Positive and negative determinants of normal linear growth among pre-school children living in better-off households: an analysis of secondary data from sub-Saharan Africa

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Abstract

This study examined the positive and negative determinants of normal linear growth among pre-school children living in better-off households, using survey data from Ghana, Kenya, Nigeria, Mozambique and Democratic Republic of Congo (DRC). The main outcome variable was child height-for-age z-scores (HAZ), categorized into HAZ≥-2SD (normal growth/not stunted) and HAZ<–2 (stunted). Logistic regression was utilized in the analysis. We estimated adjusted odd ratios (aORs) of the determinants of normal growth. Higher maternal weight (measured by body mass index) was associated with increased odds of normal growth in Mozambique, DRC, Kenya and Nigeria. A unit increase in maternal years of education was associated with increased odds in normal growth in DRC (aOR=1.06, 95% CI=1.03, 1.09), Ghana (aOR=1.08, 95% CI=1.04, 1.12), Mozambique (aOR=1.08, 95% CI=1.05, 1.11) and Nigeria (aOR=1.07, 95% CI=1.06, 1.08). A year increase in maternal age was associated positively with normal growth in all the five countries. Breastfeeding was associated with increased odds of normal growth in Nigeria (aOR= 1.30, 95% CI=1.16, 1.46) and Kenya (aOR=1.37, 95% CI=1.05, 1.79). Children of mothers who were working had 25% (aOR=0.75, 95% CI=0.60, 0.93) reduced odds of normal growth in DRC. A unit change in maternal parity was associated with 10% (aOR=0.90, 95% CI=0.84, 0.97), 23% (aOR=0.77, 95% CI=0.63, 0.93), 25% (aOR=0.75, 95% CI=0.69, 0.82), 6% (aOR=0.94, 95% CI=0.89, 0.99) and 5% (aOR=0.95, 95% CI=0.92, 0.99) reduced odds of normal growth in DRC, Ghana, Kenya, Mozambique and Nigeria respectively. A child being a male was associated with 16% (aOR=0.82, 95% CI=0.68, 0.98), 40% (aOR=0.60, 95% CI=0.40, 0.89), 37% (aOR=0.63, 95% CI=0.51, 0.77) and 21% (aOR=0.79, 95% CI=0.71, 0.87) reduced odds of normal child growth in DRC, Ghana, Kenya and Nigeria respectively. In conclusion, maternal education, weight, age, breastfeeding and

antenatal care are positive determinants of normal child growth, while maternal parity, employment, and child sex and age are negative determinants. Interventions to promote child growth should take into account these differential effects.

Key words: Normal growth, stunting, factors, sub-Saharan Africa, rich households

Introduction

Child health is a fundamental public health issue, for children's sake and because good child health sets one up for life-long health and functioning, and well-being. In sub-Saharan Africa (SSA), child physical health is of particular concern due to the high rates of illness and mortality in the region. Child normal growth, defined in this paper as children who are not stunted (short stature for age), is a foundation for optimal child health and wellbeing. This is because normal child growth is associated positively with cognitive development, higher school achievements, lower morbidity and mortality, higher economic productivity in adulthood and better maternal reproductive outcomes (1-3). This suggests the need for strong investment in nutrition interventions to promote child growth so as to ensure life-long benefits. Working with international partners such as WHO and UNCEF, governments of SSA have put in place various interventions to promote child growth by addressing stunting in the region (4, 5). However, the implementation of these programmes more often than not places more emphasis on child growth deficiencies and how to protect children against the risk factors contributing to these deficiencies (6, 7). This may make it difficult to directly attribute the effects of the programmes on child normal growth outcomes, except to infer that reduction in stunting implies increase in normal growth. The present study intends to fill this gap by providing robust evidence on the positive as well as negative determinants of normal growth among children living in better-off households. Indeed, many experts have called for this type of resource focused approach in promoting child health outcomes, as exemplified by the UNICEF childcare framework (8, 9).

85 There are a number of factors that affect child linear growth in low and middle incomes countries
86 (LMICs). These factors include maternal education, employment, household wealth index,
87 antenatal care (ANC), parity, maternal body mass index (BMI), urban place of residence,
88 breastfeeding, and maternal age among others. These factors affect child linear growth either
89 negatively or positively. There is substantial evidence that improvement in maternal education is
90 associated positively with child linear growth in many settings (10-14). Children whose mothers
91 are educated tend to have better nutritional status compared to children of mothers with no
92 education. Studies that examine the effect of maternal BMI have also elucidated the strong
93 positive association between maternal BMI and child growth (10, 11, 14-17). A study in Ethiopia
94 showed that maternal BMI was associated positively with children nutritional status (17).
95 Similarly, maternal age and parity are important factors that affect child growth. Fenske and
96 colleagues (11) observed that maternal age has significant effect on childhood stunting. Two
97 other studies established the relationship between maternal age and child nutritional status (18,
98 19). In India, undernourishment was more prevalent in children of 26-30 year age group mothers
99 than the other extremes of reproductive ages (18). Relatedly, mothers in their early 20s tend to
100 have children with poorer health outcomes, including nutrition, while children of older mothers
101 tend to suffer less from stunting (19, 20). Although, there is a paucity of literature on the effects
102 of maternal parity on child nutritional status, some few studies have observed negative effects
103 of parity on child growth (21-23). Further, Kuhnt and Vollmer (24) found in their study that having
104 at least four ANC visits is associated with reduced odds of stunting in pre-school children. Several
105 studies have observed a positive effect of breastfeeding on child growth (25-27). Household

wealth index also has a strong positive effect on child growth (28-30). Children in better-off households tend to have better growth outcomes relative to those in poor households.

