The economic burden of measles in children under five in Bangladesh

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Abstract

Background: This study estimated the economic cost of treating measles in children under-5 in Bangladesh from the caregiver, government, and societal perspectives.

Method: We conducted an incidence-based study using an ingredient-based approach. We surveyed the administrative staff and the healthcare professionals at the facilities, recording their estimates supported by administrative data from the healthcare perspective. We conducted 100 face-to-face caregiver interviews at discharge and phone interviews 7 to 14 days post-discharge to capture all expenses, including time costs related to measles. All costs are in 2018 USD ($).

Results: From a societal perspective, a hospitalized and ambulatory measles cost $159 and $18, respectively. On average, the government spent $23 per hospitalized measles. At the same time, caregivers incurred $131 and $182 in economic costs, including $48 and $83 in out-of-pocket expenses in public and private not-for-profit facilities, respectively. Seventy-eight percent of the poorest caregivers faced catastrophic health expenditures compared to 21% of the richest. In 2018, 2263 cases of measles were confirmed, totaling $348,073 in economic costs to Bangladeshi society, with $121,842 in out-of-pocket payments for households.

Conclusion: The resurgence of measles outbreaks is a substantial cost for society, requiring important short-term public expenditures putting households into a precarious financial situation. Improving vaccination coverage in areas where it is deficient (Sylhet division in our study) would likely alleviate most of this burden.

Background

The vaccination coverage for measles worldwide is estimated at 86% for the first dose of measles-containing vaccine (MCV1) and 69% for MCV2 in 2018 [1], leaving most of the measles cases to occur as outbreaks driven by gaps in vaccination coverage and humanitarian crises [2]. In 2005, Bangladesh carried out a mass measles vaccination catch-up campaign, in addition to its routine immunization, effectively bringing vaccination coverage for MCV1 in the 89-97% range nationally for the last ten years [1]. Measles vaccination effectively curbed the incidence of measles to the point where the Government of Bangladesh enacted a strategy for measles elimination in 2014 as they added a second dose (MCV2) to their expanded program for immunization (EPI) in 2012 [3]. Including the cost of the vaccine (Gavi pricing applied) and its delivery, measles vaccination in Bangladesh from 2011 to 2030 is estimated to reach about $136,116,356, which translates to $1.33 per dose on average [4].

The reported vaccination coverage remains high nationally: 92% and 83% for the first and second dose of MCV [1]. Nevertheless, the country is experiencing a resurgence of measles cases with over 1,069 and 4,001 confirmed cases in 2016 and 2017, respectively, compared to less than 400 from 2013-15 [5]. The increased prevalence of measles cases was driven in part from the South-East of the country with the Rohingya migration in Chittagong district [6] and by differences in vaccination coverage across divisions [7].

The value of vaccines with a longstanding presence in national EPI is poorly understood in economic terms. However, with declining stockpiles (yellow fever), the discovery of gaps in immunity in young adults (rubella) [8] and a sharp recrudescence of cases (measles), strategies to sustain and improve the coverage of these existing vaccines are at the forefront, potentially delaying the introduction of vaccines against other diseases. To our knowledge, there is no other empirical cost-of-illness study for measles in low-income settings: only a few were done in lower- and upper-middle-income countries [9-11].

We aimed to fill this gap with measles cost estimates for Bangladesh, including both inpatient and outpatient costs from the different sectors providing care. This study was part of an extensive stand-alone cost-of-illness study producing estimates of the cost of measles, pneumonia, and diarrhea for the healthcare facility, caregiver, and society in Bangladesh.

Methods

Study design

We conducted an incidence-based study, restricting the time horizon for costing to an episode of measles. We used an ingredient-based approach, where the cost and quantity of individual items (e.g., medications, supplies) that were reportedly used to care for this episode were assessed and aggregated. This approach allows us to estimate the “real-world” cost [12] of an episode of measles,

potentially including medications and items not typically recommended in treatment guidelines. Further explanations of these economic approaches can be found in Vassall et al. and Jo [12, 13].

Study population and sites

The study was focused on two divisions with different levels of vaccination coverage: Sylhet (low coverage at 61.1%) and Rajshahi (high coverage at 83.6%) [14]. In each division, we selected a district (Maulvibazar and Natore districts) and a city corporation (Sylhet and Rajshahi city corporations), representative of rural and urban settings. We included 24 healthcare facilities in each division (19 in city corporations and 5 in rural districts, see Figure 1), selected based on the number of measles, pneumonia and diarrhea cases reported for the prior year (2015-16) and to represent different facility levels and sectors: we included 30 public and 18 private for-profit and not-for-profit facilities. Note that only six facilities presented measles cases by the end of data collection: only the costs from those facilities were included in our analysis. Based on the recommendations of the healthcare facilities' staff, we selected 20 pharmacies from the area surrounding the facilities. Pharmacies were all privately owned and registered.

