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...L LITERACY MODIFIES THE EFFECT OF TOILETS AND ...ED WATER ON INFANT SURVIVAL IN MALAYSIA

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..., S. A. (Dept. of International Health, The Johns Hopkins U. School of ... and Public Health, Baltimore, MD 21205) and J.-P. Habicht. Maternal ... modifies the effect of toilets and piped water on infant survival in ...a. *Am J Epidemiol* 1988;127:1079–87.

The effect of toilets, piped water, and maternal literacy on infant mortality was analyzed using data from the Malaysian Family Life Survey collected in 1976–1977. The effect of toilets and piped water on infant mortality was dependent on whether or not mothers were literate. The impact of having toilets was greater among the illiterate than among the literate, but the impact of piped water was greater among the literate than among the illiterate. The effect on the infant mortality rate for toilets decreased from 130.7 ± 17.2 deaths in the absence of literate mothers to 76.2 ± 25.9 deaths in the presence of literate mothers. The reduction in the mortality rate for maternal literacy dropped from 44.4 ± 14.1 deaths without toilets to −10.1 ± 23.9 deaths with toilets. Reductions in mortality rates for piped water increased from 16.7 ± 12.7 deaths without literate mothers to 36.8 ± 21.0 deaths with literate mothers. Similarly, reductions in the mortality rate for maternal literacy rose from 44.4 ± 14.1 deaths in the absence of piped water to 64.5 ± 19.5 deaths in the presence of piped water. The results from a logistic model provided inferences similar to those from ordinary least squares. The authors infer that literate mothers protect their infants especially in unsanitary environments lacking toilets, and that when piped water is introduced, they use it more effectively to practice better hygiene for their infants.

education; infant mortality; sanitation; water supply

Efforts to improve health as a result of water or sanitation programs have met with variable success (1). Some studies failed to find a positive health impact after water or sanitation conditions were improved; other studies found large impacts. The reasons for these inconsistent results are many (1, 2), an important one being the difficulty in identifying a population that will respond to water or sanitation improvements.

Recent analyses of infant mortality rates in Malaysia showed that improvements in piped water and toilets have much greater impact where breastfeeding is not practiced (3) or where it is curtailed (4), presumably because breastfeeding protects infants from

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many of the same causes of mortality that are prevented by improved water or sanitation. In this paper, we extend these analyses to investigate whether the availability of piped water and the presence of toilets provide different protection to infants of literate mothers compared with those of illiterate mothers. We examine the data for negative and positive interactions between maternal literacy and having piped water or toilets. A priori predictions can be hypothesized.

If literate mothers dispose of feces in a sanitary manner, it can be assumed that infant mortality rates are already lower in this group than in the group in which mothers are illiterate. With the addition of toilets, it would be expected that these rates would fall less for the literate group than for the illiterate group. In this case, literacy would have an antagonistic effect with toilets on the impact of infant mortality rates.

Predicting the impact of maternal literacy on infant mortality rates if water supplies are improved is less straightforward. Providing piped water could either improve the quality of drinking water or increase the quantity of water used. A difference in the quality of water would benefit only the illiterate, since the literate would already be taking steps to decontaminate drinking water in some manner (e.g., by boiling) to protect their infants. Literacy would thus be antagonistic with water quality in reducing infant mortality rates. On the other hand, if piped water increased water availability for domestic hygiene, infants of literate mothers would benefit more than infants of illiterate mothers if literate mothers use the water to practice better domestic hygiene. Literacy would thus be synergistic with water quantity in lowering infant mortality rates.

MATERIALS AND METHODS

The data on 5,357 live singleton births used in these analyses are from the Malaysian Family Life Survey and were collected during a series of three interviews between 1976 and 1977 (5). The sample consisted of randomly selected private households, each of which contained at least one ever-married woman under 50 years of age. The households were contained in 52 primary sampling areas in Peninsular Malaysia.

Biologic and demographic data associated with each live birth were collected through a retrospective life history questionnaire. Factors included in the analyses for this paper were known to influence mortality during the first year of life in these same data (6). An imputed variable for breastfeeding was used to correct for the overestimated effect that breastfeeding exerts on infant mortality (7). A new variable, maternal literacy (i.e., whether or not a mother could read) was constructed and used in these analyses.

