Strategic Report 11

Children's Feces Disposal Practices in Developing Countries and Interventions to Prevent Diarrheal Diseases

A Literature Review

Ana Gil, Claudio Lanata, Eckhard Kleinau, Mary Penny

Instituto de Investigacion Nutricional (Peru)

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About the Authors

Ana I. Gil, BSc, MSc, has been a researcher at the Instituto de Investigacion Nutricional (IIN) in Lima, Peru, since 1982. She has been in charge of microbiology in several epidemiologic studies on diarrheal diseases, including vaccine trials, conducted in poor peri-urban areas of Lima and other regions in Peru. These studies also included hygiene interventions at the community level. Currently Ms. Gil is a senior researcher at the IIN, and her current research interests include epidemiology of infectious diseases, environmental microbiology, food and water quality control, and the ecology of V. cholerae and related organisms in the environment and their association to human infectious diseases.

Claudio F. Lanata, M.D., M.P.H., is a Senior Researcher at the Instituto de Investigacion Nutricional (IIN) in Lima, Peru, which he joined in 1983, after returning from his post-graduate training on medicine, infectious diseases and public health (epidemiology) in the United States. He has conducted research in child health and nutrition, mainly in diarrheal and respiratory diseases, micronutrients and vaccine development. More recently, he has been involved in a large quality assurance program that was able to improve the quality of maternal and perinatal health care in selected areas of Peru. Dr. Lanata is also responsible for following a cohort of 2000 children and their families representing Peru that will be followed for 16 years to study the relationship among poverty, health, education and policy issues. His work has resulted in one book, 17 book chapters, and more than 70 journal publications (the majority of which were published in international journals). He is an advisor to PAHO, WHO and other international organizations.

Eckhard F. Kleinau, M.D., Dr.P.H., has 20 years experience as a manager and consultant in public health and primary care programs in the United States, Europe, Africa, Latin and Central America. and Asia. Presently, he is Senior Technical Director at the Environmental Health Project (EHP) for JSI in Arlington, Va., and is responsible for the development and implementation of appropriate methods and standards to evaluate environmental health programs, including systems that provide information for strategic planning and management. In addition, Mr. Kleinau has specific expertise in economic analysis, health care financing, modeling and forecasting, quality assurance and quality management.

Mary E. Penny, B.A., M.B.Ch.B., M.R.C.P., worked for seven years in general medicine and pediatrics in National Health Services hospitals in the UK before relocating to Lima, Peru, in 1984, first as a Welcome Trust Clinical Lecturer in Infectious Diseases, and subsequently as a researcher. Since 1999, Ms. Penny has been General Director of the Instituto de Investigación Nutricional. Her main research experience is in clinical and community trials of different interventions to improve health and nutrition. Currently she is involved in vaccine clinical trials, a nutrition education intervention through health services, nutritional interventions to treat and/or prevent diarrhea, fortification and supplementation as strategies to combat zinc deficiency and an international multicenter longitudinal cohort study of 2000 children to investigate aspects of poverty in a child's life.

Executive Summary

Diarrheal diseases continue to be an important public health problem in developing countries, with high morbidity and still significant levels of mortality among children. Since the 1980s, where diarrheal disease control programs were implemented around the world, diarrheal mortality in children under five years of age has been reduced significantly through appropriate case management. However, diarrhea incidence has not changed despite documented progress in water availability and improved sanitation. Therefore, there is a need to better understand the conditions that facilitate diarrhea transmission in less developed countries and to identify and implement more and better interventions designed to interrupt transmission and to decrease the burden of diarrheal diseases.

The promotion of essential hygiene behaviors has been identified as an intervention that could have considerable impact in the reduction of diarrheal diseases in young children in developing countries. Among these behaviors, the sanitary disposal of human feces, particularly those of children, has been less studied. Little is known about current practices, their determinants, and the feasibility to change them. After a systematic search of the literature of studies published between 1986 and 2002, this report reviews the current state of knowledge of children's excretal practices in developing countries, the methodology used to assess it, and the epidemiological evidence that associates some of these practices with diarrheal diseases. The review aims to identify interventions that could improve the sanitary disposal of feces at the household level and interventions that have a high potential of reducing diarrheal diseases in children in developing countries.

Thirty-seven publications covering 33 studies conducted in 16 countries were selected for this review. Few studies have been done describing the excretal disposal practices of young children at the household level and very few have investigated the relationship of those practices with diarrhea. The most common method used to evaluate hygiene behaviors has been questionnaire surveys, but dissatisfaction with the reliability of the information they provide has led to the use of alternative approaches like structured observations. Qualitative methods were very important complements to data collected through observations and questionnaires. The articles reviewed suggested that using a variety of methods offers a better understanding of these human behaviors, potentially leading to better designed community participatory hygiene promotions programs.

Diaper use, primarily in Latin America, is the most prevalent defecation site for infants, decreasing drastically with age. Potties are the next most frequently used defecation sites for toddlers, used much more frequently (75% at 20 months of age) in Africa (most studies were from Burkina Faso) than in Latin America (reaching a 20% peak at 30 months of age). Defecation into the soil, either at the household level or in open fields or bushes, became the predominant defecation site for older children, reaching a prevalence rate of >60% in children by 40 months of age. Latrines were seldom used by children, reaching a peak 25% utilization rate by 50 months of age, mostly in Latin America. Latrine use was considered risky for small children by their caregivers. Studies also described the final destination of these feces, although in a third of all defecations that were reported, the feces were left where they were deposited and were not being removed during the observation period. Waste water

from washing soiled diapers frequently contaminates the household soil, although very few studies described this practice. Between 40% and 80% of the feces left in the household soil were either removed or wiped away. In Latin America, dogs were observed eating human feces left on the ground or in uncovered potties. Latrines and toilets were frequently used as a final deposition site for feces, mostly for those deposited in potties. Caregivers were observed washing their children's hands after defecation with a higher frequency in infants (>70%), decreasing when they were toddlers (25%) to peak again at 75% by 40 months of age. Rarely was this done with soap, an agent considered not appropriate for children in some cultures. The child's bottom was cleaned according to nearly all the studies, mostly with water or with the corner of the diaper. Again, soap was rarely used. Mothers' handwashing was observed or reported in <50% of children's defecation events, again mostly using just water. We classified studies linking defecation practices or their hygiene-related behaviors with diarrheal diseases either as protective (use of latrines, nappies, potties, toilets, washing diapers) or risky (open defecation, open stool disposal, stools not removed from soil or observed on the ground, child seen eating feces). In a meta-analysis, risky behaviors were associated with a significant increased risk for diarrheal diseases (risk ratio 1.23, 95% CI: 1.15-1.32) while those classified as protective had borderline protection (risk ratio 0.93, 95% CI: 0.86-1.00).

In households with poor sanitation, a high level of exposure of family members to human (and animal) feces exists. Toddlers' feces disposal in open fields has been highlighted as probably the most important contaminant in the household environment with the highest risk of exposure to young infants. The prevention of open defecation or direct contamination with children's feces was identified as an important area to focus attention, where the use of diapers or similar devices for young infants (including appropriate techniques to dispose/wash them) and the promotion of potties for toddlers were the most promising interventions to be developed and evaluated. The immediate removal of feces from the household environment and its disposal in more appropriate places (either being buried or disposed in latrines) was another area identified that deserves further evaluation. Hand contamination with fecal material, particularly of mothers and children, seems to be high in poor households. Handwashing, particularly with soap or other agents, is the most important intervention to be promoted to reduce fecal contamination, with proven efficacy in reducing diarrheal diseases. However, several barriers exist that limit handwashing, primarily because of misperceptions of what is dirty and what is not. This review has identified the urgency of further research in this area and in the appropriate development, evaluation and promotion of interventions that could reduce diarrheal diseases by elimination of fecal contamination in households in developing countries.

This report was reviewed by Christopher McGahey and May Post, and the activity was managed by John Gavin

1. Introduction

Diarrheal diseases continue to be responsible for childhood mortality and morbidity, primarily in developing countries. Although in the last several decades a significant reduction on deaths from diarrheal diseases has been observed, from 13.6 diarrhea deaths per 1,000 children under five years of age reported in studies published between 1955-1979[1] to 4.9 per 1,000 in studies published between 1990-2000[2], the median incidence rate of diarrhea in the same group of children under five years of age was unchanged, from 3.0 episodes per child per year in the Snyder review[3] from the 1980sto 3.2 episodes per child per year in the Kosek review[4] of the 2000s. The promotion and use of oral rehydration solutions and appropriate case management of diarrheal cases, combined with improved access to health services, most likely explain the reduction in diarrhea-specific mortality. However, what is also noteworthy has been the stability of incidence rates, despite improvements in education, immunization coverage and access to water and sanitation during the intervening years. The reasons for this lack of noticeable change may be explained by the fact that most diarrheal control efforts have been concentrated on appropriate case management rather than on prevention.

Between 1980 and 1990, during the "International Drinking-Water Supply and Sanitation Decade" of the United Nations General Assembly, access to excreta disposal systems increased by an estimated 8% throughout the world[5]. This brought the total sanitation coverage for the world population from 16% to 24%, an increase mainly associated with the use of latrines. However, there is still much to do. By the year 2000, it had been estimated that 2.4 billion people in the world did not have access to improved sanitation and 1.1 billion did not have access to improved water supply. The United Nations Millennium Summit adopted a target to halve the proportion of people who are unable to afford safe drinking water by the year 2015. These programs were supported by the results of earlier reviews done by Feachem[6] on the impact of excreta disposal practices on diarrheal diseases and the review of Esrey & Habicht[7] on the effectiveness of water supply and sanitation programs on diarrheal diseases, predicting between 20% to 30% reductions in incidence and mortality due to diarrheal diseases by these programs. It is still too early to determine how many lives have been saved and diarrhea cases prevented as a result of these interventions, in part

[1] F. Ahmed, J. D. Clemens, M. R. Rao, and A. K. Banik. Family latrines and pediatric shigellosis in rural Bangladesh: benefit or risk? *Int.J.Epidemiol.* 23 (4):856-862, 1994.

[2] Ibid.

[3] Ibid.

[4] Ibid.

[5] B.A. Yeager, S.R Huttly, J. Diaz, R. Bartolini, M. Marin and C.F. Lanata. An intervention for the promotion of hygienic faeces disposal behaviours in a shanty town of Lima, Peru. *Health Education Research* 17 (6):761-773, 2002

[6] T. E. Mertens, S. Jaffar, M. A. Fernando, S. N. Cousens, and R. G. Feachem. Excreta disposal behaviour and latrine ownership in relation to the risk of childhood diarrhoea in Sri Lanka. *Int.J.Epidemiol.* 21 (6):1157-1164, 1992.

[7] F. Ahmed, J. D. Clemens, M. R. Rao, and A. K. Banik. Family latrines and pediatric shigellosis in rural Bangladesh: benefit or risk? *Int.J.Epidemiol.* 23 (4):856-862, 1994.

because they benefit more affluent or urban areas and still cover only relatively small numbers among higher-risk populations in developing countries.

The promotion of hygienic behaviors has been identified as a public health intervention likely to have considerable impact in the reduction of diarrheal diseases in young children in developing countries[8]. Although the sanitary disposal of human feces has been identified by the World Health Organization as one of the three key water-related behaviors for promotion, surprisingly little is known about disposal practices, their determinants, feasibility for change as well as the health impact of related interventions[9]. While there is clearly a need to develop appropriate interventions to promote appropriate feces disposal for children in developing countries, the aim of this literature review is to document the current state of both epidemiological knowledge and programmatic experience regarding disposal of children excreta in developing countries. This documentation will serve as an initial step toward identifying potential interventions to be developed and evaluated in future research studies with the hope that they could be implemented in developing countries to prevent diarrheal diseases. In the following sections, we will describe the conceptual framework used to identify the areas to be reviewed, the methods used for this review, the methodology used in the literature to study the selected hygiene behaviors and interventions, the findings of this review, concluding with recommendations on areas that require further research and potential interventions that could be further developed and tested.

[8] J.D. McLennan. Prevention of diarrhoea in a poor District of Santo Domingo, Dominican Republic: practices, knowledge, and barriers. *Trop Med Int Health;* 5(1): 22-32,2000

[9] F. Ahmed, J. D. Clemens, M. R. Rao, and A. K. Banik. Family latrines and pediatric shigellosis in rural Bangladesh: benefit or risk? *Int.J.Epidemiol.* 23 (4):856-862, 1994.

2. Conceptual framework

Before conducting this review, it was important to develop a conceptual framework to help us identify areas to be reviewed in the literature, to interpret the results of the review, as well as to define concepts that have oriented our review, even if they are not yet sustained in evidence found in the literature.

Most diarrheal diseases are a consequence of an oral exposure to an enteropathogen emanating from feces eliminated by an infected individual in a susceptible host. The notable exception to this rule is rotavirus, and probably other enteric viruses, that could be transmitted by contact with other bodily fluids or by air droplets. The fecal-oral route of diarrheal disease transmission has been widely described. The most frequently used model was first noted by Wagner & Lanoix in 1958[10] (Figure 1). Enteropathogens from contaminated feces (mostly from humans, but in the case of some enteropathogens, also some animals) will be transmitted to a new susceptible host through contaminated water, fingers, soil and flies, either directly or by contaminating food that is ingested. The relative importance of each of these routes of transmission has not yet been measured or fully understood, although several of these routes are thought to be operating at the same time.

As is evident from this model, the first approach to interrupt transmission of enteropathogens is to eliminate feces in some way, by avoiding the contaminated water, soil or flies. Sanitation programs have been designed to accomplish this, although in most developing countries installed sewage systems are not treating collected feces, which are then left, mostly unaffected by the system, to flow into rivers or coastal waters. Therefore, despite this important investment in infrastructure, fecal material is still contaminating water in developing countries, in turn contaminating food (mostly through irrigation, although several other mechanisms exist that have been reviewed elsewhere)[11], and humans (through drinking and/or bathing). Water programs have been designed to assure safe drinking water to served populations, even if originally contaminated at its source. Handwashing is another type of second-line intervention designed to interrupt transmission from contaminated hands into food, water or directly into the mouth of the susceptible host.

For diarrheal diseases to be controlled, one needs an efficient sanitation system with universal access, where fecal material is treated before sewage waters are released into the environment, and where an effective water system also delivers large quantities of safe water to the population, Also required is a population who can afford to maintain high standards of positive hygiene behaviors such as handwashing. Developed countries have such systems and enjoy a very low incidence of diarrheal diseases as a result. Where diarrheal diseases exist in these countries, they result primarily from rotavirus and other viral entities that cannot be controlled through

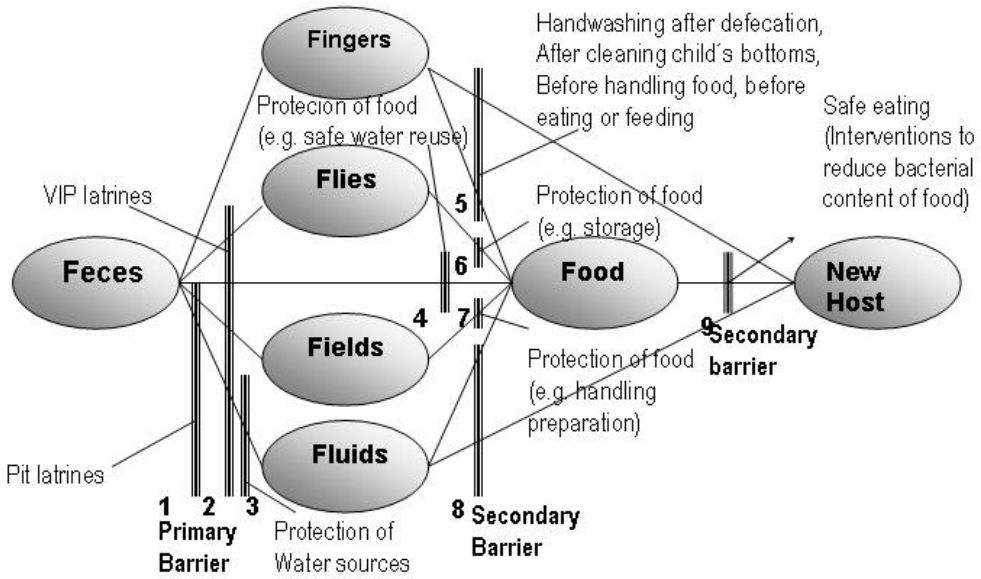
[10] F. Ahmed, J. D. Clemens, M. R. Rao, and A. K. Banik. Family latrines and pediatric shigellosis in rural Bangladesh: benefit or risk? *Int.J.Epidemiol.* 23 (4):856-862, 1994.

[11] B. K. Sircar, P. G. Sengupta, S. K. Mondal, D. N. Gupta, N. C. Saha, S. Ghosh, B. C. Deb, and S. C. Pal. Effect of handwashing on the incidence of diarrhoea in a Calcutta slum. *J.Diarrhoeal Dis.Res.* 5 (2):112-114, 1987.; Ibid.

these programs. However, that reality — of a low incidence of diarrheal diseases resulting from proper sanitation and hygiene — is still out of reach for most people living in developing countries.

In this review, we want to document the practices currently used in poor households in developing countries to handle children's feces, the evidence that such practices are associated with diarrheal diseases and the mechanisms (interventions) that could be further promoted to reduce these transmission pathways. We have selected children's feces, rather than all human feces, because it has been previously recognized that children's feces are indeed more infective and less likely to be safely disposed[12]. We will also concentrate our review on households (rather than the whole community), to help us identify interventions that could be developed at that level. We will not review mechanisms that allow water to be contaminated at the household level and the remedies for this, nor the role of flies and fly-control programs in the transmission of diarrheal diseases. Also, we will not review the role of contaminated food and what can be done to avoid its contamination and ingestion by susceptible hosts.

Figure 1 **Faeco-Oral Routes of Disease Transmission** *



*Adapted from A. Almedon et. al. *Hygiene Evaluation Procedures. Approaches and Methods for assessing Water and Sanitation Related Hygiene Practices.* Intermediate Technology Publications, London, 1997

[12] Ibid. A.A. Mahfouz, H. El-Morshedy, A. Farghaly and A Khalil. Ecological determinants of intestinal parasitic infections among pre-school children in an urban squatter settlement of Egypt. *J Trp Pediatr;*43(6): 341-344, 1997

3. Methods

Search strategy

Studies included in this review were first identified by a computerized search of published articles from 1986 to 2002 related to hygiene behaviors for the disposal of feces in children worldwide. Languages included in the search were English, Spanish, Italian and French. However, no non-English-language studies were located. Medline, Cochrane Library, Bireme and Popline computerized databases were searched using the following keywords: faeces, feces, stools, water, sewage, defecation, excreta, latrines, disposal, toilet, potties, nappies, wipes, diapers, sanitation, hygiene, hand washing, behavior, behaviour, infants and toddlers. With many of these terms, combinations of them were used to select a more specific list of references to review. The abstracts of the initial list of identified references were then reviewed to identify a list of articles for further review. Copies of identified articles were obtained from libraries in Lima and from the Welch Library of the Johns Hopkins University in Baltimore, as well as from the authors' personal collections. References cited in the articles identified that were not located in the computer search, were also sought. Other unpublished papers were obtained directly from some authors.

Review strategy

Articles were selected for review if they dealt with the following:

Inclusion Criteria

- Epidemiological, observational or intervention studies describing children's fecal disposal practices and/or its relation to diarrheal diseases at the household level
- Studies of certain behaviors, including handwashing after defecation or after cleaning a child's bottom, as well as on the use of tools like diapers or potties at the household level to handle children's feces
- Studies of methods used to assess fecal disposal practices and related behaviors at the household level
- Review of studies on children's fecal disposal practices in developing countries
- Studies done in developing countries — defined as countries located in Africa, Latin America, Caribbean region, South Pacific and Asia region, excluding the USSR, Japan, Taiwan, Australia, Korea, Singapore and Hong Kong
- Studies published between 1986 and 2002

Exclusion criteria

- Studies done in developed countries

- Studies done exclusively in hospitals, schools and day-care centers
- Cost benefit studies not reporting original data
- Papers reporting logistical and operational aspects of water and sanitation programs or hardware
- Publications without an abstract available in the search packages

To describe the quality of the articles selected, the following criteria for data available on each paper was used:

- Sample size of the study considered adequate for the objective of the study.
- Article has descriptive data on prevalence of practices studied.
- Conclusions are adequately supported with data presented.
- The study measured the correlation of excreta disposal practices with diarrhea.
- Data included adequate statistical inferences (confidence intervals, p values, odd ratios, etc.).
- Explicit theories on defecation practices or methods are included.

