Direct and indirect costs of acute diarrhea in children under five years of age in Indonesia: Health facilities and community survey

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Summary

Background Diarrhea remains a major cause of child morbidity and mortality in low- and middle-income countries. Reliable data on the economic burden of diarrhea is required to support the selection of appropriate health intervention programs. This study aimed to estimate the costs of acute diarrhea in children under five years of age in Indonesia, a large middle-income country with a substantial diarrheal burden.

Methods Direct medical cost data were extracted retrospectively for 1050 children under five years of age with acute diarrhea receiving inpatient care across 45 health facilities in seven Indonesian provinces during 2017−2020. Direct medical costs for children treated in outpatient settings were estimated by collecting unit costs associated with standard diarrhea case management in children. A structured interview of 240 caregivers of inpatients was also conducted retrospectively to estimate direct non-medical costs as well as indirect costs from caregiver income loss.

Results The weighted average direct medical cost for treatment of acute diarrhea as an inpatient and outpatient across health facility types was US$99.8 (SD±$56.8)(35% room costs, 29% professional fees, 26% medication costs, 10% diagnostic costs) and US$7.6 (SD±$4.3) (34% diagnostic costs, 28% medication costs, 27% professional fees, 10% registration fees), respectively. The average direct non-medical household cost for an acute diarrheal admission was US$4.90 and the indirect cost was US$9.90.

Conclusion There is a significant economic burden associated with acute diarrhea in children in Indonesia. This study, based on a wide variety of health care settings and geographical regions, provides data to inform the economic evaluation of rotavirus vaccines and other diarrheal prevention programs.

Abbreviations: BPJS-K, Badan Penyelenggara Jaminan Sosial Kesehatan/Indonesian Social Security Agency for Health; JKN, Jaminan Kesehatan Nasional/Indonesian National Health Insurance

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Research in context

Evidence before this study

Become the fourth most populated country worldwide, Indonesia is resided by approximately 22 million children under five of age. The Ministry of Health Republic of Indonesia indicated diarrhea as the first leading cause of death in children under five years of age, accounted for 10.7% of fatalities in 2019. One effective intervention for reducing diarrheal cases, rotavirus vaccination, was recommended by WHO and implemented in more than 100 countries worldwide. The Indonesian government has a plan to introduce the rotavirus vaccine into the routine immunization program in 2023. A rotavirus vaccine candidate, RV3-BB, is now being studied in a phase III clinical trial by Bio Farma (Indonesia) in collaboration with Murdoch Children's Research Institute (Australia). A financial investigation, such as cost-effectiveness analysis, is required to justify introducing the vaccine in the country. Therefore, costing data on diarrheal treatment is an essential part of performing such analysis. Data on diarrheal costing estimates in Indonesia are still lacking. We searched PubMed for literature published in English between Jan 1, 2009, to Dec 31, 2019, using search terms "cost", "cost-effectiveness", "diarrhea", and "Indonesia". Costing data on diarrheal treatment in Indonesia was documented around a decade ago. Wilopo and colleagues presented direct and indirect diarrheal costs analyzed from a relatively small sample size in only two cities on Java Island. Therefore, to obtain more updated and representative data, research using larger samples representing the geographical area in Indonesia is required.

Added value of this study

This study included several provinces representing all possible geographical regions in Indonesia based on the Indonesian National Insurance coverage area. Recruited many samples with 1050 inpatient subjects and 240 household survey participants, the authors hoped to obtain more robust & representative data. We highlighted the weighted average direct medical costs of inpatient and outpatient diarrhea cases across various health facility types. We compared the diarrheal cost between health facility types, between provinces (regions), and between types of payment used by patients during hospitalization due to diarrhea. In particular, costing data in patients using government insurance can be used to evaluate whether the insurance tariff set by the government can meet the financial needs of patients during diarrhea hospitalization.

Implications of all the available evidence

This study documented an updated data on the direct and indirect costs per case of diarrhea in inpatient and outpatient settings. The study also highlighted a potential considerable economic burden to households caused by diarrhea. The costing data presented in this study will be helpful for subsequent economic analyses, including the disease burden and cost-effectiveness analysis of diarrheal preventive programs such as the implementation of rotavirus vaccines. The findings documented in this study may also reflect the cost of diarrhea in other upper-middle-income countries with similar characteristics.

Introduction

Diarrhea remains a major global health problem, accounting for 1.7 billion cases with half a million fatalities annually in children under five years of age.[1,2] Patients with moderate to severe diarrhea have an 8.5 times higher risk of death than children without diarrhea, with most deaths occurring during the first two years of life.[3] Indonesian Ministry of Health reported that the prevalence of diarrhea among children under five years of age was 17%, accounting for around four million cases in 2018.[4]

Strategies to reduce the burden of childhood diarrhea include environmental approaches by providing clean water, sanitation, and hygiene; promoting finished floors in households, in addition to preventive health programs such as micronutrient supplementation.[5-8] Treatment of dehydration caused by acute diarrhea using oral rehydration therapy (ORT) is acknowledged as highly effective across a range of settings.[6] Rotavirus vaccines are highly effective in reducing the burden of diarrhea in infants and young children.[9,10] Indonesia has not yet introduced a rotavirus vaccine into the National Immunization Program and widespread use in the private market has been limited by cost.

Economic analysis data on the burden of diarrhea and rotavirus diarrhea is required to support the selection of appropriate health intervention programs in Indonesia. The government requires country-specific estimates of diarrhea treatment costs to select, prioritize, and scale up selected health interventions, including rotavirus vaccination.[11,12] The cost of diarrheal illness in Indonesia has been estimated in only a few studies, and these studies investigated data from a limited number of provinces and health care facilities.[13,14] As Indonesia consists of 34 provinces and five major islands, a study analyzing data gathered from a wider geographical area is required to obtain more representative findings.

This study aimed to estimate the costs of acute diarrhea in children under five years of age in Indonesia, to provide reliable estimates of the potential healthcare cost savings for subsequent economic evaluation of rotavirus vaccines and other diarrheal prevention programs. Specifically, we aimed to estimate the direct costs of inpatient and outpatient acute diarrhea treatment in Indonesia, as well as costs for specific types of health care facilities, regions, and type of payments. We also aimed to estimate the direct and indirect costs to households of inpatient acute diarrhea cases.

