

Exploring Household Economic Impacts of Childhood Diarrheal Illnesses in 3 African Settings

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Beyond the morbidity and mortality burden of childhood diarrhea in sub-Saharan African are significant economic costs to affected households. Using survey data from 3 of the 4 sites in sub-Saharan Africa (Gambia, Kenya, Mali) participating in the Global Enteric Multicenter Study (GEMS), we estimated the direct medical, direct nonmedical, and indirect (productivity losses) costs borne by households due to diarrhea in young children. Mean cost per episode was \$2.63 in Gambia, \$6.24 in Kenya, and \$4.11 in Mali. Direct medical costs accounted for less than half of these costs. Mean costs understate the distribution of costs, with 10% of cases exceeding \$6.50, \$11.05, and \$13.84 in Gambia, Kenya, and Mali. In all countries there was a trend toward lower costs among poorer households and in 2 of the countries for diarrheal illness affecting girls. For poor children and girls, this may reflect reduced household investment in care, which may result in increased risks of mortality.

As a leading cause of global child mortality, the primary impact of diarrheal disease is the health burden borne by children <5 years of age and their families [1]. However, there is also a growing awareness of the economic burden created by diarrheal disease. Several studies have attempted to estimate the economic burden of illness, especially that portion associated with the healthcare system [2–6]. Estimating these costs is critical for evaluating potential interventions to reduce the health burden, whether through

vaccination, improved water and sanitation, or others [7], given that these costs can partially offset the required investment. Less is understood about the household economic burden associated with diarrhea. Although this may be small in absolute terms, it may be substantial relative to incomes of low-income households, resulting in reduced care seeking and worsening impoverishment.

Although most episodes of diarrheal illness can be treated inexpensively with timely diagnosis [8], evidence suggests that many low-income families lack access to high-quality, low-cost treatments for diarrheal illnesses or simply fail to utilize appropriate care [9, 10]. Reasons for such access and utilization barriers range from a lack of healthcare provision to poor transportation and even climate conditions [11, 12]. There is also reason to believe that access to and utilization of care for diarrheal illness may be driven by household economic and cost constraints [11, 13, 14, 15]. Conversely, reducing out-of-pocket expenses stimulates greater demand and utilization for healthcare [16, 17].

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Understanding these relationships is crucial for policy-makers, particularly given health financing debates over user fees and other cost-sharing mechanisms [18]. For instance, although user fees may be effective options for discretionary care, they can have adverse impacts when applied to primary care or preventive services like diarrheal illness care [19]. Studies in several African settings have shown that reductions in user fees are more likely to stimulate demand for public healthcare services and that revenue collected from user fees are often not efficiently spent [17, 19–21]. Mwabu et al [19] found that during a period of modest cost sharing in Kenyan public clinics, demand dropped by nearly 50 percent.

This paper explores these issues using baseline survey data collected from 3 of the 4 African sites (Kenya, Gambia, and Mali) participating in the Global Enteric Multicenter Study (GEMS) prior to the onset of the main GEMS case/control study. The health economics substudy has 3 related objectives: to (1) estimate and characterize household costs associated with childhood diarrhea episodes by type and setting; (2) explore how child and household characteristics alter cost patterns; and (3) explore whether and how high costs can serve as a barrier to care or contribute to impoverishment of the household.

METHODS

This study uses data from the GEMS on acute diarrheal care in 3 African countries—Kenya, Gambia, and Mali. These countries were chosen in part owing to their relatively high rates of diarrheal illnesses and early childhood mortality. The sampling of households as part of the baseline Health Utilization and Attitudes Survey (HUAS) that preceded onset of the GEMS case/control study is described by Kotloff et al in this supplement [22]. Retrospective data were collected on household costs for children <5 years of age with diarrhea in the previous 2 weeks. Data were collected using a standardized interview from an age-stratified random sample of approximately 1000 households containing a child 0–59 months of age within each study area (described in [23]). Analyses were weighted on the basis of probability of selection. Each site aimed to enroll 400 infants 0–11 months of age, 370 children 12–23 months of age, and 370 children 24–59 months of age.

Sample sizes varied among countries and are presented in Table 1. The initial household sampling was expected to be large enough to identify approximately 200 children with diarrhea during the previous 2 weeks and 150 children with