Statistical analysis

Some articles provided data for more than one observation, more than one age group, and/or repeat observations over time. Each reported prevalence was considered independently. For data analysis, we took the mid-age range as the age of each reported prevalence. If data were available in the articles but not reported, we calculated odd ratios and its 95% confidence limits (CI) of particular behaviors as they relate to diarrhea incidence or prevalence, using the Epi Info software package. Data on proportions and risk ratios were entered into a statistical package (STATA version 8.2, 2003; Stata Corporation, Texas, USA). Two way scatter plots were generated combined with quadratic prediction plots with 95% confidence intervals using STATA. Regression analysis was done on selected variables. Data on odd ratios or risk ratios were combined using the meta analysis macro options downloaded from www.stata.com that presented results in a stem and leaf graphics with a summary measure indicating the relative weight of each study by the size of the square or diamond used to show its mean value, as well as its 95% CI.

4. Results

More than 10,000 articles were initially identified by the search packages when using some of the keywords. Some keywords, like potties, potty, nappies, wipes, diapers generated under 1,000 articles. When available, all abstracts were reviewed. Combinations of the other keywords where then used to generate a listing of articles more specific to the study area and in order to review their abstracts. From the initial electronic review of articles identified in the search, as well as through the review of initially identified article references, 144 articles were selected for review of print copies. From these, 107 were located, and printed copies were obtained. Contact with some authors in this field did not yield any additional articles. Of these, only 37 articles met the inclusion criteria and did not have any exclusion criteria and were therefore selected for this review. Those articles are listed in the table of Annex 1. The articles represented 33 studies (four studies have more than one published article associated with them) done in 16 countries. The quality and characteristics of the articles reviewed is presented in Table 1. In about 80% of the articles, the sample size was considered adequate and the conclusions reached were adequately supported by the data presented. About half of the articles contained data on prevalence of defecation practices of children, with some containing more than one type of observation or more than one observation completed at different times or with different populations.

Table 1. Characteristics of articles reviewed

Criteria	N (n=37)	%
Sample size of the study consider adequate for the objective of the study	30	81
Article has descriptive data on prevalence of practices studied	20	54
Conclusions in the article are adequately supported with data presented	31	84
The study measured the correlation of studied practices with diarrhea	13	35
Data includes adequate statistical inferences	22	59
Explicit theories on defecation practices or methods included	8	22

In the following sections, we will present the findings of these articles, beginning with a section on methods used to measure hygiene practices. We will then present the results by type of excretal disposal practices as described in the literature.

Studies on methodological issues

Methods used to measure hygiene behaviors in general, and defecation practices in particular, are quite important. Depending on the method used, results could be over

or under estimated. Several combinations of methods and tools have been used to investigate and analyze hygiene behaviors.

From the 33 studies reviewed in the 37 selected articles, the most commonly used method was questionnaires on hygiene behaviors (61%), followed by spot observations (45%), and structured observations over a time period (30%) (Table 2). Less common were studies using qualitative methods, such as in-depth interviews or focus groups.

Table 2. Methods used to study excretal practices in children

Method	N (n=33)	%
Questionnaire	20	61
Spot observations	15	45
Structured observations	10	30
Focus groups	6	18
In-depth interviews	4	12

We will briefly describe each method, and the results of those studies that evaluated their values and limitations. Since this is not a methodological review paper, our description is limited to methods used in the studies selected.

Survey questionnaires

Questionnaire surveys were used in 20 of the selected papers[13]. They were the most frequently used method primarily because of its simplicity and low cost to apply, allowing it to be applied to larger groups of individuals. A frequently used term for the type of questionnaire used in hygiene studies is a Knowledge, Attitudes, and Practice (KAP) survey. However, these surveys are considered inadequate for providing reliable information on excretal disposal practices, since most adults will tend to report the expected behavior of their children, seldom reporting wrong behaviors, as discussed later. It is for this reason that very few selected articles were based solely on information derived from questionnaire surveys.

Participatory observations

Participatory observations are increasingly used in health research. There were two types of participatory observations used in the studies selected: observations made at

[13] F. Ahmed, J. D. Clemens, M. R. Rao, and A. K. Banik. Family latrines and pediatric shigellosis in rural Bangladesh: benefit or risk? *Int.J.Epidemiol.* 23 (4):856-862, 1994; N. Alam. Predictors of diarrhea in young Bangladeshi children. *J.Trop.Pediatr.* 41 (5):278-280, 1995; A. M. Almedom. Recent developments in hygiene behaviour research: an emphasis on methods and meaning. *Trop.Med.Int.Health* 1 (2):171-182, 1996; J. C. Baltazar and F. S. Solon. Disposal of faeces of children under two years old and diarrhoea incidence: a case-control study. *Int.J.Epidemiol.* 18 (4 Suppl 2):S16-S19, 1989; V. Curtis, B. Kanki, S. Cousens, A. Sanou, I. Diallo, and T. Mertens. Dirt and diarrhoea: formative research in hygiene promotion programmes. *Health Policy Plan.* 12 (2):122-131, 1997; V. Curtis, B. Kanki, S. Cousens, I. Diallo, A. Kpozehouen, M. Sangare, and M. Nikiema. Evidence of behaviour change following a hygiene promotion programme in Burkina Faso. *Bull.World Health Organ* 79 (6):518-527, 2001; V. Curtis, B. Kanki, T. Mertens, E. Traore, I. Diallo, F. Tall, and S. Cousens. Potties, pits and pipes: explaining hygiene behaviour in Burkina Faso. *Soc.Sci.Med.* 41 (3):383-393, 1995; K. Molbak, H. Jensen, L. Ingholt, and P. Aaby. Risk factors for diarrheal disease incidence in early childhood: a community cohort study from Guinea-Bissau. *Am.J.Epidemiol.* 146 (3):273-282, 1997; E. Sorensen, M. Ismail, D. K. Amarasinghe, I. Hettiarachchi, and T. S. Dassenaieke. The effect of the availability of latrines on soil-transmitted nematode infections in the plantation sector in Sri Lanka. *Am.J.Trop.Med.Hyg.* 51 (1):36-39, 1994.

the moment the observer is visiting the household, called spot observations, and observations made by the observer on a selected set of variables over a fixed period of time in the household, called structured observations. Both observations record the observed data on a structured form. There were 15 selected studies that used spot observations[14]. Ten studies used structured observations[15]. Spot observations were usually done to classify the hygiene status of the household and to document the presence of free feces on the ground or latrine area. Structured observations, in addition, also recorded the frequency and type of hygiene behaviors like defecation, handwashing, feces disposals, etc., observed during a specific time period. Because of the time required, structured observations are more cumbersome, expensive, and require greater training needs for the observers. Therefore they are usually done with a smaller sample than spot observations.

Observation versus reporting

To highlight the methodological difficulties with the methods described above, we have reviewed and compared the few papers that have attempted to validate their results on excretal disposal practices of children in developing countries.

The methodological problems are concentrated in two areas: the validity of the method of measurement and the variability of the behavior that is being studied. Problems of validity arise when data generated by these methods do not reflect accurately the actual behavior that was studied, a problem particularly when the behavior being investigated is socially sensitive[16]. Problems with variability exist when the subjects under study do not always use the same behavior for the practice being investigated. Where an individual's behaviors are constant (repeatable), it is possible to asses it with a single measurement. If, on the other hand, his/her behavior is not constant, more than one measurement may be required to obtain a truly valid estimate. In addition, individuals in a particular society may have different behaviors associated with one hygiene practice, making even more difficult the selection of methods and sample size to describe the prevalence of those behaviors in the community studied.[17]

Questionnaire data commonly have a problem with validity[18] while participatory observations have a problem with variability. Questionnaires that attempt to recall a

[14] F. Ahmed, J. D. Clemens, M. R. Rao, and A. K. Banik. Family latrines and pediatric shigellosis in rural Bangladesh: benefit or risk? *Int.J.Epidemiol.* 23 (4):856-862, 1994; J. C. Baltazar and F. S. Solon. Disposal of faeces of children under two years old and diarrhoea incidence: a case-control study. *Int.J.Epidemiol.* 18 (4 Suppl 2):S16-S19, 1989; V. Curtis, B. Kanki, S. Cousens, A. Sanou, I. Diallo, and T. Mertens. Dirt and diarrhoea: formative research in hygiene promotion programmes. *Health Policy Plan.* 12 (2):122-131, 1997; S. A. Esrey and J. P. Habicht. Maternal literacy modifies the effect of toilets and piped water on infant survival in Malaysia. *Am.J.Epidemiol.* 127 (5):1079-1087, 1988; K. Molbak, H. Jensen, L. Ingholt, and P. Aaby. Risk factors for diarrheal disease incidence in early childhood: a community cohort study from Guinea-Bissau. *Am.J.Epidemiol.* 146 (3):273-282, 199; E. Sorensen, M. Ismail, D. K. Amarasinghe, I. Hettiarachchi, and T. S. Dassenaieke. The effect of the availability of latrines on soil-transmitted nematode infections in the plantation sector in Sri Lanka. *Am.J.Trop.Med.Hyg.* 51 (1):36-39, 1994.

[15] F. Ahmed, J. D. Clemens, M. R. Rao, and A. K. Banik. Family latrines and pediatric shigellosis in rural Bangladesh: benefit or risk? *Int.J.Epidemiol.* 23 (4):856-862, 1994; N. Alam. Predictors of diarrhea in young Bangladeshi children. *J.Trop.Pediatr.* 41 (5):278-280, 1995; J. C. Baltazar and F. S. Solon. Disposal of faeces of children under two years old and diarrhoea incidence: a case-control study. *Int.J.Epidemiol.* 18 (4 Suppl 2):S16-S19, 1989; B. A. Hoque, D. Mahalanabis, M.J. Alan and M.S. Islam. Post-defecation Handwashing in Bangladesh: practice and efficiency perspectives. *Pub Health;* 109(1):15-24, 1995; S. R. Huttly, C. F. Lanata, H. Gonzales, I. Aguilar, M. Fukumoto, H. Verastegui, and R. E. Black. Observations on handwashing and defecation practices in a shanty town of Lima, Peru. *J.Diarrhoeal Dis.Res.* 12 (1):14-18, 1994.

[16] F. Ahmed, J. D. Clemens, M. R. Rao, and A. K. Banik. Family latrines and pediatric shigellosis in rural Bangladesh: benefit or risk? *Int.J.Epidemiol.* 23 (4):856-862, 1994.

[17] Ibid.

[18] Ibid.

behavior are fraught with recall biases that worsen as the recall period is extended. Significant disagreements between questionnaires and participatory observations usually arise because desirable practices are frequently over-reported in questionnaires. Mothers may answer a question influenced by the image they wish to present to the interviewer. When observed, behavior may be altered by the presence of the observer. For example, a phenomenon called reactivity[19] may occur, when a subject feels discomfort when being observed because the observation is intrusive. Or the behavior may be modified by the Hawthorn effect (i.e., the effect on the person being studied, usually a positive or beneficial one, precisely because they are being studied)[20]. This may affect some types of behaviors more than others. The inter-observer variation is also an important issue to be considered. In that case, a single behavior may be interpreted differently by two different observers. Differences between observers could also arise because of social, economic and cultural variations that may exist between different areas of the town studied[21]. The problem with the observation of defecation practices is that they are hard to observe, particularly in older children and adults, and defecation may be done only once per day and may not occur at all during the observation period, if that period extends for only a few hours. The appropriate selection of the time of the day and the number of hours to be observed are critical for the study of defecation practices.

The degree of concordance of responses or repeat observations can be evaluated by the Kappa score[22], which provides a measure of observer agreement by taking into consideration the extent of agreement that could be expected by chance alone[23]. Kappa scores less than zero indicate agreements worse than chance; those equal to zero indicate agreements that are no better than chance; scores between 0.01-0.39 reflect poor agreement; scores between 0.4-0.75, good agreement; and between 0.76-1.0, excellent agreement.

A study conducted in Burkina Faso[24] with children aged <36 months found poor agreement among 2,775 questionnaire responses applied to mothers and 548 structured observations of child defecation practices and stool disposal practices (observations were only done during a three-hour period in the early morning). A tendency to over-report was found in those practices perceived as "good," e.g., the child used a potty (75% reported vs. 66% observed), or feces from used potties were disposed in a latrine (67% reported vs. 56% observed). There was poor agreement between the reported and observed locations where the child usually defecated in the 277 children that defecated during the observation period (kappa = 0.25, CI: 0.14, 0.35) as well as where the mother reported usually disposing the child's stool (kappa =0.38, CI: 0.27, 0.48). Repeated observations of the location of the child's defecation and stool disposal behaviors showed better agreement (Kappa= 0.76, CI: 0.48, 1.05

[19] S. R. Huttly, C. F. Lanata, H. Gonzales, I. Aguilar, M. Fukumoto, H. Verastegui, and R. E. Black. Observations on handwashing and defecation practices in a shanty town of Lima, Peru. *J.Diarrhoeal Dis.Res.* 12 (1):14-18, 1994.

[20] B.F. Stanton and J.D. Clemens. An educational intervention for altering water- sanitation behaviours to reduce childhood diarrhoea in urban Bangladesh. II. A randomized trial to assess the impact of the intervention on hygienic behaviours and rates of diarrhea. *Am.J.Epidemiol* 125, 292-301, 1987

[21] F. Ahmed, J. D. Clemens, M. R. Rao, and A. K. Banik. Family latrines and pediatric shigellosis in rural Bangladesh: benefit or risk? *Int.J.Epidemiol.* 23 (4):856-862, 1994.

[22] V. Curtis, S. Cousens, T. Mertens, E. Traore, B.Kanki and I.Diallo. Structured observations of hygiene behaviours in Burkina Faso, validity, variability and utility. *Bull.World Health Organ* 71:23-32, 1993.

[23] S. Cousens, B. Kanki, S. Toure, I. Diallo, and V. Curtis. Reactivity and repeatability of hygiene behaviour: structured observations from Burkina Faso. *Soc.Sci.Med.* 43 (9):1299-1308, 1996.

[24] Ibid.

and kappa= 0.62, CI: 0.28, 0.96, respectively) than the initial questionnaire and the observed behavior had indicated, based on a small number of behaviors that were able to be observed in two separate occasions in this study (16 repeated observations). In 10 households, the authors did six consecutive observations on separate days: three children were observed using the same defecation place on several occasions; two children used a pot in the initial observations and defecated on the ground at later observations (probably showing a "better" behavior at the beginning as the child reacted to the presence of the observer, but reverting to normal practices once the child became used to the observer's presence). The remaining children were not able to be observed more than once. The stool disposal behavior by the mother was less variable than the child's defecation place. The authors also attempted to measure the inter-observer variation in this study, suggesting that there was less variability regarding the child's defecation site than for stool disposal behavior. The authors suggested that questionnaire data could yield more valid results if the question used in the study (What "usually" happened when the child defecated?) had been replaced with what was felt to be a more valid question: "What happened the last time the child defecated?" As a whole, observations were found to be more valid than questionnaire interviews. The variability of the behavior observed posed a much more difficult problem, particularly for those behaviors that could be affected by the presence of the observer.

Another study, done in Bangladesh[25], found that agreement between questionnaire data and data collected by direct observation was poor and often contradictory. Over-reporting of "good" behavior was also found when comparing data of 24-hour recall questionnaires or knowledge-attitude-practice (KAP) questionnaires, with data obtained through 3-5 hour direct observations done in the morning in 247 households in urban Dhaka (about 20 times higher probability of feces reported to be removed from living area than observed, Kappa = 0.03). Handwashing practices also showed similar results.

Another study in Bandundu, Zaire[26], also showed mothers over-reporting the disposal of their child's stools in latrines (75% vs. 40% $p<0.001$) and under-reporting those left on the ground (4.8 % vs. 28.6%) or thrown outside in the yard (20.7% vs. 31.6%) as compared with 6-7 hour observation data in 174 households. The agreement between interview responses and structured observations was poor for the disposal of the child's feces in the latrine (kappa =0.08, CI: -0.02, 0.19). Similar results were shown for handwashing practices. There were no differences in the results according to the educational level of the mother or the gender of the observer.

In a more comprehensive study done in Burkina Faso[27], structured observations were found to be a useful tool for measuring common behaviors at the population level when the aim of the study is simply to establish the relative frequency of certain behaviors in a population, e.g., when evaluating the impact of an intervention. In this study, 200 mothers of children ages 2 to 36 months were observed in their homes for about 3 hours in the early morning on three separate occasions at weekly intervals, focusing on behaviors related to child defecation practices. Defecation in a pot, stool

[25] B.F. Stanton, J.D. Clemens, K.M.A. Azis, M. Rahaman. Twenty-four-hour recall, knowledge-attitude-practice questionnaires, and direct observations of sanitary practices: a comparative study. *Bull, World Health Org;* 65(2):217-222, 1987.

[26] A. Almedom. Participatory tools. *Dialogue on Diarrhea* 60: 4-5, 1995.

[27] S. R. Huttly, C. F. Lanata, H. Gonzales, I. Aguilar, M. Fukumoto, H. Verastegui, and R. E. Black. Observations on handwashing and defecation practices in a shanty town of Lima, Peru. *J.Diarrhoeal Dis.Res.* 12 (1):14-18, 1994.

disposal into a latrine, and rinsing the child's bottom with water afterwards, appeared largely unreactive to the presence of an observer. Other behaviors did change based on repeated observations, like the proportion of children observed defecating in the yard (it increased from 5% to 16% on three observations, p=0.01) or the proportion of children who were cleaned after defecation (which declined over time, from 95% to 85%, p=0.01), documenting the presence of the Hawthorne effect. To further examine this issue, a group of 38 women were observed an additional five times over a one-week period. The child's defecation into a potty declined from 95% on the initial observations to 64% by the eighth observation, a reactivity largely confined to the first two observations. If structured observations could be used to evaluate population changes, they are more difficult to use if the purpose of the study is to identify risk factors in an individual. The repeatability of behaviors at the individual level was generally low: the index of child defecation into a potty had a 64% concordance rate (kappa =0.27, CI: 0.11, 0.43); the child defecating in a nappy a 77% concordance rate (kappa= 0.40, CI: 0.14, 0.65); and defecation in the yard, a concordance of 79% (kappa= 0.46, CI: 0.17, 0.74) when comparing two observations. The site of stool disposal was more repeatable: stool disposal into a latrine had 91% concordance (kappa= 0.73, CI: 0.55, 0.90); in the yard, 89% concordance (kappa= 0.67, CI: 0.41, 0.93); or outside the household, 88% concordance (kappa= 0.53, CI: 0.20, 0.86). Studies investigating links between hygiene behavior and diarrhea incidence at the individual level will require repeated observations to avoid misclassification of exposure status.

From these studies we can conclude that in general, questionnaire data are less valid than direct observations for the study of defecation practices at the household level. One structured observation may be sufficient to classify populations by the presence or absence of frequently observed events. Repeated observations may be needed for more precise studies of hygiene behaviors and their impact on diarrhea morbidity or when the behavior is known in the population to have low repeatability. However, these gains in precision will have to be weighed against the greater resources, financial and human, required for a large number of observations to be done in a particular study. Research methods need to be clearly linked with the purpose of the study and should ideally lead to a contextualized understanding of the behavior studied.[28]

Qualitative studies

The use of qualitative methods, including traditional anthropological methods, may provide valuable insights into which clusters of existing behaviors are the most prevalent and why[29]. People working in public health recognize the value of qualitative research, but they are often inhibited by their own preconceptions, making it difficult for them to understand and accept the credibility of qualitative data.[30]

The use of participatory tools for facilitating group discussions on hygiene behavior is promising. The "three pile sorting" method is an approach, where a set of pictures with ideas on defecation practices is discussed one idea at a time by a group of up to

[28] S. Zeitlyn and F. Islam. The use of soap and water in two Bangladeshi communities: implications for the transmission of diarrhoea. *Rev of Inf Dis;* 13 (suppl 4):S259-264, 1991

[29] A. M. Almedom. Recent developments in hygiene behaviour research: an emphasis on methods and meaning. *Trop.Med.Int.Health* 1 (2):171-182, 1996.

[30] N. Black. We we need qualitative research. *J Epidemiol Comm Health* 48, 425-426. 1994.

