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Determinants of percent expenditure of household income due to childhood diarrhoea in rural Bangladesh

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SUMMARY

There is limited information on percent expenditure of household income due to childhood diarrhoea especially in rural Bangladesh. A total of 4205 children aged <5 years with acute diarrhoea were studied. Percent expenditure was calculated as total expenditure for the diarrhoeal episode divided by monthly family income, multiplied by 100. Overall median percent expenditure was 3·04 (range 0·01–94·35). For *Vibrio cholerae* it was 6·42 (range 0·52–82·85), for enterotoxigenic *Escherichia coli* 3·10 (range 0·22–91·87), for *Shigella* 3·17 (range 0·06–77·80), and for rotavirus 3·08 (range 0·06–48·00). In a multinomial logistic regression model, for the upper tertile of percent expenditure, significant higher odds were found for male sex, travelling a longer distance to reach hospital (⩾median of 4 miles), seeking care elsewhere before attending hospital, vomiting, higher frequency of purging (⩾10 times/day), some or severe dehydration and stunting. *V. cholerae* was the highest and rotavirus was the least responsible pathogen for percent expenditure of household income due to childhood diarrhoea.

Key words: Bangladesh, diarrhoea, health economics, paediatrics, rotavirus, rural, *Shigella*.

INTRODUCTION

Childhood diarrhoea, the second leading cause of child death in developing countries has reduced appreciably over the last decades; however, its morbidity has still not declined significantly [1]. As a result, it imposes one of the major public health problems in children aged <5 years, causing a heavy economic burden especially in developing countries like Bangladesh [2]. Several socio-demographic, host and clinical characteristics are responsible for such economic loss [2]. Many studies have documented expenditures that include out-of-pocket expenses due to childhood diarrhoeal disease [3, 4]. However, the findings are not consistent mainly due to different geographical context, availability of resources and their cost, and were not adjusted for household income. Thus, percent expenditure of household income for a diarrhoeal episode would be another approach which might help for better prediction of diarrhoeal expenditures especially in a resource-poor setting [3, 5].

The International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) implemented a 3-year

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(January 2010 to December 2012) diarrhoeal disease surveillance programme among the population of the Demographic Surveillance System (DSS) [6, 7] area in rural Bangladesh. Household monthly income and detailed expenses due to children's diarrhoeal episodes were recorded in a structured field-tested questionnaire. This allowed calculation of percent expenditure of household income for childhood diarrhoea and its determinants in this rural community.

MATERIALS AND METHODS

Study site

The study site was located in Mirzapur, Tangail district, 60 km north-west of Dhaka, the capital city of Bangladesh. Kumudini Women's Medical College and Hospital, a tertiary-level hospital located at the centre of the DSS area with a separate diarrhoea treatment unit, served as sentinel health centre, where all children aged <5 years with diarrhoea were enrolled. About 238 468 people lived in the agro-economy-based DSS catchment area. Eleven percent of these were children aged <5 years, who represented the study population [7].

Study population

The diarrhoeal disease surveillance remained open 24 h per day, and every child aged <5 years from the DSS area, irrespective of age, sex, socioeconomic status and severity of disease, was enrolled. Thus, a total of 4205 children aged <5 years with diarrhoea were finally enrolled during January 2010 to December 2012.

Collection of economic data

Information on income of all household members irrespective of age and sex was collected for the last month from the date of interview. Information on employed individuals' income, for example those who work locally (in stores, or small factories) or elsewhere (in the city or abroad), was recorded. For individuals engaged in harvesting, information on cash earnings from selling crops was considered as a major income source. Moreover, information on income from livestock products such as cows' milk, eggs or even selling of livestock (chicken or duck) or products from home gardening including seasonal fruits were also collected. On the other hand, all expenditures due to current diarrhoeal episode, for example expenditure on purchasing drugs, consultations, investigations, hospital visit or stay, diet, and other costs before and after attending the hospital, including transportation costs, were also recorded.

Collection of socio-demographic and nutritional data

Administration of a structured field-tested questionnaire, allowed the gathering of information on socio-demographic indicators and nutritional indices (weight and height) following a standard method described previously [6] from all enrolled children aged <5 years. Children's z scores were calculated using WHO anthro 2005 software (www.who.int/childgrowth/software/). Stunting was defined as height-for-age z score (HAZ) $<-2{\cdot}00$ S.D., wasting as weight-for-height z score (WHZ) $<-2{\cdot}00$ S.D., and underweight as weight-for-age z score (WAZ) $<-2{\cdot}00$ S.D. according to WHO classification of malnutrition [8].