Table 1. Study Population Characteristics and Subsamples

	Gambia						Kenya						Mali					
	Children With Diarrhea		Children With Any Costs		Children With Direct Medical Costs		Children With Diarrhea		Children With Any Costs		Children With Direct Medical Costs		Children With Diarrhea		Children With Any Costs		Children With Direct Medical Costs	
Sex																		
Male	149	(57)	56	(62)	49	(62)	157	(57)	97	(55)	78	(57)	68	(54)	46	(54)	44	(52)
Female	111	(43)	35	(39)	30	(38)	119	(43)	78	(45)	60	(44)	58	(46)	40	(47)	40	(48)
Maternal Education																		
None to primary	48	(19)	15	(17)	12	(15)	145	(53)	93	(53)	75	(54)	74	(59)	51	(59)	51	(61)
Finished primary	7	(3)	5	(6)	5	(6)	120	(44)	74	(42)	56	(41)	11	(9)	7	(8)	6	(7)
Some secondary	2	(1)	1	(1)	1	(1)	11	(4)	8	(5)	7	(5)	9	(7)	6	(7)	6	(7)
Religious only	203	(78)	70	(77)	61	(77)	...	...	...	...	...	...	32	(25)	22	(26)	21	(25)
Age																		
0–11 mo	96	(37)	34	(37)	32	(41)	116	(42)	66	(38)	52	(38)	44	(35)	29	(34)	28	(33)
12–23 mo	99	(38)	30	(33)	25	(32)	103	(37)	69	(39)	55	(40)	56	(44)	38	(44)	38	(45)
24–59 mo	65	(25)	27	(30)	22	(28)	57	(21)	40	(23)	31	(23)	26	(21)	19	(22)	18	(21)
Severity																		
Mild	47	(18)	18	(20)	16	(20)	93	(34)	44	(25)	30	(22)	47	(37)	26	(30)	26	(31)
Moderate/severe	213	(82)	73	(80)	63	(80)	183	(66)	131	(75)	108	(78)	79	(63)	60	(70)	58	(69)
Duration																		
1–3 d	75	(43)	30	(44)	25	(42)	85	(40)	59	(39)	52	(43)	50	(54)	33	(54)	33	(56)
4–7 d	93	(53)	35	(52)	32	(54)	115	(54)	80	(53)	61	(50)	40	(43)	26	(43)	24	(41)
8–14 d	6	(3)	3	(4)	2	(3)	13	(6)	11	(7)	8	(7)	2	(2)	1	(2)	1	(2)
15+ d	...	...	...	...	...	...	1	(1)	0	(0)	0	(0)	1	(1)	1	(2)	1	(2)

All data are presented as No. (%).

household costs associated with the episodes. Based on World Health Organization methods for estimating diarrheal costs [8], this was expected to be sufficient to produce estimates of means with a confidence interval of $\pm 10\%$ of the true mean with 80% power. The observed power in each country varies based on the variance in costs within each and the actual number of episodes. Sample sizes were not powered for secondary analyses to detect differences among subgroups.

We examined direct medical, direct nonmedical, and indirect costs. Direct medical costs (eg, medications, visits, diagnostics) were defined as either informal or formal expenditures, with the former representing care provided by a local healer or provider and the latter combining both outpatient and inpatient care. Outpatient and inpatient facilities at each site are described in more detail in Kotloff et al [22], but outpatient facilities were primarily health centers and private doctors' offices, while inpatient facilities were primarily public district hospitals. Direct nonmedical costs were broken down by transportation and other costs, whereas indirect costs were based on time lost from income-generating employment. For both medical and total costs, some cases incur no costs and the remainder of episodes typically produce a right-skewed distribution. Descriptive statistics (means and standard errors) for costs are provided for all cases, those incurring medical or other costs, and the proportion incurring costs (Table 1). Costs were collected in local currencies, converted to US\$, and adjusted to 2011 as the reference year.

We also examined how child, household, and episode characteristics were associated with the costs incurred by households. This was analyzed separately for direct medical costs and total costs. Analysis of variance was used to assess the effect of household economic status, maternal education, child sex, age, duration of illness, and illness severity. Multivariate analysis was considered, but not presented owing to the limited sample size. This analysis was conducted separately for all episodes and those incurring medical or any costs. Logistic regression was used to estimate the effect of these variables on the likelihood of costs being incurred by the household. Household economic status is based on an asset index calculated using principal components analysis using the full household sample for each country [24]. Maternal education was broken down into 4 categories: none to some primary, completed primary education, some secondary education, and religious education only. Because of the limited sample size and power, we considered $P < .05$ as statistically significant and P values between .05 and .20 as marginally significant.

Given the empirical evidence citing costs as a significant factor driving healthcare behavior and utilization, we examined the potential impact of costs on household impoverishment and avoidance of care due to economic costs. This is done by examining respondents' self-reported reasons for not

seeking care and strategies for paying for the costs. We also examined the distribution of costs to households and the possibility of large expenditures.

RESULTS

Expenditures by Type and Category

Table 2 displays costs of diarrheal episodes by type (direct medical, direct nonmedical, and indirect), type of medical (consultations, medications, and diagnostic), and setting of care (formal and informal). Mean costs and standard errors are calculated for all episodes and for those incurring a cost and listed for each category.

Of respondents reporting an episode of diarrhea in the previous 2 weeks, 35%, 65%, and 68% incurred some costs in the GEMS sites in Gambia, Kenya, and Mali, respectively. The mean total household costs per episode ranged from \$2.63 in Gambia to \$6.24 in Kenya, and the total cost among those with nonzero costs ranged from \$6.01 in Mali to \$8.83 in Kenya. Direct medical costs accounted for 11%, 27%, and 54% of that total cost in Kenya, Gambia, and Mali, respectively. Household indirect costs (productivity losses) accounted for more than half of the total cost in Gambia and Kenya and somewhat less (42%) in Mali. In Gambia and Kenya, expenditure on care from informal providers was more than that of formal providers. In Mali, expenditure on informal care was even greater than in Gambia or Kenya, but only accounted for 24% of the direct medical expenditure. In all 3 countries, medications (whether medically indicated or not) accounted for the majority of the direct medical cost, ranging from 77% in Gambia to 86% in Kenya.