Materials and methods

This is a retrospective study based on data collected from different health care facilities in seven Indonesian provinces for cases of acute diarrhea occurring during the period of January 2017 − December 2020.

The study flow is described in Fig. 1. Regionalization of the Indonesian Social Security Agency for Health (BPJS-K) is divided into five regions based on tariffs based on the consumer price index which are mutually agreed between BPJS-K and Association of Advanced Health Facilities. To represent each region, we selected one province within each region, except for Region I where two provinces were selected due to the large population within Region I. Provinces were selected according to the feasibility of conducting the data collection and on existing research collaborations. The healthcare facilities within each Province were selected from the capital city and, if the full range of facility types was not present in the city, from the surrounding districts. The inpatient facility types included Private and Public Hospitals (tertiary, high secondary and low secondary Hospitals) and Primary Health Centers (Fig. 1). Specific facilities were selected for convenience of data collection, such as proximity to the capital city and willingness of the facility to participate. The inpatient medical records and household survey data involved a larger sample size for Region I (∼50%) than for other regions, reflecting the distribution of the population of Indonesia.[15]

The costing data was collected using different methods, time periods, and populations to obtain a comprehensive set of information about all acute diarrhea-related expenditures for both healthcare providers and households.

Inpatients' direct medical costs

Patients aged <5 years admitted to one of the selected hospitals or primary health centers, with a primary or secondary diagnosis of acute gastroenteritis (ICD-10-CM code A09) during the period of January 2017 until December 2020 (inclusive) were eligible for inclusion in the inpatient direct medical costs portion of this study. A total of 1050 patients from seven provinces were evaluated in the study. The selection of at least 30 participants per health facility type per region was targeted, and where the number of cases on record exceeded the target, the most recent set of approximately 30 cases was selected. The minimum of 30 participants per facility is considered adequate to represent the distribution based on the consecutive sampling method as described by Memon et al. and Chang et al.[16,17] The collected data contained information on both the clinical condition, medical management, and treatment costs during hospitalization. The direct medical cost of inpatient care was extracted from the patient's medical and billing record.

Several variables, including room costs, professional medical fees, diagnostic test costs, and medication costs, were used to estimate the direct medical cost of an acute diarrheal case. Room cost was defined as the total cost charged for the patients to occupy the room according
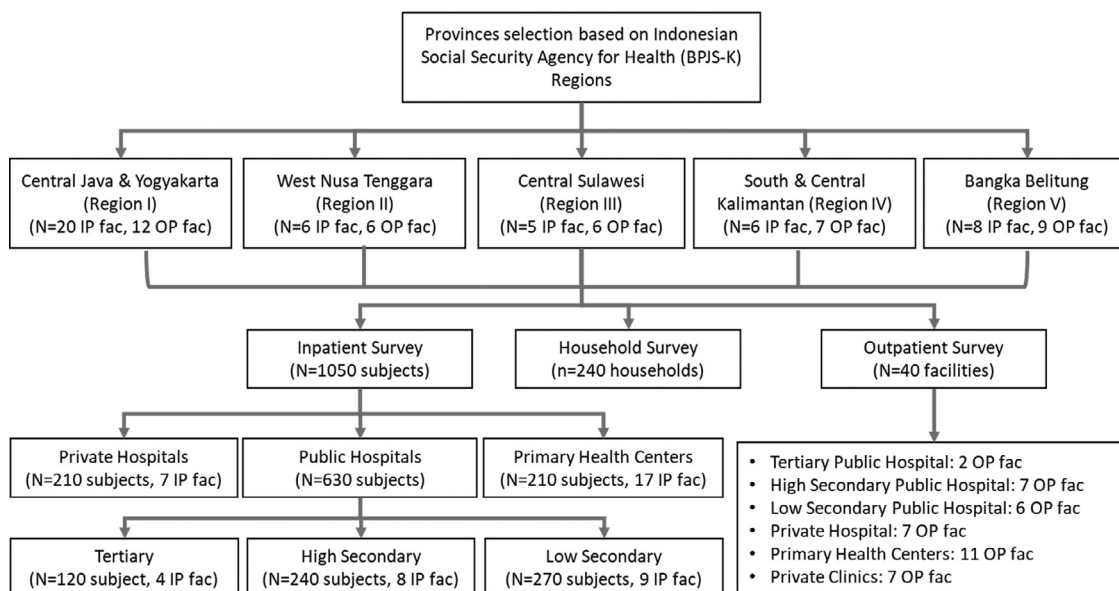

Figure 1. Study Flow Chart.

to the selected hospital class. The room cost included all costs required to cover the use of the bed, water service, electricity, meals, and cleaning service. Medical professional fees included the total cost of doctor and nurse services for treating the patients. Diagnostic costs included the cost of laboratory tests performed on patients. Medication costs were defined as the cost of all medications given to patients during hospitalization. Interviews with inpatients' caregivers were used to estimate the direct non-medical and indirect costs. The interviews were performed in a different population from the population used for inpatient direct medical costs for practical reasons, as gathering retrospective hospital cost data without limiting to survey participants allowed for a larger sample.

Outpatients' direct medical costs

Estimated costs of outpatient care per case at each study site (Fig. 1) were documented using unit costs of the standard acute diarrhea treatment, rather than calculating for individual patients. The unit costs were collected by interviewing financial department staff in hospitals, primary health centers, and private clinic staff/owners. Combining standard unit costs was the preferred method for collecting the outpatient costs because there was insufficient documentation of the cost variation among individuals at the same health facility for a case of outpatient acute diarrhea.

The data was collected from August 2019 until December 2020 from all health facility types in seven participating provinces. The direct medical costs collected in the outpatient setting consist of registration fee, professional fee, diagnostic cost and medication cost. The registration fee was defined as the cost incurred by the patient when registering at a health facility for each visit. The registration fee is considered as a direct medical cost since the fee is used for administration of health records in each facility. The costs for outpatient attendances did not include non-medical and indirect costs because these costs were not deemed as significant to either the patients or providers (for example no, or minimal transportation fee to the nearby clinics or health facilities, no or minimal supplemental foods needed for short outpatient visit, no or minimal over-counter medicines). For outpatient costs for cases managed at the Primary Health Center, the standard costs collected were applicable to the cases managed within that clinic as well as those managed by outreach activities of the Primary Health Center staff (Posyandu or Village Health Post).