We recruited adult caregivers over 18 years old of children 0-59 months of age with suspected measles to understand the caregiver perspective. Measles diagnosis was based on clinical assessment and was not always confirmed by laboratory tests. We assumed that: (1) the healthcare professionals were likely to provide an accurate assessment of measles where outbreaks occur regularly as this is the case for Sylhet and (2) the treatment provided corresponded to a treatment for measles. We did not include cases that reported only a rash without a precise diagnosis of measles in the patients' medical records. We excluded cases also diagnosed with other diseases (*e.g.*, HIV, pneumonia).

Data collection

The surveys were administered in Bengali on tablets using KoBoToolbox (Cambridge, MA), an open-source software that is used to collect, manage and analyze data in challenging settings. From August 2017 to May 2018, a team of six field research assistants interviewed the staff from the 48 selected healthcare facilities, including administrators, medical staff, laboratory technicians, statisticians, and storekeepers, to collect healthcare facility cost and utilization data. Whenever possible, we used administrative data and reports to augment and adjust the recorded estimates. Healthcare facility costs included capital costs (infrastructure, furniture and medical equipment), overhead costs, labor costs (staff salaries and benefits), and medical supplies and medications used for diagnostic tests, hospitalization, and treatment. For tertiary and secondary level hospitals, data collection was restricted to the pediatric ward. Additional data on medication pricing was retrieved from pharmacies in the private sector and surrounding the selected healthcare facilities to complement missing information from the healthcare facility surveys. The data, questionnaires, and codebooks are available in open access [15].

Caregivers were interviewed at the time of discharge from the facility and 7 to 14 days post-discharge via the phone, capturing all costs incurred during hospitalization, in previous hospital facilities, and post-discharge, as well as their medication and medical supplies utilization. We obtained information about the caregivers' out-of-pocket payment related to measles, including information about direct medical costs (registration fees, medications, medical procedures, hospitalization) and non-medical costs (transportation to and from the facilities, meals, and lodging for the caregiver). To estimate their indirect cost, we also asked caregivers' information about the time spent providing care for the child at the facility. Additionally, we collected information about their household, their daily expenditures, and their income to assess their socioeconomic status.

Cost categories were defined based on the Global Health Cost Consortium (GHCC) and Jo [12, 13], and can be found in details in the Supplementary Material: Table S1. Costs were collected in Bangladeshi Takas (BDT) and converted to 2018 US dollars, using the following conversion rate: 1 USD = 83.5 BDT [16]. Costs in 2018 BDT are available in the Supplementary Material: Tables S3-S5 and Figure S1.

Government costs

For the government perspective, all costs were patient-specific with exception for overhead, labor, and capital costs. The latter costs were shared with all other patients in the pediatric ward. Capital costs were annualized based on a standard lifetime of 50 years for infrastructure and five years for medical equipment with a discount rate of 3% [17, 18]. We found that the collected data for the cost and the lifetime of medical equipment, furniture, and infrastructure were either not known or not deemed reliable by respondents in

the healthcare facilities. Measles treatment could not be associated with a specific area of each facility and specific personnel time as recommended by the GHCC to calculate operating costs [12]. Instead, the annualized overhead, labor, and capital costs attributable to an episode of measles was calculated using patient-days (see Equation 1).

Equation 1:

$$S = \sum_{\substack{i=0 \\ j=0}}^{\substack{n \\ m}} \frac{c_j \times los_{i,j}}{p_j}$$

Where S is the total cost of overhead, labor and capital attributable to an episode of measles per facility, c_j the total annual cost, p_j the annual number of patients who used the facility and with $los_{i,j}$ the length of stay in days for patient i over n total patients whose caregiver was interviewed, and for healthcare facility j over m total facilities.

However, for the few facilities that had a dedicated measles ward, the capital costs associated with this ward were calculated based on the utilization rate of the measles ward only, while the capital costs shared across the pediatric ward used the utilization rate of the whole pediatric ward. All other costs were combined with patient-specific utilization.

Caregiver costs

For caregivers, all direct costs (*e.g.*, hospital fees, costs of medications, transportation, meals) were itemized. To calculate the total economic cost for caregivers, we add to the direct costs the indirect costs of this episode, estimated through a human capital approach that combines the head of the household's average income and the time spent traveling to and from healthcare facilities, and in the healthcare system [19]. Based on stakeholders' feedback, we also reported detailed time loss exempt of monetary valuation.

We examined whether there were any differences in direct, indirect, and overall costs for an episode of measles based on the child's gender, urban and rural areas, types of visits and facilities, and length of stay using an independent t-test. For age groups, study areas, and asset quintiles, we performed a one-way ANOVA. We used the Wilcoxon and Kruskal-Wallis rank tests when either the hypothesis of normal distribution or equal variance was rejected.