The literature reviewed above focus almost exclusively on child growth deficiencies (undernutrition/abnormal growth) and the factors associated with the same. Statistical analyses that simultaneously examine the positive as well as negative determinants of normal child growth are, to the best of our knowledge, still missing. Protective factors against child growth deficiencies may not necessarily be positive determinants of normal growth, it is significant to conduct analysis, using normal growth as the key outcome to elucidate the direct relationship between socio-demographic determinants and positive linear growth among children. It is widely recognized that children in better-off households tend to have better growth and health outcomes. However, stratified analysis to understand the key covariates responsible for the positive growth outcomes in this sub-group is lacking. This study intended to fill this gap by stratifying the analysis by better-off households, focusing on children who are growing normally (rather than those that are not) and the factors that make them to grow well. We also investigated the factors that poses a potential risk (negative determinants) to child growth in better-off households. This will further our understanding of the key positive and negative determinants of normal child growth. The objective of this study therefore is to examine the positive and negative determinants of normal child growth in better-off households.

Methodology

Data sources and sampling strategy

This analysis used data from the Demographic and Health Surveys (DHS)) (31), conducted in Ghana (2014), Kenya (2014), Nigeria (2013), Mozambique (2011) and Democratic Republic of Congo (DRC) (2013-2014). The selection of these five countries was informed by our previous work (12, 32). The DHS data are nationally representative, repeated cross-sectional household surveys collected primarily in LIMCs every 5 years using standardised questionnaires to enable cross-country comparisons (33, 34). The DHS utilises a two-stage sample design (35-39). The first stage involves the selection of sample points or clusters from an updated master sampling frame constructed from National Population and Housing Census of the respective countries. The clusters are selected using systematic sampling with probability proportional to size. Household listing is then conducted in all the selected clusters to provide a sampling frame for the second stage selection of households. The second stage selection involves the systematic sampling of the households listed in each cluster, and households to be included in the survey are randomly selected from the list. The rationale for the second stage selection is to ensure adequate numbers of completed individual interviews to provide estimates for key indicators with an acceptable precision. All men and women aged 15-59 and 15-49 respectively, in the selected households (men in half of the households) are eligible to participate in the surveys if they were either usual residents of the household or visitors present in the household on the night before the survey.

148 *Study participants*

149 Our study population comprised children aged 0–59 months, born to mothers aged 15–49 years
150 living in better-off households. Information on children was obtained through face-to-face
151 interviews with mothers. Height was measured with an adjustable measuring board calibrated in
152 millimetres. Children younger than 24 months were measured lying down (recumbent length) on
153 the board, while standing height was measured for older children. The height data were
154 converted into Z-scores based on the 2006 WHO growth standards (40). The total samples used
155 in the current analysis were: Ghana, n= 1,247; Nigeria, n= 12,999; Kenya, n= 3,895; Mozambique,
156 n= 5,711; and DRC, n= 3,943.

157

158 **Ethics statement**

159 The DHS obtained ethical clearance from Government recognised Ethical Review
160 Committees/Institutional Review Boards of the respective countries as well as the Institutional
161 Review Board of ICF International, USA, before the surveys were conducted. Written informed
162 consent was obtained from the mothers of the children before participation. The authors of this
163 paper sought and obtained permission from the DHS program for the use of the data. The data
164 were completely anonymized and therefore the authors did not seek further ethical clearance
165 before their use.

166

167

168 **Outcome and predictor variables**

169 *Outcome Variables*

170 The main indicator of child linear growth used in this analysis was child height-for-age Z-scores
171 (HAZ). The HAZ scores were computed using the 2006 WHO growth standards (40) and classified
172 into normal growth (or not stunted) and stunted (or poor growth). In this paper, children who
173 have HAZ equal to or above -2 SD (HAZ ≥ -2SD) (40, 41) were described as having a normal growth,
174 while children with HAZ below –2 SD (HAZ < -2) from the median HAZ of the WHO reference
175 population (40) were considered stunted (chronically malnourished).

176

177 *Stratification variable*

178 We used the household wealth index (WI) as the stratification variable in our analysis. The WI
179 has been used in many DHS reports to measure inequalities in household characteristics, in the
180 use of health and other services, and in health outcomes (34, 35, 37, 42). It is an indicator of
181 wealth that is consistent with expenditure and income measurement among households (33, 34,
182 37). The index in the DHS dataset was created based on assets ownership and housing
183 characteristics of each household: type of roofing, and flooring material, source of drinking
184 water, sanitation facilities, ownership of television, bicycle, motorcycle, automobile among
185 others. Principal component analysis was employed to assign weights to each asset in each
186 household. The asset scores were summed up and individuals ranked according to the household
187 score. The WI was then divided into quintiles: poorest, poorer, middle, richer and richest (33, 34,

188 37). For the purpose of this analysis, we recoded middle, richer and richest households into
189 "better-off households". All the analyses were restricted to this sub-category.

