

Unsafe child feces disposal status in Ethiopia: what factors matter? analysis of pooled data from four demographic and health surveys

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Research article

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Abstract

Background: Unsafe child feces disposal has compounding effects on children's wellbeing. In Ethiopia and many other countries, still, there is a common misconception that children's feces are not harmful, and not end up in a toilet. **Objective:** The study aims to determine the magnitude and factors associated with unsafe child feces disposal in Ethiopia. **Methods:** The study is cross-sectional in nature and the analysis was based on data from 1st to 4th rounds of the population-based Ethiopian Demographic and Health Survey (EDHS) conducted between 2000 and 2016. Descriptive statistics were computed to illustrate the given data. Multivariable logistic regression was performed, adjusted odds ratio (AOR) with a 95% confidence interval (CI) were used to identify factors associated with unsafe child feces disposal. **Results:** The pooled dataset contained information on 40,520 children younger than 5 years, male accounts 20,629 (50.9%). Overall, 77.7% (95%CI: 76.3-79.0) of children feces disposed of unsafely. In the multivariable logistic regression model, those mothers whose child was 13-24 months [AOR: 0.68, 95% CI: (0.60-0.78)] and ≥ 25 months [AOR: 0.66, 95% CI: (0.60-0.72)] were lower odds of unsafe child's feces disposal. Children born into households having two or fewer children were 33% lower [AOR: 0.67, 95% CI: (0.56-0.79)] odds of unsafe child's feces disposal than their counterparts. The odds of disposing of feces unsafely among households having improved toilet facility was 76% lower [AOR: 0.24, 95% CI: (0.19-0.29)] that of households lacking such facilities. Being an urban resident, having improved drinking water facility, a high level of maternal and paternal education, paternal occupational status (work in non-agriculture), and maternal age were factors associated with lower odds of unsafe child's feces disposal. **Conclusions:** Three in four Ethiopian children feces disposed of unsafely. Unsafe child feces disposal is less prevalent among households that had improved water and toilet facility, those in urban areas, those with older children, those with a high level of maternal and paternal education, and those with a lower number of under-five children. There is a need for more attention to be paid to curtail the significant burden of unsafe child feces disposal in Ethiopia.

Background

Unsafe child feces disposal can result in substantial health impact in children, including a higher prevalence of diarrheal diseases, environmental enteropathy, and impaired growth [1, 2]. Often times, the feces of children are less likely to be safely disposed of in a toilet than those of the general population, and poor disposal of children feces is drowning the open defecation free (ODF) progress throughout the globe [3-5]. Still, in many countries, there is a common misconception that child feces are often considered innocuous, and not end up in a toilet [6-9].

Globally, 2.5 billion individuals lacked improved sanitation; of these, an estimated one billion people were practiced open defecation (OD). Current estimates, however, do not include households that own toilets but do not use them, suggesting that the actual number of people defecating in the open is still underestimated [6, 10]. These estimates also based on the household's primary sanitation facility and may overlook the disposal practices of young children feces. In many cases, the highest levels of unsafe child feces disposal can be found among households practicing OD [6]. In this regard, effective disposal

of child feces is an essential indicator of an open defecation (OD) free community [11, 12]. According to the World Health Organization (WHO), the only safe method of child feces disposal is to help the child use a toilet or latrine or, for very young children, to put or rinse their feces into a toilet or latrine [5-7]. Recent research by the United Nations Child Fund (UNICEF) and the World Bank Global Water Practice's (WSP) in key countries showed that over 50 percent of households with children under age three reported that the feces of their children were unsafely disposed of [13]. Even among households with improved sanitation unsafe child feces disposal behavior was frequently reported [6, 14, 15].

There are several reasons, however, why unsafe child feces disposal should not be overlooked and even deserves greater priority than those of adults. First, numerous investigators revealed that unsafe disposal of children's feces in the community increased the risk of diarrhea in children [16-24]. For instance, a review found that unsafe child feces disposal associated with a 23% increase in the risk of diarrheal diseases [18]. Second, children have the highest incidence of enteric infections [2, 25, 26], and a study from rural Bangladesh also found improved child feces disposal could have an impact on enteric infections reduction by 35% in children younger than 2 years of age [27]. Third, unsafe child feces disposal associated with impaired growth in children [1, 28], and children in households where caregivers reported unsafe child feces disposal had significantly greater odds of being wasted [1]. Fourth, in many settings toilets are not designed for, or used by children and young children tend to defecate in areas where susceptible children could be exposed to fecal pathogens in the domestic environment [4, 26]. Fifth, there are still inconsistent reports regarding the complex relationship between unsafe child feces disposal and reported diarrheal prevalence [14, 29-31]. Sixth, in some cases, parents may discourage children from using a latrine with a squatting slab because they believe that children will dirty the latrine, which possibly endorses OD [32].

So far, efforts to end OD have mainly targeted adults, with only a limited focus on the management of child feces in many low-and middle-income countries (LMIC) and how children's feces are being disposed of, in general, has been a neglected area of research, policy, and program intervention [4, 6, 17, 28, 33-38]. At present, irrefutable evidence implied that sanitation for everyone everywhere has been accelerated throughout the globe [39, 40], as part of the overall drive to achieve the Sustainable Development Goal (SDG).

Ethiopia has made great progress in sanitation coverage and effort has been made to create the ODF community, through the organized effort of the community by adopting the Community-Led Total Sanitation and Hygiene (CLTSH) approach, and Water, sanitation, and hygiene (WASH) related initiatives [9, 41, 42]. Despite the efforts to date in Ethiopia, the magnitude of unsafe child feces disposal remains unclear and how progress in WASH initiatives has affected child feces management over the past decades is still doubtful. Additionally, there have been few investigations on a child's feces disposal in Ethiopia [14, 29], and they are survey specific and focuses on safe feces disposal.

To the best of my knowledge, there is no nationally representative study that has investigated the magnitude of unsafe child feces disposal using pooled data; considering the four waives of Ethiopian

Demographic and Health Survey (2000-2016), which is very important because of the characteristics of the blend of both cross-sectional and time-series data across a sequence of periods. Therefore, the purpose of this study is to determine the magnitude and factors associated with unsafe child feces disposal in Ethiopia.