Catastrophic health expenditures

Catastrophic health expenditures were calculated using the share of direct cost (medical and non-medical combined) over the monthly income of the head of the household and the monthly household expenditures. The monthly expenditures comprised of food, clothing, supplies, leisure, tax paid, other healthcare expenses (not related to current episode), and other expenses. We determined that a household experiencing catastrophic health expenditures related to this episode of measles when they spent over 10% of their income, 10% or 25% of their monthly expenditures or 40% of their monthly expenditures without food [20, 21].

Societal costs

The societal costs are the combination of the costs borne by the caregivers and the healthcare system. We assumed that all costs borne by private healthcare were transferred to caregivers through charges. We estimated the country-level costs for measles by combining the costs per episode, apportioned by sector and type of visit, with the annual number of confirmed measles cases for Bangladesh [5].

Household socioeconomic status

The socioeconomic status of each household was defined based on asset scores generated through a principle component analysis (PCA) approach. The PCA was based on the ownership of durable assets in the households [22]: the households' dwelling characteristics (*e.g.*, wall, roof and floor materials, water and sanitation facilities, and utilities) and the possession of durable goods

(*e.g.*, radio and television). Based on their asset score ranking, the households were divided into asset quintiles. In the first quintile (poorest households), 17 households obtain the same score, thus explaining the unequal proportion between the first and second quintiles.

Results

We captured a total of 100 measles cases during the data collection period; however, 5 cases were excluded because the caregivers associated with these cases did not complete the post-discharge interview. Most measles cases were captured in public healthcare facilities. Sixty-four hospitalized cases in Sylhet MAG Osmani Medical College Hospital (tertiary level) in Sylhet City Corporation, and 5 in Maulvibazar District Hospital (secondary) in Maulvibazar district (both in Sylhet division). Four outpatient cases were also captured, all in primary level facilities in Natore district (Rajshahi division): 2 in Baraigram Upazila Health Complex, 1 in Bashbaria Community Clinic, and 1 in Zoary Union Sub Center. Twenty-two hospitalized cases came from Lions Child Hospital (secondary level), a private not-for-profit hospital in Sylhet City Corporation.

In our sample, 58% of the children affected were aged under one year, with more girls (59%) than boys. Most of them came from rural areas (88%) to get treated in hospitals located in urban settings (95% of all admissions). Most children hospitalized due to their measles episode stayed five days or more in healthcare facilities (71%), with no significant difference in length of stay between public and private facilities.

Cost-of-illness estimates

Government facilities spent an average of $1.95 per outpatient case and $21.59 for a hospitalized case. Costs for outpatient cases ranged from $1.00 to $1.71, mainly driven by the estimated labor (54-84%) and capital costs (5-46%). Hospitalized cases in Maulvibazar District Hospital costed an average of $17.56, and those in Sylhet MAG Osmani Medical College Hospital an average of $22.88, both driven by labor (33% and 45%) and medication costs (59% and 42%). Overhead costs were also significant in most facilities at 4-8%. Table 1 presents detailed cost estimates from the government perspective.

Overall, the mean economic cost per episode of measles for caregivers was $138 with an average out-of-pocket cost of $54. Table 2 presents the estimates by type of cost. Caregivers who used public healthcare facilities spent significantly less than those who used private not-for-profit facilities for a hospitalized measles ($p \leq 0.01$, see Supplementary Material: Table S2). On average, caregivers spent a total of $131, including $48 in out-of-pocket expenses in the public sector compared to $182 in total costs and $83 in out-of-pocket in the private not-for-profit facility. Caregivers' time spent in healthcare facilities for inpatient care was nearly the same between public and private facilities with 4.5 days and 4.4 days, valued at $83 and $100, respectively. Neither the time spent on healthcare, nor the indirect costs were significantly different. Expectedly, longer lengths of stay (5 days or more) meant significantly higher direct costs, indirect and overall costs.

For the few outpatient episodes captured ($n = 4$), all in the public healthcare system, caregivers spent an average total cost of $16 with $3 in out-of-pocket expenses – significantly lower than the cost of inpatient cases.

Over the continuum of care for measles, either with hospitalization or ambulatory care, the cost of the current visit influenced most the total cost: 73% and 82% of the total cost in public – inpatient and outpatient, respectively – and 80% in the private not-for-profit facility. Indirect costs due to productivity loss were the most significant share of the total cost in all facilities and types of care, ranging from 55% to 85%. Caregivers residing in urban areas had statistically significantly lower direct costs with $36 than those in rural areas with $56 ($p = 0.04$). There was no difference in costs between male and female children and caregivers.

When grouping the caregivers by asset quintiles, we found that the only significant difference lay in the indirect costs for inpatient care of the 5th quintile compared to the 1st, 2nd and 3rd quintiles ($p < 0.05$). Caregivers in the poorer three quintiles incurred direct costs from $39 to $70, whereas caregivers in the richest quintile incurred costs of $138. This difference in indirect costs was driven by differences in income, as there was no significant difference in time loss between quintiles. Additionally, all outpatient cases happened in the 2nd quintile, making its associated costs significantly lower than in the other quintiles.

