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The economic burden of pneumonia in children under five in Uganda

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ABSTRACT

Background: There were about 138 million new episodes of pneumonia and 0.9 million deaths globally in 2015. In Uganda, pneumonia was the fourth leading cause of death in children under five years of age in 2017–18. However, the economic burden of pneumonia, particularly for households and caregivers, is poorly documented.
Aim: To estimate the costs associated with an episode of pneumonia from the household, government, and societal perspectives.
Methods: We selected 48 healthcare facilities from the public and private sector across all care levels (primary, secondary, and tertiary), based on the number of pneumonia episodes reported for 2015–16. Adult caregivers of children with pneumonia diagnosis at discharge were selected. Using an ingredient-based approach, we collected cost and utilization data from administrative databases, medical records, and patient caregiver surveys. Household costs included direct medical and non-medical costs, as well as indirect costs estimated through a human capital approach. All costs are presented in 2018 U.S. dollars.
Results: The treatment of pneumonia puts a substantial economic burden on households. The average societal cost per episode of pneumonia across all sectors and types of visits was $42; hospitalized episodes costed an average of $62 per episode, while episodes only requiring ambulatory care was $16 per episode. Public healthcare facilities covered $12 and $7 on average per hospitalized or ambulatory episode, respectively. Caregivers using the public system faced lower out-of-pocket payments, evaluated at $17, than those who used private for-profit ($21) and not-for-profit ($50) for hospitalized care. For ambulatory care, out-of-pocket payments amounted to $8, $18, and $9 for public, private for-profit, and not-for-profit healthcare facilities, respectively. About 39% of households experienced catastrophic health expenditures due to out-of-pocket payments related to the treatment of pneumonia.

1. Introduction

Despite advances made in prevention and care management, pneumonia remains among the main contributors to childhood morbidity and mortality. There were about 138 million new episodes of pneumonia and 0.9 million deaths globally in 2015 [1]. In low-income countries, pneumonia is the leading cause of childhood deaths [2,3]. In Uganda, pneumonia was the fourth leading cause of death in children under five years of age in 2017–18 [4]. There are several causative agents for pneumonia, including *Streptococcus Pneumoniae*, *Haemophilus influenzae* type b, and respiratory syncytial virus, with the latter accounting for most of the episodes of severe pneumonia in Kenya (36%) and Zambia (21%) [5,6].

The high cost of treatment and related productivity loss due to pneumonia leads to a considerable economic burden on the government, the caregivers of the sick child, and the general population [5]. In Uganda, public healthcare facilities treat pneumonia free of charge. In 2010, the government further strengthened its primary care response to pneumonia, scaling-up integrated community care management (ICCM) with the involvement of community healthcare workers into the medical workforce [7]. To prevent episodes, the government introduced the 10-valent pneumococcal conjugate vaccine (PCV) in the National Immunization Program in 2013, offered in 3 doses at 6, 10, and 14 weeks old [8].

While the cost-effectiveness of PCV from a government perspective has been evaluated [9], our understanding of its broader economic impact in low- and middle-income countries (LMIC) is

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limited. The existing literature focuses mostly on public sector protocols, often in tertiary-level facilities, and may not capture the impact that the disease has on caregivers and their households [5,10]. A significant number of caregivers pay for healthcare sought at private facilities, including both for-profit institutions and not-for-profit hospitals funded by charitable organizations and public subsidies [11]. Caregivers seeking care in the public sector still incur out-of-pocket expenses including travel and lodging costs, and income loss, but also medications and medical supplies whenever the facilities are unable to provide them.

This study estimated the costs associated with treating pneumonia from the perspective of government, caregivers, and society. Caregivers using public and private healthcare were enrolled and followed 14 days after discharge. Catastrophic health expenditures were also calculated by socioeconomic strata for caregivers.

2. Methods

2.1. Site selection and case definition

We selected a nationally representative set of public and private healthcare facilities in districts covering all four regions of Uganda: Wakiso, Mbarara, Gulu, and Jinja districts. The 48 selected healthcare facilities included clinics dispensing primary care (outpatient care only), such as Health Centers (H.C.) II and III, and referral hospitals providing specialized care. Table S11 in the Supplementary material presents additional information on the different types of healthcare facilities included. The selection of public and private healthcare facilities and the caregiver sample size at each facility was based on the number of pneumonia episodes reported in the Uganda Health Management Information System (HMIS) the previous year (2015–16).

We enrolled the caregivers of children 1–59 months with suspected pneumonia, identified through a review of the facility medical records. The diagnosis was based on the WHO case definition for pneumonia (any level of severity), assessed clinically [12]. We included children with both outpatient and inpatient episodes of pneumonia. Children diagnosed with other conditions (e.g., HIV, malaria) were excluded from the study.

