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Factors Associated with Timely Initiation of Complementary Feeding among Children Aged 6-23 Months in Ethiopia: A Multilevel Analysis of 2019 Ethiopian Mini Demographic Health Survey

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Abstract

Timely initiation of complementary feeding is providing the baby with solid or semisolid foods in addition to breast milk at 6-8 months of age. Due to many reasons, this feeding is extremely low in middle income and developing countries. In the current study, we aimed to identify factors contributing to the recent dataset of the Ethiopian demographic health survey. We used cross sectional EMDHS 2019 for this analysis. We cleaned the data and 4,061 women under under-two years of children were identified. We applied multilevel binary logistic regression in Stata v. 15. Model comparison was based on log-likelihood ratio, deviance and other criteria. Data were presented using mean, percent, 95% CI and Adjusted Odds Ratio (AOR). The timely complementary feeding was 36.44% (34.93-37.92%). Factors like preceding birth intervals (AOR=1.97 95% CI: 1.62-1.39), primary education (AOR=2.26 95% CI: 1.40-3.62), secondary above education (AOR=1.62 95% CI: 1.10-2.38) and rich wealth index (AOR=1.25 95% CI: 1.03-1.52) were some of the associated factors. It is highly suggested that comprehensive intervention on maternal education, empowering mothers economically, equity access to health services and birth planning should be targeted because they are attributable to maternal education, wealth index, preceding birth interval, number of under five children and regional disparities throughout the country.

Keywords: Complementary feeding; Multilevel; Children; Ethiopia

Abbreviation: DHS: Ethiopian Demographic Health Survey; EMDHS: Ethiopian Mini Demographic Health Survey; WHO: World Health Organization; SNNPR: South Nations Nationalities and Peoples Region; CI: Confidence Interval; AOR: Adjusted Odds Ratio; LL: Log Likelyhood; AIC: Akaike Information Criterion; BIC: Baye's Information Criterion; UNICEF: United Nation Children's Fund; ICC: Intra Cluster Correlation

Introduction

According to the World Health Organization (WHO), exclusive breastfeeding is no more enough for the child's growth and development at and after the age of six months. Thus, the child should be directed to breast milk plus additional (complementary) feeding to fill the nutrient gap, which is known for 45% of child deaths mostly in low and middle income countries [1,2]. Studies define timely complementary feeding as giving the baby additional food combined with the mothers' breast milk within the 6-8 months after birth [3-5]. The United Nations Children's Fund (UNICEF) informs that families have been challenged by economic, political, market, social or cultural barriers to feeding their children affordably and safely in every corner of the world. Additionally, inappropriate complementary feeding affects 149 million children around the globe [6]. The magnitude of the problem is relatively higher in Sub Saharan countries including Ethiopia.

In the South Asian countries, the untimely initiation of complementary feeding ranged from 17 to 76% in Bangladesh and 61% in Pakistan followed by 43.6% in Nepal [7]. In Sub Saharan countries, the proportion of untimely initiation of complementary feeding is 31.7% in 2019 [8]. Similarly, a systematic review of literature in the Sub-Saharan region showed 44.19% of mothers do not start complementary feeding as per WHO recommendation time [9]. One study in Nigeria revealed that 62.5% of the mothers started complementary feeding within 3-5 months [10].

In Ethiopia, a study in the Maichew district showed around 40% of mothers do not know the exact time of initiating complementary feeding [11].

A study in Addis Ababa showed that 17% of mothers started complementary feeding earlier than the normal time [12]. Another study in Dessie showed that 13.1% and 21.8% of mothers started giving complementary feeding earlier and late respectively [13]. In Northwest Ethiopia, 47.2% of mothers also practiced untimely complementary feeding and 37% in Northeast Ethiopia [14,15]. The new evidence from a systematic review in 2020 in the country showed that 34.4% of the mothers do not start complementary feeding at the recommended time [16].

