

1 **Factors associated with normal linear growth among pre-school children living in better-off**
2 **households: a multi-country analysis of nationally representative data**

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25 **Abstract**

26 This study examined the factors associated with normal linear growth among pre-school
27 children living in better-off households, using survey data from Ghana, Kenya, Nigeria,
28 Mozambique and Democratic Republic of Congo (DRC). The primary outcome variable was child
29 height-for-age z-scores (HAZ), categorised into HAZ \geq -2SD (normal growth/not stunted) and
30 HAZ $<$ -2 (stunted). Using logistic regression, we estimated adjusted odds ratios (aORs) of the
31 factors associated with normal growth. Higher maternal weight (measured by body mass index)
32 was associated with increased odds of normal growth in Mozambique, DRC, Kenya and Nigeria.
33 A unit increase in maternal years of education was associated with increased odds in normal
34 growth in DRC (aOR=1.06, 95% CI=1.03, 1.09), Ghana (aOR=1.08, 95% CI=1.04, 1.12),
35 Mozambique (aOR=1.08, 95% CI=1.05, 1.11) and Nigeria (aOR=1.07, 95% CI=1.06, 1.08). A year
36 increase in maternal age was positively associated with normal growth in all the five countries.
37 Breastfeeding was associated with increased odds of normal growth in Nigeria (aOR= 1.30, 95%
38 CI=1.16, 1.46) and Kenya (aOR=1.37, 95% CI=1.05, 1.79). Children of working mothers had 25%
39 (aOR=0.75, 95% CI=0.60, 0.93) reduced odds of normal growth in DRC. A unit change in
40 maternal parity was associated with 10% (aOR=0.90, 95% CI=0.84, 0.97), 23% (aOR=0.77, 95%
41 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%
42 (aOR=0.95, 95% CI=0.92, 0.99) reduced odds of normal growth in DRC, Ghana, Kenya,
43 Mozambique and Nigeria respectively. A child being a male was associated with 16%
44 (aOR=0.82, 95% CI=0.68, 0.98), 40% (aOR=0.60, 95% CI=0.40, 0.89), 37% (aOR=0.63, 95%
45 CI=0.51, 0.77) and 21% (aOR=0.79, 95% CI=0.71, 0.87) reduced odds of normal child growth in

46 DRC, Ghana, Kenya and Nigeria respectively. In conclusion, maternal education, weight, age,
47 breastfeeding and antenatal care are positively associated with normal child growth, while
48 maternal parity, employment, and child sex and age are associated negatively with normal
49 growth. Interventions to improve child growth should take into account these differential
50 effects.

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

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65 **Introduction**

66 Child health is a fundamental public health issue because good child health sets one up for life-
67 long health and functioning, and wellbeing. In sub-Saharan Africa (SSA), child physical health is
68 of particular concern due to the high rates of illness and mortality in the region. Child normal
69 (healthy) growth, defined in this paper as children who are not stunted (not too short for their
70 age), is a foundation for optimal child health and wellbeing. There is evidence that healthy child
71 growth is positively associated with cognitive development, higher school achievements, lower
72 morbidity and mortality, higher economic productivity in adulthood and better maternal
73 reproductive outcomes (1-3). Thus, suggesting the need for substantial investment in nutrition
74 interventions to promote child growth to ensure life-long benefits. Working with international
75 partners such as WHO and UNICEF, governments of SSA have put in place various interventions
76 to improve child growth by addressing stunting in the region (4, 5). However, the
77 implementation of these programmes tends to focus more on child growth deficiencies and
78 how to protect children against risk factors of growth deficiencies (6, 7). Therefore, it may be
79 difficult to directly attribute the effects of the programmes on child healthy growth outcomes,
80 except to infer that reduction in stunting implies an increase in healthy growth. The present
81 study fills this gap by providing robust evidence on the critical factors associated with healthy
82 growth among children living in better-off households. Indeed, many experts have called for
83 this type of resource-focused approach in promoting child health outcomes, as exemplified by
84 the UNICEF childcare framework (8, 9).

