Prevalence and associated factors of safe and improved infant and young children stool disposal in Ethiopia: evidence from demographic and health survey

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Abstract

Background: Infant and young children stools are often considered innocuous, and are not disposed of safely despite having a higher pathogen load than adult feces. In Ethiopia, sanitary management of young children’s stool is often overlooked and transmission of fecal-oral diseases is still a significant health burden. The study, therefore, describes the prevalence and associated factors of safe and improved child stool disposal.

Methods: Data from the fourth round of the Ethiopian Health and Demographic Survey (EDHS) conducted in 2016 was used for this analysis. Descriptive statistics were computed. Bivariate and multivariable logistic regression analyses were performed to identify factors associated with safe and improved child stool disposal.

Results: The prevalence of safe and improved child stool disposal in Ethiopia was 36.9% (95%CI: 33.4–40.5%) and 5.3% (95%CI: 4.3–6.5%) respectively. There was regional variation in the prevalence of safe and improved child stool disposal. The odds of safe stool disposal among households with richest wealth index had 4.54 (AOR: 4.54; 95%CI: 2.89–7.12), richer 3.64 (AOR: 3.64; 95%CI: 2.46–5.38), middle 3.26 (AOR: 2.26; 95%CI: 2.27–4.68), and poorer 1.93 (AOR: 1.93; 95%CI: 1.39–2.68) times higher odds of practicing safe child stool disposal than households with poorest wealth index. Similarly, households found in richest, richer, middle, and poorer wealth index had also (AOR: 20.23; 95%CI: 8.59–47.66), (AOR: 12.53; 95%CI: 5.59–28.10) (AOR: 4.91; 95%CI: 1.92–12.55), and (AOR: 4.50; 95%CI: 2.06–9.84) higher odds of practicing improved child stool disposal than households from poorest wealth index respectively. The odds of safe child stool disposal were higher among households whose children age between 6 and 11 months (AOR: 1.57; 95%CI: 1.17–2.09), 12–17 months (AOR: 1.39; 95%CI: 1.00–1.95), and 18–23 months (AOR: 1.43; 95%CI: 1.03–1.99) than households whose children age between 0 and 5 months. The odds of safe child stool disposal were 1.31 (AOR: 1.31; 95%CI: 1.00–1.72) and 1.44 (AOR: 1.44; 95%CI: 1.04–2.01) times higher among mothers whose age between 25 and 34 and greater than 34 years compared to mothers whose age between 15 and 24 years, respectively. In addition, children’s stools are more likely to be disposed of safely in urban households than in rural households (AOR: 3.12; 95%CI: 1.86–5.22). The present study also revealed households with access to improved sanitation facilities fail to use them for disposal of child stool (AOR: 0.99; 95% CI: 0.67–1.45).

Conclusions: The prevalence of safe and improved child stool disposal in Ethiopia was found to be very low. Household socio-demographic and economic determinate were the key factors associated with child stool disposal. Appropriate strategic interventions to ensure safe and improved child stool disposal in Ethiopia is necessary. In addition, integrating child stool management into the existing sanitation interventions programs should be strongly recommended.

Keywords: Safe stool disposal, Improved disposal, Child stool, EDHS, Ethiopia
Background

Access to adequate and equitable sanitation and hygiene for all, to end open defecation is still an issue and a cross-cutting problem throughout the globe [1–3]. The Millennium Development Goal (MDG) on sanitation coverage has not progressed as planned and remains a daunting challenge and unfinished agenda for the current era of Sustainable Development Goals (SDGs) [1]. And the SDG, particularly Goal 6 Target 6.2 holds promise to “Achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation” by 2025 [3]. According to WHO/UNICEF, Joint Monitoring Programme (JMP) for Water Supply and Sanitation report globally, about 1 billion people practice open defecation, and an estimated 2.4 billion people lived without improved sanitation facilities [4]. In Sub-Saharan Africa, it is estimated that 229 million populations continue to engage in open defecation [5]. On top of this, in this sub-region of Africa as well as in many developing countries safe disposal of child stool is given less attention and remain a huge sanitation problem [6–10]. There is also a widespread belief that the stools of infants and young children are not harmful. As a result, the safe management of children's stools has been perniciously neglected due to this misconception [10, 11].

In fact, there is evidence that children's stool could be riskier than adult feces, due to a higher prevalence of diarrhea and pathogens—such as hepatitis A, rotavirus, and E.coli [11]. Moreover, young children are frequently infected with enteric pathogens and their stools are actually an important source of infection [9]. And children whose stools were disposed of unsafely had higher odds of diarrhea prevalence [9]. A recent meta-analysis on children's feces disposal practice also confirmed that unsafe child feces disposal practices increased the risk of diarrheal diseases by 23% [11]. In this regard, the safe disposal of children's feces is decisive and essential as the safe disposal of adults' feces [8, 9, 11–15].

In Ethiopia, like many Sub-Saharan Africa countries, poor sanitation is a major cause of fecal–oral diseases, including diarrhea [16–19]. In particular, children under the age of five years are the most affected as they are prone to water-borne diseases. In addition, unsafe disposal of children's feces may be an important contaminant in household environments, posing a high risk of exposure to infants and young children [8, 13]. A study by Azage et al. also reported that the stool of more than six out of ten children under five in Ethiopia is disposed of unsafely [8]. In this regard, Ethiopia needs to walk a long road to achieve hygienic collection and disposal of young children's feces [8, 13]. On one hand, only 6% of Ethiopian households use improved toilet facilities (16% in urban areas and 4% in rural areas) according to the recent EDHS 2016 report [1]. Even among households with improved toilets or latrines, almost half (49%) reported unsafe child feces disposal practice [13]. On the other hand, a very young child may not be able to use an improved toilet or sanitation facility because of their age and stage of physical development, even if their household has access to improved sanitation facility [13].