Household costs survey

To estimate the household direct non-medical and indirect costs per hospitalized case of acute diarrhea, a retrospective interview of 240 patient caregivers was also performed in this study. The households were identified from records at Primary Health Centers documenting acute diarrheal hospitalized cases in under five children within the preceding two months. Parents of hospitalized children were contacted by village midwives for recruitment, then interviewed by study staff using a standardized data collection form. Of the 240 subjects, 120 subjects were recruited from BPJS Region I (Central Java and Yogyakarta), and 120 subjects were collected from BPJS Region II-V (30 subjects per region). The sampling method used purposive sampling until fulfilling the targeted number of households from that region. The surveys in BPJS Region I were conducted between 20 September 2019 and 13 January 2020, in Region V between 3 February 2020 and 22 March 2020, in Region II between 21 October 2020 and 10 December 2020, in Region IV between 9 October 2020 and 18 January 2021, and in Region III between 8 December 2020 and 5 February 2021. Before the COVID-19 pandemic, the surveys were conducted as face-to-face interview, but during the pandemic the interviews were conducted by telephone.

The data from the caregiver interview was collected using a self-reported recall of all illness-related expenditures. The direct non-medical costs were defined as the cost of transportation, "over-the-counter" medications, and food supplements. "Over-the-counter" mediations included all medicine for the acute diarrheal illness purchased by the household without a prescription (antipyretic drugs, vitamin, probiotics, herbal medicine, etc.). Food supplements included foodstuffs that were purchased by the patient's caregivers and were intended to support the healing process of acute diarrhea (i.e., protein-containing food, rehydration drink, yoghurt, etc.). The expenditure for food supplements was focused solely on the child as the patient. The cost of meals and accommodation for parents accompanying children during hospitalization is not documented because generally, one parent/guardian is allowed to accompany the child in the room during hospitalization. Transportation costs included the cost of transporting the child to and from the hospital. Income loss was used to estimate productivity loss and was based on the work time lost due to the need to access healthcare and to care for the hospitalized child. The income loss was calculated from the caregiver's monthly income, which was converted into daily income and multiplied by the average number of days absent from work during the child's hospitalization. This study did not estimate non-medical or indirect costs for outpatient clinic visits.

Data analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows Version 23 (IBM Corp., New York, USA). The costs in Indonesian currency (IDR) were converted into US dollars for 2019: 1 USD = 14,217 IDR.[18] Numerical data is presented in mean ± standard

deviation (SD). Most data were presented descriptively using the absolute number and the percentage, or mean ± SD. Additional information using median, the interquartile range, and minimum and maximum values are presented in the supplementary tables.

To correct for non-randomness, we weighted the direct medical costs with the assumed proportion of patients managed in each health facility type, for hospitalized and non-hospitalized cases. We used data from the Social Security Agency for Health (BPJS-K), the agency that provides the JKN insurance program. Sample data representing one percent of the acute diarrhea cases recorded by the BPJS-K program in 2015 to 2016[19] (3695 inpatient and 8211 outpatient cases) was used to estimate the percentage of under five children with acute diarrhea managed in each type of health facility (tertiary, high secondary, low secondary public hospitals or private hospitals, or primary health centers). The proportions extracted from the inpatient data, were 1.2% tertiary (Class A), 15.3% high secondary (Class B), 20.8% low secondary (Class C) public hospitals; 41.6% private hospitals; and 21.1% primary health centers. For the outpatient setting, the proportions were 0.3% tertiary (Class A), 2.1% high secondary (Class B), 3.4% low secondary (Class C) public hospitals; 4.4% private hospitals; 59.9% primary health centers; and 29.8% private clinics. The proportion of each inpatient and outpatient case was applied to the costing study results to produce weighted averages.

We estimated the total annual economic burden from hospitalization due to acute diarrhea in children under five years of age. Sample data representing one percent of the hospitalized acute diarrhea cases recorded by the BPJS-K program in 2015 to 2016 (3695 inpatient cases; mean age 23.9 ± 14.6 months) was used to estimate the burden of hospitalization due to acute diarrhea in children under five years of age in Indonesia, by first scaling to 100% and then scaling up the estimate to reflect the fact that 70% of Indonesians had JKN insurance in 2016,[20] as only hospitalizations of insured people are included in BPJS-K data. We multiplied the estimated cases (260,000) by the estimated direct medical, non-medical, and indirect costs from this study, to estimate the annual economic burden from hospitalization due to acute diarrhea in children under five years of age in Indonesia.

A multivariate analysis using linear regression was performed on direct medical cost in the inpatient setting to evaluate the factors associated with costs including age, gender, type of health facility and region.

Ethical considerations
The study was approved by the Medical and Research Ethics Committee of the Faculty of Medicine, Public Health, and Nursing Universitas Gadjah Mada, Indonesia (No. KE/FK/0348/EC/2019) and the Royal Children's Hospital Melbourne Human Research Ethics Committee, Australia (HREC/51,966/RCHM-2019.041).

Results

Costing data from the inpatient setting
Of the 1050 patients with acute diarrhea admissions, 601 patients were boys (57.2%). Acute diarrhea predominantly occurred in younger children, with an average age of 19.7 ± 13.5 months which was similar to the age of patients reported in the BPJS-K data (23.9 ± 14.6 months). Patients had a mean duration of stay of 2.96± 1.78 days. Severe dehydration was reported in 37 patients hospitalized with acute diarrhea (4%). Few patients had other concurrent diagnoses, with the most common being acute upper respiratory infection (6.3%). Most hospitalized patients were discharged from the health facility with status recovered from the disease (94%), and only eight fatalities were reported (1%) (Table 1). Fifty-nine percent of patients (625 of 1050) had their medical expenses paid by the Indonesian National Health Insurance Program (JKN), and a smaller number of the patients paid the services "out of pocket" (415 of 1050: 39%) or by private insurance (10 of 1050: 1%) (Table 2).

In an inpatient setting, the weighted average direct medical cost per case of hospitalized acute diarrhea across all health facility types was US$ 99.8 ± 56.8 (Table 2). Tertiary (Class A) public hospital had the highest average direct medical cost for treating hospitalized patients with acute diarrhea (US$ 168±132), followed by private hospitals (US$ 145±78), high secondary (Class B) public hospital (US$ 111±78), low secondary (Class C) public hospital (US$ 79±42), and primary health centers (US$ 19±10) (Table 2). Among all health providers, room cost contributed to be the largest expenditure for inpatient diarrhea (35%), while diagnostic cost was the lowest (10%). Data from primary health centers was not fully presented in the figure due to a lack of detailed information regarding each cost category comprising the total cost (Fig. 2A-B).