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86 Several factors affect child linear growth in low and middle incomes countries (LMICs). These
87 factors include maternal education, employment, household wealth index, antenatal care
88 (ANC), parity, maternal body mass index (BMI), urban place of residence, breastfeeding, and
89 maternal age among others (10-30). These factors affect child linear growth either negatively or
90 positively. There is substantial evidence that improvement in maternal education has a
91 significant positive effect on child growth outcomes in many settings (10-14). Educated mothers
92 tend to have children with better nutritional status compared to children of mothers with no
93 education.

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95 Similarly, maternal BMI has a strong positive effect on child linear growth (10, 11, 14-17). A
96 study in Ethiopia showed that maternal BMI was associated positively with children nutritional
97 status (17). Fenske and colleagues (11) observed that maternal age has a significant effect on
98 childhood stunting. In India, undernutrition was more prevalent in children of 26-30 year age
99 group mothers than the other reproductive age groups (18). Relatedly, children of older
100 mothers tend to suffer less from stunting compared to children of younger mothers (12, 19,
101 20). Although there is scanty literature on the effects of maternal parity on child nutritional
102 status, some few studies have observed negative associations between maternal parity and
103 child growth (21-23). Further, Kuhnt and Vollmer(24) found in their study that having at least
104 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

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

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109 The literature reviewed above focus almost exclusively on child growth deficiencies
110 (undernutrition/abnormal growth) and the associated risk factors. Statistical analyses that
111 examine the direct relationship between sociodemographic factors and healthy child growth
112 are still limited, to the best of our knowledge. Therefore, it is significant to conduct analysis,
113 using healthy growth as the primaryr outcome variable to elucidate the direct relationship
114 between sociodemographic factors and healthy linear growth among children. Furthermore, it
115 is widely recognised that children in better-off households tend to have better growth and
116 health outcomes. However, stratified analysis to understand the key covariates responsible for
117 the positive growth outcomes in this sub-group is lacking. This study intended to fill this gap by
118 stratifying the analysis by better-off households, focusing on children who are growing normally
119 (rather than those that are not) and the factors that make them grow well. We also
120 investigated the factors that pose potential risks to child growth in better-off households. This
121 investigation will further our understanding of the critical factors associated with healthy child
122 growth. The objective of this study, therefore, is to examine the associations between
123 sociodemographic factors at child, maternal, household and community levels and healthy
124 growth among children living in better-off households.

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127 **Methodology**

128 *Data sources and sampling strategy*

129 This analysis used data from the Demographic and Health Surveys (DHS) (31), conducted in
130 Ghana (2014), Kenya (2014), Nigeria (2013), Mozambique (2011) and Democratic Republic of
131 Congo (DRC) (2013-2014). Our previous work informed the selection of these five countries for
132 the present analysis (12, 32). The DHS data are nationally representative, repeated cross-
133 sectional household surveys collected primarily in LIMCs every five years using standardised
134 questionnaires to enable cross-country comparisons (33, 34). The DHS utilises a two-stage
135 sample design (35-39). The first stage involves the selection of sample points or clusters from
136 an updated master sampling frame constructed from National Population and Housing Census
137 of the respective countries (37). The clusters are selected using systematic sampling with
138 probability proportional to size. Household listing is then conducted in all the selected clusters
139 to provide a sampling frame for the second stage selection of households (12, 37). The second
140 stage selection involves the systematic sampling of the households listed in each cluster and
141 randomly select from the list the households to be included in the survey (12, 37). The
142 rationale for the second stage selection is to ensure adequate numbers of completed individual
143 interviews to provide estimates for critical indicators with acceptable precision. All men and
144 women aged 15-59 and 15-49 respectively, in the selected households (men in half of the
145 households) are eligible to participate in the surveys if they were either usual residents of the
146 household or visitors present in the household on the night before the study (12, 37).

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149 *Study participants*

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

158 **Ethics statement**

159 Before conducting the surveys, the DHS obtained ethical clearance from Government
160 recognised Ethical Review Committees/Institutional Review Boards of the respective countries
161 as well as the Institutional Review Board of ICF International, USA. Study children mothers or
162 caregivers gave written informed consent before the inclusion of their children. The authors of
163 this paper sought and obtained permission from the DHS program for the use of the data. The
164 data were utterly anonymised, and therefore, the authors did not seek further ethical clearance
165 before their use.

