HEALTH FINANCING AND SPENDING IN LOW- AND MIDDLE-INCOME COUNTRIES

EDITED BY: Mihajlo (Michael) Jakovljevic, Zafer Çaliskan, Paula Odete Fernandes, Sulaiman Mouselli and Michael Ekubu Otim

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HEALTH FINANCING AND SPENDING IN LOW- AND MIDDLE-INCOME COUNTRIES

Topic Editors:
Mihajlo (Michael) Jakovljevic, Hosei University, Japan
Zafer Çaliskan, Hacettepe University, Turkey
Paula Odete Fernandes, Polytechnic Institute of Bragança (IPB), Portugal
Sulaiman Mouselli, Arab International University, Syria
Michael Ekubu Otim, University of Sharjah, United Arab Emirates

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EDITORIAL
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Editorial: Health Financing and Spending in Low- and Middle-Income Countries

Mihajlo Jakovljevic[1,2]*, *Zafer Çalışkan*[3], *Paula Odete Fernandes*[4], *Sulaiman Mouselli*[5] and *Michael Ekubu Otim*[6]

[1] Institute of Comparative Economic Studies, Hosei University, Tokyo, Japan, [2] Department of Global Health Economics and Policy, University of Kragujevac, Kragujevac, Serbia, [3] Department of Economics, Hacettepe University, Ankara, Turkey, [4] Escola Superior de Tecnologia e Gestão, Instituto Politécnico de Bragança, Bragança, Portugal, [5] Faculty of Business Administration, Arab International University, Daraa, Syria, [6] Department of Health Services Administration, University of Sharjah, Sharjah, United Arab Emirates

Keywords: health financing, health spending, health insurance, LMICs, health care, health policy

Editorial on the Research Topic

Health Financing and Spending in Low- and Middle-Income Countries

The World Bank has introduced the Atlas method to determine in an econometrically valid way borderline thresholds for classifications of all national economies into low, middle, and high-income categories in an objective and predictable manner. Although this approach may be challenged to some extent, it has long served well in observation and predictions of long-term trends in GDP growth and national health expenditures (1–3).

The contribution of low- and middle-income countries (LMICs) share in total health expenditures as observed through the (4) Global Health Expenditure criteria has almost doubled in terms of purchase power parity (PPP) basis from only 20% of the global share in 1995 up to almost 40% in 2013 (5, 6). These fiscal flows have been well-documented *via* WHO's National Health Accounts database. This lengthy and rocky road forward for the LMICs contains many difficulties. A few core challenges include socioeconomic inequalities in medical care access and affordability, large out-of-pocket expenses, and vulnerabilities against catastrophic household expenditures. These challenges remain matters of grave concern in many LMICs (7).

Broad trends give far greater grounds for optimism, however, since networks of rural and suburban health care facilities are growing and strengthening. Preventive lifestyle interventions, provision of essential medicines, and spreading of cost-effective basic medical technologies, designated in WHO policy as "best buys" interventions, all contributed to exceptionally improved early childhood survival and extended life expectancy. Current circumstances in most LMICs are characterized by aging populations, rapid urbanization, and increased citizen expectations in terms of health insurance coverage. Prescription drugs consumption is still dominated by generic medicines, with brand name originals gradually taking root. Hospital sectors are state or publicly owned in most former and modern day centrally-planned socialist economies. By contrast, in some regions like the Middle East and North African (MENA) Arabic nations, Latin America, and free-market Far East Asian economies, hospital property structure is predominantly privately owned (1).

Rapidly developing world regions exhibit substantial heterogeneity in terms of historical legacy in health care establishments, provision, and financing, however, they all face a few

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Paolo Vineis,
Imperial College London,
United Kingdom

***Correspondence:**
Mihajlo Jakovljevic
sidartagothama@gmail.com

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core common challenges. Among them, epidemiological transition in morbidity and mortality structure is probably the most notable. The burden of infectious diseases, nutritional disorders, and traumatism are gradually being replaced by chronic non-communicable diseases (NCDs). Infections tend to be of acute clinical course, affect juvenile and elderly populations outside the labor market, and are mostly curable with contemporary medicine. NCDs are chronic, costly, lifetime illnesses demanding complex and expensive medical care. Another core issue is related to decreasing working ability, absenteeism, and premature mortality imposed by NCDs on the working population of society. This means that the national health systems face a double burden in terms of workload and fiscal flows face from these dual long-term epidemiology trends. LMICs national health systems have historically evolved to combat primarily communicable disorders and now they are facing much harsher challenges (8, 9).

The article entitled "*Associations Between Schemes of Social Insurance and Self-Rated Health Comparison: Evidence From the Employed Migrants in Urban China*" explored the relationship between social insurance without health insurance and self-rated health comparison (SRHC) among employed migrants in urban China. Its results pointed out that only two of the three social insurance schemes could improve SRHC among the employed migrants (Guan).

Onwujekwe et al. contributed an intriguing piece entitled "*Characteristics and Effects of Multiple and Mixed Funding Flows to Public Healthcare Facilities on Financing Outcomes: A Case Study From Nigeria*" providing proof of concept that multiple funding flows to public hospitals are beneficial as well as constraining to health providers.

Nguyen-Thi et al. conducted the exceptional original research study entitled "*Cost-Effectiveness of Gliclazide-Based Intensive Glucose Control vs. Standard Glucose Control in Type 2 Diabetes Mellitus. An Economic Analysis of the ADVANCE Trial in Vietnam*." They have highlighted that in Vietnam, gliclazide-based IGC was cost-effective compared with SGC from a healthcare payer perspective, as defined in the ADVANCE study.

The following article entitled "*Achieving Sustainable Development Goals (SDGs) in Sub-Saharan Africa (SSA): A Conceptual Review of Normative Economics Frameworks*" has provided sound evidence that the Non-Welfarist framework ought to be adopted in order to improve priority setting in the SSA countries (Otim et al.).

Ogunseye has enriched this research topic with his study entitled "*Nigerian Results-Based Financing Fellowship: A Strategic Approach for Sustaining Results-Based Financing in Nigeria*." This particular paper emphasizes the need for its utilization as a strategic approach for the sustenance and expansion of RBF in Nigeria.

The next successful publication was entitled "*Rising Catastrophic Expenditure on Households Due to Tuberculosis: Is India Moving Away From the END-TB Goal?*" Prasad et al. reveal that in India, despite free diagnostic and treatment services offered under the national program, households are exposed to catastrophic financial expenditure due to tuberculosis.

Balkhi et al. have contributed with another surprising paper entitled "*Impact of Healthcare Expenditures on Healthcare Outcomes in the Middle East and North Africa (MENA) Region: A Cross-Country Comparison, 1995–2015*" throughout a complex methodological framework, authors have proven that a large variation was demonstrated between health expenditures per capita and life expectancy in MENA countries, and this variation is growing with time.

Another valuable piece outsourcing from the Sub-Saharan Africa region was entitled "*What Drives Outpatient Care Costs in Kenya? An Analysis With Generalized Estimating Equations*." It has been discovered that cost of outpatient care changes with age in a sinusoidal manner. Households whose heads reported primary or secondary school education level tended to spend less on outpatient costs than households headed by those who never went to school (Mwenda).

Last but not least, Wu et al. found out in methodologically grounded results that heterogeneous factors influence online timebank nursing for dealing with the increasingly serious population aging problem in China and in Beijing metropolitan area in particular.

This research topic has attempted to partially explain the core challenges of medical care financing and spending primarily across LMICs. Submitted manuscripts have mostly focused on issues relevant to health care economics among the developing world nations. Various health-economic evaluations and health policy analyses have been published outsourcing from academia, industry, and regulatory authorities. How much the editors and authors achieved their goals yet remains to be seen.

AUTHOR CONTRIBUTIONS

MJ has prepared the manuscript draft while ZÇ, PF, SM, and MO have revised it for important intellectual content. All authors contributed to the article and approved the submitted version.

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Associations Between Schemes of Social Insurance and Self-Rated Health Comparison: Evidence From the Employed Migrants in Urban China

Ming Guan [1,2]*

[1] Family Issues Center, Xuchang University, Xuchang, China, [2] School of Business, Xuchang University, Xuchang, China

Background: Little was known about the relationship between social insurance without health insurance and self-rated health comparison (SRHC). The present study aimed to investigate how social insurance schemes improved SRHC among employed migrants in urban China.

Methods: The employed migrants aged 18 and above were selected from the 2009 Rural-Urban Migration in China project. Multiple probit regression models were adopted to identify the determinants of participation of social insurance. Multiple logistic regression models were used to analyze the relationship between unemployment insurance, pension insurance, and work injury insurance and SRHC.

Results: In the sample, most of the participants were middle-aged, male, and uninsured persons. However, over 80% of them reported better SRHC. Health insurance contributed to the participation of social insurance. The social insurance schemes were associated with financial risk. Regarding the confounding effects of health insurance, the three schemes of social insurance were associated with SRHC.

