Trend and predictors of unsafe child stool disposal in Ethiopia (2000-2016): pooled evidence from demographic and health survey

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Abstract

Background

Exposure to children's stool may present a greater health risk. But, in many settings including Ethiopia children's stools often considered not harmful, and do not end up in a toilet. Even those with access to sanitation facilities often fail to use them for disposal of child feces. Importantly, Ethiopia ranked among the worst third of 38 African countries whose children feces are safely disposed of. Therefore, the study aims to determine the pooled prevalence of unsafe disposal of children's stools in Ethiopia, the predictive factors associated with it and finally it examines the trend of child stool disposal in Ethiopia.

Methods

The pooled data for this study obtained from the demographic and health survey (DHS) done in Ethiopia between 2000 and 2016. Descriptive statistics were computed to illustrate the given data. Binary multivariable logistic regression was employed to identify the predictors of unsafe child stool disposal.

Results

The pooled data contained 26,014 children's with their mother, which were included in the study. Of these, 76.1% (95%CI: 74.7-77.5) of them were unsafe child stool disposal. The trend confirms that the prevalence of unsafe child stool disposal was falling from 90.8% in 2000, to 80.4% in 2005, 65.0% in 2011, and 63.1% in 2016. In the adjusted multivariable model, being male gender AOR: 1.15, 95%CI (1.04-1.27), child age (children aged 13–24 months AOR: 0.71, 95%CI (0.62-0.80); children aged ≥ 25 months AOR: 0.71, 95%CI (0.61-0.81)), mother age (mother aged 25-34 years [AOR: 0.69, 95%CI (0.61-0.79); mother aged >=35 years AOR: 0.71, 95%CI(0.61-0.83)), mother's working status AOR: 0.81, 95%CI (0.72-0.91), mother's education AOR: 2.61, 95%CI (1.69-4.01), residence AOR: 2.27, 95%CI (1.79-2.89), latrine type AOR: 3.23, 95%CI (2.75-3.79), and media exposure AOR: 1.52, 95%CI (1.34-1.73) remained strong predictors of unsafe child stool disposal.

Conclusion

In Ethiopia, almost three in four children's stool disposed unsafely, and maternal education and working status, children age, and type of sanitation facility were found to be predictive of unsafe child stool disposal. Thus, it is necessary to strengthen efforts focusing on child stool disposal behavioral to reduce the significant burden of unsafe child stool disposal and through careful consideration of these
Background

"By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations"

**Sustainable development goal (SDG): Target 6.2**

The safe disposal of human excreta is of paramount importance for the health and welfare of populations as well as the prevention of environment pollution [1]. Despite this fact, there is a common belief that child stool is often considered innocuous and not harmful in many societies, therefore not disposed of safely [2-4]. Interestingly, child feces may have higher pathogen loads than those of adults and exposure to children's stool may present a greater health risk [5]; as a result safe disposal of children's feces is as essential as that of adults' and should be treated with the same concern using safe disposal methods [2, 6]. The only safe method of child stool 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. While unsafe child stool disposal practices include 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, eaten by animals where fecal pathogens predominate and spread, or any other methods are considered unsafe [2, 3, 7].

Globally, an estimated one billion people were practiced open defecation and nine out of ten residents who defecate in the open field live in rural areas particularly in low and middle-income settings [8]. Not surprisingly, the highest levels of unsafe child feces disposal can be found among households practicing open defecation [2]. A review found that more than 50% of households with children under three years of age disposed of child stools in an unsafe manner in most of the developing countries [9].

The link between safe/unsafe child stool disposal and diarrheal diseases is explained by different authors. In one hand, numerous investigations revealed that unsafe child stool disposal as a leading cause of childhood diarrheal morbidity [10-18]. For instance, a review found that child stool disposal
behaviors that are considered risky were associated with a 23% increase in the risk of diarrheal diseases [12]. Another systematic review showed that two of the six studies found reductions in childhood diarrhea associated with safe child stool disposal practices [19]. Moreover, the health impacts of unsafe feces disposal can also extend beyond diarrheal disease; and a study from rural Bangladesh found improved child stool disposal could have an impact on enteric infections reduction by 35% in children younger than 2 years of age [20]. Similarly, George et al pointed out that the significant association between unsafe child stool disposal and environmental enteropathy and impaired growth in a pediatric population [21]. On the other hand, studies report this practice was not significantly associated with diarrhea [22-25]. Up to date, there are inconsistent reports regarding the complex relationship between unsafe child stool disposal and reported diarrheal prevalence. In general, it is important to note that the impacts of unsafe child stool disposal on diarrhea incidence must be viewed within the larger dataset; such as pooled data, which is blends characteristics of both cross-sectional and time-series data across a sequence of periods and vital in such scenario because it contains the information necessary to deal with both the intertemporal dynamics and the individuality of the entities being investigated. This paper also used the pooled dataset to illuminate the association between unsafe disposal and reported diarrheal prevalence.

In developing countries, in every location, unsafe disposal of children's stool represents a particular challenge [2, 11, 26, 27]. The latest available Multiple Indicator Cluster Survey (MICS) or Demographic data showed that in 10 locations (Africa, South Asia, and Southeast Asia), greater than 80 percent of children's feces are disposed of unsafely [2]. Even among households that have access to improved sanitation facilities, children's stool often does not end up in a toilet [2, 4, 24, 26, 28]. In Ethiopia, 63.1% and 94.7% of the households had unsafe and unimproved child stool disposal practice, respectively [24]; even among households with access to improved sanitation facilities fail to use them for disposal of child stool [24]. Interestingly, Ethiopia ranked among the worst third of 38 African countries whose children feces are safely disposed of [6].

So far, efforts to reduce and end open defecation have mainly targeted adults, with only a limited focus on the management of child stool in many low-and middle-income countries (LMIC) [19], and
how children's feces are being disposed of, in general, has been a neglected area of research, policy, and program intervention [2, 5, 30, 31]. In effect, the Sustainable Development Goal (SDG) target 6.2 calls for elimination of open defecation, aiming to "achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations by 2030"[32], and the United Nations (UN) declares access to sanitation, as a human right [33]. In light of this, the World Health Organization (WHO) Director-General stated that "After decades of neglect, the importance of access to safe sanitation for everyone, everywhere, is now rightly recognized as an essential component of universal health coverage"[3].