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169 **Outcome and predictor variables**

170 *Outcome Variables*

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

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178 *Predictor variables*

179 We classified the predictor variables into child (dietary diversity, age and sex), maternal (body
180 mass index, education, age, work status, parity, breastfeeding status, marital status, antenatal
181 attendance), household (sex of household head, household size, number of children under 5
182 years) and community (place of residence) level variables. The child dietary diversity (DD) was
183 created by counting the number of food groups the mother reported the child had consumed in
184 the past 24h before the interview. In accordance with recommended procedures on the
185 construction of the child DD indicator (42), we regrouped the food types in the data into seven
186 (7) main categories (12): (i) grains, roots and tubers; (ii) legumes and nuts; (iii) dairy products;
187 (iv) flesh foods and organ meats; (v) vitamin A-rich fruits and vegetables; (vi) eggs; and (vii)

188 other fruits and vegetables. A value of 1 was given for the child's consumption of any of the
189 food groups within 24h, while we assigned 0 for non-consumption (12). These scores were
190 then summed up to obtain the DD score, ranging from 0 to 7, and used in the analysis as a
191 categorical predictor variable. Also, a score of 1 was assigned to a mother who indicated she
192 was still breastfeeding, and 0 for "no" response. Marital status was recoded into "not in union"
193 "cohabiting" and "married". Maternal body mass index (BMI), also referred to as Quetelet's
194 Index (43), was derived by dividing weight in kilograms by the squared height in meters (12).
195 The BMI (kg/m^2) was then classified into $\text{BMI} < 18.50 \text{ kg}/\text{m}^2$ (underweight), $\text{BMI} = 18.50\text{-}24.99$
196 kg/m^2 (normal weight), $\text{BMI} = 25.0\text{-}29.9 \text{ kg}/\text{m}^2$ (overweight) and $\text{BMI} \geq 30.0 \text{ kg}/\text{m}^2$ (obese) (44).
197 We used $\text{BMI} < 18.50 \text{ kg}/\text{m}^2$ (underweight) as a referenced category in the analysis. We selected
198 the predictor variables based on the UNICEF conceptual framework of childcare (9) and the
199 literature. We subjected the selected variables to bivariate analysis to establish their
200 relationship with the outcome variable. Only statistically significant variables were included in
201 the multivariable analysis.

202 *Stratification variable*

203 We used the household wealth index (WI) as the stratification variable in the analysis. Several
204 DHS reports used the WI to estimate inequalities in household characteristics, in the use of
205 health and other services, and health outcomes (34, 35, 37, 45). It is an indicator of wealth that
206 is consistent with expenditure and income measurement among households (33, 34, 37). The
207 index was created based on assets ownership and housing characteristics of each household:
208 type of roofing, and flooring material, source of drinking water, sanitation facilities, ownership
209 of television, bicycle, motorcycle, automobile among others. A principal component analysis

210 was employed to assign weights to each asset in each household. The asset scores were
211 summed up, and individuals ranked according to the household score. The DHS then divided
212 the WI into quintiles: poorest, poorer, middle, richer and richest (33, 34, 37). For this analysis,
213 we recoded middle, richer and richest households into “better-off households”. We restricted
214 all the investigations to this sub-category.

215

216 *Framework underpinning the analysis*

217 The UNICEF conceptual framework (46), which outlines the causes of undernutrition
218 underpinned our empirical analysis. It is a socio-ecological model encompassing factors at the
219 individual, household and societal levels. In the UNICEF framework, child malnutrition is
220 analysed in terms of immediate, underlying and basic causes. The immediate causes are
221 inadequate dietary intakes and infectious disease, the underlying causes are inadequate
222 maternal, and childcare, inadequate health services and healthy environment and the basic
223 causes are institutional and socio-economic determinants and potential resources
224 (46). However, the extended UNICEF conceptual framework for childcare, survival, growth and
225 development guided the present analysis (9, 46). This framework suggests that child survival,
226 growth and development are influenced by a web of factors, with three underlying
227 determinants being food security, healthcare and a healthy environment, and care for children
228 and women (9). Basic determinants have a direct influence on these underlying determinants.
229 These basic determinants may be described as "exogenous" determinants, which influence
230 child nutrition through their effect on the intervening proximate determinants (underlying