Methods

Study design and data source

The study is cross-sectional in nature and based on data from the population-based Ethiopian Demographic and Health Survey (EDHS). Datasets used in this study were collected from the 1st, 2nd, 3rd and 4th rounds of EDHS conducted in 2000, 2005, 2011 and 2016 respectively, which are used to carry out the analysis. These surveys were conducted based on nationally representative sample households that provide estimates at the national and regional levels [37, 43-45].

EDHS was carried out by the Ethiopian Central Statistical Agency (CSA) and ICF International and provide quality information on a wide range of socio-demographic, health and health-related indicators. In general, a DHS sample is stratified, clustered and selected in two stages. At the first stage of sampling, enumeration areas (EA) were selected using systematic sampling with probability proportional to size. In the second stage of sampling, a systematic sample of households per EA was selected in all the regions to provide statistically reliable estimates of key demographic and health variables. The 1994 Population and Housing Census (PHC), conducted by the CSA, provided the sampling frame from which the 2000 and 2005 EDHS sample was drawn. Whereas, the sampling frame used for the 2011 and 2016 EDHS is the 2007 PHC. A representative sample of 11,645 households from 539 clusters (138 in urban areas and 401 in rural areas) in 2000 EDHS; 14,500 households from 540 clusters (145 urban and 395 rural) in 2005 EDHS; 17,817 households from 624 clusters (187 in urban areas and 437 in rural areas) in 2011 EDHS, and 16,650 households from 645 clusters (202 in urban areas and 443 in rural areas) in 2016 EDHS were selected for the surveys and the response rates were 99, 98, 94, and 98%, respectively. Details of the survey are described elsewhere [37, 43-45]. The present study included all youngest children under age five living with the mother and mothers were asked about the disposal practice of the last passed feces for the youngest child. All respondents who responded to the outcome variable were included in the analysis for this study.

Study variables

Outcome variable

The outcome variable for this study was unsafe child feces disposal practices. The outcome variable was constructed based on the recent WHO definition, response categories such as 'child used toilet or latrine' and 'put/rinsed into toilet or latrine' were combined and coded as "safe disposal of child feces (coded as '0')". And the others were coded as "unsafe disposal of child stool (coded as '1')". Unsafe disposal of child

feces was defined as the disposal of feces in any site other than a latrine, such as "put/rinsed into drain/ditch" "thrown into the garbage, "buried, "left in the open,' and 'other' [7].

Explanatory variables

The explanatory variables include; sex of children (male, female), age of the child (0-12 months, 13-24 months, ≥ 25 months), mother's age (< 24, 24-34, ≥ 34 years), mother educational level (no education, primary, secondary, higher), mother's working status (not working, working), partner educational level (no education, primary, secondary, higher), partner occupational status (working in agriculture, work in non-agriculture, not working), household size (<5, ≥ 5), number of children 5 and under ($\leq 2, \geq 3$), main floor material (cement, earth), sex of household head (male, female), place of residence (urban, rural), mother's exposure to media (yes, no), toilet facility (improved, unimproved), sources of drinking water (improve, unimproved) and presence of diarrhea in the last two weeks (yes, no) [7, 14, 20, 23, 29, 33].

The variable on media exposure includes exposure to the radio and television. The mothers who were not exposed to radio/television were coded as "no" and those who have frequent exposure were coded as "yes". Also, the toilet facility and source of drinking water were categorized into 'improved' and 'unimproved' following the WHO/UNICEF definition [46].

Operational definitions

Unsafe child feces disposal: refers to disposing of child feces in open areas or not disposing of them at all; those left in the open, thrown into the garbage, put/washed/rinsed into open drains, buried, or any other methods are considered unsafe disposal [6, 7].

Safe child feces disposal: safe disposal refers to a child use a toilet or latrine or, for very young children, to put or rinse their feces into a toilet or latrine [6, 7].

Statistical analysis

Data from the four waves of EDHS (2000-2016) is used to carry out the analysis. First, data were examined how outcome and explanatory variables were defined in each survey and, if necessary, create new "variables" that are as identical as possible over the survey years. Next, the four datasets (*ETKR41FL*, *ETKR51FL*, *ETKR61FL*, and *ETKR70FL*) were merged into a single data and analyzed using a complex sample analysis, taking into accounts for the strata, clusters, and weight variable. A complex sample analysis is a two-step process in SPSS, (1) create a complex sample "*plan file*" after computing a weight variable (*V005*) and (2), run analyses using the plan file through the complex sample package to account for sample design. DHS strongly recommends that weights be included in any statistical analysis that conducts with DHS data and complex sample command must be considered: for analyses of significance testing or a confidence interval (CI) [47]. A detailed explanation of the weighting procedure can be found in the EDHS methodology report [37, 43-45].

Descriptive summaries (weighted frequency and percentage) were used to explain the number of study participants in the analysis. A complex sample binary logistic regression model was employed and presented the crude odds ratio (COR) with 95% CIs to identify the relationship between the outcome variable and explanatory variables. Those variables with a p-value of < 0.25 were then entered into a multivariable logistic regression to control the effect of confounder's and to estimate the independent factors of unsafe child feces disposal [48]. Finally, significant variables were identified based on the adjusted odds ratio (AOR) with 95% CIs and p-value < 0.05. Multicollinearity effect was assessed with a cut of off point of variation inflation factor (VIF) of greater than ten [49] and finally, to check the correctness of the final formulated model, the Hosmer–Lemeshow test for overall goodness of fit was used [50]. All statistical analysis was carried out using SPSS version 20.0 (IBM Corp., Armonk, NY, USA).

Data quality assurance

In all rounds of EDHS, the data collection tools were pretested and data collectors were passes through extensive training. The training consisted of in-class training, biomarker training, and field practice days. Following the field practice, a debriefing session was held with the pretest field staff, and modifications to the questionnaires were made based on lessons drawn from the exercise [37, 43-45]. In this specific paper, I have greatly worked on data quality assurance by cleaning data before performing analysis.