At present, irrefutable evidence suggested that sanitation for everyone everywhere has been accelerated throughout the globe, of which Ethiopia is no exception, as part of the overall drive to achieve the SDG. In Ethiopia, over the past two decades a significant effort has been made, to create an enabling environment for the disposal of human excreta and to enable 100 percent adoption of improved hygiene and sanitation by Ethiopia's Ministry of Health, USAID's Hygiene Improvement Project (HIP) and the World Bank's Water and Sanitation Program (WSP) [6, 34]. The Federal Ministry of Health (FMoH) of Ethiopia had been also implemented a Community-Led Total Sanitation and Hygiene (CLTSH) campaign and other Water, Sanitation and Hygiene (WASH) related initiatives, which empower local communities on creating open defecation free (ODF) communities in Ethiopia [35]. Despite the efforts to date, the extent of unsafe child stool disposal in Ethiopia remains unclear and it is doubtful how progress in WASH has affected the practice of child stool disposal. Also, there is no nationally representative study that has investigated the trends, as well as the factors associated with unsafe child stool disposal; the existing studies [24, 30], provides limited information as they are survey specific and focuses on safe disposal. Furthermore, using a pooled dataset to explore the predictive factors associated with the behavior of the children's mothers/caregiver is critically important, at these young ages; they are responsible for disposing of their children feces. Therefore, the purpose of this study is (1) to determine the pooled prevalence of unsafe child stool disposal practice (2), to identify the predictive factors associated with unsafe child stool disposal and (3) lastly,
to look at the trends on unsafe child stool disposal (by urban/rural residence).

Methods

Study design and data source

The study design for the present study was a cross-sectional study design with pooled Demographic and Health Survey (DHS) data. Pooled data are very important because of the characteristics of the blend of both cross-sectional and time-series data. Datasets used in this study were collected from the Ethiopian Demographic and Health Survey (EDHS) data of 2000, 2005, 2011, and 2016. These DHS surveys are country-representative cross-sectional surveys providing quality information on a wide range of health and health-related indicators. The surveys were conducted based on nationally representative sample households that provide estimates at the national and regional levels. Details of the survey are described elsewhere [29, 36-38]. Briefly, the EDHS was carried out by the Ethiopian Central Statistical Agency (CSA) and ICF International and provide information on a wide range of socio-demographic, health and health-related characteristics. The samples were selected using a two-stage stratified cluster sampling technique with regions and residence as strata. Data collection was taken place by interviewing respondents from the selected households. A representative sample of 11,645 households from 539 clusters in 2000 EDHS; 14,500 households from 540 clusters in 2005 EDHS; 17,817 households from 624 clusters in 2011 EDHS, and 16,650 households from 645 clusters in 2016 EDHS were selected for the surveys. The response rates were 99, 98, 94, and 87%, respectively [29, 36-38]. The study included all youngest child under age five living with the mother from each household and mothers were asked about the disposal practice of the last passed stool for the youngest child. All respondents who responded to the outcome variable were included in the analysis for this study.

Study variables

Outcome variables

Mothers reported unsafe child stool disposal were considered for analysis as an outcome of interest. The outcome variables were 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 stool (coded as ‘0’)"). And the others were coded as "unsafe disposal of child stool (coded as ‘1’)". Unsafe disposal of child stool was defined as the disposal of stool 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' [3].

**Exposure variables**

The explanatory variables include; sex of children, age of the child (0-12 months, 13-24 months, ≥ 25 months), mother’s age (< 24, 24-34, ≥ 34), mother educational level (no education, primary, secondary, higher), marital status (married, divorced/separated, widowed, living with partner, and single), mother's working status (not working, working), sex of household head (male, female), place of residence (urban, rural), mother’s exposure to media (yes, no), latrine type (improved, unimproved), sources of drinking water (improve, unimproved) and presence of diarrhea in the last two weeks (yes, no). The variable on media exposure includes exposure to the radio. The mothers who were not exposed to radio 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 [39].

**Statistical analysis**

Statistical analysis was carried out using SPSS version 20.0 (IBM Corp., Armonk, NY, USA). A pooled cross-sectional study was conducted by using all datasets of the EDHS, 1st, 2nd, 3rd and 4th round datasets. After pooled the four datasets and data cleaning for missing information was performed before the study begins. Appropriate sampling weights were used in the estimations for the adjustment of cluster sampling design. Weighted frequency, percentage and descriptive summaries used to explain the number of study participants in the analysis. Chi-square test also used to describe child stool disposal practice by the explanatory variables. Line graph was used to display and compare the trend of child stool disposal practice in the specified period. A complex sample binary logistic regression model was employed to assess the association between the outcome variables and explanatory variables. First, bivariate logistic regression was performed and explanatory variables that were significant in the binary logistic regression analysis with a cut-off point of p-value less than
0.25 were candidate factors for the multivariable binary logistic regression analysis to identify the predictor of unsafe child stool disposal. In the multivariable model measures of strength of association were reported as odds ratio (OR) with 95% confidence intervals (CIs), by controlling the effect of other factors. P-value of less than 0.05 was used to ascertain significant association. Multicollinearity effect was assessed with a cut off point of variation inflation factor (VIF) of greater than ten [40] and finally, to check the correctness of the final formulated model, the Hosmer–Lemeshow test for overall goodness of fit was used [41].

Results

**Socio-demographic and child stool disposal characteristics**

Table 1 presents the background characteristics of the children, their mothers and households across the entire pooled data set. Overall, in this study, 26,014 young children under age five living with the mother were included. Of these, half of the children's were male, a great majority of children (88.6%) were from the rural area of residence, and one out of five children had diarrhea in past two weeks before the survey.

This study revealed that the stool of 76.1% (95%CI: 74.7-77.5) of children was disposed of unsafely (Table 2).

**Trends in child stool disposal**

Table 3 presents survey specific information about child stool disposal. Between 2000 and 2016, Ethiopia experienced significant reductions in the overall percentage of unsafe child stool disposal. The proportion of unsafe child stool disposal has decreased from 90.8% in 2000, to 80.4% in 2005, 65.0% in 2011, and 63.1% in 2016. A much higher pace of progress was observed in the reduction of unsafe child stool disposal between the years of 2005 and 2011, with a 15.4 percentage point decrease in unsafe child stool disposal.

On the other hand, improving trends in safe child stool disposal was noted over the last 16 years (from 9.2% in 2000 to 36.9% in 2016), a linear upward trend (y = 9.85x + 0.55, R² = 0.932) was also noticed (Figure 1); the R-squared value (Coefficient of determination) equals 0.932, which means that the trend line fits about 93% of data values. However, a slight improvement was observed
between the year 2011 and 2016 (from 35.0% in 2011 to 36.9% in 2016) (Table 3).

Despite the improvement, important regional variations were noted in the prevalence of unsafe child stool disposal, in all waves of EDHS including in the pooled data. Over three fourth of the rural households (80.2%) still had unsafe child stool disposal as evidenced from the pooled data, while that is true only for 44.4% of the urban households. Also, the urban-rural gap in the unsafe disposal of stool was wide in all-round of the survey (Figure 2). A closer look into the urban-rural households revealed that those children's from rural Ethiopia had much lower levels safe child stool disposal 4.4% in the year 2000 and a highest safe child stool disposal was recorded in the year 2011 among urban dwellers, 59.6% (Figure 2).