190

191 *Framework underpinning the analysis*

192 The UNICEF conceptual framework (43), which outlines the causes of undernutrition
193 underpinned our empirical analysis. This is a socio-ecological framework encompassing factors
194 at the individual, household and societal levels. In the UNICEF framework, child malnutrition can
195 be analysed in terms of immediate, underlying and basic causes. The immediate causes are
196 inadequate dietary intakes and infectious disease, the underlying causes are inadequate
197 maternal and child care, inadequate health services and health environment and the basic causes
198 are institutional and socio-economic determinants and potential resources (43). However, the
199 present analysis was guided by the extended UNICEF conceptual framework for childcare,
200 survival, growth and development (9, 43). The extended UNICEF framework suggests that child
201 survival, growth and development are influenced by a web of factors, with three underlying
202 determinants being food security, healthcare and a healthy environment, and care for children
203 and women (9). These underlying determinants are in turn influenced by basic determinants.
204 These basic determinants may be described as "exogenous" determinants, which influence child
205 nutrition through their effect on the intervening proximate determinants (underlying
206 determinants). In effect, the underlying factors are therefore, endogenously determined by the
207 exogenous factors (44). In this analysis, we included only the basic factors (socio-demographic)
208 in our empirical models. We did this because there is evidence that in examining the association

209 between child growth outcomes and exogenous factors, the proximate factors are usually
210 excluded to prevent biased and uninterpretable parameters (44-46). Besides the basic factors,
211 we also included antenatal care (ANC) and breastfeeding practices, which relies mostly on
212 exogenous public health provisions rather than socio-demographic endowments of the
213 household (44). The significance of including these two variables in the model is that changes in
214 them are likely to be more responsive to policies, programmes and interventions rather than to
215 changes in socio-demographic endowments of the household (44). For example, there is
216 evidence that policy, institutional and contextual settings are key determinants of the prevalence
217 of breastfeeding practices (44, 47).

218

219 **Data analysis**

220 We built two empirical regression models for each of the five countries. In the first models, we
221 included maternal body mass index (BMI), education, age, work status, parity, breastfeeding
222 status, marital status, antenatal attendance, sex of household head, household size, number of
223 children under five years and place of residence. We adjusted for child dietary diversity (DD)—
224 the details of how the DD is created can be found elsewhere (12), age and sex in the second and
225 final model. The selection of the explanatory variables was informed by the UNICEF conceptual
226 framework of child care (9). We estimated adjusted odd ratios (aORs) of the positive and negative
227 determinants of normal child growth in rich households.

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229

Results

Characteristics of study samples

The results showed that Ghana (87%) had the highest number of children with normal growth followed by Kenya (80%), while in Mozambique, DRC and Nigeria, the prevalence ranged from 62% to 74%. Regarding dietary diversity intake, Mozambique had the highest prevalence of children who consumed at least four food groups (21%), with DRC (12%) having the lowest prevalence. Similarly, Mozambique had the highest number of women with normal weight (73%), followed by DRC (69%). The prevalence ranged from 43% to 59% in Ghana, Kenya and Nigeria. Ghana had the highest prevalence (59%) of women who had attained a secondary school education, while Mozambique had the lowest prevalence (21%). Higher education was less than 15% among women across all countries, with Mozambique (1.3%) registering the lowest prevalence. DRC had the highest prevalence (86%) ANC attendance among women followed by Ghana (72%), while Nigeria had the lowest prevalence (19%). Also, Mozambique (35%) had the highest number of women who were household heads, with Nigeria (14%) having the lowest women headed households (Table 1).

248 **Table 1: Characteristics of the study samples of the five countries**

Variables	DRC		Ghana		Kenya		Mozambique		Nigeria	
Child-level covariates					%/mean	SD	%/mean	SD	%/mean	SD
Height-for-age (HAZ ≥-2)	62.0		87.0		80.0		66.0		74.2	
DD < 4 food groups	87.6		87.0		80.2		78.6		86.9	
DD >= 4 food groups	12.4		14.0		19.8		21.4		13.1	
Sex of child										
Female	50.4		48.0		49		49.2		49.5	
Male	49.6		52.0		51.0		50.8		50.5	
Mother-level covariates										
Body Mass Index (BMI)										
BMI <18.50	9.4		2.9		5.34		4.11		5.42	
BMI = 18.50-24.99	69.2		43.0		55.1		73.9		58.7	
BMI = 25-29.99	16.3		32.0		27.0		17.2		24.6	
BMI >= 30	3.9		22.0		12.6		4.54		10.9	
Education										
No education	12.6		15.0		6.0		24.5		20.6	
Primary education	38.7		18.0		50.8		53.4		24.3	
Secondary education	46.8		59.0		30.5		20.8		43.6	
Higher education	1.8		7.5		12.6		1.26		11.5	
Working status										
Not working	27.2		25.0		36.4		63.3		25.3	
IS working	72.5		74.0		63.4		36.7		74.3	
Parity	4.37	2.58	2.99	1.69	3.127	2.05	3.51	2.12	3.90	2.32
Is Breastfeeding	67.8		53.0		51.3		55.8		51.5	
Marital status										
Not in union	13.3		13.0		14.7		17.3		5.1	
Married	67.1		65.0		79.6		45.0		90.5	
Cohabiting	19.7		22.0		5.62		37.6		4.4	
Number of antenatal visits >=4	86.3		72.0		50.8		45.1		48.2	

