# Are burial or disposal with garbage safe forms of child faeces disposal? An expert consultation

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*The importance of safe handling and disposal of child faeces given its potential role in disease transmission are increasingly recognized. Household surveys demonstrate that the burying of child faeces ('dig-and-bury') is common in several countries, especially in sub-Saharan Africa and South-east Asia. Disposal with garbage is widely practised in middle- and high-income countries and is becoming increasingly common in urban areas of low-income countries. The safety of these two approaches is difficult to assess given the limited evidence available and we therefore sought the opinion of experts in the field of sanitation to support advocacy around the topic. We report the findings of an anonymous expert (Delphi) consultation on the safety of these two child faeces disposal methods. There was almost unanimous agreement these should be considered neither safe nor improved. A range of arguments was provided to support this position, including proximity of solid waste and burial sites to the home and children's play areas and that neither practice would be acceptable for adults. The consultation also highlighted gaps in the current evidence base that should be addressed to gain a fuller insight into the risks involved in these two forms of sanitation with a view to providing both programmatic and normative guidance. In particular further work is needed to assess the potential for exposure to faecal matter in solid waste in low- and middle-income countries and to elucidate the predominant practices of child faeces burial including proximity to the home or infant play areas as well as depth of burial.*

**Keywords:** child faeces, burial, solid waste, garbage, sanitation

OVER TWO AND A HALF BILLION people did not have access to an improved form of sanitation at home in 2012 (WHO/UNICEF, 2014), a facility defined as hygienically separating faeces from human contact (WHO/UNICEF, 2006). Even where improved sanitation facilities are used by most household members, these figures do not account for infants and young children who often are not able to use toilets/latrines and whose sanitation practices differ considerably from adults (Lanata et al., 1998).

Efforts to reduce transmission of faecal pathogens and associated conditions, ranging from millions of deaths due to diarrhoea (Pruss-Ustun et al., 2014), to environmental enteropathy (Korpe and Petri, 2012) and helminthiasis (Roy et al., 2011),

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should consider the practices relating to the handling and disposal of children's faeces. Despite a misconception that children's faeces are unpleasant but harmless (Isely, 1984), research studies indicate that they may in fact pose a particularly high risk given a variety of factors including the prevalence of diarrhoeal diseases in this age group (Gil et al., 2004; Fischer Walker et al., 2012) and unsafe disposal practices even in households with access to improved sanitation facilities (Majorin et al., 2014). Children are also more likely to be exposed to children's faeces when it is not safely removed from the household environment (Majorin et al., 2014), for example through geophagy (Ngure et al., 2013). It has been argued that children's faeces may in fact pose a greater risk than those of adults (Lanata et al., 1998). The presence of children's faeces in the home environment has been related to admissions of children to the hospital with diarrhoea (Traoré et al., 1994) and a case-control study in the Philippines found children were at greater risk of diarrhoea if their caretakers were disposing of their faeces unsafely (Baltazar and Solon, 1989).

Information on child faeces disposal practices has been collected by household surveys including the Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) from the beginning of these programmes in 1986 and 1995, respectively, in response to the following question to caregivers of children under two years of age (up to five in the case of DHS): '*The last time [name] passed stools, what was done to dispose of the stools?'* These surveys demonstrate the wide variety of child faeces disposal practices taking place in different countries (Table 1). Throwing child faeces in garbage is the most common practice in 12 countries in Table 1 and in six countries burial is practised by at least one in ten households.

Monitoring guidelines outlined in the *Core Questions on Drinking-Water and Sanitation for Household Surveys* differentiate between 'sanitary' and 'unsanitary' forms of child faeces disposal (WHO/UNICEF, 2006). Sanitary forms include direct use of a toilet or latrine, putting/rinsing the faeces into a toilet/latrine or burial of child faeces. Notably, use of a toilet/latrine or rinsing/putting faeces in a toilet/latrine are considered sanitary whether or not the household has access to improved sanitation. Furthermore, the guidelines make a somewhat unclear distinction between 'burial' and 'burial in the open', with only the former considered sanitary. Burial is taken to mean burying of child faeces under the ground and covering the faeces with soil or another material (a.k.a. the cat method or dig-and-bury). Rinsing into a drain or ditch, leaving or burying faeces out in the open and disposal with garbage are all classed as unsanitary. Disposal with garbage is often practised by households using diapers or nappies but is also common in some settings where these are not widely used (Majorin et al., 2014).