The trends of unsafe child stool disposal are displayed for rural and urban households in Figure 3. The surveys have shown a steady decrement in unsafe child stool disposal in urban-rural households from 95.6% into 66.2% and from 51.9% into 40.4% between 2000 and 2016, respectively.

**Survey specific unsafe child stool disposal by background characteristics**

Table 4-7 presents survey specific information of children, their mothers and unsafe disposal of children's stool characteristics. Data about child stool disposal and characteristics attributable to it were analyzed using 7,412, 6,937, 7,520 and 4,145 children living with the mother respectively for 2000, 2005, 2011, and 2016 EDHS. The percentage of children under age five who had diarrhea in the two weeks before the survey period decreased from 27.9% in 2000 to 21.4% in 2005, to 16.2% in 2011, and 16.2% in 2016.

**Results of bivariate and multivariable analysis**

The results of bivariate and multivariable binary logistic regression assessing the factors associated with unsafe disposal of the stool are presented in Table 8. In the bivariate regression analysis, socio-demographic and sanitation characteristics of households such as sex of the child, sex of the household head, age of the child, age of mother, marital status, mother's education, place of residence, presence of diarrhea in past two weeks prior to the survey, water sources, latrine type, and media exposure were associated with unsafe child stool disposal.

In the multivariable logistic regression model, the odds of disposing of stools unsafely were 1.15
times more likely [AOR: 1.15, 95%CI: (1.04-1.27)] among households having male children than that of households having female children. The odds of disposing of the stools unsafely were 29% lower [AOR: 0.71, 95% CI: (0.62-0.80)] and [AOR: 0.71, 95% CI: (0.61-0.81)] in children aged between 13–24 months and ≥ 25 months than children age between 0–12 months.

The odds of disposing of the stools unsafely were 31% [AOR: 0.69, 95%CI: (0.61-0.79)] and 29% lower [AOR: 0.71, 95%CI: (0.61-0.83)] in mothers age between 25-34 and ≥ 35 years old than mothers age less than or equal to 24, respectively. Unsafe disposal of stool also depended on the mother's working and educational status. The odds of unsafe stool disposal was 19% lower [AOR: 0.81, 95% CI: (0.72-0.91)] in mothers who were not working than in mothers who were working. And, the odds of disposing of the stools unsafely were 2.61 times higher [AOR: 2.61, 95% CI: (1.69-4.01)] in mothers who were no education than those who had higher education.

Unsafe disposal of stool was also statistically associated with place of residence. The odds of unsafe disposal were 2.27 times higher [AOR: 2.27, 95% CI: (1.79-2.89)] among rural households than urban dwellers. Lack of access to improved toilet facility was statistically associated with the unsafe disposal of stool. The odds of disposing of stools unsafely among households having a lack of access to improved toilets were three times [AOR: 3.23, 95% CI: (2.75-3.79)] that of households having access to improved toilets. Moreover, unsafe disposal of stool also significantly associated with the mother's exposure to media. The odds of unsafe stool disposal were 1.52 times higher [AOR: 1.52, 95% CI: (1.34-1.73)] in mothers who were not exposed to media than in mothers who were exposed to media. However, the presence of diarrhea in the past two weeks before the survey [AOR: 1.05, 95%CI (0.92-1.20)] were significant at bivariate but insignificant in multivariable logistic regression analysis.

Discussion
The pooled data contained 26,014 children's with their mother. Of these, 76.1% of them had unsafe child stool disposal. The trend confirms that the prevalence of unsafe child stool disposal was falling from 90.8% in 2000 to 63.1% in 2016. Factors such as maternal education and working status, children age, media exposure, and type of sanitation facility were the most important variables that significantly associated with unsafe child stool disposal.
The prevalence of unsafe child stool disposal found in this study is reasonably higher than the prevalence reported in the latest EDHS 2016, which reported that 63.1% of child stool were disposed of unsafely [24]. However, the finding was in line with a survey report from India, which also reported 79.0% of child feces were disposed of unsafely [14, 42]. Similarly, high prevalence of unsafe child stool disposal was reported from studies conducted elsewhere, 84% in rural Bangladesh [21], 81.4% in rural Orissa (India) [43], 79% in Malawi [44], and 75% in Uganda [45]. A study conducted in 26 locations showed that more than 50 percent of households with children under age three in 15 of the 26 locations reported that the feces of their youngest child under age three were not deposited into any kind of improved or unimproved toilet or latrine. That is, they were unsafely disposed of. The finding has important implications for interventions, as it indicates the high prevalence of unsafe child stool disposal in Ethiopia. As a result, those ongoing sanitation and hygiene programs should consider child stool disposal as an innermost component of an intervention to end open defecation, by extension to achieve the SGD goal.

The present study also revealed that most child stools ended up in the household waste disposal site or throw outside the yard 18.9%. Meaning a considerable number of children stools were disposed of unsafely in open field, which may put children's at high risk of acquiring fecal-oral diseases. Studies indicated that environmental contamination, as a result, unsafe child stool disposal can cause enteric diseases among young children's [25, 46]. A review also showed that diarrheal diseases were prevalent in areas where poor hygiene and sanitation is widespread [12].

The results also revealed that the proportion of unsafe child stool disposal in Ethiopia dropped from 90.8% in 2000 to 63.1% in 2016. Likewise, the trend showed a considerable decline in unsafe child stool disposal in rural areas (95.6% and 66.2% in 2000 and 2016, respectively); whereas in the urban areas a slow reduction of unsafe disposal was noted, from 51.9% in 2000 to 40.4% in 2016. Moreover, the pace in decline of unsafe child disposal was encouraging between the year 2000 and 2011 in Ethiopia however it becomes steady in the following five years between 2011 to 2016. The possible reason for a significant decline in unsafe child stool disposal between the year 2000 and 2011 may be due to the promotion of hygiene and sanitation through the well-known countrywide health extension
program, which has been active since 2003. And the frequency of visitation by health extension workers might have increased the implementation of safe child stool disposal by households in Ethiopia, particularly in rural areas. Existing evidence also showed that between 2000 and 2011, reported latrine coverage and safe disposal of child feces improved in Ethiopia [6]. Despite the efforts through different approaches, still, 63.1% of children stool unsafely disposed of according to the recent EDHS report [24]. This finding, therefore, embodies an important message for the ongoing WASH, CLTSH, and other sanitation-related projects in the country that should be strengthened with particular emphasis on young children excreta management practices.