Collection of specimen and laboratory procedures

A fresh stool sample was collected from enrolled children aged <5 years. A faecal swab was then placed in Cary–Blair medium in a plastic screw-topped test tube. Using a Styrofoam container with cold packs, the specimen was transported to the central laboratory in Dhaka within 6–18 h of collection for detection of certain common pathogens such as rotavirus, *Shigella* spp., *Vibrio cholerae* and enterotoxigenic *Escherichia coli* (ETEC). The detection procedure has been described previously [9–11].

Ethical considerations

This study of children aged <5 years was part of a surveillance system that aimed to understand diarrhoeal disease aetiology and burden. The study was approved by the Research Review Committee and the Ethical Review Committee of icddr,b in December, 2009. Caregivers of children provided informed written consent before collection of stool samples and enrolment.

Data analysis

Household monthly income was calculated by adding monthly income of all the household members. Each mode of expenditure (before and after attending the hospital) was also added. Then, overall percent expenditure of household income for the current episode of diarrhoea was calculated by total expenditure for the diarrhoeal episode divided by monthly family income

and multiplied by 100 for an individual child. Percent expenditure of household income for each mode of expenditure (before and after attending hospital) was also calculated for each mode of expenditure divided by total income and multiplied by 100. Overall and pathogen-specific percent expenditure of household income was also calculated. Percent household expenditure was categorized into lower, middle and upper tertiles based on 33 percentile values as outcome of interest. Then, multinomial logistic regression analysis was performed considering the middle tertile as reference in order to determine the factors associated with percent expenditure of household income. Potential determinants for childhood diarrhoea were first identified based on previous studies [3, 4, 12, 13]. Factors assumed to be linked with percent expenditure of household income were, for example, socio-demographic factors (age, sex, family size, number of children aged <5 years), clinical characteristics (vomiting, frequency of purging, bloody-mucoid stool, some or severe dehydration), host characteristics (malnutrition, stunting), and causative pathogens (rotavirus, and *V. cholerae*), in addition to distance of hospital from household (transportation costs), and direct expenses for diarrhoeal episode (use of antimicrobials at home, and seeking care elsewhere before attending hospital). Data were analysed using SPSS for Windows v. 15.2 (SPSS Inc., USA).

RESULTS

Overall mean percent expenditure of household income was 6·44 (median 3·04, S.D. = 10·26, range 0·10–94·35). By contrast, pathogen-specific mean percent expenditures were 5·74 (median 3·17, S.D. = 8·55, 0·06–77·80) for *Shigella*, 5·03 (median 3·08, S.D. = 5·84, 0·06–48·00) for rotavirus, 6·49 (median 3·10, S.D. = 11·22, 0·22–91·87) for ETEC, and 13·44 (median 6·42, S.D. = 18·26, 0·52–82·85) for *V. cholerae*. Details of mode of percent expenditure of household income, both overall and individual (before and after attending hospital) are given in Table 1. At least 4% of households spent more than 30% of their household income because of diarrhoeal episodes of their <5-year-old children (data not shown).

A detailed list of socio-demographic, clinical, and host characteristics including common pathogens responsible for diarrhoea is given in Table 2. In the adjusted multinomial logistic regression model, for the upper tertile significantly higher odds were found for male sex, travelling greater distances to reach hospital ($\geqslant$ median value of 4 miles), seeking care elsewhere before attending hospital, vomiting, higher frequency of purging ($\geqslant$ 10 times in 24 h), some or severe dehydration and stunting. Similarly, odds for family size (>5 members), number of children aged <5 years >1, and use of antimicrobials at home were significantly lower in the upper tertile group of percent expenditure of household income (Table 2). No association was found for any pathogens or age and other clinical characteristics for the upper tertile.

DISCUSSION

The present analysis using the concept of percent expenditure of household income gives a clear idea about how childhood diarrhoea contributes to the economic burden for the affected family; especially in a rural community in Bangladesh. A very recent study reported costs for diarrhoeal episodes were higher for African children compared to Asian children [3, 4]. Even within the continent it differed by geographical location, for example mean cost per episode for The Gambia was US$2.63, for Kenya US$6.24, for Mali US$4.11 and this was also true for other continents [3, 4]. To our knowledge, the percent expenditure of household income might explain these discrepancies.

V. cholerae is the main pathogen which places a large economic burden on children aged <5 years in rural communities. This might be due to the use of intravenous fluid for immediate rehydration in addition to costs for antimicrobials. Cholera is less common in children aged <5 years compared to adults [5, 14]. Profuse loss of water and electrolytes in these children leads to some or severe dehydration, and severely dehydrated children in particular require immediate resuscitation by expensive saline rehydration. However, for those children who received oral replacement therapy at home their diarrhoeal percent expenditure was lower compared to those children who required hospitalization as well as intravenous saline rehydration and antimicrobials and thus, cumulatively increased the percent expenditure for the life-threatening illnesses. Therefore, a higher odds ratio (OR) was revealed for children who had some or severe dehydration within the upper tertile expenditure.