15 people. Pictures are then sorted into the categories of pros and cons or good and bad; a third category — in-between — is included for unclear pictures. This method was highly effective in stimulating discussions on sensitive/personal topics such as latrine use and personal hygiene over a very short period of time in a study done in Tanzania[31]. "Mapping" is another participatory tool used in hygiene studies[32]. Here, participants draw their own map to locate the availability of sanitation facilities. This also can be a very quick, reliable, and enjoyable way of obtaining data on general characteristics of a town or community, especially where baseline data are unreliable, incomplete or simply non-existent. Another method used has been the "pocket chart," where individuals write their own hygiene practices and choice of defecation sites[33]. This method generates quantifiable information that can be tabulated and analyzed on the spot. The information obtained by these participatory methods was found consistent with information obtained using more traditional methods in Tanzania, Kenya and Ethiopia[34]. The combination of methods and tools used in this study increased the interaction between the community and researchers, with everyone benefiting from a greater understanding of the purpose and meaning behind observed hygiene behaviors, thereby facilitating the introduction of hygiene interventions.

The most frequently used qualitative methods in the reviewed studies on hygiene behaviors have been focus groups and in-depth interviews with key informants. These traditional anthropological methods were used in 18% and 12% of the studies reviewed, respectively (Table 2). In focus groups, between six and 15 individuals are invited to participate in a discussion facilitated by one or two researchers who use a discussion guide to help focus the discussion on areas of interest to the study and also to make sure that all topics of interest are covered in the discussion. In more informal studies, notes are taken during the course of the discussion that are then analyzed. In more formal studies, the discussion is taped, with the consent of the participants, and later transcribed so that it can be analyzed using special software designed for anthropological studies. Most studies use several focus groups, with different types of participants, until the information collected no longer provides additional meaningful information. In-depth interviews are usually done to complement the information obtained in focus groups. They are useful for amplifying information or to gain additional insight data on key areas of the study. These qualitative methods are more appropriate for producing information on culturally sensitive issues or behaviors, as well as to study the determinants of those behaviors. Interviews with community leaders also can be used to explore the acceptability of potential interventions.

In a study done in Bobo-Dioulasso, Burkina Faso[35], several methods for the design of hygiene promotion programs were used, including structured observations and qualitative methods such as focus group discussions and behavioral trials. Focus groups enabled the investigation of the relationship of hygiene and diarrhea in children through guided discussions with women representing different associations, ethnic groups, age groups or economic activities. Through behavior trials, women

[31] A. M. Almedom. Recent developments in hygiene behaviour research: an emphasis on methods and meaning. *Trop.Med.Int.Health* 1 (2):171-182, 1996.

[32] A. Almedom & C Odhiambo The rationality factor: choosing water sources according to water uses. *Waterlines* 13: 28-31, 1994.

[33] Ibid.

[34] A. M. Almedom. Recent developments in hygiene behaviour research: an emphasis on methods and meaning. *Trop.Med.Int.Health* 1 (2):171-182, 1996.

[35] V. Curtis, B. Kanki, S. Cousens, A. Sanou, I. Diallo, and T. Mertens. Dirt and diarrhoea: formative research in hygiene promotion programmes. *Health Policy Plan.* 12 (2):122-131, 1997.

were asked to adopt “safe” behaviors over a 10-day period, as part of a small-scale pilot study testing the planned hygiene promotion program. This study documented the importance of validating data by triangulation, cross-checking whether key findings from one research method are borne out by the others.

Methods and tools are not in and of themselves sufficient for obtaining accurate and useful results. The attitude and behavior of investigators are equal, if not more important[36]. Communicating study results to the communities surveyed for further discussion can also ensure greater validity of the findings and enhance mutual understanding of the methods and benefits[37]. After all, hygiene promotion programs can only be effective to the extent that they stem from the culture in which they must operate. Qualitative methods are essential to obtaining this cultural-related knowledge when planning hygiene interventions, complementing data obtained by participatory observations and questionnaires.

Defecation practices of children in developing countries

Defecation sites

Several studies have described the frequency of defecation practices in children, many using more than one observation. We have classified these by region and age groups, since they varied by both these parameters. In some studies, data were presented in a large age group, while some presented data by narrower groups. Additionally, not all regions were well represented by the studies that are highlighted here. Table 3 describes the prevalence of defecation practices of children reported by the studies that we identified, by both region and age group. Children were reported or observed to defecate either in the soil inside the household, as well as in diapers, potties, latrines, and the backyard. Outside the household, they defecated in bushes in the open field, as well as directly into rivers.

[36] A. M. Almedom. Recent developments in hygiene behaviour research: an emphasis on methods and meaning. *Trop.Med.Int.Health* 1 (2):171-182, 1996.

[37] V. Curtis, B. Kanki, T. Mertens, E. Traore, I. Diallo, F. Tall, and S. Cousens. Potties, pits and pipes: explaining hygiene behaviour in Burkina Faso. *Soc.Sci.Med.* 41 (3):383-393, 1995.

Table 3. Prevalence of defecation practices of children by region and age group

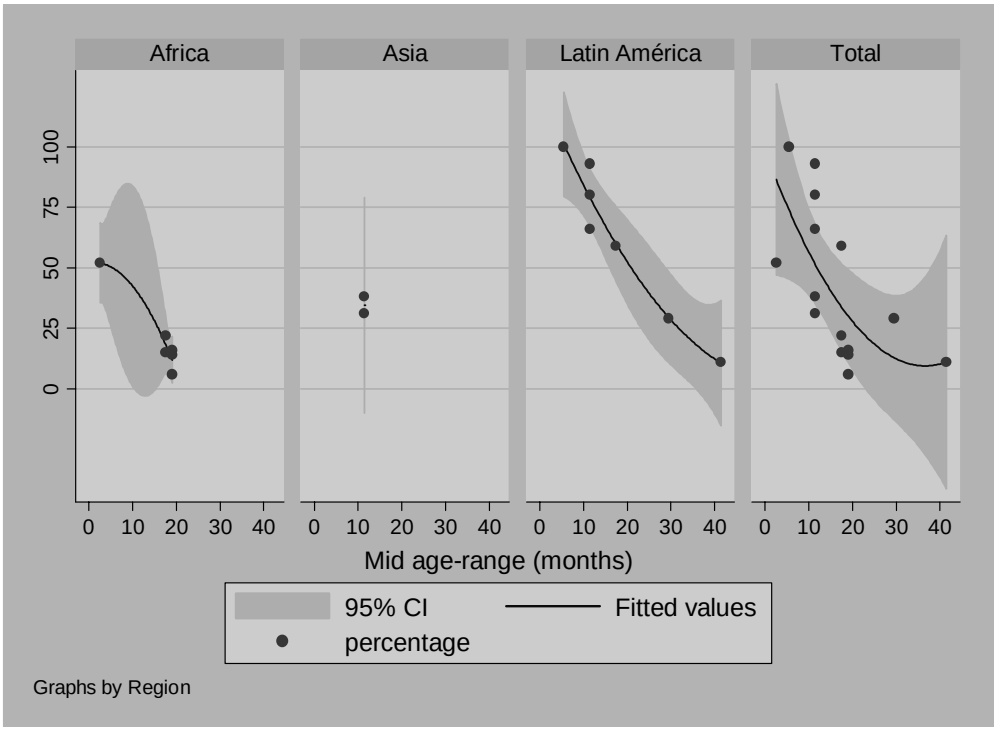
Practice/Region/ Country		Age (in months)	Study method	Reference
Diapers				
Africa: Burkina Faso	16/106 (16%)	2-36	Observation	S. Cousens 1996
	14/106 (14%)	< 36	Reporting	V. Curtis 1993
	2/48 (6%)	< 6	Observation	E. Traore 1994
	415/2775 (15%)		Reporting	
	61/277 (22%)			
	189/364 (52%)			
Asia: Philippines	85/275 (31%) cases	<24	Reporting	J. C. Baltazar 1989
	144/381 (38%) control			
Latin America: Mexico	42/51 (93%)	<24	Reporting	C. Bessenecker 1994
Nicaragua	9/51 (11%)	24-60	Observation	
Peru	77/118 (66%)	<24	Observation	
	43/54 (80%)	<12		
	8/8 (100%)	12-23		
	20/34 (59%)	24-35		
	8/28 (29%)			
Potties				
Africa: Burkina Faso	77/106 (73%)	2-36	Observation	S. Cousens 1996
	68/106 (65%)	0-35	Observation	
	37/48 (79%)	6-36 m	Reporting	
	183/277 (66%) pre int	< 36	Reporting	V. Curtis2001
	74/107 (69%)	< 36	Reporting	
	225/306 (74%)		Observation	
	83/107 (82%) post int			
	1943/2429 (80%)			E. Traore 1994
	2094/2793 (75%)			V. Curtis 1995
	2068/2775 (75%)			V. Curtis 1993
	183/277 (66%			
Asia: Philippines	87/275 (32%) cases	< 24	Reporting	J. C. Baltazar 1989
	119/381 (31%) control			
Latin America: Mexico	1/16 (2%)	<24	Reporting	C. Bessenecker 1994
Peru	13/16 (16%)	24-60	Observation	
	0/8 (0%)	< 12		S. R. Huttly 1994
	5/34 (15%)	12-23		
	4/28 (14%)	24-35		
	11/141 (27%)	> 36		
Household´s soil area				
Africa : Burkina Faso	8/101 (8%)	2-36	Observation	S. Cousens 1996
Nigeria	19/113 (17%)	0- 35	Observation	E. Traore 1994
	14/110 (13%)	< 36	Reporting	V. Curtis 1993
	48/374 (13%)	< 60	Observation	
	183/2775 (7%)		Observation	
	22/277 (8%)			O. O. Omotade 1995
	189/331 (57%)			

Practice/Region /Country		Age (in months)	Study method	Reference
Asia :Bangladesh Indonesia Philippines Sri Lanka	138/389 (35%) cases 174/390 (45%) control 93/282 (33%) 103/275 (37%) cases 118/381 (31%) control 107/133 (81%)	6-23 < 12 < 24 < 60	Observation Reporting Reporting Observation	N. Alam 1989 H. Aulia 1994 J. C. Baltazar 1989 T. E. Mertens 1992
Latin America: Mexico Peru	1/47 (2%) 32-47 (40%) 127/289 (48%) 0/8 (0%) 7/34 (21%) 4/28 (14%)	< 24 24-60 < 36 m < 12 12-23 24-35	Reporting Observation Observation	S. R. Huttly 1998 S. R. Huttly 1994
Latrines Africa: Indonesia Nigeria	 31/282 (11%) 81/430 (19%)	 6-23 24-60	 Reporting Reporting	 H. Aulia 1994 D. Blum 1990
Asia: Sri Lanka	10/133 (8%)	< 60	Observation	T. E. Mertens 1992
Latin America: Mexico Peru	1/92 (2%) 26/92 (33%) 0/8 (0%) 0-34 (0%) 1/28 (4%) 11/41 (27%)	< 24 24-60 < 12 12-23 24-35 > 36	Reporting Observation	C. Bessenecker 1994
Rivers Asia: Indonesia	 13/282 (4.6%)	 6-23	 Reporting	 H. Aulia 1994
Outside/Bushes/Fields Africa: Burkina Faso	 98/2775 (4%) 3/277 (1%)	 < 36	 Reporting	 V. Curtis 1993
Nigeria	804/935 (86%) 347/470 (74%)	 24-60	 Reporting	 D. Blum 1990
Latin America: Peru	0/8 (0%) 2/34 (6%) 5/28 (18%) 7/41 (17%)	<12 12-23 24-35 > 36	Observation	S. R. Huttly 1994
Backyard Africa: Burkina Faso	 102/2775 (3.6%) 11/548 (2%)	 2-36	 Reporting Observation	 S. Cousens 1996
Asia: Indonesia	36/282 (12.8%)	<36	Reporting	H. Aulia 1994
Latin America: Peru	 0/8 (0%) 0/34 (0%) 6/28 (21%) 10/41 (24%)	 <12 12-23 24-35 > 36	 Observation	 S. R. Huttly 1998

Diapers

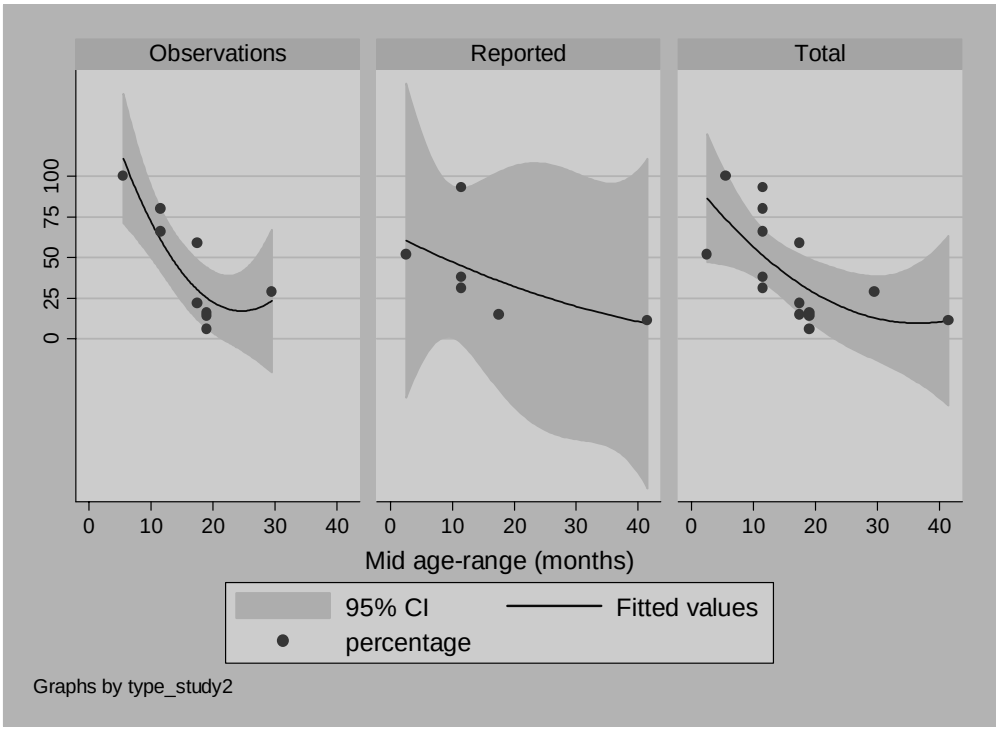
Defecation into diapers was reported only in eight studies, half of them in Latin America and in only one study in Asia. It was universal in infants under six months of age in studies done in Latin America. Its use was significantly less frequent in Asia and in Africa than in Latin America. The prevalence of its use declined significantly with age, from 85% in infants of six month of age to 10% in children 40 months of age, although these fitted values had wide confidence intervals (Fig 2).

Figure 2. Prevalence of diaper use by children in developing countries, by age and region



The prevalence of diaper use varied by the method used in the study. Studies using structured or spot observations had less variability (narrow 95% CI) than studies using reported behavior in questionnaires (Fig 3).

Figure 3. Prevalence of diaper use by children in developing countries, by age, in studies using observations or reported behaviors in questionnaires



In Peru, diapers were considered necessary because the alternative — letting the child defecate in his/her clothes — was considered highly impractical, requiring a greater stock of clothes or more frequent washing[38]. However, mothers wanted to get their children out of diapers as soon as possible to cut their water utilization for laundry[39].

Potties

Potties were reported in nine studies from five countries. There was a high prevalence of potty use in the Burkina Faso studies[40] including infants under six months of age. This was in contrast with a significantly lower prevalence reported in Asian studies and a much lower rate in Latin American studies. The prevalence of potty use significantly increased with age, with a predicted 0% prevalence in infants six months of age, reaching a peak of 70% in children two years of age (a peak mostly due to studies from Africa), with a subsequent decrease to about 5% use in children at 40 months of age (Fig 4). The prevalence of potty use was not influenced by the method

[38] B. A. Yeager, S. R. Huttly, R. Bartolini, M. Rojas, and C. F. Lanata. Defecation practices of young children in a Peruvian shanty town. *Soc.Sci.Med.* 49 (4):531-541, 1999.

[39] S. R. Huttly, C. F. Lanata, H. Gonzales, I. Aguilar, M. Fukumoto, H. Verastegui, and R. E. Black. Observations on handwashing and defecation practices in a shanty town of Lima, Peru. *J.Diarrhoeal Dis.Res.* 12 (1):14-18, 1994.

[40] S. Cousens, B. Kanki, S. Toure, I. Diallo, and V. Curtis. Reactivity and repeatability of hygiene behaviour: structured observations from Burkina Faso. *Soc.Sci.Med.* 43 (9):1299-1308, 1996; V. Curtis, B. Kanki, S. Cousens, I. Diallo, A. Kpozehouen, M. Sangare, and M. Nikiema. Evidence of behaviour change following a hygiene promotion programme in Burkina Faso. *Bull.World Health Organ* 79 (6):518-527, 2001; V. Curtis, B. Kanki, T. Mertens, E. Traore, I. Diallo, F. Tall, and S. Cousens. Potties, pits and pipes: explaining hygiene behaviour in Burkina Faso. *Soc.Sci.Med.* 41 (3):383-393, 1995; V. Curtis, S. Cousens, T. Mertens, E. Traore, B.Kanki and I.Diallo. Structured observations of hygiene behaviours in Burkina Faso, validity, variability and utility. *Bull.World Health Organ* 71:23-32, 1993; E. Traore, S. Cousens, V. Curtis, T. Mertens , F. Tall, A. Traore, B. Kanki, I. Diallo, A. Rochereau, J. P. Chiron, and . Child defecation behaviour, stool disposal practices, and childhood diarrhoea in Burkina Faso: results from a case-control study. *J.Epidemiol.Community Health* 48 (3):270-275, 1994.

used in these studies (no significant relationship in a regression model) (Fig. 5). It will be important to increase the number of studies of the prevalence of potty use in different regions, particularly in more African countries and in Asia, as well as to have more information on the type of potties used by children in Burkina Faso.