These findings have also important implications for the design of future sanitation interventions and call urgent attention to reducing the high burden of unsafe child stool disposal. First, interventions which encourage children to use the latrine directly may be potentially beneficial. Second, enhancing the behavior of the children's mothers/caregiver is essential, since in many cases they are responsible for disposing of their children 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 child stool disposal. From this perspective, it must be noted that the presence of physical sanitation infrastructure alone is not sufficient to ensure safe hygienic practice [47]. Besides, the common barriers and perception that young child's feces are not harmful should be addressed to achieve safe child feces disposal. Curtis et al [48] identified in some cases, parents may discourage children from using a latrine with a squatting slab because they believe that children will dirty the latrine. In light of this, there may be a need to rethink safe child stool 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 [49].

In the multivariable logistic regression analysis; mothers' educational status appeared to be significantly associated with unsafe child stool disposal. The odds of disposing of the stools unsafely were higher in mothers who were no education than those who had higher 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 [50]. Similarly, studies from Ethiopia, Kenya, and India found that the odds of practicing safe disposal of child feces increased with the level of mothers' education [22-24, 51]. Again, this association can be easily explained by the fact that educated mothers are more likely aware of the negative effects of unsafe child stool disposal and therefore practice safe disposal.

It also appeared that the age of a child was strongly associated with unsafe child stool disposal; the odds of disposing of the stools unsafely were lower in children aged between 13-24 months and ≥ 25 months than children age between 0-12 months. Meaning households with younger children; particularly households with children in their first year of life were more likely to report unsafe child stool disposal practice. This strong association can be satisfactorily explained by the fact that a shift in safe disposal practices 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 [6]. Past studies have also found child feces disposal to be associated with the child's age [22, 25, 52]. Behavioral interventions that encourage greater use of toilets by young children and encourage children to use a toilet consistently at a younger age may have a meaningful impact on improving child feces disposal practices. Hussain et al also suggested four behaviors that should be promoted in a child potty behavior change intervention for safe disposal of children's feces: 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 [49]. And studies conducted in Nigeria [53], Burkina Faso (54), and Bangladesh (49) showed that child defecation in potties was strongly associated with safe child feces disposal.

Also, studies have found child feces disposal to be associated with the mother/caregiver's age, mother's education, media exposure, residence, and toilet/latrine access [22-24, 49, 52, 54] which is generally consistent with the present study results.

Indiscriminate disposal of stools was one of the risky behaviors of mothers causing diarrhea in children [24]. There is evidence 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 [55, 56]. The present study also identified a strong association between unsafe child
stool disposal and high prevalence of childhood diarrhea in the bivariate analysis; though somewhat surprisingly this association disappears in the multivariable analysis. However, another Ethiopian study showed evidence of childhood diarrheal risks from unsafe child stool disposal [16]. These findings are similar to those from Nepal [10], Indonesia [11], Thailand [13], India [14], and in Burkina Faso [18]. Gil et al in their meta-analysis also found that unsafe disposal of young children’s stools was associated with a 23% increased risk of diarrhea [risk ratio (RR): 1.23, 95% CI (1.15–1.32)] [12]. In this particular case, children whose stools were put in a toilet were less likely to suffer from diarrhea than those whose stools were left in the open [23]. These in general translate to mounting challenges for the health of a child in Ethiopia. As noted, this finding clearly indicates that the focus of safe child stool disposal interventions must consider sanitation coverage as well as behavioral changes, such as efforts to change the behavior of mothers/caregivers that encourage cleaning children after defecation, potty training at early age, and using proper methods to transport child stool to a sanitation facility. In support of this assertion, in this study, among households that lack improved toilets or latrines, higher odds of unsafe child stool disposal behavior was reported. This finding is consistent with other studies and that have similarly reported unsafe child stool disposal among households that lacked improved toilet facility [22, 24, 47].

**Limitations of the study**

Although the study uses a nationally representative population-based dataset for examining the trend, and factors associated with unsafe child stool disposal in Ethiopia. This study has several limitations. First, the study suffers from the disadvantages of 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 understanding of the relationship between unsafe child stool disposal and child stool transportation mechanisms. Third, reporting bias is likely to over-report child stool 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. Finally, despite there were similar trends for many of the countries in
the practice of child stool 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

In conclusion, the findings indicate that the prevalence of unsafe child stool disposal remains a
significant health burden in Ethiopia; almost three in four children's stool disposed of unsafely.

Overall, the pace in decrease of unsafe child stool disposal was encouraging between 2000 and 2016,
dropped from 90.8% in 2000 to 63.1% in 2016. A closer look into the trends of unsafe child stool
disposal revealed that a steady decrement in unsafe disposal was observed in urban-rural
households. In multivariate analysis, predictive factors associated with being unsafe child stool
disposal were age, working status, education and media exposure of the mother/primary caregiver,
place of residence, age of the child, and type of the latrine used by the household. The study
emphasizes the need for urgent specific measures to reduce the significant burden of unsafe child
stool disposal in Ethiopia and indicates the necessity of focusing on certain age groups, especially in
children's in the first year of life, were more likely to report unsafe child stool disposal. Also, it is
necessary to strengthen efforts focusing on child stool disposal behavioral along with access to
improved sanitation facilities, including the promotion of improved child stool management practices
in national sanitation and hygiene interventions programs. Finally, the findings of the present study
add further evidence to the current literature and call for intervention through careful consideration of
those identified factors. Based on the insights from the current finding, more research is needed to
evaluate the most effective methods to reduce unsafe child stool disposal practices and promote
child's toilet training in ways that will achieve open defecation free communities.

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=26,014)
| Characteristic                          | Categories          | Weighted frequency | Percent |
|----------------------------------------|---------------------|--------------------|---------|
| Sex of the child                       | Male                | 13,189             | 50.7    |
|                                        | Female              | 12,825             | 49.3    |
| Age of the child                       | 0-12 months         | 8,538              | 38.9    |
|                                        | 13-24 months        | 6,318              | 28.8    |
|                                        | ≥25 months          | 7,099              | 32.3    |
| Diarrhea in past two weeks             | Yes                 | 5,443              | 21.4    |
|                                        | No                  | 20,047             | 78.6    |
| Age of the child                       | 0–12 months         | 8,538              | 38.9    |
|                                        | 13–24 months        | 6,318              | 28.8    |
|                                        | ≥25 months          | 7,099              | 32.3    |
| Age of mother                          | <=24                | 6,886              | 26.5    |
|                                        | 25-34               | 12,401             | 47.7    |
|                                        | >=35                | 6,728              | 25.9    |
| Marital status                         | Married             | 23,507             | 90.4    |
|                                        | Divorced/separated  | 1,319              | 5.1     |
|                                        | Widowed             | 451                | 1.7     |
|                                        | Living with partner | 563                | 2.1     |
|                                        | Single              | 175                | 0.7     |
| Mother’s working status                | Not working         | 13,189             | 50.9    |
|                                        | Working             | 12,746             | 49.1    |
| Mother’s education                     | No education        | 19,079             | 73.3    |
|                                        | Primary             | 5,493              | 21.1    |
|                                        | Secondary           | 1,141              | 4.4     |
|                                        | Higher              | 300                | 1.2     |
| Residence                              | Urban               | 2,975              | 11.4    |
|                                        | Rural               | 23,039             | 88.6    |
| Water sources                          | Improved            | 16,822             | 66.2    |
|                                        | Unimproved          | 8,581              | 33.8    |
| Latrine type                           | Improved            | 3,082              | 12.1    |
|                                        | Unimproved          | 22,327             | 87.9    |
| Sex of the household head              | Male                | 22,372             | 86.0    |
|                                        | Female              | 3,642              | 14.0    |
| Listening radio                        | Yes                 | 9,243              | 35.5    |
|                                        | No                  | 16,762             | 64.5    |