Economic burden

The economic cost of an episode of measles contributed to 8% of the annual national gross domestic product (GDP) per capita. Based on our sample, 89% of the caregivers reported having spent over 10% of their monthly household income on treating measles. This cost represented, on average, 32% of their monthly income.

Focusing on the household consumption, 92% of caregivers reported that a measles episode accounted for 10% of their household expenditures, and 44% spending over 25% of their household expenditure. When excluding food, 57% reported spending over 40% of their household expenditure. The proportion of households experiencing catastrophic health expenditures decreased with richer asset quintiles: focusing on daily consumption excluding food, 78% of caregivers in the poorest 1st asset quintile faced catastrophic health expenditures, compared to 60%, 49% and 21% in the 3rd, 4th and 5th quintiles, respectively.

Ninety percent of caregivers reported coping with the additional expenses by using their savings, in combination with getting a loan from a bank or a lending institution (46%) or borrowing from friends (2%). Caregivers in the richest 4th and 5th quintiles all reported relying primarily on savings to fund measles-related treatment, with several (33% and 5%, respectively) who reported having to take a loan. In the poorest 1st and 2nd quintiles, the inverse trend was observed with 81% and 43%, respectively, using their savings, and with 81% and 71% having to take a loan to pay for a measles episode.

Societal costs and country-level cost of measles

From a societal perspective, a hospitalized episode of measles costed $159 and an outpatient episode $18. Across sectors, the societal cost of a hospitalized measles was $153 when using public healthcare, and $182 when accessing private not-for-profit healthcare. Direct medical costs contributed to 27% and 29% of the cost for users of public and private facilities, respectively, albeit a different distribution: half of the cost was borne by the government in public facilities (see Figure 3). Non-medical costs, including transportation and meals, took 18% of the societal cost for those using public facilities and 16% for private facilities, indicating that the caregiver made significant out-of-pocket payments to access healthcare. Indirect costs took the largest share of the societal cost, with 55% at both public and private facilities.

By the end of 2018, when data collection was completed, there were 2263 confirmed cases of measles [5], causing $348,073 in societal cost, including $121,842 for Bangladeshi households to bear in out-of-pocket expenses. If we include the previous two years when the incidence rate for measles spiked and used our 2018 average cost, we estimate the societal, economic cost at $1,127,892 with $394,815 in caregiver out-of-pocket expenses for 2016 – 2018.

Discussion

Government provision of healthcare services is a clear path towards universal health coverage. As illustrated in Figure 3, a significant share of the medical costs ($20) shifted from the caregivers to the government, leaving them to cover the remaining $21. While this is significantly less than for those who used the private sector and were charged $53 in medical expenses, there is room for progress.

Additionally, the allocation of resources to treat and prevent measles should consider urban and rural communities. Measles outbreaks took a heavy toll on rural areas, where most of the study caregivers resided (88% were rural residents). This said, most of the measles-related healthcare services were provided at tertiary and secondary-level hospitals located in urban areas (Sylhet city corporation, 91%), with only a few cases seen at a hospital in rural areas (Maulvibazar, 5%). Rural residents incurred additional costs for transportation and meals to access healthcare, increasing their out-of-pocket expenditures substantially compared to those residing in urban areas.

Finally, these estimates also highlight the weight of the indirect cost due to productivity loss for both users of government facilities and private healthcare, averaging 64-85% of the total cost of the former and 55% of the latter. Caregivers must spend a significant amount of time away from work and from the household to access care for measles treatment.

The cost estimates provide invaluable insights to understand the burden that measles poses to the healthcare system and households in Bangladesh, both in financial and economic terms. However, without the assessment of the impact of sequelae to the child's future health and of mortality to a household's expected income, our estimates are likely conservative. The extent to which a measles infection impacts a child's future health is yet to be fully understood. Clinical studies pre-post measles infection revealed that children who survived went on with a weakened immune system. Measles seems to be severely weakening the child's immunity

against other infectious diseases for which the child had previously received a vaccine [23]. An episode of measles could create the need to re-vaccinate affected children, with all the costs vaccination entails.

The study had several limitations linked to the definition of the disease: access to laboratory confirmation was limited, and the vaccination status of the child was difficult to assess. When asked whether the child had an immunization card, nearly all caregivers reported that their child had one, but did not have it at the time of their interview. Since we required to see immunization cards to record the date when vaccines were given, we were unable to check the vaccination status of the children treated for measles. Additionally, the study estimates are conservative as the analysis does not include the medium to long-term costs of measles-related sequelae.

Conclusion

This study is one of the few studies that examined the economic burden of a disease with a vaccine with a longstanding presence in national EPI. Considering the high effectiveness of MCV, these societal cost estimates directly quantify the benefits in expanding the measles eradication strategy started in 2012. The government should continue to improve the vaccination coverage, particularly by consolidating routine immunization to bridge the gap between high and low performing divisions. It is an essential contribution to health systems strengthening.

