

Research Article

Breastfeeding Duration Is Associated With Growth among Children Aged 0 To 23 Months; Analysis of the Zambia 2018 Demographic and Healthy Survey Data

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Abstract

Background

The World Health Organization recommends exclusive breastfeeding for the first 6 months and continued breastfeeding up to 24 months and beyond. Breastfeeding is beneficial for infant growth, development, and survival. Evidence on the association between breastfeeding duration and growth is not conclusive. The aim of the present study was to establish the association between breastfeeding duration and growth among infants and young children.

Methods

The study is based on data from the 2018 Zambia Demographic and Health Survey (ZDHS). The primary outcome for the study was height-for-age Z-score (HAZ). Association between HAZ and breastfeeding duration was assessed by using regression analysis.

Results

The overall mean \pm SD for HAZ was -1.24 ± 1.46 and the median (interquartile range) breastfeeding duration was 9 (4-14 months).

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After controlling for potential confounders, breastfeeding duration was inversely associated with HAZ ($\beta=-0.07$, $p<0.001$) and WHZ ($\beta=-0.04$, $p<0.001$). Path analysis demonstrated that the effect of breastfeeding duration is independent of child's birth weight and maternal perceived birth size. Other determinants of HAZ were child's weight and sex, while WHZ was predicted by maternal age, diarrhea episode and child's birth weight.

Conclusion

Breastfeeding duration is negatively associated with both HAZ and WHZ among Zambian children. However, the magnitudes of the association are quite small to be of clinical significance. Thus, breastfeeding should continue to be promoted, protected and supported from birth up to two years and beyond.

Keywords: Breastfeeding duration; Growth; Infants; Zambia

Introduction

Breastfeeding infants and young children up to 24 months and beyond is beneficial to the mother-infant dyad and the entire society at large [1]. Breastfeeding is associated with health, nutritional and developmental benefits for infants [2], and optimal breastfeeding is one of the most cost-effective interventions for prevention of malnutrition in children [3]. Conversely, suboptimal breastfeeding practices increase the risk of malnutrition, morbidity, and mortality in infant and young children both in developed [4] and developing countries [5]. Scaling up optimal breastfeeding to a near universal level has the potential to prevent up to 823 000 deaths among children under five years and 20 000 maternal deaths from breast cancer per year [1]. According to the United Nations Children's Fund (UNICEF), optimal breastfeeding is described as initiating breastfeeding within the first hour of birth without discarding colostrum, exclusive breastfeeding for the first 6 months from birth and continued breastfeeding for 2 years or beyond, with the introduction of appropriate complementary feeding.

In Zambia, breastfeeding is almost universal. The most recent nationally representative data shows that almost 98% of children were breastfed in the last 2 years preceding the survey [6]. On the other hand, only about 16% of children aged between 6-23 months receive the minimum acceptable diet (meeting age-appropriate dietary diversity and frequency). At country level, there are substantial variations by province with respect to breastfeeding indicators and age-appropriate complementary feeding. For instance, timely initiation of breastfeeding is lowest in the northern province at 65.2% and highest in Northwestern province, at 86.3% [6]. Coincidentally, in Zambia stunting among children under the age of five is a serious public health problem.

Breast milk forms an important source of energy and high-quality nutrients for growth and development of infants and young children. Furthermore, breast milk contains bioactive components essential for the immune system development of the infants [7]. Some of the bioactive compounds found in breast milk have been linked to promotion of linear growth in infants and young children [8]. Despite the

potential for breastfeeding to improve growth, there is still no consensus on whether continued breastfeeding from six months of age is associated with growth among infants and young children. Studies which demonstrated a positive association between breastfeeding and growth are characterized by methodological errors [9,10], evidence of reverse causality has been reported in several epidemiological analyses linking breastfeeding and growth outcomes among infants and young children [11-13]. In recent publications, breastfeeding duration has also been shown to be associated with higher adiposity both in young infants [14] and older children [15]. To address these concerns, we explore the relationship between breastfeeding and nutritional status among children under the age of five years using a national representative sample.