In addition to mean costs, we examined the distribution of costs to better understand how high-cost events might affect households. The distributions of total costs by wealth quintile for each country are shown in Figure 1. In Gambia, among all children 25% of episodes resulted in costs over \$1.73, in 10% the cost was over \$6.50, and in 5% it was over \$15.27. In Kenya the distribution was higher with 25% having costs over \$4.93, 10% having costs over \$11.05, and 5% having costs over \$21.20. In Mali the costs were similar, with 25% over \$4.26, 10% over \$13.84, and 5% over \$20.77.

Determinants of Costs

We examined the effect of household economic status, maternal education, child sex, child age, disease severity, and disease duration on the likelihood of incurring direct medical costs and the mean household cost (for all episodes and those incurring costs) for each of the 3 countries (Table 3). For each determinant the table shows the probability of incurring a cost and the mean household cost. P values represent a bivariate comparison of differences among the different subgroups for

Table 2. Household Costs Associated With Diarrheal Illness by Type and Setting (2011 US\$) in Gambia, Kenya, and Mali

	Gambia				Kenya				Mali			
	All Seeking Care	Std. Error	Incurring Any Treatment Cost	Std. Error	All Seeking Care	Std. Error	Incurring Any Treatment Cost	Std. Error	All Seeking Care	Std. Error	Incurring Any Treatment Cost	Std. Error
Cost by Type	n = 259		n = 97		n = 275		n = 186		n = 126		n = 86	
Direct medical	0.71	0.16	1.81	0.39	0.70	0.09	0.99	0.13	2.20	0.44	3.22	0.61
Direct nonmedical	0.37	0.07	0.96	0.16	0.55	0.28	0.79	0.39	0.19	0.05	0.28	0.07
Total direct	1.08	0.18	2.76	0.40	1.25	0.30	1.77	0.41	2.39	0.46	3.50	0.65
Indirect cost	1.55	0.42	3.97	1.03	4.99	1.41	7.06	1.97	1.72	0.40	2.52	0.56
Total	2.63	0.53	6.74	1.24	6.24	1.45	8.83	2.01	4.11	0.67	6.01	0.91
Direct medical cost by setting												
Informal (healer, pharmacist)	0.49	0.15	1.25	0.37	0.41	0.06	0.59	0.09	0.60	0.12	0.87	0.17
Formal (hospital, clinic, office, etc)	0.22	0.06	0.56	0.16	0.28	0.06	0.40	0.09	1.60	0.39	2.34	0.56
Direct medical cost by purpose												
Consultation	0.07	0.04	0.17	0.10	0.05	0.02	0.08	0.02	0.29	0.06	0.41	0.08
Medication	0.55	0.11	1.40	0.27	0.60	0.08	0.85	0.10	1.81	0.29	2.66	0.35
Diagnostic tests	0.09	0.09	0.24	0.23	0.05	0.02	0.07	0.03	0.10	0.07	0.15	0.11

each determinant. For many of the determinants, low sample size in the subcategories (Table 1) led to limited statistical power.

In all 3 countries, there was a trend toward differences by economic status for both medical (Table 3) and total costs (Table 4). For medical costs, there were increased expenditures for children in high-wealth quintiles. For Gambia and Kenya this was found for both mean costs among all episodes and among episodes with nonzero costs. For Mali, direct medical costs exhibit an inverted U-shaped curve with lowest costs among the poorest quintile and highest costs among children in the middle and upper wealth quintiles for both all episodes and those with nonzero costs. These trends were statistically significant ($P < .05$) or marginally significant ($P < .20$). In all 3 countries, medical costs per episode were 2–3 times greater in the highest wealth quintile compared with the lowest. Trends were similar for total household, but only statistically significant for Mali and Gambia.

In Mali and Gambia there were significant or marginally significant differences in household medical and total costs by sex. For both countries, household direct medical and total costs for boys were approximately twice that for girls; however, the differences were only marginally statistically significant. For Kenya there were no differences by sex.

Although there were country-level differences in medical and total costs by maternal education, there were few clear

patterns within or among countries. There were no clear associations between child age and household medical or total costs within or across countries.

In Kenya and Mali, there were higher household medical costs for moderate-to-severe episodes (all episodes and those with nonzero costs). However, there was no such association for Gambia. Total household costs were higher for moderate-to-severe cases only in Mali. Duration of illness was also associated with household medical and total costs in Gambia and Mali.

Costs as a Barrier and Cause of Impoverishment

Table 5 shows household reasons for not seeking care or hospitalization and payment method for the expenses associated with the episode. Across all 3 countries the main reasons for not seeking hospital care when advised were either not believing their child needed care or that the costs were too high. Broken down further, 55.8% of Kenyan households seeking alternative forms of care did so because they felt hospital treatment or transportation costs were too high; nearly 18% did not think their child was sick enough to seek hospital care. Among Gambian households, these figures are 22.2% and 48.1%, respectively. Among Malian households, they are roughly 53% and 30%.