Household-level covariates										
Sex of household head										
Household head is Female	19.7		29.0		29.6		34.5		13.9	
Household head is Male	80.3		71.0		70.4		65.5		86.1	
Household size	7.30	2.99	5.0	1.93	5.57	2.31	6.49	2.89	6.73	3.56
Number of children under 5	2.28		1.6	0.69	1.64	0.76	1.92	0.94	2.14	1.11
Community-level covariates										
Urban residence	49.2		73.0		52.3		45.2		55.1	

249 DD=Dietary diversity; DRC=Democratic Republic of Congo; SD=Standard deviati

Multivariable results of the factors promoting or inhibiting normal child growth

The results of the multivariable analysis of the positive and negative determinants of normal growth among children under 5 years in better-off households are presented in Tables 2-6. The results are presented as adjusted odd ratios (aORs).

Positive determinants of normal child growth

The results showed that maternal normal weight (measured by BMI) was associated with increased odds of normal linear growth among children in Mozambique (aOR=1.82, 95% CI=1.33, 2.50), while overweight associated with increased odds of normal linear growth in DRC (aOR=1.75, 95% CI=1.17,2.62), Kenya (aOR=2.01, 95% CI= 1.28, 3.16), Mozambique (aOR=2.19, 95%= 1.53, 3.14) and Nigeria (aOR=1.44, 95%=1.16,1.77) relative to children of underweight mothers. Maternal obesity had similar effect on normal linear growth in Kenya, Mozambique and Nigeria. One year increase in maternal years of education was associated with increased odds in normal linear growth among children in DRC (aOR=1.06, 95% CI=1.03, 1.09), Ghana (aOR=1.08, 95% CI=1.04, 1.12), Mozambique (aOR=1.08, 95% CI=1.05, 1.11) and Nigeria (aOR=1.07, 95% CI=1.06, 1.08). The results in Kenya did not reach statistical significance. An additional year in maternal age was associated with increased odds of normal linear growth among children in all the countries included in the analysis. Breastfeeding was associated with increased odds of normal linear growth in Nigeria (aOR= 1.30, 95% CI=1.16, 1.46) and Kenya (aOR=1.37, 95% CI=1.05, 1.79). In Ghana, Mozambique and DRC, breastfeeding was positively associated with normal linear growth in the first model but this statistical significant association disappeared

271 after the child level covariates such as age, sex and dietary dieversity were included in the final
272 empirical model. Urban place of residence was associated with increased odds of normal linear
273 growth among children in DRC (aOR=1.32, 95% CI=1.06, 1.65) and Mozambique (aOR=1.18, 95%
274 CI=1.01, 1.38). The association did not reach statistical significance in the remaining three
275 countries.

276

277 *Negative determinants normal child growth*

278 This section examines the negative determinants of normal linear growth. The results showed
279 that children of mothers who were working had 25% (aOR=0.75, 95% CI=0.60, 0.93) reduced odds
280 of normal linear growth in DRC. A unit change in maternal parity was associated with 10%
281 (aOR=0.90, 95% CI=0.84, 0.97), 23% (aOR=0.77, 95% CI=0.63, 0.93), 25% (aOR=0.75, 95% CI=0.69,
282 0.82), 6% (aOR=0.94, 95% CI=0.89, 0.99) and 5% (aOR=0.95, 95% CI=0.92, 0.99) reduced odds of
283 normal linear growth among children in DRC, Ghana, Kenya, Mozambique and Nigeria
284 respectively. Similarly, a unit change in child's age was associated with reduced odds of normal
285 linear growth in DRC, Mozambique and Nigeria. Further, a child being a male was associated with
286 16% (aOR=0.82, 95% CI=0.68, 0.98), 40% (aOR=0.60, 95% CI=0.40, 0.89), 37% (aOR=0.63, 95%
287 CI=0.51, 0.77) and 21% (aOR=0.79, 95% CI=0.71, 0.87) reduced odds of normal linear growth
288 among children in DRC, Ghana, Kenya and Nigeria respectively. The association in Mozambique
289 did not reach statistical significance.

290

291 **Table 2: Adjusted odd ratios (aOR) of positive and negative determinants of normal linear growth**
292 **among children living in better-off households, DRC**