In the multivariate analysis, BPJS region, type of facility and age were significantly associated with direct medical cost of hospitalized acute diarrhea in children

Parameter	Public Hospitals			Private Hospitals	Primary Health Centers	Total
	Tertiary (Class A)	High secondary (Class B)	Low Secondary (Class C)			
Subjects in all Regions (n)	120	240	270	210	210	1050
Subjects by BPJS Region, n (%)						
Region I	90 (75%)	90 (38%)	90 (33%)	90 (43%)	90 (43%)	450 (43%)
Region II	–	30 (13%)	60 (22%)	30 (14%)	30 (14%)	150 (14%)
Region III	–	60 (25%)	30 (11%)	30 (14%)	30 (14%)	150 (14%)
Region IV	30 (25%)	30 (13%)	30 (11%)	30 (14%)	30 (14%)	150 (14%)
Region V	–	30 (13%)	60 (22%)	30 (14%)	30 (14%)	150 (14%)
Subject characteristics						
Gender: n=male; (%)	73 (61%)	148 (62%)	151 (56%)	114 (54%)	114 (54%)	601 (57%)
Age in months: mean ±SD	20.7 ± 13.8	18.5 (14.0)	18.1 ± 13.0	20.6 ± 13.9	21.8 ± 12.7	19.7 ± 13.5
Dehydration severity; n (%)						
Subjects (n) with data available	116	234	218	196	106	870
No dehydration	25 (22%)	28 (12%)	19 (9%)	23 (12%)	7 (7%)	102 (12%)
Mild to moderate	84 (72%)	192 (82%)	190 (87%)	169 (86%)	96 (90%)	731 (84%)
Severe	7 (6%)	14 (6%)	9 (4%)	4 (2%)	3 (3%)	37 (4%)
Other concurrent diagnosis; n (%)	50 (41.7%)	98 (40.8%)	67 (24.8%)	64 (30.5%)	26 (12.4%)	305 (29%)
Outcome: n (%)						
Recovered	115 (96%)	224 (93%)	248 (92%)	206 (98%)	195 (93%)	988 (94%)
Died	3 (2%)	2 (1%)	3 (1%)	0	0	8 (1%)
Discharged against medical advice	2 (2%)	13 (5%)	19 (7%)	3 (1%)	10 (5%)	47 (%)
Referred	0	1 (1%)	0	1 (1%)	5 (2%)	7 (1%)

Table 1: **Subject characteristics for Inpatient direct medical cost evaluation.**

Parameter	Public Hospitals			Private Hospitals	Primary Health Centers	Total
	Tertiary (Class A)	High secondary (Class B)	Low Secondary (Class C)			
Number of Facilities	4	8	9	7	17	45
Subjects (n)	120	240	270	210	210	1050
Duration of hospital stay in days: mean ±SD	3.4 ± 2.1	3.6 ± 2.4	2.9 ± 1.6	2.8 ± 1.2	2.2 ± 1.2	2.96±1.78
Payment type						
JKN insurance	97 (80.8%)	152 (63.3%)	166 (61.5%)	131 (62.4%)	69 (32.9%)	625 (59.5%)
Out of pocket	23 (19.2%)	88 (36.7%)	104 (38.5%)	69 (32.9%)	131 (62.4%)	415 (39.5%)
Private insurance	0 (0.0%)	0 (0.0%)	0 (0.0%)	10 (4.8%)	0 (0.0%)	10 (1.0%)
Inpatient Direct Medical Costs ($USD mean ±SD)						
Room costs	47 ± 51	25 ± 24	29 ± 25	74 ± 51	NA	
Professional Fee	63 ± 61	29 ± 35	20 ± 16	31 ± 28	NA	
Diagnostic cost	20 ± 25	12 ± 18	8 ± 6	10 ± 7	NA	
Medication cost	40 ± 43	29 ± 32	2 2 ± 13	29 ± 23	NA	
Total	168 ± 132	111 ± 78	79 ± 42	145 ± 78	NA	
Estimated proportion of cases seeking care in each facility* (% of all cases)	1.2%	15.3%	20.8%	41.6%	21.1%	
Weighted average costs ($USD)						99.8 ± 56.8