Similar results were found among those not seeking any care. Among all 3 countries, the most common reasons for not seeking any care was that, on average, 53.4% of all

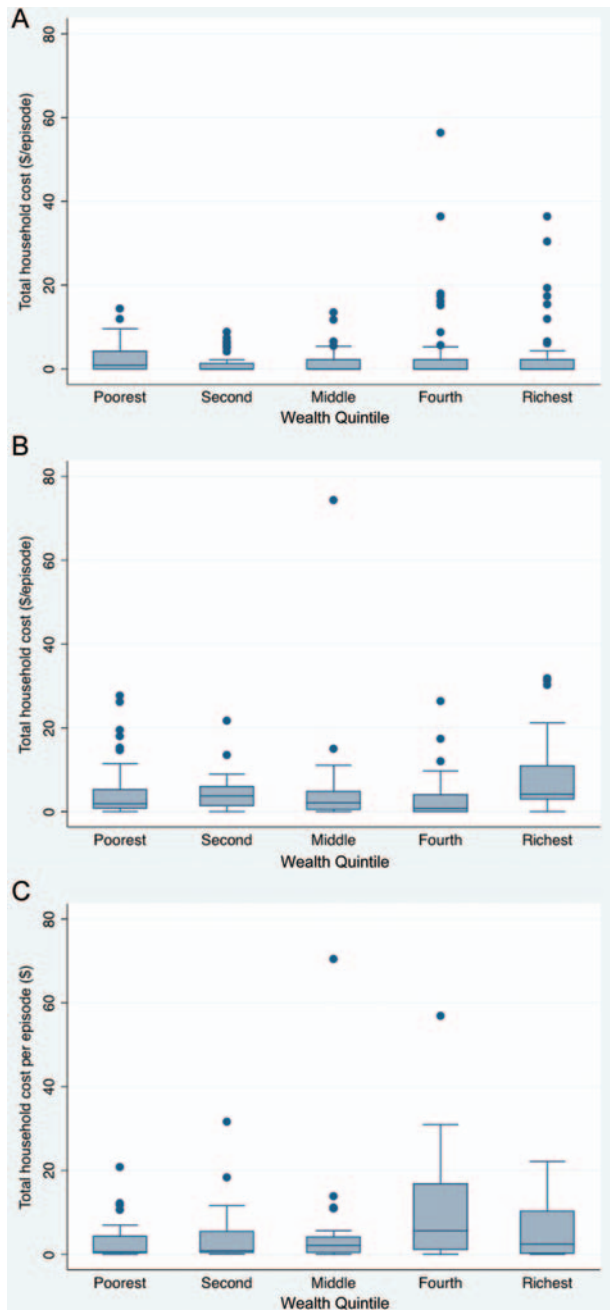


Figure 1. Distribution of total household diarrhea costs by wealth quintile (\$/episode) in Gambia (A), Kenya (B), and Mali (C). For each group the box shows the 25th and 75th percentile and the bars show the 5th and 95th percentiles.

households believed their child did not need care for his or her illness. Among Kenyan families, treatment and transportation costs were close behind (41.2%), followed by a high demand for traditional medicine (17.4%), too far a distance (12.7%), and lack of transportation (9.5%). For Gambia, these included treatment costs (22.5%), transportation costs (10%),

and preference for traditional medicine (10%). For Malian households, treatment and transportation costs (26.6%) and preference for traditional medicine (10%) were also common reasons. The data indicate that households either believe their child does not need care or, if he or she does, costs are too high.

DISCUSSION

The GEMS case/control study, the keystone of GEMS, is intended to provide information on the etiology and burden of moderate-to-severe diarrhea and its nutritional and mortality consequences. However, as part of the rationale for undertaking GEMS, we also wished to expand the assessment of burden by gathering information on the direct and indirect economic costs of diarrheal disease in sites where the case/control study would be carried out. Our results document a substantial economic burden stemming from diarrheal disease and provide an additional reason to support interventions to control the incidence and severity of diarrheal disease.

What Are the Costs and Where Do They Occur?

Our results suggest that households encounter a substantial economic burden due to childhood diarrhea in the 3 settings. For episodes with nonzero costs, the mean total cost ranged from \$6.01 in Mali to \$8.83 in Kenya. When all episodes are considered, the range was \$2.63 in Gambia to \$6.24 in Kenya. Although these amounts may seem small in absolute terms, these are settings where a substantial portion of households live on <\$1 per day. In addition, diarrhea is frequent in children <5 years of age [25], implying that these expenses may be incurred regularly.

Direct medical expenses only account for a fraction of these total costs: 27% in Gambia, 11% in Kenya, and 53% in Mali. Costs in informal settings ranged from \$0.41 in Kenya to \$0.60 in Mali per episode, and accounted for more than half of the household medical costs in both Gambia and Kenya. In Mali, direct medical costs in formal settings accounted for a larger fraction of household costs. For all 3 countries, the majority of household direct medical costs were for medications. High nonmedical costs, whether for transportation or for lost earnings, suggest that user fees for formal care may not be the only financial barriers to treatment.

What Are the Determinants for Household Costs?