As a result, strengthening efforts to change the behavior of mothers and caregivers through programs and activities that aimed to filled knowledge and that encourage safe collection and disposal of child stool are crucial. On top of this, the prevalence of diarrhea increases after age 6 months, from 8% among children under age 6 months to 23% among those 6–11 months, and remains high (18%) at age 12–23 months, which is the time when children begin walking and are at increased risk of contamination from the environment [1].

The mini Ethiopian Demographic and Health Survey (EDHS) 2014 report showed open defecation remains a significant problem in Ethiopia with a national rate of 34.1% (37.9% in rural and 8.7% in urban) [20]. In effect, the Ministry of Health of Ethiopia has implemented a number of initiatives long ago and currently being run, to increase sanitation and create awareness of the risks associated with open defecations [21, 22]. Moreover, Ethiopia's launched a “National Hygiene and Sanitation Strategy: To Enable 100 percent Adoption of Improved Hygiene and Sanitation”, which focus on eliminating the practice of open defecation [22–24]. Despite the efforts to date in Ethiopia, it is unclear how progress has affected the practice of different segments of sub-populations, in particular, young children's stool disposal practice. From the available evidence, the practice of child feces disposal of mothers has only been documented in a few pieces of literature [8]. Even the formerly conducted study did not assess the prevalence and associated factors of improved child feces disposal. To the best of the author's knowledge, this is the first study in Ethiopia that uses a large-scale population-based representative dataset to assess the association between socio-demographic, economic and environmental variables and improved child stool disposal. The study, therefore, aims to describe the prevalence and associated factors of safe and improved child stool disposal in Ethiopia.

Methods

Study design, setting, and data

The study was conducted following the methodology presented by the Central Statistical Agency (CSA) and ICF [1]. And the recent nationally representative population-based Ethiopian Demographic and Health Survey (EDHS-4) data conducted in 2016 was used in this analysis. The sample is representative at a national, residence (i.e., urban/rural), and regional level. The samples were selected using a two-stage stratified cluster sampling technique with regions and residence as strata. Initially, all nine regions were stratified into urban and
rural clusters. From 645 enumeration areas, 202 urban and 443 rural clusters were considered. In the second stage of selection, a fixed number of 28 households per cluster were selected from the newly updated listing of households. Altogether, 16,650 households and 15,683 women aged 15–49 years were interviewed in the survey. The response rates were 98 and 95%, respectively.

The study included all youngest child under age two living with the mother from each household and mothers were asked about the disposal practice of the last passed stool with respect to the youngest child.

**Study variables**

The outcome variables for this study were the disposal practice of children’s stool, “safe/unsafe” and “improved/unimproved”. Mothers of children were asked, “The last time passed stools, what was done to dispose of the stools”? The response included: ‘child used the toilet or latrine,’ ‘put/rinsed into toilet or latrine,’ ‘put/rinsed into drain/ditch,’ ‘thrown into the garbage,’ ‘buried,’ ‘left in the open,’ and ‘other.’ The outcome variables were constructed based on the 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 ‘1’). And the others were coded as ‘unsafe disposal of child stool (coded as ‘0’). Similarly, improved child’s stool disposal was coded as ‘1’ when a child’s stools were put or rinsed into an “improved” toilet/latrine or child used toilet/latrine and ‘0’ otherwise.

Explanatory variables such as socioeconomic, demographic and environmental factors from the EDHS-4 dataset were extracted for further analysis. The variables include; household’s wealth (poorest, poorer, middle, richer, richest), sex of children, age of the child (0–5 months, 6–11 months, 12–17 months, 18–23 months), mother’s age (15–24, 25–34, >34), mother educational level (no education, primary, secondary, higher), region, place of residence (urban, rural), religion, mother’s exposure to media, toilet facility (improved, unimproved), sources of drinking water (improve, unimproved) and presence of diarrhea in the last two weeks preceding the survey.

Factors associated with safe child stool disposal

Table 4 shows the result of the bivariate and multivariable logistic regression analyses of factors associated with children’s stool disposal. In bivariate logistic regression analysis region, place of residence, mother educational level, religion, household wealth index, watching television, reading the newspaper or magazine, diarrhea in the last two weeks, age of the child, mother’s age, toilet facility and source of drinking water were factors associated with safe child stool disposal. In multivariable logistic regression analysis, the odds of disposing of stools safely were 60% lower (AOR: 0.40; 95%CI: 0.17–0.90), 55% lower (AOR: 0.45; 95%CI: 0.22–0.92) and 83% lower (AOR: 0.17; 95%CI: 0.07–0.40) among households in Tigray, Oromiya and Addis Ababa than Dire Dawa, respectively. Safe disposal of children’s stools was statistically associated with the household wealth index. The odds of safe stools disposal among households with poorer, middle, richer and richest wealth index had 1.93, 3.26, 3.64 and 4.54 times higher odds to practice safe child stool disposal than households with poorest wealth index (AOR:1.93; 95%CI: 1.39–2.68), (AOR: 3.26; 95%CI: 2.27–4.68), (AOR: 3.64; 95%CI: 2.46–5.38) and (AOR: 4.54; 95%: 2.89–7.12), respectively. Another variable that was statistically associated with safe disposal of stool was the age of the child and mother. The odds of safe child stool disposal were 1.57 times higher among households whose children age between 6 and 11 months (AOR: 1.57; 95%CI: 1.17–2.09), 1.39 times higher among households whose children age between 12 and
17 months (AOR: 1.39; 95%CI: 1.00–1.95), and 1.43 times higher among households whose children age between 18 and 23 months (AOR: 1.43; 95%CI: 1.03–1.99) compared to households whose child age between 0 and 5 months. Similarly, the odds of safe child stool disposal were 1.31 times higher among mothers whose age between 25 and 34 years old (AOR: 1.31; 95%CI: 1.00–1.72) and 1.44 times higher among mothers whose age greater than 34 years old compared to mothers whose age group were between 15 and 24 years old (AOR: 1.44; 95%CI: 1.04–2.01). In this study, children's stools are more likely to be disposed of safely in urban households than in rural households (AOR: 3.12; 95%CI: 1.86–5.22). On the other hand, households with access to improved sanitation facilities fail to use them for disposal of child stool (AOR: 0.99; 95% CI: 0.67–1.45).