Conclusions: The result indicated that not all three, but two schemes of social insurance, could improve SRHC among the employed migrants.

Keywords: SRHC, social insurance, health insurance, employed migrants, urban China

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Suresh Munuswamy, Public Health Foundation of India, India
Simon Grima, University of Malta, Malta
Martin Dlouhy, University of Economics, Czechia

***Correspondence:**
Ming Guan
gming0604@163.com

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INTRODUCTION

A large part of the literature has reported the protective effect of health insurance on health status (1–5). Regarding the causal effect of health insurance on health, a review concluded that the observed correlation between insurance and good health might be driven by other factors (6). Two current studies indicated that the effect relied on the health insurance coverage (7, 8). Also, health insurance had some limitations. A study in India revealed that health insurance aggravated the inequities in accessing health care services (9). Similarly, in China, this was also true. Using the 2006 China Agricultural Census, a study found that the New Cooperative Medical System (NCMS) did not affect child morality or maternal mortality (10). The Chinese health insurance policy could not realize full coverage and equal utilization of health insurance among migrant workers in China (11). As for rural-to-urban migrants in China, migration to urban areas limited the effectiveness of

rural health insurance on chronic disease management due to its non-portable nature (12). Thus, social insurance as an alternative method could be used to safeguard the health status.

Currently, little attention has been paid to the impacts of social insurance on health status in academic circles. Similar to the financing system for health insurance in China, the employers are required to make monthly contributions to unemployment insurance (UI), pension insurance (PI), and work injury insurance (WII). Additionally, individuals need to make monthly contributions to UI and PI. Only employers in hazardous industries were required to make monthly WII contributions. WII generally covered all work-related injuries and occupational illnesses. Prior studies reported the relationship between enrollment in the social security system and health status in China (13). Thus, non-medical insurance could be speculated to have a relationship with health change of the insured.

Empirically, a government-run mandatory insurance program could decrease medical care utilization and expenditures. However, it had little impact on self-reported health status (14). Interestingly, it was confirmed that firm-supported insurance schemes protected employees' health. UI mitigated adverse health effects both at individual and country levels during the financial crisis (15). Clinically, UI programs mitigated cardiovascular disease risk (16). From an examination of social insurance coverage and relative concerns, a positive relationship between PI and subjective well-being was observed for the first time in happiness literature on Chinese rural-to-urban migrants (17).

In China, the WII coverage rate was far lower than expected. A current study found the WII coverage was higher than the national average level but much lower than the average international level (18). The awareness of occupational disease and injury insurance was closely associated with WII coverage. Therefore, it was imperative to popularize knowledge on occupational health and safety for migrant workers as well as to elevate the coverage rate of WII.

Recently, very little of the work on the relationship between social insurance schemes and self-rated health comparison (SRHC) has been focused on employed migrant groups in China. Additionally, this study was enlightened by a prior study. For instance, a study suggested that the community-based health insurance in Burkina Faso substantially reduced the likelihood of catastrophic health expenditure (19). This study aimed to fill in the gap, with publicly available survey data covering social insurance schemes among the employed migrants in urban China.

METHODS

Data Source

Data were from the 2009 Rural-Urban Migration in China (RUMiC) project, which was established to study the patterns and effects of migration in China. It could answer the questions with respect to migration's impact on income mobility, health, and the assimilation of migrant workers into cities.

Main Variables

The dependent variable was SRHC. SRHC was measured by the question: "Compared to people of the same age as you, how is your current state of health?" Degree of health comparison was measured with an ordinal response scale following five response options: excellent, good, fair, poor, and very poor. In the analysis, this study converted the responses from a five-point scale to a two-point scale by combining excellent and good to "better (=1)," and fair, poor, and very poor to "worse (=0)."

There were three schemes of social insurance, including UI, PI, and WII in the questionnaire. UI was reflected by the answer to the question: "Do you have UI?" PI was denoted by the answer to the question: "Do you have PI?" WII was defined by the answer to the question: "Do you have WII?" Their response options to answer these questions were available on a four-point Likert scale: paid by employer, paid by yourself, paid by both employer and yourself, and none. In the analysis, this study converted the responses from a four-point scale to a two-point scale by combining paid by employer, paid by yourself, paid by both employer and yourself to "yes (=1)," and none to "no (=0)."

Regarding marital status, married, remarried, and cohabited status were considered as married status (recoded as 1) and divorced, widowed, and never married considered as single status (recoded as 0).

Main Questions

As reviewed earlier, researchers have correlated social insurance with SRHC. However, it was unclear how schemes of social insurance were associated with SRHC. Thus, the main research questions were below.

Question 1: With regard to financial risk, how was social insurance associated with medical expense?

Question 2: With regard to interactive items of social insurance, how was social insurance associated with SRHC?

Question 3: With regard to health insurance confounders, how was social insurance associated with SRHC?

Statistical Methods

Here, all the statistical work was conducted by STATA S.E. 14.0 (STATA Corp., Inc., College Station, TX). Chi-square tests were performed to assess whether there were significant gender differences in the sample by demographic factors, social insurance schemes, health insurance schemes, and SRHC.

Predictors of participation of social insurance were computed with socioeconomic factors, life style, health status, and health insurance like commercial medical insurance (CMI), public health insurance (PHI), labor insurance (LI), medical insurance covering family members (MICFM), rural cooperatives medical insurance (RCMI), and comprehensive medical insurance (CHMI) with probit models.

Relationship between social insurance and financial risk were computed with multiple probit models. According to literature (20), health expense were defined as "high" if they exceeded 5%

Abbreviations: SRHC, self-rated health comparison; RUMiC, Rural-Urban Migration in China; AOR, adjusted odd ratio; CI, confidence interval; UI, unemployment insurance; PI, pension insurance; WII, work injury insurance; CMI, commercial medical insurance; PHI, public health insurance; LI, labor insurance; MICFM, medical insurance covering family members; RCMI, rural cooperatives medical insurance; CHMI, comprehensive medical insurance.

of the sample average monthly income (abbreviated by INCOME, Unit: Chinese Yuan), and as "catastrophic" if they exceeded 10% of the average monthly income.

The positive health effects of social insurance possibly resulted from participation in health insurance. Thus, the confounding effects of health insurance and interactive effects of social insurance were considered.

Considering confounding factors in a stepwise fashion, the association between social insurance and SRHC was assessed using logistic regression models. The *chest* command in Stata was used to examine confounding effects for total, males, and females separately. The socioeconomic factors, lifestyle, health status, and health insurance were considered as potential confounding variables. When measuring mediating effects, change-in-estimate criterion with a 0.09% cutoff was adopted (21, 22).

Analyzing how the SRHC in the employed migrants was affected by the schemes of social insurance participation with logistic regressions, partial effects in probit models with a triple dummy-variable interaction term could be derived with Stata *inteff3* command (23). Simultaneously, socioeconomic factors, lifestyle, health status, and health insurance were considered as control variables. Here, interactions between the schemes of insurance were adopted to reflect social insurance enrollment portfolio. For convenience, the symbol "×" denoted interactive computation. Thus, interaction terms like UI × PI, UI × WII, WII × PI, and WII × UI × PI could be covariates.

RESULTS

Subjects

The respondents were selected from the 2009 RUMiC project on the basis of migrants in urban China. As seen in **Table 1**, the average age of the sample was 32.53 ($SD = 10.237$, min = 18, max = 72, $n = 7{,}176$). Overall, 4,218 (58.63%) were male, 2,976 (41.37%) were female. Considering insurance, 884 (12.54%, $n = 7{,}051$) were covered by UI; 1,484 (20.95%, $n = 7{,}084$) were covered by PI; and 1,199 (17.03%, $n = 7{,}039$) were covered by WII. Likewise, 5,817 (80.86%, $n = 7{,}194$) reported better SRHC. There were significant gender differences in the case of age, marital status, body mass index (BMI) categories, UI, PI, WII, and LI.

Predicting Participation of Social Insurance

In **Table 2**, gender, CMI, PHI, LI, and CHMI were significantly associated with social insurance. BMI was significantly associated with social insurance. Marital status was significantly associated with PI. Age and physical disabilities were significantly associated with WII and UI. MICFM was significantly associated with WII and PI. This suggested that health insurance schemes would promote the participation possibilities of the schemes of social insurance of the employed migrants. But, age, BMI, and physical disabilities decreased participation possibilities for the social insurance schemes. Males and females differed in the participation in the social insurance schemes. With respect to health insurance, CMI, PHI, LI, and CHMI increased the participation of the schemes of social insurance. The employed migrants with MICFM were more likely to participate in WII

TABLE 1 | Sample characteristics by gender.