Table 2: **Inpatient direct medical costs per case and weighted average cost by health facility type.**
All costs were measured in USD 2019 (1 USD= 14,217 IDR).
JKN: *Jaminan Kesehatan Nasional*/ Indonesian National Health Insurance.
NA= Not Applicable.
 * The proportions were estimated based on BPJS-K sample data 2015−201,6[19].
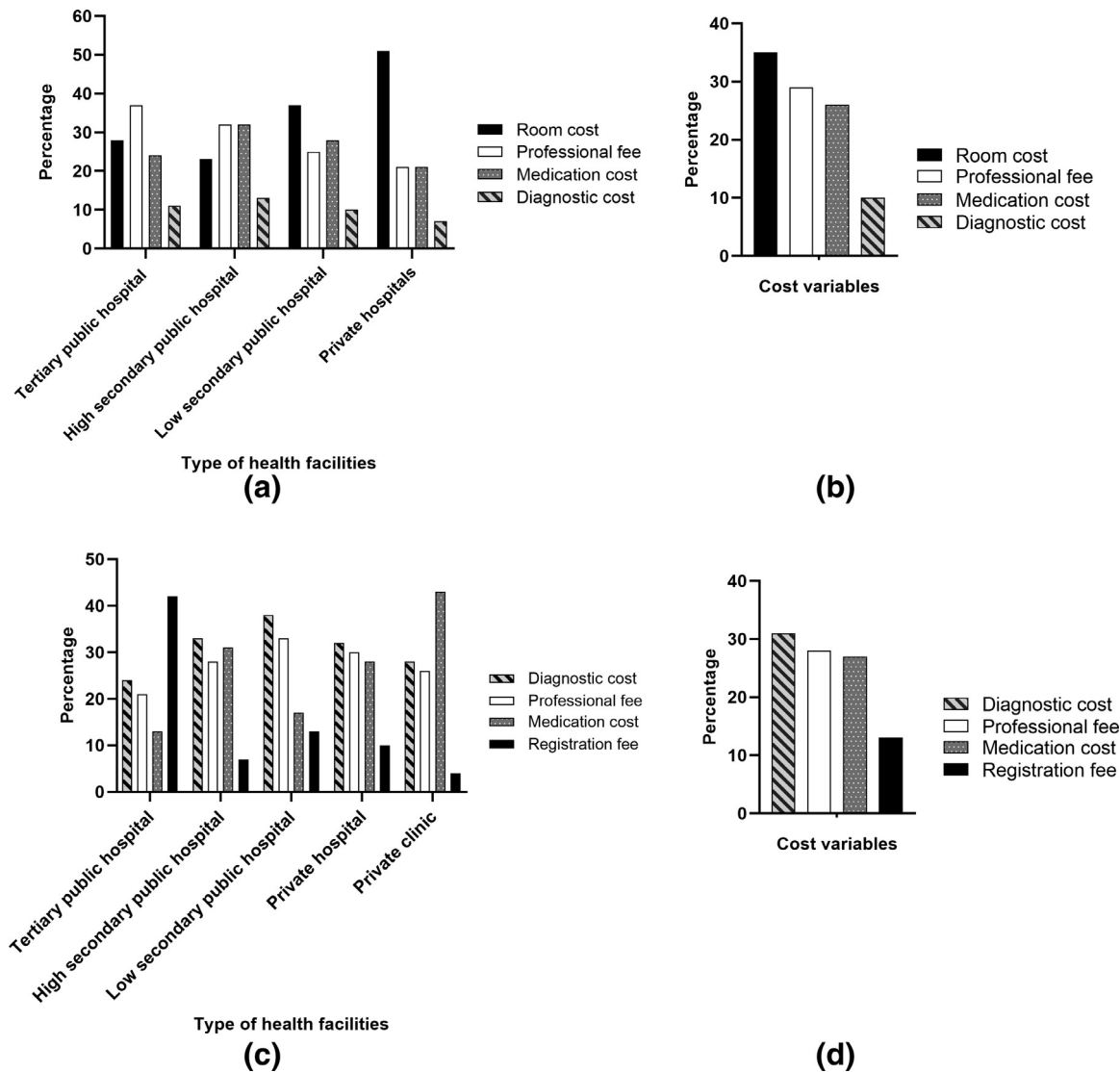
Figure 2. Proportion of total direct medical costs for treating acute diarrhea at each type of health facility, and cumulative proportion across all health facilities for inpatient (A-B) and outpatient (C-D) settings.

under five years. BPJS region I, II, and IV were significantly associated with higher direct medical cost in inpatient cases compared to Region V. Private facilities and public hospitals were significantly correlated with higher direct medical cost compared to Primary Health Centers. Increasing age was associated with lower direct medical cost in inpatient cases.

Based on the type of payment, the highest proportion of self-paying patients was found in primary health centers (62.4%), and the lowest was in tertiary public hospitals (19.2%). In public facilities, the total direct medical costs were higher in government-insured patients than in the self-paying group. In contrast, the government-insured patients in private hospitals had the lowest cost

compared to those using private-insurance and out-of-pocket payment methods (Table 3).

Comparison of total direct medical costs for acute diarrheal inpatient care in each province (Table 4) showed that the unweighted average cost in Yogyakarta was relatively higher than in Central Java, although both provinces were located in the same BPJS region (US$ 122±120 vs. US$ 100±81, respectively). Among provinces located outside Java Island, South Kalimantan demonstrated the highest unweighted average cost than any other province (US$ 134±89), and the lowest cost was reported in Bangka Belitung islands as US$ 59± 46. For outpatient care, the highest unweighted average cost was documented in South Kalimantan again, and

| | Public Hospitals ($USD mean ±SD) | | | | | | | | | Private Hospitals ($USD mean ±SD) | | | Primary Health Center ($USD mean ±SD) | | |
| | Tertiary (Class A) | | | High secondary (Class B) | | | Low secondary (Class C) | | | | | | | | |
	JKN Insurance	Out of pocket	Private Insurance	JKN Insurance	Out of pocket	Private Insurance	JKN Insurance	Out of pocket	Private Insurance	JKN Insurance	Out of pocket	Private Insurance	JKN Insurance	Out of pocket	Private Insurance
Number of patients	97	23	0	152	88	0	166	104	0	131	69	10	79	131	0
Room cost	44 ± 46	57 ± 70	NA	25 ± 25	25 ± 23	NA	31 ± 28	27 ± 20	NA	73 ± 48	72 ± 56	111 ± 54	NA	NA	NA
Professional fee	69 ± 66	39 ± 17	NA	25 ± 31	36 ± 39	NA	22 ± 16	17 ± 15	NA	34 ± 33	28 ± 15	25 ± 13	NA	NA	NA
Diagnostic cost	22 ± 27	12 ± 8	NA	12 ± 20	13 ± 12	NA	8 ± 5	9 ± 6	NA	10 ± 6	11 ± 10	12 ± 6	NA	NA	NA
Medication cost	42 ± 46	30 ± 29	NA	22 ± 28	41 ± 33	NA	22 ± 11	22 ± 15	NA	23 ± 21	38 ± 20	49 ± 30	NA	NA	NA
Total direct medical cost	176 ± 138	137 ± 101	NA	108 ± 82	116 ± 71	NA	82 ± 44	75 ± 39	NA	140 ± 77	149 ± 80	197 ± 76	23 ± 12	17 ± 9	NA

Table 3: Inpatient direct medical costs per case stratified by the type of payment.

JKN: *Jaminan Kesehatan Nasional*/ Indonesian National Health Insurance.

All costs were measured in USD 2019 (1 USD= 14,217 IDR).

NA = Not Applicable.

the lowest was reported in Central Java (US$ 16.7 ± 15.0 vs. US$ 9.9 ± 8.9, respectively) (Table 4).