While the patterns vary among countries, wealth and sex appear to be associated with direct medical and total household diarrhea costs. Although there are a number of potential explanations for this association, the relationship between household wealth and diarrhea economic burden may reflect rationing of care in poorer households. That is, household resources provide

Table 3. Household Direct Medical Costs for Childhood Diarrhea by Socioeconomic, Demographic, and Illness Characteristic in Gambia, Kenya, and Mali

	Gambia						Kenya						Mali					
	Mean Cost for All Episodes		Proportion With Costs		Mean Cost for Episodes With Costs		Mean Cost for All Episodes		Proportion With Costs		Mean Cost for Episodes With Costs		Mean Cost for All Episodes		Proportion With Costs		Mean Cost for Episodes With Costs	
	\$	ANOVA		P Value	\$	ANOVA	\$	ANOVA		P Value	\$	ANOVA	\$	ANOVA		P Value	\$	ANOVA
Wealth quintile																		
Poorest	0.40		0.40		1.33	0.50		0.44		1.22		1.11		0.72			1.55	
Second	0.29	<i>P</i> = .07	0.21	.07	1.37	<i>P</i> = .04	0.52	<i>P</i> = .03	0.59	.22	0.92	<i>P</i> = .09	2.15	<i>P</i> = .38	0.75	.79	2.85	<i>P</i> = .26
Middle	1.24		0.35	.68	3.91		0.60		0.47	.79	1.20		3.16		0.68	.76	4.65	
Fourth	0.42		0.31	.40	2.01		0.63		0.54	.36	1.19		2.73		0.47	.09	5.84	
Richest	1.55		0.30	.37	7.76		1.42		0.66	.06	2.44		2.01		0.65	.61	3.53	
Sex																		
Male	1.00		0.34		4.13		0.67		0.50		1.42		2.75		0.65		4.37	
Female	0.37	<i>P</i> = .10	0.29	.48	1.49	<i>P</i> = .10	0.74	<i>P</i> = .62	0.53	.67	1.37	<i>P</i> = .87	1.52	<i>P</i> = .15	0.68	.73	2.26	<i>P</i> = .10
Maternal education																		
None to primary	0.41		0.19		3.47		0.68		0.57		1.18		2.76		0.70		4.03	
Finished primary	1.48	<i>P</i> = .99	0.91	.00	3.57	<i>P</i> = .92	0.74	<i>P</i> = .78	0.46	.14	1.74	<i>P</i> = .33	0.26	<i>P</i> = .57	0.55	.33	0.47	<i>P</i> = .66
Some secondary	0.22		0.50	.33	0.43		0.53		0.45	.48	1.56		1.37		0.60	.58	2.56	
Religious only	0.75		0.31	.14	2.79								1.92		0.63	.47	3.07	
Age																		
0–11 mo	0.91		0.33		3.42		0.48		0.45		1.11		1.86		0.64		3.03	
12–23 mo	1.01	<i>P</i> = .56	0.26	.28	4.45	<i>P</i> = .40	0.86	<i>P</i> = .13	0.53	.22	1.68	<i>P</i> = .26	4.11	<i>P</i> = .12	0.68	.66	6.22	<i>P</i> = .10
24–59 mo	0.49		0.34	.89	1.98		0.71		0.55	.23	1.35		1.08		0.69	.64	1.56	
Severity																		
Mild	0.81		0.35		2.47		0.22		0.34		0.59		0.71		0.58		1.24	
Moderate/severe	0.68	<i>P</i> = .66	0.31	.61	3.01	<i>P</i> = .65	0.92	<i>P</i> < .001	0.60	.00	1.65	<i>P</i> = .003	3.13	<i>P</i> = .02	0.72	.15	4.53	<i>P</i> = .06
Duration																		
1–3 d	0.51		0.30		2.19		0.71		0.64		1.14		2.31		0.70		3.37	
4–7 d	0.75	<i>P</i> = .10	0.39	.35	2.47	<i>P</i> = .10	0.84	<i>P</i> = .91	0.53	.20	1.63	<i>P</i> = .59	1.81	<i>P</i> = .06	0.53	.12	3.68	<i>P</i> = .14
8–14 d	4.28		0.57	.27	7.52		0.76		0.66	.86	1.29		3.84		0.29	.24	13.21	
15+ d	...		...		...		...		...		...		16.19		1.00		16.19	

Abbreviation: ANOVA, analysis of variance.

Table 4. Household Total Costs for Childhood Diarrhea by Socioeconomic, Demographic, and Illness Characteristic in Gambia, Kenya, and Mali