Figure 4. Prevalence of potty use by children in developing countries, by age and region

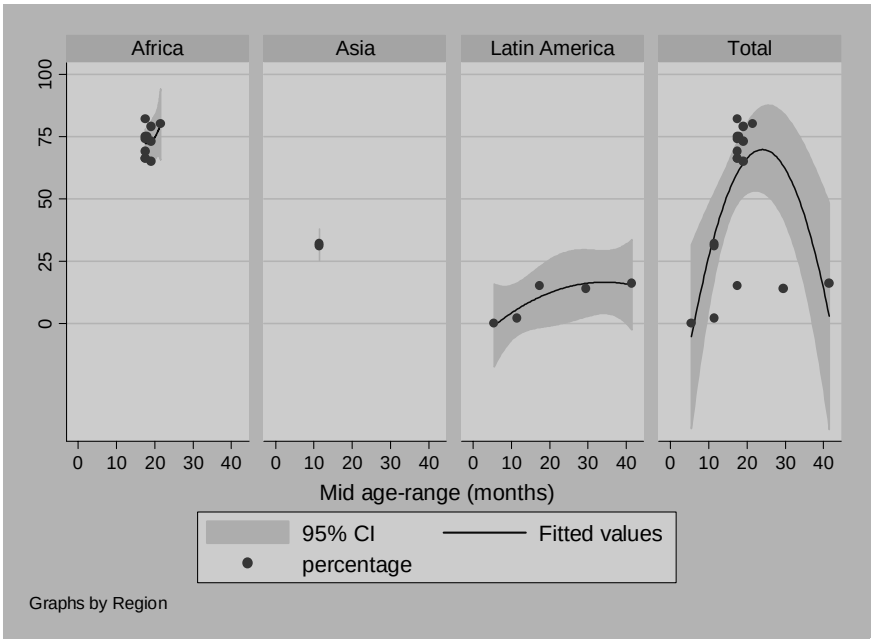
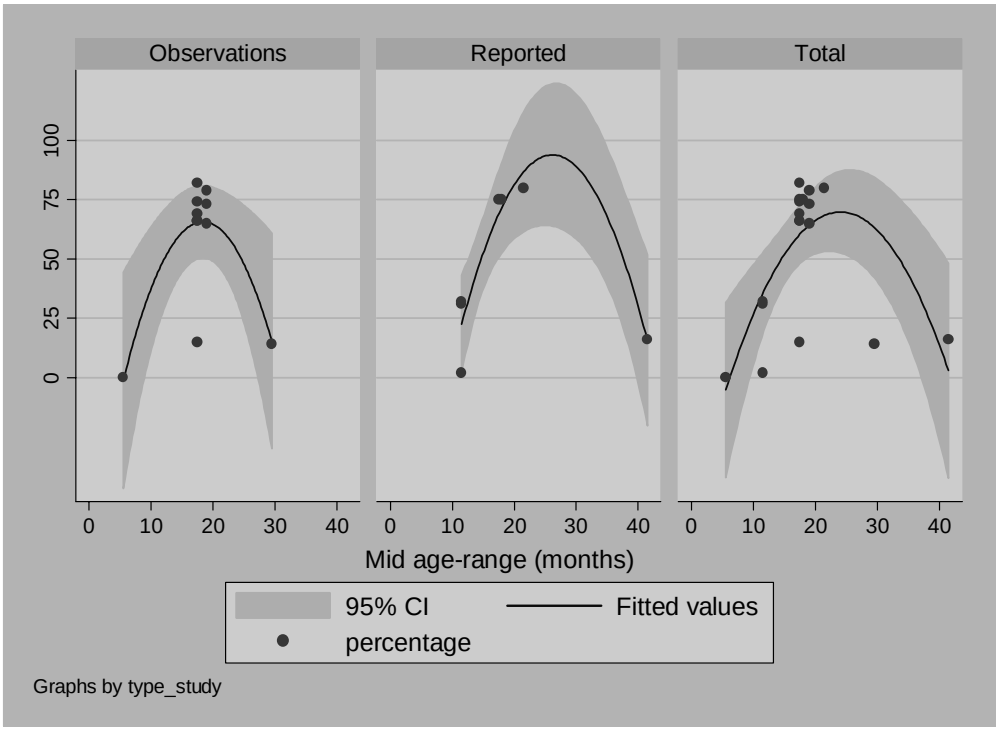


Figure 5. Prevalence of potty use by children in developing countries, by age, in studies using observations or reported behaviors in questionnaires

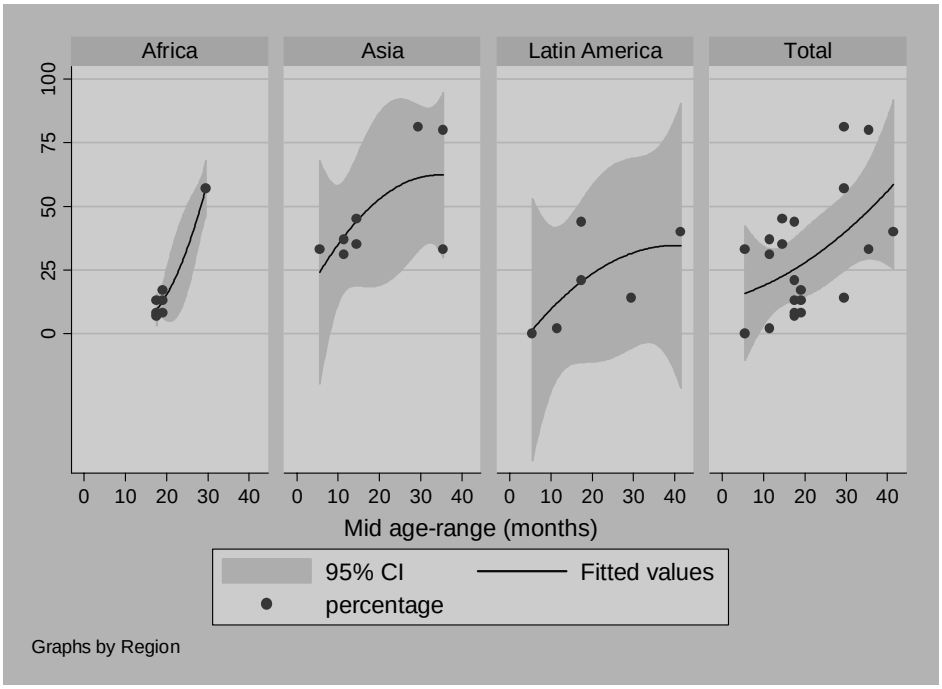


Potties have been found as the ideal method for toddlers' defecation in Peru because they were considered socially appropriate, more hygienic than alternative defecation methods for children of that age and easier to clean than diapers with less water utilized[41]. However, mothers also reported that potty training was time-consuming, requiring a great deal of patience, with some children refusing to use them[42]. Rejection by children of potties was found to be associated with mothers attempting to train them at very early ages (six to nine months) as they sought to get them out of diapers as soon as possible, or when children becomes afraid of them after falling[43].

Defecation on the household's soil

The prevalence of open defecation on the household soil (or in the yard close to the house compound in rural areas, where children spend most of their time) was reported in 12 studies, and varied significantly by age. It was seen or reported less frequently in infants (estimated prevalence at about 20% in infants at six months of age) than in older children (estimated prevalence of 60% by 40 months of age, Fig. 6). There was no significant difference by region or type of methods used in the studies reviewed, although the variability of the estimates was high, with very wide 95% CI. This variability probably indicates that this behavior is not constant, suggesting that children at these ages may alternate their defecation practices and behaviors.

Figure 6. Prevalence of defecation in the household's soil or yard by children in developing countries, by age and region



[41] B. A. Yeager, S. R. Huttly, R. Bartolini, M. Rojas, and C. F. Lanata. Defecation practices of young children in a Peruvian shanty town. *Soc.Sci.Med.* 49 (4):531-541, 1999.

[42] S. R. Huttly, C. F. Lanata, B. A. Yeager, M. Fukumoto, R. del Aguila, and C. Kendall. Feces, flies, and fetor: findings from a Peruvian shantytown. *Rev.Panam.Salud Publica* 4 (2):75-79, 1998; B. A. Yeager, S. R. Huttly, R. Bartolini, M. Rojas, and C. F. Lanata. Defecation practices of young children in a Peruvian shanty town. *Soc.Sci.Med.* 49 (4):531-541, 1999.

[43] B. A. Yeager, S. R. Huttly, R. Bartolini, M. Rojas, and C. F. Lanata. Defecation practices of young children in a Peruvian shanty town. *Soc.Sci.Med.* 49 (4):531-541, 1999.

Anthropological studies have indicated that open defecation is seldom seen as the preferred site by mothers. In fact, it is usually seen as a failure to use alternative, preferred sites for defecation. However, in rural areas, defecation directly onto the ground is considered natural, and for some mothers, allowing their child to do so is a way of continuing their cultural pattern of behavior[44]. It also has the advantage of being an easier method than many for both the child and the mother, i.e., the child can go when and where he/she wants and the mother does not need to wash anything afterwards. But feces deposited in the soil may have different levels of social tolerance according to the age of the person and the feces characteristics. It seems universally true that mothers perceive that the feces of infants and young children are less dirty than those of adults or older children[45]. This seems to be because of their lack of strong odors, their smaller size and because they are less likely to have food residuals. Smelly stools attract flies, which are considered risky since they can transport feces and contaminate food[46]. Therefore defecation in open areas or in the bush by adults is categorized as a bad behavior[47].

Latrines

Latrine use was reported in only four studies, and more frequently in the Latin America than in the Africa or Asia studies. Its use was rare in infants (0 to 5% in children six months of age) and increased by age, reaching a predicted 25% prevalence by age 50 months (Fig. 7). As a result of a scarcity of studies, it is not possible to conclude anything about regional variations and the influences by study type. Anthropological studies, however, have indicated that mothers fear the use of latrines by younger children for two reasons: first, because they consider them contaminated with adult feces, and second, because they consider them unsafe, fearing that the child may fall in[48]. Latrines, particularly those that are poorly constructed, attract flies, emit noxious odors, and endanger children who could be bitten by insects or rats[49]. Some therefore consider latrines a defecation site more appropriate for older children and adults. The few studies reviewed endorse this concept. It will be useful to conduct additional studies reporting on the use of latrines

[44] B. A. Yeager, S. R. Huttly, R. Bartolini, M. Rojas, and C. F. Lanata. Defecation practices of young children in a Peruvian shanty town. *Soc.Sci.Med.* 49 (4):531-541, 1999.

[45] A. M. Almedom. Recent developments in hygiene behaviour research: an emphasis on methods and meaning. *Trop.Med.Int.Health* 1 (2):171-182, 1996; C. Bessenecker. A Study of child-related excreta disposal practices and beliefs in a peri-urban community of Ciudad Juarez, Mexico. MPH Project. School of Public Health. The University of Texas Health Science Center at Houston. Houston, Texas USA. 1994; O. Rauyajin, V. Pasandhanatorn, V. Rauyajin, S. Na-nakorn, J. Ngarmyithayapong, and C. Varothai. Mothers' hygiene behaviours and their determinants in Suphanburi, Thailand. *J.Diarrhoeal Dis.Res.* 12 (1):25-34, 1994; S. Zeitlyn and F. Islam. The use of soap and water in two Bangladeshi communities: implications for the transmission of diarrhoea. *Rev of Inf Dis;* 13 (suppl 4):S259-264, 1991.

[46] A. M. Almedom. Recent developments in hygiene behaviour research: an emphasis on methods and meaning. *Trop.Med.Int.Health* 1 (2):171-182, 1996; S. R. Huttly, C. F. Lanata, B. A. Yeager, M. Fukumoto, R. del Aguila, and C. Kendall. Feces, flies, and fetor: findings from a Peruvian shantytown. *Rev.Panam.Salud Publica* 4 (2):75-79, 1998.

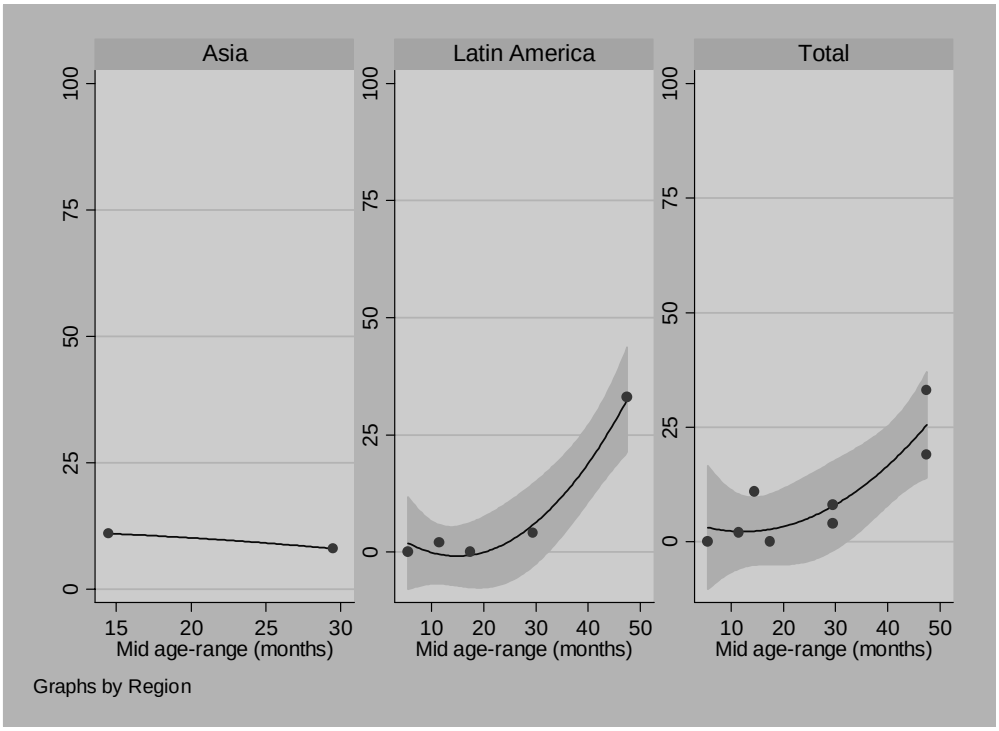
[47] A. M. Almedom. Recent developments in hygiene behaviour research: an emphasis on methods and meaning. *Trop.Med.Int.Health* 1 (2):171-182, 1996.

[48] C. Bessenecker. A Study of child-related excreta disposal practices and beliefs in a peri-urban community of Ciudad Juarez, Mexico. MPH Project. School of Public Health. The University of Texas Health Science Center at Houston. Houston, Texas USA. 1994; S. R. Huttly, C. F. Lanata, B. A. Yeager, M. Fukumoto, R. del Aguila, and C. Kendall. Feces, flies, and fetor: findings from a Peruvian shantytown. *Rev.Panam.Salud Publica* 4 (2):75-79, 1998; B. A. Yeager, S. R. Huttly, R. Bartolini, M. Rojas, and C. F. Lanata. Defecation practices of young children in a Peruvian shanty town. *Soc.Sci.Med.* 49 (4):531-541, 1999.

[49] C. Bessenecker. A Study of child-related excreta disposal practices and beliefs in a peri-urban community of Ciudad Juarez, Mexico. MPH Project. School of Public Health. The University of Texas Health Science Center at Houston. Houston, Texas USA. 1994; B. A. Yeager, S. R. Huttly, R. Bartolini, M. Rojas, and C. F. Lanata. Defecation practices of young children in a Peruvian shanty town. *Soc.Sci.Med.* 49 (4):531-541, 1999.

by children as well as the determinants of their use in more regions and sites in order to properly evaluate how sanitation programs installing latrines in developing countries might increase utilization by younger children.

Figure 7. Prevalence of defecation in latrines by children in developing countries, by age and region



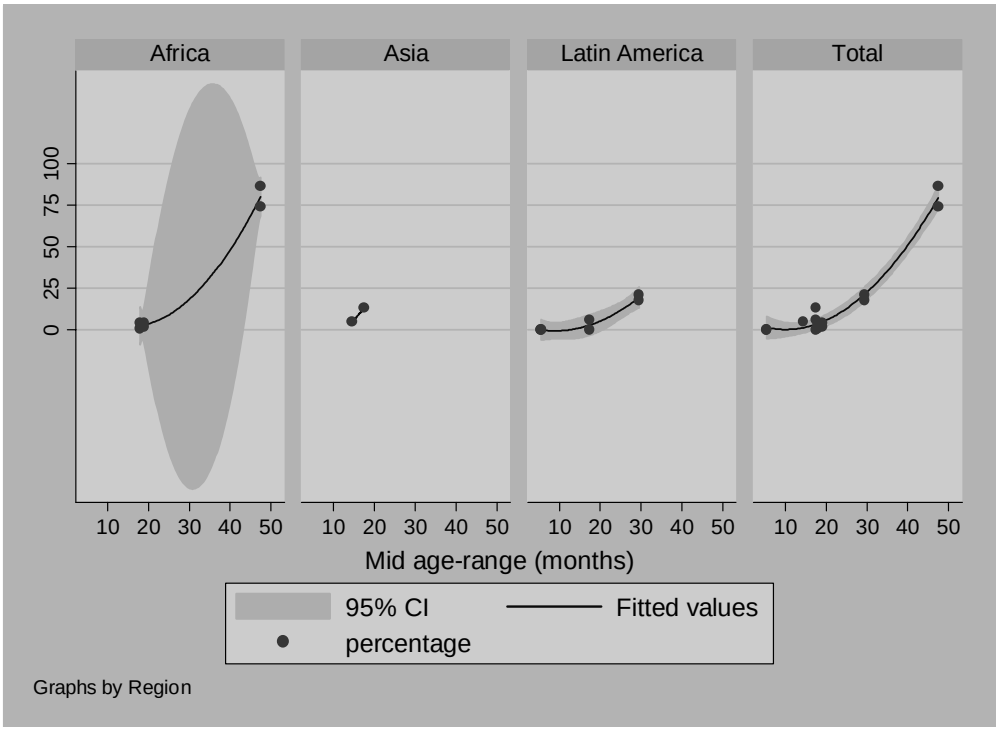
Rivers and open fields

Only one study reported children defecating directly into rivers in Indonesia. A study in Peru documented children defecating in the backyard and three other studies from Africa and Latin America reported children defecating in the open fields or bushes near their homes. These practices were seen mostly in older children (75% of children of 50 months of age, fitted values) and only very rarely in infants (0% in children of six months of age, Fig. 8). Studies reporting observed prevalence had more precise estimates than studies done with questionnaires (Fig. 9). Given the narrow 95% CI of observed studies, and the high prevalence observed in older children, we can postulate that older children, who may not have access to latrines or alternate defecation sites, will — as a preferred site — defecate in open spaces or rivers outside the home environment. Anthropological studies conducted in Peru[50] support this conclusion. Using a hill or an open field — as long it was some distance from the household — was considered acceptable for older children and adults and certainly preferable to using a poorly constructed latrine in their homes. It was believed that feces deposited in an open field would not pose any risk to the home environment. In addition, using a

[50] S. R. Huttly, C. F. Lanata, H. Gonzales, I. Aguilar, M. Fukumoto, H. Verastegui, and R. E. Black. Observations on handwashing and defecation practices in a shanty town of Lima, Peru. *J.Diarrhoeal Dis.Res.* 12 (1):14-18, 1994; B. A. Yeager, S. R. Huttly, R. Bartolini, M. Rojas, and C. F. Lanata. Defecation practices of young children in a Peruvian shanty town. *Soc.Sci.Med.* 49 (4):531-541, 1999; B.A. Yeager, S.R Huttly, J. Diaz, R. Bartolini, M. Marin and C.F. Lanata. An intervention for the promotion of hygienic faeces disposal behaviours in a shanty town of Lima, Peru. *Health Education Research* 17 (6):761-773, 2002

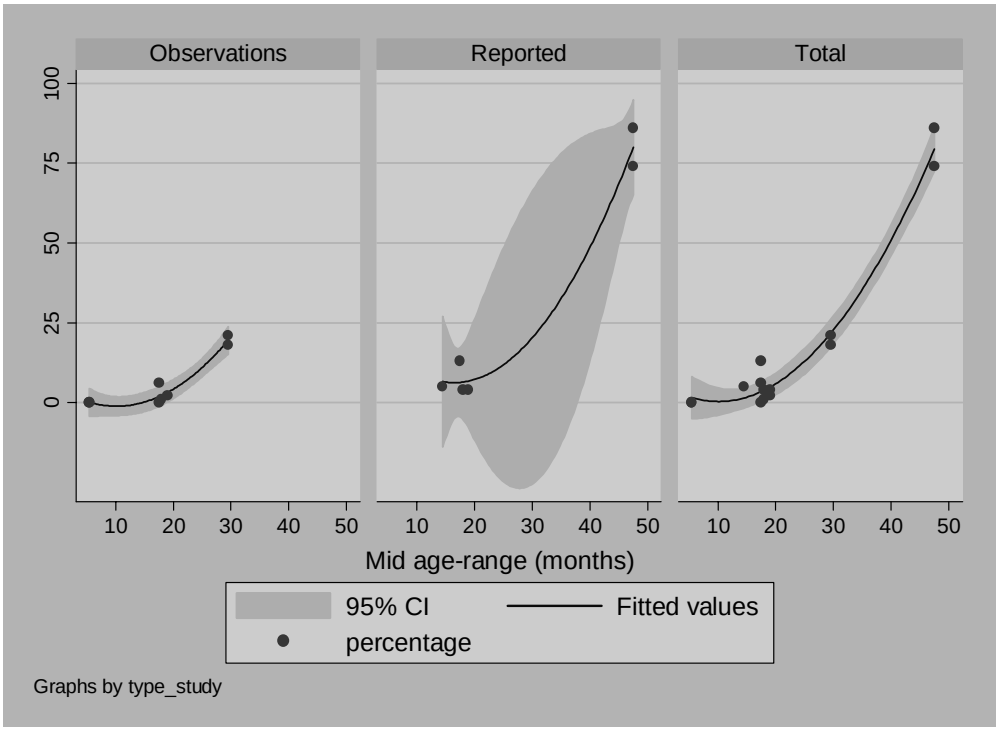
hill or an open area is more practical than constructing and maintaining a latrine, according to study respondents[51]. It would be useful to conduct further studies on this behavior in order to explore how older children could be convinced to use more hygienic defecation sites, like latrines.

Figure 8. Prevalence of defecation in rivers and open fields by children in developing countries, by age and region



[51] B. A. Yeager, S. R. Huttly, R. Bartolini, M. Rojas, and C. F. Lanata. Defecation practices of young children in a Peruvian shanty town. *Soc.Sci.Med.* 49 (4):531-541, 1999.

Figure 9. Prevalence of defecation in rivers or open fields by children in developing countries, by age, in studies using observations or reported behaviors in questionnaires



Conclusions

The review of defecation practices by children in developing countries indicates that the most prevalent practices varied significantly by age, and in some cases, by region. Most infants, particularly those in Latin America, defecate in diapers. Next in prevalence was defecation in potties by toddlers, particularly in Africa. For older children, the next most popular approach is defecation in a household's soil or yard or defecation in rivers or in open fields. Latrines are rarely used by older children. The reviewed studies endorse the concept that studies using spot or structured observations yield more precise estimates than studies using questionnaire data on reported behaviors. It will be useful to seek to increase the number of studies on defecation practices by children in developing countries, particularly in Asia and in more African countries, as well as to explore the determinants of latrine use by older children, to see if defecation in open fields or rivers can be reduced. It would be useful to study the determinants of potty use by toddlers and to develop interventions to promote its use, particularly in Latin America.

