weaning period , mother's education; those who could not have their education up to the secondary level, wealth index; families who were below the richer/richest categories, have contributed to the under-nutrition of children under five. This finding is similar to a study that reported child's age, mother's education and wealth index to have a consistently significant association with HAZ score (Chittur et al, 2013).

Breastfeeding duration is not a factor contributing to a child being under-nutrition (wasted and under-weight). Study by Huiquan et al. 2014 showed that children tend to have higher BMI if they received longer duration of breastfeeding.

This study consistently showed that children in the North East and North West were wasted, stunted and underweight, while those in South East (stunted), South West (wasted) and South South, South West, South East (underweight), this is in line with the NDHS 2013 report which showed that there was higher percent of under-nutrition at the northern part of the country

5.2 COMPARISON OF THE RESULTS OF THE ORDINARY LEAST SQUARE REGRESSION WITH THE QUANTILE REGRESSION ANALYSIS

The results of wasting, underweight and stunting was looked at as a whole and some factors were identified as either contributing to under-nutrition or not. Also the overweight and obesity was looked at to extract some factors contributing to over-nutrition, this was done in both the OLS regression and the QR analysis. These factors shall be compared below:

5.2.1 Under-nutrition in OLS and QR

This study identified the child's sex, size of child at birth as factors consistently associated with under nutrition. All the age groups seemed to be associated with under nutrition but the OLS specified children aged 12-23months as not contributing to wasting, likewise the QR result showed that children in the age of 48-59months category were not associated with underweight. Maternal age was not a factor influencing under nutrition in the QR while the OLS varied by specifying maternal age not to influence wasting but being associated with stunting and underweight (36years and above). Both the OLS and QR analysis showed that maternal education is an important factor in helping a child out of being under nourished as there is need for every mother to have at least a secondary education, (Pongou et al, 2006) reported that the risk of childhood malnutrition is reduced in educated mothers because they have greater capacity to substitute with less costly sources of nutrients during periods of recession. Under nutrition tends to be more in the northern part of the country, it was evident in the analysis of both the OLS and QR, this is consistent with the study by (Uthman, 2009) which found that the childhood malnutrition is worst in the North region. The QR analysis showed that working status of mothers did not influence the under nutritional status of a child while the OLS also agreed with the result but only specified this condition for stunting and wasting.

5.2.2 Over-nutrition in OLS and QR

This study identified sex (Rathavuth, 2006) reported that child's sex had a statistically significant effects on mal-nutrition) and the size of a child at birth as an important factor contributing the over nutritional status of a child. Maternal age and maternal education which tend to have contributed to over nutrition in OLS but did not contribute significantly in QR analysis. Working mothers were found to have influenced over nutrition in both the OLS and QR analysis. Both analysis showed that over nutrition is more common in the southern part of the country than the northern part. The OLS result showed that children below 3years of age are associated with over nutrition while QR showed that all except those within 48-59 months were associated with over nutrition, (Acharya et al, 2013) reported that age of children and maternal education are some key determinants of nutritional status of under-five children. While QR specified that those in richest category of SES were associated with over nutrition, OLS included those who are poorer, richer and in middle class. Both OLS and QR showed that breast feeding duration influenced over nutrition, this is consistent with the study by (Huiquan, 2014) which found out that children tend to have higher BMI if they received longer duration of breastfeeding.

5.3 LOGISTICS REGRESSION

A logistics regression was performed to ascertain the effects of child's age, wealth index, sex of child, size of child at birth, maternal age, mother's educational level, breastfeeding duration, mother's working status, mother's BMI, region, antenatal visits on the likelihood that children were stunted, wasted and underweighted.

This study identified maternal age, child's age, wealth index (those in richer and richest categories), sex, size of child at birth, mother's education (at least secondary), working mothers, all the regions (except south west), mother's BMI (overweight and obese) as factors significantly related to under-nutrition.

Maternal age was not statistically associated with wasting and underweight, but there was an association with stunting. A study by (Beyene, 2012) reported that there was no significant association between wasting, underweight and maternal age. Similarly, a study by (Darteh et al, 2014) found that stunting was associated with advanced maternal age.