List Of Abbreviations

Authors:	
BP	Dr. Bryan Patenaude
DC	Dr. Dagna Constenla
GD	Mr. Gatien de Broucker
GM	Mr. Gazi Golam Mehdi
JM	Dr. Jorge Martin del Campo
JU	Dr. Md. Jasim Uddin
SA	Dr. Sayem Ahmed
WA	Mr. Md. Wazed Ali
ZH	Mr. Md. Zahid Hasan

In-text abbreviations:	
ANOVA	Analysis of Variance
BDT	Bangladeshi Takas
DOVE	Decade Of Vaccine Economics project
EPI	Expanded Program for Immunization
GDP	Gross Domestic Product
GHCC	Global Health Cost Consortium
GSK	GlaxoSmithKline
icddr,b	International Centre for Diarrhoeal Disease Research, Bangladesh
IRB	Institutional Review Board
MCV	Measles-Containing Vaccine
MCV1	First dose of Measles-Containing Vaccine
MCV2	Second dose of Measles-Containing Vaccine
PCA	Principal Component Analysis
PFP	Private For-Profit sector
PNFP	Private Not-For-Profit sector
USD	United States Dollars

Declarations

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE: The Institutional Review Boards of the International Centre for Diarrhoeal Disease Research, Bangladesh (IRB PR-16067), and the Johns Hopkins Bloomberg School of Public Health (IRB #7256) examined the risks and benefits related to this research project, reviewed the surveys, consent forms and other material, and granted ethical approval. Written consent from study participants was obtained prior to the interview.

CONSENT TO PUBLISH: There is no individual or identifiable data attached to this paper.

AVAILABILITY OF DATA AND MATERIALS: The datasets supporting the conclusions of this article are available in the Harvard Data Verse repository:

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AUTHORS CONTRIBUTIONS: GD, SA, JM, WA, JU, DC designed the study; GD, SA, ZH, GM, JM, WA, JU managed data collection; GD, SA, ZH, GM, BP analyzed the data; all authors reviewed the results and wrote this paper. All authors have read and approved the manuscript.

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Tables

Table 1: Government costs for an episode of measles in 2018 US dollars ($)

Level, name & type of care	n	Service costs					
		Capital	Overhead	Labor	Supplies	Medications[A]	**Total**
Primary level							
Bashbaria Community Clinic							
Outpatient care	1	$0.46	$0.00	$0.54	$0.00	$0.00	**$1.00**
Baraigram Upazila Health Complex							
Outpatient care	2	$0.08	$0.13	$0.99	$0.02	$0.49	**$1.71**
Zoary Union Sub Center							
Outpatient care	1	$0.23	$0.00	$1.20	$0.00	$0.00	**$1.43**
Secondary level							
Moulvibazar District Hospital, Moulvibazar							
Inpatient care	5	$0.32	$0.98	$5.76	$0.21	$10.30	**$17.56**
Tertiary level							
Sylhet MAG Osmani Medical College Hospital							
Inpatient care	64	$1.32	$0.81	$10.29	$0.92	$9.53	**$22.88**

Notes: n, number of caregivers interviewed at the facility.

[A] Medications provided included: paracetamol, antihistamine, vitamin A, calamine lotion, oral analgesic gel, and chloramphenicol eye drop.

Table 2: Total caregiver costs for a hospitalized episode of measles in 2018 US dollars ($), and time loss in days

		INPATIENT VISIT									
Timing	**Cost**	**Public healthcare facilities (n=69)**					**Private not-for-profit healthcare facilities (n=22)**				
		Mean	SD	95% CI		n(c>0)	Mean	SD	95% CI		n(c>0)
Before current visit[A]	Direct medical	$3.53	$6.78	$1.90	$5.16	31	$7.17	$6.74	$4.18	$10.16	17
	Direct non-medical	$0.36	$1.60	-$0.02	$0.75	4	$1.52	$3.43	$0.00	$3.04	5
	Indirect	$28.85	$30.02	$21.58	$36.12	69	$24.72	$23.02	$14.51	$34.92	22
	Time loss [days]	1.6	1.2	1.3	1.9	69	1.1	0.7	0.8	1.4	22
Current visit	Direct medical	$14.65	$10.19	$12.19	$17.09	69	$42.42	$21.17	$33.03	$51.81	22
	Direct non-medical	$26.00	$13.71	$22.69	$29.29	69	$28.32	$14.74	$21.78	$34.86	22
	Indirect	$54.51	$42.81	$44.23	$64.80	69	$74.86	$55.25	$50.37	$99.37	22
	Time loss [days]	2.9	1.4	2.5	3.2	69	3.3	0.9	2.8	3.7	22
Follow-up[A]	Direct medical	$2.57	$2.90	$1.88	$3.27	52	$3.07	$2.99	$1.75	$4.40	16
	Direct non-medical	$0.54	$4.32	-$0.50	$1.57	2	$0.11	$0.30	-$0.02	$0.24	3
	Indirect	$0.44	$3.60	-$0.43	$1.31	2	$0.00	$0.00	$0.00	$0.00	0
	Time loss [days]	0.0	0.3	0.0	0.1	2	0.0	0.0	0.0	0.0	0
Total out-of-pocket payment		**$47.64**	**$21.87**	**$44.73**	**$55.43**	**69**	**$82.61**	**$34.92**	**$70.02**	**$101.32**	**22**
Total economic cost		**$131.03**	**$83.65**	**$110.93**	**$151.13**	**69**	**$182.20**	**$96.59**	**$139.38**	**$225.02**	**22**