Disposal of children's feces

Reviewed studies also described the final destination of children's feces, irrespective of the initial defecation site. The observed or reported practices of feces disposal are described in Table 4. It should be noted that not all studies were able to observe or obtain information on these practices, either because the practice did not occur during the observation period, or it was not reported. Therefore the validity of the prevalence values presented in Table 4 should be considered in that light. Also, between 10% and

30% of feces were either observed or reported not to have been discarded or removed after being deposited in their original defecation site. One would then have to consider that these locations were not necessarily definitive disposal sites.

Table 4. Practices for the disposal of feces of children in developing countries, by age and region

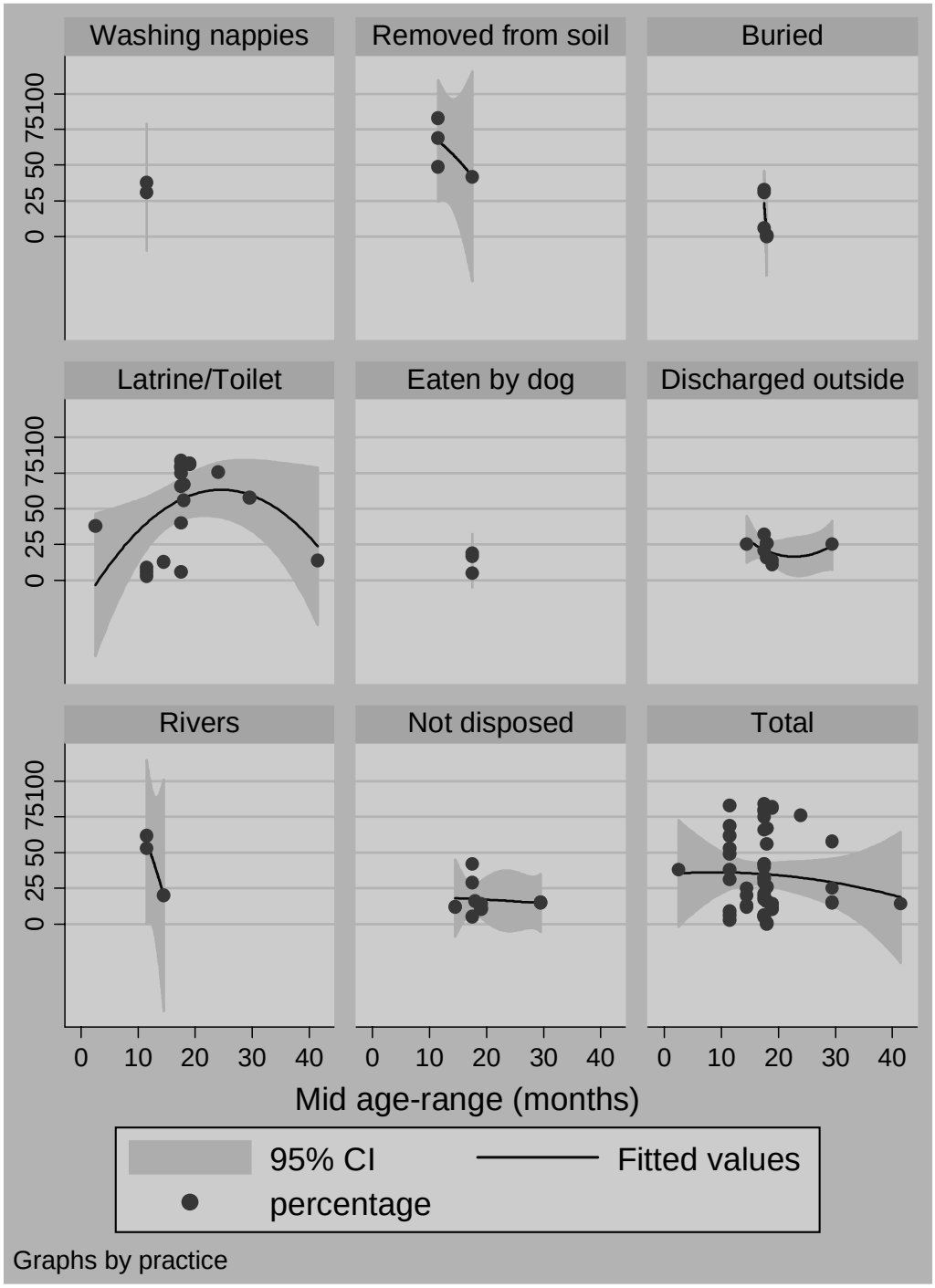
Practice/Region/Country	Age group			Study method	Ref.	Comments
	0- 1 y	1-3 y	>3 y			
1.Washing nappy						
Asia						
Philippines	31% cases (85/272) 38% control (144/379)			Reported	J. C. Baltazar 1989	< 2 y
2. Removed from soil						
Asia						
Sri Lanka	49% (65/133)			Observed	T. E. Mertens 1992	< 2 y
Latin America						
Nicaragua	69% cases (81/118) 83% controls (44/54)			Observed	A.C. Gorter 1998	<2y
Peru	42% (5/12)			Observed	S. R. Huttly 1994	< 3 y
3.Buried						
Africa						
Burkina Faso	0% (11/2775) 1% (2/277)			Reported Observed	V. Curtis 1993	< 36m
Latin America						
Peru	6% from clothes 2/36 33% from floor (3/12) 19% from yard (4/16)			Observed	S. R. Huttly 1994	< 3y
4.Eaten by dog						
Latin America						
Peru	5% from potty (1/19) 17% from floor (2/12) 19% from yard (3/16)			Observed	S. R. Huttly 1994	< 3y
5.Toilet/ latrine						
Latin America						
Peru	79% from potty (15/19) 6% from yard (1/16)			Observed	S. R. Huttly 1994	< 3 y
Asia						
Philippines	6% cases (17/272) 9% control (34/379)			Reported	J. C. Baltazar 1989	< 2y

Practice/Region/Country	Age group			Study method	Ref.	Comments
	0- 1 y	1-3 y	>3 y			
Indonesia	13% (37/282)			Reported	H. Aulia 1994	6-23m
Sri Lanka	3% < 2 y (27/773)	14% > 2y (109/805)		Reported	T. E. Mertens 1992	< 5 y
Africa						
Nigeria	58% (81/142)			Observed	O. O. Omotade 1995	<5 y
Zaire	40% (31/78) 75% (150/202)			Observed Reported	M. Manun'Ebo 1997	< 3y
Burkina Faso	81% (85/106) 82% (39/48)			Observed	S. Cousens 1996	2-36m
	67% 1871/2793			Reported	V. Curtis 1995	36 m
	66% - 80% pre interview (154/233) (220/275) 84% (229/272) post interview			Observed	V. Curtis 2001	0-35m
	38% < 6m (138/364) 76% (1380/1817) >12m			Reported	E. Traore 1994	<36 m
	67% (1855/2775) 56% (154/277)			Reported Observed	V. Curtis 1993	<36 m
6.Outside/ open air/bush						
Asia						
Indonesia	25% (70/282)			Reported	H. Aulia 1994	6-23m
Africa						
Nigeria	25% (35/142)			Observed	O. O. Omotade 1995	< 5y
Zaire	32% (62/196) 21% (56/270)			Observed Reported	M. Manun'Ebo 1997	< 3y
Burkina Faso	11% (12/106) 14% (15/106)			Observed	S. Cousens 1996	2-36m
	26% (726/2793)			Reported	V. Curtis 1995	36 m
	26% (716/2775) 16% (44/277)			Reported Observed	V. Curtis 1993	< 36m
7.Rivers/canal						
Asia						
Indonesia	20% (56/282)			Reported	H. Aulia 1994	6-23m
Philippines	62% cases			Reported	J. C. Baltazar 1989	< 2 y

Practice/Region/Country	Age group			Study method	Ref.	Comments
	0- 1 y	1-3 y	>3 y			
	(170/272) 53% control (201/379)					
8. Not disposed						
Latin America						
Peru	42% (30/72)			Observed	S. R. Huttly 1994	< 3y
Asia						
Indonesia	12% (33/282)			Reported	H. Aulia 1994	6-23m
Sri Lanka	15% (19/133)			Observed	T. E. Mertens 1992	< 5 y
Africa						
Nigeria	15% (42/282)			Observed	O. O. Omotade 1995	< 5y
Zaire	29% (56/195) 5% (13/270)			Observed Reported	M. Manun'Ebo 1997	< 3 y
Burkina Faso	14% (15/106) 11% (12/106) 10% (5/48)			Observed	S. Cousens 1996	2-36m
	16% (45/277)			Observed	V. Curtis 1993	< 36 m

Stools were observed or reported to be discarded at several locations (Fig. 10): in the water — discarded after washing diapers; removed or buried from the soil; discharged in latrines, in the outside field or in rivers; and in one study in Peru, eaten by dogs.

Figure 10. Prevalence of practices for the final disposal of children's feces in developing countries, by age



Washing diapers

When dirty cloth diapers are washed, it would be expected that children's feces would be transferred to the washing water and discarded at the site where the dirty water had been discharged, most frequently in the soil of the household or a nearby area. Despite this expectation, this practice was reported in only one study done in the Philippines,

which described a low frequency of washing diapers, i.e., in a case control study, 31% of children with diarrhea and 38% of children without diarrhea[52]. Qualitative studies have mentioned this practice as the route for most feces deposited in cloth diapers, unless the diaper contents include large pieces of solid stools, which are removed and discharged in latrines or in open fields or rivers[53]. It could be assumed that all or most feces deposited in cloth diapers will follow these disposal practices. No studies have reported a significant use of disposable diapers, which with increased urbanization and economic development, may alter these practices.

Removed from the soil or buried

Three studies described feces being removed from the soil after the child defecated on the ground. It was reported in 42% and 49% of the cases in Peru[54] and Sri Lanka[55], respectively, and in 69% of diarrhea cases and 83% of children without diarrhea in a case control study in Nicaragua[56]. The method for feces removal varied between being swiped away or being picked up and discarded elsewhere. In Latin America ,17% of feces deposited on the floor were buried with soil.

Eaten by dogs

One study in Peru[57] reported feces eaten by dogs during structured observations periods. This happened either with feces left on the ground (around 20% of the time) or when used potties were left uncovered on the floor (5%). It is not known if this practice was observed or reported.

Latrines or toilets

Ten studies reported children's feces being discarded in latrines or toilets. This practice was less frequent in Asia (three studies with a prevalence of <25%) than in Africa or Latin America (prevalences of >50%), and varied by age, with an estimated frequency of 0% in children six months of age, 70% in children 24 months of age, and 25% in children 40 months of age (Fig. 11). These prevalences had wide 95% CI, independent of the type of method used (reported or observed), although in a regression model, the type of study (p=0.04) and region (p=0.06) were significant predictors of this practice (Fig 12). In Peru, the majority of stools deposited in potties were eliminated into a latrine, again identifying potties as an appropriate stool disposal method for toddlers[58].

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[52] J. C. Baltazar and F. S. Solon. Disposal of faeces of children under two years old and diarrhoea incidence: a case-control study. *Int.J.Epidemiol.* 18 (4 Suppl 2):S16-S19, 1989

[53] B. A. Yeager, S. R. Huttly, R. Bartolini, M. Rojas, and C. F. Lanata. Defecation practices of young children in a Peruvian shanty town. *Soc.Sci.Med.* 49 (4):531-541, 1999.

[54] S. R. Huttly, C. F. Lanata, H. Gonzales, I. Aguilar, M. Fukumoto, H. Verastegui, and R. E. Black. Observations on handwashing and defecation practices in a shanty town of Lima, Peru. *J.Diarrhoeal Dis.Res.* 12 (1):14-18, 1994.

[55] T. E. Mertens, S. Jaffar, M. A. Fernando, S. N. Cousens, and R. G. Feachem. Excreta disposal behaviour and latrine ownership in relation to the risk of childhood diarrhoea in Sri Lanka. *Int.J.Epidemiol.* 21 (6):1157-1164, 1992.

[56] A.C. Gorter, P. Sandiford, J. Pauw, P. Morales, R.M. Perez & H Alberts. Hygiene behaviour in rural Nicaragua in relation to diarrhoea. *Int.J.Epidemiol* 27, 1090-1100, 1998

[57] S. R. Huttly, C. F. Lanata, H. Gonzales, I. Aguilar, M. Fukumoto, H. Verastegui, and R. E. Black. Observations on handwashing and defecation practices in a shanty town of Lima, Peru. *J.Diarrhoeal Dis.Res.* 12 (1):14-18, 1994.

[58] Ibid.

Figure 11. Prevalence of latrines or toilets as the site for the disposal of children's feces in developing countries, by age and region

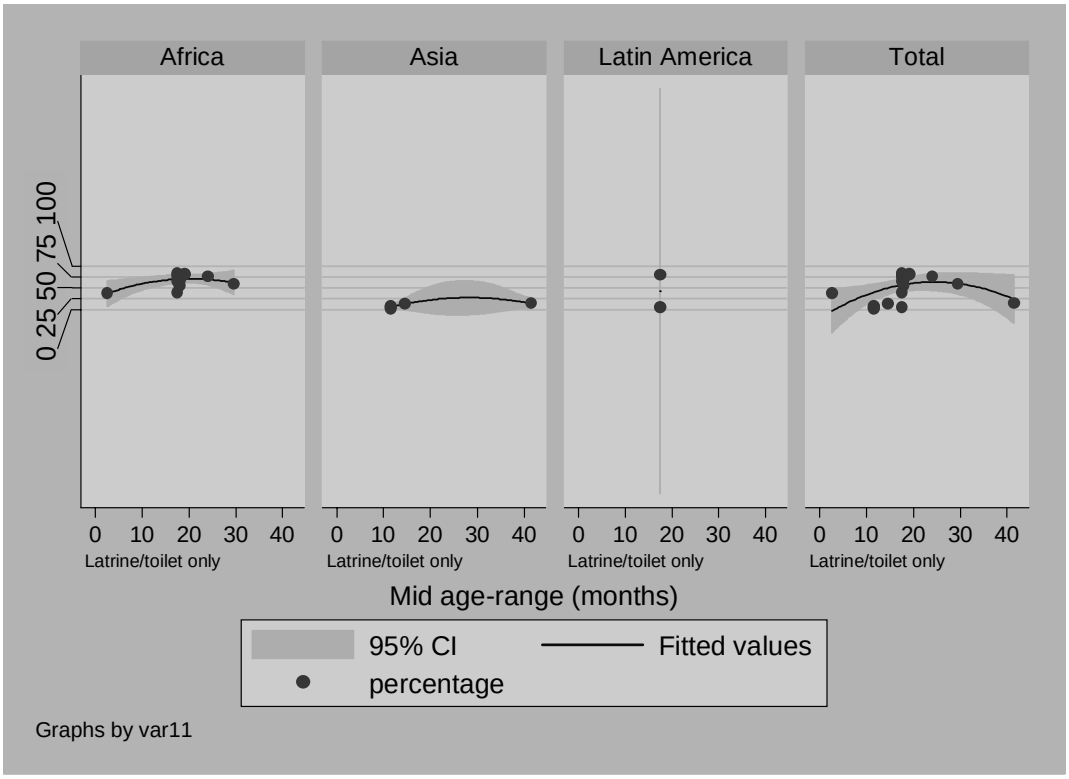
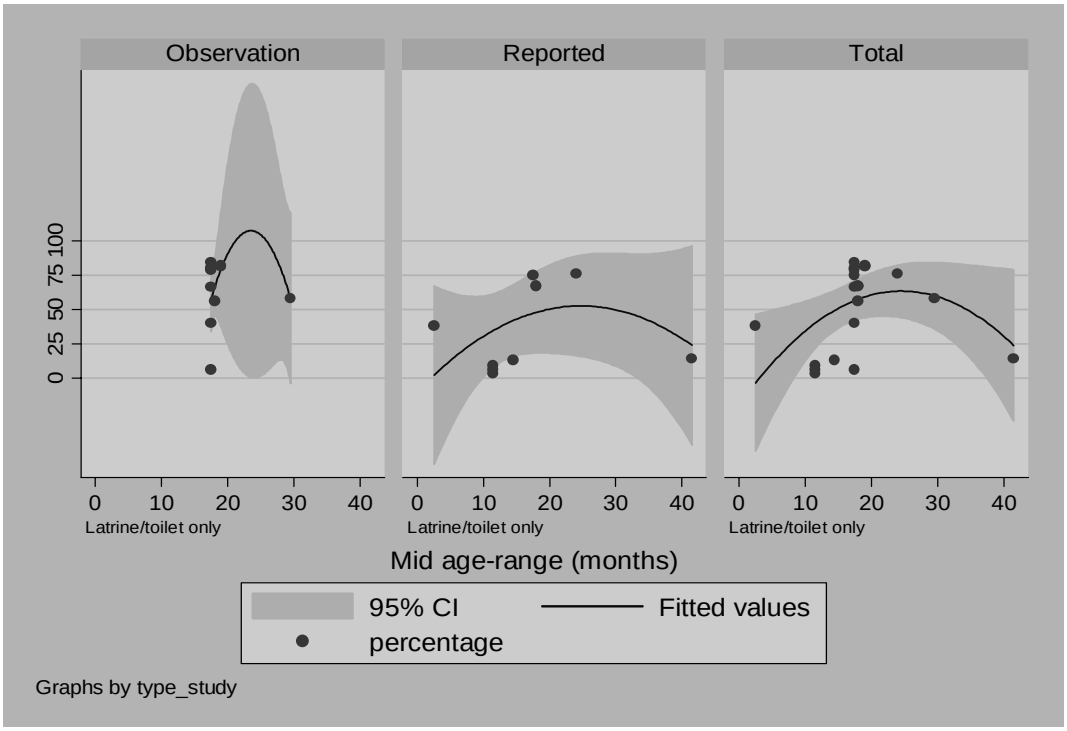


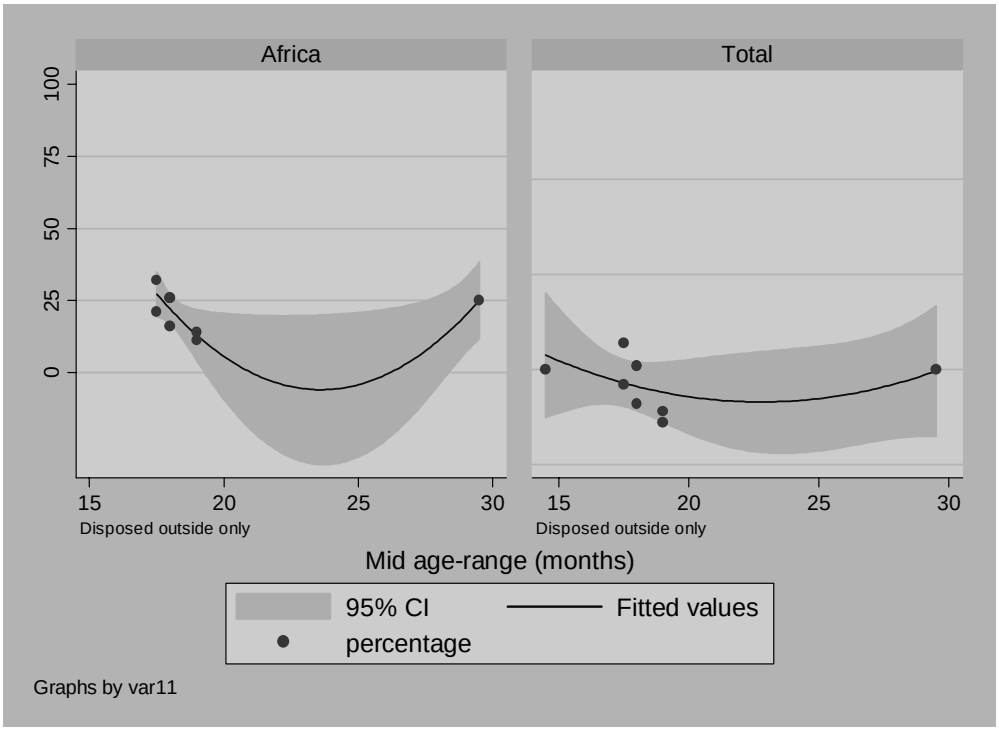
Figure 12. Prevalence of latrines or toilets as the site for the disposal of children's feces in developing countries, by age, in studies using observations or reported behaviors in questionnaires



Outside the household

In about 25% of the studies completed in Asia and Africa, children's feces were observed or reported to be disposed outside the house, either among bushes or in open fields, or in rivers (Fig. 13). This practice was not reported in Latin America, probably because most studies were done in urban or peri-urban areas, with access to alternative sites for stool disposal, as described above.