231 determinants). The underlying factors are, therefore, endogenously determined by the
232 exogenous factors (46). In this analysis, we included only the basic factors (socio-demographic)
233 in our empirical models. We did this because there is evidence that in examining the
234 association between child growth outcomes and exogenous factors, the proximate factors are
235 usually excluded to prevent biased and uninterpretable parameters (47-49). Besides the basic
236 factors, we also included antenatal care (ANC) and breastfeeding practices, which relies mostly
237 on exogenous public health provisions rather than socio-demographic endowments of the
238 household (46). We included the two variables in the models' because changes in them are
239 likely to be more responsive to policies, programmes and interventions rather than to
240 differences in socio-demographic endowments of the household (46). For example, there is
241 evidence that policy, institutional and contextual settings are critical determinants of the
242 prevalence of breastfeeding practices (47, 50).

243 **Data analysis**

244 We built two empirical regression models for each of the five countries. In the first models, we
245 included maternal BMI, education, age, work status, parity, breastfeeding status, marital status,
246 antenatal attendance, sex of household head, household size, number of children under five
247 years and place of residence. We adjusted for child DD, age and sex in the second and final
248 model. We estimated adjusted odds ratios (aORs) of the associations between the
249 sociodemographic factors and normal growth among children in better-off households. Because
250 the DHS utilised complex sample design, we accounted for design effect in all the analysis using
251 parameters such as primary sampling unit, strata and weight.

252 **Results**

253 *Characteristics of study samples*

254 The results showed that Ghana (87%) had the highest number of children with normal growth
255 followed by Kenya (80%), while in Mozambique, DRC and Nigeria, the prevalence ranged from
256 62% to 74%. Regarding dietary diversity intake, Mozambique had the highest prevalence of
257 children who consumed at least four food groups (21%), with DRC (12%) having the lowest
258 prevalence. Similarly, Mozambique had the highest number of women with normal weight
259 (73%), followed by DRC (69%). The prevalence ranged from 43% to 59% in Ghana, Kenya and
260 Nigeria. Ghana had the highest prevalence (59%) of women who had attained a secondary
261 school education, while Mozambique had the lowest prevalence (21%). Higher education was
262 less than 15% among women across all countries, with Mozambique (1.3%) registering the
263 lowest prevalence. DRC had the highest prevalence (86%) of ANC attendance among women
264 followed by Ghana (72%), while Nigeria had the lowest prevalence (19%). Also, Mozambique
265 (35%) had the highest number of women who were household heads, with Nigeria (14%) having
266 the lowest women-headed households (Table 1).

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

Variables	DRC		Ghana		Kenya		Mozambique		Nigeria	
	%/mean	SD	%/mean	SD	%/mean	SD	%/mean	SD	%/mean	SD
Child-level covariates										
Height-for-age (HAZ \geq -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 \geq 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 \geq 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	
Antenatal attendance (ANC)										

	Number of ANC 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	
268	DD=Dietary diversity;		DRC=Democratic		Republic		of	Congo;		SD=Standard	deviation

269 *Multivariable results of the factors promoting or inhibiting normal child growth*

270 The results of the multivariable analysis of the associations between maternal, child, household
271 and community-level factors, and normal growth among children under five years in better-off
272 households are presented in Tables 2-6.

273 *Factors associated positively with normal child growth*

274 The results showed that normal maternal weight (measured by BMI) was associated with
275 increased odds of normal linear growth among children in Mozambique (aOR=1.82, 95%
276 CI=1.33, 2.50). Similarly, overweight associated with increased odds of normal linear growth in
277 DRC (aOR=1.75, 95% CI=1.17,2.62), Kenya (aOR=2.01, 95% CI= 1.28, 3.16), Mozambique
278 (aOR=2.19, 95%= 1.53, 3.14) and Nigeria (aOR=1.44, 95%=1.16,1.77) relative to children of
279 underweight mothers. Maternal obesity had a similar effect on normal linear growth in Kenya,
280 Mozambique and Nigeria. One year increase in maternal years of education was associated
281 with increased odds in normal linear growth among children in DRC (aOR=1.06, 95% CI=1.03,
282 1.09), Ghana (aOR=1.08, 95% CI=1.04, 1.12), Mozambique (aOR=1.08, 95% CI=1.05, 1.11) and
283 Nigeria (aOR=1.07, 95% CI=1.06, 1.08). The results in Kenya did not reach statistical significance.
284 An additional year in maternal age was associated with increased odds of normal linear growth
285 among children in all the countries included in the analysis. Breastfeeding was associated with
286 increased odds of normal linear growth in Nigeria (aOR= 1.30, 95% CI=1.16, 1.46) and Kenya
287 (aOR=1.37, 95% CI=1.05, 1.79). In Ghana, Mozambique and DRC, breastfeeding was associated
288 positively with normal linear growth in the first model. Still, this statistical significant
289 association disappeared after the child level covariates such as age, sex and dietary diversity