With respect to public health concerns, it has been suggested that the additive scale is more relevant than the multiplicative scale (8). Previous publications on these data have also used the additive scale (4), for which ordinary least squares analysis is the correct procedure and the attributable risk is the correct measure of effect. On the other hand, logit analysis is the correct procedure for a dichotomous outcome such as mortality, and the relative odds is the correct measure. Therefore, both ordinary least squares and logit are presented here.

In addition to the effects previously identified (6), all possible two-way interactions between breastfeeding, maternal literacy, toilets, and piped water were included in ordinary least squares analyses. The three-way or higher-order interactions (e.g., literacy by toilet and piped water) were omitted because of numeric instability in the logistic model. Variables with uncertain effects on infant mortality (80 per cent confidence intervals included zero) were dropped from subsequent analyses, except for splines (if one of the spline's 80 per cent confidence intervals did not include zero) and except for the variables breastfeeding, toilets, maternal literacy, and piped water because they were included in interaction terms.

A clustering effect of infants within

mothers or within the 52 sampling units was investigated previously and found not to have an effect on the errors associated with each parameter or with the parameters themselves (7). Furthermore, the 52 sampling units were reported to be homogeneous since the variables used in these analyses exerted a similar influence on mortality in each of the units (7). Thus, a clustering effect was not controlled in the analyses below.

The Statistical Analysis System package was used for all analyses (9, 10). The ordinary least squares models were estimated using PROC REG. When the final reduced ordinary least squares model was estimated, the logit procedure was run using PROC LOGIST (9). A two-tailed test (95 per cent confidence interval) was used for the interaction terms. A one-tailed test (90 per cent confidence interval) was used for each of the simple effects since each of the factors would be expected to lower, not increase, infant mortality rates.

In tables 1 and 2, the attributable risks are calculated from the differences in the unadjusted mortality rates, and the relative odds are the ratios of the two odds of dying (*mortality rate*/(1 − *mortality rate*)). The adjusted attributable risks and odds ratios (OR) in tables 4 and 5 were calculated from the coefficients in table 3, which reports the reduced multivariate model. Adjusted mortality rates are not presented in tables 4 and 5 because there is no consistent way to impute mortality rates from the adjusted attributable risks and odds ratios, and these rates are not necessary for the inferences made in this paper.

RESULTS

Forty-seven per cent of the sample infants had literate mothers, 79 per cent of the infants had families with access to a toilet, and 42 per cent had families with piped water, either inside or outside of the household. The unadjusted infant mortality rate was highest in the group whose mothers were illiterate and in which no toilet was present (table 1). The lowest infant mortality rate was found among infants whose mothers were literate and for whom piped water was present (table 2). It is difficult, however, to judge this comparison because many of the families in the first group had no piped water, and many of those in the latter group had toilets. Therefore, multivariate analyses were performed to investigate the maternal literacy by toilet and maternal literacy by piped water interactions.

Dropping the variables with uncertain effects, which included the literacy by breastfeeding and piped water by toilet interactions, affected the remaining parameters and their standard errors very little. For instance, the largest discrepancy between the full and reduced models for any of the toilet, piped water, or maternal literacy variables was the interaction of piped water by maternal literacy. The ordinary least squares coefficients were −0.0170 ($p = 0.1899$) and −0.0201 ($p = 0.1084$) for the full and reduced models (table 3), respectively. The coefficients for the other variables in table 3 were similar to those reported previously (6).

Overall, maternal literacy and the presence of toilets were associated with lower mortality rates compared with illiteracy and having no toilets (table 3), but their combined effects (120.6 deaths) were less than the sum of their individual effects (175.1 deaths) (table 3). The corresponding odds of dying was also less if both factors were present (OR = 3.19) than if each factor was multiplied separately (OR = 8.22). That is, the presence of one factor reduced the impact of the other, indicating an antagonistic effect of maternal literacy and toilets.