2.2. Data collection

Service costs from the government perspective included costs for capital (X-ray equipment, microscopes), overhead (electricity, water, telephone, vehicles for referrals, and facility maintenance), labor (healthcare professionals), medications, and disposable items. Infrastructure and furniture costs were not available or reliable and, therefore, were not included in the capital costs. Unit costs and resource utilization data were obtained from administrative records, patient medical records, and national estimates from the HMIS. Unit costs of medications were obtained from the national medical stores for public facilities and joint medical stores for private for- and not-for-profit facilities.

Caregivers were interviewed in person at the time of discharge from the healthcare facility (hospitalization or outpatient visit) and by phone 7 to 14 days post-discharge in a follow-up survey. For each patient, we collected data on direct medical costs (medications, testing, consultation, supplies), direct non-medical costs (transportation, meals), and indirect costs (travel time, loss of income), including costs incurred prior to hospitalization or outpatient visit where the discharge interview took place, during the current hospitalization or outpatient visit, and future hospitalization or outpatient visit.

We collected data from August 2016 to July 2017. We used KoboToolBox™ to record the data and WhatsApp™ to communicate updates with the field team. Data quality was regularly assessed throughout the collection period, and formative evaluations and training were provided to data collectors. Healthcare professionals were engaged throughout the study with health economics workshops at the district health offices, and a monthly newsletter on the study progress.

2.3. Data analysis

We used Stata 13™ and Microsoft Excel™ for data cleaning and analysis. Costs are reported in 2018 U.S. dollars, and converted from Ugandan Shillings: $1 = 3,727 shillings [13].

Government costs combined patient-specific costs for medication and disposable items, based on individual patient medication use, with operating costs comprising capital, overhead, and labor costs, following the methods outlined by the Global Health Cost Consortium (GHCC) [14]. Capital costs were annualized based on an assumed lifetime of 5 years for medical equipment and applied a discount rate of 3%. Overhead and labor costs were estimated for the pediatric ward or, for facilities without a pediatric ward, for the whole facility. No specialized pneumonia ward or specific personnel time could be attributed to the treatment of pneumonia, as recommended by GHCC to calculate overhead and labor costs [14]. We apportioned the operating costs to an episode of pneumonia (S) using a patient-days ratio (see Eq. (1)), where c_j is the total annual cost, p_j is the annual number of patients who used the facility, and $los_{i,j}$ is the length of stay in days for caregiver i over n total caregiver, and for healthcare facility j over m total facilities.

Eq. (1):

$$S = \sum_{j=0}^{m} \sum_{i=0}^{n} \frac{c_j \times los_{i,j}}{p_j} \quad (1)$$

Caregiver costs were estimated as they were reported, summing direct medical and non-medical costs as out-of-pocket payments. We used the human capital approach to estimate indirect costs, using the time spent travelling to facilities and caring for the sick child at the facility, and the reported average income of the head of the household [15]. Indirect costs were added to out-of-pocket payments to generate the economic cost per episode of pneumonia.

The societal cost represents the sum of the costs from the caregiver and healthcare provider perspectives, the latter, including both the government and private sectors. We assumed that costs incurred by the private sector to deliver healthcare were transferred entirely to caregivers through fees. Thus, the societal cost is the sum of the caregiver and government costs, minus medical costs borne by caregivers at public facilities to prevent double-counting.

2.4. Catastrophic health expenditures

We calculated catastrophic health expenditures using the share of out-of-pocket payments over the household's monthly income (including all wage-earners in the household) or monthly expenditures [16]. The monthly expenditures comprised of expenses on basic needs such as clothing, household supplies, food as well as expenditure on other illnesses. We reported catastrophic health expenditures using several thresholds, including 10% of the household's total monthly income, 10% of its monthly expenditures, or 40% of its monthly expenditures excluding food.

2.5. Socioeconomic status

The socioeconomic status of the household was determined using an asset score that was derived using principal component analysis [17]. The assets included the possession of durable items such as radios and televisions, and the household dwelling characteristics. The households were divided into five quintiles according to their asset score ranking.

3. Results

3.1. Sample characteristics

We obtained resource and cost data from 693 pneumonia episodes during the data collection period. Pneumonia episodes in our sample came from public healthcare facilities (362 children, 52%), private, not-for-profit facilities (276, 40%), and private for-profit facilities (55, 8%). Our sample included 391 inpatient (56%) and 302 outpatient episodes (44%). In our sample, most children were over the age of 1 year (386 children, 56%) with almost equal proportion of males (373, 54%) and females (313, 46%). About 93% of the caregivers were women. Most caregivers had completed primary school education (528, 76%), including 174 (25%) who completed secondary school.