Table 2: Weighted pooled prevalence of child stool disposal practice in Ethiopia, DHS 2000-2016, Ethiopia (n=26,014)
| Child stool disposal practice | Weighted Frequency | Weighted percent of unsafe child stool disposal (95 % CI) |
|------------------------------|--------------------|-------------------------------------------------------|
| Always use toilet/latrine    | 674                | 2.6 (2.3-3.0)                                         |
| Throw in toilet/latrine      | 5531               | 21.3 (20.0-22.6)                                      |
| Throw outside the dwelling   | 3328               | 12.8 (11.6-14.0)                                      |
| Throw outside the yard       | 4913               | 18.9 (17.7-20.1)                                      |
| Bury in the yard             | 1312               | 5.0 (4.4-5.7)                                         |
| Rinse away                   | 2658               | 10.2 (9.4-11.1)                                       |
| Use disposable diapers       | 235                | 0.9 (0.7-1.2)                                         |
| Use washable diapers         | 1283               | 4.9 (4.2-5.7)                                         |
| Not disposed of              | 4317               | 16.6 (15.3-17.9)                                      |
| Other                        | 1742               | 6.7 (6.0-7.4)                                         |
| I don't know                 | 22                 | 0.1 (0.0-0.1)                                         |

**Overall pooled child stool disposal practice**

|                             | 19,809             | 76.1 (74.7-77.5) |
|-----------------------------|--------------------|-----------------|
| Unsafe §                    |                    |                 |
| Safe                        | 6,205              | 23.9 (22.5-25.3) |

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

Table 3: Child stool disposal characteristics of the households included in the sample from DHS of 2000, 2005, 2011, and 2016, Ethiopia
| Child stool disposal practices | DHS 2000, weighted frequency (%) | DHS 2005, weighted frequency (%) | DHS 2011, weighted frequency (%) | DHS 2016, weighted frequency (%) |
|-------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
|                              | n= 7,412†                       | n= 6,937†                        | n= 7,520†                        | n= 4,145†                        |
| Used toilet/latrine          | 53(0.7)                         | 147(2.1)                         | 444(5.9)                         | 30 (0.7)                         |
| Put/rinsed in toilet/latrine | 625(8.4)                        | 1,215(17.5)                      | 2,191(29.1)                      | 1,499(3)                         |
| Put/rinsed into drain or ditch/ | 2,439(32.9)                    | 485(7.0)                         | 249(3.3)                         | 155(3.7)                         |
| Throw into garbage          | 2,326 (31.4)                    | 764 (11.0)                       | 1,063(14.1)                      | 758(18)                          |
| Buried                       | 990 (13.4)                      | 1,241(1.8)                       | 81(1.1)                          | 117 (2.8)                        |
| Left in the open/not disposed of | 73(1.0)                         | 1,769(25.5)                      | 3,054(40.6)                      | 1,055 (26.6)                     |
| Rinse away                   | 889(12.0)                       | -                               | -                                | -                                |
| Collected in small cloth and washed/thrown away | - | 235(3.4) | - | - |
| Disposed of on field with water | - | 135(1.9) | - | - |
| Thrown away on field         | -                               | 1,283(18.5)                      | -                                | -                                |
| Other                        | 16(0.2)                         | 760 (11.0)                       | 437(5.8)                         | 529(12.8)                        |
| I don't know                 | -                               | 22(0.3)                         | -                                | -                                |
| Overall children’s stool disposal practice | - | - | - | - |
| Unsafe                       | 6,734 (90.8)                    | 5,575(80.4)                      | 4,885(65.0)                      | 2,615 (63.1)                     |
| Safe                         | 678 (9.2)                       | 1,362(19.6)                      | 2,635(35.0)                      | 1,530 (36.9)                     |

† The variation is due to in the report the missing values were included in the EDHS report.