Among the illiterate group, the difference in the infant mortality rate between having and not having a toilet was 130.7 deaths per 1,000 live singleton births, while the difference was 76.2 deaths for infants of literate mothers (table 4). The logit analysis, and therefore the odds ratios, for these simple effects was also similar in comparative magnitude to that in ordinary least

TABLE 1

Unadjusted attributable risks and odds ratios for the combination of the presence or absence of toilets and maternal literacy

		Maternal literacy		AR*	OR†
		No	Yes		
Toilets	No	98.3‡ (804)§	47.6 (315)	50.7 (27.4–73.9)‖	2.18 (1.35–3.51)
	Yes	39.5 (2,049)	37.0 (2,189)	2.5 (−8.2–13.3)	1.07 (0.82–1.39)
AR		58.8 (44.2–73.3)	10.6 (−10.4–31.7)		
OR		2.65 (2.02–3.47)	1.30 (0.81–2.09)		

* Unadjusted attributable risk (infant mortality rate per 1,000 live singleton births).
† Unadjusted odds ratio.
‡ Unadjusted infant mortality rate.
§ Sample size.
‖ 90 per cent confidence interval for the respective attributable risk or odds ratio.

TABLE 2

Unadjusted attributable risks and odds ratios for the combination of the presence or absence of piped water and maternal literacy

		Maternal literacy		AR*	OR†
		No	Yes		
Piped water	No	59.1‡ (2,012)§	50.7 (1,084)	8.4 (−4.8–21.6)‖	1.18 (0.90–1.55)
	Yes	48.8 (841)	28.9 (1,420)	19.9 (4.6–35.1)	1.72 (1.19–2.49)
AR		10.3 (−4.0–24.8)	21.8 (7.7–36.0)		
OR		1.22 (0.90–1.66)	1.79 (1.27–2.53)		

* Unadjusted attributable risk (infant mortality rate per 1,000 live singleton births).
† Unadjusted odds ratio.
‡ Unadjusted infant mortality rate.
§ Sample size.
‖ 90 per cent confidence interval for the respective attributable risk or odds ratio.

squares (table 4). For instance, among the illiterate group, an infant was four times as likely to die (OR = 4.08) if a toilet was not present than if a toilet was present. Among the literate group, the odds of an infant dying was only slightly greater (OR = 1.58) if a toilet was absent than if a toilet was present.

Among families without a toilet, the difference in the infant mortality rate between the literate and illiterate groups was 44.4 deaths. When a toilet was present, literacy had no effect on the infant mortality rate (−10.1 deaths). When no toilet was present, the odds of dying was twice that among the illiterate group compared with the literate group. Among families with a toilet, infants of literate mothers were no more likely to die than infants of illiterate mothers (OR = 0.78). In summary, the largest reduction in infant mortality was associated more with the presence of a toilet than with maternal literacy, and the presence of a toilet was particularly associated with de-

TABLE 3

Ordinary least squares and logit determinants of infant mortality including the interaction effects of literacy by toilets and by piped water for the full 12 months of infancy

Variable	Model			
	Ordinary least squares		Logit	
	Beta	*t*	Beta	*t*
Toilet (yes = 1)	−0.1307	(−7.58)	−1.4043	(−4.74)
Piped water (yes = 1)	−0.0167	(−1.32)	−0.3049	(−0.99)
Literacy (literate = 1)	−0.0444	(−3.11)	−0.7020	(−2.18)
Literacy × toilet	0.0545	(3.44)	0.9454	(2.58)
Literacy × piped water	−0.0201	(−1.61)	−0.5758	(−1.85)
Maternal age (years) spline				
<18	−0.0106	(−1.71)	−0.0488	(−0.47)
18–40	−0.0004	(−0.70)	−0.0104	(−0.67)
>40	0.0126	(1.22)	0.2666	(1.20)
Birth weight (kg) spline				
<2.0	−0.2879	(−3.86)	−2.5287	(−2.82)
2.0–2.5	−0.1331	(−3.47)	−1.3968	(−2.24)
2.5–3.5	−0.0308	(−2.83)	−0.9405	(−3.54)
>3.5	0.0007	(0.05)	0.1497	(0.39)
Sex (male = 1)	0.0328	(5.79)	0.7874	(5.51)
Proportion of stillbirths	0.0673	(1.91)	0.7729	(1.42)
Preceding interpregnancy interval <15 months	0.0357	(4.22)	0.6694	(4.01)
Year of birth	−0.0021	(−4.57)	−0.0468	(−4.35)
No. of grandparents	−0.0071	(−1.94)	−0.1628	(−1.84)
Hospital-born (yes = 1)	−0.0166	(−2.01)	−0.6061	(−2.33)
Chinese vs. Malay	−0.0390	(−5.20)	−1.0737	(−5.27)
Indian vs. Malay	−0.0360	(−3.63)	−0.6459	(−2.93)
Breastfeeding				
Full	−0.0180	(−5.51)	−0.4219	(−2.93)
Full × piped water	0.0050	(2.14)	0.1901	(1.93)
Full × toilet	0.0109	(3.09)	0.1522	(0.96)
Partial	−0.0128	(−8.72)	−0.1564	(−6.32)
Partial × piped water	0.0035	(2.67)	0.0681	(2.11)
Partial × toilet	0.0091	(5.46)	0.0853	(2.66)
Constant	1.1882	(6.62)	8.8080	(3.50)