Ethical consideration

The DHS surveys are anonymous surveys that do not allow any potential identification of any single household or individual in the data file. The analysis presented in the paper is based on EDHS (2000-2016) which is a publically available dataset with no identifiable information on the survey participants; no further effort was made to trace back the subjects. All the ethical concerns, including informed consent, are strictly followed in all rounds of EDHS. Given these, no ethical approval or informed consent was required for the current study. The data used in this analysis were obtained via online registration to measure the DHS program and downloaded after the purpose of the analysis was communicated and approved.

Results

Socio-demographic characteristics

Table 1 presents the background characteristics of the children across the entire pooled dataset. In this study, 40,520 children under age five living with the mother were included. Of these, 20,629 (50.9%) of the children were male, a great majority of children (90.0%) were from the rural area, and almost one out of five children had diarrhea in the past two weeks before the survey. The mean (standard deviation) age of the child was 28.5 (\pm 17.6) months.

Unsafe child feces disposal

This study revealed that 77.7% (95%CI: 76.3-79.0) of the children feces in Ethiopia were disposed of unsafely (**Table 2**). The proportion of unsafe child feces disposal has decreased from 91.8% (95%CI: 90.0-93.3) in the year 2000, to 81.9% (95%CI: 79.4-84.2) in 2005, 67.4% (95%CI: 64.5-70.2) in 2011, and 64.3% (95%CI: 60.4-68.0) in 2016 (**Table 3**). Despite the decline of unsafe child feces disposal over the last 16 years; it is not statistically significant as the confidence intervals overlapped each other (**Table 3** and **Figure 1**).

Child feces disposal for urban-rural households

Figure 2 presents information about child feces disposal in Ethiopia for urban-rural households. Evidence from the pooled data showed, over three fourth of the rural households (81.2%) had unsafe child feces disposal while that is true only for (45.8%) of the urban households. A closer look into the urban-rural households showed that there are wide disparities in unsafe child feces disposal between urban and rural households in all waves of EDHS. The highest level of unsafe child feces disposal was reported among those children from a rural area in the year 2000 (96.2%) and the lowest level was recorded in the year 2011 among urban dwellers (40.3%).

The surveys have shown that a slow decrement in unsafe feces disposal in urban-rural households in the past 16 years; from 96.2% to 67% in rural households and from 52.5% to 40.4% in urban households between the year 2000 and 2016 (**Figure 3**).

Result of bivariate and multivariable analysis

The results of bivariate logistic regression analysis are presented in **Table 4**. The results indicate that child's characteristics (age and sex of the child), mother's characteristics (age and maternal education), paternal characteristics (educational status and occupational status), household characteristics (number of children 5 and under, sex of household head, residence place, and main floor material), media exposure (listening to radio and watching TV), and WASH-related variables (latrine type and sources of drinking water) were associated with unsafe child feces disposal.

In the multivariable logistic regression model, the odds of unsafe child feces disposal were higher [AOR: 1.11, 95%CI: (1.03-1.21)] among households having male children than households having female children. Children aged 13-24 months [AOR: 0.68, 95% CI: (0.60-0.78)] and ≥ 25 months [AOR: 0.66, 95% CI: (0.60-0.72)] were less likely to have their feces disposed unsafely than children age between 0–12 months. Lower odds of unsafe child feces disposal was observed among children born to mothers aged 25-34 years [AOR: 0.74, 95%CI: (0.63-0.87)] and ≥ 35 years [AOR: 0.69, 95%CI: (0.57-0.82)] compared to those children born to mothers aged 15-24 years. The odds of unsafe child feces disposal were 35% [AOR: 0.65, 95%CI: (0.55-0.76)] and 27% lower [AOR: 0.73, 95%CI: (0.55-0.96)] in mothers who had primary and secondary education than mothers who had no education, respectively. Likewise, higher paternal educational level and working in non-agriculture were associated with lower odds of unsafe feces disposal.

In this study, the odds of unsafe feces disposal was 36% lower [AOR: 0.64, 95%CI (0.49-0.82)] in households residing in urban areas than households residing in rural areas. The odds of unsafe feces disposal were 33% lower [AOR: 0.67, 95% CI: (0.56-0.79)] among households having two or fewer children than their counterparts. In this study, lack of access to drinking water sources and improved toilet facilities were statistically associated with unsafe disposal of feces. The odds of disposing of feces unsafely among households having improved drinking water and improved toilet facility were 18% [AOR: 0.82, 95% CI: (0.70-0.94)] and 76% lower [AOR: 0.24, 95% CI: (0.19-0.29)] than that of households lacking such facilities, respectively.

Unsafe disposal of feces was statistically associated with the presence of diarrhea. The odds of unsafe child feces disposal was 25% higher [AOR: 1.25, 95% CI: (1.11-1.42)] in children without diarrhea compared to children who suffer from diarrhea. From the pooled data, the odds of unsafe feces disposal were 66% [AOR: 0.34, 95% CI:(0.27-0.43)], 85% [AOR: 0.15, 95%CI (0.12-0.19)] and 89% lower [AOR: 0.11, 95%CI: (0.09-0.14)] in EDHS 2005, 2011 and 2016, respectively compared to EDHS 2000.

Discussion

The study used four waves of EDHS data to carry out the analysis and the pooled data contained 40,520 children under age five. Of these, 77.7% of them had an unsafe child's feces disposal. The study revealed that unsafe child's feces disposal is less prevalent among households that had improved water and toilet facility, those in urban areas, those with older children, those with a high level of maternal and paternal education, and those with lower numbers of under-five children.

The high proportion of unsafe child's feces disposal found in this study was in line with a national survey reported from India, which reported 79.0% of the child's feces were disposed of unsafely [20, 51]. Similarly, the high burden of unsafe child feces disposal was reported from different low and middle-income settings, 84% in Bangladesh [1], 81.4% in Orissa (India) [25], 79% in Malawi [52], and 75% in Uganda [53]. The possible reason for these similarities may be due to the fact that in these locations of Africa and Asia high proportion of people without sustainable access basic sanitation is abundant, and in these regions, the most common type of child feces disposal method was left child feces in the open or not disposed. The Multiple Indicator Cluster Survey (MICS) report also showed that, more than 50 percent of households with children under age three in 15 of the 26 locations, particular in Africa, south Asia and southeast Asia reported that the feces of their youngest child under age three were not deposited into any kind of improved or unimproved toilet or latrine i.e., they were unsafely disposed of [6]. The current high burden of unsafe feces disposal in Ethiopia and in many other countries has important implications. In order to reach the proposed sustainable development goals of universal coverage or end open defecation by 2030, we must ensure children's feces are safely disposed of [6]. Also, current WASH programs should consider child feces management as an innermost component of an intervention.