There are various factors identified as predictors of untimely complementary feeding. In South Asia, lack of complementary feeding knowledge, low maternal education, socio-economic status

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and cultural beliefs were some factors that contributed to low timely complementary feeding; while, income, lack of knowledge and incorrect advice were the influencers from another study [17]. A study conducted in Nigeria showed that orthodox maternity care, exclusive breastfeeding and absence of siblings were associated with timely initiation of complementary feeding [18]. In Ethiopia, women employment, husband education, birth preparedness, growth monitoring, knowledge of time to introduce complementary feeding and paternal support were some of the factors that influence the time to initiate complementary feeding [19-21]. In another study, maternal educational status, complementary feeding counseling and maternal knowledge were identified as affecting factors.

Many national and international studies show that remarkable number of mothers do not adhere to the World Health Organization (WHO) complementary feeding recommendations; however, there is limited information on the larger population (country level samples) for policy and decision makers in Ethiopia. Thus, the current study had the aim of identifying factors enforcing mothers for untimely complementary feeding to provide the most recent representative information for further policy decisions from the recent country level data using multilevel logistic regression that accounts regional differences.

Materials and Methods

Study setting and data source

Ethiopia has conducted two EMDHS recently. In the 2019 EMDHS, the data collection was a community based cross sectional carried out from March 21, 2019 to June 28, 2019. All the nine regional states of the country (Afar, Tigray, Amhara, Oromia, Somali, Southern Nations, Nationalities and People's Region (SNNPR), Benishangul Gumuz, Gambella and Harari) and two city administrations (Addis Ababa and Dire Dawa) were included in the study.

The EMDHS data was used as a secondary data source for this study. A stratified two staged cluster sampling was taken as data source. Randomly, the Enumeration Areas (EA) was selected in the first stage and then households were selected in the second stage. In all selected households, height, weight measurements and all nutritional data were collected from children 0-59 months and 4,061 women aged 15-49 were interviewed face to face using the woman's questionnaire [22]. The detail of the recorded data is now available from the measure program web address. We extracted a 4,061 weighted number of children who are living with their mothers for this analysis.

Study variables

Outcome variable: The outcome for this study was timely initiation of complementary feeding. Complementary feeding termed to be timely when the feeding initiated between 6 and 8 months while complementary feeding commenced before 6 months or beyond 8 months was described as untimely.

Independent variables

The explanatory variables are the socio-demographic of the family, maternal services and nutritional factors (Table 1).

S.No	Variable	Description	Code
1	*Region	The 11 regional location of the households included in the study	1=Tigray, 2=Afar, 3=Amhara, 4=Oromia, 5=Somali, 6=Benishangul-Gumuz, 7=SNNP, 8=Gambela, 9= Harari, 10=Addis Ababa, 11=Dire Dawa
2	*Place of residence	Type of place of residence	1=Urban, 2=Rural
3	Less than 5 yr children	No. of children <5 yr in household	1=0-1 Child, 2=2 Children, 3= ≥3 Children
4	Mother's Education	Mother's level of education achieved	0=No education, 1=Primary, 2=Secondary, 3=Higher and above
5	Place of delivery	Place of delivery	0=Home, 1=Health Sector
6	Breastfeeding	Breast feeding status	0=Not breastfed, 1=Exclusive, 2=Breastfed+plain water, 3=Breastfed +non-milk liquid, 4=Breastfed+ complementary food
7	Wealth index	Wealth index of household	0=Poor, 1=Medium, 2=Rich
8	Gender	Gender of child	1=Male, 2=Female
9	Birth order	Birth order of child	1=First order, 2=2nd, 3=3rd or greater
10	Current age	Current age of mother	0=15-24 years, 1=25-34 years, 2=35-49 years
11	Birth interval	Preceding birth interval (months)	0= ≤ 24 months, 1=25-35 months, 2= ≥ 36 months

12	Household head	Head of house hold	1=Male, 2=Female
13	Vitamin A	Child received vitamin A	0=No, 1=Yes
14	Contraception	Current use by method	0=Traditional, 1=Modern
Note: *Community level factors			

Table 1: Coding and description of explanatory variables.

Data processing and analysis

Frequencies, weighted frequencies, mean standard deviations and percentages or proportions were applied to describe timely initiation of complementary feeding. We also calculated the mean Variance Inflation Factor (VIF) that became 1.23 and in the acceptable range. Sampling weight was applied to manage the representativeness of the survey and to account for sampling design when calculating standard errors.