Factors associated with improved child stool disposal

Table 5 presented the result of the bivariate and multivariable logistic regression analyses assessing the factors associated with improved children’s stool disposal. In bivariate logistic regression analysis region, place of residence, mother educational level, household wealth index, listening to radio, watching television, reading the newspaper or magazine, and source of drinking water were factors associated with improved child stool disposal. In multivariable logistic regression analysis, the odds of improved child stool disposal were 71, 75, 95, and 91% lower among households in Tigray (AOR: 0.29; 95%CI: 0.15–0.55), Afar (AOR: 0.25; 95%CI: 0.13–0.47), Amhara (AOR: 0.05; 95%: 0.02–0.19) and Oromiya (AOR: 0.09; 95%CI: 0.04–0.22) than Dire Dawa, respectively. Similarly, the odds of improved child stool disposal were 91, 73, 84, 63 and 74% lower among households in Benishangul (AOR: 0.09; 95%CI: 0.04–0.22), SNNP (AOR: 0.27; 95%CI: 0.12–0.59), Gambela (AOR: 0.16; 95%CI: 0.07–0.36), Harari (AOR: 0.37; 95%CI: 0.19–0.72), and Addis Ababa (AOR: 0.26; 95%CI: 0.13–0.51) than Dire Dawa, respectively. On the other hand, in the Somali region the prevalence was 2.61 times (AOR: 2.61; 95%CI: 1.06–6.42) higher odds of improved child stool disposal compared to Dire Dawa. In the present study improved child stool disposal were associated with the household wealth index. The odds of improved child stool disposal among households with poorer, middle, richer and richest wealth index were 4.50, 4.91, 12.53 and 20.23 times higher compared to households with poorest wealth index (AOR: 4.50; 95%CI: 2.06–9.84), (AOR: 4.91; 95%CI: 1.92–12.55), (AOR: 12.53; 95%CI: 5.59–28.10) and (AOR: 20.23; 95%CI: 8.59–47.66), respectively. Mother’s exposure to television also another factor associated with improved child stool disposal. The odds of improved child stool disposal was 2.23 times higher (AOR: 2.23; 95%CI: 1.19–4.15) among mother who was watching television than those who were not at all.

Discussion

This study reported the safe and improved child stool disposal practices of 4145 children under age two living with the mother in Ethiopia, together with the factors associated with these practices. Overall, the stool of 36.9 and 5.3% of children below two years of age was disposed of safely and with improved sanitation, respectively. Variables such as region, place of residence, household wealth index, the age of the child and age of the mother were the main factors associated with child stool disposal.