In this study, a considerable number of children feces disposed of in open fields throw outside the yard and buried in the household compound; which may put children at risk of fecal exposure. In connection, a

study from rural Bangladesh reported that unsafe feces disposal in the residential compound can increase the risk of fecal exposure for household members, particularly children who spend time in the yard area and have hand contact with the soil that has been contaminated by feces [54]. Different studies also indicated that environmental contamination, as a result, unsafe child's feces disposal played an important role in child health [2, 31, 55]. Bawankule et al (2017) found that unsafe disposal of children's feces even in the neighborhood was associated with a higher risk of diarrhea in children. A review showed that diarrheal diseases were prevalent in areas where poor hygiene and sanitation is widespread [18].

Although the decline of unsafe child feces disposal over the last 16 years is not statistically significant, there was a modest drop on unsafe feces disposal in Ethiopia from 91.8% in the year 2000 to 64.3% in 2016. This is less than 30% in 16 years: about 2% per year, which is very low and a significant sanitation problem. This finding, therefore, embodies an important message for the ongoing WASH, CLTS, and other sanitation-related projects in Ethiopia. First, interventions that encourage children to use the latrine directly may be potentially beneficial to improve the current practice. Second, enhancing the behavior of the children's mothers/caregivers is essential, since in many cases they are responsible for disposing of their children's feces and shaping the child's toilet training. Third, access to a latrine is a necessary condition to have a positive effect on the reduction of unsafe feces disposal [56]. Furthermore, there may be a need to rethink safe child feces disposal measures and a child-friendly and socially acceptable method for feces disposal that would encourage caregivers to adopt consistent hygienic disposal of child feces [32, 57].

In the multivariable logistic regression analysis; mothers' educational status appeared to be significantly associated with unsafe feces disposal. The odds of unsafe child feces disposal were lower in mothers who had primary and secondary education than mothers who had no formal education. These observations are quite as expected because less-educated parents are more likely to be unaware of the health risks associated with unsafe excreta disposal and environmental sanitation and show poor hygiene behavior [58]. Again, this association can easily be explained by the fact that educated mothers are more likely aware of the negative effects of unsafe child feces disposal and therefore practice safe disposal. This finding is consistent with other studies from Kenya and India that have similarly reported that the odds of practicing safe disposal of child feces increased with the level of mothers' education [30, 59].

In this study, households with younger children were more likely to report unsafe disposal. This finding was consistent with other studies that revealed that children aged three and above three years old were less likely to practice open defecation [29, 31, 33, 60]. This association can be satisfactorily explained by the fact that a shift in safe disposal is usually seen as children grow: children being more likely to use a toilet/latrine themselves as they get older, rather than have their feces put or rinsed into one [9]. To overcome unsafe feces disposal among young children, Hussain et al suggested four behaviors that should be promoted in a child potty behavior: 1) acquisition of a potty, 2) potty training, 3) regular emptying of the potty into a latrine, and 4) cleaning and maintenance for continued use [57]. And studies conducted in Nigeria [34], Burkina Faso [61], and Bangladesh [57] also showed that child defecation in

potties was strongly associated with safe feces disposal. Besides, exposing mothers to the advantages of potties and educating them on how to potty-train their children as part of sanitation and hygiene programs might lead to improved child feces disposal [31].

This study further revealed that child feces disposal was associated with maternal age, media exposure, and toilet/latrine access, which is generally consistent with other studies conducted elsewhere [20, 30, 33, 57, 61]. This study also found that having a lower number of under-five years old children in a household associated with lower odds of practicing unsafe feces disposal. This finding also coincides with another study [62]. Place of residence was another factor associated with unsafe child feces disposal. The odds of practicing unsafe child feces disposal were lower among urban residents. The possible justification could be urban residents might have better sanitation coverage and awareness, than rural areas which in turn can influence the hygienic behavior of households. Urban-rural disparity regarding child feces management was reported from other settings [6, 59].

Evidence showed that children's feces could be riskier than adults' feces, due to a higher prevalence of diarrheal disease and their feces may contain higher levels of pathogens and helminth eggs [26, 63]. Also, children are at a greater risk of diarrhea if their mothers disposed of their feces in an unsafe manner [23]. Somewhat surprisingly the association between unsafe feces disposal and reported diarrhea is not detected in the present study. However, several studies reported the link between unsafe feces disposal and childhood diarrhea, a study from Ethiopia [22], Nepal [16], Indonesia [17], Thailand [19], India [20], and Burkina Faso [24]. Gil et al in their meta-analysis also found that unsafe disposal of young children's feces was associated with a 23% increased risk of diarrhea [risk ratio (RR): 1.23, 95% CI (1.15-1.32)] [18]. A recent study from Nigeria reported unsanitary passage of child feces is associated with four folds of having diarrhea in under-five children [64].

Limitations of the study

This study has several limitations. First, the study suffers from the disadvantages of a cross-sectional study; the temporal relationship between the outcome and explanatory variables could not be established. Second, the study did not record how feces were transported for disposal in study households. This would have added an understanding of the relationship between unsafe child feces disposal and transportation mechanisms. Third, reporting bias is likely to over-report child feces disposal behavior. Fourth, the study may be susceptible to recall bias, as the data dealt with reported practices rather than direct observation of the actual practice. Fifth, the measurement of the prevalence of diarrhea in all EDHS is based on a two weeks recall period, which may introduce a recall and reporting bias in childhood diarrhea prevalence. Sixth, the study didn't use multilevel analysis which is the ideal alternative to address nested data. Therefore, the associations that were found in the multivariable analysis should thus be interpreted cautiously. Finally, despite there were similar trends for many of the countries in the practice of child feces disposal, I would suggest caution against applying the results to countries located in other regions of the world, as cultural differences may affect child stool disposal practices.