TABLE 4

Adjusted simple effect attributable risks and odds ratios for the combination of the presence or absence of toilets and maternal literacy

		Maternal literacy		AR*	OR†
		No	Yes		
Toilet	No			44.4 (21.2–67.6)‡	2.02 (1.19–3.43)
	Yes			−10.1 (−49.4–29.2)	0.78 (0.33–1.87)
AR		130.7 (102.3–159.1)	76.2 (33.7–118.7)		
OR		4.08 (2.50–6.63)	1.58 (0.68–3.68)		

* Adjusted attributable risks are derived from the ordinary least squares coefficients in table 3.

† Adjusted odds ratios are derived from the logit coefficients in table 3.

‡ One-tailed 95 per cent confidence interval for the respective attributable risk or odds ratio.

creased mortality if the mother was illiterate.

The direction of effects of the literacy by piped water interaction was different from that of the literacy by toilet interaction (table 3). The presence of piped water tended to be associated with a lower infant mortality rate than was the absence of piped water, with 16.7 deaths per 1,000 live singleton births among the illiterate; among the literate, the difference in the infant mortality rate was more than twice as much at 36.8 deaths per 1,000 live singleton births (table 5). The relative odds from the logit model again provided results and inferences similar to those for the ordinary least squares procedure (table 3). Among the illiterate group, an infant was 1.36 times more likely to die if no piped water was available compared with having piped water, while among the literate group, the relative odds of an infant dying was more than doubled (OR = 2.41) if no piped water was available compared with having piped water (table 5).

The difference in mortality between the literate and illiterate groups among those without piped water was 44.4 deaths; the corresponding difference in the infant mortality rate between the literate and illiterate groups was 64.5 deaths among the families with piped water. An infant whose mother was illiterate was twice as likely to die than an infant whose mother was literate when neither had piped water; if piped water was available, the relative odds of dying was three and one half times greater for the illiterate group compared with the literate group. In summary, having piped water and a literate mother was associated with a larger drop in infant mortality rates (81.2 deaths) than would be expected by adding each effect separately (61.1 deaths). The corresponding odds of dying if both factors were present was greater (OR = 4.87) than would be expected by multiplying each effect separately (OR = 2.73).

Discussion

The interaction between maternal literacy and toilets was in agreement with our original hypothesis that toilets would be of most benefit among illiterates, who do not know how to dispose of feces in a sanitary manner. The only other study to investigate the interaction between maternal literacy and toilets was in Sri Lanka (11); no interaction was found during the entire infancy period. In that study, which also used retrospective data, mortality events were pooled over a 25-year period, but all independent variables pertained to conditions in only one year, 1975, possibly biasing results toward no interaction. In contrast,

Table 5

Adjusted simple effect attributable risks and odds ratios for the combination of the presence or absence of piped water and maternal literacy

		Maternal literacy: No	Maternal literacy: Yes	AR*	OR†
Piped water	No			44.4 (21.2–67.6)‡	2.02 (1.19–3.43)
	Yes			64.5 (32.4–96.6)	3.59 (1.68–7.67)
AR		16.7 (−4.1–37.5)	36.8 (2.3–71.3)		
OR		1.36 (0.82–2.25)	2.41 (1.15–5.08)		

* Adjusted attributable risks are derived from the ordinary least squares coefficients in table 3.

† Adjusted odds ratios are derived from the logit coefficients in table 3.