Variables	Model 1	Model 2
Mother-level covariates		
BMI (kg/m^2) = 18.50 - 24.99	1.093	1.124
	(0.782 - 1.526)	(0.796 - 1.589)
BMI (kg/m^2) = 25 - 29.99	1.685***	1.751***
	(1.138 - 2.493)	(1.172 - 2.617)
BMI (kg/m^2) >= 30	1.573	1.729
	(0.855 - 2.892)	(0.884 - 3.382)
Maternal education (in single years)	1.061***	1.060***
	(1.032 - 1.090)	(1.030 - 1.091)
Age of the mother (in years)	1.039***	1.051***
	(1.015 - 1.063)	(1.026 - 1.077)
Working status = Is working	0.741***	0.747**
	(0.597 - 0.920)	(0.597 - 0.934)
Parity	0.902***	0.899***
	(0.844 - 0.965)	(0.838 - 0.965)
Is Breastfeeding = YES	1.678***	1.184
	(1.370 - 2.055)	(0.943 - 1.487)
Marital Status = Married	1.034	1.076
	(0.756 - 1.415)	(0.786 - 1.473)
Marital Status = Cohabiting	0.976	0.994
	(0.687 - 1.389)	(0.697 - 1.418)
Number of antenatal visits = 4+ visits	1.589***	1.159
	(1.296 - 1.947)	(0.923 - 1.457)
Household-level covariates		
Head of HH is Male	0.865	0.868
	(0.681 - 1.098)	(0.678 - 1.111)
Household size	1.007	1.002
	(0.968 - 1.048)	(0.962 - 1.043)
Number of children under 5 years	0.945	0.954
	(0.844 - 1.059)	(0.850 - 1.071)
Community-level covariates		
Urban residence = Urban	1.322**	1.320**
	(1.066 - 1.640)	(1.059 - 1.646)
Child-level covariates		
Dietary Diversity (DD) >= 4		1.294*
		(0.971 - 1.724)
Age of the child (in months)		0.975***
		(0.969 - 0.982)
Sex of child = Male		0.815**
		(0.677 - 0.982)
Observations	**3,943**	**3,943**

95% Confidence Intervals (CIs) in parentheses; DD-Dietary diversity; HH-Household; BMI-Body mass index
*** p<0.01, ** p<0.05, * p<0.1

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294

295 **Table 3: Adjusted odd ratios (aOR) of positive and negative determinants of normal linear growth**
296 **among children living in better-off households, Ghana**

Variables	Model 1	Model 2
Mother-level covariates		
BMI (kg/m^2) = 18.50 - 24.99	0.692	0.725
	(0.224 - 2.136)	(0.241 - 2.181)
BMI (kg/m^2) = 25 - 29.99	1.230	1.270
	(0.385 - 3.929)	(0.410 - 3.931)
BMI (kg/m^2) >= 30	1.617	1.700
	(0.478 - 5.469)	(0.514 - 5.628)
Maternal education (in single years)	1.078***	1.081***
	(1.037 - 1.121)	(1.039 - 1.124)
Age of the mother (in years)	1.047*	1.052**
	(0.998 - 1.099)	(1.001 - 1.105)
Working status = Is working	1.276	1.264
	(0.821 - 1.983)	(0.804 - 1.987)
Parity	0.779**	0.766***
	(0.643 - 0.944)	(0.630 - 0.932)
Is Breastfeeding = YES	1.769**	1.748*
	(1.129 - 2.771)	(0.981 - 3.116)
Marital Status = Married	1.956**	2.104**
	(1.032 - 3.708)	(1.101 - 4.022)
Marital Status = Cohabiting	1.524	1.659
	(0.783 - 2.967)	(0.849 - 3.240)
Number of antenatal visits = 4+ visits	1.124	1.110
	(0.695 - 1.817)	(0.646 - 1.906)
Household-level covariates		
Head of HH is Male	1.250	1.200
	(0.783 - 1.996)	(0.753 - 1.911)
Household size	0.998	0.998
	(0.894 - 1.114)	(0.891 - 1.117)
Number of children under 5	0.834	0.843
	(0.555 - 1.253)	(0.559 - 1.274)
Community-level covariate		
Urban residence = Urban	1.020	0.988
	(0.640 - 1.628)	(0.623 - 1.565)
Child-level covariates		
Dietary Diversity (DD) >= 4		1.022
		(0.590 - 1.770)
Age of the child (in months)		0.998
		(0.982 - 1.014)
Sex of child = Male		0.596**
		(0.400 - 0.887)
Observations	**1,247**	**1,247**

95% Confidence Intervals (CIs) in parentheses; DD-Dietary diversity; HH-Household; BMI-Body mass index
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Adjusted odd ratios (aOR) of positive and negative determinants of normal linear growth among children living in better-off households, Kenya

Variables	Model 1	Model 2
Mother-level covariates		
BMI (kg/m^2) = 18.50 - 24.99	1.245	1.313
	(0.824 - 1.881)	(0.872 - 1.976)
BMI (kg/m^2) = 25 - 29.99	1.880***	2.014***
	(1.195 - 2.960)	(1.284 - 3.158)
BMI (kg/m^2) >= 30	1.860**	1.991**
	(1.082 - 3.195)	(1.165 - 3.402)
Maternal education (in single years)	1.017	1.021
	(0.984 - 1.051)	(0.987 - 1.055)
Age of the mother (in years)	1.074***	1.075***
	(1.046 - 1.102)	(1.046 - 1.104)
Working status = Is working	0.969	0.982
	(0.775 - 1.211)	(0.786 - 1.227)
Parity	0.752***	0.752***
	(0.688 - 0.823)	(0.687 - 0.822)
Is Breastfeeding = YES	1.373***	1.367**
	(1.103 - 1.710)	(1.047 - 1.785)
Marital Status = Married	1.131	1.112
	(0.826 - 1.547)	(0.810 - 1.526)
Marital Status = Cohabiting	1.278	1.233
	(0.785 - 2.079)	(0.756 - 2.009)
Number of antenatal visits = 4+ visits	1.132	1.095
	(0.906 - 1.415)	(0.862 - 1.390)
Household-level covariates		
Head of HH is Male	0.986	0.987
	(0.781 - 1.245)	(0.780 - 1.248)
Household size	1.054*	1.047
	(0.991 - 1.122)	(0.984 - 1.114)
Number of children under 5	1.018	1.026
	(0.871 - 1.189)	(0.878 - 1.200)
Community-level covariate		
Urban residence = Urban	0.883	0.890
	(0.719 - 1.085)	(0.723 - 1.096)
Child-level covariates		
Dietary Diversity (DD) >= 4		0.784*
		(0.597 - 1.030)
Age of the child (in months)		0.996
		(0.989 - 1.003)
Sex of child = Male		0.625***
		(0.507 - 0.770)
Observations	**3,985**	**3,985**