Variables	Male		Female		Chi2	*P*-value
	N	%	*N*	%		
Age ($n = 7{,}176$)					34.0493	0.000***
18–29	1,873	26.10	1,381	19.24		
30–39	1,241	17.29	862	12.01		
40–49	773	10.77	589	8.21		
50–	326	4.54	131	1.83		
Marital status ($n = 7{,}192$)					14.0598	0.000***
Single	1,482	20.61	919	12.78		
Married	2,736	38.04	2,055	28.57		
BMI Categories ($n = 7{,}156$)					214.0485	0.000***
Underweight	247	3.45	454	6.34		
Normal	3,129	43.73	2,139	29.89		
Overweight	763	10.66	337	4.71		
Obesity	58	0.81	29	0.41		
Physical disabilities ($n = 7{,}194$)					0.6655	0.415
Yes	160	2.22	102	1.42		
No	4,058	56.41	2,874	39.95		
High expense ($n = 1{,}098$)					0.2837	0.594
Yes	586	53.37	433	39.44		
No	43	3.92	36	3.28		
Catastrophic expense ($n = 1{,}098$)					0.2837	0.594
Yes	586	53.37	433	39.44		
No	43	3.92	36	3.28		
UI ($n = 7{,}051$)					11.7576	0.001***
No	3,567	50.59	2,600	36.87		
Yes	565	8.01	319	4.52		
PI ($n = 7{,}084$)					25.3775	0.000***
No	3,202	45.20	2,398	33.85		
Yes	956	13.50	528	7.45		
WII ($n = 7{,}039$)					64.4566	0.000***
No	3,306	46.97	2,534	36.00		
Yes	829	11.78	370	5.26		
CMI ($n = 7{,}193$)					0.3679	0.544
No	4,042	56.19	2,861	39.77		
Yes	175	2.43	115	1.60		
PHI ($n = 7{,}193$)					2.3122	0.128
No	4,128	57.39	2,928	40.71		
Yes	89	1.24	48	0.67		
LI ($n = 7{,}193$)					12.2432	0.000***
No	3,865	53.73	2,793	38.83		
Yes	352	4.89	183	2.54		
MICFM ($n = 7{,}193$)					0.8081	0.369
No	4,192	58.28	2,963	41.19		
Yes	25	0.35	13	0.18		
RCMI ($n = 7{,}193$)					0.2528	0.615
No	1,783	24.79	1,276	17.74		
Yes	2,434	33.84	1,700	23.63		
CHMI ($n = 7{,}193$)					0.7362	0.391
No	4,170	57.97	2,949	41.00		
Yes	47	0.65	27	0.38		
SRHC ($n = 7{,}194$)					1.8522	0.174
No	785	10.91	592	8.23		
Yes	3,433	47.72	2,384	33.14		

****p < 0.01.*

SRHC, self-rated health comparison; UI, unemployment insurance; PI, pension insurance; WII, work injury insurance; CMI, commercial medical insurance; PHI, public health insurance; LI, labor insurance; MICFM, medical insurance covering family members; RCMI, rural cooperatives medical insurance; CHMI, comprehensive medical insurance.

TABLE 2 | Predictors of participation of social insurance.

	WII	PI	UI
Age	−0.01***	−0.00	−0.01***
	(0.00)	(0.00)	(0.00)
Gender	0.32***	0.14***	0.12***
	(0.04)	(0.04)	(0.04)
Marital status	0.01	0.11**	0.05
	(0.05)	(0.05)	(0.06)
BMI	−0.05***	−0.05***	−0.05***
	(0.00)	(0.00)	(0.00)
Physical disabilities	−0.38***	−0.08	−0.34**
	(0.13)	(0.10)	(0.14)
SRHC	0.02	−0.05	−0.05
	(0.05)	(0.05)	(0.05)
INCOME	−0.00	−0.00	−0.00
	(0.00)	(0.00)	(0.00)
CMI	1.04***	1.46***	1.02***
	(0.09)	(0.10)	(0.09)
PHI	1.29***	1.48***	1.27***
	(0.13)	(0.14)	(0.12)
LI	1.77***	1.96***	1.46***
	(0.07)	(0.08)	(0.07)
MICFM	0.47*	0.60**	0.24
	(0.27)	(0.25)	(0.27)
RCMI	0.06	−0.03	−0.02
	(0.04)	(0.04)	(0.04)
CHMI	1.95***	1.85***	1.72***
	(0.18)	(0.24)	(0.19)
Observations	6,859	6,900	6,868

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

SRHC, self-rated health comparison; UI, unemployment insurance; PI, pension insurance; WII, work injury insurance; CMI, commercial medical insurance; PHI, public health insurance; LI, labor insurance; MICFM, medical insurance covering family members; RCMI, rural cooperatives medical insurance; CHMI, comprehensive medical insurance.

TABLE 3 | Associations between schemes of social insurance and high expense and catastrophic expense.

	High expense			Catastrophic expense		
	Total	Female	Male	Total	Female	Male
Age	−0.01*	−0.01	−0.01	−0.01*	−0.01***	−0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Gender	0.02	−0.84***	−0.62***	0.02	−0.84	−0.62***
	(0.13)	(0.28)	(0.21)	(0.13)	(0.28)	(0.21)
Marital status	−0.65***	0.12***	0.09***	−0.65***	0.12***	0.09***
	(0.17)	(0.02)	(0.01)	(0.17)	(0.02)	(0.01)
BMI	0.10***	−0.87**	0.30	0.10***	−0.87**	0.30
	(0.01)	(0.44)	(0.54)	(0.01)	(0.44)	(0.54)
Physical disabilities	−0.28	0.49	0.14	−0.28	0.49	0.14
	(0.32)	(0.50)	(0.41)	(0.32)	(0.50)	(0.41)
UI	0.17	0.66**	0.03	0.17	0.66**	0.03
	(0.32)	(0.32)	(0.29)	(0.32)	(0.32)	(0.29)
PI	0.30	−0.94*	0.29	0.30	−0.94*	0.29
	(0.23)	(0.50)	(0.33)	(0.23)	(0.50)	(0.33)
WII	−0.12	0.39**	0.61***	−0.12	0.39**	0.61***
	(0.27)	(0.20)	(0.17)	(0.27)	(0.20)	(0.17)
SRHC	0.52***	−0.00	−0.00	0.52***	−0.00	−0.00
	(0.13)	(0.00)	(0.00)	(0.13)	(0.00)	(0.00)
INCOME	−0.00	−0.52	−0.88**	−0.00	−0.52	−0.88**
	(0.00)	(0.37)	(0.35)	(0.00)	(0.37)	(0.35)
CMI	−0.76***			−0.76***		
	(0.25)			(0.25)		
PHI		−0.40	−0.25		−0.40	−0.25
		(0.34)	(0.33)		(0.34)	(0.33)
LI	−0.33		−1.24**	−0.33		−1.24**
	(0.24)		(0.48)	(0.24)		(0.48)
MICFM	−0.92**	−0.10	0.13	−0.92**	−0.10	0.13
	(0.43)	(0.21)	(0.19)	(0.43)	(0.21)	(0.19)
RCMI	0.06			0.06		
	(0.14)			(0.14)		

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

SRHC, self-rated health comparison; UI, unemployment insurance; PI, pension insurance; WII, work injury insurance; CMI, commercial medical insurance; PHI, public health insurance; LI, labor insurance; MICFM, medical insurance covering family members; RCMI, rural cooperatives medical insurance; CHMI, comprehensive medical insurance.

and PI, while the employed migrants with physical disabilities were less likely to participate in WII and UI. Thus, the health insurance schemes could predict the possibilities of participation of the schemes of social insurance.

Different from the early studies that health status might contribute to the participation of social health insurance (24) and the enrollment choice of the community-based health insurance scheme (25), this study found SRHC was not the predictor of participation of social insurance.

Associations Between Social Insurance and Financial Risk

In **Table 3**, UI raised the probabilities of "high" and "catastrophic" medical expenses by 0.66% in the female sample. PI reduced the probabilities of "high" and "catastrophic" medical expenses by 0.94% in the female sample. WII raised the probabilities of high and catastrophic medical expense by 0.39% and 0.61% in female and male sample, respectively.

In the total sample, age was negatively associated with an increase in high expense in the total sample and catastrophic expense in the total and female samples. Gender was negatively associated with an increase in high expense in the female and male samples and catastrophic expense in the male sample. Marital status was negatively associated with an increase in high and catastrophic expense in the total sample and positively associated with an increase in high and catastrophic expense in the female and male samples. However, BMI was positively associated with an increase in high and catastrophic expense in the total sample and negatively associated with an increase in high and catastrophic expense in the female sample. There was no significant effect of health insurance on the probabilities of incurring high and catastrophic health expenses in the total, female, or male samples.

Among the schemes of health insurance, there were negatively significant effects of CMI and MICFM on the probabilities of incurring high and catastrophic health expenses in the total sample. Similarly, LI was negatively associated with an increase in high and catastrophic expense in the male sample. There were no significant effects of PHI or RCMI on the probabilities

TABLE 4 | Change-in-estimate for UI with possible confounding factors.