#  youngest children under age 2 living with the mother

Table 4: Unsafe disposal of children’s stool by socio-demographic characteristics of DHS 2000, Ethiopia (n=7,412)
| Characteristic                          | Category        | DHS 2000, Weighted frequency n(%) | Child stool disposal | Pr(\ p) |
|----------------------------------------|-----------------|----------------------------------|----------------------|---------|
|                                        |                 | Unsafe N(%)                      | Safe N(%)            |         |
|                                        |                 | Safe N(%)                        |                      |         |
| Sex of the child                       | Male            | 3812 (51.4)                      | 3475 (51.6)          | 337 (49.7) | 0.2 |
|                                        | Female          | 3600 (48.6)                      | 3259 (48.4)          | 341 (50.3) | 0.2 |
| Age of the child (n=7,231)             | 0-12 months     | 2342 (32.4)                      | 2228 (33.9)          | 114 (17.5) | 0.1 |
|                                        | 13-24 months    | 2040 (28.2)                      | 1834 (27.9)          | 206 (31.6) | 0.1 |
|                                        | ≥ 25 months     | 2849 (39.4)                      | 2518 (38.3)          | 331 (50.8) | 0.1 |
| Diarrhea in past two weeks (n=7,413)   | Yes             | 2068 (27.9)                      | 1914 (28.4)          | 154 (22.7) | 0.1 |
|                                        | No              | 5345 (72.1)                      | 4827 (71.6)          | 524 (77.3) | 0.1 |
| Age of mother (n=7,413)                | <24             | 2017 (27.2)                      | 1832 (27.2)          | 185 (27.2) | 0.1 |
|                                        | 24-34           | 3335 (45.0)                      | 3007 (44.7)          | 328 (48.3) | 0.1 |
|                                        | ≥ 35            | 2061 (27.8)                      | 1895 (28.1)          | 166 (24.4) | 0.1 |
| Marital status (n=7,413)               | Married         | 6715 (90.6)                      | 6140 (91.2)          | 575 (84.7) | 0.1 |
|                                        | Divorced/       | 454 (6.1)                        | 396 (5.9)            | 58 (8.5)  |         |
|                                        | separated       |                                 |                      |          |         |
|                                        | Widowed         | 135 (1.8)                        | 116 (1.7)            | 19 (2.8)  |         |
|                                        | Living with     | 58 (0.8)                         | 42 (0.6)             | 16 (2.4)  |         |
|                                        | partner         |                                 |                      |          |         |
|                                        | Single          | 51 (0.7)                         | 40 (0.6)             | 11 (1.6)  |         |
| Mother’s working status (n=7,413)      | Not working     | 2587 (34.9)                      | 2322 (34.5)          | 265 (39.0) | 0.1 |
|                                        | Working         | 4826 (65.1)                      | 4412 (65.5)          | 414 (61.0) | 0.1 |
| Mother’s education                    |                 | 6085 (82.1)                      | 5767 (85.6)          | 318 (46.9) | 0.1 |
|                                        | No education    | 929 (12.5)                       | 776 (11.5)           | 153 (22.6) | 0.1 |
|                                        | Primary         | 37 (0.5)                         | 18 (0.2)             | 196 (28.9) | 0.1 |
|                                        | Secondary       | 21 (0.3)                         | 10 (0.1)             | 111 (1.6) | 0.1 |
|                                        | Higher          | 10 (0.1)                         | 58 (0.8)             | 55 (81.4) | 0.1 |
| Sex of the household head (n=7,413)    | Male            | 6335 (85.7)                      | 5802 (86.2)          | 553 (81.4) | 0.1 |
|                                        | Female          | 1038 (14.3)                      | 932 (13.8)           | 126 (18.6) | 0.1 |
| Listening radio (n=7410)               | Yes             | 1840 (24.8)                      | 1435 (21.3)          | 405 (59.7) | 0.1 |
|                                        | No              | 5570 (75.2)                      | 5297 (78.7)          | 273 (40.3) | 0.1 |
| Residence (n=7414)                    | Urban           | 810 (10.9)                       | 420 (6.2)            | 390 (57.4) | 0.1 |
|                                        | Rural           | 6004 (81.9)                      | 6315 (93.8)          | 399 (58.2) | 0.1 |
| Water sources                          | Improved        | 7151 (96.5)                      | 6491 (96.4)          | 660 (97.3) | 0.2 |
|                                        | Unimproved      | 261 (3.5)                        | 243 (3.6)            | 18 (2.7)  |         |
| Latrine type                           | Improved        | 7152 (96.5)                      | 6492 (96.4)          | 660 (97.3) | 0.2 |
|                                        | Unimproved      | 260 (3.5)                        | 242 (3.6)            | 18 (2.7)  |         |

Table 5: Unsafe disposal of children's stool by socio-demographic characteristics of DHS 2005, Ethiopia (n=6,937)
| Characteristic                          | Category       | DHS 2005, Weighted frequency n(%) | Child stool disposal | P-value |
|----------------------------------------|----------------|-----------------------------------|----------------------|---------|
|                                       |                | Unsafe N(%)                       | Safe N(%)            |         |
| Sex of the child (n=6,938)            | Male           | 3548(51.1)                        | 2874(51.6)           | 674(49.4)| 0.1    |
|                                       | Female         | 3390(48.9)                        | 2701(48.4)           | 689(50.6)| 0.0    |
| Age of the child (n=6,755)            | 0-12 months    | 3981(58.9)                        | 3307(61.0)           | 674(50.5)| 0.0    |
|                                       | 13-24 months   | 1391(20.6)                        | 1121(20.7)           | 270(20.2)| 0.0    |
|                                       | ≥25 months     | 1383(20.8)                        | 993(18.3)            | 390(29.3)| 0.0    |
| Diarrhea in past two weeks (n=6,838)  | Yes            | 1448(21.4)                        | 1151(21.2)           | 297(22.3)| 0.4    |
|                                       | No             | 5304(78.6)                        | 4267(78.8)           | 1037(77.7)| 0.4    |
| Age of mother (n=6,936)               | <=24           | 1782(25.7)                        | 1476(26.5)           | 306(22.5)| 0.0    |
|                                       | 25-34          | 3257(46.9)                        | 2572(46.1)           | 685(50.3)| 0.0    |
|                                       | >=35           | 1898(27.4)                        | 1526(27.4)           | 371(27.2)| 0.0    |
| Marital status (n=6,936)              | Married        | 6399(92.2)                        | 5142(92.2)           | 1252(91.9)| 0.7    |
|                                       | Divorced/separated | 303(4.4)             | 245(4.4)            | 58(4.3)    |         |
|                                       | Widowed        | 137(2.0)                         | 104(1.9)             | 33(2.4)    |         |
|                                       | Living with partner | 70(1.0)             | 58(1.0)            | 12(0.9)    |         |
|                                       | Single         | 33(0.5)                          | 26(0.5)             | 7(0.5)     |         |
| Mother’s working status (n=6,936)     | Not working    | 4813(69.4)                       | 3863(69.3)           | 950(69.8) | 0.7    |
|                                       | Working        | 2123(30.6)                       | 1711(30.7)           | 412(30.2) | 0.7    |
| Mother’s education (n=6,935)          | No education   | 5455(78.7)                       | 4635(83.2)           | 820(60.2) | 0.0    |
|                                       | Primary        | 1133(16.3)                       | 764(13.7)           | 369(27.1) | 0.0    |
|                                       | Secondary      | 308(4.4)                        | 160(2.9)             | 148(10.9) | 0.0    |
|                                       | Higher         | 39(0.6)                          | 15(0.3)             | 24(1.8)   |         |
| Residence (n=6,879)                   | Urban          | 586(8.4)                         | 292(5.2)            | 294(21.6) | 0.0    |
|                                       | Rural          | 6351(91.6)                       | 5283(94.8)           | 1068(78.4)| 0.0    |
| Water sources (n=6,879)               | Improved       | 3970(57.7)                       | 3081(55.4)          | 918(67.3) | 0.0    |
|                                       | Unimproved     | 2909(42.3)                       | 246(44.6)           | 442(32.7) | 0.0    |
| Latrine type (n=6,936)                | Improved       | 637(9.2)                         | 324(5.8)            | 313(32.0) | 0.0    |
|                                       | Unimproved     | 6300(90.8)                       | 5251(94.2)          | 1049(77.0)| 0.0    |
| Sex of the household head             | Male           | 6114(88.1)                       | 4941(88.6)          | 1173(86.1)| 0.0    |
|                                       | Female         | 823(11.9)                         | 634(11.4)           | 189(13.9) | 0.0    |
| Listening radio (n=6,936)             | Yes            | 2449(35.3)                       | 1866(33.5)          | 583(42.8) | 0.0    |
|                                       | No             | 3629(66.6)                       | 3708(66.5)          | 779(57.2) | 0.0    |