The prevalence of safe child stool disposal practice found in this study is almost similar to the prevalence reported by Azage et al., 33.68% [8] and other low-income
| Background characteristics | Child’s stool disposal practice | Total | Percent | $X^2$ (df), P-value |
|-----------------------------|--------------------------------|-------|---------|---------------------|
|                             | Safe                           | Unsafe|         |                     |
| Region                      |                                |       |         |                     |
| Tigray                      | 88                             | 216   | 304     | 7.3                 | 291.9 (10), p-value = 0.000 |
| Affar                       | 10                             | 30    | 40      | 1.0                 |                     |
| Amhara                      | 261                            | 499   | 760     | 18.3                |                     |
| Oromiya                     | 532                            | 1316  | 1848    | 44.6                |                     |
| Somali                      | 42                             | 129   | 171     | 4.1                 |                     |
| Benishangul                 | 22                             | 22    | 44      | 1.1                 |                     |
| SNNP                        | 508                            | 328   | 836     | 20.2                |                     |
| Gambela                     | 3                              | 6     | 9       | 0.2                 |                     |
| Harari                      | 4                              | 6     | 10      | 0.2                 |                     |
| Addis Ababa                 | 50                             | 55    | 105     | 2.5                 |                     |
| Dire Dawa                   | 10                             | 8     | 18      | 0.4                 |                     |
| Place of residence          |                                |       |         |                     |
| Urban                       | 297                            | 201   | 498     | 12.0                | 125.5 (1), p-value = 0.000 |
| Rural                       | 1233                           | 2414  | 3647    | 88.0                |                     |
| Mother educational level    |                                |       |         |                     |
| No education                | 801                            | 1699  | 2500    | 60.3                | 91.3 (3), p-value = 0.000 |
| Primary                     | 535                            | 744   | 1279    | 30.9                |                     |
| Secondary                   | 120                            | 134   | 254     | 6.1                 |                     |
| Higher                      | 74                             | 38    | 112     | 2.7                 |                     |
| Religion (n = 4144)         |                                |       |         |                     |
| Orthodox                    | 502                            | 902   | 1407    | 34.0                | 168.4 (5), p-value = 0.000 |
| Catholic                    | 12                             | 29    | 41      | 1.0                 |                     |
| Protestant                  | 469                            | 389   | 858     | 20.7                |                     |
| Muslin                      | 515                            | 1211  | 1726    | 41.7                |                     |
| Traditional                 | 11                             | 59    | 70      | 1.7                 |                     |
| Other                       | 16                             | 26    | 42      | 1.0                 |                     |
| Household wealth index (n = 4144) |                           |       |         |                     |
| Poorest                     | 171                            | 740   | 911     | 22.0                | 247.3(4), p-value = 0.000 |
| Poorer                      | 274                            | 629   | 903     | 21.8                |                     |
| Middle                      | 381                            | 500   | 881     | 21.3                |                     |
| Richer                      | 345                            | 398   | 743     | 17.9                |                     |
| Richest                     | 358                            | 348   | 706     | 17.0                |                     |
| Listening to radio          |                                |       |         |                     |
| Yes                         | 529                            | 601   | 1130    | 27.3                | 65.4(1), p-value = 0.000 |
| No                          | 1001                           | 2014  | 3015    | 72.7                |                     |
| Watching television         |                                |       |         |                     |
| Yes                         | 417                            | 345   | 763     | 18.4                | 127.4(1), p-value = 0.000 |
| No                          | 1112                           | 2270  | 3382    | 81.6                |                     |
| Reading the newspaper or magazine |                            |       |         |                     |
| Yes                         | 160                            | 125   | 285     | 6.9                 | 48.5(1), p-value = 0.000 |
| No                          | 1370                           | 2490  | 3860    | 93.1                |                     |
settings, such as Madagascar [26] and Nepal [27]. Additionally, studies conducted in India and Bangladeshi also reported a similar low prevalence of safe child stool disposal [28–30]. The finding implies the majority of cases children’s stool was disposed of unsafely, which may possibly put a child at risk of infection through multiple pathways. And, when there is improper child’s stool disposal in the community, both adults and children are at risk of enteric infection and not just the children alone. There are also evidence regarding the association between unsafe excreta disposal and a high burden of diarrhea, soil-transmitted helminth infections, trachoma and other enteric diseases [12, 25]. In connection, a study conducted by Bawankule et al. reported children whose stools were disposed of unsafely were more likely to suffer from diarrhea than children whose stools were disposed of safely [9].

However, the present study did not detect such association, safe child stool disposal and decreased odds of diarrheal prevalence. Likewise, a study by Islam et al. also reported unsafe child feces disposal was not significantly associated with presences of diarrhea among children under age three [29]. The absence of such an association might be explained in a number of ways. The first reason might be due to the age category of children. This age category of children (age < 2 years) may not be able to use a toilet facility because of their age and stage of physical development. In addition, children under age 6 months and those 6–11 months were not beginning walking and less likely to exposed to a contaminated environment. Although the prevalence of diarrhea may not only depend on unsafe stool disposal but also psychosocial factors (feeding practice and nurturing), mother personal hygiene, and environmental sanitation. To overcome, such phenomenon improving access to sanitation facilities alone is not enough, however context-specific behavior change strategies equally important. Countries like Ethiopia, where the burden of childhood diarrhea is prevalent should explore opportunities to integrate child stool management into existing sanitation intervention programs that target mothers and caregivers of young children. Sanitation strategies such as educating mothers or caregivers on safe disposal of children’s stools along with building sanitation facilities are also essential in curbing the high prevalence of unsafe child stool disposal. Furthermore, the promotions of behavior change strategies to prevail over barriers to

**Table 2** Child’s stool disposal by selected socio-demographic and socio-economic characteristics in Ethiopia, EDHS 2016 (N = 4145) (Continued)

| Background characteristics | Child’s stool disposal practice | Total   | Percent | X² (df), P-value |
|----------------------------|-------------------------------|---------|---------|-----------------|
|                            | Safe                         | Unsafe  |         |                 |
| Sex of child (n = 4144)    |                               |         |         |                 |
| Male                       | 697                           | 1283    | 1980    | 47.8            |
| Female                     | 832                           | 1332    | 2164    | 52.2            |
| Diarrhea in the last two weeks (n = 4129) | |         |         |                 |
| Yes                        | 305                           | 365     | 670     | 16.2            |
| No                         | 1222                          | 2237    | 3459    | 83.8            |
| Toilet facility            |                               |         |         |                 |
| Improvedᵃ                  | 216                           | 203     | 419     | 10.1            |
| Unimproved                 | 1314                          | 2412    | 3726    | 89.9            |
| Source of drinking water   |                               |         |         |                 |
| Improvedᵇ                  | 966                           | 1364    | 2330    | 56.2            |
| Unimproved                 | 563                           | 1251    | 1815    | 43.8            |
| Age of the child (n = 4144) |                               |         |         |                 |
| 0–5 months                 | 356                           | 831     | 1187    | 28.6            |
| 6–11 months                | 438                           | 621     | 1059    | 25.6            |
| 12–17 months               | 412                           | 672     | 1084    | 26.2            |
| 18–23 months               | 323                           | 491     | 814     | 19.6            |
| Mother’s age               |                               |         |         |                 |
| 15–24                      | 373                           | 842     | 1215    | 29.3            |
| 25–34                      | 839                           | 1267    | 2106    | 50.8            |
| > 34                       | 318                           | 506     | 824     | 19.9            |