95% Confidence Intervals (CIs) in parentheses; DD-Dietary diversity; HH-Household; BMI-Body mass index
*** p<0.01, ** p<0.05, * p<0.1

297

298 **Table 5: Adjusted odd ratios (aOR) of positive and negative determinants of normal linear growth**
299 **among children living in better-off households, Mozambique**

Variables	Model 1	Model 2
Mother-level covariates		
BMI (kg/m^2) = 18.50 - 24.99	1.780***	1.823***
	(1.303 - 2.430)	(1.329 - 2.500)
BMI (kg/m^2) = 25.00 - 29.99	2.144***	2.190***
	(1.502 - 3.060)	(1.528 - 3.137)
BMI (kg/m^2) >= 30	4.106***	4.268***
	(2.453 - 6.870)	(2.537 - 7.179)
Maternal education (in single years)	1.077***	1.079***
	(1.052 - 1.102)	(1.054 - 1.105)
Age of the mother (in years)	1.035***	1.039***
	(1.018 - 1.052)	(1.022 - 1.056)
Working status = Is working	0.941	0.950
	(0.813 - 1.088)	(0.821 - 1.098)
Parity	0.943**	0.942**
	(0.894 - 0.995)	(0.892 - 0.994)
Is Breastfeeding = YES	1.240***	1.070
	(1.068 - 1.439)	(0.906 - 1.263)
Marital Status = Married	0.977	1.009
	(0.787 - 1.213)	(0.811 - 1.255)
Marital Status = Cohabiting	1.278**	1.289**
	(1.035 - 1.578)	(1.043 - 1.593)
Number of antenatal visits = 4+ visits	1.055	0.942
	(0.911 - 1.222)	(0.807 - 1.100)
Household-level covariates		
Head of HH is Male	0.874*	0.887
	(0.746 - 1.024)	(0.757 - 1.039)
Household size	1.018	1.016
	(0.988 - 1.048)	(0.986 - 1.046)
Number of children under 5	0.998	1.009
	(0.908 - 1.098)	(0.916 - 1.111)
Community-level covariate		
Urban residence = Urban	1.185**	1.181**
	(1.014 - 1.385)	(1.010 - 1.381)
Child-level covariates		
Dietary Diversity (DD) >= 4		0.888
		(0.752 - 1.048)
Age of the child (in months)		0.991***
		(0.986 - 0.995)
Sex of child = Male		0.931
		(0.811 - 1.069)
Observations	**5,711**	**5,711**

95% Confidence Intervals (CIs) in parentheses; DD-Dietary diversity; HH-Household; BMI-Body mass index
*** p<0.01, ** p<0.05, * p<0.1

300

Table 6: Adjusted odd ratios (aOR) of positive and negative determinants of normal linear growth among children living in better-off households, Nigeria

Variables	Model 1	Model 2
Mother-level covariates		
BMI (kg/m^2) = 18.50 - 24.99	1.135	1.129
	(0.934 - 1.379)	(0.931 - 1.371)
BMI (kg/m^2) = 25.00 - 29.99	1.434***	1.435***
	(1.157 - 1.777)	(1.159 - 1.777)
BMI (kg/m^2) >= 30	1.697***	1.706***
	(1.309 - 2.200)	(1.316 - 2.211)
Maternal education (in single years)	1.067***	1.068***
	(1.056 - 1.079)	(1.057 - 1.080)
Age of the mother (in years)	1.033***	1.039***
	(1.021 - 1.045)	(1.027 - 1.051)
Working status = Is working	1.072	1.106*
	(0.958 - 1.199)	(0.988 - 1.238)
Parity	0.957***	0.954***
	(0.925 - 0.989)	(0.922 - 0.986)
Is Breastfeeding = Yes	1.537***	1.303***
	(1.388 - 1.703)	(1.162 - 1.461)
Marital Status = Married	0.806*	0.803*
	(0.625 - 1.039)	(0.622 - 1.037)
Marital Status = Cohabiting	0.866	0.846
	(0.606 - 1.237)	(0.592 - 1.209)
Number of antenatal visits = 4+ visits	1.080	0.877**
	(0.975 - 1.197)	(0.776 - 0.990)
Household-level covariates		
Head of HH is Male	0.850**	0.856*
	(0.728 - 0.992)	(0.733 - 1.000)
Household size	0.980**	0.980**
	(0.963 - 0.998)	(0.962 - 0.998)
Number of children under 5	0.946*	0.941**
	(0.893 - 1.002)	(0.888 - 0.997)
Community-level covariate		
Urban residence = Urban	1.004	1.013
	(0.910 - 1.108)	(0.917 - 1.118)
Child-level covariates		
Dietary Diversity (DD) >= 4		1.055
		(0.904 - 1.231)
Age of the child (in months)		0.988***
		(0.984 - 0.991)
Sex of child = Male		0.785***
		(0.712 - 0.865)
Observations	**12,999**	**12,999**