	OR	95% CI	Change, %
Adj.All	0.8698	0.6458–1.1714	
–MICFM	0.8697	0.6458–1.1711	0.0161
–CMI	0.8690	0.6452–1.1704	0.0740
–BMI	0.8698	0.6459–1.1713	0.0859
–RCMI	0.8708	0.6465–1.1730	0.1225
–Average monthly income	0.8696	0.6455–1.1715	0.1412
–Physical disabilities	0.8674	0.6440–1.1683	0.2530
–CHMI	0.8698	0.6456–1.1718	0.2806
–Gender	0.8669	0.6435–1.1679	0.3318
–Marital status	0.8693	0.6465–1.1689	0.2750
–LI	0.8616	0.6406–1.1588	0.8881
–PHI	0.8687	0.6468–1.1666	0.8191
–PI	0.8936	0.6821–1.1707	2.8722
–Age	0.8944	0.6866–1.1651	0.0898
–WII	1.2270	1.0106–1.4899	37.1900

TABLE 5 | Change-in-estimate for PI with possible confounding factors.

	OR	95% CI	Change, %
Adj.All	1.0859	0.8450–1.3955	
–Gender	1.0857	0.8448–1.3952	0.0207
–MICFM	1.0860	0.8454–1.3951	0.0300
–BMI	1.0864	0.8458–1.3954	0.0328
–RCMI	1.0875	0.8465–1.3971	0.1060
–CHMI	1.0903	0.8485–1.4010	0.2586
–Physical disabilities	1.0930	0.8508–1.4042	0.2479
–Average monthly income	1.0977	0.8550–1.4093	0.4253
–CMI	1.0916	0.8545–1.3945	0.5555
–Marital status	1.0813	0.8473–1.3799	0.9407
–PHI	1.1100	0.8723–1.4125	2.6531
–UI	1.0735	0.8606–1.3390	3.2900
–LI	1.0244	0.8282–1.2670	4.5737
–Age	0.9660	0.7809–1.1949	5.7026
–WII	1.2016	1.0282–1.4042	24.3918

of incurring high and catastrophic health expenses in the total, female, or male samples.

Association Between Social Insurance and SRHC Regarding Health Insurance

Table 4 showed that the change-in-estimate of BMI, MICFM, and CMI were lower than the 0.09% cutoff criterion, which indicated they were covariates. However, the change-in-estimate of RCMI, INCOME, physical disabilities, CHMI, gender, marital status, LI, PHI, PI, and WII were higher than the 0.12% cutoff criterion, which indicated they were potential confounding variables.

Table 5 showed that the change-in-estimate of gender, BMI, and MICFM were lower than the 0.09% cutoff criterion, which indicated they were covariates. However, the change-in-estimate of RCMI, CHMI, physical disabilities, INCOME, CMI, marital status, PHI, UI, LI, age, and WII were higher than the 0.11% cutoff criterion, which indicated they were potential confounding variables.

Table 6 showed that the change-in-estimate of INCOME, MICFM, and CMI were lower than the 0.09% cutoff criterion, which indicated they were covariates. However, the change-in-estimate of BMI, CHMI, RCMI, physical disabilities, marital status, PHI, gender, LI, PI, UI, and age were higher than the 0.12% cutoff criterion, which indicated they were potential confounding variables.

In **Table 7**, controlling for RCMI, INCOME, physical disabilities, CHMI, gender, marital status, LI, PHI, PI, and WII, UI was significantly associated with SRHC (OR = 1.24, 95%CI: 1.02–1.51). Controlling for RCMI, CHMI, physical disabilities, INCOME, CMI, marital status, PHI, UI, LI, age, and WII, PI was significantly associated with SRHC (OR = 1.24, 95%CI: 1.07–1.45). Controlling for BMI, CHMI, RCMI, physical disabilities, marital status, PHI, gender, LI, PI, UI, and age, WII was significantly associated with SRHC (OR = 1.72, 95%CI: 1.19–2.48). In model 1, the aged migrants tended to be with worse health status. Moreover, the health effect appeared to be stronger for the employed migrants with higher BMI and those with more expenses than their counterparts.

TABLE 6 | Change-in-estimate for WII with possible confounding factors.

	OR	95% CI	Change, %
Adj.All	1.3645	1.0363–1.7965	
–MICFM	1.3646	1.0366–1.7965	0.0105
–Average monthly income	1.3645	1.0361–1.7970	0.0108
–CMI	1.3636	1.0351–1.7965	0.0620
–BMI	1.3609	1.0331–1.7926	0.2024
–CHMI	1.3637	1.0367–1.7938	0.2054
–RCMI	1.3588	1.0330–1.7873	0.3583
–Physical disabilities	1.3493	1.0264–1.7737	0.6996
–Marital status	1.3591	1.0364–1.7824	0.7315
–PHI	1.3703	1.0466–1.7942	0.8243
–Gender	1.3874	1.0609–1.8142	1.2427
–LI	1.3391	1.0259–1.7479	3.4805
–PI	1.3776	1.0799–1.7574	2.8756
–UI	1.2817	1.0739–1.5296	6.9642
–Age	1.3840	1.1614–1.6493	7.9840

Association Between Interactions Between Schemes of Social Insurance and SRHC

In **Table 8**, the effect of the variable WII showed that the probability of WII to have better health status was about 4.2% points higher than that not covered by WII.

Among the female sample, the interaction effect −0.182 of PI and WII (PI×WII) meant that (1) the PI difference was 18.2% points higher for average individuals with WII compared with similar individuals without WII, or that (2) the negative effect of WII participation was 18.2% points higher for individuals with PI than it was for individuals without PI.

TABLE 7 | SRHC for social insurance without confounders, OR (95%CI).

	Model 1	Model 2	Model 3
UI	Ref.=No		
Yes	1.24** (1.02–1.51)		
PI		Ref.=No	
Yes		1.24*** (1.07–1.45)	
WII			Ref.=No
Yes			1.72*** (1.19–2.48)
Age	0.97*** (0.97–0.98)		
Gender		Ref.=Female	
Male		1.09 (0.97–1.23)	
BMI	1.11*** (1.10–1.12)	1.06*** (1.06–1.07)	
High expense			Ref.=No
Yes			1.45*** (1.26–1.66)
MICFM	Ref.=No	Ref.=No	Ref.=No
Yes	1.26 (0.51–3.12)	1.26 (0.52–3.08)	1.57 (0.46–5.36)
CMI	Ref.=No		Ref.=No
Yes	1.06 (0.77–1.48)		1.39 (0.78–2.47)

$^{**}p < 0.05$, $^{***}p < 0.01$.

SRHC, self-rated health comparison; UI, unemployment insurance; PI, pension insurance; WII, work injury insurance; CMI, commercial medical insurance; MICFM, medical insurance covering family members.

TABLE 8 | Association between social insurance portfolio and SRHC.

	Total	Female	Male
UI	−0.030	0.023	−0.093
	(0.052)	(0.073)	(0.079)
PI	0.008	0.035	0.000
	(0.019)	(0.029)	(0.025)
WII	0.042*	−0.013	0.071**
	(0.024)	(0.053)	(0.027)
UI×PI	0.082	−0.007	0.190
	(0.078)	(0.107)	(0.118)
UI×WII	−0.162*	−0.417**	−0.016
	(0.096)	(0.181)	(0.127)
PI×WII	0.023	0.182**	−0.042
	(0.040)	(0.080)	(0.048)
UI×PI×WII	0.113	0.334	−0.062
	(0.136)	(0.227)	(0.185)

$^{*}p < 0.1$, $^{**}p < 0.05$.

SRHC, self-rated health comparison; UI, unemployment insurance; PI, pension insurance; WII, work injury insurance.

Among the total sample, the effect for UI×WII showed that (1) for the employed migrants with WII, the UI difference was 16.2% points lower than for the employed migrants without WII, or (2) for the employed migrants with UI, the negative effect of WII on SRHC was 16.2% points lower than it was for the employed migrants without UI.

Among the female sample, the effect for UI×WII showed that (1) for the employed migrants with WII, the UI difference was 41.7% points smaller than for the employed migrants without WII, or (2) for the employed migrants with UI, the negative effect of WII on SRHC was 41.7% points lower than it was for the employed migrants without UI.

The insignificant effect of UI×PI×WII implied that (1) the effect of UI on PI did not seem to depend on WII, (2) the effect of UI on WII did not seem to depend on PI, or (3) the effect of PI on WII did not seem to depend on UI.

DISCUSSION

To my knowledge, this was the first study to report the relationship between social insurance schemes and SRHC among employed migrants in urban China. Considering participation of the social insurance schemes, besides socio-demographic and lifestyle variables, health insurance schemes contributed significantly. Regarding financial risk, UI and WII could increase medical expenditure while PI could decrease the medical expense. Controlling for the schemes of health insurance, social insurance schemes were associated with SRHC. In the terms of interactive effects, two schemes of social insurance interaction terms had marginal effects at the means of probit estimation.