290 were included in the final empirical model. Urban place of residence was associated with
291 increased odds of normal linear growth among children in DRC (aOR=1.32, 95% CI=1.06, 1.65)
292 and Mozambique (aOR=1.18, 95% CI=1.01, 1.38). The association did not reach statistical
293 significance in the remaining three countries.

294

295 *Factors associated negatively with normal child growth*

296 This section examines the factors associated negatively with normal linear growth. The results
297 showed that children of mothers who were working had 25% (aOR=0.75, 95% CI=0.60, 0.93)
298 reduced odds of normal linear growth in DRC. A unit change in maternal parity was associated
299 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,
300 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)
301 reduced odds of normal linear growth among children in DRC, Ghana, Kenya, Mozambique and
302 Nigeria respectively. Similarly, a unit change in child's age was associated with reduced odds of
303 normal linear growth in DRC, Mozambique and Nigeria. Further, a child being a male was
304 associated with 16% (aOR=0.82, 95% CI=0.68, 0.98), 40% (aOR=0.60, 95% CI=0.40, 0.89), 37%
305 (aOR=0.63, 95% CI=0.51, 0.77) and 21% (aOR=0.79, 95% CI=0.71, 0.87) reduced odds of normal
306 linear growth among children in DRC, Ghana, Kenya and Nigeria respectively. The association in
307 Mozambique did not reach statistical significance.

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311 **Table 2: Adjusted odd ratios (aOR) of factors associated with normal growth among children living in**
 312 **better-off households, DRC**

Variables	Model 1	Model 2
Mother-level covariates		
BMI (kg/m ²) = 18.50 - 24.99	1.093 (0.782 - 1.526)	1.124 (0.796 - 1.589)
BMI (kg/m ²) = 25 - 29.99	1.685*** (1.138 - 2.493)	1.751*** (1.172 - 2.617)
BMI (kg/m ²) >= 30	1.573 (0.855 - 2.892)	1.729 (0.884 - 3.382)
Maternal education (in single years)	1.061*** (1.032 - 1.090)	1.060*** (1.030 - 1.091)
Age of the mother (in years)	1.039*** (1.015 - 1.063)	1.051*** (1.026 - 1.077)
Working status = Is working	0.741*** (0.597 - 0.920)	0.747** (0.597 - 0.934)
Parity	0.902*** (0.844 - 0.965)	0.899*** (0.838 - 0.965)
Is Breastfeeding = Yes	1.678*** (1.370 - 2.055)	1.184 (0.943 - 1.487)
Marital Status = Married	1.034 (0.756 - 1.415)	1.076 (0.786 - 1.473)
Marital Status = Cohabiting	0.976 (0.687 - 1.389)	0.994 (0.697 - 1.418)
Number of antenatal visits = 4+ visits	1.589*** (1.296 - 1.947)	1.159 (0.923 - 1.457)
Household-level covariates		
Head of HH is Male	0.865 (0.681 - 1.098)	0.868 (0.678 - 1.111)
Household size	1.007 (0.968 - 1.048)	1.002 (0.962 - 1.043)
Number of children under 5 years	0.945 (0.844 - 1.059)	0.954 (0.850 - 1.071)
Community-level covariates		
Urban residence = Urban	1.322** (1.066 - 1.640)	1.320** (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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315 **Table 3: Adjusted odd ratios (aOR) of factors associated with normal growth among children living in**
 316 **better-off households, Ghana**