ᵃFacilities that would be considered improved if they were not shared by two or more households
ᵇInclude piped water, public taps, standpipes, tube wells, boreholes, protected dug wells and springs, rainwater and bottled water
| Background characteristics | Improved child’s feces disposal practice | Total | Percent | X² (df), p-value |
|----------------------------|----------------------------------------|-------|---------|-----------------|
|                            | Improved Unimproved                     |       |         |                 |
| Region                     |                                        |       |         |                 |
| Tigray                     | 33                                     | 271   | 304     | 7.3             | 375.37(10), p-value = 0.000 |
| Affar                      | 2                                      | 37    | 39      | 0.9             |                               |
| Amhara                     | 14                                     | 747   | 761     | 18.4            |                               |
| Oromiya                    | 43                                     | 1805  | 1848    | 44.6            |                               |
| Somali                     | 29                                     | 142   | 171     | 4.1             |                               |
| Benishangul                | 1                                      | 43    | 44      | 1.1             |                               |
| SNPP                       | 50                                     | 786   | 836     | 20.2            |                               |
| Gambela                    | 1                                      | 9     | 10      | 0.2             |                               |
| Harari                     | 2                                      | 8     | 10      | 0.2             |                               |
| Addis Ababa                | 40                                     | 65    | 105     | 2.5             |                               |
| Dire Dawa                  | 6                                      | 11    | 17      | 0.4             |                               |
| Place of residence         |                                        |       |         |                 |
| Urban                      | 133                                    | 365   | 498     | 12.0            | 512.35(1), p-value = 0.000    |
| Rural                      | 83                                     | 3559  | 3647    | 88.0            |                               |
| Mother educational level   |                                        |       |         |                 |
| No education               | 62                                     | 2437  | 2500    | 60.3            | 253.09(3), p-value = 0.000    |
| Primary                    | 78                                     | 1201  | 1279    | 30.9            |                               |
| Secondary                  | 48                                     | 206   | 254     | 6.1             |                               |
| Higher                     | 32                                     | 80    | 112     | 2.7             |                               |
| Religion                   |                                        |       |         |                 |
| Orthodox                   | 92                                     | 1315  | 1407    | 33.9            | 11.99(5), p-value = 0.035     |
| Catholic                   | 0                                      | 41    | 41      | 1.0             |                               |
| Protestant                 | 45                                     | 814   | 859     | 20.7            |                               |
| Muslin                     | 81                                     | 1645  | 1726    | 41.6            |                               |
| Traditional                | 0                                      | 70    | 70      | 1.7             |                               |
| Other                      | 3                                      | 39    | 42      | 1.0             |                               |
| Household wealth index     |                                        |       |         |                 |
| Poorest                    | 7                                      | 968   | 975     | 23.5            | 489.97(4), p-value = 0.000    |
| Poorer                     | 14                                     | 891   | 905     | 21.8            |                               |
| Middle                     | 15                                     | 852   | 867     | 20.9            |                               |
| Richer                     | 36                                     | 718   | 754     | 18.2            |                               |
| Richest                    | 148                                    | 495   | 643     | 15.5            |                               |
| Listening to radio         |                                        |       |         |                 |
| Yes                        | 105                                    | 1024  | 1129    | 27.2            | 48.41(1), p-value = 0.000     |
| No                         | 116                                    | 2900  | 3016    | 72.8            |                               |
| Watching television        |                                        |       |         |                 |
| Yes                        | 138                                    | 625   | 763     | 18.4            | 301.404(1), p-value = 0.000   |
| No                         | 83                                     | 3299  | 3382    | 81.6            |                               |
| Reading the newspaper or magazine |                        |       |         |                 |
| Yes                        | 53                                     | 232   | 285     | 6.9             | 107.49(1), p-value = 0.000    |
| No                         | 167                                    | 3692  | 3859    | 93.1            |                               |
disposal of child stool and water used for child bathing after defecation should be considered [25].

In this study, the most common type of unsafe child stool disposal method was left child feces in the open or not disposed of (25.5%). Meaning a significant number of children's stools were disposed of unsafely in open field, and if feces are left uncontained, diseases may spread by direct contact or animal contact [1, 25, 31]. Systematic studies also plainly indicated that diarrheal diseases were highly prevalent in areas where poor hygiene and lack of sanitation is widespread [11, 32]. In connection, literature documented that the practice of unsafe child stool disposal can cause environmental contamination by fecal pathogens that can cause enteric diseases among young children [10, 29, 30, 33, 34].

In this study, the odds of practicing safe disposal of child stool were increased with the increased level of household wealth index. Households from a higher wealth quintile were more likely to practice safe disposal of child stool than those households from the poorest wealth quintile. This finding is consistent with the studies from Ethiopia [8], India [9], South Africa [35] and Burkina Faso [36].

Place of residence was another factor that significantly associated with safe child stool disposal. Children's stools are more likely to be disposed of safely in urban households than in rural households. Similar higher safe child stool disposal practice among urban residents was reported from a similar study from Ethiopia [8], and Kenya [37].