The results in this study were in line with an early study. The socioeconomic factors influenced the participation of rural migrant workers in social insurance systems. However, the relative importance of these factors in participation in social insurance was differentiated by gender (26). Also, the AORs of the UI×WII were less than the AORs of PI×WII. This suggested that PI would shorten the health contribution of social insurance schemes.

Although two studies confirmed health insurance could reduce medical expenditures (27–31), this study was not in line with the prior study regarding the role of health insurance in China. For example, an analysis concluded NCMS had failed to prevent catastrophic health expenditure and medical impoverishment (32) and could not lead to better self-assessed general health status in rural China (33). Using data from the 2015 China Migrants Dynamic Survey, it was observed that participation in the health insurance system significantly improved floating seniors' self-rated health (34). This could be partly explained by an early study that a small percentage of households with health insurance coverage were unable to self-finance out-of-pocket medical cost, particularly for inpatient treatments and/or chronic diseases in China (35).

The interaction analysis possibly implied that the social insurance system played an important role in participants' health improvement. This was congruent with several studies that attached importance to social insurance officers (36, 37). Individual health improvement of the insured workers might also be negatively affected by information exchange with social insurance physicians and occupational physicians (38), insurance underutilization (39), poor personal contact with social insurance officers and health care professionals (40), and low use of evidence-based medicine and clinical practice guidelines in insurance medicine (41). Another study showed that the interaction with the social insurance agency and health care could be considered as an important part of the rehabilitation process (42). A current study that used data from the 2014 National Internal Migrant Dynamic Monitoring

Survey confirmed the positive financial protection effect of social health insurance among rural-to-urban internal migrants in China (43).

Here, there was little likelihood that the majority of migrant workers who moved to cities were able to access the social insurance benefits traditionally available to those with urban household registration. This result was in line with the early result that the migrants, the poor and the vulnerable remained in the edge of the public, private and multiple insurance coverage system (44). It could be explained in the case of socioeconomic factors in Jiangsu Survey Data (45), exclusion from urban residents (46), employers' attitudes toward social insurance compliance (47), and large disparities between firm ownership sectors in social insurance participation and generosity (48). Also, migrants' limited access to health insurance owed more to their reluctance than to system exclusions (49). However, the results in this study provided new insights.

This study presented the idea of interaction effect of social insurance among the employed migrants. This judgment was congruent with another early study. In fact, possibly due to the lack of systematic financing schemes, medical insurance programs were not effective in alleviating the financial burden of healthcare and promoting formal medical utilization among migrant workers (50). Another example showed that the disharmonized social insurance systems caused insured clients to wait unnecessarily in Sweden (51). Thus, the existence of the interaction effect and order of enrollment in insurance schemes could help the employed save economic cost.

LIMITATIONS AND STRENGTHS

This study had two main limitations. First, dynamic benefits of combinations of insurance schemes could not be reflected in a cross-sectional data. Second, subjective assessments among the employed migrants necessarily need support from objective criteria.

The strength of this study was that advanced statistical methods were adopted through reducing confounding effects of health insurance to explore the associations between social insurance and SRHC.

FUTURE RESEARCH

This study could not reveal why socio-demographic factors statistically reduced the contribution of insurance schemes to SRHC among employed migrants. Further exploration should focus on the moderating and mediating effects of socioeconomic factors on the change of health status among employed migrants.

CONCLUSION

In conclusion, SRHC of employed migrants in urban China was found to be affected by social insurance. This study also confirmed that the effects of social insurance on SRHC were mediated by the health insurance of employed migrants. This study still highlighted the interaction effect in social insurance schemes for the employed migrants. These findings suggested that individuals might choose to optimize insurance schemes in order to obtain optimal health status. This study also provided implications on reforming China's social insurance system.

DATA AVAILABILITY

The dataset 2009 RUMiC project for this study can be found in the Institute for the Study of Labor [http://idsc.iza.org/rumic].

AUTHOR CONTRIBUTIONS

MG conceived the study, performed statistical analyses, drafted the manuscript, read, and approved the final manuscript.

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Characteristics and Effects of Multiple and Mixed Funding Flows to Public Healthcare Facilities on Financing Outcomes: A Case Study From Nigeria

Obinna Onwujekwe[1,2], Chinyere Mbachu[1,3,4], Uche Ezenwaka[1], Ifeyinwa Arize[1,2] and Nkoli Ezumah[1]*

[1] *Health Policy Research Group, Department of Pharmacology and Therapeutics, College of Medicine, University of Nigeria Enugu Campus, Enugu, Nigeria,* [2] *Department of Health Administration and Management, College of Medicine, University of Nigeria Enugu Campus, Enugu, Nigeria,* [3] *Department of Community Medicine, College of Medicine, University of Nigeria Enugu Campus, Enugu, Nigeria,* [4] *Institute of Public Health, College of Medicine, University of Nigeria Enugu Campus, Enugu, Nigeria*

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Edited by:
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****Correspondence:***
Obinna Onwujekwe
obinna.onwujekwe@unn.edu.ng

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Introduction: Most public hospitals in Nigeria are usually financed by funding flows from different health financing mechanisms, which could potentially trigger different provider behaviors that can affect the health system goals of efficiency, equity, and quality of care. The study examined how healthcare providers respond to multiple funding flows and the implications of such flows for achieving equity, efficiency, and quality.

Methods: A cross-sectional qualitative study of selected healthcare providers and purchasers in Enugu state was used. Four public hospitals were selected—two tertiary and two secondary; because they received funding from more than one healthcare financing mechanism. Key informants were individual healthcare providers and decision-makers in the hospitals, State Ministry of Health, National Health Insurance Scheme and Health Maintenance Organizations. Service users from each hospital were purposively selected for focus group discussions (FGDs). A total of 66 key informant interviews and 8 FGDs were conducted.

Findings: The multiple flows that were received by public hospitals varied by type of health facility (Secondary vs. Tertiary), ownership of health facility (Federal government vs. State government) and population served. Out-of-pocket payment (OOP) and government budget were the only recurring forms of funding to all the public hospitals. It was found that multiple funding flows, generate different signals to service providers, resulting in positive and negative consequences. The results also showed that multiple flows lead to predictability and stability of funding to public hospitals. Hospital Managers and administrators reported that multiple flows increased their financial pool and capacity to undertake capital projects and enabled the provision of a wider range of services to clients. Multiple sources of funding also give a sense of security to health facilities, because there would always be a back-up source of funding if one flow delays or defaults in payment. Nevertheless, health providers were seen to shift resources from less

attractive to more attractive flows in response to the relative size perceived adequacy, predictability, and flexibility of funding flow. Patients were also shifted from less predictable to more predictable funding flows and providers charged different rates to different funding flows to make up for the inadequacies in some sources of funding. The negative consequences of multiple funding flows on provider behavior that was reported in the study were wastage/under-utilization of resources, differential quality of care provided to clients, and inequities in resource distribution and access to health services. In some instances, providers' responses resulted in better quality of care for clients and improved access to services that were not ordinarily available or clients could not have been afforded.

Conclusion: Multiple funding flows to public hospitals are beneficial as well as constraining to health providers. They can be beneficial in ensuring that hospitals have a ready and predictable pool of funds to render services with. However, they could be detrimental to some patients that could be charged more for some services that other patients pay less and may also lead of provision of differential quality of services to different payments depending on the funding flows that are used to purchase services for them. Ultimately, some of the consequences of multiple funding flows if not properly managed, will affect health systems goals of equity, efficiency and quality of care, either positively or negatively.

Keywords: multiple funding flows, public hospitals, provider behaviors, health financing, Nigeria

INTRODUCTION

Health system financing mechanisms are critical in ensuring Universal Health Coverage as they determine the availability, affordability, and acceptability of health services to the people (1). Health system financing functions include mobilizing revenues, pooling resources and purchasing services (1, 2). Evidence from all over the world suggests that equity and access are greater when healthcare is funded through taxation or social health insurance than when funded from private health insurance (PHI) or Out-Of-Pocket payments (3, 4). Purchasing is the health financing function through which pooled funds are transferred to health care providers (5).

Purchasing is a core function of health care financing that involves the transfer of pooled resources to healthcare providers in exchange for healthcare services (6) and it is high on the health financing agenda as it is critical in achieving universal health coverage (7). Purchasing entails that purchasers act as agents for the people in the purchase of healthcare services (7). To fulfill this role effectively, it is important for purchasers needs to ensure that there are effective mechanisms in place to determine people's needs, preferences, and values in purchasing decisions and to hold themselves accountable to the population for which they are responsible (7).

All the states in Nigeria rely on a mixture of government budget (from general tax revenue), health insurance (social and private), external funding (donor funding), and private out-of-pocket spending to finance health care (8). In Nigeria, public funding accounts for about 25% of total health spending while the private sector provides 75% of the funding, with household out-of-pocket expenditure accounting for 95% of the private sector expenditure (9). However, the sources of funding to healthcare service providers in Nigeria vary at different levels of health facilities and in different states.