Variables	Model 1	Model 2
Mother-level covariates		
BMI (kg/m ²) = 18.50 - 24.99	0.692 (0.224 - 2.136)	0.725 (0.241 - 2.181)
BMI (kg/ m ²) = 25 - 29.99	1.230 (0.385 - 3.929)	1.270 (0.410 - 3.931)
BMI (kg/ m ²) >= 30	1.617 (0.478 - 5.469)	1.700 (0.514 - 5.628)
Maternal education (in single years)	1.078*** (1.037 - 1.121)	1.081*** (1.039 - 1.124)
Age of the mother (in years)	1.047* (0.998 - 1.099)	1.052** (1.001 - 1.105)
Working status = Is working	1.276 (0.821 - 1.983)	1.264 (0.804 - 1.987)
Parity	0.779** (0.643 - 0.944)	0.766*** (0.630 - 0.932)
Is Breastfeeding = Yes	1.769** (1.129 - 2.771)	1.748* (0.981 - 3.116)
Marital Status = Married	1.956** (1.032 - 3.708)	2.104** (1.101 - 4.022)
Marital Status = Cohabiting	1.524 (0.783 - 2.967)	1.659 (0.849 - 3.240)
Number of antenatal visits = 4+ visits	1.124 (0.695 - 1.817)	1.110 (0.646 - 1.906)
Household-level covariates		
Head of HH is Male	1.250 (0.783 - 1.996)	1.200 (0.753 - 1.911)
Household size	0.998 (0.894 - 1.114)	0.998 (0.891 - 1.117)
Number of children under 5	0.834 (0.555 - 1.253)	0.843 (0.559 - 1.274)
Community-level covariate		
Urban residence = Urban	1.020 (0.640 - 1.628)	0.988 (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 factors associated with normal 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 (0.824 - 1.881)	1.313 (0.872 - 1.976)
BMI (kg/ m ²) = 25 - 29.99	1.880*** (1.195 - 2.960)	2.014*** (1.284 - 3.158)
BMI (kg/ m ²) >= 30	1.860** (1.082 - 3.195)	1.991** (1.165 - 3.402)
Maternal education (in single years)	1.017 (0.984 - 1.051)	1.021 (0.987 - 1.055)
Age of the mother (in years)	1.074*** (1.046 - 1.102)	1.075*** (1.046 - 1.104)
Working status = Is working	0.969 (0.775 - 1.211)	0.982 (0.786 - 1.227)
Parity	0.752*** (0.688 - 0.823)	0.752*** (0.687 - 0.822)
Is Breastfeeding = Yes	1.373*** (1.103 - 1.710)	1.367** (1.047 - 1.785)
Marital Status = Married	1.131 (0.826 - 1.547)	1.112 (0.810 - 1.526)
Marital Status = Cohabiting	1.278 (0.785 - 2.079)	1.233 (0.756 - 2.009)
Number of antenatal visits = 4+ visits	1.132 (0.906 - 1.415)	1.095 (0.862 - 1.390)
Household-level covariates		
Head of HH is Male	0.986 (0.781 - 1.245)	0.987 (0.780 - 1.248)
Household size	1.054* (0.991 - 1.122)	1.047 (0.984 - 1.114)
Number of children under 5	1.018 (0.871 - 1.189)	1.026 (0.878 - 1.200)
Community-level covariate		
Urban residence = Urban	0.883 (0.719 - 1.085)	0.890 (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

318 **Table 5: : Adjusted odd ratios (aOR) of factors associated with normal growth among children living in**
 319 **better-off households, Mozambique**

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

321 **Table 6: : Adjusted odd ratios (aOR) of factors associated with normal growth among children living in**
 322 **better-off households, Nigeria**

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

323

324

325 **Discussion**

326 This study investigated the maternal, child, household and community factors associated with
327 normal linear growth among children living in better-off households in DRC, Ghana, Kenya,
328 Mozambique and Nigeria. The results highlight the critical factors related to child growth
329 outcomes and country-specific variations of these effects in the five countries. In the current
330 analysis, higher maternal weight (measured by BMI) tends to have a significant positive impact
331 on normal growth among children living in better-off households in all countries except Ghana.
332 Thus, maternal weight is a crucial determinant of positive child growth outcomes. Even though
333 a higher maternal weight has a positive effect on child normal growth, interventions should
334 target increasing maternal weight qualitatively for the benefit of both the mother and child. It is
335 critical because of the negative effect of unhealthy weight on maternal health outcomes (51-
336 53). These findings are in line with the literature. Maternal nutrition was found to have a
337 significant positive effect on child linear growth in many settings (10-12). In India, BMI, among
338 other variables, was found to have a substantial impact on child linear growth (11). The
339 preceding discussion illuminated the crucial role maternal nutrition plays in improving child
340 nutritional status, although the pathways through which this happens may be complicated.

