FACTORS ASSOCIATED WITH USE OF IMPROVED WATER SOURCES AND SANITATION AMONG RURAL PRIMARY SCHOOLCHILDREN IN PURSAT PROVINCE, CAMBODIA

Wee Liang En[1] and Goh Lee Gan[2]

[1]Yong Loo Lin School of Medicine, [2]Division of Family Medicine, Department of Medicine, National University Hospital, National University Health System, Singapore

Abstract. Access to improved water supplies and sanitation generally reduces childhood diarrhea incidence. Using a cross-sectional stratified cluster sampling design, interviews were conducted among grade 4-6 primary schoolchildren from 10 primary schools in highland and lowland districts of Pursat Province, Cambodia, in both June (rainy season) and December (dry season) 2009 to determine the demographics and water sources/sanitation used. Parents also recorded any incidents of diarrhea in their children over those months. We explored the sociodemographic factors associated with use of improved water sources/sanitation, using mixed effect modelling. Participation was 84.7% (1,101/1,300). About half exclusively used improved water sources but less than 25% had access to improved sanitation during both seasons. Adjusting for clustering within households and within individuals over time, exclusive use of improved water sources and sanitation were associated with the following: dry season, more permanent housing type, family size < 8 members, and higher levels of education. Exclusive use of improved sanitation was associated with good hygiene practices and exclusive use of improved water sources was associated with male gender. Access to improved water sources and sanitation among rural Cambodian primary schoolchildren can be improved, particularly in those with lower socio-economic status. Programs to promote use of improved water sources/sanitation need to target less educated parents.

Keywords: water source, sanitation, schoolchildren, Cambodia

INTRODUCTION

Diarrheal diseases cause significant mortality and morbidity among children of developing countries (Sunoto, 1982). Many interventions can reduce diarrhea incidence, including improving water quality and sanitation facilities (Esrey *et al*, 1991). Water quality can be addressed at many levels, including at the source, storage and point-of-use; it can also be improved through investment in infrastructure or catalysing behavioral change. Infrastructure improvement tends to be more cost-effective in areas where access to improved water sources and sanitation

Correspondence: Wee Liang En, Block MD3, #03-20, 16 Medical Drive, Department of Epidemiology and Public Health, Yong Loo Lin School of Medicine, National University of Singapore, National University Health System, Singapore 117597.
Tel: +65 96777651; Fax: +65 67791489
E-mail: u0801139@nus.edu.sg

remains low (Haller *et al*, 2007).

Reduced access in childhood to improved water sources and proper sanitation can lead to poor nutritional status and impaired growth (Esrey *et al*, 1988; Checkley *et al*, 2004). One of the targets of the Millennium Development Goals is to halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation; though improvements have been made for ensuring better access to improved water sources, progress towards basic sanitation is unfortunately insufficient (WHO/UNICEF, 2010a). Improved water sources have been shown to be associated with decreased childhood diarrhea (Plate *et al*, 2004), perhaps because of decreased fecal contamination (Kravitz *et al*, 1999). Similarly, improved sanitation can likewise be linked with decreased risk of diarrhea (Cairncross *et al*, 2010), and reduced diarrhea mortality in children (Burnstrom *et al*, 2005). Improvements are most marked when access to improved sanitation and water sources are combined (Gasana *et al*, 2002). In developing countries with low levels of access to these improvements, encouraging increased use of improved water sources and sanitation has the potential to reduce diarrhea morbidity and improve pediatric health.

Cambodia is a developing Southeast Asian country with low levels of access to improved water sources and sanitation, particularly in rural areas. In 2008, 46% of the rural population had access to improved water sources; while only 18% of the rural population had access to improved sanitation (WHO/UNICEF, 2010b). This is in contrast to urbanized areas of the country where more than 90% of residents in Phnom Penh (the capital) have access to potable drinking water, compared to less than 12% in largely rural Pursat Province (Ministry of Planning, 2007). However, the factors associated with use of improved water sources and sanitation are unknown, making it difficult to define a target group for potential intervention. It is therefore of interest to investigate the factors influencing use of improved sanitation and water sources in this country; especially in rural areas where interventions to increase use can potentially yield significant dividends and improve child health. Here we present the results of such a study done in June and December 2009 among rural primary school-going children in Pursat Province, Cambodia. Pursat is one of Cambodia's twenty-four provinces; predominantly rural and incorporating both highland and lake basin regions, it is a microcosm of Cambodia proper.