Methods

Study design and subjects

The present study is based on data from a nationally representative data from the 2018 Zambia Demographic and Health Survey (ZDHS). The 2018 ZDHS was conducted by the Zambia Statistics Agency (ZSA) and the Ministry of Health in conjunction with ICF. The survey design and sampling has been described elsewhere [6]. Briefly, the primary sampling unit was a household which was obtained using a stratified two stage sample design. The initial stage was aimed at sampling clusters from which eligible households were systematically sampled to obtain a total sample size of 13,625 households. Both men and women aged 15-49 from selected households whether permanent residents or visitors who stayed in the households the night before the survey were eligible to be interviewed. For the present study included living children aged between 0-23 months that had complete anthropometric data and infant and young child feeding variables. Permission to use the 2018 dataset was sought and obtained from the Demographic and Health Surveys (DHS) Program. The DHS protocols were all approved by relevant ethics institutional review boards in Zambia (Tropical Diseases Research Centre) as well as at ICF, thus for the current analysis no further ethical review was warranted.

Variables

Outcome variables

The primary outcome variable used to assess the relationship between breastfeeding and growth was height-for-age Z (HAZ) considering that it is the main nutritional problem in Zambia. Weight-for-age Z (WHZ) was used as a secondary outcome. Both HAZ and WHZ were calculated using the WHO child growth standards. Stunting and wasting were generated from the HAZ and WHZ scores as binary variables based on World Health Organization cut off points for malnutrition using anthropometric indices (<-2 standard deviations denoting presence of stunting or wasting).

Predictor variables (main independent)

To determine the association between continued breastfeeding and growth, the main predictor variable used was duration of breastfeeding in months. Other independent variables included were; 1) child characteristics such as age, sex, birthweight, "size at birth", morbidity in the last two weeks-diarrhea, fever and cough; 2) maternal characteristics such as age, education level (No formal education, primary, secondary and higher); infant and young child feeding-dietary diversity based on eight food groups which included breast milk;

grains, roots, and tubers; flesh foods (meat, fish, poultry, and liver/organ meat); eggs; legumes and nuts; dairy products (milk, yogurt, and cheese); vitamin A-rich fruits and vegetables; and other fruits and vegetables; 3) household variables including sex of the household head, marital status of the respondent, number of children under the age of five, literacy (ability to read or write), household size and wealth index. The ZDHS calculated household wealth index based on consumer goods owned by the household such as radio, television, refrigerator, bicycle, motorcycle, and car; housing construction materials used for making the house main floor, walls and the roof and types of water access and sanitation facilities. The household wealth scores were generated using the principal component analysis.

Statistical Analysis

All statistical analyses were performed using Stata version 13 (version 13; STATA Corp, College Station, TX, USA). Before conducting any statistical analyses, sample weights were applied to address effects of two stage cluster sampling design to ensure that the results reflect representativeness of the children at national level [16]. Furthermore, the analysis was stratified by age (all children 0-59 months and children 0-23 months) to eliminate what has been termed as partial exposure bias [17]. All continuous variables were assessed for normality using Shapiro-Wilk test before running any statistical test. Associations were assessed using bivariate and multivariate analyses, the former was used to identify variables significantly associated with growth outcomes which were to be included in the latter analysis to establish the independent association between growth outcomes and each of the included variables. Pearson and multiple linear regression were used to assess correlation and independent association between growth and independent variables, respectively. Path analysis was conducted to assess hypothetical causal relationship between variables and their relationship with growth outcomes. For this purpose, three regression analyses were run to establish whether or not breastfeeding duration was a mediator or directly was associated with nutritional status. In one model breastfeeding duration was regressed on child's birth weight, maternal age and education. The level of statistical significance was set at $p<0.05$.