	Gambia			Kenya			Mali											
	Mean Cost for All Episodes		Proportion With Costs	Mean Cost for Episodes With Costs		Proportion With Costs	Mean Cost for All Episodes		Proportion With Costs	Mean Cost for Episodes With Costs								
	\$	ANOVA	P Value	\$	ANOVA	\$	ANOVA	\$	ANOVA	P Value	\$	ANOVA						
Wealth quintile																		
Poorest	2.65		0.52	5.04		5.39		0.67	5.93		3.20		0.72	4.45				
Second	1.04	<i>P</i> = .09	0.23	.01	3.33	<i>P</i> = .03	6.16	<i>P</i> = .89	0.76	.40	4.83	<i>P</i> = .12	3.50	<i>P</i> = .52	0.75	.79	4.64	<i>P</i> = .28
Middle	1.38		0.36	.21	3.81		5.31		0.59	.40	7.08		4.00		0.68	.76	5.89	
Fourth	2.84		0.40	.29	6.96		8.99		0.59	.42	4.10		5.89		0.54	.21	10.98	
Richest	5.28		0.31	.08	16.96		6.09		0.78	.26	7.83		4.54		0.70	.92	6.45	
Sex																		
Male	3.41		0.39		8.69		7.93		0.62		7.19		5.20		0.69		7.57	
Female	1.72	<i>P</i> = .16	0.35	.65	4.52	<i>P</i> = .25	4.11	<i>P</i> = .40	0.71	.18	4.87	<i>P</i> = .29	2.77	<i>P</i> = .09	0.68	.93	4.07	<i>P</i> = .07
Maternal education																		
None to primary	1.06		0.26		4.12		4.46		0.69		6.41		4.38		0.70		6.22	
Finished primary	10.45	<i>P</i> = .36	0.91	.00	11.49	<i>P</i> = .82	7.48	<i>P</i> = .04	0.63	.43	5.25	<i>P</i> = .03	0.79	<i>P</i> = .52	0.65	.73	1.21	<i>P</i> = .52
Some secondary	0.22		0.50	.47	0.43		14.27		0.62	.71	10.08		2.42		0.60	.58	4.02	
Religious only	2.66		0.38	.19	6.84						5.33		5.33		0.67	.74	7.96	
Age																		
0–11 mo	1.87		0.35		5.39		4.35		0.57		5.65		4.02		0.66		6.10	
12–23 mo	3.73	<i>P</i> = .36	0.31	.55	11.33	<i>P</i> = .17	4.71	<i>P</i> = .21	0.67	.13	5.49	<i>P</i> = .70	6.23	<i>P</i> = .23	0.68	.84	9.17	<i>P</i> = .17
24–59 mo	2.33		0.42	.39	5.61		8.32		0.71	.08	6.67		2.39		0.73	.53	3.27	
Severity																		
Mild	2.84		0.42		6.82		4.92		0.47		4.01		1.82		0.58		3.15	
Moderate/severe	2.58	<i>P</i> = .93	0.36	.59	6.86	<i>P</i> = .97	6.85	<i>P</i> = .98	0.75	<.01	6.69	<i>P</i> = .38	5.55	<i>P</i> = .02	0.75	.06	7.39	<i>P</i> = .09
Duration																		
1–3 d	2.48		0.41		5.62		5.44		0.70		6.61		3.75		0.70		5.38	
4–7 d	2.47	<i>P</i> < .001	0.43	.82	5.72	<i>P</i> < .001	8.75	<i>P</i> = .93	0.73	.71	5.80	<i>P</i> = .80	4.79	<i>P</i> = .38	0.59	.34	8.10	<i>P</i> = .43
8–14 d	14.48		0.70	.18	20.57		4.88		0.87	.22	5.63		5.39		0.29	.24	18.53	
15+ d	...		...		...		...		...		...		18.32		1.00		18.32

Abbreviation: ANOVA, analysis of variance.

Table 5. Reasons for Not Seeking Treatment and Sources of Household Costs for Diarrhea Episodes—Kenya, Gambia, and Mali

Question	Kenya (n = 63)	Gambia (n = 49)	Mali (n = 30)
Why did households not seek care for their child?			
No need for care	44.4%	49.0%	66.7%
Distance too far	12.7%	2.0%	0.0%
Lack of transportation	9.5%	2.0%	0.0%
No time off work	3.2%	8.2%	0.0%
Local situation (political)	0.0%	4.1%	3.3%
Transportation costs	4.8%	10.2%	3.3%
Treatment costs	36.5%	22.5%	23.3%
Leaving other children at home	4.8%	0.0%	0.0%
Unhappy with clinical services	1.6%	8.2%	0.0%
Preferred traditional medicine	17.4%	10.2%	10.0%
Cultural differences	3.1%	0.0%	0.0%
Other	12.6%	0.0%	0.0%
Why did the household not seek hospital care when advised?			
Hospital too far	0.0%	7.4%	0.0%
No transportation	2.9%	3.7%	0.0%
Travel costs too high	2.9%	14.8%	0.0%
No time off work	0.0%	11.1%	0.0%
Local situation	0.0%	0.0%	0.0%
Treatment costs	52.9%	7.4%	52.9%
Needs of other children at home	2.9%	0.0%	0.0%
Child not sick enough	17.7%	48.2%	29.4%
Unhappy with clinical services	0.0%	3.7%	0.0%
Other	20.6%	3.7%	17.7%
Where did the money come from?			
Fewer meals	18.3%	7.1%	8.3%
Cutting other expenses	15.0%	17.1%	12.5%
Savings	34.3%	44.1%	65.6%
Borrowing	15.5%	8.1%	3.1%
Selling assets	16.4%	1.9%	5.2%
Donations	1.4%	0.0%	3.1%
Relative or friend	9.4%	5.7%	3.1%
Other	7.9%	6.2%	3.1%

a constraint on what can be spent on treatment or transportation, resulting in less care seeking and less expenditure among poor households. However, we saw no differences in the proportion of episodes incurring some costs among wealth quintiles, suggesting that household wealth may not affect whether money is spent, but rather how much is spent.