Conversely, rotavirus is the commonest pathogen responsible for childhood diarrhoea. The disease is often self-limiting [15] and never requires antimicrobials. However, irresponsible use of antibiotics is common in Bangladesh and thus, may contribute to excess

Table 1. *Overall and pathogen-specific different modes of percent expenditure of household income*

Expenditure	Overall estimated cost ($n = 4205$)	*Shigella* spp.($n = 518$)	Rotavirus ($n = 1174$)	ETEC ($n = 154$)	*Vibrio cholerae* ($n = 110$)
Estimated cost before attending hospital (US$)					
Drugs	0·69, 1·17, 0·25 (<0·01–16·00)	0·51, 0·83, 0·19 (<0·01–7·33)	0·93, 1·22, 0·49 (<0·01–9·17)	0·63, 1·08, 0·21 (<0·01–7·20)	1·05, 1·83, 0·46 (<0·01–12·50)
Consultations	0·01, 0·16, <0·01 (<0·01–5·00)	0·01, 0·09, <0·01 (<0·01–1·67)	0·03, 0·24, <0·01 (<0·01–5·00)	0·03, 0·25, <0·01 (<0·01–2·50)	0·02, 0·24, <0·01 (<0·01–2·50)
Transportation	0·07, 0·37, <0·01 (<0·01–7·50)	0·04, 0·22, <0·01 (<0·01–2·00)	0·14, 0·58, <0·01 (<0·01–7·50)	0·07, 0·33, <0·01 (<0·01–3·33)	0·07, 0·24, <0·01 (<0·01–1·33)
Investigations	<0·01, 0·04, <0·01 (<0·01–2·31)	<0·01*	<0·01, 0·07, <0·01 (<0·01–2·31)	<0·01*	<0·01*
Stay in hospital	0·02, 0·14, <0·01 (<0·01–3·57)	0·01, 0·07, <0·01 (<0·01–0·83)	0·04, 0·19, <0·01 (<0·01–3·33)	0·01, 0·05, <0·01 (<0·01–0·50)	0·02, 0·09, <0·01 (<0·01–0·63)
Others	<0·01, <0·01, <0·01 (<0·01–0·30)	<0·01*	<0·01, 0·01, <0·01(<0·01–0·30)	<0·01*	<0·01*
Total	0·79, 1·42, 0·25 (<0·01–20·00)	0·57, 0·99, 0·20 (0·00–8·67)	1·14, 1·65, 0·50 (<0·01–12·25)	0·74, 1·29, 0·22 (<0·01–7·20)	1·16, 2·04, 0·46 (<0·01–15·00)
Estimated cost after attending hospital (US$)					
Drugs	3·99, 7·87, 1·61 (<0·01–78·00)	3·35, 6·05, 1·67 (0·03–67·85)	2·21, 2·86, 1·38 (<0·01–32·07)	4·05, 8·88, 1·63 (0·03–75·37)	9·44, 14·42, 3·25 (0·20–64·53)
Consultations	0·60, 0·69, 0·38 (<0·01–15·00)	0·67, 0·95, 0·42 (0·01–15·00)	0·59,0·64, 0·38 (0·01–6·25)	0·65, 0·82, 0·43 (0·02–6·25)	0·88, 0·83, 0·63 (0·06–3·75)
Investigations	0·08, 0·96, <0·01 (<0·01–32·86)	0·04, 0·74, <0·01 (<0·01–16·50)	<0·01, 0·07, <0·01 (<0·01–1·98)	<0·01	0·26, 1·87, <0·01 (<0·01–18·75)
Stay in hospital	0·01, 0·21, <0·01 (<0·01–12·00)	<0·01*	<0·01*	<0·01*	<0·01*
Diet	0·93, 2·02, <0·01 (<0·01–30·00)	1·09, 2·41, <0·01 (<0·01–30·00)	1·05, 2·21, <0·01 (<0·01–25·00)	1·02, 2·39, <0·01 (<0·01–15·00)	1·69, 2·08, 1·09 (<0·01–7·50)
Others	0·02, 0·22, <0·01 (<0·01–6·25)	0·01, 0·19, <0·01 (<0·01–4·00)	0·04, 0·36, <0·01 (<0·01–6·25)	0·01, 0·13, <0·01 (<0·01–1·67)	0·01, 0·07, <0·01 (<0·01–0·75)
Total	5·65, 9·83, 2·35 (0·01–90·04)	5·18, 8·34, 2·58 (0·06–76·80)	3·88, 5·04, 2·21 (0·05–46·50)	5·75, 10·66, 2·31 (0·11–86·20)	12·28, 17·27, 5·25 (0·33–75·70)
Grand total	6·44, 10·26, 3·04 (0·01–94·35)	5·74, 8·55, 3·17 (0·06–77·80)	5·03, 5·84, 3·08 (0·06–48·00)	6·49, 11·22, 3·10 (0·22–91·87)	13·44, 18·26, 6·42 (0·52–82·85)