Results

Sample characteristics

Demographic characteristics of the sample are shown in Table 1. The proportion of girls in the sample was comparable to that of boys. The median age (IQR) for children was 9 (5-15) months. The children's median birthweight (IQR) was 3.1 (2.8-3.5) kg. Incidence of diarrhea was low among children. The median maternal age was 26 years and most mothers had attended formal education up to primary school. Mothers were more likely to be rural resident and coming from households mostly headed by males. About two thirds of the households had access to clean water.

Bivariate analysis

Results for correlational analysis are presented in Table 2. Breastfeeding duration was negatively correlated with both HAZ ($r=-0.284$, $p<0.000$) and WHZ ($r=-0.178$, $p<0.000$). Other variables associated with both HAZ and WHZ were dietary diversity, wealth index, water source, residence, maternal education, birthweight, perceived birth size, maternal literacy, diarrhea, and fever. Some variables were only associated with HAZ but not WHZ, such as child sex ($r=0.114$, $p<0.000$) and bottle feeding ($r=0.041$, $p=0.029$). Variables only correlated with WHZ but not HAZ were maternal marital status, age when the mother had her first child.

Characteristic	n	% or Median (IQR)*
Child characteristics		
Proportion of females	1611	51.1
Age in months	3116	9 (5-15)
Age categorized		
<6 months	971	32.4
6 -11 months	891	29.7
12-18 months	816	27.2
>18 months	324	10.8
Perceived size at birth		
Very large	143	4.6
Larger than average	618	19.8
Average	1888	60.6
Smaller than average	337	10.8
Very small	72	2.8
Birth weight	4150	3.1 (2.8-3.5)
Diarrhea episode		
Yes	702	24.2
No	2194	75.8
Fever episode		
Yes	576	19.9
No	2320	80.1
Maternal characteristics		
Median age	2896	26 (21-32)
Median age at first child	2896	18 (17-20)
Age at first childbirth		
<19	1242	42.9
19-49	1654	57.1
Education level		
No education	287	9.9
Primary	1531	52.9
Secondary	976	33.7
Tertiary	102	3.5
Literacy level		
Yes	1583	54.7
No	1313	45.3
Household characteristics		
Province		
Central	283	9.77
Copperbelt	227	7.84
Eastern	382	13.19
Luapula	342	11.81
Lusaka	263	9.08
Muchinga	257	8.87
Northern	324	11.19
North Western	230	7.94
Southern	303	10.46

Western	285	9.84
Residence		
Rural	2098	72.4
Urban	798	27.6
Wealth quintile		
Poorest	881	30.42
Poorer	723	24.97
Middle	578	19.96
Richer	391	13.5
Richest	323	11.15
Source of drinking water		
Protected	1779	63
Unprotected	1045	37
Household size	2896	6 (4-8)
Number of children <5 years	2896	2 (1-2)
Sex of household head		
Female	583	20.1
Male	2313	79.9
Age of household head	2896	36 (29-45)

Table 1: Sample characteristics.

*IQR, Interquartile range

Variable	Anthropometric index	
	HAZ	WHZ
Dietary diversity	-0.138*	-0.112*
Breastfeeding initiation	-0.002	-0.030
Age of the Household head	0.031	-0.010
Maternal age at first child	-0.030	-0.046*
Maternal age	0.014	-0.051*
Breastfeed duration	-0.284*	-0.178*
Female sex of child	0.114*	0.027
Maternal marital status	-0.009	-0.042*
Household size	0.014	-0.023
Bottle feeding	0.041***	-0.002
Number of children U5	0.017	-0.035
Wealth index	0.118*	0.071*
Water source (1=safe, 0=unsafe)	0.050**	0.053*
Residence (Urban/rural)	-0.068*	-0.051*
Maternal education	0.101*	0.072*
Birthweight	0.243*	0.119*
Perceived birth size	-0.152*	-0.116*
Maternal Literacy	0.078*	0.042*
Type of toilet facility	0.047***	0.055*
Fever	-0.081*	-0.056*
Diarrhea	-0.040*	-0.098*

Table 2: Bivariate analysis for HAZ and WHZ.