95% Confidence Intervals (CIs) in parentheses; DD-Dietary diversity; HH-Household; BMI-Body mass index
*** p<0.01, ** p<0.05, * p<0.1

305

306

307 **Discussion**

308 This study investigated the positive and negative determinants of normal linear growth among
309 children living in better-off households in DRC, Ghana, Kenya, Mozambique and Nigeria. The
310 results shed new insights on both positive and negative determinants of child growth, and
311 country-specific variations of these effects in the five countries. In the current analysis, higher
312 maternal weight (measured by BMI) tends to have significant positive effect on normal growth
313 among children living in better-off households in all countries except Ghana. Thus, maternal
314 weight is a key determinant of positive child growth outcomes. Despite the fact that higher
315 maternal weight has positive effect on child normal growth, interventions should target at
316 increasing maternal weight qualitatively for the benefit of both the mother and child. This is
317 critical because of the negative effect of unhealthy weight on maternal health outcomes (48-50).
318 These findings are in line with the literature. Maternal nutrition was found to have a significant
319 positive effect on child linear growth in many settings (10-12). In India, BMI among other
320 variables, was found to have significantly effect on child linear growth (11). The preceding
321 discussion illuminated the crucial role maternal nutrition plays in improving child nutritional
322 status, even though the pathways through which this happens may be complex.

323

324 The importance role maternal education plays in promoting positive child health outcomes was
325 observed in the present study. Our results showed that maternal years of education have

326 significant positive effects on normal linear growth in all the five countries except Kenya. This
327 suggests that education has the potential to promote normal growth of children living in better-
328 off households. Interventions to promote child growth may have positive impact of normal linear
329 growth of children living in these households. The beneficial effects of maternal years of
330 education on child growth has previously been documented. An improvement in maternal
331 education was associated positively with dramatic change in linear growth among pre-school
332 children (10, 11). This may be the case because educated mothers tend to utilize both preventive
333 and curative health care more (51, 52). Educated mothers also tend to have more strongly
334 committed attitude towards good childcare than uneducated mothers (53, 54). Furthermore, the
335 more education the mother has the more the likelihood that she is sensitive and responsive to
336 caregiving duties (53, 54). Also, there is evidence that children seemingly engage more positively
337 with their mothers when maternal education is greater (54). All the above have positive effects
338 on child growth outcomes. The literature discussed above together with our study clearly
339 demonstrated the importance of maternal education for positive child health outcomes.

340

341 The health benefits of breastfeeding were illuminated in this study but only in two countries.
342 Breastfeeding was found to associate with the likelihood of normal linear growth among children
343 living in better-off households in Kenya and Nigeria. This suggests that mothers in these
344 households should be encouraged to practice breastfeeding because of its beneficial effects on
345 their children growth. These findings confirm the widely recognised benefits of breastfeeding
346 for improved health and developmental outcomes (25-27). In the contrary, breastfeeding
347 showed a significant positive effect on child normal linear growth in the models containing only

348 the socio-demographic factors in Ghana, Mozambique and DRC. This significant association
349 disappeared after child level covariates such as dietary diversity, age and sex were included in
350 the final empirical models. This suggests that whether breastfeeding will have positive effect on
351 normal child growth in better-off households or not is conditional on the inclusion or otherwise
352 of child level co-variates. This corroborates previous research, which suggests that child level
353 factors must be considered when evaluating the association of breastfeeding with
354 anthropometric outcomes (55). The non-significant positive effect of breastfeeding on child
355 growth has previously been documented (55-57). Thus, while breastfeeding is critical for positive
356 child health outcomes, it is not always the case that its effects would be statistically significant.

357

358 Our analysis also illuminated negative determinants of normal linear growth. Maternal work
359 status is inversely related to normal child growth in DRC. This implies that DRC mothers who are
360 engaged in any form of work tend to have children who have poor linear growth relative to
361 mothers who are not working. This negative effect may boil down to inadequate childcare due
362 to limited time available to working mothers. A study in India concluded that a mother's
363 employment compromises infant feeding and care, particularly so when mothers are not able to
364 get alternative caregivers (58). This study further reported that the compromises related to
365 childcare and feeding outweigh the benefits from employment (58). Other studies have shown
366 that mothers working away from home spend less time with their children compared to mothers
367 who are not working outside the home and therefore likely to have children who are
368 undernourished (59, 60). Although, it is a well-documented fact that women who are working
369 tend to have access to disposal income and therefore able to provide nutritious food as well as

370 other care services to their children (13, 17, 61, 62), the above discussion showed that maternal
371 employment, indeed, could have negative effect on child growth outcomes. It is worthy to note
372 that this analysis did not investigate the categories of employment and their effect on child
373 growth. We are therefore unable to tell the independent effect of the various occupational
374 groups on child linear growth. This is a limitation worth noting, as different occupations may have
375 different effects.