The federal, state and local government areas provide budgets from general tax revenue to the Federal Ministry of Health (FMOH), State Ministries of Health (SMOH), and Local Government Areas' (LGA) health authorities (LGAHA), respectively, who then act as purchasing organizations using budget flows, respectively, at the three tiers of government to allocate budgets for providers at health facilities (7). The FMOH, SMoH, and LGAHA also define a minimum package of health care services which covers promotion, preventive, and curative care at primary and secondary care levels, and includes services for communicable and non-communicable diseases, child survival, safe motherhood, nutrition, health education, laboratory services and community mobilization (10). The FMOH, SMoH, and LGA pay salaries of public servants.

Another existing major health financing mechanism in Nigeria is the Formal sector health insurance Programme (FSSHIP), which is run by the National Health Insurance Scheme (NHIS). It is a mandatory scheme for employees in the formal sector (11). The NHIS contracts private, for-profit Health Maintenance Organizations (HMOs) to administer the purchasing system and channel resources to providers. Healthcare providers receive capitation payments for primary healthcare services and fee-for-service for secondary services (6). A mix of NHIS-accredited public and private health care providers are contracted to deliver services a standard benefit package. FSSHIP enrollees are allocated to specific HMOs, but

can choose their primary health care providers from an NHIS accredited provider list (7).

Figure 1 illustrates the multiple funding flows to healthcare providers in Nigeria. It shows that many healthcare providers in Nigeria receive funding flows from different health financing mechanisms. These include budgets, health insurance, out-of-pocket payments, donor funding, and others. A funding flow refers to any transfer of funds, in cash or kind, from a purchaser to a healthcare provider that is characterized by a distinct combination of arrangements (12). Each funding flow is characterized by different payment mechanism, provider payment rates, contractual agreement, reporting requirement, decision space, and accountability mechanisms.

Purchasing for health in Nigeria is undertaken by government at all levels through the Ministries of Health and LGAHA, the National Health Insurance Scheme (NHIS), the National Primary Healthcare Development Agency (NPHCDA), HMOs, PHI, Community based health insurance (CBHI), development partners, non-governmental organizations (NGO), and households. The purchasers transfer funds to healthcare providers for the provision of services.

Economic theory suggests that different payment mechanisms can produce different behaviors on the part of providers that can affect efficiency, equity and quality of care (13). The design and implementation of parallel funding flows are likely to impact on the financial resilience of healthcare providers and create signals to which providers respond in both intended and unintended ways. Parallel mechanisms, unless designed as part of an integrated system, can undermine the ability of purchasers to undertake strategic purchasing. The report of the RESYST multi-country study on strategic purchasing found that where multiple purchasing mechanisms operate within a health system, it is important to understand the signals sent by each mechanism and funding flow and determine how these together influence the behaviors of healthcare providers (5).

It is important to understand the signals sent by each mechanism and funding flow, and determine how these together influence the behavior of healthcare providers. The signals sent to providers by a mix of funding flows are likely to be shaped by their relative size, provider payment mechanisms, provider payment rates, the services purchased, the population covered, levels of supervision, accountability requirements, and interactions between all of these factors.

Parallel mechanisms, unless designed as part of an integrated system, can undermine the ability of purchasers to undertake strategic purchasing. Multiple funding flows are also associated with different levels of decision space and, in some cases, the possibility of cross-subsidization between purchasers and individuals (5, 14). The existence of multiple funding flows could aide or bring about improvements in health financing. However, previous studies have always focused on influence of a single funding flow or purchaser without considering the combined effects of multiple funds to health facilities (5, 15).

The study aimed to examine how healthcare providers respond to multiple funding flows and the implications of such flows for achieving the health systems goals of efficiency, quality, financial protection, equity, and resilience. It identified the different flows of funds to healthcare providers and characterized each funding flow by their inherent attributes. It also practically examined some theoretical provider responses to multiple funding flows and how the flows affect the health systems goals.

CONCEPTUAL FRAMEWORK

This study analyzed how multiple funding flows send signals that influence behavior of healthcare providers and the implications of these behaviors on health systems goals of efficiency, equity, and quality. Healthcare provider is used in this study to refer to organizations that provide healthcare services (e.g., hospitals), rather than individual healthcare workers working in these organizations or independently (e.g., doctors). A funding flow refers to any transfer of funds, in cash or kind, from a purchaser to a healthcare provider that is characterized by a distinct combination of arrangements.

Individual funding flows will have their own attributes/characteristics and incentives, which include: duplication or gaps in service coverage across multiple funding flows; contribution of each funding flow as a share of total; adequacy of funding flow to cover the costs of services purchased; flexibility that healthcare providers have over funding flow; accountability mechanisms; predictability; performance requirements; and inherent incentives generated by the provider payment mechanisms. The presence of multiple funding flows creates an additional layer of response defined by the relativeness of these attributes across funding flows. The interaction of these characteristics across funding flows could generate any of three behavioral responses among providers, namely: (i) shifting costs between different funding mechanisms; (ii) shifting patients between funding flows; and (iii) shifting resources from less attractive to more attractive flows (**Figure 2**).

Each of these provider responses occurs when healthcare providers value or prefer one funding flow over another due to a higher rate of financial return, or to other characteristics of the funding flow. It is also possible that there are positive consequences of multiple funding flows—for example, opportunities to cross-subsidize patients with lower financial capacity, enabling equity; or covering deficits in one funding flow through another, covering gaps in services, or shifting resources to more cost-effective services. The operational definitions are provided in **Table 1**.

METHODS

Study Sites and Design

It was a mixed-method cross-sectional study of selected healthcare providers and purchasers in Enugu state. The healthcare providers were the unit of analysis. Four public hospitals were purposively selected (2 tertiary and 2 secondary) on the bases that in addition to health insurance payments, they received funding from more than one healthcare financing mechanism. Out of the four public tertiary hospitals in Enugu state that received multiple flows, we selected the two biggest tertiary hospitals that were in the state and the secondary facilities that were affiliated to the two tertiary hospitals as their training

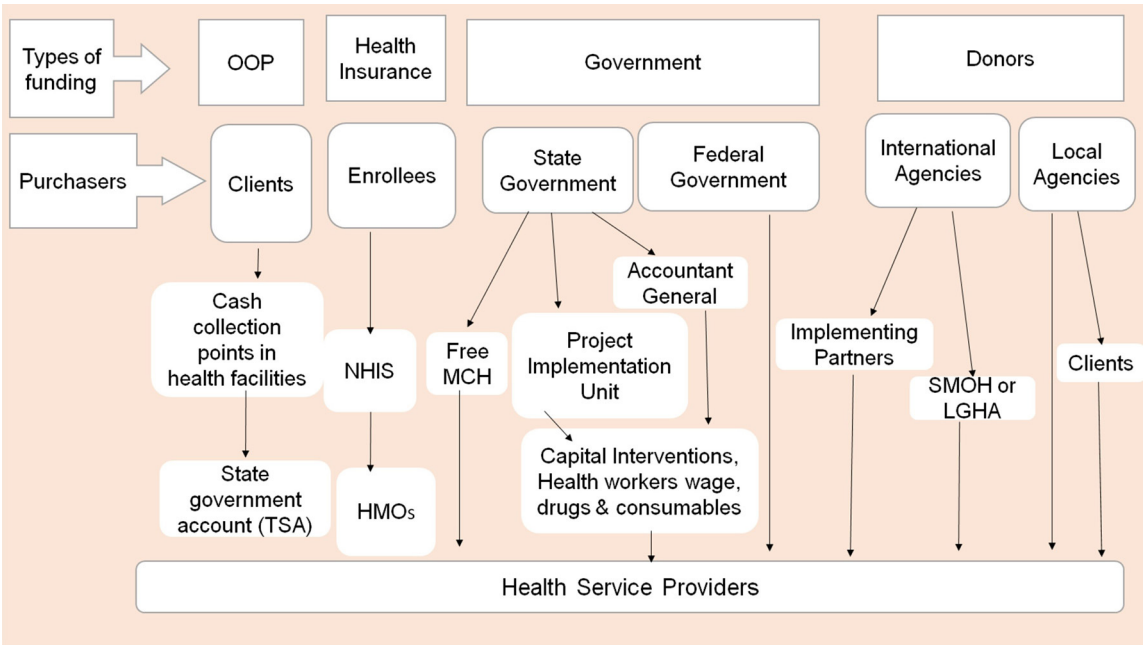

FIGURE 1 | Different funding flows to health providers in Nigeria.