Ages of the child and mother's age were the other factors that positively associated safe child stool disposal. This finding is consistent with the finding of a similar study conducted in Ethiopia [8] and Bangladesh [30, 31]. This could be explained by a shift in safe disposal practices seen as children grow; children are increasingly likely to use a toilet/latrine themselves, rather than have their feces put or rinsed into one [13]. And the old age mothers and caregivers may be more conscious and observant about disposing of child feces safely and are more likely to understand the causes of childhood illness.

In multivariable logistic regression analysis, the presence of an improved sanitation facility was not associated with safe child stool disposal. The comparable finding was reported from rural Bangladesh [30]. Rand et al. also reported, in 15 out of 26 locations more than 50% of households reported that the feces of their youngest child under three years were disposed of unsafely; even the percentage of feces ending up in improved sanitation facilities is much lower [14]. These findings suggested that even those with

| Background characteristics | Improved child’s feces disposal practice | Total | Percent | $X^2$ (df), p-value |
|----------------------------|----------------------------------------|-------|---------|------------------|
|                            | Improved | Unimproved |       |                   |
| Sex of child               |          |            |       |                   |
| Male                       | 103      | 1877       | 1980  | 47.8             | 0.13(1), p-value = 0.722 |
| Female                     | 118      | 2047       | 2165  | 52.2             |                   |
| Diarrhea in the last two weeks (n = 4129) |          |            |       |                   |
| Yes                        | 39       | 631        | 670   | 16.2             | 0.35(1), p-value = 0.556 |
| No                         | 182      | 3277       | 3459  | 83.8             |                   |
| Toilet facility            |          |            |       |                   |
| Improved*                  | 221      | 198        | 419   | 10.1             | 2075.95(1), p-value = 0.000 |
| Unimproved                 | 0        | 3726       | 3726  | 89.9             |                   |
| Source of drinking water   |          |            |       |                   |
| Improved                   | 187      | 2143       | 2330  | 56.2             | 76.51(1), p-value = 0.000 |
| Unimproved                 | 34       | 1781       | 1815  | 43.8             |                   |
| Age of the child           |          |            |       |                   |
| 0–5 months                 | 46       | 1141       | 1187  | 28.6             | 7.13(3), p-value = 0.000 |
| 6–11 months                | 64       | 995        | 1059  | 25.5             |                   |
| 12–17 months               | 62       | 1023       | 1085  | 26.2             |                   |
| 18–23 months               | 49       | 765        | 814   | 19.6             |                   |
| Mother’s age               |          |            |       |                   |
| 15–24                      | 60       | 1156       | 1216  | 29.3             | 2.32(2), p-value = 0.314 |
| 25–34                      | 123      | 1982       | 2105  | 50.8             |                   |
| > 34                       | 38       | 786        | 824   | 19.9             |                   |

Table 3 Improved child’s stool disposal by selected socio-demographic and socio-economic characteristics in Ethiopia, EDHS 2016 (N = 4145) (Continued)
### Table 4 Factors associated with safe children’s stool disposal in Ethiopia, EDHS 2016

| Background characteristics | Child’s stool disposal practice | COR (95% CI) | AOR (95% CI) |
|----------------------------|--------------------------------|--------------|--------------|
|                            | Safe                           | Unsafe       |              |
| **Region**                 |                                |              |              |
| Tigray                     | 88                             | 216          | 0.32(0.17–0.60)* | 0.40 (0.17–0.90)** |
| Affar                      | 10                             | 30           | 0.26(0.13–0.52)* | 0.65 (0.29–1.46) |
| Amhara                     | 261                            | 499          | 0.42(0.22–0.77)* | 0.59(0.26–1.30) |
| Oromiya                    | 532                            | 1316         | 0.32(0.18–0.57)* | 0.45(0.22–0.92)** |
| Somali                     | 42                             | 129          | 0.26(0.14–0.47)* | 0.67(0.33–1.36) |
| Benishangul                | 22                             | 22           | 0.77(0.41–1.43) | 1.45(0.67–3.15) |
| SNNP                       | 508                            | 328          | 1.24(0.71–2.17) | 1.65(0.74–3.69) |
| Gambela                    | 3                              | 6            | 0.40(0.20–0.79)* | 0.48(0.21–1.09) |
| Harari                     | 4                              | 6            | 0.57(0.30–1.08) | 0.51(0.23–1.13) |
| Addis Ababa                | 50                             | 55           | 0.72(0.39–1.32) | 0.17(0.07–0.40)** |
| Dire Dawa                  | 10                             | 8            | 1             | 1             |
| **Place of residence**     |                                |              |              |
| Urban                      | 297                            | 201          | 2.88(1.95–4.26)* | 3.12(1.86–5.22)** |
| Rural                      | 1233                           | 2414         | 1             | 1             |
| **Mother educational level** |                              |              |              |
| No education               | 801                            | 1699         | 1             | 1             |
| Primary                    | 535                            | 744          | 1.52(1.21–1.91)* | 1.12(0.86–1.46) |
| Secondary                  | 120                            | 134          | 1.89(1.24–2.87)* | 0.78(0.50–1.21) |
| Higher                     | 74                             | 38           | 4.16(2.27–7.63)* | 0.93(0.48–1.79) |
| **Religion (n = 4144)**    |                                |              |              |
| Orthodox                   | 502                            | 902          | 1             | 1             |
| Catholic                   | 12                             | 29           | 0.75(0.24–2.35) | 0.69(0.22–2.11) |
| Protestant                 | 469                            | 389          | 2.14(1.50–3.06)* | 1.36(0.86–2.16) |
| Muslin                     | 515                            | 1211         | 0.75(0.54–1.05) | 1.06(0.69–1.63) |
| Traditional                | 11                             | 59           | 0.34(0.09–1.33) | 1.02(0.49–2.11) |
| Other                      | 16                             | 26           | 1.14(0.37–3.47) | 1.07(0.38–2.99) |
| **Household wealth index (n = 4144)** |              |              |              |
| Poorest                    | 171                            | 740          | 1             | 1             |
| Poorer                     | 274                            | 629          | 1.89(1.33–2.67)* | 1.93(1.39–2.68)** |
| Middle                     | 381                            | 500          | 3.30(2.32–4.70)* | 3.26(2.27–4.68)** |
| Richer                     | 345                            | 398          | 3.76(2.54–5.55)* | 3.64(2.46–5.38)** |
| Richest                    | 358                            | 348          | 4.46(2.96–6.71)* | 4.54(2.89–7.12)** |
| **Listening to radio (n = 4144)** |              |              |              |
| Yes                        | 529                            | 601          | 1.77(1.40–2.23)* | 1.18(0.87–1.60) |
| No                         | 1001                           | 2014         | 1             | 1             |
| **Watching television**    |                                |              |              |
| Yes                        | 417                            | 345          | 2.46(1.84–3.31)* | 1.45(0.99–2.12) |
| No                         | 1112                           | 2270         | 1             | 1             |
| **Reading the newspaper or magazine** |              |              |              |
| Yes                        | 160                            | 125          | 2.31(1.56–3.42)* | 1.21(0.77–1.89) |
| No                         | 1370                           | 2490         | 1             | 1             |
access to improved sanitation facilities often fail to use them for disposal of child feces [25, 31]. Meaning, people who are having improved toilets at their house are disposing of the child stool in a risky way.