MATERIALS AND METHODS

This study was carried out in Pursat Province, Cambodia, using a cross-sectional, stratified cluster sampling design. Pursat Province is Cambodia's 4th largest province and is organised into six districts: one urban (Sampov Meas), one remote and relatively underpopulated district (Veal Veng), and four rural districts, one highland (Phnom Kravanh), and three lowland districts in the Tonle Sap lake basin (Bakan, Kandieng and Krakor). We excluded urban and remote districts from our study. The total schoolgoing population in the rural districts of Pursat Province was 56,921; 19.5% (11,117/56,921) of which stay in highland districts (Ministry of Education, Youth and Sport, 2008). We chose only children in grades 4-6 due to improve communication and reliability of data. Of the three districts, we chose Bakan District as the most representative of the lowland population, given that a

majority of the population stayed in this district. There were 63 primary schools in Bakan District (lowland) and 35 in Phnom Kravanh (highland) enrolled in grades 4-6. The total population enrolled in grades 4-6 in these schools was 12,546. An updated list of all 98 primary schools was used as the sampling frame; schools were stratified proportionately according to highland/lowland distribution. Ten schools were randomly selected, consisting of 7 lowland and 3 highland schools, with a total enrolment of 1,300 students and a range of 120-140 students per school. All eligible students in each school were surveyed.

We collected demographic information and descriptions of water sources/ sanitation through interviews with the students' parents, using self-reported questionnaires and the help of trained Khmer translators and picture aids. Parents recorded a 1-month history of diarrhea symptoms among the schoolchildren, after the definition of diarrhea was communicated to them. Data was collected on two occasions; once in the rainy season (June 2009) and once in the dry season (December 2009). Ethical approval was obtained from the National University of Singapore Institutional Review Board, and permission to conduct the study was obtained from local school authorities; informed consent was obtained from both parents and children, and participation was fully voluntary.

Definitions

Diarrhea was defined as ≥ 3 loose stools during the previous 24 hours. Using the 2000 WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation classification, tube wells, dug wells, and rainwater collection were defined as "improved water sources", whereas surface water sources, like springs, rivers and ponds, were considered unimproved; pour-flush and simple-pit latrines were considered "improved sanitation", while public and open latrines were considered unimproved. Due to the difficulty of calculating rural incomes, we used housing type as a proxy for socio-economic status. Those staying in more temporary housing (*eg*, thatched roof instead of zinc roof, wooden walls instead of brick/concrete) were classified as having a lower socio-economic status.

Statistical analysis

Children were chategorize as exclusive or non-exclusive users of improved water sources/improved sanitation. Descriptive statistics were computed for the general population. McNemar's chi-square test was used to determine significant differences in usage of various water sources and sanitation between the rainy and dry seasons. To control for clustering within households and within individuals over time, we used mixed effect models to determine the independent predictors of exclusive use of improved water sources and improved sanitation; as well as independent predictors of diarrhea incidence. We used an unstructured model based on the results of likelihood ratio testing. The random effects were households and individuals. The statistical Package for Social Sciences (SPSS, Version 17.0, Chicaco) and STATA Data Analysis and Statistical Software, version 11.0 were used; statistical significance was set at the conventional $p<0.05$.

RESULTS

A majority of the study population consented to participate in the study (88.8%, 1,155/1,300). Of these, a majority completed both the June and December

Table 1
Use of improved water sources and sanitation in the rainy and dry seasons among rural schoolchildren (*N*=1,101) in Pursat Province, Cambodia.

	Rainy season (June 2009)	Dry season (December 2009)	*p*-value
	Children (*N*=1,101) using a particular water source or mode of sanitation, *n* (%)		
Water sources			
Overall exclusive use of improved water sources	494 (44.9)	655 (59.5)	<0.001
Primary water source			
Groundwater from wells	452 (41.1)	514 (46.7)	<0.001
Rainwater	242 (22.0)	209 (19.0)	<0.001
Surface water from ponds, temporary pools	318 (28.9)	294 (26.7)	<0.001
River water	88 (8.0)	83 (7.5)	0.063
Sanitation			
Use of pour-flush/simple-pit latrines (improved sanitation)	150 (13.6)	253 (23.0)	<0.001
Use of public latrines (unimproved sanitation)	260 (23.6)	196 (17.8)	<0.001
Use of open latrines (unimproved sanitation)	688 (62.5)	649 (58.9)	<0.001