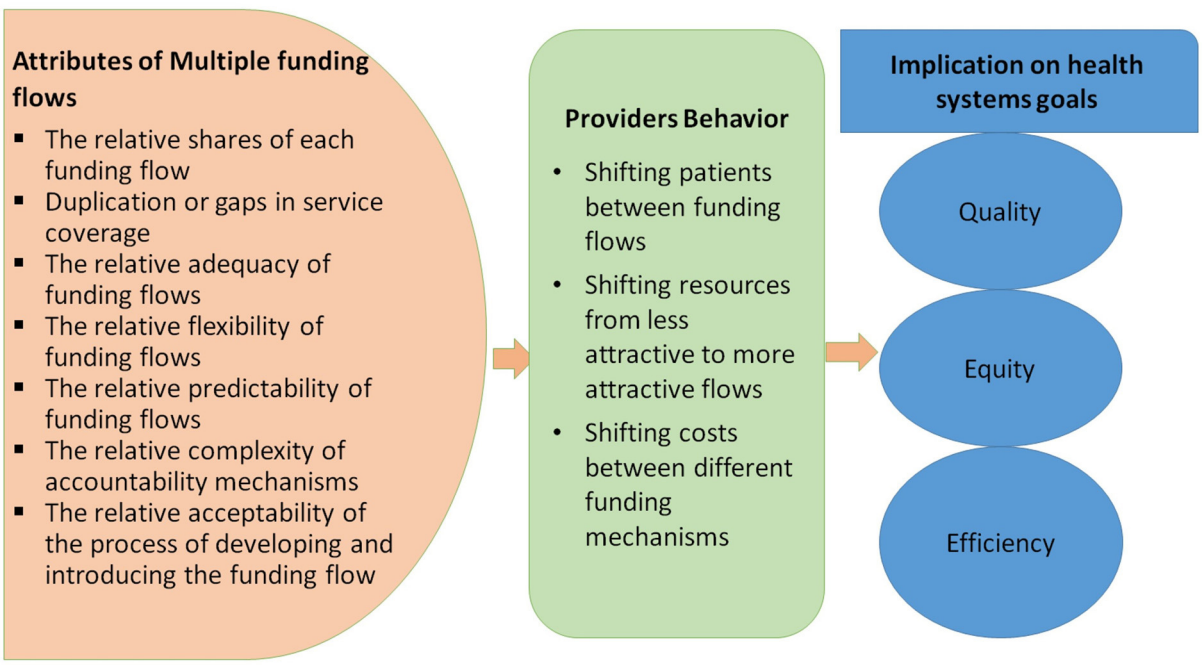

FIGURE 2 | Conceptual framework for provider behavior to multiple funding flows in public health facilities.

outposts. Hence, we selected the University of Nigeria Teaching Hospital (UNTH) and Enugu State University Teaching Hospital (ESUTH). The secondary hospitals were Enugu State University Medical Center (ESUT Agbani) and Comprehensive Health Center, Obukpa (CHC Obukpa). UNTH and CHC Obukpa belong to the federal government, whilst ESUTH and ESUT are owned by the Enugu state government. The study was part of a multi-country study that was undertaken by the Responsive and Resilient Health Systems Consortium (RESYST), which had no impact on the data collection and findings from the study.

TABLE 1 | Operational definitions of provider behavior to multiple funding flows.

Behavior	Definition
Resource shifting	Resources (staff time, attention, beds, materials, equipment) moved to a more attractive funding flow
Patient shifting	Patients relocated from less profitable to more profitable funding flows/payment methods. This can also include situations where patients/services are shifted outside the facility, resulting in unnecessary admissions, treatments or charges
Cost shifting	Providers charge different rates to different purchasers for the same service. Providers charge more services to purchasers with higher payment rates or more attractive payment features than they do to other providers. One purchaser can be considered as overpaying while the other considered as underpaying (shifting the expected burden of costs). Cost shifting may also occur as over-billing to purchasers or individuals
Extra-billing	This means provision of additional services, not necessarily medically justified, to more generous purchasers
Service shifting/Patient transfer	A situation whereby a patient is transferred outside the facility for reasons that are not medically justified; horizontal referral (to another facility, e.g., private sector) or vertical referral (to a higher level facility)
Over-treatment	A provider decides to over-treat a patient to generate additional resources (over-prescription, unnecessary admission, DRG creep, etc.)
Patient selection	Providers give priority to patients with financially more attractive remuneration rates (patients with higher remuneration rates or patients that are less costly to be treated)

TABLE 2 | The coding scheme used in data analysis.

Purchasers	Service providers	Service users
Selection of health care providers	Sources of funding	Health service need and utilization in last 1–2 years
Provider payment methods and rates	Funding flows	Membership of health insurance scheme
Size of funding in past 3 years	Size of funding (how does it influence service delivery)	Non-membership of health insurance scheme
Contractual agreements with health providers	Duplication and gaps in service coverage of funding flows	
Relative adequacy of funding for services covered Relative flexibility of different funding flows		Care experience in health facility
Relative complexity of accountability mechanisms for different funding flows		Fairness in health service provision/delivery
Relative acceptability of process of development and introduction of funding sources and mechanisms		
Relative predictability of funding sources		Recommendations for improvement in equity, quality and efficiency
Conflicting incentives as a result of multiple funding flows		
Other experiences/benefits/challenges of having multiple sources of funding		
Shifting costs between different funding mechanisms Shifting patients between funding flows Shifting resources from less attractive to more attractive flows		
• Nature of … (type of …., how does it happen and to what extent?) • For whom/what … (patient groups/services) • Why does it occur (related attributes of funding flows) • Implications on health systems goals of quality, equity, and efficiency		

Sampling

Key informants were purposively selected among hospital managers, administrators, and frontline health workers, as well as relevant officials from State Ministry of Health (SMoH), State Health Board (SHB), National Health Insurance Scheme (NHIS), and HMOs. The respondents were purposively selected based on the key consideration of people that will be able to provide the requisite information. Service users from each hospital were also purposively selected for focus group discussions (FGDs), to represent the range of funding flows in that hospital. A total of 66 key informant interviews (KII) and 8 FGDs were conducted. The FGDs comprised of 6–8 participants and were disaggregated by gender category (male and female). The service users were stratified by gender in the FGD to ensure that the opinions of the females were heard, otherwise the males will dominate the discussions as happens in the study context.

Data Collection and Analysis

Primary data was collected through qualitative and quantitative methods. Key informant interviews (KIIs) and FGDs were conducted using pre-tested topic guides. Information on hospital characteristics and size of funding flows was collected using a structured checklist.

The interviews and FGDs were conducted by a team of trained researchers. All interviews were audio-recorded and lasted an average of 60 min. The FGDs were conducted in the local language (Igbo language) and translated into English. All audio recordings were transcribed verbatim and notes taken during the interviews were appended to the transcripts. The interviews were conducted between November and December 2017.

All transcripts were anonymised with pseudonyms. Deductive analysis of transcripts followed a rigorous process that started with familiarization of the transcripts to identify recurrent/common themes; generation of a provisional list of codes that were based on the research objectives, topic guide questions, and recurrent themes; testing of the provisional coding scheme; revision of the coding scheme and application to the rest of the transcripts. Coded data were sorted and relationships between participant categories and their perceptions/experiences explored. Coding was guided by including and comparing coded elements, leading to the identification of patterns and explanations.

Three different coding schemes were generated for the three categories of respondents namely, purchasers, service providers and service users. The final codes that were used in analysis are presented in **Table 2**.

Ethical Considerations

Ethical approval was obtained from the Health Research Ethics Committee of University of Nigeria Teaching Hospital Ituku-Ozalla, Enugu State, Nigeria. Written consent was obtained from

each participant before the interview. Participants were provided with an information sheet that contained a brief description of the purpose of the study, their rights as participants and measures that will be taken by the research team to ensure confidentiality of information given.

FINDINGS

Characteristics of Participants and Study Sites

Table 3 shows the category of key informants and FGD participants. In the KII, there were 66 respondents, of which 51.5% of them were females. Majority of the respondents (53.0%) were frontline health workers (Doctors, Nurses, Pharmacists, Laboratory scientists, CHEWs), 22.7% were purchasers and hospital managers/administrators were 13.6%. In the FGDs, there was an equal number of male and female participants. Thirty-two percent of the participants were petty trader/businessman, 28.8% were students while 11.5% were either retirees or pensioners.

Mapping of Funding Flows to Public Hospitals in Enugu

The data shows that funding flows to the public hospitals surveyed were multiple and varied by type of health facility (Secondary vs. Tertiary), ownership of health facility (Federal government vs. State government) and population served. **Table 5** highlights respondents' reports of the various forms of funding to the hospitals. OOP and government budget were the only recurring forms of funding for all the public hospitals. The other common forms of funding were social health insurance and donations from development partners and voluntary agencies. Other sources of funding were PHI which was only available to tertiary hospitals and the drug-revolving fund which was only available to Federal government-owned hospitals.