Most caregivers reported that their household lived in rural or semi-urban areas (447, 64%). Those households most often included the parents of the child, other children, as well as several other adults: 255 (37%) from households with 4–5 people and 192 (28%) with six people or more. The average number of adults and children in each household was 2.5 adults and 3.2 children (median of 2 adults and 2 children). In most cases (63%), only one adult was a wage earner in the household.

Almost all caregivers reported that the child had an immunization card (96%), although only 17% had it with them at the time of the interview. Among the children who presented their immunization card, 93% received at least one dose of PCV, and 73% received all three doses prescribed in the national guidelines. Only a handful of children (31 children, 4%) had health insurance to help cover their medical expenses.

3.2. Government perspective

The cost of treating pneumonia varied by level of facility and by type of care. In HC II and III, the total cost of care for outpatient care averaged $1 and $5, respectively. HC IV had an average total cost of care of $7 to treat an outpatient episode and $19 for a hospitalized episode of pneumonia. For regional referral hospitals, average total costs were $5 for an outpatient episode and $10 for a hospitalized episode. Labor cost was the main driver of facility costs ranging between 64% and 74% of the total cost for an outpatient episode and 48% to 82% for an inpatient episode (see Table 1).

Overall, the government spent an average of $7 per outpatient episode and $12 per hospitalized episode of pneumonia, accounting for fees or purchases charged to the patient.

3.3. Household cost estimates

Caregivers faced an average of $20 in out-of-pocket payments and $17 in indirect costs per episode of pneumonia, for a total economic cost of $37.

Caregivers who used public healthcare facilities incurred lower costs than those in private for-profit and not-for-profit facilities for inpatient care. On average, for a hospitalized episode of pneumonia in a public facility in Uganda, caregivers faced an average economic cost of $31, including $17 in out-of-pocket payments. In comparison, caregivers using private for-profit and not-for-profit facilities for hospitalization incurred $40 and $96, respectively, in economic costs, including $21 and $50 in out-of-pocket payments. For outpatient episodes, caregivers using private for-profit and not-for-profit facilities spent similar amounts: an average total cost of $21 and

Table 1
Government costs for an episode of pneumonia (2018 U.S. dollars).

Cost	Inpatient care				Outpatient care			
	Public Healthcare Centre II							
	Mean	S.E.	95% CI		Mean	S.E.	95% CI	
Capital	.	.	.	.	$0.00	$0.00	$0.00	$0.00
Overhead	.	.	.	.	$0.02	$0.01	−$0.01	$0.05
Labor	.	.	.	.	$0.59	$0.30	−$0.36	$1.54
Investigations	.	.	.	.	$0.00	$0.00	$0.00	$0.00
Medications	.	.	.	.	$0.21	$0.08	−$0.05	$0.48
Total cost	**.**	**.**	**.**	**.**	**$0.83**	**$0.33**	**−$0.23**	**$1.88**
	Public Healthcare Centre III							
Capital	.	.	.	.	$0.01	$0.00	$0.00	$0.02
Overhead	.	.	.	.	$0.09	$0.03	$0.01	$0.18
Labor	.	.	.	.	$3.18	$1.54	−$1.72	$8.08
Investigations	.	.	.	.	$0.09	$0.09	−$0.20	$0.39
Medications	.	.	.	.	$1.63	$1.48	−$3.08	$6.33
Total cost	**.**	**.**	**.**	**.**	**$5.00**	**$2.32**	**−$2.37**	**$12.37**
	Public Healthcare Centre IV							
Capital	$0.05	$0.05	−$0.10	$0.19	$0.01	$0.01	−$0.02	$0.05
Overhead	$0.27	$0.10	−$0.03	$0.58	$0.11	$0.04	−$0.02	$0.25
Labor	$15.45	$7.02	−$6.87	$37.78	$5.49	$2.17	−$1.42	$12.41
Investigations	$1.60	$1.60	−$3.48	$6.67	$1.60	$1.60	−$3.48	$6.67
Medications	$1.51	$0.86	−$1.22	$4.25	$0.20	$0.08	−$0.04	$0.45
Total cost	**$18.88**	**$8.41**	**−$7.87**	**$45.64**	**$7.41**	**$3.49**	**−$3.69**	**$18.51**
	Public Regional Referral Hospital							
Capital	$0.03	$0.02	−$0.05	$0.10	$0.01	$0.01	−$0.02	$0.05
Overhead	$2.66	$1.31	−$1.51	$6.84	$0.95	$0.45	−$0.48	$2.38
Labor	$4.86	$1.09	$1.40	$8.32	$1.87	$0.55	$0.14	$3.61
Investigations	$0.22	$0.17	−$0.31	$0.75	$0.22	$0.17	−$0.31	$0.75
Medications	$2.35	$0.46	$0.88	$3.81	$2.08	$0.68	−$0.07	$4.23
Total cost	**$10.12**	**$1.66**	**$4.84**	**$15.40**	**$5.14**	**$0.38**	**$3.92**	**$6.35**

Table 2
Total household costs for an episode of pneumonia (2018 U.S. dollars).