Conclusion

Three in four Ethiopian children feces disposed of unsafely. Unsafe child's feces disposal is less prevalent among households that had improved water and toilet facility, those reside in urban areas, those with older children, those with a high level of maternal and paternal education, and those with a lower number of under-five children. The finding highlighted, there is a need for more attention to be paid to curb the significant burden of unsafe child feces disposal in Ethiopia. It is also essential to explore opportunities to integrate child feces management into existing sanitation and hygiene efforts. Moreover, child feces management interventions must consider sanitation coverage as well as behavioral changes, such as efforts to change the behavior of mothers that encourage cleaning children after defecation, potty training at an early age, and using proper methods to transport children feces to a sanitation facility.

Abbreviations

AOR: Adjusted odds ratio; CI: Confidence interval; CLTS: Community-Led Total Sanitation; COR: Crude odds ratio; DHS: Health and demographic surveys; EDHS: Ethiopian Health and demographic surveys; SDGs: Sustainable Development Goals; SPSS: Statistical Package for Social Sciences; VIF: Variance inflation factor; WHO: World Health Organization

Declarations

Ethics approval and consent to participate

Ethical clearance for this survey was obtained from the Ethiopia Health and Nutrition Research Institute Review Board, the National Research Ethics Review Committee at the Ministry of Science and Technology, and the Institutional Review Board of ICF International and the Centers for Disease Control and Prevention. Informed verbal consent was obtained from all mothers/caretakers of the selected children on behalf of their children. The data were obtained via online registration to measure the DHS program and downloaded after the purpose of the analysis was communicated and approved.

Consent for publication

Not Applicable

Availability of supporting data

The dataset was demanded and retrieved from the DHS website <https://dhsprogram.com> after formal online registration and submission of the project title and detail project description.

Competing interests

The author declares that he has no competing interests.

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Authors' Contribution

BS conceptualizes, performed the analysis, wrote and approved the final manuscript.

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Tables

Table 1: The characteristics of the respondents in the DHS pooled data 2000-2016, Ethiopia (n=40,520)

Characteristic	Categories	Weighted frequency	Percent
Child's characteristics			
Sex of the child	Male	20,629	50.9
	Female	19,890	49.1
Age of the child	0-12 months	10,040	24.8
	13-24 months	8,093	20.0
	≥25 months	22,386	55.2
Diarrhea in the past two weeks (n=38,037)	Yes	6,616	17.4
	No	31,421	82.6
Mother's characteristics			
Age of mother	15-24	10,216	25.2
	25-34	20,388	50.3
	≥35	9,916	24.5
Marital status	Married	37,281	92.0
	Divorced/separated	1,651	4.1
	Widowed	576	1.4
	Living with a partner	823	2.0
	Single	188	0.5
Mother's working status (n=40,404)	Not working	21,250	52.6
	Working	19,155	47.4
Mother's education	No education	30,365	74.9
	Primary	8,258	20.4
	Secondary	1,527	3.8
	Higher	369	0.9
Paternal characteristics			
Partner educational level (n=39,822)	No education	22,254	55.9
	Primary	13,485	33.9
	Secondary	3,193	8.0
	Higher	890	2.2
Partner occupational status (n=40,006)	Working in agriculture	32,539	81.3
	Work in non-agriculture	6,794	17.0
	Not working	673	1.7
Household characteristics			
Household size	Less than 5	9,841	24.3
	5 or more	30,679	75.7
Number of children 5 and under	2 or less	33,572	82.9
	3 and above	6,948	17.1
Sex of household head	Male	35,364	87.3
	Female	5,156	12.7
Place of residence	Urban	4,032	10.0
	Rural	36,488	90.0
Main floor material (n=39,595)	Cement	2,705	6.8
	Earth	36,890	93.2
Media exposure			
Listening radio (n=40,508)	Yes	14,094	34.8
	No	26,414	65.2
Watching TV (n=40,476)	Yes	6,369	84.3
	No	34,107	15.7
Water and sanitation facility			
Sources of drinking water (n=39,685)	Improved	17,519	44.1
	Unimproved	22,165	55.9
Latrine type (n=39,698)	Improved	4,475	11.3
	Unimproved	35,223	88.7
Survey year	2000	11,550	28.5

2005	10,692	26.4
2011	11,413	28.2
2016	6,864	16.9

Table 2: Weighted child feces disposal practice in Ethiopia, pooled data from DHS 2000-2016 (n=40,520)

Child stool disposal practice	Weighted Frequency	Weighted percent with 95 % (CI)
Always use toilet/latrine	831	2.1 (1.8-2.4)
Throw in toilet/latrine	8,217	20.3 (19.0-21.6)
Throw outside the dwelling	5,158	12.7 (11.6-14.0)
Throw outside the yard	7,598	18.8 (17.6-20.0)
Bury in the yard	2,088	5.2 (4.5-5.9)
Rinse away	4,397	10.9 (10.0-11.8)
Use disposable diapers	402	1.0 (0.8-1.3)
Use washable diapers	1,993	4.9 (4.2-5.7)
Not disposed of	7,000	17.3 (15.9-18.7)
Other	2,837	7.0 (6.3-7.8)
Overall pooled child stool disposal practice		
Unsafe §	31,471	77.7 (76.3-79.0)
Safe	9,048	22.3 (21.0-23.7)

§Unsafe disposal of child stool was defined as disposal of stool in any site other than a sanitary latrine

Table 3: Unsafe child feces disposal characteristics of the households in DHS 2000, 2005, 2011, and 2016, Ethiopia

Survey year	Unsafe child feces disposal		
	Frequency*	Percent	95%CI
EDHS 2000, n= 11,550	10,602	91.8	90.0-93.3
EDHS 2005, n= 10,693	8,762	81.9	79.4-84.2
EDHS 2011, n= 11,413	7,697	67.4	64.5-70.2
EDHS 2016, n= 6,864	4,411	64.3	60.4-68.0
EDHS (2000-2016), n=40,520	31,452	77.7	76.3-79.0

* weighted frequency

Table 4: Bivariate logistic regression result on factors associated with unsafe child feces disposal in Ethiopian DHS 2000-2016, (n=40,520)