In fact, access to sanitation facilities is a pre-requisite to ending open defecation as well as unsafe child stool disposal, but it is not always a sufficient condition to overcome unsafe child stool disposal [25, 38, 39]. A study by Phaswana-Mafuya et al. identified improvement and presence of physical sanitation infrastructure alone is not sufficient to ensure safe hygienic practices [35]. In overcome such situation, robust sanitation promotion and strong behavior change program that targeted on the determinants of behaviors is important.

The prevalence of improved child stool disposal found in this study (5.3%) is almost close to the prevalence reported in the last EDHS-3 (2011) 3.0% [13]. In fact, according to the most recent EDHS-4 report overall 6% of Ethiopian households use improved toilet facilities (16% in urban areas and 4% in rural areas) [1]. Subsequently, improved child stool disposal is only possible where there is access to improved sanitation facilities [13]. According to the recent WHO sanitation and health guideline, disposal of child feces in a toilet connected to a safe sanitation chain is the only safe method where solid waste management systems for children’s absorbent underclothes (nappies) disposal are not safe [25]. The association between place of residence and improved disposal of child feces in this study is not surprising since there is a significant variation in improved sanitation coverage among urban and rural residents in Ethiopia. In the present study, the household wealth index was a strong predictive factor for having improved child stool disposal. The finding is in line with other related studies [35, 40, 41].

This study has several limitations. First, it has all the disadvantages of any cross-sectional study; the temporal relationship between the outcome and independent variables could not be established. Second, mothers’ knowledge and perception towards safe and improved disposal of child feces were not assessed in this study. Moreover, the study may be susceptible to social desirability and recall bias, as the data dealt with reported practices rather than direct observation. The other limitation of this study was lack of exhaustiveness to include all the relevant variables, such as child stool collection practice that may influence the practice of safe and improved disposal of child stool. Furthermore, some of the regions had a small sample size, which questions the

### Table 4 Factors associated with safe children’s stool disposal in Ethiopia, EDHS 2016 (Continued)

| Background characteristics | Child’s stool disposal practice | COR (95% CI) | AOR (95% CI) |
|----------------------------|--------------------------------|--------------|--------------|
| Sex of child (n = 4144)    |                                |              |              |
| Male                      | 697                            | 1283         | 1            |
| Female                    | 832                            | 1332         | 1.14(0.94–1.40) |
| Diarrhea in the last two weeks (n = 4129) |                        |              |              |
| Yes                       | 305                            | 365          | 1.52(1.17–1.97)* | 1.27(0.97–1.68) |
| No                        | 1222                           | 2237         | 1            | 1            |
| Toilet facility           |                                |              |              |
| Improved                  | 216                            | 203          | 1.95(1.42–2.67)* | 0.99(0.66–1.47) |
| Unimproved                | 1314                           | 2412         | 1            | 1            |
| Source of drinking water  |                                |              |              |
| Improved                  | 966                            | 1364         | 1.57(1.19–2.07)* | 1.04(0.80–1.36) |
| Unimproved                | 563                            | 1251         | 1            | 1            |
| Age of the child (n = 4144) |                               |              |              |
| 0–5 months                | 356                            | 831          | 1            | 1            |
| 6–11 months               | 438                            | 621          | 1.64(1.28–2.11)* | 1.57(1.17–2.09)** |
| 12–17 months              | 412                            | 672          | 1.43(1.05–1.94)* | 1.39(1.00–1.95)** |
| 18–23 months              | 323                            | 491          | 1.53(1.16–2.03)* | 1.43(1.03–1.99)** |
| Mother’s age              |                                |              |              |
| 15–24                     | 373                            | 842          | 1            | 1            |
| 25–34                     | 839                            | 1267         | 1.49(1.19–1.87)* | 1.31(1.00–1.72)** |
| > 34                      | 318                            | 506          | 1.41(1.06–1.88)* | 1.44(1.04–2.01)** |