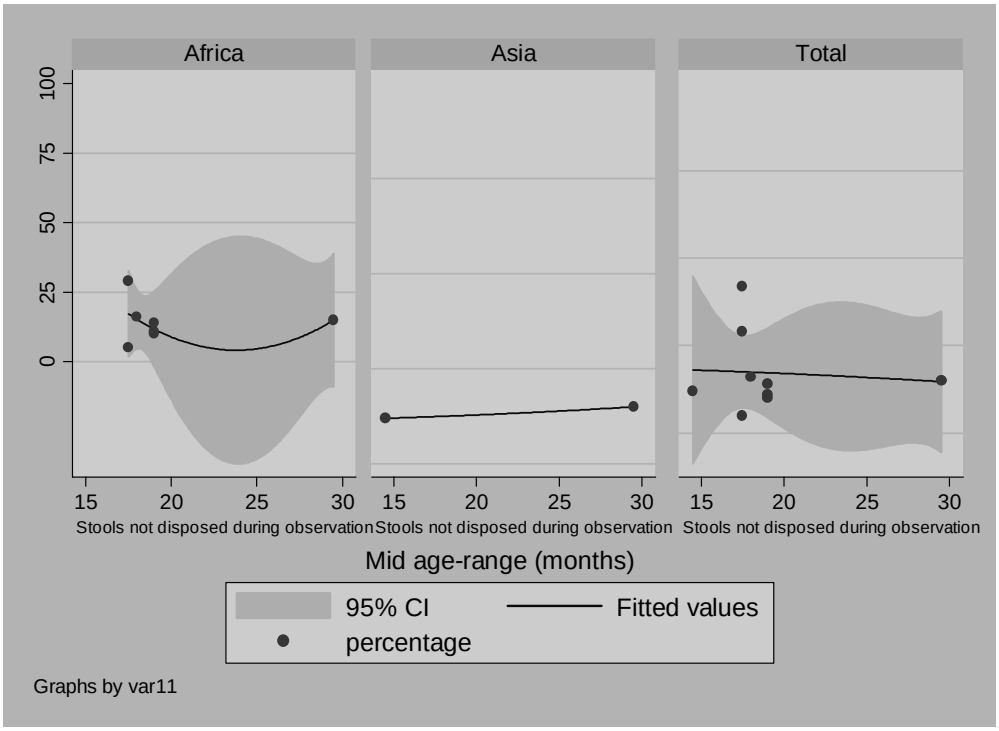
Figure 13. Prevalence of latrines or toilets as the site for the disposal of children's feces in developing countries, by age and region



Not removed

In up to 30% of feces, it was observed or reported that they were not removed or disposed from the original defecation place during the study period (Fig. 14). This would indicate either that the practice was undertaken at a later date or time or not at all, allowing the stool material to remain exposed to household inhabitants and domestic animals.

Figure 14. Prevalence of children's feces left at the defecation site (not removed) during the study period (or not reported) in developing countries, by age and region



Conclusions

Not all studies reporting defecation practices of children in developed countries reported the final destination of the observed or reported feces. This has limited the capacity of the authors of this review to offer firm conclusions about this important aspect of defecation practices. In addition, in about 20% of studies a final destination of the observed or reported feces was not described. Despite these limitations, what can be concluded is that waste waters from washing diapers were reported in 30% of studies; feces removed from the soil, in about 50% of cases; discharged in latrines or toilets, in about 75% of cases; buried, 20% of cases; or discharged in rivers or outside the household, in 25-30% of cases. Feces eaten by dogs were reported at about 17% frequency only in Peru. More studies are needed to describe these important aspects of children's defecation practices.

Hygiene practices after children's defecation

Three hygiene behaviors have been described as associated with children's defecation practices: handwashing (of the child's hand), cleaning/washing of the child's bottom, and handwashing of the mother/care provider after cleaning the child (Table 5).

Table 5. Prevalence of handwashing or bottom-cleaning/washing after child's defecation in developing countries

Practice/ Country/Reference	Age group			Study method	Reference	Comments
	0- 1 y	1-3 y	>3 y			
1.Child's handwashing						
Asia						
Bangladesh	71% diarrhea cases (17/24) 52% control (13/25)			Observed	J.D. Clemens 1987	< 6 y handwashing type not specified
Indonesia	cloth: 11% (31/278) water : 84% (234/278) soap: 5% (14/278)			Reported	H. Aulia 1994	6-23m
Latin America						
Mexico	58% < 2 y (26/45)		81%2-5y (65/80)	Reported	C. Bessenecker 1994	handwashing type not specified
Peru	Intervention: 19% (27/140) pre interview 10% (17/167) post interview Control: 14% (23/165) pre interview 14% (22/156) post interview			Observed	B.A. Yeager 2002	15-47 m handwashing type not specified
	5% (9/170)			Observed	S. R. Huttly 1998	< 3y handwashing type not specified
2.Child's bottom cleaning/ washing						
Africa						
Burkina Faso	total: 96% (102/106); 91% (96/106); 98% (47/48) wiped : 6% (6/106); 3% (3/106) ; 3% (1/48) water only: 85% (90/106); 89% (94/106); 84% (40/48) soap: 9%(10/106); 8%(8/106); 5% (2/48)			Observed	S. Cousens 1996	2-36m
	92% (256/277)pre interview 97% (104/107) post interview 85% (259/306)pre interview 95% (275/289) post interview			Observed	V. Curtis 2001	0-35 m Cleaning type not specified
Nigeria	total: 43% (142/331) cloth: 5% (15/331) toilet tissue: 4% (14/331) water only: 26% (85/331) soap: 6% (20/331) paper: 2% (8/331)			Observed	O. O. Omotade 1995	< 5 y
Latin America						
Nicaragua	69% cases (81/118) 83% control (45/54)			Observed	O. Grados 1988	< 2 y Cleaning type not specified
Peru	total 95% (162/170) diaper 65% (111/170) cloth 25% (43/170) paper 11% (19/170) water 12% (20/170) soap 7% (12/170)			Observed	S. R. Huttly 1998	< 3 y

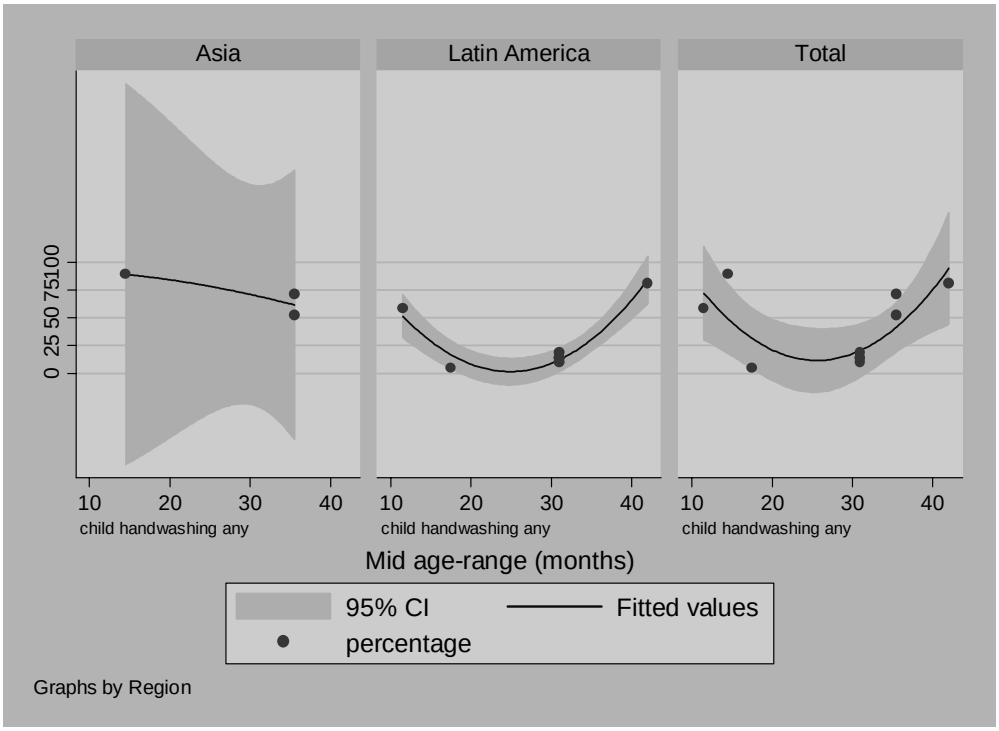
Practice/ Country/Reference	Age group			Study method	Reference	Comments
	0- 1 y	1-3 y	>3 y			
	89% (125/140) pre interview 88%(145/165) pre interview 90% (150/167) post interview 96% (150/156) post interview			Observed	B.A. Yeager 2002	15-47 m Cleaning type not specified
3.Mother's handwashing						
Asia						
Bangladesh	ash/mud 55%(215/389) interview 28%(108/390) control water 45% (174/389) interview 72% (282/390) control			Observed	N. Alam 1989	6-23 months
	91% (21/23) diarrhea cases 82% (18/22) control			Observed	J.D. Clemens 1987	< 6 y
Indonesia	water 72% (203/282) soap 24% (68/282)			Reported	H. Aulia 1994	< 3 y
Latin America						
Mexico	67% < 2y (30/45)		49% 2-5 y (39/80)	Reported	C. Bessenecker 1994	
Peru	20% (34/170) soap 5% (9/170)			Observed	S. R. Huttly 1998	< 3 y
	15% (11/72) water 64% (7/11) soap 27% (3/11)			Observed	S. R. Huttly 1994	0-35 m
	38%(53/140) pre interview 33% (54/165) pre interview 21% (35/167) post interview 26% (41/156) post interview			Observed	B.A. Yeager 2002	15-47 m
Africa						
Nigeria	after cleaning child: 43% (142/331) water only 57%(81/142) soap 10% (14/142) after disposal feces: 30% (101/335) water only 25% (84/335) with soap 4.5% (15/335)			Observed	O. O. Omotade 1995	< 5y
Burkina Faso	28% (30/106) 35% (37/106) 25%(12/48)			Observed	S. Cousens 1996	2-36m
	9% (22/244) pre interview 13% (13/100) pre interview 31% (86/ 277) post interview			Observed	V. Curtis 2001	0-35 m

Child's handwashing

In a high proportion of child defecation events, it was either observed or reported that the hands of the child were washed. No study in Africa reported this behavior, which would not necessarily imply that it was not practiced. The prevalence of washing a child's hands after defecation, with any agent, varied significantly with age, being reported or observed with a higher frequency in children 10 months of age (70%) and 40 months of age (90%) than in children of 24 months of age (10%). These patterns

were more pronounced in Latin America (Fig. 15). Only one study from Indonesia[59] described the characteristics of this handwashing: most often, it was accomplished using only water (84%) and only seldomly, using soap (5%). Traditional beliefs such as hot and cold temperatures causing disease may also influence the use of soap. Soap may not be considered appropriate for use with children, because it is seen to increase the cooling proprieties of water in cultures that believe in the cold/hot theories of diseases[60]. Soap utilization is believed to increase the need to use cold water for rinsing, thereby increasing the child's exposure to cooling. Soap is also an expensive commodity, which could limit its use. Also, beauty soap, considered more appropriate to protect the child's skin, is seldom used or even available because of its higher cost; at the same time, laundry soap is considered less appropriate, being too strong for a child's skin[61].

Figure 15. Prevalence of child handwashing, with any agent, after defecation in developing countries, by age and region



Cleaning and washing the child's bottom

In six studies done in Africa and Latin America (Fig. 16) practically all children were either observed or reported to having been cleaned after defecation. No studies in Asia reported this behavior. In Burkina Faso[62], most children (84-89%) were cleaned with

[59] A. M. Almedom, U. Blumenthal & L. Manderson. *Hygiene Evaluation Procedures. Approaches and Methods for assessing Water and Sanitation Related Hygiene Practices.* Intermediate Technology Publications, London, 1997.

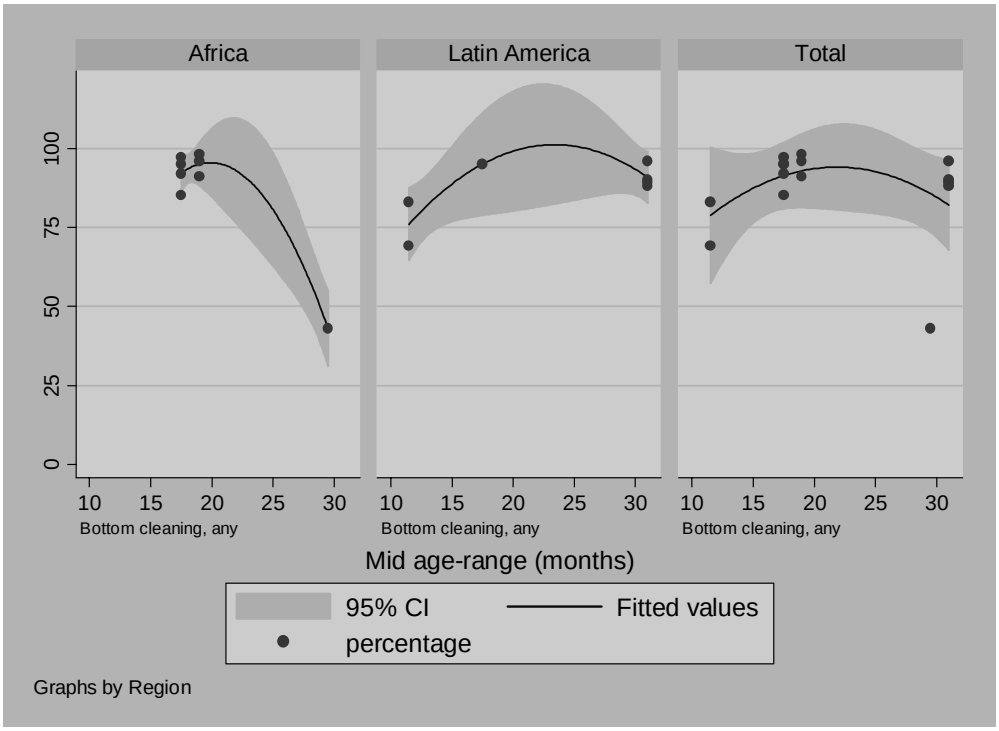
[60] S. Zeitlyn and F. Islam. The use of soap and water in two Bangladeshi communities: implications for the transmission of diarrhoea. *Rev of Inf Dis;* 13 (suppl 4):S259-264, 1991

[61] Ibid.

[62] S. Cousens, B. Kanki, S. Toure, I. Diallo, and V. Curtis. Reactivity and repeatability of hygiene behaviour: structured observations from Burkina Faso. *Soc.Sci.Med.* 43 (9):1299-1308, 1996.

water only, while in Peru[63] most children (65%) were cleaned with the same used diaper, albeit using a clean corner of the diaper. Soap use was reported or observed infrequently (<10%). There were no significant differences seen in this practice by age, region or type of methodology used.

Figure 16. Prevalence of the child's bottom cleaning after defecation in developing countries, by age and region



In Bangladesh[64], cleaning a child after defecation is usually done with water from a small pot, using the left hand (in Islamic cultures people traditionally eat and handle food with the right hand and perform tasks considered contaminated or dirty, such as cleaning a child's bottom, with the left hand). Even though they expect their children to clean themselves after defecation once they became older, most mothers in Bangladesh did not consider children under five years of age capable of that task. In Peru[65], while anal cleansing after defecation was accomplished in nearly all observed events, in 20% of observations the observer noted that stools were left on the child's bottom, and in 8%, in the child's clothes, which were accessible for contaminating the child's hands.

Mother/caretaker handwashing

Handwashing by the mother or the child's caretaker after attending to the child's defecation/cleaning was reported or observed in 10 studies. At the age of 12 months

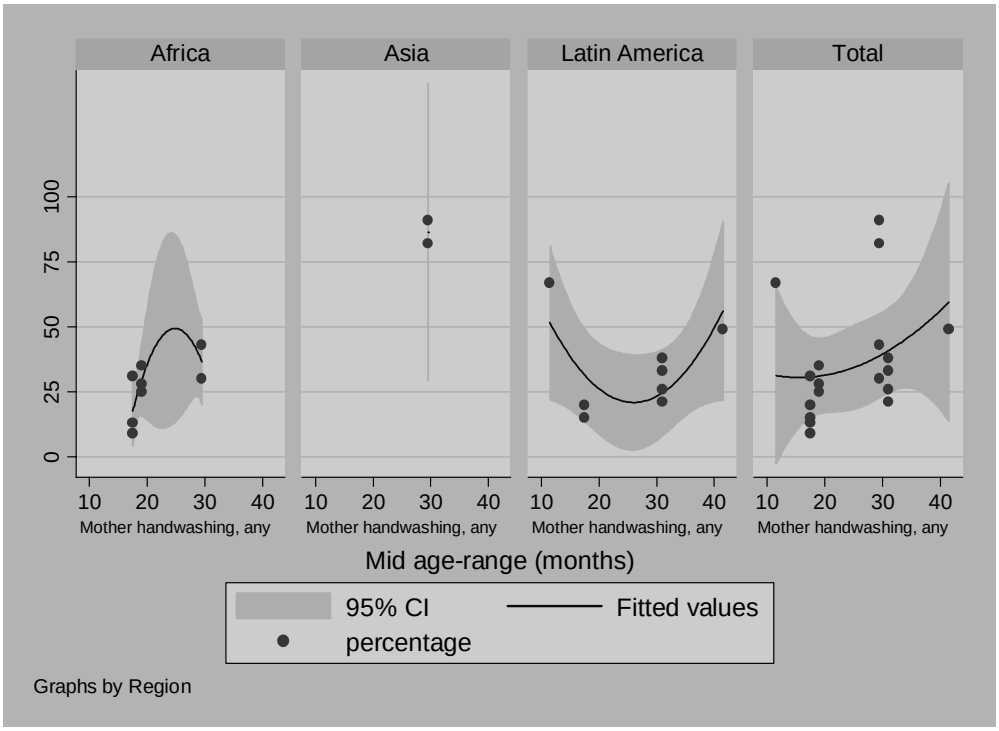
[63] S. R. Huttly, C. F. Lanata, B. A. Yeager, M. Fukumoto, R. del Aguila, and C. Kendall. Feces, flies, and fetor: findings from a Peruvian shantytown. *Rev.Panam.Salud Publica* 4 (2):75-79, 1998.

[64] S. Zeitlyn and F. Islam. The use of soap and water in two Bangladeshi communities: implications for the transmission of diarrhoea. *Rev of Inf Dis;* 13 (suppl 4):S259-264, 1991.

[65] S. R. Huttly, C. F. Lanata, B. A. Yeager, M. Fukumoto, R. del Aguila, and C. Kendall. Feces, flies, and fetor: findings from a Peruvian shantytown. *Rev.Panam.Salud Publica* 4 (2):75-79, 1998.

handwashing occurred in about 30% of cases with the same frequency reported for any type of handwashing (Fig. 17) whether handwashing was done with water alone, soap, mud, or ashes. However, as the age of the reported study groups increased, the predicted prevalence varied by type of handwashing: i.e., it increased to 60% by the time the child was 40 months old if the handwashing was done with water only, but it decreased to 5% if the handwashing was done with soap, mud, or ashes by the time the child was 30 months old (data not shown). Future studies should seek to explore whether these differences are real and the reason they occur. There were no significant differences by region or methodology used in the studies reviewed. Many mothers considered their hands already washed at the same time they were using the water to clean their child's bottom, thereby considering it unnecessary to wash their own hands afterwards[66]. They seemed to be more inclined to wash their hands if they saw that they had gotten contaminated with feces or had became stained[67].

Figure 17. Prevalence of the mother/caretaker's hand washing after attending the child's defecation/cleaning, in developing countries, by age and region



Conclusions

Observing the few studies that reported hygiene practices associated with children's defecation in developing countries, it can be said that the most frequent practices, handwashing by the child or the mother/caretaker, or cleaning the child's bottom after defecation, occurred using water only. The use of soap or alternative agents like mud or ashes, occurred either rarely or not at all. These findings would justify the need to incorporate these behaviors in handwashing promotion programs.

[66] O. Rauyajin, V. Pasandhanatorn, V. Rauyajin, S. Na-nakorn, J. Ngarmyithayapong, and C. Varothai. Mothers' hygiene behaviours and their determinants in Suphanburi, Thailand. *J.Diarrhoeal Dis.Res.* 12 (1):25-34, 1994.

[67] Ibid.

Risk for diarrhea of children's defecation practices

Fifteen studies reported associations between observed or reported defecation practices or stool disposal practices and diarrhea in children, either in case-control studies, descriptive studies or during intervention trials (Table 6).