Sex was a second determinant of household diarrhea costs in Gambia and Mali, but not in Kenya. There are 2 potential explanations for this association. First, it is possible that this reflects differences in diarrhea severity between boys and girls that result in the need for greater care among boys. However, there were no differences in the frequency of moderate-to-severe diarrhea between boys and girls in either country. The second interpretation is that cost differences reflect intrahousehold resource allocation that disadvantages girls. Several

studies have documented reduced health expenditures for girls in low-income settings [26–29]. If resources are limiting care seeking for diarrhea, then it is plausible that girls will bear a greater burden in terms of missed treatment and the resulting negative outcomes. It is interesting to note that this relationship only held for the 2 lower-income countries in the study. It is also interesting to note that this relationship was not observed in our related study in 3 Asian settings [30].

Is Household Economic Burden a Barrier to Appropriate Care?

Average costs per episode only provide one aspect of the burden costs place on households in low-income settings. Three other related factors must be considered: the distribution of costs, the potential for impoverishment due to the costs, and the health burden of avoided costs. The cost

distributions within each setting demonstrate that costs often substantially exceed the mean. In all countries, 10% of episodes resulted in costs that were twice the mean and even further above the median. In Kenya and Mali, this resulted in 10% of cases having costs of >\$10, a substantial burden in settings where households live on \$1 per day. Figure 1 shows that even the poorest households experience episodes with high costs. Additionally, diarrhea is a frequent outcome among children <5 years of age, implying that each episode brings a chance of high costs when compared to earnings. In all 3 countries, households were most likely to get the funds from reduced savings. Other common responses included incurring debt and selling household assets. Our results do not allow us to determine the long-term consequences of these costs on household impoverishment. However, it is likely that reduced savings, diminished assets, and increased debt would make it harder for households to respond to adverse economic events in the future, especially for the small but important fraction of households that incur substantial costs.

Possibly the greatest economic burden is not the costs themselves, but that they may encourage rationing of care for children with diarrhea. The most common reasons for not seeking care was related to a lack of resources or a perception that the episode was not severe. These costs were not just the formal costs of direct medical treatment but also the costs of transportation, childcare, and missed work. Given that direct medical costs in formal settings account for only a small fraction of household costs, it is unclear whether reduced user fees would have an impact on this barrier. Medication costs (typically separate from user fees) are substantial, suggesting that even with low costs for visits, households face other economic costs that may impede access. Lower observed costs for girls and children in poor households are likely symptoms of this rationing of care, implying that the health burden associated with household economic costs falls primarily on these children. The data analyzed here do not allow us to directly address whether these household costs resulted in greater adverse outcomes (eg, severe illness or mortality); however, the results point to the importance of addressing these questions empirical with the additional data being collected in the study.

Limitations

The current work suffers from several limitations. First, the study sample size was designed to provide estimates of overall costs within a margin of error but was not powered to examine determinants of costs. As a result, differences among subgroups are often not statistically significant and could be addressed with larger samples in subsequent research. Second, one-time cross-sectional data did not allow direct examination of the long-term consequences of incurred costs by

household for individual events or repeated episodes. Last, the cross-sectional nature of the study makes it difficult to assess whether low costs for specific subgroups are the result of reduced severity, cheaper services, or rationing of care. Additional work must also be conducted to better understand how the complex interaction between direct medical, direct non-medical, and indirect costs impact households' demand for and decisions to seek informal or formal care.

CONCLUSIONS

Diarrheal episodes are common among children <5 years of age in low-income settings, resulting in significant mortality burden as well as substantial economic costs associated with nonfatal events. These 2 aspects of burden—mortality and household costs—may be closely connected. Costs may serve as barriers that result in reduced healthcare seeking, especially for poorer households and for girls. These costs may force households to take other steps like borrowing and reducing savings that may expose them to economic insecurity. While the results here cannot prove this connection between household costs and mortality, it points to importance of further study. The costs of diarrhea treatment to the healthcare system are important and must be considered by national decision makers choosing between health interventions.

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References

1. Black RE, Cousens S, Johnson HL, et al. Global, regional, and national causes of child mortality in 2008: a systematic analysis. *Lancet* **2010**; 375:1969–87.
2. Atherly D, Dreifelbis R, Parashar UD, Levin C, Wecker J, Rheingans RD. Rotavirus vaccination: cost-effectiveness and impact on child mortality in developing countries. *J Infect Dis* **2009**; 200(suppl 1):S28–38.
3. Khoury H, Ogilvie I, El Khoury AC, Duan Y, Goetghebeur MM. Burden of rotavirus gastroenteritis in the Middle Eastern and North African pediatric population. *BMC Infect Dis* **2011**; 11:9.
4. Kirigia JM, Sambo LG, Yokouide A, Soumbey-Alley E, Muthuri LK, Kirigia DG. Economic burden of cholera in the WHO African region. *BMC Int Health Hum Rights* **2009**; 9:14.