Costing data from the outpatient setting

In an outpatient setting, the weighted average direct medical cost per case of non-hospitalized diarrhea across all health facility types was US$ 7.6 ± 4.3 (Table 5). The highest average direct medical cost for acute diarrheal care was found in private hospitals (US$ 24.6 ± 10.4), followed by low secondary (Class C) public hospitals (US$ 13.6 ± 6.1), private clinics (US$ 13.4 ± 7.7), high secondary (Class B) public hospitals (US$ 12.1 ± 2.4), tertiary (Class A) public hospitals (US $ 8.9 ± 4.6), and primary health centers (US$ 3.0 ± 2.2). The category accounting for the largest proportion of total cost varied among all health facilities. In every health facility type, the diagnostic cost was a major part of outpatient expenditure (Table 5, Fig. 2C-D).

Costing data from the household survey

Of the 240 participants interviewed, the primary caregivers for the patients during a diarrheal admission were predominantly their mothers (78.3%), followed by grandparents (14.2%) and fathers (2.1%). Most of the parents graduated from senior high school and university (73.7%) and have a monthly income of > US$127 (58.2%) (Table 6). During a diarrheal admission, the parents spent an average of US$4.9 ± 6.4 out of pocket for the direct non-medical cost. Most of the cost was made up of transportation costs, accounting for US$ 3.1 ± 3.9, followed by US$1.1 ± 3.6 and US$0.7 ± 3.0 for food supplements and OTC medicines, respectively. Of the 240 hospitalized patients, 98.3% (236/240) of the caregivers spent their own money on the transportation cost, 21.3% (53/236) on the OTC medicines, and 20.0% (48/240) on the food supplements. Furthermore, the average indirect cost incurred to the patient's household due to the caregiver's absence from work during an acute diarrheal hospitalization was calculated as US$ 9.9 ± 3.6 (Table 4). Review of the direct non-medical and indirect costs in each province showed that the highest total direct non-medical cost was documented in Central Sulawesi (US$ 12.5 ± 10.2), and the highest income loss per acute diarrheal hospitalization was reported in South and Central Kalimantan (US$ 17.4 ± 4.8) (Table 4).

Total economic burden for hospitalized acute diarrhea in children under five years

Based on the total costs per inpatient case of US$113.6 (including direct medical and non-medical costs and indirect costs), the estimation of the total economic burden in Indonesia resulting from hospitalization of children under five years of age due to acute diarrhea was over $30 million per year. This includes direct medical

	Central Java Region I	Yogyakarta Region I	West Nusa Tenggara Region II	Central Sulawesi Region III	South Kalimantan Region IV	Bangka Belitung Islands Region IV	Unweighted average
DIRECT MEDICAL COSTS: INPATIENT*							
Subjects: n	240	210	150	150	150	150	
Healthcare Type: (USD $ mean ±SD)							
Tertiary (Class A)	128±95	256 ± 186	NA	NA	161 ± 186	NA	
High Secondary (Class B)	159 ± 67	123 ± 96	125 ± 61	83 ± 70	148 ± 53	46 ± 22	
Low Secondary (Class C)	72 ± 16	84 ± 49	79 ± 33	52 ± 26	146 ± 33	59 ± 19	
Private Hospital	129 ± 76	168 ± 99	158 ± 55	109 ± 44	205 ± 86	120 ± 57	
Primary Health Center	26 ± 8	34 ± 22	24 ± 10	14 ± 12	12 ± 9	13 ± 5	
Unweighted average	100 ± 81	122 ± 120	93 ± 62	65 ± 67	134 ± 89	59 ± 46	
DIRECT MEDICAL COSTS: OUTPATIENT#							
Facilities: n	7	5	6	6	7	9	
Unweighted average: (USD $ mean ±SD)	99 ± 8.9	13.0 ± 12.6	11.1 ± 4.3	11.0 ± 5.3	16.7 ± 15.0	10.3 ± 8.1	
DIRECT NON-MEDICAL COSTS ^							
Subjects/Households: n	60	60	30	30	30	30	240
Costs: (USD $ mean ±SD)							
Transportation	3.2 ± 3.6	2.4 ± 3.9	2.2 ± 2.8	4.6 ± 3.9	5.6 ± 4.6	1.4 ± 2.8	3.1 ± 3.9
"Over-the-counter" medications	0.3 ± 0.9	0.5 ± 1.9	0.1 ± 0.2	3.3 ± 7.3	0.8 ± 2.0	0.1 ± 0.6	0.7 ± 3.0
Food supplements	1.4 ± 3.7	0.5 ± 2.2	0	4.6 ± 7.4	0.2 ± 0.9	0.2 ± 0.4	1.1 ± 3.6
Total Costs	4.9 ± 5.4	3.4 ± 5.0	2.2 ± 2.8	12.5 ± 10.2	6.7 ± 5.0	1.7 ± 2.9	4.9 ± 6.4
INDIRECT COSTS^							
Income Loss: (USD $ mean ±SD)	12.9 ± 4.5	3.0 ± 1.3	24 ± 10	9.8 ± 3.1	17.4 ± 4.8	0.7 ± 0.2	9.9 ± 3.6

Table 4: **Costs for Inpatient and Outpatient Treatment by Province.**
All costs were measured in USD 2019 (1 USD= 14,217 IDR).
NA= Not Applicable.
 * Data from Inpatient billing records.
 # Data based on Facility standard costs for Outpatient treatment.
 ^ Data from Household Costs Survey.

Parameter	Public Hospitals			Private Hospitals	Primary Health Centers	Private Clinic	Total
	Tertiary (Class A)	High secondary (Class B)	Low Secondary (Class C)				
Number of Facilities	2	7	6	7	11	7	40
Outpatient Direct Medical Costs (USD $ mean ±SD)							
Registration Fee	3.7 ± 4.7	0.9 ± 0.7	1.7 ± 1.0	2.4 ± 1.8	0.4 ± 0.3	0.5 ± 0.4	
Professional Fee	1.9 ± 2.6	3.4 ± 2.4	4.4 ± 4.0	7.4 ± 3.9	0	3.5 ± 3.1	
Diagnostic cost	2.1 ± 3.0	4.0 ± 2.0	5.1 ± 1.4	7.9 ± 6.5	2.3 ± 2.0	3.7 ± 3.5	
Medication cost	1.2 ± 0.4	3.8 ± 3.2	2.3 ± 1.5	6.9 ± 5.9	0.3 ± 0.5	5.7 ± 3.8	
Total	8.9 ± 4.6	12.1 ± 2.4	13.6 ± 6.1	24.6 ± 10.4	3.0 ± 2.2	13.4 ± 7.7	
Estimated proportion of cases seeking care in each facility* (% of all cases)	0.3%	2.1%	3.4%	4.4%	59.9%	29.8%	100%
Weighted average costs (USD $)							7.6 ± 4.3