Timing	Type of cost	INPATIENT CARE Public (n = 230)					Private for-profit (n = 19)					Private not-for-profit (n = 142)				
		Mean	SD	95% CI		n(c > 0)	Mean	SD	95% CI		n(c > 0)	Mean	SD	95% CI		n(c > 0)
Before current visit[A]	Direct medical	$1.73	$7.77	$0.72	$2.74	71	$0.70	$1.54	-$0.04	$1.44	7	$2.41	$7.02	$1.25	$3.58	33
	Direct non-medical	$0.73	$2.84	$0.36	$1.10	53	$0.62	$1.42	-$0.06	$1.31	5	$1.94	$4.45	$1.20	$2.68	42
	Indirect	$2.01	$9.83	$0.64	$3.38	200	$0.23	$0.46	-$0.04	$0.49	13	$3.16	$10.22	$1.25	$5.06	108
	Time loss [days]	$0.00	$0.00	$0.00	$0.00	230	$0.00	$0.00	$0.00	$0.00	18	$0.00	$0.00	$0.00	$0.00	141
Current visit	Direct medical	$2.60	$3.84	$2.10	$3.09	121	$8.76	$13.28	$2.36	$15.16	12	$27.84	$60.63	$17.78	$37.90	129
	Direct non-medical	$8.67	$6.26	$7.86	$9.48	229	$6.40	$7.10	$2.98	$9.83	19	$16.81	$12.63	$14.71	$18.91	142
	Indirect	$13.05	$17.98	$10.54	$15.55	187	$26.27	$34.86	$6.14	$46.40	14	$53.57	$227.89	$11.09	$96.04	103
	Time loss [days]	$0.00	$0.00	$0.00	$0.00	210	$0.00	$0.00	$0.00	$0.00	18	$0.00	$0.03	$0.00	$0.01	135
Follow-up[A]	Direct medical	$0.36	$1.56	$0.15	$0.58	15	$3.29	$12.93	-$3.61	$10.18	2	$0.72	$4.08	-$0.01	$1.46	4
	Direct non-medical	$3.46	$7.01	$2.48	$4.44	54	$2.01	$7.91	-$2.20	$6.23	2	$0.59	$2.96	$0.06	$1.12	10
	Indirect	$0.88	$3.61	$0.34	$1.41	22	$0.00	$0.00	$0.00	$0.00	0	$1.44	$6.00	$0.22	$2.66	8
	Time loss [days]	$0.00	$0.00	$0.00	$0.00	22	$0.00	$0.00	$0.00	$0.00	1	$0.00	$0.00	$0.00	$0.00	9
Total out-of-pocket payments		**$17.05**	**$13.31**	**$15.32**	**$18.78**	**229**	**$20.95**	**$34.09**	**$4.52**	**$37.38**	**19**	**$50.13**	**$66.74**	**$39.05**	**$61.20**	**142**
Total economic cost		**$30.83**	**$26.73**	**$27.35**	**$34.30**	**229**	**$40.47**	**$43.90**	**$19.32**	**$61.63**	**19**	**$96.23**	**$217.09**	**$60.21**	**$132.24**	**142**
Timing	**Type of cost**	**OUTPATIENT CARE** **Public (n = 132)**					**Private for-profit (n = 36)**					**Private not-for-profit (n = 134)**				
		Mean	SD	95% CI		n(c > 0)	Mean	SD	95% CI		n(c > 0)	Mean	SD	95% CI		n(c > 0)
Before current visit[A]	Direct medical	$0.59	$2.36	$0.19	$1.00	23	$0.34	$0.96	$0.02	$0.67	7	$1.70	$11.67	-$0.29	$3.69	40
	Direct non-medical	$0.20	$1.00	$0.03	$0.37	12	$0.35	$1.88	-$0.29	$0.99	3	$0.26	$0.94	$0.10	$0.42	18
	Indirect	$0.49	$2.34	$0.07	$0.92	116	$0.35	$1.34	-$0.15	$0.85	28	$0.60	$1.50	$0.34	$0.86	117
	Time loss [hours]	$0.00	$0.00	$0.00	$0.00	129	$0.00	$0.00	$0.00	$0.00	35	$0.00	$0.00	$0.00	$0.00	124
Current visit	Direct medical	$0.67	$1.81	$0.36	$0.98	30	$9.61	$11.16	$5.84	$13.39	29	$3.15	$4.48	$2.38	$3.91	118
	Direct non-medical	$1.11	$2.08	$0.75	$1.47	86	$3.84	$4.90	$2.18	$5.50	35	$1.60	$1.62	$1.33	$1.88	107
	Indirect	$3.21	$9.91	$1.40	$5.02	116	$2.75	$3.60	$1.41	$4.09	29	$4.71	$18.34	$1.49	$7.93	120
	Time loss [hours]	$0.00	$0.00	$0.00	$0.00	131	$0.00	$0.00	$0.00	$0.00	36	$0.00	$0.00	$0.00	$0.00	126
Follow-up[A]	Direct medical	$0.86	$2.11	$0.48	$1.24	29	$3.81	$11.49	-$0.27	$7.88	4	$1.98	$2.45	$1.50	$2.45	50
	Direct non-medical	$0.48	$2.34	$0.06	$0.90	19	$0.41	$1.61	-$0.16	$0.98	4	$1.10	$1.36	$0.84	$1.36	50
	Indirect	$0.66	$3.18	$0.05	$1.26	33	$0.23	$0.68	-$0.03	$0.50	3	$2.17	$3.30	$1.51	$2.83	50
	Time loss [hours]	$0.00	$0.00	$0.00	$0.00	33	$0.00	$0.00	$0.00	$0.00	4	$0.00	$0.00	$0.00	$0.00	51
Total out-of-pocket payments		**$3.81**	**$5.99**	**$2.78**	**$4.84**	**107**	**$18.01**	**$21.80**	**$10.64**	**$25.39**	**36**	**$9.12**	**$14.06**	**$6.72**	**$11.53**	**125**
Total economic cost		**$7.66**	**$12.72**	**$5.47**	**$9.85**	**128**	**$20.77**	**$23.52**	**$12.81**	**$28.73**	**36**	**$15.76**	**$23.87**	**$11.68**	**$19.84**	**134**