2009 surveys (95.3%, 1,101/1,155). Reasons for attrition included: could not be accounted for (*n*=15), refusal to continue the study (*n*=25); migration out of their villages (*n*=11), and mortality (*n*=3). Participants with incomplete data were excluded from further analysis. The mean age was 10.6 years (SD=1.6); 52.0% (573/1,101) were male and all were of Khmer ethnicity. About four-fifths (79.4%, 873/1,101) lived in the Tonle Sap lake basin and 20.6% (227/1,101) lived in highland districts; about half (52.9%, 582/1,101) stayed in temporary housing. During the rainy season, 38.6% (425/1,101) reported at least one diarrhea episode during the month of June; the mean number of episodes was 0.56 (SD=0.89). During the dry season, 22.7% (250/1,101) reported at least one diarrheal episode during the month of December; the mean number of episodes was 0.31 (SD=0.65). Figures for the use of improved water sources and improved sanitation among rural primary schoolgoing children in Pursat Province are given in Table 1. About 80% of children had access to improved water sources, either as their primary or secondary water source.

Factors associated independently with exclusive use of improved water sources, and improved sanitation, are detailed in Table 2. Adjusting for clustering within households and within individuals over time, favorable behavior regarding water use and sanitation shared six predictors, which included dry season, permanent housing, family size smaller than 8 members, paternal literacy, higher grade of the child and having soap at home. Factors not having a significant relationship to outcomes include geographical location (highland or lake basin district), storing water in covered containers, and having had education about water, sanitation and

Table 2
Associations between measured cofactors and exclusive use of improved water and sanitation amongst rural primary schoolchildren in Pursat Province, Cambodia; adjusting for clustering within households and within individuals over time.

Factors	Exclusive use of improved water		Exclusive use of improved sanitation	
	Adjusted OR (95% CI)	*p*-value	Adjusted OR (95% CI)	*p*-value
District				
Highland *vs* lake basin	1.26 (0.96-1.65)	0.100	1.30 (0.97-1.75)	0.082
Season				
Dry season *vs* wet season	0.43 (0.34-0.53)	<0.001	0.54 (0.43-0.70)	<0.001
Gender of child				
Female *vs* male	1.26 (1.01-1.56)	0.043	1.12 (0.88-1.43)	0.341
Housing type				
Temporary *vs* more permanent	2.24 (1.63-3.08)	<0.001	1.62 (1.13-2.34)	<0.010
Family size				
Less than 8 members *vs* more than 8 members	0.70 (0.56-0.89)	0.003	0.54 (0.41-0.71)	<0.001
Education level				
Father is literate *vs* father is illiterate	0.65 (0.53-0.81)	<0.001	0.76 (0.61-0.97)	0.032
Mother is literate *vs* mother is illiterate	0.34 (0.25-0.47)	<0.001	0.77 (0.56-1.05)	0.101
Educational level of child				
Grade 4 (referent category)	N.C	N.C	N.C	N.C
Grade 5	1.05 (0.80-1.38)	0.722	1.49 (1.10-2.02)	0.011
Grade 6	1.37 (1.04-1.80)	0.026	1.43 (1.06-1.94)	0.020
Distance to primary water source				
> 500 meters *vs* < 500 meters	0.83 (0.64-1.09)	0.189	1.40 (1.06-1.85)	0.017
Water, sanitation and hygiene practices				
Not storing water in covered containers *vs* storing water in covered containers	0.85 (0.63-1.14)	0.280	0.95 (0.71-1.27)	0.948
Mother is main adult responsible for water collection *vs* father is main adult responsible for water collection	0.16 (0.10-0.26)	<0.001	1.20 (0.86-1.68)	0.278
Not exclusively using improved water source *vs* exclusively using improved water source	N.A	N.A	1.40 (1.04-1.90)	0.029
Using a tap or designated dipper to collect household stored water *vs* using hands to collect household stored water	1.42 (0.97-2.08)	0.074	0.68 (0.48-0.97)	0.035
Not treating water before drinking[a] *vs* treating water before drinking	1.01 (0.74-1.39)	0.952	3.85 (2.63-5.55)	<0.001
Not exclusively using improved sanitation *vs* exclusively using improved sanitation	1.37 (1.02-1.84)	0.036	N.A	N.A
Have no soap at home *vs* have soap at home	3.85 (3.03-5.00)	<0.001	1.87 (1.27-2.85)	0.002
Does not wash hands before meals, after defecation *vs* washes hands before meals, after defecation	0.75 (0.55-1.02)	0.065	2.27 (1.53-3.22)	<0.0001
Parent has had no education about water, sanitation and hygiene *vs* parent has had education about water, sanitation and hygiene	1.16 (0.83-1.62)	0.389	0.80 (0.43-1.49)	0.474