With the exception of burying, which has been classified as unsafe, this guidance is reflected in MICS to classify disposal practices as 'safe' (Table 1). The classification of disposal with garbage as unsafe can create difficulties for international household survey programmes since the definitions apply equally to upper middle-income countries as well as least developed countries – countries with radically different solid waste infrastructure. A review was commissioned by the Joint Monitoring Programme (JMP) for Water Supply and Sanitation (Reese et al., this issue) to compile

**Table 1** Distribution of children age 0–2 years according to place of disposal of child's faeces the last time the child passed stools

| *Country* | *Year* | *Child used toilet/ latrine* | *Put/Rinsed into toilet or latrine* | *Put/Rinsed into drain or ditch* | *Thrown into garbage (solid waste)* | *Buried* | *Left in the open* | *Other* | *DK/ Missing* | *Stools disposed of safely*[1] | *Number of children aged 0–2* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Afghanistan | 2010–11 | 5.3 | 40.5 | 20.2 | 8.7 | 5.8 | 17.6 | 0.5 | 1.5 | 45.8 | 7,950 |
| Barbados | 2012 | 20.1 | 4.5 | 0.4 | 72.4 | – | – | 1.4 | 1.3 | 24.6 | 263 |
| Belarus | 2012 | 5.5 | 50.5 | 1.4 | 42.4 | – | – | 0.3 | 0.0 | 56.0 | 2,097 |
| Belize | 2011 | 13.0 | 12.6 | 0.7 | 67.9 | 1.6 | 1.3 | 2.3 | 0.6 | 25.6 | 1,152 |
| Bhutan | 2010 | 18.1 | 39.4 | 31.3 | 3.8 | 1.0 | 5.1 | 0.7 | 0.6 | 57.5 | 3,798 |
| Bosnia and Herzegovina | 2011–12 | 12.2 | 7.4 | 0.5 | 78.6 | 0.2 | 0.1 | 0.2 | 0.8 | 19.6 | 1,377 |
| Central African Republic | 2010 | 3.3 | 46.9 | 8.8 | 30.3 | 1.6 | 4.8 | 1.1 | 3.3 | 50.2 | 6,627 |
| Chad | 2010 | 1.9 | 16.1 | 4.8 | 50.2 | 6.4 | 16.0 | 0.8 | 3.7 | 18.1 | 9,985 |
| Costa Rica | 2011 | 20.3 | 7.6 | 1.1 | 66.7 | 2.9 | 0.1 | 1.1 | 0.2 | 27.9 | 1,376 |
| Cuba | 2010–11 | 18.5 | 67.3 | 5.6 | 4.6 | 0.1 | 1.8 | 1.8 | 0.1 | 85.8 | 4,175 |
| Dem. Rep. Congo | 2010 | 2.8 | 53.7 | 7.4 | 15.9 | 5.1 | 6.8 | 6.9 | 1.5 | 56.5 | 7,119 |
| Gambia | 2010 | 1.5 | 86.6 | 3.2 | 6.9 | 0.2 | 0.2 | 0.6 | 0.9 | 88.1 | 7,603 |
| Ghana | 2011 | 1.8 | 34.2 | 13.1 | 37.8 | 5.7 | 2.4 | 4.4 | 0.7 | 36.0 | 4,535 |
| Iraq | 2011 | 12.3 | 7.0 | 4.2 | 69.4 | 0.5 | 5.1 | 1.4 | 0.1 | 19.3 | 22,554 |
| Jamaica | 2011 | 13.2 | 15.1 | 0.7 | 66.5 | 1.2 | – | 2.0 | 1.3 | 28.2 | 980 |
| Kazakhstan | 2010–11 | 4.6 | 62.1 | 4.0 | 26.6 | 0.0 | 0.1 | 2.1 | 0.5 | 66.7 | 3,198 |
| Korea Dem. Rep. | 2009 | 30.0 | 36.8 | 17.8 | 3.0 | 12.4 | – | – | 0.0 | 66.8 | 1,285 |
| Lao PDR | 2011–12 | 12.0 | 6.5 | 1.6 | 5.2 | 18.5 | 42.7 | 11.5 | 1.8 | 18.6 | 6,622 |
| Macedonia | 2011 | 10.2 | 7.1 | 1.5 | 79.8 | 0.2 | 0.4 | 0.3 | 0.6 | 17.3 | 815 |

