1   **Positive and negative determinants of normal linear growth among pre-school children living**

2   **in better-off households: an analysis of secondary data from sub-Saharan Africa**

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4   Dickson A. Amugsi[1*], Zacharie T. Dimbuene[2, 3], Elizabeth W. Kimani-Murage[1]

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6   1. Maternal and Child Wellbeing Unit, Research Division, African Population and Health Research

7   Center, Nairobi, Kenya

8   2. Department of Population Sciences and Development, University of Kinshasa, Democratic

9   Republic of the Congo

10   3. Microdata Access Division, Statistics Canada, Ottawa, Canada

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12   * Corresponding author

13   Email: damugsi2002@yahoo.com; damugsi@aphrc.org (DAA)

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24 **Abstract**

25 This study examined the positive and negative determinants of normal linear growth among pre-

26 school children living in better-off households, using survey data from Ghana, Kenya, Nigeria,

27 Mozambique and Democratic Republic of Congo (DRC). The main outcome variable was child

28 height-for-age z-scores (HAZ), categorized into HAZ≥-2SD (normal growth/not stunted) and

29 HAZ<–2 (stunted). Logistic regression was utilized in the analysis. We estimated adjusted odd

30 ratios (aORs) of the determinants of normal growth. Higher maternal weight (measured by body

31 mass index) was associated with increased odds of normal growth in Mozambique, DRC, Kenya

32 and Nigeria. A unit increase in maternal years of education was associated with increased odds

33 in normal growth in DRC (aOR=1.06, 95% CI=1.03, 1.09), Ghana (aOR=1.08, 95% CI=1.04, 1.12),

34 Mozambique (aOR=1.08, 95% CI=1.05, 1.11) and Nigeria (aOR=1.07, 95% CI=1.06, 1.08). A year

35 increase in maternal age was associated positively with normal growth in all the five countries.

36 Breastfeeding was associated with increased odds of normal growth in Nigeria (aOR= 1.30, 95%

37 CI=1.16, 1.46) and Kenya (aOR=1.37, 95% CI=1.05, 1.79). Children of mothers who were working

38 had 25% (aOR=0.75, 95% CI=0.60, 0.93) reduced odds of normal growth in DRC. A unit change in

39 maternal parity was associated with 10% (aOR=0.90, 95% CI=0.84, 0.97), 23% (aOR=0.77, 95%

40 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%

41 (aOR=0.95, 95% CI=0.92, 0.99) reduced odds of normal growth in DRC, Ghana, Kenya,

42 Mozambique and Nigeria respectively. A child being a male was associated with 16% (aOR=0.82,

43 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

44 21% (aOR=0.79, 95% CI=0.71, 0.87) reduced odds of normal child growth in DRC, Ghana, Kenya

45 and Nigeria respectively. In conclusion, maternal education, weight, age, breastfeeding and

46   antenatal care are positive determinants of normal child growth, while maternal parity,

47   employment, and child sex and age are negative determinants. Interventions to promote child

48   growth should take into account these differential effects.

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

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64   **Introduction**

65   Child health is a fundamental public health issue, for children's sake and because good child

66   health sets one up for life-long health and functioning, and well-being. In sub-Saharan Africa

67   (SSA), child physical health is of particular concern due to the high rates of illness and mortality

68   in the region. Child normal growth, defined in this paper as children who are not stunted (short

69   stature for age), is a foundation for optimal child health and wellbeing. This is because normal

70   child growth is associated positively with cognitive development, higher school achievements,

71   lower morbidity and mortality, higher economic productivity in adulthood and better maternal

72   reproductive outcomes (1-3). This suggests the need for strong investment in nutrition

73   interventions to promote child growth so as to ensure life-long benefits. Working with

74   international partners such as WHO and UNCEF, governments of SSA have put in place various

75   interventions to promote child growth by addressing stunting in the region (4, 5). However, the

76   implementation of these programmes more often than not places more emphasis on child

77   growth deficiencies and how to protect children against the risk factors contributing to these

78   deficiencies (6, 7). This may make it difficult to directly attribute the effects of the programmes

79   on child normal growth outcomes, except to infer that reduction in stunting implies increase in

80   normal growth. The present study intends to fill this gap by providing robust evidence on the

81   positive as well as negative determinants of normal growth among children living in better-off

82   households. Indeed, many experts have called for this type of resource focused approach in

83   promoting child health outcomes, as exemplified by the UNICEF childcare framework (8, 9).