[a]Treatment methods include filtration (sand or ceramic) or chemical treatment at the household level, or use of traditional cloth filters, or boiling

Table 3
Association between exclusive use of improved water and sanitation and diarrhea incidence among rural primary schoolchildren in Pursat Province, Cambodia, adjusting for clustering within households and within individuals over time.

	Had at least one reported episode of diarrhea	
	Adjusted OR (95% CI)	*p*-value
Exclusive use of improved water source[a]		
No	6.67 (5.00-12.50)	<0.001
Yes		
Exclusive use of improved sanitation[b]		
No	2.33 (1.67-5.00)	<0.001
Yes		

[a]Adjusted for: district, season, gender, housing type, family size, distance to primary water source, and water, sanitation and hygiene practices such as storing water in covered containers, not using hands to collect stored water, treating water before drinking, exclusive use of improved sanitation, have soap at home, washes hands, parent has had education about water, sanitation and hygiene.
[b]Adjusted for: district, season, gender, housing type, family size, distance to primary water source, and water sanitation and hygiene practices such as storing water in covered containers, not using hands to collect stored water, treating water before drinking, exclusive use of improved water, have soap at home, washes hands, parent has had education about water, sanitation and hygiene.

hygiene. Finally, the effects of gender, maternal literacy, distance to primary water source, main adult responsible for water collection (mother or father), and other water, sanitation and hygiene practices, such as using a designated instrument for collecting household stored water, treating water before drinking, and washing hands at critical points were not consistently significant.

With regards to the association between exclusive use of improved water/ sanitation and diarrhea incidence, exclusive use of improved water sources and improved sanitation were independently associated with lower incidence of diarrhea both univariately and when adjusted for other sociodemographic factors, as well as other water, sanitation and hygiene practices (Table 3).

DISCUSSION

Exclusive use of improved water sources and sanitation was low among rural primary schoolgoing children in Pursat Province, Cambodia. However, on a seasonal basis, exclusive use of improved water sources increased during the dry season, possibly because of decreased availability of water from unprotected surface sources, such as ponds and pools, during the dry months. There were differences in use of safer water sources by gender; males were more likely to have exclusive use of improved water than females; however, this was not replicated for access to improved sanitation. This suggests that there might be some gender bias in allocation of water sources in rural Cambodia, like some other Asian countries where females have reduced access to various

resources (Chen *et al*, 1981; Miller, 1997). Higher socioeconomic status (as defined by housing type) was a key independent factor associated with use of improved water sources and sanitation. The education level of the parents played a role in the use of improved water sources, with greater exclusive use of improved water sources among children with better-educated parents; this is similar to previous studies that report associations between improved management of child diarrhea and higher maternal education among rural mothers (Ibrahim *et al*, 1994; Webb *et al*, 2010). Parental literacy is important for encouraging modification of health behavior, like changing water sources; effort should be made to educate illiterate parents on the importance of hygiene and safe water sources/waste disposal. Targeted interventions designed to facilitate use of improved water sources/sanitation amongst lower-income segments of the population are necessary. Children in higher grades had a greater tendency to use improved sanitation; this might reflect the effect of successful public education campaigns, to which older children would have longer exposure. It was gratifying that the use of improved water sources was independently associated with improved sanitation, since use of either intervention can disrupt the fecal-oral chain of disease transmission, and use of both methods can reap synergistic benefits (Lewin *et al*, 1997). This was probably because increased awareness of hygiene resulted in a propensity to use both safer water sources and waste disposal methods (Curtis *et al*, 1995).