*(Continued)*

**Table 1** Continued

| *Country* | *Year* | *Child used toilet/ latrine* | *Put/Rinsed into toilet or latrine* | *Put/Rinsed into drain or ditch* | *Thrown into garbage (solid waste)* | *Buried* | *Left in the open* | *Other* | *DK/ Missing* | *Stools disposed of safely*[1] | *Number of children aged 0–2* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mauritania | 2011 | 2.1 | 18.2 | 3.0 | 41.2 | 12.1 | 18.1 | 1.2 | 4.2 | 20.3 | 5,589 |
| Mongolia | 2010 | 1.8 | 58.2 | 6.2 | 13.4 | 3.6 | 12.5 | 2.6 | 1.7 | 60.0 | 2,656 |
| Nepal | 2010 | 1.2 | 15.9 | 7.3 | 43.7 | 0.6 | 29.3 | 1.8 | 0.2 | 17.1 | 2,028 |
| Nigeria | 2011 | 1.8 | 50.5 | 6.3 | 25.3 | 4.5 | 2.7 | 6.1 | 2.7 | 52.3 | 15,125 |
| Serbia | 2010 | 10.2 | 15.6 | 0.4 | 72.4 | 0.0 | 0.1 | 0.0 | 1.3 | 25.7 | 1,968 |
| Sierra Leone | 2010 | 1.6 | 52.1 | 14.2 | 20.9 | 1.5 | 0.9 | 5.5 | 3.3 | 53.7 | 4,953 |
| St Lucia | 2012 | 19.1 | 7.5 | 0.8 | 71.0 | – | 0.7 | 0.3 | 0.7 | 26.6 | 168 |
| South Sudan | 2010 | 3.0 | 12.8 | 3.1 | 28.5 | 19.9 | 21.3 | 2.8 | 8.6 | 15.7 | 5,024 |
| Sudan | 2010 | 5.4 | 41.1 | 2.6 | 15.3 | 12.7 | 17.9 | 3.1 | 2.0 | 46.5 | 8,245 |
| Suriname | 2010 | 7.1 | 14.9 | 3.0 | 58.4 | 6.4 | 0.2 | 8.1 | 1.9 | 22.0 | 2,028 |
| Swaziland | 2010 | 10.1 | 50.5 | 6.6 | 12.8 | 8.3 | 8.7 | 1.5 | 1.5 | 60.6 | 1,573 |
| Thailand | 2012 | 23.2 | 33.8 | 1.3 | 32.1 | 5.9 | 2.8 | 0.8 | 0.1 | 56.9 | 5,801 |
| Togo | 2010 | 1.3 | 25.3 | 5.9 | 39.1 | 12.5 | 6.4 | 8.7 | 0.8 | 26.7 | 2,919 |
| Tunisia | 2011–12 | 11.5 | 2.3 | – | 77.2 | 0.7 | 7.1 | 0.8 | 0.4 | 13.8 | 1,748 |
| Vietnam | 2010–11 | 3.0 | 58.0 | 12.1 | 7.5 | 2.3 | 10.4 | 6.1 | 0.4 | 61.1 | 2,219 |

Note: [1]Refers to a child using a toilet/latrine or disposal of the stool by the mother or caretaker by rinsing the stool into a toilet/latrine.
*Source*: Multiple Indicator Cluster Surveys 4th round

the evidence on the health risks associated with disposal with garbage. The Reese et al. review found that diapers form a large proportion of municipal solid waste in many settings but that there is little to no official guidance on disposal of diapers with solid waste and very limited evidence on the health risks associated with this practice.

Child faeces profiles for over 20 countries produced by the Water and Sanitation Program of the World Bank and UNICEF (Water and Sanitation Program/UNICEF, 2015) distinguish between both 'safe' and 'improved' disposal. The latter category is more stringent – use of a latrine must be coupled with household access to an improved latrine. *Burial* of child faeces was classed as both unsafe and unimproved in these profiles, further illustrating the inconsistent classification of this form of child faeces disposal.

With the above in mind, the safety of disposal of child faeces with garbage and burial of child faeces were considered equivocal and are the focus of this article. In light of the evidence gaps and need for guidance on how to assess child defecation practices for global monitoring, we conducted an expert consultation. The objective of this consultation was to determine whether disposal of child faeces with garbage or burial of child faeces should be considered as safe or improved.

## Methods

We conducted a Delphi consultation between May and July 2014 to ascertain the opinions of experts on the safety of two forms of child faeces disposal, specifically for children aged two or under. Originally developed as a means to predict future events, Delphi consultations provide a robust approach to gauge expert opinion on an issue without undue influence for example by the most pre-eminent or vocal among the group; the main features of this approach are anonymity, feedback, and quantitative synthesis (Linstone and Turoff, 1975).