*P<0.001, **P<0.01, ***<0.05

Multivariate analysis

After controlling for maternal, child and household characteristics, breastfeeding duration was negatively associated with HAZ ($\beta=-0.07$, $p<0.001$) (Table 3). Female sex and birthweight positively predicted HAZ, the latter was the strongest determinant of HAZ among Zambian children under the age of 2 years. The rest of the other variables ceased to be significantly associated with HAZ (Table 3). In secondary analysis, when HAZ was dichotomized to classify children as either stunted or not, breastfeeding duration was independently associated with stunting (Odds ratio=1.10, $p<0.001$) after controlling for potential confounders (Supplementary Table 1). On the other hand, an increase in birth weight by one kilogram was associated with 65% decrease in the odds of stunting (Odds ratio 0.35, $p<0.001$).

HAZ	Coefficient.	P>t	95% CI	
Dietary diversity	0.03	0.090	-0.01	0.07
Breastfeeding duration	-0.07	<0.001	-0.08	-0.06
Female sex	0.41	<0.001	0.31	0.52
Bottle feeding	0.02	0.90	-0.25	0.29
Wealth	0.06	0.06	0.00	0.13
Water source	0.08	0.21	-0.05	0.21
Residence	0.02	0.82	-0.14	0.18
Maternal education in years	0.08	0.13	-0.02	0.19
Birthweight	0.59	<0.001	0.47	0.71
Perceived birth size	-0.08	0.07	-0.17	0.01
Literacy	0.01	0.83	-0.12	0.15
Toilet facility	-0.03	0.66	-0.15	0.10
Fever in the previous two weeks	-0.13	0.08	-0.27	0.02
Diarrhea in the previous two weeks	0.10	0.16	-0.04	0.24

Table 3: Predictors for HAZ for children aged 0 to 23 months from linear regression model.

Stunting	Odds Ratio	P-value	95% Confidence Interval	
Dietary diversity	0.95	0.131	0.89	1.02
Breastfeeding duration	1.10	0.000	1.08	1.12
Male sex	0.49	0.000	0.40	0.60
Bottle-feeding	1.17	0.531	0.71	1.92
Number of children <5 years	1.01	0.851	0.90	1.14
Wealth	0.86	0.005	0.77	0.96
Residence	0.84	0.240	0.63	1.12
Maternal education in years	0.81	0.026	0.67	0.97
Birthweight	0.35	0.000	0.28	0.42
Literacy	1.06	0.616	0.84	1.35
Fever in the previous two weeks	1.02	0.882	0.80	1.29

Supplementary Table 1: Determinants of stunting among Zambian children aged 0-23 months.

Results of the path analysis models are presented in Figure 1; breastfeeding duration mediated the effects of maternal age ($\beta=0.11$, $p<0.001$) and education ($\beta=-0.05$, $p=0.018$). On the other hand, breastfeeding duration continued to directly affect HAZ scores. The

direct, indirect and total effects of variables on HAZ scores are presented in Table 4. Birthweight had a non-significant effect on breastfeeding duration, indicative of absence of reverse causality, but had the strongest direct and indirect effects on HAZ-scores than all the other covariates.

Predictors for weight-for-height. Controlling for potential confounding factors, breastfeeding duration ($\beta=-0.04$, $p<0.001$), maternal age, children under the age of five, and diarrhea were all negatively associated with WHZ while birth weight was a positive determinant of WHZ among children under the age of five (Supplementary Table 2).

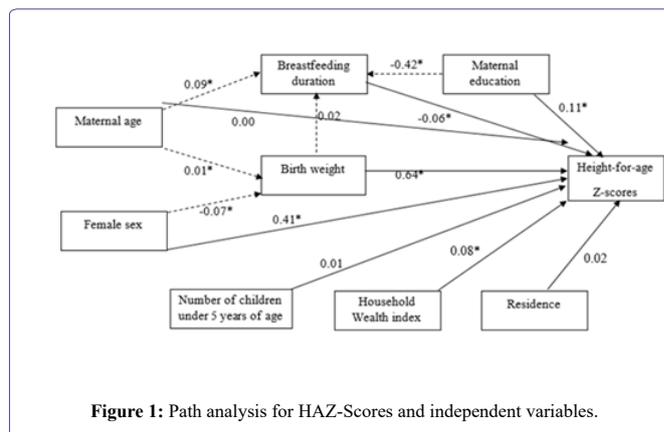


Figure 1: Path analysis for HAZ-Scores and independent variables.