Characteristic	Categories	Child stool disposal		COR(95%CI)	P-value
		Unsafe (n=31,471)	Safe (n=9,048)		
Child's characteristics					
Sex of the child	Male	16,202	4,427	1.12(1.04-1.18)*	0.00
	Female	15,269	4,621	1	
Age of the child	0-12 months	8,035	2,005	1	
	13-24 months	6,064	2,029	0.75(0.67-0.83)*	0.00
	≥25 months	17,372	5,014	0.86(0.80-0.93)*	
Diarrhea in the past two weeks (n=38,038)	Yes	5,220	1,396	1	
	No	24,194	7,228	0.89(0.79-1.00)	0.06
Mother's characteristics					
Age of mother	15-24	8,197	2,019	1	
	25-34	15,509	4,879	0.78(0.69-0.88)*	0.00
	≥35	7,765	2,151	0.89(0.78-1.02)	
Mother's working status (n=40,403)	Not working	16,371	4,878	1	
	Working	15,018	4,136	1.08(0.96-1.21)	0.18
Mother's education	No education	25,181	5,184	1	
	Primary	5,403	2,855	0.39(0.34-0.44)*	0.00
	Secondary	779	748	0.21(0.17-0.26)*	
	Higher	108	261	0.09(0.06-0.12)*	
Paternal characteristics					
Partner educational level (n=39,825)	No education	18,834	3,421	1	
	Primary	9,828	3,657	0.49(0.43-0.55)*	0.00
	Secondary	1,923	1,271	0.28(0.23-0.33)*	
	Higher	347	544	0.12(0.09-0.15)*	
Partner occupational status (n=40,006)	Working in agriculture	26,817	5,721	1	
	Work in non-agriculture	3,839	2,955	0.28(0.24-0.32)*	0.00
	Not working	444	229	0.41(0.29-0.59)*	
Household characteristics					
Household size	Less than 5	7,552	2,289	0.93(0.85-1.03)	0.15
	5 or more	23,919	6,759	1	
Number of children 5 and under	2 or fewer	25,857	7,715	0.79(0.69-0.92)*	0.00
	3 and above	5,614	1,333	1	
Sex of household head	Male	27,636	7,728	1	
	Female	3,835	1,321	0.81(0.71-0.92)*	0.00

Place of residence	Urban	1,847	2,185	0.19(0.16-0.24)*	0.00
	Rural	29,625	6,863	1	
Main floor material (n=39,595)	Cement	1,117	1,588	0.17(0.14-0.21)*	0.00
	Earthen floors	29,615	7,275	1	
Media exposure					
Listening radio (n=40,508)	Yes	9,798	4,296	0.50(0.45-0.56)*	0.00
	No	21,663	4,751	1	
Watching TV (n=40,476)	Yes	3,595	2,774	0.29(0.25-0.34)*	0.00
	No	27,834	6,274	1	
Water and sanitation facility					
Sources of drinking water (n=39,685)	Improved	12,582	4,937	0.56(0.48-0.64)*	0.00
	Unimproved	18,195	3,971	1	
Latrine type (n=39,698)	Improved	2,093	2,382	0.20(0.17-0.23)*	0.00
	Unimproved	28,696	6,527	1	
Survey year	2000	10,602	948	1	
	2005	8,762	1,931	0.41(0.31-0.53)*	0.00
	2011	7,697	3,716	0.19(0.14-0.24)*	
	2016	4,411	2,453	0.16(0.12-0.21)*	

Crude odds ratio (COR); *significantly associated p-value < 0.05(crude)

Table 5: Multivariable logistic regression result on factors associated with unsafe child feces disposal in Ethiopia DHS, 2000-2016 (n=40,520)

Characteristic	Categories	Child stool disposal		AOR(95%CI)
		Unsafe (n=31,471)	Safe (n=9,048)	
Child's characteristics				
Sex of the child	Male	16,202	4,427	1.11(1.03-1.21)**
	Female	15,269	4,621	1
Age of the child	0-12 months	8,035	2,005	1
	13-24 months	6,064	2,029	0.68(0.60-0.78)**
	≥25 months	17,372	5,014	0.66(0.60-0.72)**
Diarrhea in past two weeks (n=38,038)	Yes	5,220	1,396	1
	No	24,194	7,228	1.25(1.11-1.42)**
Mother's characteristics				
Age of mother	15-24	8,197	2,019	1
	25-34	15,509	4,879	0.74(0.63-0.87)**
	>=35	7,765	2,151	0.69(0.57-0.82)**
Mother's working status (n=40,403)	Not working	16,371	4,878	1
	Working	15,018	4,136	1.04(0.92-1.17)
Mother's education	No education	25,181	5,184	1
	Primary	5,403	2,855	0.65(0.55-0.76)**
	Secondary	779	748	0.73(0.55-0.96)**
	Higher	108	261	0.87(0.50-1.53)
Paternal characteristics				
Partner educational level (n=39,825)	No education	18,834	3,421	1
	Primary	9,828	3,657	0.74(0.64-0.85)**
	Secondary	1,923	1,271	0.56(0.46-0.69)**
	Higher	347	544	0.72(0.50-1.04)
Partner occupational status (n=40,006)	Working in agriculture	26,817	5,721	1
	Work in non-agriculture	3,839	2,955	0.74(0.62-0.90)**
	Not working	444	229	0.94(0.61-1.42)
Household characteristics				
Household size	Less than 5	7,552	2,289	1.09(0.96-1.25)
	5 or more	23,919	6,759	1
Number of children 5 and under	2 or fewer	25,857	7,715	0.67(0.56-0.79)**
	3 and above	5,614	1,333	1
Sex of household head	Male	27,636	7,728	1
	Female	3,835	1,321	1.00(0.86-1.17)
Place of residence	Urban	1,847	2,185	0.64(0.49-0.82)**
	Rural	29,625	6,863	1

Main floor material (n=39,595)	Cement	1,117	1,588	0.71(0.54-0.92)**
	Earthen floors	29,615	7,275	1
Media exposure				
Listening radio (n=40,508)	Yes	9,798	4,296	0.88(0.76-1.01)
	No	21,663	4,751	1
Watching TV (n=40,476)	Yes	3,595	2,774	0.96(0.72-1.03)
	No	27,834	6,274	1
Water and sanitation facility				
Sources of drinking water (n=39,685)	Improved	12,582	4,937	0.82(0.70-0.94)**
	Unimproved	18,195	3,971	1
Latrine type (n=39,698)	Improved	2,093	2,382	0.24(0.19-0.29)**
	Unimproved	28,696	6,527	1
Survey year	2000	10,602	948	1
	2005	8,762	1,931	0.34(0.27-0.43)**
	2011	7,697	3,716	0.15(0.12-0.19)**
	2016	4,411	2,453	0.11(0.09-0.14)**