We used multilevel mixed effects logistic regression model to analyze the data because DHS data has some structures. The data as it is violates the independency of the observations and the equal variance assumption of the traditional logistic regression model. In the current model, we fitted four models to estimate both fixed and random effect of the individual and community level variables. We used the null model, a model without any independent variable, to check the presence of the between cluster variability. Secondly, we included all individual level factors in the model (Model I). Additionally, Model II was fitted with only community level variables. Finally, the combined model (Model III) was done with both the individual and community level variables to identify factors associated with timely initiation of complementary feeding (net fixed and random effects). Intra class correlation coefficient.

$$ICC = \frac{\partial 1}{\partial 1 + \pi^{2/3}}$$

Where $\partial 1$ is variance of null model and fixed number 3.29. Proportional change in variance.

$$PCV = \frac{\partial 1 - \partial n}{\partial 1}$$

Where $\partial 1$ null model variance and ∂n is variance of neighborhood in subsequent model; median odds ratio

$$MOR = e^{0.95\sqrt{\partial 1}}$$

Where, ∂n is the variance of null model and deviance were used to compare models and identify best fitted model with AIC and BIC. We checked each variable for significance at $p<0.20$ and used $p<0.05$ for the final association indication. We cleaned the data as per the study criteria and analysed it in STATA v. 15.0 after weighting.

Results

We analyzed of 4,061 children's initiation of complementary feeding time and found 36.44% (34.93%-37.92%), meaning more than 63% of families in Ethiopia initiate their children complementary feeding either earlier or later than the recommended 6-8 months. Participants from agrarian regions accounted for 87.81%. Nearly sixty percent (59.69%) of the mother were aged 25-34. Additionally, 50.10% of the mothers had 2 children under five years old, 61.98% of mothers were not learned, 48.85% of mothers were from poor wealth index families, 21.69% of preceding intervals were below 24 months and 58.32% of mothers gave birth at home (Table 2).

Variable **Regions**	**Unweighted (%)**	**Weighted (%)**	**Variable** **Age of mother**	**Unweighted (%)**	**Weighted (%)**
Agrarian	2,762 (66.22)	3,566.53 (87.81)	15-24	572 (13.71)	570.20 (11.58)
Pastoralist	992 (23.78)	387.76 (9.55)	25-34	2,514 (60.27)	2,424.31 (59.69)
City administrations	417 (10.00)	107.12 (2.64)	≥ 35	1,085 (26.01)	1,166.90 (28.73)
Number of children <5 yr			**Mother's Education**		
1	1,276 (30.59)	1,351.96 (33.29)	No education	2,605 (62.46)	2,517.12 (61.98)
2	2,045 (49.03)	2,034.90 (50.10)	Primary	1,151 (27.60)	1,233.25 (30.37)
≥ 3	850 (20.38)	674.55 (16.61)	Secondary and above	415 (9.95)	311.04 (7.66)
Birth interval			**Wealth index**		

≤ 24 months	966 (23.16)	880.81 (21.69)	Poor	2,282 (54.71)	1,984.01 (48.85)
25-35 months	1,233 (29.56)	1,135.64 (27.96)	Middle	595 (14.27)	760.37 (18.72)
≥ 36 months	1,972 (47.28)	2,044.90 (50.35)	Rich	1,294 (31.02)	1,317 (32.43)
Breast feeding status			**Place of delivery**		
Not breastfed	2,442 (58.55)	2,264.93 (55.77)	Home	2,329 (55.84)	2,368.43 (58.32)
Exclusive breastfed	840 (20.14)	926.82 (22.82)	Health facility	1,842 (44.16)	1,692.98 (41.68)
Breastfed + other liquids	98 (2.35)	57.67 (1.42)	Child received vitamin A		
Breastfed +complementary food	791 (18.96)	811.99 (19.99)	No	1,358 (55.27)	1,320.96 (55.82)
			Yes	1,099 (44.73)	1,045.32 (44.18)

Table 2: Factors associated with timely initiation of complementary feeding in Ethiopia, EMDHS 2019.