Table 6: Unsafe disposal of children’s stool by socio-demographic characteristics of DHS 2011, Ethiopia (n=7,520)
| Characteristic                          | Category               | DHS 2011, Weighted frequency n(%) | Child stool disposal | Prob (p-value) |
|----------------------------------------|-------------------------|-----------------------------------|----------------------|----------------|
|                                        |                         | Unsafe N(%)                       | Safe N(%)            |                |
| **Sex of the child (n=7,521)**         | Male                    | 3849(51.2)                        | 2561(52.4)           | 1288(48.9)     | 0.0            |
|                                        | Female                  | 3672(48.8)                        | 2325(47.6)           | 1347(51.1)     |                |
| **Age of the child (n=7,381)**         | 0-12 months             | 2335(31.6)                        | 1779(37.0)           | 556(21.6)      | 0.0            |
|                                        | 13-24 months            | 3288(44.5)                        | 2081(43.3)           | 1207(46.9)     |                |
|                                        | >=25 months             | 1758(23.8)                        | 946(19.7)            | 812(31.5)      |                |
| **Diarrhea in past two weeks (n=7,364)**| Yes                    | 1216(16.5)                        | 776(16.2)            | 440(17.1)      | 0.3            |
|                                        | No                      | 6148(83.5)                        | 4018(83.8)           | 2130(82.9)     |                |
| **Age of mother (n=7,521)**            | <=24                    | 1887(25.1)                        | 1298(26.6)           | 589(22.4)      | 0.0            |
|                                        | 25-34                   | 3714(49.4)                        | 2345(48.0)           | 1369(52.0)     |                |
|                                        | >=35                    | 1919(25.5)                        | 1242(25.4)           | 677(25.7)      |                |
| **Marital status (n=7,521)**           | Married                 | 6498(86.4)                        | 4242(86.8)           | 2256(85.6)     | 0.0            |
|                                        | Divorced/separated      | 424(5.6)                          | 260(5.7)             | 144(5.3)       |                |
|                                        | Widowed                 | 148(2.0)                          | 89(1.8)              | 60(2.3)        |                |
|                                        | Living with partner     | 389(5.2)                          | 230(4.7)             | 159(6.0)       |                |
|                                        | Single                  | 61(0.8)                           | 44(0.9)              | 17(0.6)        |                |
| **Mother’s working status**            | Not working             | 3349(44.5)                        | 2176(44.5)           | 1173(44.5)     | 0.9            |
|                                        | Working                 | 4171(55.5)                        | 2709(55.5)           | 1462(55.5)     |                |
| **Mother’s education**                 | No education            | 5040(67.0)                        | 3579(73.3)           | 1461(55.4)     | 0.0            |
|                                        | Primary                 | 2152(28.6)                        | 1207(24.7)           | 945(35.9)      |                |
|                                        | Secondary               | 200(2.7)                          | 69(1.4)              | 131(5.0)       |                |
|                                        | Higher                  | 128(1.7)                          | 30(0.6)              | 98(3.7)        |                |
| **Residence**                          | Urban                   | 1082(14.4)                        | 408(8.4)             | 674(25.6)      | 0.0            |
|                                        | Rural                   | 6430(85.6)                        | 4477(91.6)           | 1961(74.4)     |                |
| **Water sources (n=7,313)**            | Improved                | 3931(48.3)                        | 2694(57.0)           | 1088(42.1)     | 0.0            |
|                                        | Unimproved              | 3782(51.7)                        | 2033(43.0)           | 1498(57.9)     |                |
| **Latrine type (n=7,317)**             | Improved                | 984(13.4)                         | 404(8.5)             | 580(22.4)      | 0.0            |
|                                        | Unimproved              | 6333(86.6)                        | 4327(91.5)           | 2006(77.6)     |                |
| **Sex of the household head (n=7,519)**| Male                    | 6317(84.0)                        | 4139(84.7)           | 2178(82.7)     | 0.0            |
|                                        | Female                  | 1202(16.0)                        | 746(15.3)            | 456(17.3)      |                |
| **Listening radio(n=7,513)**           | Yes                     | 3823(50.9)                        | 2293(47.0)           | 1530(58.1)     | 0.0            |
|                                        | No                      | 3690(49.1)                        | 2587(53.0)           | 1103(41.9)     |                |

Table 7: Unsafe disposal of children’s stool by socio-demographic characteristics of DHS 2016, Ethiopia (n=4,145)
| Characteristic               | Category       | DHS 2016, Weighted frequency n(%) | Unsafe N(%) | Safe N(%) | Pro (p-value) |
|-----------------------------|----------------|----------------------------------|-------------|-----------|---------------|
| Sex of the child (n=4,144)  | Male           | 1980 (47.8)                      | 1283(49.1)  | 697(45.6) | 0.0           |
|                             | Female         | 2164(52.2)                       | 1332(50.9)  | 832(54.4) |               |
| Age of the child (n=4,124)  | 0–12 months    | 2446(59.3)                       | 1577(60.6)  | 869(57.1) | 0.0           |
|                             | 13–24 months   | 1678(40.7)                       | 1024(39.4)  | 654(42.9) |               |
| Diarrhea in past two weeks (n=4,129) | Yes | 670(16.2)                        | 365(14.0)   | 305(20.0) | 0.0           |
|                             | No             | 3459(83.8)                       | 2237(86.0)  | 1222(80.0) |               |
| Age of the mother (n=4,124) | <=24           | 1215(29.3)                       | 842(32.2)   | 373(24.4) | 0.0           |
|                             | 25-34          | 2106(50.8)                       | 1267(48.5)  | 839(54.8) |               |
| Marital status (n=4,146)    | Married        | 3900(94.1)                       | 2455(93.8)  | 1445(94.4) | 0.1           |
|                             | Divorced/separated | 140(3.4)                      | 92(3.5)     | 48(3.1)   |               |
|                             | Widowed        | 30(0.7)                          | 21(0.8)     | 9(0.6)    |               |
|                             | Living with partner | 46(1.1)                      | 24(0.9)     | 22(1.4)   |               |
|                             | Single         | 30(0.7)                          | 24(0.9)     | 60(4)     |               |
| Mother’s working status     | Not working    | 2439(58.8)                       | 1577(60.3)  | 862(56.3) | 0.0           |
|                             | Working        | 1706(41.2)                       | 1038(39.7)  | 668(43.7) |               |
| Mother’s education          | No education   | 2500(60.3)                       | 1699(65.0)  | 801(52.4) | 0.0           |
|                             | Primary        | 1279(30.9)                       | 744(28.5)   | 535(35.0) |               |
|                             | Secondary      | 254(6.1)                         | 134(5.1)    | 120(7.8)  |               |
|                             | Higher         | 112(2.7)                         | 38(1.5)     | 74(4.8)   |               |
| Residence                   | Urban          | 498(12.0)                        | 201(7.7)    | 297(19.4) | 0.0           |
|                             | Rural          | 3647(88.0)                       | 2414(92.3)  | 1233(80.6) |               |
| Water sources (n=4,144)     | Improved       | 2330(56.2)                       | 1364(52.2)  | 966(63.2) | 0.0           |
|                             | Unimproved     | 1814(43.8)                       | 1251(47.8)  | 563(36.8) |               |
| Latrine type                | Improved       | 419(10.1)                        | 203(7.8)    | 216(14.1) | 0.0           |
|                             | Unimproved     | 3726(89.9)                       | 2412(92.2)  | 1314(85.9) |               |
| Sex of the household head   | Male           | 3585(86.5)                       | 2270(86.8)  | 1315(85.9) | 0.4           |
|                             | Female         | 560(13.5)                        | 345(13.2)   | 215(14.1) |               |
| Listening radio             | Yes            | 1130(27.3)                       | 601(23.0)   | 529(34.6) | 0.0           |
|                             | No             | 3015(72.7)                       | 2014(77.0)  | 1001(65.4) |               |