		OUTPATIENT VISIT					INPATIENT & OUTPATIENT VISITS				
Timing	**Cost**	**Public healthcare facilities (n=4)**					**All healthcare facilities (n=95)**				
		Mean	SD	95% CI		n(c>0)	Mean	SD	95% CI		n(c>0)
Before current visit[A]	Direct medical	$0.00	$0.00	$0.00	$0.00	0	$4.23	$6.82	$2.84	$5.62	48
	Direct non-medical	$0.00	$0.00	$0.00	$0.00	0	$0.62	$2.18	$0.17	$1.06	9
	Indirect	$0.29	$0.31	-$0.20	$0.78	4	$26.67	$28.34	$20.86	$32.47	95
	Time loss [days]	0.0	0.0	0.0	0.1	4	1.4	1.2	1.2	1.6	95
Current visit	Direct medical	$0.02	$0.02	$0.00	$0.04	3	$20.46	$18.19	$16.75	$24.17	94

	Direct non-medical	$0.06	$0.06	-$0.13	$0.25	1	$25.44	$14.64	$22.46	$28.42	92
	Indirect	$13.32	$19.54	-$17.80	$44.42	4	$57.49	$46.69	$47.98	$67.00	95
	Time loss [days]	1.1	1.6	-1.5	3.7	4	2.9	1.4	2.6	3.2	95
Follow-up[A]	Direct medical	$2.08	$2.42	-$1.77	$5.93	2	$2.67	$2.89	$2.08	$3.26	70
	Direct non-medical	$0.36	$0.72	-$0.78	$1.50	1	$0.43	$3.69	-$0.32	$1.18	6
	Indirect	$0.13	$0.26	-$0.29	$0.55	1	$0.32	$3.07	-$0.30	$0.95	3
	Time loss [days]	0.0	0.0	0.0	0.0	1	0.0	0.3	-0.0	0.1	3
Total out-of-pocket payment		**$2.51**	**$2.89**	**-$3.62**	**$12.22**	**4**	$53.84	$30.87	$47.55	$60.13	**95**
Total economic cost		**$16.25**	**$21.37**	**-$17.75**	**$50.25**	**4**	$138.04	$91.02	$119.50	$156.59	**95**

Notes: SD, standard deviation; n(c>0), number of caregivers with a cost/time spent valued over zero.

[A] Includes costs incurred at public and private healthcare facilities and providers.