341

342 The vital role maternal education plays in promoting positive child health outcomes was
343 observed in the present study. Our results showed that maternal years of schooling have
344 significant positive effects on normal linear growth in all the five countries except Kenya. Thus,
345 suggesting that maternal education has the potential to promote the normal growth of children

346 living in better-off households. Interventions to improve child growth may have a positive
347 impact on children living in these households. Previous studies documented the beneficial
348 effects of maternal years of education on child growth outcomes. Improvement in maternal
349 education was associated positively with a dramatic change in linear growth among pre-school
350 children (10-12). It may be the case because educated mothers tend to utilise both preventive
351 and curative health care more (54, 55). Educated mothers also tend to have more strongly
352 committed attitude towards good childcare than uneducated mothers (56, 57). Furthermore,
353 the more education the mother has, the more the likelihood that she is sensitive and
354 responsive to caregiving duties (56, 57). Also, there is evidence that children seemingly engage
355 more positively with their mothers when maternal education is higher (12, 57). All the above
356 have positive effects on child growth outcomes. The literature discussed above, together with
357 our study, demonstrated the importance of maternal education for positive child health
358 outcomes.

359

360 The benefits of breastfeeding to child health were illuminated in this study but only in two
361 countries. Breastfeeding practice was found to associate with the likelihood of normal linear
362 growth among children living in better-off households in Kenya and Nigeria. The finding may
363 imply that mothers in these households should be encouraged to practice breastfeeding
364 because of its beneficial effects on their children growth. These findings confirm the widely
365 recognised benefits of breastfeeding for improved health and developmental outcomes (25-
366 27). On the contrary, breastfeeding showed a significant positive effect on child normal linear
367 growth in the models containing only the socio-demographic factors in Ghana, Mozambique

368 and DRC. The statistically significant association disappeared after the inclusion of child-level
369 covariates such as dietary diversity, age and sex in the final empirical models. Hence, whether
370 breastfeeding will have a positive effect on normal child growth in better-off households or not
371 is conditional on the inclusion or otherwise of child-level covariates. This finding corroborates
372 previous research, which suggests the addition of child-level factors when evaluating the
373 association of breastfeeding with anthropometric outcomes (57). The non-significant positive
374 effect of breastfeeding on child growth has previously been documented(58-60). Thus, while
375 breastfeeding is critical for positive child health outcomes, it is not always the case that its
376 effects would be statistically significant.

377

378 Our analysis also illuminated negative determinants of normal linear growth. Maternal work
379 status is inversely related to normal child growth in DRC. It implies that DRC mothers who are
380 engaged in any form of work tend to have children who have poor linear growth relative to
381 mothers who are not working. The negative effect may boil down to inadequate childcare due
382 to limited time available to working mothers. A study in India concluded that a mother's
383 employment compromises infant feeding and care, particularly so when mothers are not able
384 to get alternative caregivers (61). This study further reported that the compromises related to
385 childcare and feeding outweigh the benefits from employment (61). Other studies have shown
386 that mothers working away from home spend less time with their children compared to
387 mothers who are not working outside the home and therefore likely to have children who are
388 undernourished (62, 63). Although women who are working tend to have access to disposable
389 income and consequently able to provide nutritious food for their children (13, 17, 64, 65), the

390 above discussion showed that maternal employment, indeed, could negatively affect child
391 growth outcomes. It is worthy to note that this analysis did not investigate the categories of
392 work and their effect on child growth (12). We are therefore unable to tell the independent
393 impact of the various occupational groups on child linear growth. It is a limitation worth noting,
394 as different occupations may have different effects.