Variable	Effects		
	Direct	Indirect	Total
Breastfeeding duration	-0.06*		-0.06*
Birth weight	0.64*	-0.001	0.64*
Maternal age	0.00	0.002	0.007
Maternal education	0.11*	0.027	0.134*
Female sex	0.41*	-0.04*	0.368*
Residence	0.02		0.023
Household wealth index	0.08*		0.08*
Number of children under the age of five years	0.01		0.01

Table 4: Standardized effects of the variables on HAZ-Scores from the path analysis.

Variables	Coef.	P>t	95% CI	
Dietary diversity	0.00	0.82	-0.040	0.032
Maternal age at birth of first child	-0.08	0.14	-0.195	0.028
Maternal age	-0.01	0.01	-0.019	-0.002
Breastfeeding duration	-0.04	<0.001	-0.047	-0.024
Maternal marital status	-0.03	0.25	-0.087	0.022
Wealth	0.00	0.99	-0.064	0.063
Water source	0.03	0.63	-0.093	0.154
Residence	-0.05	0.56	-0.200	0.109
Maternal education	0.03	0.53	-0.072	0.139
Birth weight	0.23	<0.001	0.117	0.352
Perceived birth size	-0.09	0.06	-0.173	0.002

Literacy	-0.01	0.83	-0.147	0.119
Toilet facility	0.04	0.53	-0.082	0.160
Fever in the previous two weeks	-0.04	0.61	-0.175	0.104
Diarrhea in the previous two weeks	-0.14	0.04	-0.276	-0.009

Supplementary Table 2: Predictors of WHZ among children under the age of five.

Discussion

The present study was designed to assess the relationship between breastfeeding duration and nutritional status among children aged 0 to 23 months. Among Zambian infants and young children, breastfeeding duration was inversely associated with HAZ after controlling for potential child, maternal and household confounders. Other than breastfeeding duration, birth weight was the strongest predictor of HAZ among children under the age of 24 months. Additionally, being female was positively associated with HAZ. Using stunting as an outcome variable, breastfeeding duration increased the odds of stunting among children. Similar findings were observed between breastfeeding duration and WHZ. Apart from breastfeeding duration, birth weight and child sex were the other variables significantly associated with both HAZ and WHZ. Diarrhea episode in the previous two weeks was only associated with WHZ.

Our finding that duration of breastfeeding is negatively associated with nutritional status among children is in line with findings from other low- and middle-income countries. In a prospective cohort study conducted by Fall, Sachdev [18], breastfeeding duration was negatively correlated with HAZ among South African and Filipino infants and young children. Similarly, among Pakistani [19] breastfeeding duration was negatively associated with lower HAZ and height respectively among children. In an earlier analysis, Caulfield, Bentley [11] also observed a positive association between prolonged breastfeeding and malnutrition among child less than three years old. Our results on breastfeeding duration and HAZ are not in agreement with findings among Nepalese [20] and Guatemalan [18] children, in whom breastfeeding duration was shown to be positively associated with HAZ. The differences in the results could be due to failure to account for confounding in some studies or mediating factors such as age of the children. It may as well be due to reverse causality, children perceived to be smaller and shorter are likely to be breastfed longer than their taller counterparts [13,21]. In the present study we controlled for potential confounding and we explored mediation as well as possibility for reverse causality using path analysis. The latter was not evidence in our study.