Notes: SD, Standard Deviation; n, number of caregivers; n(c > 0), number of caregivers who incurred costs greater than $0.[A] Includes costs incurred at public and private healthcare facilities and providers.

$16, including $18 and $9 in out-of-pocket expenses, while caregivers using public facilities spent only $8 in total costs with $4 in out-of-pocket expenses (see Table 2).

Medical costs drive only 27% of the out-of-pocket payments for caregivers using public healthcare facilities for inpatient care, compared to 63% and 61% for those using private for-profit and not-for-profit facilities. Indirect costs due to productivity loss account for 45–48% of the caregivers' economic cost per episode across all three sectors. Over the continuum of care for an episode of pneumonia that required hospitalization, the cost of the current visit influenced most of the costs contributing to 53–64% of the total cost. For outpatient episodes, costs incurred at facilities before the current visit were the key drivers: 53–68%.

Forty-two percent of the households experienced catastrophic health expenditures based on their monthly income for an episode of pneumonia, on average, spending 28% of their income. The proportion climbs to 69% when based on their household expenditures (10% threshold; including food) and 39% when excluding food from the household expenditures (40% threshold). An episode of pneumonia was more likely to incur catastrophic health expenditures in caregivers in the two most deprived quintiles than in the wealthier quintiles (see Fig. 1).

The mean direct or indirect costs by wealth quintiles were significantly different; however, the outliers within each quintile clouds the presence of any significant trend (see Supplementary Material: Table S4). Applying non-parametric tests (Kruskal-Wallis and the Wilcoxon ranking tests), the median costs revealed an upward trend, where households in wealthier quintiles incurred higher direct and indirect costs than those in the poorer quintiles for both inpatient and outpatient care – with the notable exception of households in the 2nd quintile, whom incurred the second highest direct costs for inpatient care. This said, only the 1st (poorest) and 5th (richest) quintiles showed to be significantly different (see Supplementary Material: Tables S6 & S8). There was no difference in time spent across wealth quintiles in either types of care: differences in indirect costs were solely driven by differences in