395

396 Similarly, maternal parity was negatively associated with normal child growth. The results show
397 that higher maternal parity impact negatively on normal linear growth in better-off households.
398 The effect is most significant in Kenya (25%) followed by Ghana (23%), with the least impact
399 being in Nigeria (5%). The findings suggest that higher parity has a stronger negative effect on
400 child normal growth in Kenya and Ghana relative to the other countries. The adverse effects of
401 parity on child growth may be attributed to it being an essential factor that affects maternal
402 depletion, particularly among high fertility mothers (66, 67). Poor maternal health has the
403 potential to compromise the mothers' ability to provide proper care for their children. The
404 consequential effect of the lack of adequate care is poor child growth. Secondly, women with
405 higher parity are likely to have many young children, who might compete for the available care
406 resources, which can affect good care practices and consequently their children growth
407 outcomes. Previous studies have documented that the higher the maternal parity, the less likely
408 that their children will have positive growth outcomes (21, 22). Children of multiparous
409 mothers tend to have lower rates of growth and lower levels of childhood body mass index
410 than children of nulliparous mothers (22). The preceding discussion demonstrated that parity
411 has a significant negative effect on child linear growth.

412 Similarly, child biological factors such as sex and age were found to negatively associate with
413 normal linear growth. A year increase in child's age was associated negatively with normal
414 linear growth in three (DRC, Mozambique and Nigeria) of the five countries. The implication is
415 that older children living in better-off households have a less likelihood of achieving a normal
416 linear growth. These findings are consistent with previous research. Nshimiyiryo and colleagues
417 (68) observed that an increase in the child's age had a significant association with poor linear
418 growth. For instance, children aged 6–23 months were at lower risk of poor growth than those
419 in the older age group 24–59 months (68). Also, being a male child is associated with less
420 likelihood of normal growth among children living in better-off households. Previous work has
421 shown that poor linear growth was higher among male children as compared to female children
422 (69). Suggesting that male children tend to be more vulnerable to poor growth than their
423 female counterparts in the same age group (70). It might be due to preferences in feeding
424 practices or other types of exposures (70). The findings could also be explained by the fact that
425 boys are expected to grow at a slightly more rapid rate compared to girls and their growth is
426 perhaps more easily affected by nutritional deficiencies or other exposures (71).

427

428 **Strengths and limitations of the study**

429 One significant advantage is the use of high quality, extensive nationally representative DHS
430 data to investigate the factors associated with normal linear growth among children living in
431 better-off households. The comprehensive data make it possible for the findings to be
432 generalised to the population of young children in the respective countries. The large data also

433 help to produce more robust estimates of observed associations. The use of multi-country data
434 unmask differences and highlights commonalities in the effects of the correlates on child
435 growth across countries. Revealing these differences may not have been possible with single
436 country data.

437
438 Further, the height data used for computing the HAZ indicator were objectively measured,
439 reducing possible misclassification. The novelty of this study is its focus on positive child growth
440 outcomes rather than child growth deficiencies. A limitation worth mentioning is the cross-
441 sectional nature of the data, which makes it challenging to disentangle potential reciprocal and
442 otherwise complex causal relationships. We, therefore, restrict the interpretation of findings to
443 mere associations between the explanatory variables and the outcome variables.

444

445 **Conclusions**

446 Maternal weight (BMI) tends to have significant positive effects on normal linear growth among
447 children living in better-off households across all countries except Ghana. Interventions aimed
448 at increasing maternal weight qualitatively are likely to be effective in improving the linear
449 growth of children living in better-off households. Maternal years of education have significant
450 positive effects on normal linear growth in all the five countries except Kenya. Schooling has the
451 potential to improve normal linear growth among children in better-off households.
452 Breastfeeding was associated with the likelihood of normal linear growth in Kenya and Nigeria.
453 Implying that mothers in better-off households should be encouraged to practice breastfeeding

454 because of its beneficial effect on their children growth. Maternal work status is inversely
455 related to normal growth in DRC. Thus, in DRC, mothers who are engaged in any form of work
456 tend to have children with poor growth relative to mothers who are not working. The results
457 show that higher maternal parity associates negatively with normal linear growth. The effect is
458 most significant in Kenya (25%) followed by Ghana (23%), with the least impact being in Nigeria
459 (5%). Thus, higher parity has a stronger negative impact on child normal linear growth in Kenya
460 and Ghana relative to the other countries.

461

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466

467 **Competing Interest**

468 The authors have no competing interests to declare.

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471 **Data Sharing Statement**

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

476 **Authors' Contribution**

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

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