AOR = adjusted odds ratio; ** significantly associated p-value < 0.05(Adjusted)

Figures

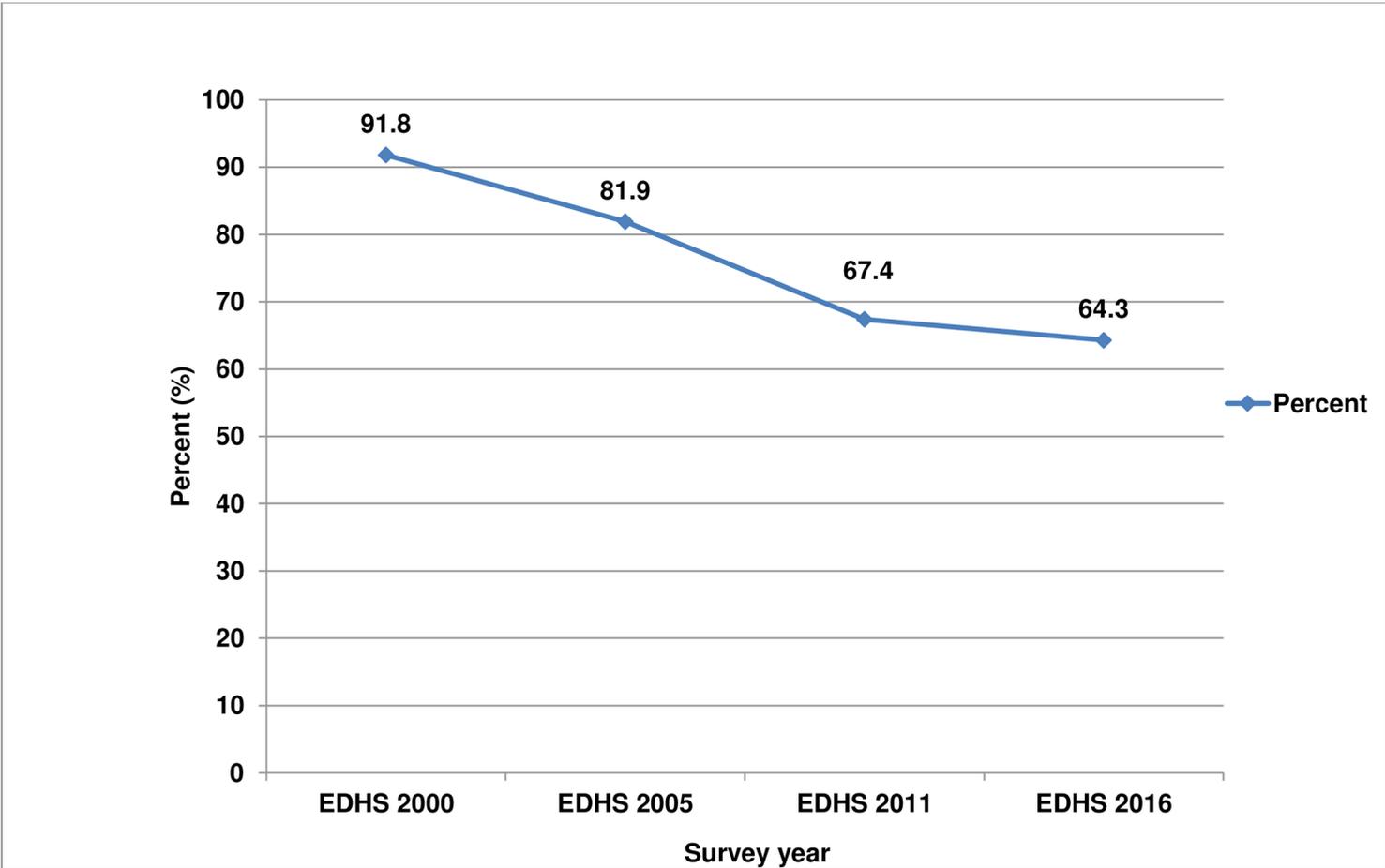


Figure 1

Unsafe child feces disposal in Ethiopia, DHS 2000-2016 (n=40,520)