Figures

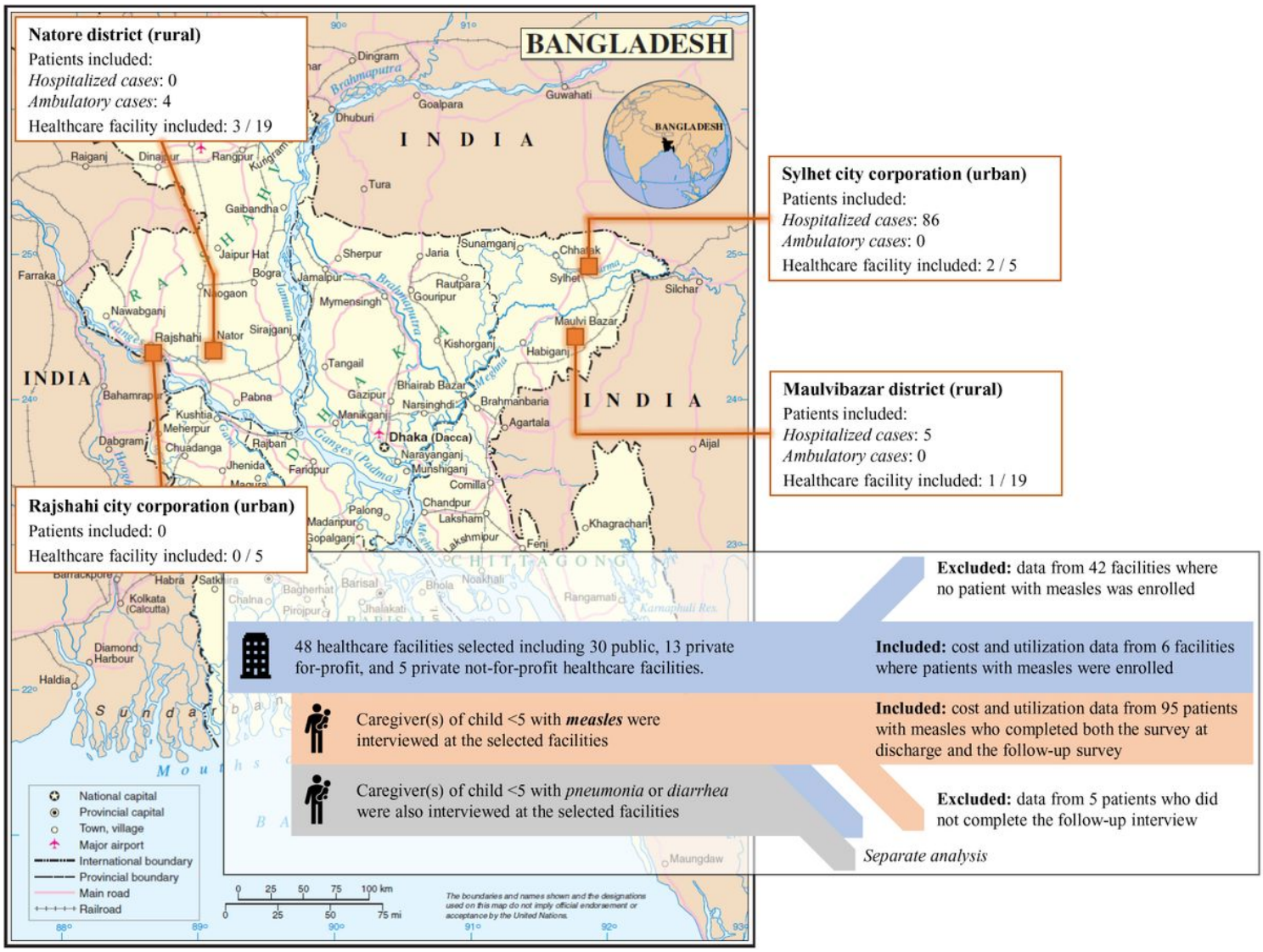


Figure 1

Map of the study sites, based on the United Nations Map No. 3711 Rev.2, January 2004.