Our study demonstrates that being female among Zambian children under the age of 24 months was associated with greater HAZ. Similar findings have been reported among African countries. In a meta-analysis on the determinants of stunting and obesity among children in sub-Saharan Africa, Keino, Plasqui [22] demonstrated higher prevalence of stunting among boys than girls, confirming what was reported by Wamani, Astrom [23]. The similar findings have recently been observed in Tanzania [24] and Ethiopia [25]. The differential sex growth may be related to differences in feeding and care practices for boys and girls or morbidity, the former was observed among Senegalese children younger than three years [26]. There is also some evidence that the differences may be linked to differences in the biology of growth between boys and girls [27]. Overall, there

is currently no universally agreed plausible explanation for the differential sex growth outcomes for children under the age of five years. Further research is needed to unequivocally elucidate the mechanisms explaining sex differences with respect to malnutrition between boys and girls. Such evidence may prove quite beneficial in public health nutrition programming.

The strongest determinant of HAZ in our study was birth weight. Our results confirm results from earlier studies demonstrating the association between birth weight and HAZ among children [28]. The positive association between birth weight and height is also evident beyond childhood. A study among Brazilian adolescents demonstrated an increase of 0.28 cm in height corresponding to an increase of 100 g in birth weight [29]. Similarly, Jelenkovic, Yokoyama [30] demonstrated birth weight was significantly associated with height from infancy up to adulthood among twins. The mechanisms underlying the association between birth weight and height remain less elucidated. However, it is speculated that intrauterine conditioning may partly explain the associations observed postnatally [31].

Birth weight was the strongest and only positive determinant of WHZ in our sample. Similar association have previously been reported from nationally representative samples [32]. Apart from breastfeeding duration, the other factors negatively associated with WHZ were episode of diarrhea in the last two weeks and maternal age. Our results on diarrhea are in line with findings from other countries from sub-Saharan Africa. Masibo and Makoka [33] and Wasihun, Dejene [34] observed an inverse relationship between diarrhea episode and wasting among Kenyan and Ethiopian children under the age of five respectively. Diarrhea can lead to undernutrition through impaired appetite, malabsorption, acute phase catabolism [35]. The negative association between maternal age and WHZ is in contrast with evidence from other studies both in sub-Saharan Africa [36]. The difference between our results and those showing a positive association may be due to differential socioeconomic mechanisms operating in different environment [37].

The present study has several of strengths including large sample size, robust statistical approach to account for confounding, effect modification, and mediation. The main weaknesses of the study were failure to control for maternal height, which is a positive predictor of HAZ for children; potential for recall bias for variables measured using maternal memory and cross-sectional design rendering it difficult to ascertain causality. Finally, the effect of residual confounding may not be ruled out. Overall, taken together the present study has demonstrated that breastfeeding duration is negatively associated with growth outcomes among children, however, the effect is unlikely to be of clinical importance.

Conclusion

Our study has demonstrated that breastfeeding duration is negatively associated with both HAZ and WHZ among Zambian children. However, the magnitudes of the association were quite small to be of clinical significance. Thus, breastfeeding should continue to be protected and supported from birth up to two years.

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Ethical approval

Permission to use the 2018 dataset was sought and obtained from the Demographic and Health Surveys (DHS) Program. The DHS protocols were all approved by relevant ethics institutional review boards in Zambia (Tropical Diseases Research Centre) as well as at ICF, thus for the current analysis no further ethical review was warranted.

Conflict of interest

No financial or non-financial benefits have been received or will be received from any party related directly or indirectly to the subject of this article.

Author's contribution

CK conceptualized the study, performed data analysis and drafted the manuscript. LMZ, MU, DN, HNS and KA contributed in writing the manuscript. All authors read and approved the final manuscript.

Availability of data and materials

The main data set used for the present analysis was obtained from the Demographic and Health Survey Program is available from the https://www.dhsprogram.com/data/dataset_admin/login_main.cfm. However, sharing of these data to a third party is not allowed. The weighted data used for preparing the current manuscript may be obtained from the corresponding author upon reasonable request and with permission of DHS Program.

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