The use of either improved water sources or improved sanitation, was independently associated with reduced diarrhea among rural Cambodian schoolchildren. Studies in other Southeast Asian countries also support a link between improved water/sanitation and reduction in diarrheal disease (Muttamara and Krishnaswamy, 1982; Chongsuivivatwong *et al*, 1994). Diarrhea has been linked to protein energy malnutrition amongst Southeast Asian children (Tontisirin and Valyasevi, 1981), and can result in increased morbidity from various diseases (English *et al*, 1997); underlining the importance of making improved water and sanitation available early in life when such problems are still reversible. This suggests making these improvements more widespread in Cambodia, either by improving infrastructure or by educating children (and their caregivers) to use improved water sources/sanitation, the disease burden of diarrhea in this community can be significantly reduced. About 80% of children had access to improved water sources in both the rainy and dry seasons, only small refinements may be necessary to improve the reliability and quantity of water available, obviating the need for significant investment to improve the cost-effectiveness of such an intervention (Clasen *et al*, 2007). The burden of diarrheal disease in this population is not insignificant: improved water and sanitation needs to be made more accessible, especially to those of lower socio-economic status.

Providing access to improved water and sanitation, is just one part of the picture. Water storage and point-of-use issues also need to be addressed. Good hygiene practices need to be implemented with infrastructural improvements. In this community, access to improved water and sanitation was associated with some other good practices in water, sanitation and hygiene, but not all. While exclusive use of improved sanitation was not associated with other good practices, such as treating water at the point-of-use, not

using hands to collect household stored water, having soap at home and washing hands: these associations were not seen for exclusive use of improved water. This suggests public education campaigns can focus on encouraging water, hygiene and sanitation interventions, rather than just isolated improvements.

This study had limitations. We had an attrition rate of 4.7%; thus our sample might not be fully representative of the study population. However, we note that there were no significant statistical differences between those participants who completed both surveys and those who only completed one survey, in terms of sociodemographic characteristics, such as gender (p=0.442), age (p=0.073), highland *versus* lake district (p=0.433), temporary *versus* permanent housing (p=0.633), use of improved water (p=0.215), and use of improved sanitation (p=0.466). Since we only made two visits during two seasons, we were unable to fully investigate the effect of seasonality on exclusive use of improved water or sanitation, for which a longer follow-up period would have been necessary. Since water sources were not tested for coliforms, we have no direct evidence that the water sources represented the main source of diarrheal illness. However, the significant difference in diarrhea prevalence between exclusive and non-exclusive users of improved water sources suggests significant variation in water quality between the water sources. A further limitation was investigators did not make house visits to inspect the water, sanitation and hygiene practices of individual households; hence there could have been some discrepancies between what was self-reported and what was actually used. Our study was conducted among rural primary school-going children; thus, the results may not be generalizable to all children of a similar age in Pursat Province; however, we note that primary school enrolment is generally high, at 70-80% of the population (Ministry of Education, Youth and Sport, 2008).

In conclusion, more can be done to improve access to improved water sources and sanitation amongst rural children in Pursat Province, Cambodia, in order to tackle diarrheal disease. Efforts should be focused on those coming from families with a lower socio-economic status. The low levels of existing use mean intervention to improve water sources and sanitation can potentially yield significant benefit. Since most already have access to an improved water source, efforts should be focused on encouraging utilization of these sources through behavioral interventions, with minimal structural improvements to increase the quantity of water and the dependability of these sources. Use of improved sanitation should also be encouraged. However, access to improved water sources and sanitation is only one piece of the puzzle in combating diarrhea in rural communities.

ACKNOWLEDGEMENTS

Thanks to the medical student volunteers from the Yong Loo Lin School of Medicine, National University of Singapore, for helping out with the fieldwork for this study; as well as the Center for Research on Optimal Agricultural Practices, Pursat, Cambodia, for providing logistical support.

REFERENCES

Burström B, Macassa G, Oberg L, Bernhardt E, Smedman L. Equitable child health interventions: the impact of improved water and sanitation on inequalities in child mortality in Stockholm, 1878 to 1925. *Am*

J Public Health 2005; 95: 208-16.

Cairncross S, Hunt C, Boisson S, *et al*. Water, sanitation and hygiene for the prevention of diarrhoea. *Int J Epidemiol* 2010; 39: i193-205.

Checkley W, Gilman RH, Black RE, *et al*. Effect of water and sanitation on childhood health in a poor Peruvian peri-urban community. *Lancet* 2004; 363: 112-8.