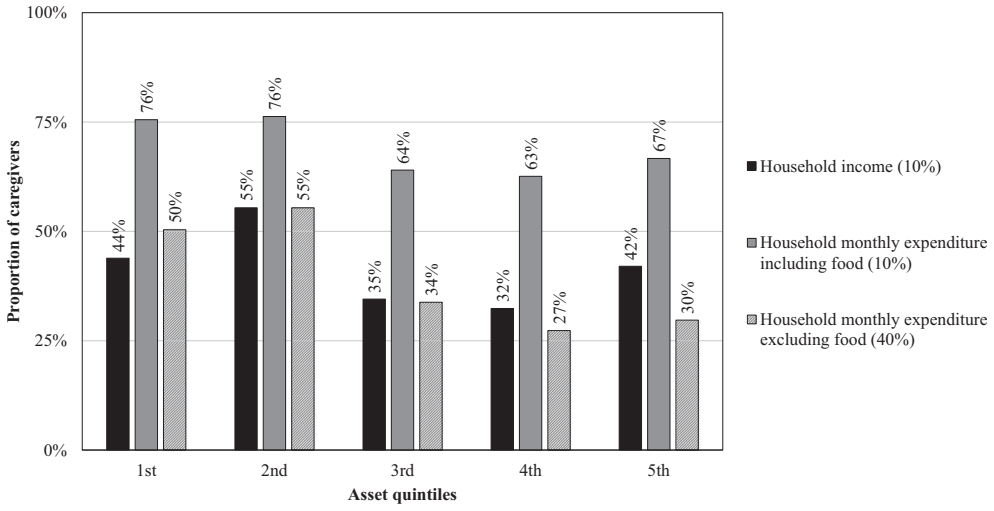

Fig. 1. Catastrophic health expenditures related to pneumonia by asset quintile in Uganda.

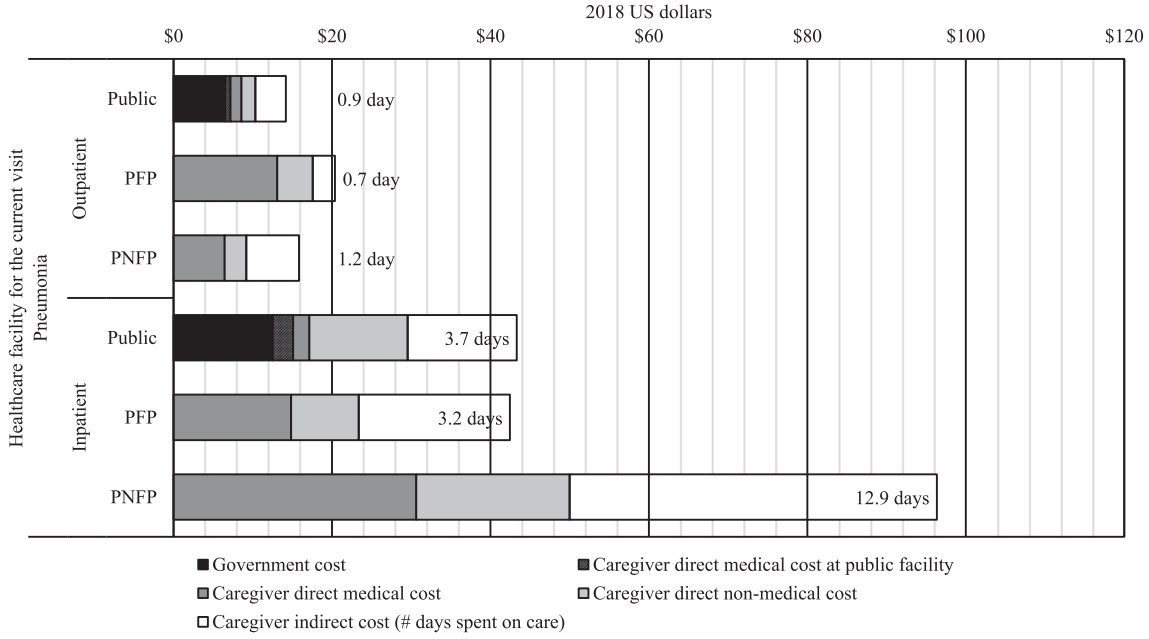

Fig. 2. Societal cost per episode of pneumonia in Uganda.

average monthly income for the head of the household (see Supplementary Material: Tables S7 & S9). Caregivers from the 2nd quintile came mostly came from Mbarara (40%) and Wakiso districts (31%), used inpatient care more than those in other wealth quintiles (65%), and used private not-for-profit healthcare facilities much more for inpatient care (27% of all households) (see Supplementary Material: Table S5). Considering the high medical costs associated with the use of private not-for-profit facilities for inpatient care, this combination of factors explains why this second quintiles experienced such high costs, directly translating into a high rate of catastrophic health expenditures for this group.