‡ One-tailed 95 per cent confidence interval for the respective attributable risk or odds ratio.

data used in this paper related to the year in which the infant was born. Removing this bias would tend to support our findings.

Since it was possible that piped water improved the quality of the drinking water (expected antagonism with literacy) and increased accessibility and use of water (expected synergism with literacy), a larger interaction effect may have been masked. Both the illiterate and literate groups could benefit from these improvements for different reasons. Literate mothers presumably decontaminate impure drinking water, whereas illiterate mothers do not, resulting in a gap in the infant mortality rate between these two groups. Thus, providing good quality water would close the gap and result in an antagonistic interaction. Providing a larger quantity of water would benefit the literate, who know how and are able to use the increased water for better hygiene. In this case, infant mortality rates between the literate and illiterate would widen, resulting in a synergistic interaction.

If both more and cleaner water is provided, the chances of finding an interaction between piped water and literacy would be diminished, because the antagonistic effect of maternal literacy with water quality would counterbalance the synergistic effect of maternal literacy with water quantity. The fact that the effect was largest for the literate group suggests that improvements in the quantity of water, and therefore its use, were more prevalent or produced larger health impacts than did improvements in water quality.

In a previous study from Brazil (12), water was piped into the homes and was reported to lower childhood mortality among the less educated mothers. It is possible that tap water in the Brazilian homes was not contaminated relative to community standposts, since community water that has been purified is often recontaminated when it is carried to and stored in homes (13–16). Furthermore, increases in per capita water use have not occurred by merely supplying piped water (16, 17), particularly if the alternative supplies were within 1 km of the dwellings (17). Thus, the Brazilian study may have examined the interaction of literacy and only water quality, which would explain the antagonistic interaction. As was found in the present study, maternal literacy was associated more strongly with the decline in childhood mortality than was household water.

Factors other than maternal literacy have also been reported to modify the impact that toilets or piped water exerts on child health. For instance, with these same data, it was shown that the presence of toilets lowered infant mortality rates where breastfeeding is curtailed (4) or not practiced (3). In Fiji, having toilets improved child growth when income was low (18). Piped water was beneficial among infants who were not breastfed in the Malaysian sample (3, 4). Piped water of good quality was associated with better nutritional status among high income urban groups in the Philippines (19), and increased water quantity was associated with less diarrhea among children living in crowded families in Haiti (20).

These results reinforce a theoretical model (21) and a conclusion, based on a review of the literature (1), that when exposure to fecal-oral pathogenic agents that can cause mortality (e.g., agents that lead to diarrhea or poliomyelitis) is high, toilets will have a larger health impact than will water supplies. Furthermore, improved water quality alone may benefit those families that have little exposure to pathogens from sources other than drinking water, whereas water quantity improvements may benefit those families that experience much exposure to pathogens from sources other than drinking water. Thus, the groups that can benefit from water quality improvements are most likely those that have already benefited from increases in water quantity and its use.

Two major differences occurred in the above analyses compared with previous analyses of the same data (3, 4). First, a

new variable, maternal literacy, was used instead of maternal educational level; maternal literacy explained more of the deaths in this sample than did educational level. Although the use of maternal literacy, instead of education, may have produced the above results by chance, antagonistic effects of maternal education and family planning clinics on contraceptive use have also been reported in these data (22).

Second, several factors found to have an uncertain impact on infant mortality rates were eliminated from the final analyses: parity, proportion of interpregnancy intervals of less than 15 months, crowding, number of children less than two years of age in the family, income, number of relatives who were not immediate family members, and a rurality scale. Elimination of these variables did not alter the effect that the remaining factors had on infant mortality; thus, the results of previous analyses (3, 4, 7) still hold. Furthermore, the effects found in this study for the interaction between toilets and piped water with maternal literacy were above and beyond the effects reported previously for breastfeeding (3, 4), although these effects remain valid.

It is unlikely that an uncontrolled confounding factor affected the results, because any uncontrolled influences on mortality that would be correlated with toilets would most likely be correlated with piped water. The effects of piped water and toilets were different, however, because the interaction of toilets and maternal literacy was antagonistic, while the interaction of piped water and maternal literacy was synergistic.