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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

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106   wealth index also has a strong positive effect 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 factors associated with the same. Statistical analyses

111   that simultaneously examine the positive as well as negative determinants of normal child

112   growth are, to the best of our knowledge, still missing. Protective factors against child growth

113   deficiencies may not necessarily be positive determinants of normal growth, it is significant to

114   conduct analysis, using normal growth as the key outcome to elucidate the direct relationship

115   between socio-demographic determinants and positive linear growth among children. It is widely

116   recognized that children in better-off households tend to have better growth and health

117   outcomes. However, stratified analysis to understand the key covariates responsible for the

118   positive growth outcomes in this sub-group is lacking. This study intended to fill this gap by

119   stratifying the analysis by better-off households, focusing on children who are growing normally

120   (rather than those that are not) and the factors that make them to grow well. We also

121   investigated the factors that poses a potential risk (negative determinants) to child growth in

122   better-off households. This will further our understanding of the key positive and negative

123   determinants of normal child growth. The objective of this study therefore is to examine the

124   positive and negative determinants of normal child growth 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). The selection of these five countries was informed by our previous

132   work (12, 32). The DHS data are nationally representative, repeated cross-sectional household

133   surveys collected primarily in LIMCs every 5 years using standardised questionnaires to enable

134   cross-country comparisons (33, 34). The DHS utilises a two-stage sample design (35-39). The first

135   stage involves the selection of sample points or clusters from an updated master sampling frame

136   constructed from National Population and Housing Census of the respective countries. The

137   clusters are selected using systematic sampling with probability proportional to size. Household

138   listing is then conducted in all the selected clusters to provide a sampling frame for the second

139   stage selection of households. The second stage selection involves the systematic sampling of

140   the households listed in each cluster, and households to be included in the survey are randomly

141   selected from the list. The rationale for the second stage selection is to ensure adequate numbers

142   of completed individual interviews to provide estimates for key indicators with an acceptable

143   precision. All men and women aged 15-59 and 15-49 respectively, in the selected households

144   (men in half of the households) are eligible to participate in the surveys if they were either usual

145   residents of the household or visitors present in the household on the night before the survey.

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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.

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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.

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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).

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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.

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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

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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).

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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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230   **Results**

231   *Characteristics of study samples*

232   The results showed that Ghana (87%) had the highest number of children with normal growth

233   followed by Kenya (80%), while in Mozambique, DRC and Nigeria, the prevalence ranged from

234   62% to 74%. Regarding dietary diversity intake, Mozambique had the highest prevalence of

235   children who consumed at least four food groups (21%), with DRC (12%) having the lowest

236   prevalence. Similarly, Mozambique had the highest number of women with normal weight (73%),

237   followed by DRC (69%). The prevalence ranged from 43% to 59% in Ghana, Kenya and Nigeria.

238   Ghana had the highest prevalence (59%) of women who had attained a secondary school

239   education, while Mozambique had the lowest prevalence (21%). Higher education was less than

240   15% among women across all countries, with Mozambique (1.3%) registering the lowest

241   prevalence. DRC had the highest prevalence (86%) ANC attendance among women followed by

242   Ghana (72%), while Nigeria had the lowest prevalence (19%). Also, Mozambique (35%) had the

243   highest number of women who were household heads, with Nigeria (14%) having the lowest

244   women headed households (Table 1).

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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

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

251   The results of the multivariable analysis of the positive and negative determinants of normal

252   growth among children under 5 years in better-off households are presented in Tables 2-6. The

253   results are presented as adjusted odd ratios (aORs).