Table 6. Association between hygiene behaviors and/or children's defecation practices associated with diarrhea incidence or prevalence in developing countries, by country and study design

Country	Study design	N	Age	Risk Factor/ Hygiene Practice	Diarrhea association	Refer	Study Quality
Bangladesh	Case control. Questionnaire	79/219 case 348/1310 control	< 5 y	Hanging latrine	Increased risk of shigellosis OR 1.42 (1.02-1.98) adj OR 1.57 (1.16-2.13) crude	F. Ahmed 1994	1,3,4,5
	Nested Case-control Structured Observation	12/15 ca 5/15 co	< 6 y	Open air defecation	Increase OR 8.00 (1.21-61.94) crude	J.D. Clemens 1987	1,2,3,4,5
		34/45 ca 33/53 co		Feces not removed	OR 1.87 (0.72-4.96) crude		
Indonesia	Case-control Questionnaire	48/48 high inc 24/111 low inc	< 3 y	Disposal of feces in open places vs. latrine	Increase OR > 10.47 (1.47- 214.7)	H. Aulia 1994	1,2,3,4,5
Philippines	Case-control Questionnaire	85/275 ca 144/381 co	< 2 y	Use of nappy	Protection 32% OR 0.68 (0.46-1.00)	J. C. Baltazar 1989	1,2,3,4,5
		87/275 ca 119/381 co		Potties use	OR 0.84 (0.56-1.21)		
		103/275 ca 118/381 co		Open defecation	OR 1.32 (0.94-1.85)		
		85/272 ca 144/379 co		Washing nappies	OR 0.70 (0.49-0.99)		
		17/272 ca 34/379 co		Toilet use	OR 0.59 (0.30-1.13)		
		170/272 ca 201/379 co		Open disposal	OR 1.48 (1.06-2.05) unadjusted		
Lesotho	Case-control	292/803 ca 347/810 co	< 5 y	Latrine ownership	Reduction 24% OR 0.76 (0.62-0.93)	D. L. Daniels 1990	1,3,4,5
Egypt	Observation Questionnaire	52/521 69/806	< 5 y	having latrine	Increased risk 88.2 % vs. 75.7% p=0.047	S. Galal 2001	1,3,5

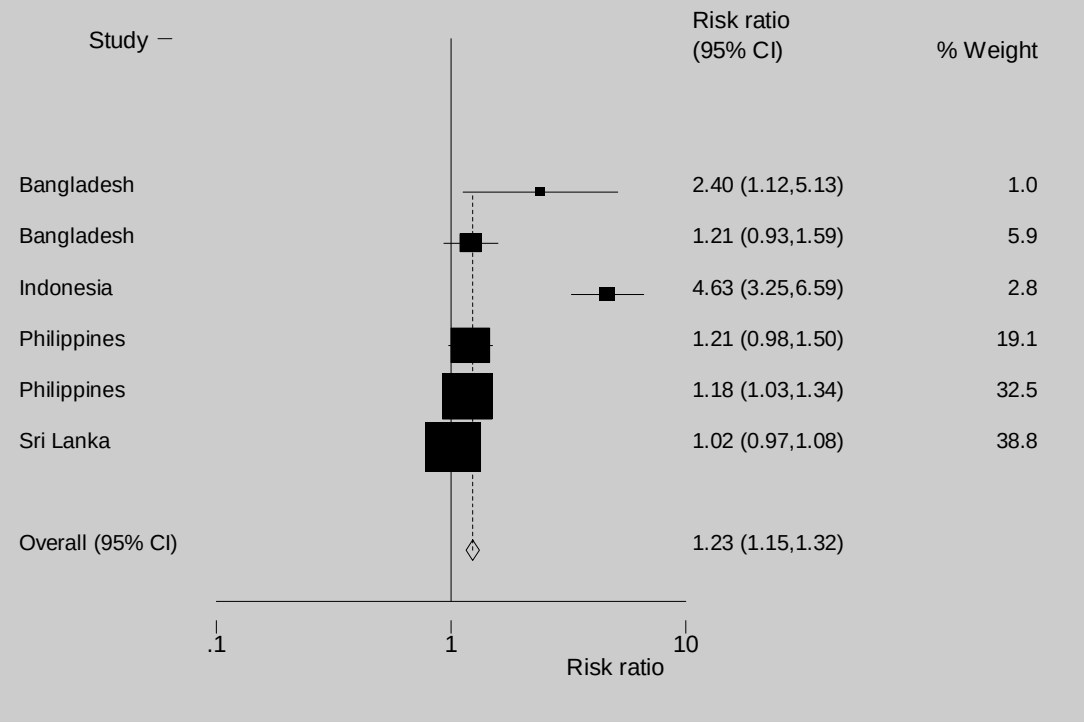
Country	Study design	N	Age	Risk Factor/ Hygiene Practice	Diarrhea association	Refer	Study Quality
Peru	Questionnaire	63 (10+ 7.2) 313 (7.7+ 7.9)	< 3y	Child Eating feces	Increase OR 2.71 (1.36-5.37)	B. A. Yeager 1991	1,3,4,5
		48		Using latrine	OR 0.35 (0.135-0.92)		
		284		Using potties	OR 0.43 (0.203-0.91)		
Bangladesh	Intervention Questionnaire	314 int 309 con	6-23 m	Visible feces	Not known	N. Alam 1989	1,2,3,4,5
	Intervention Questionnaire	576/711 int 550/680 co	< 5 y	Not using latrine	OR 1.3 (0.8-2.0)	K.M. Aziz 1990	1,3,4,5
					OR 1.7 (1.0-2.8)		
Sri-Lanka	Intervention Case-control Observation	111/119 ca 1331/1459 co 1415/2458 ca 2279/4140 co	< 5 y	Feces disposal other than latrine	Increase OR 1.68 (1.25-2.27)	T. E. Mertens 1992	1,2,3,4,5

Legend:
N=Number of diarrhea cases/Total sample size
Refer=Reference
OR=Odds Ratio
ca=Case group (in a case-control trial)
int=Intervention group (in an intervention study)
co=Control group (in case-control or intervention trials)
inc=incidence

1. Sample size of the study consider adequate for the objective of the study
2. Article has descriptive data on prevalence of practices studied
3. Conclusions are adequately supported with data
4. Study measured the correlation of excreta disposal practices with diarrhea
5. Data included adequate statistical inference
6. Explicit theories on defecation practices or methods

Hygiene behaviors or defecation practices were classified either as protective (use of latrines, nappies, potties, toilets, washing diapers), or as risky (open defecation or stool disposal, stools not removed from soil or stools seen in household soil, child seen eating feces). In a meta-analysis of these studies, it was seen that risky behaviors were associated with a significantly increased risk of diarrheal diseases (risk ratio 1.23, CI 1.15, 1.32), where studies from Sri Lanka[68] and the Philippines[69] had a greater influence on the overall estimate because of the greater weight assigned in the meta-analysis (Fig. 18).

Figure 18. Meta-analysis of studies showing the relationship between risky behaviors/hygiene practices and diarrheal diseases in children from developing countries, by study site



In contrast, the association of behaviors or hygiene practices considered as protective for diarrheal diseases showed a borderline protective effect for diarrheal diseases (risk ratio of 0.93, CI 0.86, 1.00) (Fig 19), with the result influenced by the study done in Lesotho[70] that showed a protective effect of latrine ownership for diarrheal diseases in a case-control study (risk ratio of 0.85, CI 0.75, 0.96). Two other studies, one done in Bangladesh[71] (risk ratio for shigellosis 1.36, CI 1.11, 1.66) and the other in Egypt (risk ratio 1.17, CI 0.83, 1.64) showed an increased risk for diarrheal diseases with ownership/use of latrines, suggesting that this intervention may constitute a risk for diarrheal diseases in children, particularly for shigellosis.

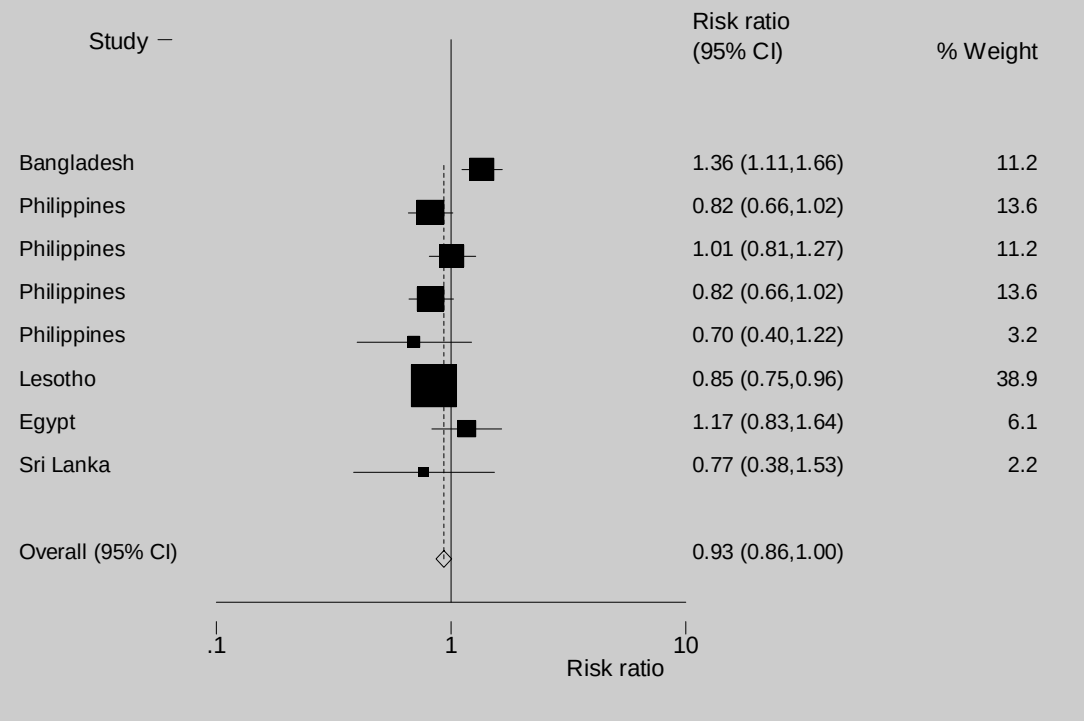
[68] T. E. Mertens, S. Jaffar, M. A. Fernando, S. N. Cousens, and R. G. Feachem. Excreta disposal behaviour and latrine ownership in relation to the risk of childhood diarrhoea in Sri Lanka. *Int.J.Epidemiol.* 21 (6):1157-1164, 1992.

[69] J. C. Baltazar and F. S. Solon. Disposal of faeces of children under two years old and diarrhoea incidence: a case-control study. *Int.J.Epidemiol.* 18 (4 Suppl 2):S16-S19, 1989.

[70] D. L. Daniels, S. N. Cousens, L. N. Makoae, and R. G. Feachem. A case-control study of the impact of improved sanitation on diarrhoea morbidity in Lesotho. *Bull.World Health Organ* 68 (4):455-463, 1990.

[71] F. Ahmed, J. D. Clemens, M. R. Rao, and A. K. Banik. Family latrines and pediatric shigellosis in rural Bangladesh: benefit or risk? *Int.J.Epidemiol.* 23 (4):856-862, 1994.

Figure 19. Meta-analysis of studies showing the relationship between protective behaviors/hygiene practices and diarrheal diseases in children from developing countries, by study site



5. Discussion

The main objective of this review was to document the current state of knowledge on excreta disposal practices — one of the important fecal-oral routes of diarrheal transmission — for children less than five years of age in developing countries. We identified 37 articles from 33 studies conducted over the last 15 years in 16 countries. The relatively small number of studies identified suggests that this important public health topic has not been a research priority. Still, the data obtained from these articles have provided important information that has been summarized in this report.

The methodology used to evaluate defecation practices plays an important role in the results obtained. The majority of reviewed studies have used questionnaire data (61%) to obtain information on defecation practices, while spot observations (45% of the studies) and more formal structured observations (30%) have been used less frequently and usually to complement questionnaire data. Rarely qualitative studies, like focus groups or in-depth interviews, have been used. As has been well documented in the methodological studies reviewed, all methods — and the validity of the results — are affected by the variability of the behavior studied as well as the influence that the method has on the individuals observed or questioned.

Questionnaire data have been shown to be less valid than structured observations and our results endorse that finding, with the variance around mean reported behaviors from different studies was greater and had wider 95% confidence intervals than those means obtained from studies utilizing observations. Some behaviors have been shown to be less reactive to study observations — usually those considered more appropriate by mothers, like the use of potties, latrines, or cleaning the child's bottom. However, these behaviors are affected by the Hawthorn effect, as families usually react to the presence of the observer/study by attempting to demonstrate or affirm what are considered to be better behaviors. Defecation in the household's soil or yard, for instance is less frequently seen at initial observations than during repeat observations. Therefore, this review clearly indicates the importance of combining methods in studies on defecation practices including hygiene-associated behaviors. More intensive and frequent observations may be needed in studies designed to evaluate the impact of interventions and multiple populations, to capture the diversity of these behaviors as well as to protect the study results from the problems of validity, variability and reactivity. Qualitative methods are an important complement to these studies and provide an important source of information to validate questionnaire and observation data. They should be used more widely and should include various participatory tools.

Even with the methodological limitations described and with the limitations caused by the scarcity of the studies identified, important conclusions can be drawn about defecation practices of children in developing countries. As expected, all defecation

practices by children have a strong variation by age. Very few studies had sufficiently adequate sample sizes to provide precise estimates by different age groups. However, the combined results from all the studies clearly indicated age-related behaviors for most practices. This finding should be more adequately explored in future studies. Also, several practices had significant variations by region. While it remains difficult to draw firm conclusions about regional variations given the number of studies as well as the concentration of several studies in single countries/sites, it appears that regional differences exist, possibly linked to levels of socio-economic development as well as cultural differences. More studies, particularly in additional African countries and in Asia, can better probe these possibilities.

Diapers constitute the most frequent defecation practice for infants — especially in Latin America when compared to other regions. As expected, its use declines rapidly with age, being rarely practiced by children older than 35 months of age. Potties constituted the next most frequent defecation practice for older infants and toddlers. It was used less often in Latin American countries than in Africa. However, several studies done in one African country, Burkina Faso, heavily influenced overall results since in that country up to 75% of toddlers used potties, compared with less than 20% of children in Latin America. More precise information about the characteristics of potty use in that country as well as identifying the determinants of its use would be useful to see if potty promotion programs could be developed elsewhere. When children get older, potties are used less as defecation in open areas, either inside the household or in the yard, or in outside areas or rivers, becomes the predominant practice. Latrines have not been used with any frequency by children under five years of age. They were rarely used by children under three and by no more than 25% of children under five. Anthropological studies, primarily in Peru, indicated why mothers do not prefer that their children use latrines: fear of contamination as well as the possibility of a child falling into badly constructed latrines, which many times are just open pits without appropriate covers. This review has clearly indicated that latrine promotion programs should carefully address these maternal concerns to increase latrine use by older children. This would, in turn, decrease open defecation in household areas or in rivers, a practice that contaminates the environment. Very few studies have reported toilet use by older children, in part because of the slow progress in installing appropriate sewage systems in developing countries. Also, most studies of children's defecation practices have been done in areas considered problems for hygiene and health, while excluding more affluent sectors in those societies. Therefore the reported prevalence rates must be used with caution, particularly when seeking to extrapolate those figures to other countries or regions.

An important part of the review was to identify the final destination of the child's feces, regardless of the original defecation site. Cloth diapers are usually washed and wastewater is either discarded in the household soil or nearby yard, or in a latrine or toilet facility. Studies in Peru have identified that mothers do not consider this contaminated water dirty, given their perception that baby's feces are not dirty. More research is needed to evaluate these determinants in other countries and regions and to develop appropriate interventions to avoid household contamination with water already contaminated by soiled diapers.

Feces deposited in the soil are either picked up and disposed of in a proper place like a latrine or toilet, or are discarded in an open area near the home or in rivers. An alternate behavior is covering feces with dirt or burying them. If feces are not properly disposed, they remain a source of contamination in the environment. In Peru, dogs were observed eating feces left on the soil or on potties before being discharged. This was not reported in other studies, but it may occur in other sites/regions. Animal feces, including those from dogs, are seldom contaminated with human enteropathogens[72]. The only exception seems to be chickens. Epidemiological studies have incriminated chickens as a risk factor for the development of *Campylobacter jejuni* diarrhea in children[73]. The great majority (80%) of chickens have this organism in their cloaca[74]. Campylobacter can survive up to 48 hours in chicken feces deposited in the soil (especially if the weather is humid and they are not exposed to the sun). In a Lima study, children of crawling age were observed to have a mean of 2.9 contacts with chicken stools in a 12 hour observation period[75]. We have not identified similar studies with human feces in household soil, but it is likely a similar pattern exists, where soil contaminated with feces from toddlers' defecations and not properly disposed, may come into contact with younger children, who crawl around the house. There may be variations in the frequency of these contacts, since mothers do not consider chicken's feces dirty while toddler's feces are. However, given the fact that a significant proportion of children's feces were not discharged or removed from their original defecation sites during the observation period in up to 30% of studies, this type of contamination may be important. It has been postulated that toddlers' feces deposited in the household soil constitute the greatest risk for diarrheal diseases in younger children[76]. Further studies are needed, in more sites and regions to evaluate the degree of exposure of young children to feces from toddlers deposited in the household soil. Studies could also evaluate if an intervention, like the promotion of potties that occurred in Lima, Peru[77], could be developed and implemented more widely if shown to be protective and cost-effective for the prevention of diarrheal diseases.

Other important aspects of defecation practices are the hygiene behaviors with which they are associated. Studies have reported three practices: washing the child's hands and cleaning his/her bottom after defecation, as well as handwashing by the mother/caretaker after attending the child. Washing the hands of children after they defecated was strongly dependent on the child's age, following an unexpected pattern: it was frequently done (>75%) with infants, then rarely with toddlers (about 10%), increasing once more in older children. This pattern may suggest that the initial handwashing was done by the mother

[72] R. E. Black, G. Lopez de Romana , K. H. Brown, N. Bravo, O. G. Bazalar, and H. C. Kanashiro. Incidence and etiology of infantile diarrhea and major routes of transmission in Huascar, Peru. *Am.J.Epidemiol.* 129 (4):785-799, 1989.

[73] O. Grados, N Bravo, R.E. Black, J.P. Butzler. Paediatric campylobacter diarrhoea from household explosure to live chickens in Lima, Peru. Bulletin of the World Health Organization; 66(3):369-74, 1988.

[74] R. E. Black, G. Lopez de Romana , K. H. Brown, N. Bravo, O. G. Bazalar, and H. C. Kanashiro. Incidence and etiology of infantile diarrhea and major routes of transmission in Huascar, Peru. *Am.J.Epidemiol.* 129 (4):785-799, 1989.

[75] G.S. Marquis, G. Ventura, R.H. Gilman, E. Porras, E. Miranda, L. Carvajal and M Pentafiel. Fecal contamination of shanty town toddlers in households with non-correlated poultry, Lima, Peru. *Am. J.Pub. Health;* 80: 146-149, 1990.

[76] C.F. Lanata, S.R. Huttly and B.A. Yeager. Diarrhea-whose faeces matter? Reflections from studies in a Peruvian shanty town. *J Ped.Inf.Dis*, 17, 7-9, 1998.

[77] B.A. Yeager, S.R Huttly, J. Diaz, R. Bartolini, M. Marin and C.F. Lanata. An intervention for the promotion of hygienic faeces disposal behaviours in a shanty town of Lima, Peru. *Health Education Research* 17 (6):761-773, 2002.

of infants, since she may have greater concerns about her child's safety while also being in attendance at most or all of her infant's defecation events. This may change as the child gets older, probably as the mother considers the child less vulnerable and the child becomes more independent. Later, as the child reaches an age that allows him or her to imitate adult roles and/or respond to specific commands from the mother, the child may take charge of washing his or her hands. It will be important to test this hypothesis in future studies. Soap was rarely used when washing the child's hands, although this fact was reported in only one study. There is therefore a real need to conduct further studies of these practices and to stimulate the use of soap by children, a behavior that may be associated with greater acceptance of soap use as adults. Soap promotion programs should also include use by children. In contrast, the mother/caretaker handwashing practices followed a different age-related trend: such handwashing frequently did not occur around infants (at a rate of about 30%), with water or soap use (or alternative acceptable methods like mud or ashes) showing a similar frequency. The frequency increased with older children (up to 60% in children four to five years of age), but only with water. Again, this pattern may reflect a mother's perception on how dirty are her child's feces. The low frequency of handwashing in infants again may reflect her lack of awareness of contamination from infant's feces, and its greater frequency in older children may reflect her perception that feces are dirtier as the child becomes older. Again, soap is seldom used, an important reality that needs to be improved by soap promotion programs. Cleaning the child's bottom after defecation represents a frequent practice for most children. It is either accomplished using water or a clean corner of the diaper (a practice prevalent in Latin America.) Again, soap is rarely used.