In summary, the presence of toilets was associated with larger reductions in infant mortality rates than was maternal literacy, which in turn had a greater effect than the presence of piped water. Maternal literacy and piped water were synergistic in that the reductions in mortality rates from either factor were enhanced if the other factor was present at the same time. On the other hand, the antagonistic interaction between the presence of toilets and maternal literacy meant that maternal literacy saved more lives in absolute and relative terms in unhygienic compared with hygienic circumstances. This leads us to believe that literate mothers protect their children much better in unhygienic circumstances than do illiterate mothers, and they use water more effectively for better hygiene than do illiterate mothers.

References

1. Esrey SA, Habicht J-P. Epidemiologic evidence for health benefits from improved water and sanitation in developing countries. Epidemiol Rev 1986;8:117–28.
2. Blum D, Feachem RG. Measuring the impact of water supply and sanitation investments on diarrhoeal diseases: problems of methodology. Int J Epidemiol 1983;12:357–65.
3. Habicht J-P, DaVanzo J, Butz WP. Mother's milk and sewage: their interactive effects on infant mortality. Pediatrics 1988;81:456–61.
4. Butz WP, Habicht J-P, DaVanzo J. Environmental factors in the relationship between breastfeeding and infant mortality: the role of sanitation and water in Malaysia. Am J Epidemiol 1984;119:516–25.
5. Butz WP, DaVanzo J. The Malaysian Family Life Survey: Summary Report, R-2351-AID. Santa Monica, CA: Rand Corporation, 1978.
6. Butz WP, DaVanzo J, Habicht J-P. Biological and behavioral influences on the mortality of Malaysian infants. N-1638-AID. Santa Monica, CA: Rand Corporation, 1982.
7. Habicht J-P, DaVanzo J, Butz WP. Does breastfeeding really save lives, or are apparent benefits due to biases? Am J Epidemiol 1986;123:279–90.
8. Kleinbaum DG, Kupper LL, Morgenstern H. Epidemiologic research: principles and quantitative methods. Belmont, CA: Lifetime Learning Publications, 1982.
9. Statistical Analysis System. SAS supplemental user's guide. Cary, NC: SAS Institute Inc, 1981.
10. Statistical Analysis System. SAS user's guide: statistics. Cary, NC: SAS Institute, 1982.
11. Meegema SA. Socioeconomic determinants of infant and childhood mortality in Sri Lanka: an analysis of post-war experience. London: World Fertility Survey Report 8, 1980.
12. Merrick T. The effect of piped water on early childhood mortality in urban Brazil, 1970–1976. Demography 1985;22:1–24.
13. Rajasekaran P, Dutt PR, Pisharoti KA. Impact of water supply on the incidence of diarrhoea and shigellosis among children in rural communities in Madurai. Indian J Med Res 1977;66:189–99.
14. Feachem RG, Burns E, Cairncross S, et al. Water, health and development. London: Tri-Med Books, 1978.
15. Shiffman MA, Schneider R, Faigenblum JM, et al. Field studies on water, sanitation and health education in relation to health status in Central America. Prog Water Tech 1978;11:143–50.

16. Esrey SA. The effect of improved water supplies and sanitation on child growth and diarrheal rates in Lesotho. PhD thesis. Ithaca, NY: Cornell University, 1987.
17. White GF, Bradley DJ, White AU. Drawers of water: domestic water use in East Africa. Chicago, IL: University of Chicago Press, 1972.
18. Yee V. Household level correlates of child nutritional status in Fiji. Master's thesis. Ithaca, NY: Cornell University, 1984.
19. Magnani R, Tourkin S, Hartz M. Evaluation of the provincial water project in the Philippines. International Statistical Program Center, Bureau of the Census, US Dept of Commerce, Washington, DC, 1984.
20. Thacker SB, Music SI, Pollard RA, et al. Acute water shortage and health problems in Haiti. Lancet 1980;1:471–3.
21. Esrey SA, Feachem RG, Hughes J. Interventions for the control of diarrhoeal diseases among young children: improving water supplies and excreta disposal facilities. Bull WHO 1985;63:757–72.
22. DaVanzo J, Ann TB, Othman R, et al. Determinants of contraceptive method choice in peninsular Malaysia, 1961–1975. Rand N-2453-PC. Santa Monica, CA: Rand Corporation, 1986.