The analysis of factors associated with timely initiation of complementary feeding showed that variables like age of the mothers, maternal education, preceding birth interval, the number of children under five years old, gender of the household leader, wealth index were significant under the fixed effect model, while city administration the only random effect variable significant. Except for gender of the household leader, all those variables were also significant under the final model (mixed effect model. We interpreted variables from the last model here. Accordingly, mothers with age range of the 25-34 and the age ≥ 35 years had 40% and 53% reduced odds of starting their children complementary feeding at the recommended time with AOR of 0.60 (0.49-0.74 and 0.47 (0.37-0.60 respectively relative age 15-24 years. Conversely, mothers who reported preceding birth intervals greater than 36 months had 1.97 times more like to start complementary feeding timely with AOR of 1.97 (1.62-1.39) compared to less than 24 months. In contrast to this fact mothers who had 2 and more three under five children during the survey had higher odds of starting complementary feeding timely with AOR of 3.63 (3.03-4.36) and 4.12 (3.25-5.21) respectively. Maternal education of either primary or secondary and above is associated with higher odds of timely initiation of complementary feeding with AOR of 2.26 (1.40-3.62) and 1.62 (1.10-2.38) respectively. Respondents from the rich family wealth index had high odds of reporting timely complementary feeding with AOR of 1.25 (1.03-1.52). At community level, respondents from pastoralist regions had 33% reduced odds of starting complementary feeding on time with AOR of 0.77 (0.61-0.98); while, those from city administrations had higher odds of reporting timely complementary feeding with AOR of 1.47 (1.11-1.96) (Table 3).

Variables	Model 0	Model I	Model II	Model III
Age in 5 years group				
15-24	-	1	-	1
25-34	-	0.62 (0.51-0.76)***	-	0.60 (0.49-0.74) ***
≥ 35	-	0.49 (0.38-0.62)***	-	0.47 (0.37-0.60) ***
Education				
No education	-	1	-	1
Primary education	-	2.39 (1.49-3.82)***	-	2.26 (1.40-3.62)***
Secondary education and above	-	1.78 (1.22-2.60)**	-	1.62 (1.10-2.38)**
Preceding birth interval				
<24 months		1		-
24-36 months		1.04 (0.86-1.25)		1.03 (0.85-1.24)

>36 months		2.00 (1.65-2.43)***		1.97 (1.62-1.39)***
Number of children <5 yr				
1	1			
2		3.63 (0.03-4.35)***		3.63 (3.03-4.36)***
≥ 3		3.99 (3.16-5.04)***		4.12 (3.25-5.21)***
Gender of household leader				
Male	-	1		
Female	-	1.17 (1.02-1.47)*		1.10 (1.07-1.68)
Wealth index				
Poor		1		
Middle		1.02 (0.81-1.25)		0.99 (0.79-1.23)
Rich		1.25 (1.08-1.67)**		1.25 (1.03-1.52)*
Region				
Agrarian		-	1	1
Pastoralist			0.91 (0.73-1.12)	0.77 (0.61-0.98)*
City administrations			1.52 (1.13-2.04)**	1.47 (1.11-1.96)**
Note: *=indicates a significant difference of AOR.				

Table 3: Multilevel analysis of timely initiation of complementary feeding among aged 6-23 months in Ethiopia, 2019 EMDHS.

Although the data is not highly affected by clusters as results from Table 4 shown, the model fitting with balancing the existing hierarchies is very good. The decreased ICC, AIC, BIC, the increased log likelihood ratio showed how model improved over the process. The 2% ICC can be only raid off by including further random effect variables table.

Random effect model comparison	**Model 0**	**Model 1**	**Model 2**	**Model 3**
Community level Variance	0.25	0.15	0.10	0.08
Inter Cluster Correlation (ICC)	0.066	0.04	0.03	0.02
Log Likelihood Ratio (LLR)	-2729	-2572	-2722	-2566
Proportional Change in Variance (PCV)	Ref	0.4	0.6	0.68
Media Odds Ratio (MOR)	1.60			
AIC	5463	5171	5455	5163
BIC	5476	5254	5487	5258

Table 4: Model comparison and random effect distribution of timel y initiation of complementary feeding among children of 6-23 months age in Ethiopia, 2019 EMDHS.