To pay for hospitalized care, most caregivers used the household's savings. The use of savings increased with wealthier asset quintiles (see Supplementary Material: Fig. S1-2). While 95% of those in the 5th quintile reported the use of savings, only 70% in the first quintile used savings to pay for hospitalization costs. The proportion of households selling off assets, borrowing from family and friends, and taking a loan, decreased with the wealthier quintiles. However, 8% of responders in the first quintile reported selling assets to cover hospital bills. No responder from the 3rd, 4th, or 5th quintiles reported selling assets to cover hospitalization costs.

3.4. Societal cost estimates

When weighted to represent the sample utilization rates of each facility, the average societal cost per episode of pneumonia across all sectors and types of visits was $42. Hospitalized episodes accounted for an average of $62 per episode, while episodes only requiring ambulatory care had an average of $16.

The societal cost related to public healthcare facilities was the lowest for outpatient care at $14. The cost of inpatient care was $43. The cost at private for-profit facilities averaged $42 for inpatient care and $20 for outpatient care see Fig. 2.

Indirect costs weighted more heavily in private not-for-profit facilities for both inpatient and outpatient care; the time spent in the healthcare system for a hospitalized episode of pneumonia was 12.9 days in private not-for-profit facilities compared to 3.2–3.7 days in the other sectors. This difference drove the cost up with a societal cost of $96 per hospitalized and $15 per outpatient episode see Fig. 2.

4. Discussion

The treatment of pneumonia puts a substantial economic burden on households, digging the health inequality between wealthy and poor households. Most wealthy households used their savings to make out-of-pocket payments for the treatment of pneumonia. In contrast, poor households turned to friends and family for help (7–15%), sold assets (0–8%), and took out bank loans (11–13%) to make out-of-pocket payments for the treatment of pneumonia. Furthermore, 39% of caregivers reported spending >40% of their household expenditure (excluding food) on a pneumonia episode. Across wealth quintiles, the proportion of households experiencing catastrophic health expenditures went from 50 to 55% in the poorest 1st and 2nd quintiles to 27–30% in the wealthiest 4th and 5th (34% in the 3rd). Other studies have shown that catastrophic health expenditures are typical in LMICs that do not have adequate financial protection mechanisms in place [18,19]. Such prevalence of catastrophic health expenditures and such mechanisms to cope with high healthcare costs show that households are pushed deeper into poverty by hindering their economic development, leading them to a vicious cycle of poverty [20]. Subnational particularities, such as using private not-for-profit facilities for inpatient care in specific districts (such as Mbarara), likely shape inequalities in access to care, as made explicit by the high costs incurred by caregivers from the 2nd wealth quintile.

Measures, therefore, need to be taken by the government to make care for pneumonia more affordable for all households [5]. Although the government of Uganda provides subsidies to private not-for-profit facilities, the cost borne by the households using these facilities remains high. Communities that are served only by private for- and not-for-profit healthcare facilities, principally in rural areas, may be more reluctant to seek healthcare because of these high costs [7]. The government could consider providing adequate and long-term funding to rural private facilities in order to make care more affordable for those they serve. Ideally, such a policy should take place within a national health insurance scheme, which has been shown to reduce catastrophic health expenditures while controlling for the fees charged by private healthcare facilities [21].

Travel costs also contributed to the high non-medical direct costs, especially for inpatient services. Households had to travel long distances to access inpatient care. According to the Uganda National Household Survey, access to health facilities is reported to have increased overall in the country: 92% and 82% of people living in urban and rural areas, respectively, reside within 5 km from a health facility [11]. It is possible, however, that these healthcare facilities are not able to provide the necessary services, thus forcing caregivers to travel longer distances to access appropriate care. These findings are also supported by findings from the Uganda National Household Survey, where 14% of those who did not seek care for an illness reported long distance as the main reason, and 13% reported high travel costs [11]. The Ministry of Health and the local district health authorities should strengthen programs like integrated community care management (ICCM). The program's ability to provide low cost and accessible treatment for mild illnesses will be cost-saving for both the government and households, compared to facility care, and reduce the need to travel for non-severe episodes [5,7,22].