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255   *Positive determinants of normal child growth*

256   The results showed that maternal normal weight (measured by BMI) was associated with

257   increased odds of normal linear growth among children in Mozambique (aOR=1.82, 95% CI=1.33,

258   2.50), while overweight associated with increased odds of normal linear growth in DRC

259   (aOR=1.75, 95% CI=1.17,2.62), Kenya (aOR=2.01, 95% CI= 1.28, 3.16), Mozambique (aOR=2.19,

260   95%= 1.53, 3.14) and Nigeria (aOR=1.44, 95%=1.16,1.77) relative to children of underweight

261   mothers. Maternal obesity had similar effect on normal linear growth in Kenya, Mozambique and

262   Nigeria. One year increase in maternal years of education was associated with increased odds in

263   normal linear growth among children in DRC (aOR=1.06, 95% CI=1.03, 1.09), Ghana (aOR=1.08,

264   95% CI=1.04, 1.12), Mozambique (aOR=1.08, 95% CI=1.05, 1.11) and Nigeria (aOR=1.07, 95%

265   CI=1.06, 1.08). The results in Kenya did not reach statistical significance. An additional year in

266   maternal age was associated with increased odds of normal linear growth among children in all

267   the countries included in the analysis. Breastfeeding was associated with increased odds of

268   normal linear growth in Nigeria (aOR= 1.30, 95% CI=1.16, 1.46) and Kenya (aOR=1.37, 95%

269   CI=1.05, 1.79). In Ghana, Mozambique and DRC, breastfeeding was positively associated with

270   normal linear growth in the first model but this statistical significant association disappeared

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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.

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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.

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Table 2: Adjusted odd ratios (aOR) of positive and negative determinants of normal linear growth 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

Table 3: Adjusted odd ratios (aOR) of positive and negative determinants of normal linear growth 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

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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

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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

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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

22

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

23

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

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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

25

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).

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26

Strengths and limitations of the study

413   This study has some strengths. One important strength is the use of high quality large nationally

415   representative DHS data to investigate the positive and negative determinants of normal linear

416   growth among children living in rich households. This makes it possible for the findings to be

417   generalized to the population of young children in the respective countries. The large data also

418   help to produce more robust estimates of observed associations. The use of multi-country data

419   unmask differences and highlights commonalities in the effects of the correlates on child growth

420   across countries. This may not have been possible with single country data. Further, the height

421   data used for computing the HAZ indicator were objectively measured, reducing possible

422   misclassification. The novelty of this study is its focus on positive child growth outcomes rather

423   than child growth deficiencies. A limitation worth mentioning is the cross-sectional nature of the

424   data, which makes it difficult to disentangle potential reciprocal and otherwise complex causal

425   relationships. The conclusions in this paper are therefore meant to be restricted to statements

426   about the associations between the explanatory variables and the outcome variables.

427

428

Conclusions

430   Maternal weight (BMI) tends to have significant positive effects on normal linear growth among

431   children living in better-off households across all countries except Ghana. Interventions aimed at

432   increasing maternal weight qualitatively are likely to be effective in improving the linear growth

433   of children living in better-off households. Maternal years of education have significant positive

27

434   effects on normal linear growth in all the five countries except Kenya. This suggests that

435   education has the potential to promote normal linear growth among of children living in better-

436   off households. Breastfeeding was associated with the likelihood of normal linear growth in

437   Kenya and Nigeria. This implies that mothers in better-off households should be encouraged to

438   practice breastfeeding because of its beneficial effect on their children growth. Maternal work

439   status is inversely related to normal growth in DRC. Thus, in DRC, mothers who are engaged in

440   any form of work tend to have children with poor growth relative to mothers who are not

441   working. The results show that higher maternal parity associate negatively with normal linear

442   growth. The effect is largest in Kenya (25%) followed by Ghana (23%), with the least effect being

443   in Nigeria (5%). In effect, higher parity has a stronger negative effect on child normal linear

444   growth in Kenya and Ghana relative to the other countries.

445

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450

Competing Interest

452   The authors have no competing interests to declare.

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455   **Data Sharing Statement**

456   This study was a re-analysis of existing data that are publicly available from The DHS Program at

457   http://dhsprogram.com/publications/publication-fr221-dhs-final-reports.cfm.   Data   are

458   accessible free of charge upon a registration with the Demographic and Health Survey program

459   (The DHS Program). The registration is done on the DHS website indicated above.

460   **Authors' Contribution**

461   DAA conceived and designed the study, interpreted the results, wrote the first draft of the

462   manuscript, and contributed to revision of the manuscript. DAA and ZTD analysed the data. ZTD

463   and EWK contributed to study design, data interpretation, and critical revision of the manuscript.

464   All authors take responsibility of any issues that might arise from the publication of this

465   manuscript.

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