Experts were selected based on their knowledge of the topic and were drawn primarily from authors of recent research articles on child faeces disposal and members of the JMP sanitation working group. The consultation was conducted in three stages using an online survey tool (SurveyMonkey) and respondents were asked for their opinion on whether: 1) burying child faeces should be considered a safe/improved form of child faeces disposal; and 2) disposal of child faeces in garbage should be considered a safe/improved form of child faeces disposal. They were also requested to share any relevant links or background documents together with a rationale for their opinion. At the start of the consultation, experts were provided with a draft of the forthcoming review (Reese et al., this issue) and two background documents (Gil et al., 2004; Majorin et al., 2014). After each stage a summary of the responses was provided to respondents together with a spreadsheet containing the full set of individual responses. The purpose of these was to provide feedback to experts and enable them to take others' views into consideration prior to offering a final verdict on this issue. In the first two stages respondents were asked to provide a response along a Likert scale (strongly agree, agree, neither agree

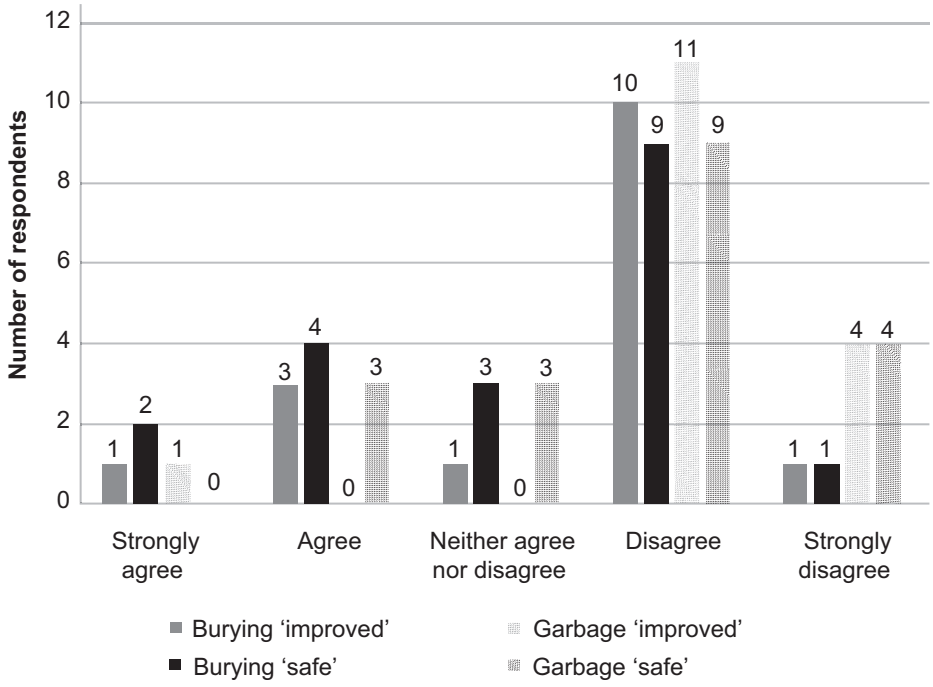


**Figure 1** Number of respondents by response type on a Likert scale

nor disagree, disagree, strongly disagree) and in the final stage they were asked for a 'recommend'/'do not recommend'. In communications with the experts we clarified the age range under consideration (less than two years of age) and the definition for an improved sanitation facility. It was decided not to refer specifically to any context (e.g. rural sub-Saharan Africa or Eastern Europe) so as not to influence the outcome of the consultation. Similarly we did not define 'safe' as one of our objectives was to understand how experts might differentiate between 'safe' and 'improved'.

## Results

### *Responses and recommendations*

In total 52 responses were obtained from 19 experts: 19 and 16 in stages 1 and 2, respectively, and a further 17 in the final stage. Responses from the first two stages of the consultation are shown in Figure 1. Most respondents (n = 9 to 11) disagreed with the statements that burying or disposal with garbage should be considered as safe or improved. A small number of respondents agreed or strongly agreed with these statements with the greatest number agreeing that burial should be considered as 'safe' (n = 6). In the first two stages there were a few experts who neither agreed nor disagreed. In the third stage 17 respondents indicated their final recommendation as either a 'recommend' or 'do not recommend'. Twelve experts disagreed with the

statement that burial is an 'improved' form of sanitation and 15 out of the 17 did not recommended that disposal with garbage be considered 'improved'. Few respondents made a distinction between 'improved' and 'safe' and most gave the same response on the Likert scale. Indeed one respondent noted that 'if a practice is not safe, then I think it also cannot be considered improved'.

### *Disposal of child faeces with garbage*

Selected arguments provided by experts for and against classifying disposal with garbage as safe or improved are listed below.