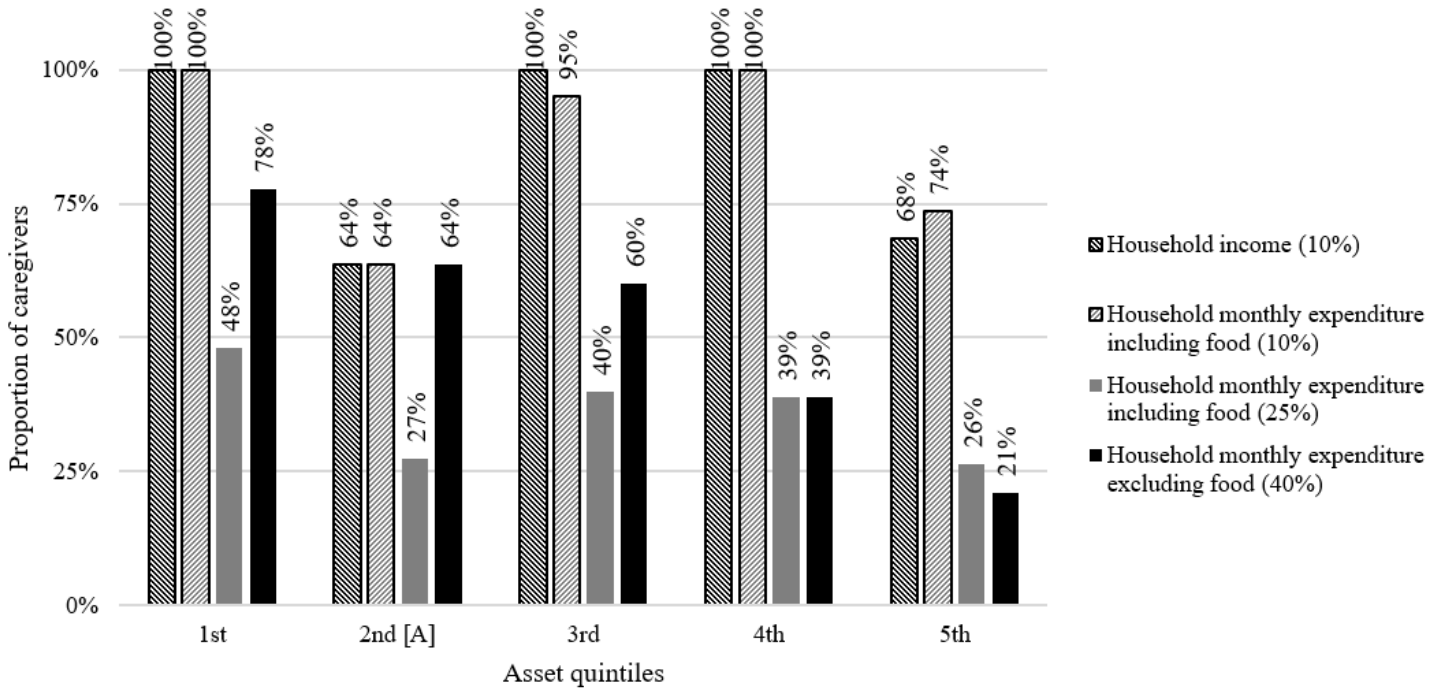
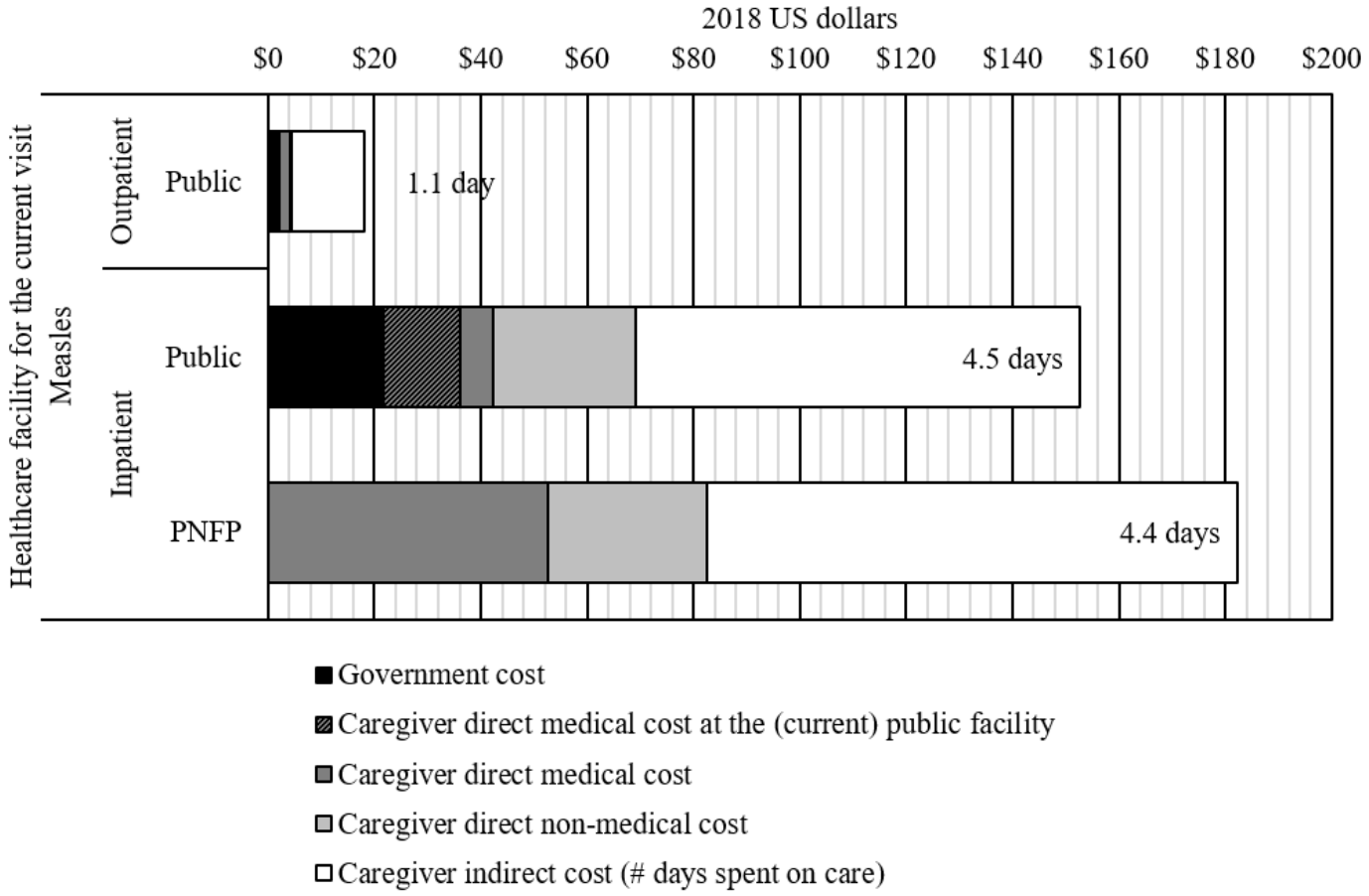


Figure 2

Proportion of caregivers facing catastrophic health expenditures by asset quintile in Bangladesh. Note: [A] The 2nd quintile (n = 11) contains all 4 outpatient cases, hence lower costs.



Note: PNFP, Private not-for-profit sector.

Figure 3

Societal costs for measles in Bangladesh.

Supplementary Files

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- ADDITIONALFILES.docx
- Supplementaryfigures20200914clean.docx