Table 5: **Outpatient direct medical costs and weighted average costs.**
All costs were measured in USD 2019 (1 USD= 14,217 IDR).
 * The proportions were estimated based on BPJS-K sample data (2015−2016).[19]

Variables	Central Java & Yogyakarta	West Nusa Tenggara	Central Sulawesi	South & Central Kalimantan	Bangka Belitung Islands	All Regions
BPJS Region	I	II	III	IV	V	
Patients						
Number	120	30	30	30	30	240
Age in months: mean ±SD	21.8 ± 13.6	22.3 ± 15.1	24.4 ± 16.4	27.0 ± 18.2	24.5 ± 15.8	23.3 ± 15.1
Households						
Household size: number of members (%)						
Less than 4	13 (10.8)	9 (30)	6 (20)	7 (23.3)	5 (16.7)	40 (16.7)
4 to 6	86 (71.7)	19 (63.3)	17 (56.7)	21 (70)	21 (70)	164 (68.3)
More than 6	21 (17.5)	2 (6.7)	7 (23.3)	2 (6.7)	4 (13.3)	36 (15)
Parental age in years: mean ±SD						
Father	34.6 ± 7.5	33.8 ± 6.8	33.8 ± 6.6	34.3 ± 6.7	32 ±6.9	34.0 ± 7.1
Mother	31.6 ± 6.3	29.8 ± 5.5	32.2 ± 6.0	31.6 ± 6.3	27.7 ± 6.2	30.9 ± 6.2
Parental Education (highest level completed): n(%)						
Father						
Elementary School	5 (4.2)	5(16.7)	1(3.3)	4(13.3)	13 (43.3)	28 (11.7)
Junior High School	22 (18.5)	5(16.7)	0	0	7 (23.3)	34 (14.2)
Senior High School	75 (63)	9 (30)	15 (50)	11 (36.7)	7 (23.3)	117 (49)
University	17 (14.3)	11 (36.7)	14 (46.7)	15 (50)	3 (10)	60 (25.1)
Mother						
Elementary School	6 (5)	6 (20)	0	3 (10)	11 (36.7)	26 (10.8)
Junior High School	26 (21.7)	2 (6.7)	1 (3.3)	1 (3.3)	8 (26.7)	38 (15.8)
Senior High School	66 (55)	13 (43.3)	6 (20)	8 (26.7)	10 (33.3)	103 (42.9)
University	22 (18.3)	9 (30)	23 (76.7)	18 (60)	1 (3.3)	73 (30.4)
Primary caregiver during hospitalization: n (%)						
Parents	86 (71.7)	27 (90)	24 (80)	26 (86.7)	30 (100)	193 (80.4)
Father	3 (2.5)	1 (3•.3)	0	1 (3.3)	0	5 (2.1)
Mother	83 (69.2)	26 (86.7)	24 (80)	25 (83.3)	30 (100)	188 (78.3)
Grandparents	25 (20.8)	3 (10)	3 (10)	3 (10	0	34 (14.2)
Other family members	9 (7.5)	0	3 (10)	1 (3.3)	0	13 (5.4)
Caregiver's monthly income in USD						
Number (%)						
Less than $42	7 (5.8)	3 (10)	2 (6.9)	1 (3.3)	0	13 (5.4)
$42 to $127	48 (40)	15 (50)	5 (17.2)	6 (20)	13 (43.3)	87 (36.4)
$128 to $253	34 (28.3)	8 (26.7)	8 (27.6)	3 (10)	15 (50)	68 (28.5)
More than $253	31 (25.8)	4 (13.3)	14 (48.3)	20 (66.7)	2 (6.7)	71 (29.7)
Mean ±SD	190.5 ± 71.5	169.4 ± 74.2	217.1 ± 68.7	221.4 ± 61.7	198.5 ± 63.6	195.9 ± 70.6
Type of Heath Facility: number patients (%)						
Public Hospital	50 (41.7)	6 (2.0)	17 (56.7)	10 (33.3)	4 (13.3)	87 (36.3)
Private Hospital	24 (20.0)	4 (13.3)	12 (40.0)	17 (56.7)	0	57 (23.8)
Primary Health Center	46 (38.3)	17 (56.7)	1 (3.3)	2 (6.7)	26 (86.7)	92 (38.3)
Midwife Clinic	0	3 (10.0)	0	0	0	3 (1.3)
Private Doctor Clinic	0	0	0	1 (3.3)	0	1 (0.4)
Duration of stay in days: mean ±SD						
Public Hospital	4.7 ± 2.2	3.7 ± 2.2	4.6 ± 2.7	4.8 ± 1.7	3.0 ± 1.8	4.6 ± 2.2
Private Hospital	3.5 ± 0.6	3.3 ± 2.9	3.8 ± 1.1	3.3 ± 1.0	NA	3.5 ± 1.1
Primary Health Center	4.0 ± 1.8	1.8 ± 0.7	2.0	3.5 ± 0.7	2.6 ± 0.9	3.2 ± 1.7
Midwife Clinic	NA	1.7 ± 0.6	NA	NA	NA	1.7 ± 0.6
Private Doctor Clinic	NA	NA	NA	3.0	NA	3.0
Overall	4.2 ± 1.9	2.4 ± 1.6	4.2 ± 2.2	3.8 ± 1.4	2.7 ± 0.9	3.7 ± 1.9

Table 6: **Household Survey: Subject and Household characteristics used in the direct non-medical and indirect costs analyses.**

costs of $26.34 million, direct non-medical costs of $1.29 million and indirect medical costs of $2.16 million.

Discussion

This study describes the direct and indirect costs incurred for the care of children with acute diarrhea in the in- and outpatient care settings in Indonesia. The costing data from the inpatient cases reflects the costs required to treat an acute diarrhea case requiring hospitalization. Additionally, the costs incurred for less severe acute diarrhea are reflected by the estimates of the cost of care for outpatient cases across facilities. The household survey provides an overview of the family perspective regarding the illness-related expenditure for an acute diarrheal admission.