Arguments against:

- Disposal with solid waste could only be considered as safe if the majority of waste is collected and disposed of in a controlled landfill.
- Criteria that would need to be met: diapers double-bagged and promptly removed to a landfill where trash picking is forbidden. These are unlikely to be met.
- Risk of exposure by solid waste pickers/scavengers and those living in the vicinity of landfills/waste piles.
- Disposal with waste is just moving from one place to another and faeces remain in the open.
- Proximity of waste to households. Animals (chickens, rats) and insects (flies) can uncover faecal matter and spread it to areas where people will come into contact. Active children may also explore the disposed items. This is like promoting open defecation.
- Faecal matter may come into contact with water sources and soils.
- Conditions for disposal to be considered safe are unlikely to be met in most developing country contexts.
- The reality of solid waste management practice is that mixing excreta in the municipal waste stream is likely to increase the distribution of raw excreta around the neighbourhood (area-based collection is common) and more widely at zonal transfer points.
- We should not recommend a method of sanitation for children that is not accepted for adults. It is highly likely that adults would think this was acceptable if promoted.
- Microbiological studies from less developed countries show that faeces are omnipresent in the household environment: on cutting boards, on household utensils, in the dirt surrounding a home.

Arguments for:

- In comparison to unsafe disposal of pit latrine sludge the risks are relatively small.
- There is no safe alternative for diapers.
- Other than disposal with diapers other forms are relatively uncommon.
- The waste is confined at least in a specific location where it is unlikely that the most vulnerable group – young children – will come into contact with it.
- The sense of disgust means that small children are highly unlikely to play with solid waste.

- Risks are lower due to containment in the garbage collection facility.
- It is widely accepted in the more developed parts of the world and increasingly practised in urban areas of the developing world.
- There are concerns about how solid waste is handled and disposed of afterwards, but those concerns are similar to pit latrines that need to be de-sludged and sewage which is dumped untreated in waterways.
- There is no evidence (not even examples of regulation) that disposal of diapers with solid waste poses a serious health hazard.
- If disposal were officially 'unsafe' it would be virtually impossible to regulate and would also take away the focus from basic messages of safe sanitation.

These arguments reflect the range and most commonly cited justifications. In addition to these arguments, the following reflections were made by one or more experts:

> Disposal with garbage could potentially be classed as improved if several criteria were met as can be the case for 'gold standard' solid waste management systems such as those in parts of Western Europe and North America and when disposal is restricted to the contents remaining on emptied diapers/nappies. In order to determine whether disposal could be considered as improved, the following questions would need to be answered: How was the faeces handled getting to the garbage? How is the garbage disposed of? How are scavengers and animals kept away from the garbage? Where is the garbage stored in relation to households and water sources?

One respondent considered the issues relating to disposal with garbage to be similar to those of pit latrines (are they emptied safely if at all?) and sewer-connected sanitation (is wastewater treated?). In other words considering how garbage is disposed parallels the need to broaden the improved sanitation definition to address faecal sludge management.

### *Burial of child faeces*

In comparison to disposal with garbage there was somewhat more support for burial of child faeces but this was still a minority of respondents. Arguments for and against burial being classed as safe or improved are listed below.

Arguments against:

- Dig-and-bury methods are susceptible to exposure by foraging animals and exposure by wash-away during rain events. Anecdotally, the dig-and-bury method is poorly implemented with faeces incompletely covered due to lack of time or care, difficulty in digging or lack of a suitable digging implement.
- There is no evidence that burying child faeces is ever actually done in a way that hygienically separates human waste from human contact … what little evidence there is, mostly from back country, hiking-related research, suggests burying faeces is unsafe.
- There are varied practices and it is impossible from a monitoring perspective to determine how deep faeces were actually buried. … Anecdotal evidence suggests

that child faeces, when buried, are buried in the yard – the domain where small children roam and play.

- When rain comes, it is highly likely that buried faeces can spill over and that may cross-contaminate nearby water sources and the environment.
- [O]bservation shows pits are quite shallow, close to the house, left open for multiple days, animals and rain water can uncover the faeces, and in locations with space issues holes are sometimes unintentionally dug at the same location as existing holes, meaning faeces are brought to the surface.
- Busy caregivers who have to travel some distance from their home to dispose of faeces are unlikely to have time to dig a deep hole each time a child defecates.
- The logistics of child faeces burial raise many questions, as each step in the process creates another opportunity for a human to come in contact with human faecal matter.
- Qualitative evidence (in the form of in-depth interviews about household sanitation with rural Cambodian villagers (unpublished)) reveals that in many cases, when faeces are buried by rural families in Cambodia, they are buried near the home and at such a depth that chickens and dogs around the household can easily dig them up and further spread pathogens around the household environment.
- Unless some stipulations were added specifying that faeces be buried at a certain depth, at a certain distance from homes and water sources, and covered carefully in a certain way that would legitimately form a barrier from human contact, burial cannot be classified as an improved form of faeces disposal.
- Handling of child faeces provides opportunity for faecal contamination of the caregiver's hands and there are no standard tools for use across different contexts. Child faeces have long been considered not to be harmful and caregivers' hand washing with soap in a low-income context is inadequate and rarely practised, even after a nappy change. … Given that child defecation is a random event that is hard for caregivers to follow up, loose child faeces from diarrhoea episodes can go unnoticed in child play and feeding areas.
- There is some evidence that faeces in the open might dry quicker than buried faeces and no evidence that burying is safer than open defection.
- The same standards should be held for adult and child faeces.