5. Rheingans R, Atherly D, Anderson J. Distributional impact of rotavirus vaccination in 25 GAVI countries: estimating disparities in benefits and cost-effectiveness. *Vaccine* **2012**; 30(suppl 1):A15–23.
6. Tate JE, Rheingans RD, O'Reilly CE, et al. Rotavirus disease burden and impact and cost-effectiveness of a rotavirus vaccination program in Kenya. *J Infect Dis* **2009**; 200(suppl 1):S76–84.
7. Rheingans RD, Antil L, Dreibelbis R, Podewils LJ, Bresee JS, Parashar UD. Economic costs of rotavirus gastroenteritis and cost-effectiveness of vaccination in developing countries. *J Infect Dis* **2009**; 200(suppl 1): S16–27.
8. World Health Organization. Guidelines for estimating the economic burden of diarrheal disease with focus on assessing the costs of rotavirus diarrhea. Geneva, Switzerland: WHO, **2005**.
9. Patil AV, Somasundaram KV, Goyal RC. Current health scenario in rural India. *Aust J Rural Health* **2002**; 10:129–35.
10. Rao NS. Delivery of health services in the public sector. Financing and delivery of health care services. In: India in National Commission on Macroeconomics and Health - Background papers. New Delhi: Ministry of Health and Family Welfare, **2005**; 4:43–59.
11. Gelberg L, Andersen RM, Leake BD. The behavioral model for vulnerable populations: application to medical care use and outcomes for homeless people. *Health Serv Res* **2000**; 34:1273–302.
12. Banerjee A, Deaton A, Duflo E. Health, health care, and economic development: Wealth, health, and health services in rural Rajasthan. *Am Econ Rev* **2004**; 94:326–30.
13. Andersen RM, Davidson PL. Improving access to care in America: individual and contextual indicators. In: Andersen RM, Rice TH, Kominski GE, eds. Changing the US health care systems: key issues in health services policy and management. San Francisco: Jossey-Bass, **2001**:3–30.
14. Chola L, Robberstad B. Estimating average inpatient and outpatient costs and childhood pneumonia and diarrhoea treatment costs in an urban health centre in Zambia. *Cost Eff Resour Alloc* **2009**; 7:16.
15. Burton DC, Flannery B, Onyango B, Larson C, Alaii J, Zhang X, Hamel MJ, Breiman RF, Feikin DR. Healthcare-seeking behaviour for common infectious disease-related illnesses in rural Kenya: a community-based house-to-house survey. *J Health Popul Nutr* **2011**; 29:61–70.
16. Ridde V, Morestin F. A scoping review of the literature on the abolition of user fees in health care services in Africa. *Health Policy Plan* **2011**; 26:1–11.
17. James CD, Hanson K, McPake B, et al. To retain or remove user fees? Reflections on the current debate in low- and middle-income countries. *Appl Health Econ Health Policy* **2006**; 5:137–53.
18. Stanton B, Clemens J. User fees for health care in developing countries: a case study of Bangladesh. *Soc Sci Med* **1989**; 29:199–205.
19. Mwabu G, Mwanzia J, Liambila W. User charges in government health facilities in Kenya: effect on attendance and revenue. *Health Policy Plan* **1995**; 10:164–70.
20. Chuma J, Musimbi J, Okungu V, Goodman C, Molyneux C. Reducing user fees for primary health care in Kenya: policy on paper or policy in practice? *Int J Equity Health* **2009**; 8:15.
21. Gilson L. The lessons of user fee experience in Africa. *Health Policy Plan* **1997**; 12:273–85.
22. Kotloff KL BW, Nasrin D, et al. The Global Enterics Multicenter Study (GEMS) of diarrheal disease in infants and young children in developing countries: epidemiologic and clinical methods of the case/control study. *Clin Infect Dis* **2012**; 55(Suppl 4):S232–45.
23. Levine MM. Etiology of diarrhoeal and enteric diseases in developing countries: the Global Enteric Multicenter Study (GEMS) project. Global vaccine research forum. Bamako, Mali: World Health Organization, **2009**.
24. O'Donnell O, van Doorslaer E, Wagstaff A, Lindelow M. Measurement of living standards. In: O'Donnell O, van Doorslaer E, Wagstaff A, Lindelow M, eds. Analyzing health equity using household survey data: a guide to techniques and their implementation. Washington, DC: World Bank, **2008**:69–82.
25. Feikin DR, Olack B, Bigogo GM, et al. The burden of common infectious disease syndromes at the clinic and household level from population-based surveillance in rural and urban Kenya. *PLoS One* **2011**; 6:e16085.
26. Pokhrel S, Snow R, Dong H, Hidayat B, Flessa S, Sauerborn R. Gender role and child health care utilization in Nepal. *Health Policy* **2005**; 74:100–9.
27. Pandey A, Sengupta PG, Mondal SK, et al. Gender differences in healthcare-seeking during common illnesses in a rural community of West Bengal, India. *J Health Popul Nutr* **2002**; 20:306–11.
28. Nuruddin R, Hadden WC, Petersen MR, Lim MK. Does child gender determine household decision for health care in rural Thatta, Pakistan? *J Public Health (Oxf)* **2009**; 31:389–97.
29. Nguyen H, Knowles J. Demand for voluntary health insurance in developing countries: the case of Vietnam's school-age children and adolescent student health insurance program. *Soc Sci Med* **2010**; 71:2074–82.
30. Rheingans R, Kukla M, Faruque A, et al. Determinants of household costs associated with childhood diarrhea in three South Asian settings. *Clin Infect Dis* **2012**; 55(Suppl 4):S327–35.