Discussion

From our analysis, only 36.44% (95% CI: 34.93%-37.92%) children were started their complementary feeding within the WHO recommended time, that means nearly 64% of the children began complementary feeding either before six months or later than eight months. The 64% untimely complementary feeding magnitude is less than 76% in Bangladesh, but consistent with the 61% in Pakistan and 62.5% in Nigeria. It is greater than 43.6% in Nepal, 44.19% in Sub Saharan region, 47.2% in Northwest Ethiopia, 37% in Northeast Ethiopia and 34.4% pooled prevalence in Ethiopia. This means, the finding is greater than the South Asian, regional and the country level average untimely proportions. The reason might be due to the overall decreasing timely complementary feeding and increased number of mothers using formula milk feeding which need serious considerations. Additionally, 50.10% of the mothers had two children aged below five years. One study showed that most mothers are young and had ≥ 7 children [23]. It is not a secret that 27.96% birth interval is around 35 months which mean, mother have plenty of time to have another baby before the fifth birthday of the preceding child when modern contraceptive proportion is also low. In other words, 61.98%of the mother had no education. This is supported by 62.8% of poor education in Nigeria and 54.0% in North Ethiopia but different from 30% in Northwest Ethiopia. The consistency might indicate the poor achievement in education both regionally and at country level bearing in mind that there are also areas in the country where maternal education is good. In addition to this, 48.85% of mothers were from poor wealth index families the evidence which is supported by many studies. Overall, from evidence, the economic status of people in the country is not good enough but supporting mother economically and in educational matters could worth a lot. The 58.32% of home deliveries might also need the same intervention as evidences directed toward the poor achievements in the country.

During multilevel modeling, the mixed effect model appeared with age of the mothers, maternal education, preceding birth interval, the number of children under five years old per woman and wealth index the fixed effect factors, while pastoralists and city administrations the random effect factors were significant. The age of the mothers that is greater than 24 years was inversely associated with timely initiation of complementary feeding in Ethiopia. One study also agreed that mothers of these ages usually begin complementary feeding very early, where another study stated age less than 20 year is associated with timely complementary feeding compared to the higher groups. As the age increase number of children increase and the focus of the mothers might be falling away. As global expectations, maternal education whether it is primary or higher, had independently predicted timely initiation of complementary feeding. This is also supported by the huge evidence from the literature. This means, maternal education is another independent predictor of timely initiation of complementary feeding that is why supporting mothers in education might worth much. As preceding birth interval increase above 36 months, the probability of mothers sticking to the recommended time of initiating complementary feeding increased. This is also supported by some studies in the country. It might mean, child spacing is something to focus on. However, it might also mean that, those mothers were educated, use family planning, economically enough and taking up service. Mothers with rich wealth index had good timely initiation of complementary feeding, the impression which is also supported by other studies. The consistency might be due the fact that mothers of lower economic level might struggle to find something to feed their baby. Mothers from pastoralists regions do not practice timely complementary feeding; while, mother from city administrations did well. The regional difference regarding complementary feeding is also immense form another study. The difference might be due to differences in equity distribution of health services, access and availability related matters. Despite the very important finding of this study, there were also some limitations that need to be considered. Disproportion of sampling, high missing in the data, secondary nature of the data and others were some of the problems which authors approached through weighting, reducing sample by missing and considering the time of data collection in the discussion were involved

Conclusion

According our analysis, the timely initiation of complementary feeding in Ethiopia was very low. Mothers started complementary feeding either earlier or later than the recommended time. Factors like age of the mothers, maternal education, preceding birth interval, the number of children under five years old and wealth index, pastoralists and city administrations were found to be affected the achievements. It is highly suggested that comprehensive intervention on maternal education, empowering mothers economically, equity access to health services and birth planning should be targeted to get more dividend. Especial policy attention should go to the pastoralists regions where those problems were enormous.

Authors' Contribution

GG has involved in conception, design, interpretation, writing methods and analysis; while, SS, TD and KG were involved in validation, drafting the manuscript and reviewing the manuscript.

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