CI = Confidence Interval, COR = Crude Odds Ratio, AOR = Adjusted Odds Ratio, *Significant association (P < 0.05) crude, ** Significant association (P < 0.05) adjusted
| Background characteristics | Improved child’s feces disposal practice | COR (95% CI) | AOR (95% CI) |
|----------------------------|----------------------------------------|--------------|--------------|
|                            | Improved | Unimproved |                 |                 |
| Region                     |          |            |                 |                 |
| Tigray                     | 33       | 271        | 0.22(0.13–0.38)* | 0.29(0.15–0.55)** |
| Affar                      | 2        | 37         | 0.11(0.05–0.25)* | 0.25(0.13–0.47)** |
| Amhara                     | 14       | 747        | 0.03(0.01–0.11)* | 0.05(0.02–0.19)** |
| Oromiya                    | 43       | 1805       | 0.04(0.02–0.09)* | 0.09(0.04–0.22)** |
| Somali                     | 29       | 142        | 0.36(0.19–0.65)* | 2.61(1.06–6.42)** |
| Benishangul                | 1        | 43         | 0.04(0.02–0.10)* | 0.09(0.04–0.22)** |
| SNPN                       | 50       | 786        | 0.11(0.06–0.21)* | 0.27(0.12–0.59)** |
| Gambela                    | 1        | 9          | 0.17(0.09–0.35)* | 0.16(0.07–0.36)** |
| Harari                     | 2        | 8          | 0.45(0.24–0.83)* | 0.37(0.19–0.72)** |
| Addis Ababa                | 40       | 65         | 1.08(0.61–1.92)  | 0.26(0.13–0.51)** |
| Dire Dawa                  | 6        | 11         | 1              | 1              |
| Place of residence         |          |            |                 |                 |
| Urban                      | 133      | 365        | 14.77(9.29–23.49)* | 1.859(0.90–3.84) |
| Rural                      | 83       | 3559       | 1              | 1              |
| Mother educational level   |          |            |                 |                 |
| No education               | 62       | 2437       | 1              | 1              |
| Primary                    | 78       | 1201       | 2.52(1.64–3.89)* | 1.40(0.85–2.31) |
| Secondary                  | 48       | 206        | 9.14(5.03–16.61)* | 1.90(0.93–3.89) |
| Higher                     | 32       | 80         | 15.27(8.20–28.45)* | 1.62(0.73–3.62) |
| Household wealth index (n = 4144) |          |            |                 |                 |
| Poorest                    | 7        | 968        | 1              | 1              |
| Poorer                     | 14       | 891        | 2.12(1.02–4.42)* | 4.50(2.06–9.84)** |
| Middle                     | 15       | 852        | 2.33(0.88–6.19)* | 4.91(1.92–12.55)** |
| Richer                     | 36       | 718        | 6.65(3.10–14.27)* | 12.53(5.59–28.10)** |
| Richest                    | 148      | 495        | 39.43(20.22–76.88)* | 20.23(8.59–47.66)** |
| Listening to radio         |          |            |                 |                 |
| Yes                        | 105      | 1024       | 2.58(1.76–3.78)* | 0.92(0.55–1.55) |
| No                         | 116      | 2900       | 1              | 1              |
| Watching television        |          |            |                 |                 |
| Yes                        | 138      | 625        | 8.73(5.88–12.94)* | 2.23(1.19–4.15)** |
| No                         | 83       | 3299       | 1              | 1              |
| Reading the newspaper or magazine |      |            |                 |                 |
| Yes                        | 53       | 232        | 5.08(3.30–7.81)* | 0.99(0.51–1.91) |
| No                         | 167      | 3692       | 1              | 1              |
| Diarrhea in the last two weeks (n = 4129) |          |            |                 |                 |
| Yes                        | 39       | 631        | 1.11(0.68–1.82)  |               |
| No                         | 182      | 3277       | 1              | 1              |
| Source of drinking water   |          |            |                 |                 |
| Improved                   | 187      | 2143       | 4.58(2.78–7.54)* | 1.55(0.91–2.66) |
| Unimproved                 | 34       | 1781       | 1              | 1              |
| Age of the child           |          |            |                 |                 |
| 0–5 months                 | 46       | 1141       | 1              | 1              |
awareness creation and educating mothers and care-givers 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.

Competing interests
The author declares that he has no competing interests.

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Table 5 Factors associated with improved child’s stool disposal in Ethiopia, EDHS 2016 (Continued)

| Background characteristics | Improved child’s feces disposal practice | COR (95% CI) | AOR (95% CI) |
|----------------------------|----------------------------------------|--------------|--------------|
|                            | Improved                               | Unimproved   |              |
| 6–11 months                | 64                                     | 995          | 1.60(0.96–2.68) |
| 12–17 months               | 62                                     | 1023         | 1.52(0.96–2.39) |
| 18–23 months               | 49                                     | 765          | 1.59(0.92–2.74) |
| Mother’s age               |                                        |              |              |
| 15–24                      | 60                                     | 1156         | 1              |
| 25–34                      | 123                                    | 1982         | 1.21(0.83–1.77) |
| > 34                       | 38                                     | 786          | 0.94(0.53–1.66) |

CI = Confidence Interval, COR = Crude Odds Ratio, AOR = Adjusted Odds Ratio, *Significant association (P < 0.05) crude, ** Significant association (p < 0.05) adjusted
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