Arguments for:

- It provides a barrier between humans and faeces.
- The practice ensures hygienic disposal and contains faeces effectively.
- Child faeces remain under the soil do not produce odour, prevent access to flies or mosquitoes, prevent animals from scavenging, and prevent people from stepping into it and spreading it around.
- As long as burying is carried out in such a way that child faecal material is not dug up by animals, or exposed during a rainstorm, it is as good a method as using a latrine (which is just burying, after all).

- It breaks the primary links in terms of faecal/oral transmission by removing raw excreta from the immediate household/neighbourhood environment. There will remain a risk in terms of creating a hazard for groundwater/infiltration but the associated risk is much less than the alternative 'do nothing'.
- At some level this method effectively separates child faeces from human and animal contact … faeces remains invisible under the soil through this method which is less likely to attract the scavengers (chickens, dogs, foxes) by producing smell.
- Burying will reduce exposure of child faeces to other children.
- If burying is well-executed this is as good a method of faeces disposal as a pit latrine.

Other reflections on the safety of burying child faeces included the following:

Safety depends on where and how faeces are buried. Of the respondents agreeing with the statement, two noted that conditions would need to be met (depth/location of burial) and highlighted the potential burden on household surveys of ascertaining this information. This was in contrast to one respondent strongly agreeing with the statement who indicated that the depth of burial would not matter. If child faeces are to be buried this has to be far from child feeding and play areas, otherwise burying just below the soil surface might spread loose contaminated soil to areas within the reach of crawling children. In addition animal and human activity can uncover such faecal material and spread faecal pathogens and bacteria, and soil transmitted helminths.

Experts were split on the issue of whether burial should be supported as better than nothing (i.e. open defecation) or whether doing so would entail promoting malpractice. On the one hand it can be seen as a 'stopgap' measure which can mitigate some of the risks of faeces in the home environment. On the other hand this runs counter to the total sanitation movement and there is a risk that adults may consider it safe to dispose of their faeces in a similar manner. One respondent noted that considering burial as 'not safe' in global monitoring would not prevent burial being promoted in the absence of improved sanitation.

## Discussion

The main concern regarding disposal of child faeces with solid waste relates to inadequate disposal and management of solid waste, particularly in developing countries where waste may, for example, be easily accessible to children. Even more so than with the burial of child faeces, respondents generally considered this practice to be unsafe. Several respondents point to substantial differences in the handling of solid waste between developed and developing regions. One respondent noted that exposure to child faeces in developing countries may be just as likely when child faeces are disposed of in latrines or flush toilets; this is because faecal sludge may not be safely contained or treated. There are also concerns over exposure by waste pickers who are at high risk of exposure (see arguments above).

The primary concern with burial of child faeces related to the low likelihood that this would be practised in a manner that would effectively ensure no human contact with faeces. One respondent summarized the findings as follows:

> Given all the conditions that must be satisfied for effective separation (hole depth and location, elapsed time between defecation and transfer of faeces to hole, method of transfer, etc.), and the low likelihood that these would usually be complied with, burial of children's faeces cannot be considered an improved method.

What limited evidence there is from research studies in high-income countries suggests that where widely practised shallow burial of faeces may be a health hazard (Temple et al., 1980). Furthermore, in East Africa, Tumwine et al. (2002) found burial of child faeces to be associated with increased odds of diarrhoea.

More general concerns around the handling of child faeces apply equally to both methods. Caregivers may not be able to supervise children at all times; where diapers are not common and children do not directly use toilets/latrines there is a risk of missing a proportion of stools as noted by Curtis et al. (1995). The limited availability of water and soap together with inadequate handwashing practices (Freeman et al., 2014) was also highlighted by experts.

Overall, the consultation identified limited published evidence on the risks of these two forms of child faeces disposal. This was particularly the case for burial – for which anecdotal or unpublished evidence was often referred to. This in turn underlines the need for further investigation and in part justifies the approach that was taken herein (expert consultation). A few respondents highlighted a number of criteria that would need to be met for burial or disposal with garbage to be considered as safe (or improved) and these criteria could be refined. Future research should seek to establish what questions should be asked and to pilot these and build up the evidence on what are the most important aspects to monitor. Such investigations must be done bearing in mind the severe constraints on household surveys and the additional questions that may need to be added to address proposed targets for the Sustainable Development Goals (United Nations, 2014; WHO/UNICEF, 2013). Future studies could seek to determine what practices are most appropriate for different settings in order to inform programmatic as well as monitoring work. This could include a typology of settings in which disposal with garbage could be considered a safe practice.