Chen LC, Hug E, D'Souza S. Sex bias in the family allocation of food and health care in rural Bangladesh. *Pop Develop Rev* 1981; 7: 55-70.

Chongsuivivatwong V, Mo-suwan L, Chompikul J, Vitsupakorn K, NcNeil D. Effects of piped water supply on the incidence of diarrheal diseases in children in southern Thailand. *Southeast Asian J Trop Med Public Health* 1994; 25: 628-32.

Clasen T, Haller L, Walker D, Bartram J, Cairncross S. Cost-effectiveness of water quality interventions for preventing diarrhoeal disease in developing countries. *J Water Health* 2007; 5: 599-608.

Curtis V, Kanki B, Mertens T, *et al*. Potties, pits and pipes: explaining hygiene behaviour in Burkina Faso. *Soc Sci Med* 1995; 41: 383-93.

Esrey SA, Habicht JP, Latham MC, Sisler DG, Casella G. Drinking water source, diarrheal morbidity, and child growth in villages with both traditional and improved water supplies in rural Lesotho, southern Africa. *Am J Public Health* 1988; 78: 1451-5.

Esrey SA, Potash JB, Roberts L, Shiff C. Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. *Bull World Health Organ* 1991; 69: 609-21.

English RM, Badcock JC, Giay T, Ngu T, Waters AM, Bennett SA. Effect of nutrition improvement project on morbidity from infectious diseases in preschool children in Vietnam: comparison with control commune. *Br Med J* 1997; 315: 1122-5.

Gasana J, Morin J, Ndikuyeze A, Kamoso P. Impact of water supply and sanitation on diarrheal morbidity among young children in the socioeconomic and cultural context of Rwanda (Africa). *Environ Res* 2002; 90: 76-88.

Haller L, Hutton G, Bartram J. Estimating the costs and health benefits of water and sanitation improvements at global level. *J Water Health* 2007; 5: 467-80.

Ibrahim MM, Aden AS, Omar HM, Wall S, Persson LA. Diarrhoea among children in rural Somalia. Maternal perceptions, management and mortality. *Ann Trop Paediatr* 1994; 14: 215-22.

Kravitz JD, Nyaphisi M, Mandel R, Petersen E. Quantitative bacterial examination of domestic water supplies in the Lesotho Highlands: water quality, sanitation, and village health. *Bull World Health Organ* 1999; 77: 829-36.

Lewin S, Stephens C, Cairncross S. Reviewing the health impacts of improvements in water supply. *Urban Health Newsl* 1997; 32: 34-47.

Miller BD. Social class, gender and intrahousehold food allocation to children in South Asia. *Soc Sci Med* 1997; 44: 1685-95.

Ministry of Education, Youth and Sport, Kingdom of Cambodia. Education statistics and indicators, 2007/2008, Pursat Province. Phnom Penh: Ministry of Education, Youth and Sport, 2008.

Ministry of Planning, Kingdom of Cambodia. Cambodia human development report 2007- Expanding choices for rural people. Phnom Penh: Ministry of Planning, 2007.

Muttamara S, Krishnaswamy M. Diarrhoeal diseases related to sanitation and water supply. *Southeast Asian J Trop Med Public Health* 1982; 13: 348-51.

Plate DK, Strassmann BI, Wilson ML. Water sources are associated with childhood diarrhoea prevalence in rural east-central Mali. *Trop Med Int Health* 2004; 9: 416-25.

Sunoto. Diarrheal problems in Southeast Asia.

Southeast Asian J Trop Med Public Health 1982; 13: 306-18.

Tontisirin K, Valyasevi A. Protein energy malnutrition related to diarrhea in Thai children. *J Nutr Sci Vitaminol* 1981; 27: 513-20.

WHO/UNICEF. WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation. Progress on sanitation and drinking water. Geneva: WHO, 2010a.

WHO/UNICEF. WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation. Estimates for the use of improved drinking-water sources- Cambodia. Geneva: WHO, 2010b.

Webb AL, Ramakrishnan U, Stein AD, Sellen DW, Merchant M, Martorell R. Greater years of maternal schooling and higher scores on academic achievement tests are independently associated with improved management of child diarrhea by rural Guatemalan mothers. *Matern Child Health J* 2010; 14: 799-806.