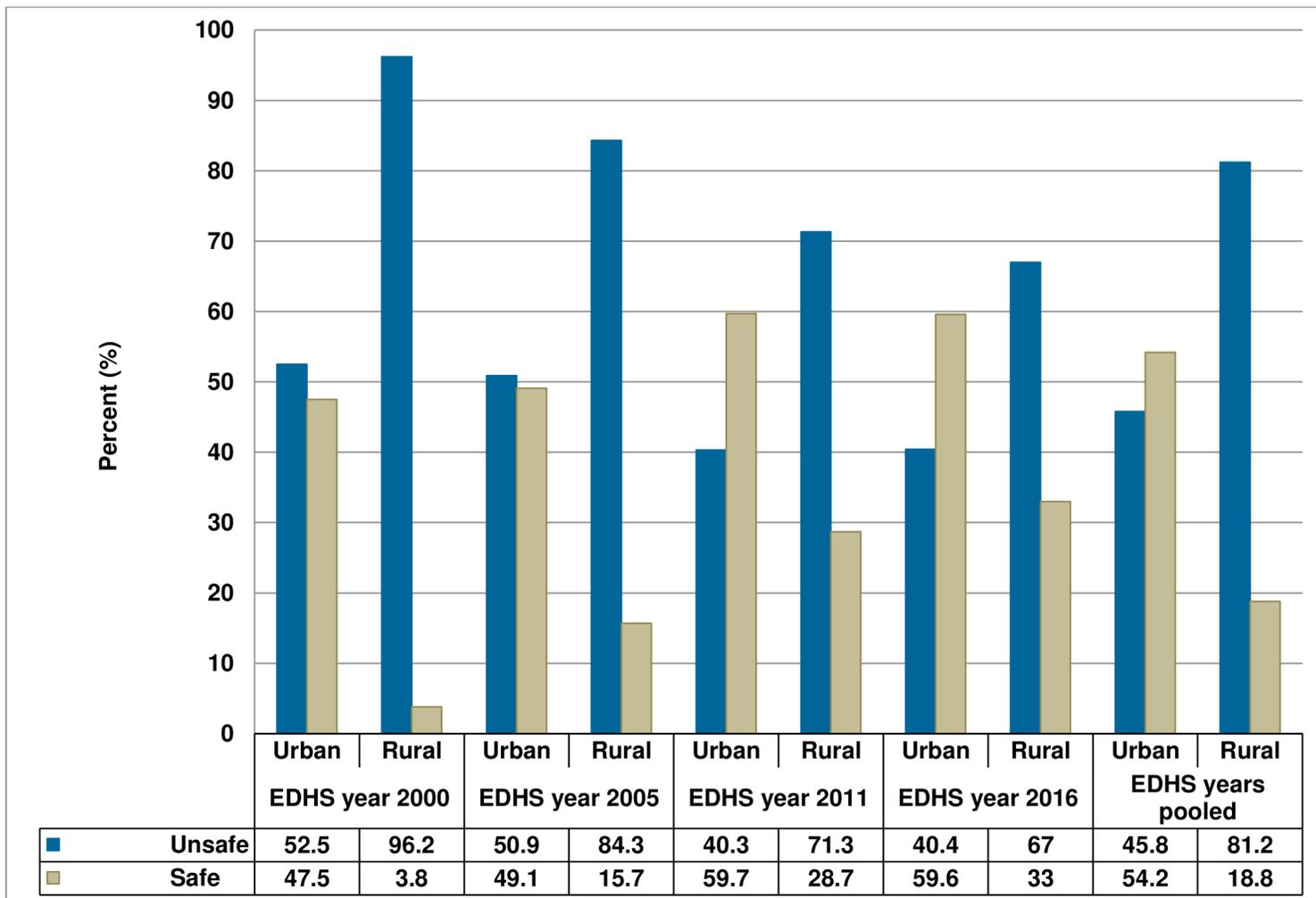


Figure 2

Child feces disposal status among urban and rural households in Ethiopia, DHS 2000-2016 (n=40,520)

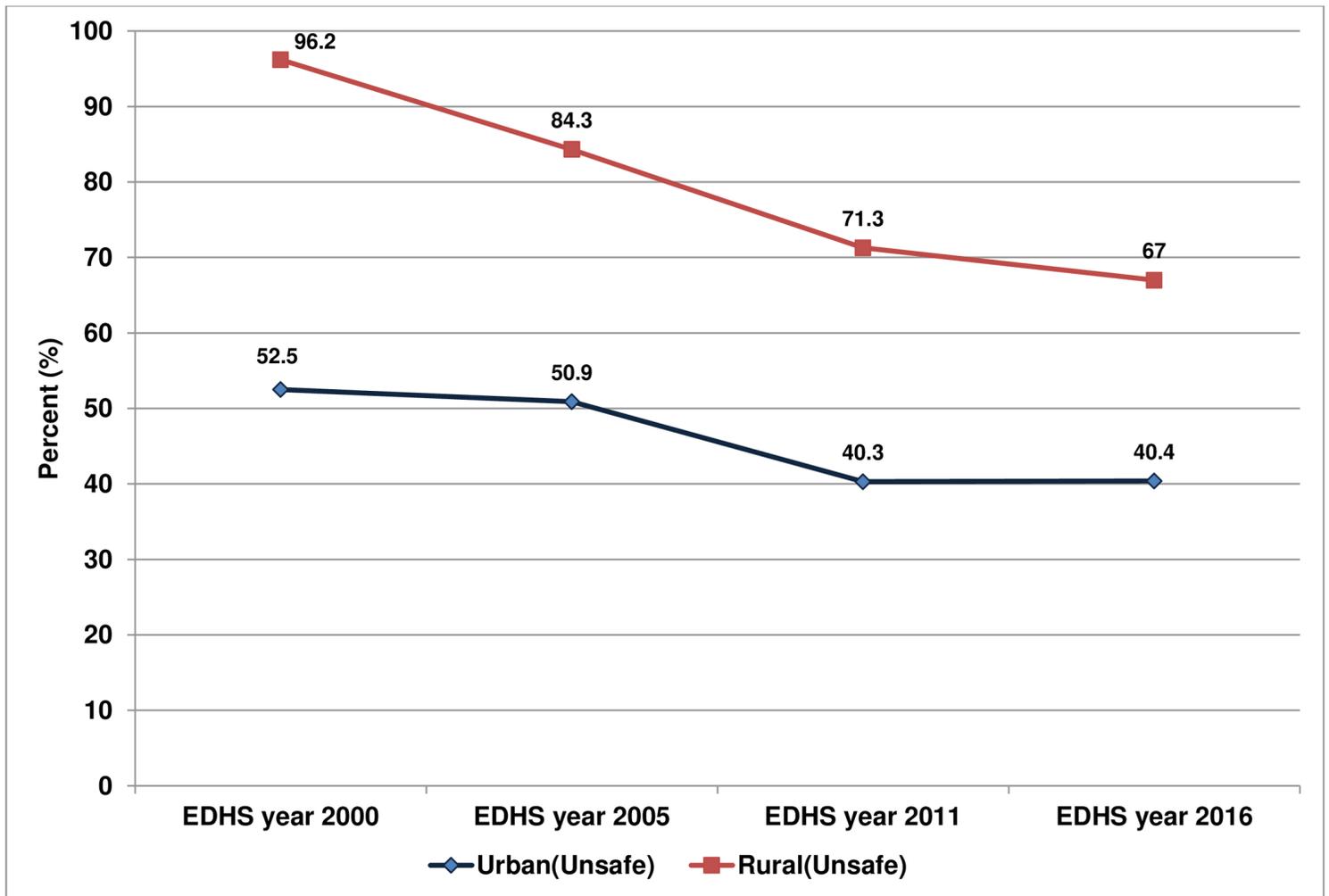


Figure 3

Unsafe feces disposal among urban and rural households in DHS 2000-2016, Ethiopia