376

377 Another negative growth determinant is maternal parity (number of pregnancies reaching viable
378 gestational age). The results show that higher maternal parity has negative effect on normal
379 linear growth among children living in better-off households. The effect is largest in Kenya (25%)
380 followed by Ghana (23%), with the least effect being in Nigeria (5%). This suggests that higher
381 parity has a stronger negative effect on child normal growth in Kenya and Ghana relative to the
382 other countries. The negative effects of parity on child growth may be attributed to it being an
383 important factor that affect maternal depletion, particular so among high fertility mothers (63,
384 64), which has the potential to compromise the mothers ability to provide good care for their
385 children. The consequential effect of lack of good care is poor child growth. Secondly, women
386 with higher parity are likely to have many young children, who might compete for the available
387 care resources, which can have a negative effect on good care practices and consequently their
388 children growth outcomes. Previous studies have documented that the higher the maternal
389 parity, the less likelihood that their children will have positive growth outcomes (21, 22). For
390 example, children from multiparous mothers were found to have lower rates of accelerated
391 infant growth and lower levels of childhood body mass index than children of nulliparous mothers

392 (22). The preceding discussion clearly demonstrated that parity is a key negative determinant of
393 of child linear growth.

394

395 Similarly, two child biological factors (sex and age) were found to associate negatively with
396 normal linear growth. A year increase in child's age was associated negatively with normal linear
397 growth in three (DRC, Mozambique and Nigeria) of the five countries. This suggests that older
398 children living in better-off households have a less likelihood of achieving a normal linear growth.
399 These findings are consistent with previous research. Nshimyiryo and colleagues (65) observed
400 that increasing age of the child had a significant association with poor linear growth. For instance,
401 children aged 6–23 months were at lower risk of poor growth than those in the older age group
402 24–59 months (65). Also, being a male child affects the likelihood of children living in better-off
403 households to have a normal linear growth. Previous work has shown that poor linear growth
404 was higher among male children as compared to female children (66). Suggesting that male
405 children tend to be more vulnerable to poor growth than their female counterparts in the same
406 age group (67). This might be due to preferences in feeding practices or other types of exposures
407 (67). It could also be explained by the fact that boys are expected to grow at a slightly more rapid
408 rate compared to girls and their growth is perhaps more easily affected by nutritional deficiencies
409 or other exposures (68).

410

411

412

Strengths and limitations of the study

This study has some strengths. One important strength is the use of high quality large nationally representative DHS data to investigate the positive and negative determinants of normal linear growth among children living in rich households. This makes it possible for the findings to be generalized to the population of young children in the respective countries. The large data also help to produce more robust estimates of observed associations. The use of multi-country data unmask differences and highlights commonalities in the effects of the correlates on child growth across countries. This may not have been possible with single country data. Further, the height data used for computing the HAZ indicator were objectively measured, reducing possible misclassification. The novelty of this study is its focus on positive child growth outcomes rather than child growth deficiencies. A limitation worth mentioning is the cross-sectional nature of the data, which makes it difficult to disentangle potential reciprocal and otherwise complex causal relationships. The conclusions in this paper are therefore meant to be restricted to statements about the associations between the explanatory variables and the outcome variables.

Conclusions

Maternal weight (BMI) tends to have significant positive effects on normal linear growth among children living in better-off households across all countries except Ghana. Interventions aimed at increasing maternal weight qualitatively are likely to be effective in improving the linear growth of children living in better-off households. Maternal years of education have significant positive

effects on normal linear growth in all the five countries except Kenya. This suggests that education has the potential to promote normal linear growth among of children living in better-off households. Breastfeeding was associated with the likelihood of normal linear growth in Kenya and Nigeria. This implies that mothers in better-off households should be encouraged to practice breastfeeding because of its beneficial effect on their children growth. Maternal work status is inversely related to normal growth in DRC. Thus, in DRC, mothers who are engaged in any form of work tend to have children with poor growth relative to mothers who are not working. The results show that higher maternal parity associate negatively with normal linear growth. The effect is largest in Kenya (25%) followed by Ghana (23%), with the least effect being in Nigeria (5%). In effect, higher parity has a stronger negative effect on child normal linear growth in Kenya and Ghana relative to the other countries.

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Competing Interest

The authors have no competing interests to declare.

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Data Sharing Statement

This study was a re-analysis of existing data that are publicly available from The DHS Program at http://dhsprogram.com/publications/publication-fr221-dhs-final-reports.cfm. Data are accessible free of charge upon a registration with the Demographic and Health Survey program (The DHS Program). The registration is done on the DHS website indicated above.

Authors' Contribution

DAA conceived and designed the study, interpreted the results, wrote the first draft of the manuscript, and contributed to revision of the manuscript. DAA and ZTD analysed the data. ZTD and EWK contributed to study design, data interpretation, and critical revision of the manuscript. All authors take responsibility of any issues that might arise from the publication of this manuscript.

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