A final section in this review included those few studies that attempted to link children's defecation practices with diarrhea. Behaviors that were considered risky (open defecation, stool disposal in open fields, stools not removed from soil, stools seen in household soil, and children seen eating feces) were found to increase the risk of diarrhea in the studies reviewed (combined weighted risk ratio 1.23, CI 1.15, 1.32). In contrast, behaviors that were considered protective (use of latrines, nappies, potties, toilets, washing diapers), were found to be protective but with borderline statistical significance (combined weighted risk ratio of 0.93, CI 0.86, 1.00). Most of these studies were case-control studies, and none were done as part of interventions aimed to improve children defecation practices while evaluating the impact on diarrhea rates. Of the three studies that looked for an association of latrine use/existence with diarrheal diseases, two found that latrine use was risky — particularly for contracting shigellosis. This association may endorse the mother's perception that latrines are dirty and may be a source of contamination for children. Such findings and perceptions are significant and should be explored with further studies and taken into consideration by latrine promotion programs.

From these reviews, we would offer the following conclusions/recommendations:

- When measuring or evaluating children's defecation practices in developing countries, more than one methodology, ideally combining participatory observation techniques with qualitative methods, should be used to produce more valid and precise results. Questionnaires are less valid and produce less precise estimates when compared to observations.

- Very few studies have been done in developing countries on children's defecation practices. More studies should be done, including an increase in the number of African and Asian countries studied, to improve the precision of the estimates, as well as to seek to identify possible trends over time in some practices, like the use of diapers or disposable diapers in developing countries.
- Supported by current practices, hygiene-promotion programs should recommend the following defecation practices for children in developing countries:
    - Diapers, ideally disposable ones, should be used by all infants. In the case of cloth diapers, appropriate care should be taken to avoid contamination of the household soil by waste water.
    - Potties should constitute the next best recommended defecation practice for toddlers, since they help avoid contamination of household soil. Feces deposited in potties should be covered and discarded in appropriate places, like latrines or toilets.
    - Older children should use latrines or toilets. Currently, very few of them use these facilities, and opt for open defecation in areas near the house or in rivers. Maternal perceptions on the risks involved in using latrines by children may play an important role in explaining its poor utilization. Latrine promotion programs should develop appropriate interventions to increase their use by older children.
    - The maternal perception of how dirty a child's feces are, is based on the child's age. Feces from infants or small children are not considered dirty, a fact that seems to influence hygiene practices like handwashing. It is very important to study maternal perceptions in this area in different countries/regions, since it seems to be an important determinant of children's defecation and hygiene-related practices.
    - Mothers/caretakers/family members should be aware that leaving human feces in the household soil represents a real risk for diarrheal diseases. These feces should be removed from the soil and discarded in appropriate places like latrines. Either covering them with soil or sweeping them away are probably inadequate practices and should be avoided.
    - Handwashing with soap and cleaning the child's bottom with water and soap after defecation should be promoted. Handwashing promotion programs should include messages designed to increase the use of soap by children and mother/caretakers after defecation.

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Annex

Legend:
N= Total sample size
OR=Odds Ratio
ca=Case group (in a case-control trial)
int=Intervention group (in an intervention study)
co=Control group (in case-control or intervention trials)
inc=incidence
m=months
y=years
c=child
(*) N = value referred only to the sample population included in the data analysis, not to the whole population participating in the study
(**) Study ' criteria:
1. Sample size of the study consider adequate for the objective of the study
2. Article has descriptive data on prevalence of practices studied
3. Conclusions are adequately supported with data
4. Study measured the correlation of excreta disposal practices with diarrhea
5. Data included adequate statistical inference
6. Explicit theories on defecation practices or methods

Author	Location, setting	Study period	Type of study	Exposure/ Intervention	Age group	N *	Main result	Study quality**
F. Ahmed, 1994 0	Bangladesh, rural	87-89	Case-control: Questionnaire	Use of latrine	< 5 y	219 ca 1310 co	High risk for Shigella having: Hanging latrine 1.42 (1.02-1.98) Family latrine 1.37 (0.99-1.89)	1, 3, 4, 5
N. Ahmed, 1993 0	Bangladesh, rural	85-86	Intervention: Questionnaire, Structured	Health education (ground sanitation +personal hygiene +food	0-19 m	185 ca 185 co	40% diarrhea reduction	1, 3

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			observation, Focus groups	hygiene)				
N. Alam, 1991 0	Bangladesh, rural	80- 83	Intervention: Spot observation, Questionnaire	Hygiene education Handwashing, Removal of feces Hand pumps	3-59 m	611int	80% less diarrhea in child 3-11 m from families who adopted the intervention as compared to those who did not	1, 2, 3 ,4, 5
N. Alam, 1989 0					6-23 m	314 int 309 co	40% diarrhea reduction in children from families who adopted four behaviors compared to children in families with none or only one , p<0.01	1, 2, 3, 4, 5
A. Almedon, 1996 0	Kenya, Tanzania, Ethiopia, rural	93-94	Spot observation, Structured observation, Focus group, Questionnaire	Hygiene behavior Disposal of feces Handwashing			Feces disposal by digging and burying. Child defecates in fixed site and informs mother for feces disposal Mother's handwashing with ashes	6
H. Aulia, 1994 0	Indonesia, rural	88	Cohort study: Questionnaire, Spot observation	Place of defecation Disposal of feces	< 3 y	332	Comparing children with high and no incidence of diarrhea with disposal of feces in open field vs. latrine: OR 10.47 (1.47-214.7) p=0.001	1, 2, 3, 4, 5
K. Aziz, 1990 0	Bangladesh, rural	84-87	Intervention: Questionnaire	Hygiene education Hand pumps Pit latrines	< 5 y	576-711 ch-y int 550- 680 ch-y co	25% reduction in diarrhea episodes int vs. co. Greater effect in older children Higher diarrhea incidence in 0-59 m with no disposal of feces into a latrine OR 1.7 (1.0-2.8) only in 1987	1, 3, 4, 5
J. Baltazar, 1989 0	Philippines, urban/rural	85	Case-control: Questionnaire	Defecation places Feces disposal	< 2 y	275 ca 381 co	Use of nappies 32% diarrhea protection OR 0.68 (0.46-1.00) Open defecation OR 1.32 (0.94-1.85) Washing nappies OR 0.70 (0.49-0.99) Disposal of feces in open field OR 1.48 (1.06-2.05) unadjusted	1, 2, 3, 4, 5

Author	Location, setting	Study period	Type of study	Exposure/ Intervention	Age group	N *	Main result	Study quality**
Bessenecker, 1994 0	Mexico, rural	94	Questionnaire, Spot observation, Focus Group	Hygiene behavior Place of defecation Feces disposal Handwashing	< 9 y	142	Defecation is related to age: 0-2 y (90% diapers); 2-5 y (40% open air, 32% latrine, 16% potty); >5y (80% latrines, 16% open air, 3% potty). Toddlers 0-2y do not use latrines for fear of falls/ contamination. Child's feces less dangerous than adult feces. Disposal of feces mostly in < 2 y: diapers in open air direct or first into garbage container that is then dumped in open air. Mother's handwash after child defecation: 0-2 y 66%, 2-5 y 49%, > 5y 7%. Child's handwash after defecation: 2-5y 81%, >5y 89%; Child's bottom cleaned 0-2y 58%	1,2,3
D. Blum, 1990 0	Nigeria	82-86	Intervention: Questionnaire	Hand pumps Pit latrines Hygiene education	< 6 y	935 int 470 co	Children 12-23 m defecate in open area at home. Ch 2-5 y 74% in open field. Intervention increased latrine use by ch 2-5 y from 0 to 19%	1, 2,
J. Clemens, 1987 0	Bangladesh	84-85	Nested Case-control: Structured observation	Hygiene behavior Place of defecation Feces removal	< 6 y	45 ca 53 co	Open air defecation associated with diarrhea OR 8.00 (1.21-61.94) No removal of feces OR 1.87 (0.72-4.96) Handwashing after defecation by mother or children not related to diarrhea.	1, 2, 3, 4, 5
S. Cousens, 1996 0	Burkina Faso	93-94	Structured observation	Hygiene behavior Place of defecation Feces disposal Handwashing	2-36 m	200	65%-79% used potty; 6-16% used nappy; 8-17% open field Siblings (3-5 y) use potty 48% , latrine 30% Feces disposed in latrine 79%; yard 10-17%. Child bottom clean w/o soap 75%, with soap 5-9% Mother handwash 25% after cleaning child, 12% with soap Defecation in yard (increased) cleaning child after defecation (decreased) were reactive to observer presence in repeated observations	1, 2, 3, 5, 6
V. Curtis,	Burkina Faso	90-93	Case-control:	Hygiene behavior	0-36 m	277	Feces disposal on yard 60% in children <	6

Author	Location, setting	Study period	Type of study	Exposure/ Intervention	Age group	N *	Main result	Study quality**
1997 0			Focus group, Structured observations, Questionnaire	Defecation practices Mother's/caretaker's handwashing			6m. Mother's handwashing after cleaning child's bottom is rare, 5% use soap.	
V. Curtis, 2001 0	Burkina Faso	95-98	Intervention: Structured observation	Hygiene education Place of defecation Feces disposal Handwashing	0-35 m	107-306	Children using potty 66-74% Feces disposed in latrine 66-80% Cleaning child's bottom 85-95% Mother's handwash after cleaning child 9-13% Mother's handwashing increased from 13% to 31% (before vs. after) p <0.001 Use of potty increased from 74% to 82 % (before vs. after intervention, p=0.009) but it was due to trend Feces disposed into latrine increased from 80% to 84%, not significant	1, 2, 3, 5
V. Curtis, 1995 0	Burkina Faso	90-91	Case-control : Questionnaire, Spot observation	Hygiene behavior Place of defecation Feces disposal	< 36 m	2793 house-holds	Child < 6 m: lining diapers 52%; potty 45%; soil 2%; 6-11 m: diapers 18%; potty 80%, soil 5%; 12-17 m: diapers 5%, potty 85%, soil 10% Feces disposal: <6 m : 23% soil, 40% latrine, 38% outside home; 6-11 m: 8% soil, 67% latrine, 25% outside home; 12-17 m: 3% soil, 77% latrine, 20% outside home. Washing diapers more often in compound with tap water OR 2.24 (0.74-6.85) Mother's handwash after cleaning child's bottom often if tap water OR 1.91 (1.08-3.37)	1, 2, 3, 5,
E.Traore, 1994 0						757 ca 631 co	Feces seen in yard 13% of observations; 12% in children reported using pot vs. 24% in children reported defecating in yard (p<0.001) Feces 11% observed in yard if feces reported disposed in latrine vs. 22% if	1, 2, 3, 4, 5

Author	Location, setting	Study period	Type of study	Exposure/ Intervention	Age group	N *	Main result	Study quality**
							feces reported disposed in yard (p< 0.0001) Diarrhea associated to feces reported disposed elsewhere than latrine OR 1.50 (1.09-2.06). Reported defecation in pot or latrine, not associated with diarrhea. Feces seen in yard more frequent in diarrhea cases OR 1.44 (1.03-2.03)	
V. Curtis, 1993 0						549	Questionnaire vs. observation had poor agreement (k <0.3) Repeated observations had good agreement (k>0.6)	1, 2, 3, 5, 6
D. Daniels, 1990 0	Lesotho, rural	87-88	Case-control: Questionnaire	Latrine ownership Feces disposal	< 5 y	803 ca 810 co	24% reduction of diarrhea in latrine ownership OR 0.76 (0.62-0.93). Child's feces disposed in latrine 50% among latrine ownership	1, 3, 4, 5
E. Ekanem, 19910	Nigeria	89	Case-control: Spot observation	Hygiene behavior	6-36 m	67 ca 206 co	Presence of feces in toilet area/bowl associated with diarrhea OR 1.79 (1.20-2.41)	1, 3, 5
S. Galal, 2001 0	Egypt, rural	>98	Spot observation, Questionnaire	Latrine cleanliness	< 5 y	541	Exposure to flies in latrines is a risk for diarrhea 88.2 % vs. 75.7% p=0.047	1, 3, 5
A. Gorter, 1998 0	Nicaragua	89	Case-control: Spot observation	Hygiene behavior Place of defecation Bottom cleaning Feces disposal	< 2 y	88 ca 64 co	Use of diaper 77-78%. Removal of feces from where deposited 77-91%. Bottom cleaning 82-86%. Feces in or around house 40% Use of diaper or underclothes protected diarrhea OR 0.50 (0.22-1.13). Child's bottom cleaned protected diarrhea OR 0.44 (0.18-1.05). Feces removed from where deposited OR 0.44 (0.18- 1.05) Repeatability was good for use of diapers (k=0.56) and feces in or around house (k=0.42) for repeated observations	2, 3, 4, 5

Author	Location, setting	Study period	Type of study	Exposure/ Intervention	Age group	N *	Main result	Study quality**
P. Haggerty, 1994 0	Zaire, rural	87-88	Intervention: Structured observations	Hygiene education	3-35 m	1764	11% reduction in diarrhea 0.89 (0.84-0.98), p<0.025. More impact in child 24-35 m.	1, 3, 5
S. Huttly, 1998 0	Peru, peri-uban	87-88	Spot observation, Questionnaire, In depth interview	Hygiene behavior Place of defecation Feces disposal Mother's/caretaker's handwashing	< 3 y	120	Feces seen in soil 82% of households. Human feces more likely to be clear if deposited in household floor (50%, patio 12%, surroundings 6%). Diaper used: 100% < 6 m, 14% > 18 m. Potty : 0% < 6 m, 22% >18 m. Defecation in soil: 12% 12-17 m, 48% >18 m Stools in diapers most likely to be washed. Feces in potties disposed in latrine or surrounding area. Potties desirable but hard to get trained Child's bottom cleaned after defecation in 95%; using diaper 65%, their clothes 25%, paper 11%. After child's cleaning, 21% still had feces on their body, 8% on clothes. Mother's handwashing after cleaning child in 20%, 5% with soap Latrines dangerous for young children; safe for 3-4 y	1, 2, 3
S. Huttly, 1994 0	Peru, peri-urban	87	Spot observation	Hygiene behavior Place of defecation Feces disposal	< 3 y	62 families	Child uses diapers or clothes: 100% < 12 m; 59% 12-23 m; 29% 24-35 m. Potty: 0% < 12m; 15% 12-23m; 14% 24-35 m. Pit latrine: 4% 24-35 m. Soil: 0% < 12 m; 21% 12-23 m; 14% 24-35 m. Feces disposal: Diapers by washing; potty 79% thrown into a latrine; soil 33% covered, 17% eating by dog, 42% swept aside Handwashing after changing diaper 27% with soap, 46% the whole hands	2, 3

Author	Location, setting	Study period	Type of study	Exposure/ Intervention	Age group	N *	Main result	Study quality**
C. Lanata, 1998 0	Peru, peri-urban						Toddlers & other young children defecating in/around home are highest threat for child < 2 y Older children & adults defecate in hills are lower direct threat, but only through fecal-oral route Contamination with diapers is not important Animal feces are no major threat most important from chickens Potties recommended for toddlers	6
C. Lanata 1994 0	Peru, peri-urban	89	Intervention: Questionnaire, Spot observation	Handwashing with soap water containers playpen for children corralling animals	6-18 m	500	43% diarrhea reduction in group consuming 0.2 g of soap per handwashing No impact on Campylobacter jejuni excretion using playpen & corralling animals	1
M.Manun'Ebo 1997 0	Zaire	87	Structured Observation, Questionnaire	Hygiene behavior Feces disposal	3-35 m	300	Child feces left on ground 5% observed vs. 29% reported. Feces thrown outside yard 21% observed vs. 32% reported Mother's report disposal of feces into latrine 40% observed vs .75% reported.	1, 2, 3, 6
T. Mertens, 1992 0	Sri-Lanka, rural	87-88	Intervention: Case-control, Questionnaire, Spot observation	Health education Latrine installation	< 5 y	1415-2458 ca 2279 - 4140 co	Commonest place of defecation was 81% house environment; 28% thrown into latrine; 49% thrown outside the house; 15% left on site Few mothers use potties Disposal of feces not in latrine was associated with diarrhea OR 1.68 (1.25-2.27)	1, 2, 3, 4, 5
O. Oomatode, 1995 0	Nigeria, rural/peri-urban	93-94	Spot observation	Mother's/caretaker's handwashing	<5 y	638	Child's bottom cleaning 26% only with water, 6% with soap, 7% with paper, 4% with cloth, 57% did not clean Handwashing after cleaning child's bottom: 57% only with water; 10% with soap, 33% did not wash hands. Handwashing after disposal of child's	1, 2, 3, 4

Author	Location, setting	Study period	Type of study	Exposure/ Intervention	Age group	N *	Main result	Study quality**
							feces: 25% only with water; 4% with soap, 71% did not wash Good agreement on handwashing after feces disposal and cleaning child after defecation in repeated observations Human feces around the house in 17% of households. More rural than peri-urban	
O. Rauyajin, 19940	Thailand, rural & urban	89	Spot observation, Focus group, In depth interview	Hygiene behavior	< 2 y	12 mo/ch	Young children defecate on their bed sheets, older on floor Child's cleaning after defection with bed sheet corner and water without soap No mother's handwashing after child's cleaning	-----
N. Sahid, 19960	Bangladesh, peri-urban	83	Intervention: Questionnaire	Handwashing Health education + Soap + water containers	All ages	671 ca 695 co	60% reduction of diarrhea incidence in child 1-5 years RR 0.38 (0.33-0.43). Similar effect in all age groups including infants and toddlers. Effect mostly on bacterial diarrhea, not rotavirus	1, 3, 5
B. Stanton & J. Clemens 19870	Bangladesh, urban	84-85	Intervention: Spot observation, Questionnaires	Hygiene behavior Mother's/caretaker's handwashing,	< 6 y	937 in 986 co	Child defecates in living area 39-63%. Feces seen in house area 63-77% 26% diarrhea reduction in <6 y RR=0.74 (0.67-0.82). Effect most pronounced in 2-3 y. No decrease in child defecation in living area intervention 67% vs. control 63%. Feces seen in house area 57% intervention vs 54% control.	1, 2, 3, 5
B. Stanton & J. Clemens, 1987 0						247 house holds	Over reporting of good behavior. Poor agreement between KAP and 24-recall questionnaire k=0.03, direct observation k=0.00	1, 3, 5
B. Yeager, 1991 0	Peru, peri-urban	85-87	Questionnaire	Hygiene behavior Defecation practices	< 3 y	677	Increased diarrhea incidence if child seen eating feces OR 2.71 (1.36-5.37) or eating soil OR 1.36 (0.83-2.21) Compared with child defecation outside, child defecation in latrines OR 0.35 (0.135-0.92); potty OR 0.43 (0.203-0.91) had less incidence of diarrhea	1, 3, 4, 5

Author	Location, setting	Study period	Type of study	Exposure/ Intervention	Age group	N *	Main result	Study quality**
B. Yeager, 1999 0	Peru, peri-urban	94	In depth interview, Focus group	Hygiene behavior Reported defecation practices	< 3 y	69	Diapers until 1 year; potties less the best option for 1-3 y but fail to train: fear of falling, no time for training. Soil defecation accepted: close for the child, easy to clean, not dangerous. Hill and latrines: dangerous for young child	1, 3, 6
B. Yeager, 2002. 0	Peru, peri-urban	97-98	Intervention: Structured observation	Potty training (video + pamphlet)	15-47 m	362 int 360 co	Successful pilot trial. Low coverage of intervention did not allow to show potentially impact Defecation in nappies 10-20%, clothes 9-19%, potty 27-46%, soil 9-21%, latrine 12-19% Child cleaning after defection 88-96%. Handwashing after cleaning children 21-38%. Feces in soil were cleared up 25-42%	1, 2, 3
S. Zeitlyn, 1991 0	Bangladesh, rural & urban		Structured Observation, In depth Interviews	Handwashing Hygiene behavior	< 5 y	100	Handwashing after defecation with water alone. Ash or mud used only if there is grossly visible soil; soap is considered cosmetic Diapers not used. Toddler's feces are less polluting than older child's feces	1, 3, 6