Earlier studies estimated the government (or provider) and societal costs of an episode of pneumonia in East and West Africa. All costs were corrected to 2018 U.S. dollars [13,23]. Government costs for hospitalized episodes of pneumonia ranged from $57–85 in The Gambia [24], $105 in Kenya [25], to $221 in Zambia [26]. In Kenya, a hospitalized episode costed up to $429 to private not-for-profit providers [25]. For outpatient care, estimates ranged from $5–9 in The Gambia to $49 in Zambia [24,26]. Societal costs ranged from $14 in outpatient care to $101 for inpatient care in The Gambia [24]. While nearing the Gambian cost estimates, our estimates for the same type of care are much lower than those found in prior studies. Inpatient and outpatient episodes (all seen in urban secondary healthcare facilities) in Kenya and Zambia seemed much costlier than those in our sample: $19 for a hospitalized episode and $7 for an outpatient episode. In both studies, hospitals were in urban areas, and episodes of severe to very severe pneumonia were selected. In contrast, hospitals in our sample treated episodes of all severity levels and our sample was drawn from hospitals in both urban and rural settings were some medications and diagnostic tests may not be readily available for episodes of pneumonia.

Most children with pneumonia in our sample were vaccinated with PCV. Based on the immunization cards seen by the data collectors, over 73% of the children received all three doses of the vaccine (interestingly, the proportion remains at 73% when including self-reported vaccination status, without immunization card). Most of our episodes likely result from an infection by strains of bacteria or viruses that are not covered by the vaccine, such as the respiratory syncytial virus, the primary cause of severe pneumonia episodes in neighboring Kenya [6]. It could also be the result of poor cold chain maintenance, leading to the delivery of vaccines that have lost their potency. The Ministry of Health and its partners

should ensure adherence to the required cold chain procedures and conduct an etiology study that can provide accurate information on the causative agents of pneumonia in Uganda. This will help the country to determine the reason for the high pneumonia episodes among vaccinated children and prioritize interventions effectively.

This study had several strengths. The data collection was conducted in a variety of facilities that were representative of both the public and private sectors, as well as primary and specialized levels of care. The ingredient (bottom-up) costing approach allowed us to collect detailed and patient-specific cost information. We noted several limitations, most inherent to the challenges met by cost of illness studies in the field. First, the episode definition was based on clinical assessment and did not include laboratory confirmation: we cannot exclude that patients diagnosed with pneumonia were ill from a different condition. To limit this issue, we considered the diagnosis at discharge for inclusion, meaning that the patient effectively received the treatment appropriate for pneumonia. Second, the indirect costs were likely overestimated, due to the chosen valuation of time loss, the head of the household's average monthly income. Most caregivers did not report any monetary income, prohibiting its use to value time loss properly. Finally, we were unable to measure external funding of private healthcare facilities (government subsidy, grants, private donations) and attribute it to the treatment of pneumonia. Thus, the estimates do not include any cost borne by private facilities and not transferred as fees to the households.

5. Conclusions

The results of the study indicated that the treatment of pneumonia puts a substantial economic burden on households in Uganda. The average societal cost per episode of pneumonia across all sectors and types of visits was $42. Hospitalized episodes accounted for an average of $62 per episode, while episodes only requiring ambulatory care had an average cost of $16. From the perspective of the caregivers, whether the episode of pneumonia was hospitalized or ambulatory, and treated in the public or private sector predominantly influenced the cost of treating pneumonia. The proportion of households affected by catastrophic health expenditures was high, with 39% of the households surveyed spending over 40% of their expenditures excluding food to treat a episode of pneumonia. Mechanisms should be in place to assist poorer households from incurring out-of-pocket healthcare payments. These include increasing conditional subsidies to the private sector through initiatives such as national health insurance, and strengthening the delivery of primary healthcare through ICCM. Lastly, most children who had pneumonia had received all three doses of PCV; further examination of the status of the cold chain and investigation of the causative strains of pneumonia in Uganda is needed to shed more light on the factors driving the high number of children with pneumonia.

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Meetings where this information has previously been presented

Preliminary findings of this research were presented to the Ministry of Health of Uganda on December 4, 2018, in Kampala, Uganda. Regional-specific preliminary findings were presented at the district health office of each district: Jinja (December 5, 2018), Gulu (December 7), and Mbarara (December 11). Results for Wakiso district were presented on December 4. Local stakeholders involved in the project attended these meetings, including healthcare facility managers, district health office staff, and representatives of international organizations. Their expertise and feedback was invaluable to the development of this article.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: At the time the study was conducted, all co-authors received funds from the Bill & Melinda Gates Foundation. At the time of the development of this manuscript, Dagna Constenla was employee of GSK and holds stock option as an employee of GSK.

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Ethical approval

The Institutional Review Board (IRB) of the Johns Hopkins Bloomberg School of Public Health examined the risks and benefits related to this research project and granted ethical approval (IRB #7256). The IRBs of Makerere University and the Uganda National Council for Science and Technology examined the risks and benefits related to this research project in the context of Uganda and granted ethical approval (IRB HS 2131). In Gulu, additional local review was done by the IRB at St. Mary Lacor Hospital.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jvacx.2021.100095.

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