ETEC, Enterotoxigenic *E. coli.*

All values in the table are mean, S.D., median (range), respectively.

* Values could not be quantified.

Table 2. *Percent household expenditure for diarrhoeal illness by socioeconomic, clinical and host characteristics in children aged <5 years*

Characteristics	Lower tertile ($n = 1387$) *n* (%)	Middle tertile ($n = 1433$) *n* (%)	Upper tertile ($n = 1385$) *n* (%)	Unadjusted OR (95% CI)		Adjusted OR (95% CI)	
				Lower tertile	Upper tertile	Lower tertile	Upper tertile
Socioeconomic status							
Child's age							
0–11 months	675 (49)	625 (44)	412 (30)	1	1	1	1
12–23 months	439 (32)	466 (33)	289 (21)	0·87 (0·74–1·03)	0·94 (0·78–1·14)	0·95 (0·79–1·14)	0·84 (0·69–1·03)
24–59 months	273 (20)	342 (24)	684 (49)	0·74 (0·61–0·89)*	3·03 (2·54–3·63)*	0·94 (0·74–1·18)	0·95 (0·73–1·22)
Male	868 (63)	786 (57)	805 (56)	1·30 (1·12–1·52)*	1·02 (0·88–1·19)	1·29 (1·09–1·52)*	1·32 (1·10–1·59)*
Family members (>5)	800 (58)	498 (35)	408 (30)	2·56 (2·19–2·98)*	0·78 (0·67–0·92)*	2·75 (2·31–3·26)*	0·75 (0·61–0·92)*
No. of children aged <5 yr (>1)	435 (31)	321 (22)	197 (14)	1·58 (1·33–1·88)*	0·57 (0·47–0·70)*	1·14 (0·94–1·38)	0·74 (0·58–0·93)*
Antimicrobial use at home	399 (29)	701 (51)	605 (42)	0·55 (0·47–0·65)*	1·40 (1·21–1·63)*	1·54 (1·28–1·85)*	0·80 (0·66–0·98)*
Distance of hospital from home ($\geqslant$median 4 miles)	710 (51)	866 (63)	661 (46)	1·22 (0·06–1·42)*	1·95 (1·67–2·26)*	0·87 (0·74–1·02)	1·26 (1·05–1·50)*
Seeking care elsewhere before attending hospital	1091 (79)	1200 (84)	1272 (92)	0·72 (0·59–0·87)*	2·19 (1·71–2·79)*	0·96 (0·76–1·21)	1·51 (1·11–2·04)*
Clinical characteristics							
Duration of diarrhoea (>1 day)	849 (61)	1002 (70)	865 (63)	0·82 (0·70–0·95)*	0·72 (0·61–0·84)*	0·71 (0·59–0·85)*	0·87 (0·71–1·08)
Vomiting	679 (49)	731 (51)	880 (64)	0·92 (0·79–1·07)	1·67 (1·44–1·95)*	0·95 (0·80–1·13)	1·56 (1·29–1·89)*
No. of purgings ($\geqslant$10 times in 24 h)	583 (42)	723 (51)	906 (65)	0·71 (0·61–0·83)*	1·86 (1·59–2·17)*	0·77 (0·65–0·91)*	1·43 (1·19–1·72)*
Bloody mucoid stool	941 (68)	1056 (76)	931 (65)	1·14 (0·97–1·33)	1·73 (1·47–2·04)*	0·71 (0·59–0·86)*	1·05 (0·85–1·29)
Some or severe dehydration	55 (4)	135 (9)	397 (29)	0·40 (0·28–0·55)*	3·86 (3·11–4·80)*	0·49 (0·34–0·71)*	2·59 (1·95–3·44)*
Nutritional status							
Stunting	160/1357 (12)	211/1343 (16)	166/873 (19)	0·72 (0·57–0·90)*	1·26 (1·00–1·59)*	0·66 (0·52–0·84)*	1·33 (1·05–1·69)*
Wasting	142/1357 (11)	211/1343 (16)	173/873 (20)	0·63 (0·50–0·79)*	1·33 (1·06–1·67)*	—	—
Underweight	220/1357 (16)	292/1343 (22)	253/873 (29)	0·70 (0·57–0·85)*	1·47 (1·20–1·79)*	—	—
Aetiological agents							
Shigella spp.	161/1353 (12)	195/1408 (14)	162/1380 (12)	0·84 (0·67–1·06)	0·83 (0·66–1·04)	—	—
Rotavirus	362/1385 (26)	439/1432 (31)	373/1384 (27)	0·80 (0·68–0·95)*	0·83 (0·71–0·99)*	0·72 (0·59–0·88)*	1·09 (0·89–1·34)
ETEC	55/1353 (4)	46/1408 (3)	53/1380 (4)	1·25 (0·83–1·90)	1·18 (0·78–1·80)	—	—
Vibrio cholerae	20/1353 (2)	28/1408 (2)	62/1380 (5)	0·74 (0·40–1·36)	2·32 (1·44–3·74)*	0·99 (0·53–1·86)	1·17 (0·62–2·18)