There are several limitations to this expert consultation. The pool of experts based on contacts known to the JMP may not represent the full spectrum of opinions of those with expertise in this topic. In addition a small number of individuals were consulted (<20) and the non-response rate increased gradually as is typical of a Delphi consultation. In this survey we assessed whether the two forms of sanitation ought to be considered 'improved' or 'safe'. While a definition of 'improved sanitation' was provided, no definition was given for what constitutes 'safe'. A definition based on the concept of an acceptable threshold of risk could have been explicitly given. More generally the survey did not address other phrases which like 'improved' and 'safe' mean different things to different actors within and beyond

the sector (e.g. adequate). The limited evidence suggests that most experts made little distinction between the terms and that this did not appear to have greatly influenced the overall conclusions. In hindsight, providing multiple contexts could have been more useful than multiple definitions.

## Conclusions

A basic prerequisite to good health is to avoid human contact with faeces. In order to achieve this, everyone must use appropriate sanitation, including children. This Delphi consultation was conducted to support the JMP, household surveys, and other stakeholders in future revisions of guidance on these two forms of sanitation, to provide justification for any future classification and narratives for use in advocacy on this issue. Delphi approaches provide an opportunity to make decisions in areas where there are substantial knowledge gaps and to do so in a transparent manner with full anonymity with consequent benefits in terms of avoiding potential for biases such as confirmation bias.

We found a strong consensus between experts that neither burial nor disposal with garbage should be considered safe or improved for the purposes of global monitoring. This finding supports the classification currently used by MICS. A wide range of arguments was used to support this position and has been documented in this report. Further evidence is needed on the risks posed by different forms of child faeces disposal and studies are needed to establish means of addressing the gaps in our understanding of predominant practices. In the meantime, advocacy on this issue can focus on highlighting the risks posed by child faeces in order to tackle any perception that they are unpleasant but harmless.

The consultation highlighted gaps in the current evidence base that should be addressed to gain a fuller insight into the risks involved in these two forms of sanitation with a view to providing both programmatic and normative guidance. In particular further work is needed to assess the potential for exposure to faecal matter in solid waste in low- and middle-income countries and to elucidate the predominant practices of child faeces burial including proximity to the home or infant play areas as well as depth of burial.

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## References

Baltazar, J.C. and Solon, F.S. (1989) 'Disposal of faeces of children under two years old and diarrhoea incidence: a case-control study', *International Journal of Epidemiology* 18(4 Suppl 2): S16–19 <http://dx.doi.org/10.1093/ije/18.Supplement_2.S16>.

Curtis, V., Kanki, B., Mertens, T., Traoré, E., Diallo, I., Tall, F. and Cousens, S. (1995) 'Potties, pits and pipes: explaining hygiene behaviour in Burkina Faso', *Social Science & Medicine* 41(3): 383–93 <http://doi.org/10.1016/0277-9536(94)00341-P>.

Fischer Walker, C.L., Perin, J., Aryee, M.J., Boschi-Pinto, C. and Black, R.E. (2012) 'Diarrhea incidence in low- and middle-income countries in 1990 and 2010: a systematic review', *BMC Public Health* 12: 220 <http://dx.doi.org/10.1186/1471-2458-12-220>.

Freeman, M.C., Stocks, M.E., Cumming, O., Jeandron, A., Higgins, J.P., Wolf, J., Pruss-Ustun, A., Bonjour, S., Hunter, P.R., Fewtrell, L. and Curtis, V. (2014) 'Hygiene and health: systematic review of handwashing practices worldwide and update of health effects', *Tropical Medicine & International Health* 19(8): 906–16 <http://dx.doi.org/10.1111/tmi.12339>.

Gil, A., Lanata, C., Kleinau, E. and Penny, M. (2004) *Children's Feces Disposal Practices in Developing Countries and Interventions to Prevent Diarrheal Diseases: A Literature Review*, Environmental Health Project of USAID Strategic Report 11: 1–67.

Isely, R.B. (1984) 'Focusing sanitation programmes on mothers and older siblings of small children', *Tropical Doctor* 14: 136–9 <http://dx.doi.org/10.1177/004947558401400313>.

Korpe, P.S. and Petri, W.A. (2012) 'Environmental enteropathy: critical implications of a poorly understood condition', *Trends in Molecular Medicine* 18(6): 328–36 <http://dx.doi.org/10.1016/j.molmed.2012.04.007>.