Only mothers with secondary education and higher were significantly associated with the three indices, this showed that children whose mothers had modestly higher education levels were significantly less likely to be undernourished than those mother with less or no formal education. Owoaje et al, 2014 found out that children whose mothers had less than secondary level education had a higher risk of being undernourished than those whose mothers had been educated beyond primary school level.

High levels of stunting, wasting and underweight was found in the North West while the lowest levels was found in the South South, South West and South South respectively, this conformed with the findings that was reported by (Glover et al, 2016).

Across all the age groups was found a statistical significant effect of child's age on undernutrition. Children aged 12months upwards were more likely to be stunted and underweight and less likely to be wasted, this could be associated with the fact that when children are weaned, some women go back to their work places and devote less time to the care of their children. Studies by (Nguyen et al, 2008 and Babatunde 2011) reported similar findings.

There was a significant relationship between the sex of child and under-nutrition as female children were not as likely as male children to be wasted, stunted and underweight. One report suggested that boys were more influenced by environmental stress than girls (Wells, 2000)

In this study, children in the richest wealth category remained significant risk factor of under-nutrition, as those in these category were not as likely to be under-nutrition as others in the wealth index category, though closely followed by those in richer category, this is a similar result with the study by Owoaje et al, 2014.

The size of a child at birth is a very important factor that determines the nutritional status of a child, this study showed a significant influence of child's size at birth on under-nutrition, though children who were small at birth were at higher risk of being under-nourished. Edem et al, 2015 showed in their study that children who had low birth weight or showed evidence of developmental delay were associated with higher odds of malnutrition.

5.4 STRENGTHS AND LIMITATIONS

One of the strengths of this study is the use of simultaneous quantile regression, a more detailed technique than OLS regression, to examine the effect of the explanatory variables across the z-scores distribution of the nutritional indices. The use of continuous response variable rather than categorized response variables led to more flexibility in choosing the level of response to consider in regression. Also, a large sample size was used.

One of the limitations of this study is that some variables like child vaccination, birth order, household size, paternal variables, initiation of breastfeeding, and family variables (house structure, kind of latrine, source of water) were not used for the analysis. Also, some children (those whose mothers were not interviewed, weighed and measured) were not included in the study.

To the best of my knowledge, many studies have not looked at various factors contributing to the nutritional status of under five children using quantile regression.

5.5 CONCLUSION

This study identified the factors associated with the nutritional status (both over-nutrition and under-nutrition) of under five children in Nigeria using the nutritional indices: BMI-for-age, Height-for-age, Weight-for-age and Weight-for-height. It employed the statistical method that showed the effect of these factors based on the pre-defined percentile of the quantiles corresponding to the reference cut-offs recommended by WHO to identify the effect of each variable. The quantile regression can be used to model specific parts of the distribution of the nutritional indices and should be preferred to OLS regression if the original scale of the outcome variable was continuous with a non-normal distribution.

Attention should be paid to some factors which have contributed to the mal-nutritional status (either over-nutrition or under-nutrition) of the under five children. The factors which include child's age, size of the child birth, antenatal clinic visits and region.

5.6 RECOMMENDATION

This study recommends that for a grossly skewed variable or a distribution which distribution appeared to be normally distributed but not coming from a normal distribution, it is not appropriate to use OLS for the analysis but quantile regression method is recommended. Also, quantile regression is recommended over OLS when an analysis which involves a reference cut-off is being attached to certain sample quantile of a conditional distribution as quantile regression will provide a more detailed analysis of the relationship.

I recommend that every pregnant woman should be encouraged to regularly attend antenatal/postnatal clinic until her child reaches age five which is even the age when immunization stops. Female children should be encouraged to have at least basic education or more, as this helps them to be more enlightened in taking care of their children as they grow up. Also, the lectures/programmes given in the antenatal clinic should be reviewed in line with other factors which would be beneficial to both the mother and the child. Good nutrition is the cornerstone for survival, health and development. Well-nourished children perform better in school, grow into healthy adults and in turn give their children a better start in life.

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