OR, Odds ratio; CI, confidence interval; ETEC, enterotoxigenic *E. coli.*
Reference group: middle tertile.
* $P < 0·005$.

expenditure for rotavirus episodes. Lower OR was found for use of antimicrobials at home which is difficult to explain. It might be due to remission of the disease or non-progressing severity that leads to seeking care at a healthcare facility. This could be explained by another covariate such as duration of diarrhoea >1 day, which was associated with the lower tertile of percent expenditure rather than the upper tertile.

The other pathogen, *Shigella* is usually responsible for invasive diarrhoea with bloody-mucoid stool and often shows toxic presentation [16]. An antimicrobial is often required in addition to oral rehydration solution [16] and thus increases the percent expenditure of household income. However, no significant association was found in case of bloody-mucoid stool with percent household expenditure in the multivariate model. Such dysenteric episodes are considered as one of the major clinical conditions that prompt caregivers into taking their children to healthcare facilities.

Finally, although, ETEC causes acute diarrhoea, and is mostly self-limiting as rotavirus diarrhoea, it often remains undiagnosed [11, 15]. ETEC diarrhoea may present as cholera-like illness causing clinicians [15] to instigate use of empirical antibiotics with fluid; this might be an underlying reason for excess percent expenditures next to cholera.

Interestingly, none of the pathogens associated with percent expenditure of household income indicated the expenditure might be based on the parent's perception and realization of the need to seek treatment rather than laboratory confirmation of the causative pathogens. However, the present study was not aimed to determine quantitative assessment.

Another factor associated with upper tertile expenditure with a higher OR, was being a male child with diarrhoea. Male children receive more expenditure compared to female children in poor agro-economy-based rural communities with cultural beliefs. Although, males are considered at a lower risk for diarrhoea as well as other comorbidities like malnutrition [17], they receive greater priority in health-seeking behaviours. On the other hand, larger family size (>5 members) and more than one child aged <5 years had lower ORs for the upper tertile of household income, which might be associated with poor socioeconomic status where parents might not consider diarrhoea as a severe childhood morbidity.

Distance of the hospital from the household is one of the major barriers to reaching the healthcare facility, as reported elsewhere [6], and it was found to demonstrate a significantly higher OR in the upper tertile group. This is an expected association and mainly due to high travel costs to reach the facility. Some other clinical and host characteristics such as vomiting, higher stool frequency, and stunting independently influenced the families to spend more on treating their offspring, irrespective of the pathogens responsible for childhood diarrhoea. However, in the present study no association was found with age, which once again indicated an association of percent expenditure with disease severity and other indicators as already described.

Limitations

The collection of information regarding household income and expenditure may be biased by reports from the respondents. Extra efforts were made by the trained research assistants during data collection. Data from a single rural site might not be nationally representative; however, the scenario is presumed to be almost similar throughout the country with an agro-based economy. In the present study, we did not collect information on intangible time loss, and we did not include the laboratory costs. Thus, further researches are needed to admit or refute the present observations. However, a large sample size, a 3-year prospective enrolment from the DSS area, and a high-quality laboratory performance were strengths of the present study.

CONCLUSION

V. cholerae followed by ETEC were mostly responsible for higher percent expenditure of household income due to childhood diarrhoea in rural Bangladesh; *Shigella* and rotavirus follow next. Moreover, clinical presentation of acute diarrhoea and other socio-demographic characteristics of the patients potentially influence the percent expenditure of the income of the caregivers in this study.

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DECLARATION OF INTEREST

None.

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