Lanata, C.F., Huttly, S.R.A. and Yeager, B.A.C. (1998) 'Diarrhea: whose feces matter? Reflections from studies in a Peruvian shanty town', *Pediatric Infectious Disease Journal* 17(1): 7–9 <http://dx.doi.org/10.1097/00006454-199801000-00003>.

Linstone, H.A. and Turoff, M. (1975) *The Delphi method: Techniques and applications*, Reading, MA: Addison-Wesley.

Majorin, F., Freeman, M.C., Barnard, S., Routray, P., Boisson, S. and Clasen, T. (2014) 'Child feces disposal practices in rural Orissa: a cross sectional study', *PLOS One* 9(2): e89551 <http://doi.org/10.1371/journal.pone.0089551>.

Ngure, F.M., Humphrey, J.H., Mbuya, M.N., Majo, F., Mutasa, K., Govha, M., Mazarura, E., Chasekwa, B., Prendergast, A.J., Curtis, V., Boor, K.J. and Stoltzfus, R.J. (2013) 'Formative research on hygiene behaviors and geophagy among infants and young children and implications of exposure to fecal bacteria', *American Journal of Tropical Medicine and Health* 89(4): 709–16 <http://dx.doi.org/10.4269/ajtmh.12-0568>.

Pruss-Ustun, A., Bartram, J., Clasen, T., Colford, J.M., Cumming, O., Curtis, V., Bonjour, S., Dangour, A.D., De France, J., Fewtrell, L., Freeman, M.C., Gordon, B., Hunter, P.R., Johnston, R.B., Mathers, C., Mausezahl, D., Medlicott, K., Neira, M., Stocks, M., Wolf, J. and Cairncross, S. (2014) 'Burden of disease from inadequate water, sanitation and hygiene in low- and middle-income settings: a retrospective analysis of data from 145 countries', *Tropical Medicine & International Health* 19(8): 894–905 <http://dx.doi.org/10.1111/tmi.12329>.

Roy, E., Hasan, K.Z., Haque, R., Fazlul Haque, A.K.M., Siddique, A.K. and Bradley Sack, R. (2011) 'Patterns and risk factors for helminthiasis in rural children aged under 2 in Bangladesh', *SA Journal of Child Health* 5: 78–84.

Temple, K.L., Camper, A.K. and McFeters, G.A. (1980) 'Survival of two enterobacteria in feces buried in soil under field conditions', *Applied and Environmental Microbiology* 40(4): 794–7.

Traoré, E., Cousens, S., Curtis, V., Mertens, T., Tall, F., Traoré, A., Kanki, B., Diallo, I., Rochereau, A. and Chiron, J.P. (1994) 'Child defecation behavior, stool disposal practices, and childhood diarrhoea in Burkina Faso: results from a case-control study', *Journal of Epidemiology and Community Health* 48(3): 270–5.

Tumwine, J.K., Thompson, J., Katua-Katua, M., Mujwajuzi, M., Johnstone, N. and Porras, I. (2002) 'Diarrhoea and effects of different water sources, sanitation and hygiene behaviour in East Africa', *Tropical Medicine & International Health* 7(9): 750–6 <http://dx.doi.org/10.1046/j.1365-3156.2002.00927.x>.

United Nations (2014) *The Road to Dignity by 2030: Ending Poverty, Transforming All Lives and Protecting the Planet* [pdf] Synthesis Report of the Secretary-General on the Post-2015 Agenda <www.un.org/disabilities/documents/reports/SG_Synthesis_Report_Road_to_Dignity_by_2030.pdf> [accessed 1 March 2015].

Water and Sanitation Program/UNICEF (2015) 'Ensuring safe sanitation for children', child faeces disposal profiles for 26 countries [online] <www.wsp.org/content/ensuring-safe-sanitation-children-0> [accessed 1 March 2015].

WHO/UNICEF (2006) *Core Questions on Drinking-water and Sanitation for Household Surveys* [pdf] <www.wssinfo.org/fileadmin/user_upload/resources/1268174016-JMP_Core_Questions.pdf> [accessed 1 March 2015].

WHO/UNICEF (2013) *Post-2015 WASH Indicators and Targets* [pdf] <www.unicef.org/wash/files/4_WSSCC_JMP_Fact_Sheets_4_UK_LoRes.pdf> [accessed 1 March 2015].

WHO/UNICEF (2014) *Progress on Drinking-water and Sanitation: 2014 Update* [pdf] <www.wssinfo.org/fileadmin/user_upload/resources/JMP_report_2014_webEng.pdf> [accessed 1 March 2015].