Table 8: Bivariate and multivariable logistic regression result on factors associated with unsafe child stool disposal in DHS of 2000-2016, Ethiopia (n=26,014)
| Characteristic                        | Category | Child stool disposal, weighted frequency | COR(95%CI) | AOR(95%CI) |
|--------------------------------------|----------|------------------------------------------|------------|------------|
|                                     |          | **Unsafe** | **Safe** | **COR** | **AOR** | **AC** |
| Sex of the child                    | Male     | 19,809(51.5) | 6,205(48.3) | 1.14(1.05-1.23)* | 1.15(1.04-1.27)** | 1.1 |
|                                     | Female   | 9,616(48.5) | 3,209(51.7) | 1 | 1 |
| Age of the child (n=21,955)         | 0–12 months | 6,775(40.7) | 1,763(33.1) | 1 | 1 |
|                                     | 13–24 months | 4,662(28.0) | 1,656(31.1) | 0.73(0.65-0.82)* | 0.71(0.62-0.81)* | 0.7 |
|                                     | ≥25 months | 5,191(31.2) | 1,908(35.8) | 0.71(0.62-0.81)* | 0.71(0.61-0.81)** | 0.7 |
| Diarrhea in past two weeks (n=25,490) | Yes | 4,240(21.9) | 1,203(19.8) | 1.14(1.01-1.28)* | 1.05(0.92-1.20) | 1.1 |
|                                     | No       | 15,163(78.1) | 4,884(80.2) | 1 | 1 |
| Age of the mother (n=26,015)        | <=24 | 5,433(27.4) | 1,453(23.4) | 1 | 1 |
|                                     | 25-34 | 9,183(46.4) | 3,218(51.9) | 0.76(0.68-0.85)* | 0.71(0.62-0.80)** | 0.7 |
|                                     | >=35 | 5,194(26.2) | 1,534(24.7) | 0.91(0.80-1.02) | 0.71(0.61-0.83)** | 0.7 |
| Marital status (n=26,015)           | Married | 17,979(90.8) | 5,528(89.1) | 0.99(0.63-1.56) | 0.98(0.57-1.71) | 0.9 |
|                                     | Widowed | 1,012(5.1) | 307(4.9) | 1.00(0.62-1.63) | 1.00(0.62-1.63) | 1 |
|                                     | Living with partner | 350(1.9) | 209(3.4) | 0.52(0.31-0.86)* | 0.52(0.31-0.86)* | 0.5 |
|                                     | Single | 134(0.7) | 41(0.7) | 1 | 1 |
| Mother's working status (n=25,935)  | Not working | 9,940(50.3) | 3,249(52.5) | 0.92(0.82-1.02) | 0.92(0.82-1.02) | 0.9 |
|                                     | Working | 9,812(49.7) | 2,934(47.5) | 1 | 1 |
| Mother's education (n=26,013)       | No education | 15,679(79.2) | 3,400(54.8) | 10.24(7.17-14.61)* | 10.24(7.17-14.61)* | 10.2 |
|                                     | Primary | 3,491(17.6) | 2,002(32.3) | 3.87(2.72-5.51)* | 3.87(2.72-5.51)* | 3.8 |
|                                     | Secondary | 545(2.8) | 596(9.6) | 2.03(1.39-2.96)* | 2.03(1.39-2.96)* | 2.0 |
|                                     | Higher | 93(0.4) | 20(0.7) | 1 | 1 |
| Residence (n=25,403)                | Urban | 1,321(6.7) | 1,654(26.7) | 1 | 1 |
|                                     | Rural | 18,488(93.3) | 4,551(73.3) | 5.09(4.20-6.16)* | 5.09(4.20-6.16)* | 5.1 |
| Water sources (n=25,403)            | Improved | 12,486(64.7) | 4,336(71.2) | 1 | 1 |
|                                     | Unimproved | 6,826(35.3) | 1,755(28.8) | 1.35(1.16-1.57)* | 1.35(1.16-1.57)* | 1.3 |
| Latrine type (n=25,409)             | Improved | 1,349(7.0) | 1,733(28.5) | 1 | 1 |
|                                     | Unimproved | 17,969(93.0) | 4,358(71.5) | 5.29(4.62-6.08)* | 5.29(4.62-6.08)* | 5.3 |
| Sex of the household head           | Male | 17,153(86.6) | 5,219(84.1) | 1.22(1.08-1.38)* | 1.22(1.08-1.38)* | 1.2 |
|                                     | Female | 2,656(13.4) | 986(15.9) | 1 | 1 |
| Listening radio (n=26,005)          | Yes | 6,196(31.3) | 3,047(49.1) | 1 | 1 |
|                                     | No | 13,606(68.7) | 3,156(50.9) | 2.12(1.90-2.36)* | 2.12(1.90-2.36)* | 2.1 |

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

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

**Figures**
Figure 1

Trends in child stool disposal practice DHS in the year 2000, 2005, 2011, and 2016, Ethiopia
Figure 2

Child stool disposal practice by urban and rural in DHS 2000-2016, Ethiopia
Figure 3
Trends in unsafe child stool disposal practice in rural and urban households in DHS 2000-2016, Ethiopia