In this study the total direct medical cost for an inpatient case was 1.3 times higher in a private hospital than in a public hospital and is consistent with a previous study in Indonesia conducted over a decade ago.[13] This is likely due to the higher costs of a higher quality of room facilities and medical and general services offered by private hospitals.[21] The direct medical cost of inpatient treatment in a private hospital was US$ 145 per episode, similar to that reported recently by Siregar et al. (US$ 146).[14] However, the direct medical cost for inpatient treatment in a public hospital varied with the level of hospital and across regions, but was lower in this study (US$128-$256) than that reported by Siregar et al. (US$ 363).[14] The tertiary public hospitals had higher professional fees, diagnostic and medication costs compared with other health facilities. This may reflect the complexity and severity of diarrhea cases (6% had severe dehydration and 41.7% had at least one concurrent diagnosis; Table 1) as well as access to a range of specialty and subspeciality medical professionals.[4]

The costs for the treatment of a diarrheal episode requiring hospitalization observed in this study was similar to the BPJS tariff. For instance, the average BPJS tariffs for a diarrheal hospitalization in a tertiary (Class A), high secondary (Class B), and low secondary (Class C) public hospitals are US$213, US$178, and US$162, respectively.[22] We observed that the mean cost per case for those using JKN insurance for hospitalization was US$176 for treatment in a tertiary Hospital (Class A), US$108 for treatment in a high secondary (Class B) and US$82 for treatment in a low secondary Hospital (Class C), suggesting that the BPJS tariff is generally adequate for the cost of treatment. However, the direct medical costs for over 60% of children hospitalized in Primary Health Centers were paid by caregivers from their own pocket. While in the hospital setting, higher tendency to pay out of pocket was observed in public hospitals compared to private hospitals. Due to the retrospective study design we were not able to explore why patients elected to directly pay

medical costs and not use JKN insurance. This was also observed in a 2015 survey conducted in Eastern Indonesia in which 45% of patients opted to directly pay for hospitalization, even though 25% were eligible to use insurance.[23]

For patients treated in the outpatient setting, the average direct medical cost was estimated at US$3 per visit, similar to estimates from a previous survey conducted in Bandung & Tomohon city (US$2.84)[14]. However, in our study non-medical costs for hospitalized cases varied across Indonesia. For example, transportation costs in South Kalimantan, Central Kalimantan and Central Sulawesi were more expensive than in other regions, likely due to geography, availability of public transportation, and the varied distances to reach hospitals or primary health centers.

Acute diarrhea has the potential to pose a considerable economic burden on households. Financial problems may arise, particularly in hospitalized patients who are paying their own costs (out-of-pocket method). For instance, the weighted average direct medical cost for an acute diarrheal admission across facility types constitutes 50.9% (US$ 99.8) of the average family monthly income (US$195.9). Direct non-medical and indirect costs represent an additional burden estimated as 7.5% (US$ 14.8) of the average family monthly income.

From the societal perspective, this study highlights that acute diarrhea presents a considerable economic burden with costs of over US$30 million per year for hospitalization related costs alone. Rotavirus is the most common cause of severe diarrhea in children less than five years of age in Indonesia and the introduction of a rotavirus vaccine into National Immunization Program in Indonesia has the potential not only to reduce diarrheal disease but also the economic burden of acute diarrhea.[13] This study, based on a wide variety of health care settings and geographical regions, provides the evidence needed to inform the economic evaluation of rotavirus vaccines and to support key public health and policy decision making.

A key strength of this study is that the data has been collected from a range of health care settings, including public hospitals, private hospitals, primary health centers, and private clinics, as well as costs incurred by households, public insurers, and private insurers. The data was collected from provinces in all regional areas of BPJS (I-V) including the major islands in Indonesia, including Sumatra, Kalimantan, Sulawesi, Java, and Nusa Tenggara Islands, with the aim to reflect the costs of acute diarrhea across Indonesia.

The household costs survey sample was selected from patient records at 55 primary health centers across all five Regions, however the population of Indonesia is large and diverse and it is possible that this selected sample may not be fully representative of the population in each region. The mean age of diarrhea cases

identified in the household survey (23.3 ± 15.1 months) and the proportion of patients hospitalized in public hospitals (36.3%) were similar to that reported in the BPJS-K data (23.9 ± 14.6 months and 38.3%, respectively), providing confidence that this sample reflects the disease burden in the community and the household costs associated with inpatient cases.[19]

A limitation of this retrospective study design was that inpatient cost data was collected from billing records which meant there was no ability to explore why some patients opted to directly pay medical costs and not use insurance. It also meant it was not feasible to retrospectively collect non-medical and indirect cost related to outpatient treatment. However, as the majority of outpatient care is received within villages, transportation costs and time taken to attend for an outpatient visit was likely to be minimal.

Conclusion

This study highlights the considerable economic burden with costs of over US$30 million per year for hospitalization of children less than five years of age in Indonesia. Direct and indirect costs of acute diarrhea in inpatient and outpatient settings varied across health care facilities, and regions in Indonesia. The direct medical costs for treating acute diarrhea in hospital ranged from US$12 in a primary health center in South Kalimantan (Region IV) to US$256 at a Tertiary public hospital in Yogyakarta (Region I). The direct medical costs for outpatient treatment varied across health care facilities from US$3 in primary health centers to US$25 in private hospitals, and across regions, from US$10 in Bangka Belitung (Region V) to US$17 in South Kalimantan (Region IV). Direct non-medical and indirect costs for an acute diarrheal hospitalization also varied across regions from $2 to $13 and $1 to $24 respectively. Acute diarrhea has the potential to pose a considerable economic burden on households. Payment using JKN insurance was the most common method of payment, although some families opted to use "out of pocket" payment, particularly for treatment provided in primary health centers. This data will be used to estimate potential healthcare cost savings within future cost-effectiveness analysis of programs aimed at preventing and treating acute diarrhea in children including the implementation of vaccines, such as rotavirus vaccine.

Contributors

JAT, AWE, EMW, NAC, FRD, ANC, YAS, JUB conceptualized and contributed to the methodology of the study.

JAT, AWE, and SUT participated in the investigation and project administration.

JAT and EMW curated and validated the data.

JAT and SUT performed the formal analysis of the collected data.

YAS and JUB participated in the supervision on this study.

JAT and SUT wrote the original draft of the manuscript. All authors reviewed the manuscript.

Supplementary materials

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