The findings showed that the major sources of funding for both inpatient and outpatient services in both the state and federal government-owned health facilities, tare OOP, the NHIS and government budget. Donations are also used to fund some of the services to a lesser extent. The mechanism through which NHIS and government funds flowed from purchasers to providers varied for State-owned and Federal-owned public hospitals. NHIS payments from HMOs to State government health providers for capitation are first made into the centralized government account and then transferred to the hospitals. However, for fee-for-service payments from the NHIS, which is another funding flow, the funds are transferred directly to the hospitals by the HMOs after verifying the claims. Whereas, for Federal government-owned health providers, it is paid directly to hospital accounts. With respect to the o government budget, there were three purchasers for State-government hospitals namely, State Ministry of Health, Project Implementation Unit and State Ministry of Finance. Whereas, for Federal government-owned hospitals, the Federal Ministry of Health was the only government purchaser.

TABLE 3 | Characteristics of participants.

Key informants Variable	No of participants	Percentage
Gender		
Male	32	48.5
Female	34	51.5
Roles		
Purchaser	15	22.7
Legislator	1	1.5
Hospital managers/administrators	6	3.96
Medical records/Accounts clerk/Medical Stores	9	13.6
Frontline health workers (Doctors, Nurses, Pharmacists, Laboratory scientists, CHEWs)	35	53.0
Total	66	100
FGD participants (service users)		
Gender		
Male	26	50
Female	26	50
Source of funding		
Direct OOP	34	65.4
NHIS (FSSHIP,TISHIP)	18	34.6
Occupation		
Petty trader/business man	17	32.7
Student	15	28.8
Retiree/pensioner	6	11.5
Civil/public servant	5	9.6
Artisans	2	3.8
Farmer	2	3.8
Un-employee	1	1.9
Other (Sales girl, cleaner, Security guard)	4	7.7
Total	**52**	**100**

A summary of the characteristics of each hospital in terms of the number of outpatients, number of in-patients, and numbers of bed spaces (expected and observed) is shown in ***Table 4****.*

Each of the major funding flows to the four public hospitals is described in terms of services covered, target population, provider payment mechanisms and accountability mechanisms (**Table 6**).

Characteristics of Major Funding Flows to Public Hospitals

The attributes or characteristics of each major funding flow is described in relation to other funding flows. Evidence from one of the tertiary hospitals shows that government funding for personnel cost contributes the largest share to overall hospital funds (63.1%). This is followed by OOP (17.9%), government funds for overhead (15.3%) and NHIS capitation (2.0%). Others are government funds for capital (1.4%) and NHIS-fee for service (0.3%). Details of other attributes of funding flows are presented in **Table 7**.

TABLE 4 | Characteristics of study facilities.

Characteristics of study facility	UNTH		ESUTH		ESUT Agbani		CHC Obukpa	
	2016	2017	2016	2017	2016	2017	2016	2017
Total number of Outpatient visits	164,089	137,787	27,531	30,031	2,879	2481	2,091	1,590
Total number of Inpatient admissions	7,399	5,957	8,094	8,084	431	590	284	250
Number of bed spaces that the hospital has	500	500	337	337	10	10	30	30
Number of beds (actual)	435	435	320	320	10	10	30	30

TABLE 5 | Variation in major forms of funding to public hospitals.

Facility name	Facility type	Ownership	Population served	Major forms of funding			
				Government budget	Out of pocket payment	NHIS	Donations
UNTH	Tertiary	Federal	General population				
ESUTH	Tertiary	State	General population				
ESUT Medical Center	Secondary	State	Staff and students				
CHC Obukpa	Secondary	Federal	Rural community				

Key.
Yes.
No.

Providers' Behaviors to Attributes of Multiple Funding Flows

Table 8 shows that the relative attributes/characteristics of multiple funding flows to public hospitals send signals to providers that trigger responses such as resource shifting from less profitable/valuable to more profitable/valuable funding flows, patient shifting to more profitable or valuable funding flows, and cost shifting across funding flows to make up for inadequacy of funds. These provider responses/behaviors resulted in a differential quality of care for clients, inequities in access to health services, and wastage of resources. In some instances, providers' responses resulted in a better quality of care for clients and improved access to services that were not ordinarily available or clients could not have been able to afford otherwise.

Positive Experiences of Having Multiple Funding Flows

Some respondents highlighted that having multiple sources of funding has been beneficial to the hospital in various ways. It increases the financial pool or internal revenue base of the hospital, which enables provision of wider range of services. Hence, client patronage is better. The capacity of the health facility to undertake capital projects from its internal revenue is also enhanced. Having multiple sources of funding also gives a sense of security to the health facility, in the sense that there would always be a back-up source of funding if one flow delays or defaults in payment.

"It has a lot of benefits, when you have multiple fund, you see that you have sources of money that will help you to do what you want to do" (FP/KII /R23)

"It is a good thing that we have multiple sources; if this one is failing, you will lay hands on the other one, but if you have only one channel and it fails then you will be in trouble, so it is okay for us" (FP/KII /R19)

"Well, I will say that definitely having multiple source of funding has improved service delivery, because it has given so many options... definitely it is going to increase the financial pool. If you have a larger base, then it means that you can do more works" (FP/KII/R25).

DISCUSSION

This paper provides new knowledge on how healthcare providers respond to multiple funding flows and the implications of such flows for achieving the health systems goals of equity, efficiency, and quality. It has identified the different flows of funds to healthcare providers and characterized each funding flow by ascertaining: the contribution of each funding flow to total resources; characterized a number of provider responses to multiple funding flows; and analyzed the likely impact of the overall funding mix on efficiency, quality, financial protection and equity in the healthcare services provided.

The findings showed that the different funding flows send signals to health providers that trigger responses such as resource shifting from less valuable to more valuable funding flows, patient shifting to more profitable or valuable funding flows, and cost shifting across funding flows to make up for inadequacy of funds. This also aligns with findings in other studies that health providers respond to signals sent by different funding flows (16, 17). Resources were also shifted to funding flows that providers find valuable because they address a gap in service delivery. Patients were shifted from less predictable to more predictable funding flows. They were also shifted from funding flows that had more complex accountability mechanisms to those that had less complex mechanisms. Providers charged different rates to

TABLE 6 | Characteristics of funding flows in terms of services purchased, target population, provider payment and accountability mechanisms.

Funding source	Funding flow	Services purchased and target population	Provider payment mechanism	Accountability mechanism
Government budget	Personnel (Salaries)	Staff salaries	Staff salaries are paid monthly	Electronic transfer of staff salaries in FG-owned hospitals Periodic financial audits of staff payroll in both FG-owned and SG-owned hospitals
	Recurrent budget	Direct subventions for overhead and other recurrent expenditure This is applicable for FG-owned hospitals	Monthly payments for overhead and other recurrent budgets	Electronic transfer, Documentation of income and expenditure, monthly reporting, monitoring visits by Ministry of Health
	Capital budget	Capital vote for infrastructure and equipment	Capital projects are implemented when needed, depending on funds available	Tendering receipts for capital expenditure; inspection of capital projects for quality and compliance to standard
	Free-MCH payments	State government funds free MCH which covers maternity and child health services for eligible mothers and children under 5 years of age	For free-MCH, periodic reimbursements are made on a case-by-case basis	Periodic financial audits
	Drug-revolving fund	Drugs that are purchased through direct out-of-pocket payments or cash transfers	One-off payment to FG-owned hospitals	Documentation of income and expenditure, periodic reporting, monitoring visits
Out of pocket payment		OOP can be used to purchase all services provided in public hospitals—consultations, laboratory tests, drugs, and other procedures. Also used to pay for utility bills and other consumables for service delivery	Cash payments direct from clients at the point of receiving care for services utilized (or yet to be utilized). Funds are transferred to Treasury Single Account and returned to hospitals	Automated electronic payment system tracks all payments made by clients Cash invoice to clients as evidence of payment. Monthly financial reporting Internal and external financial audits
NHIS	Capitation	Consultations, laboratory tests, drugs, and simple procedures listed in the NHIS benefit package. Also contributes to hospital revenue used for utility bills, infrastructure maintenance, and purchase of equipment FSSHIP covers federal government employees and beneficiaries. TISHIP covers students of registered tertiary institutions	Monthly capitation for primary level care. Capitation for FSSHIP is a fixed rate of ₦750/beneficiary and for TISHIP is ₦1,000/student	Authorization is required from HMOs for services not listed under capitation or FFS payments Periodic audits of hospital accounts by NHIS and HMOs. Periodic verification of payments made by HMOs' to the hospitals Technical committee approvals
	Fee for service	Secondary and tertiary level care as listed in the benefits package—surgeries, complex procedures, admissions	Monthly payments based on calculations. FFS rates vary depending on service type. Clients make 10% co-payment for FFS and drugs	
Donations		Cash or in-kind donations earmarked for specific services such as drugs and test kits for HIV, vaccines for immunization Overseas and local missions provide free surgical procedures. Philanthropists offset hospital bills of indigent clients	Donations are sometimes paid directly into the hospital account or given to the clients. Drugs and commodities for HIV treatment and care are given directly to the pharmacy unit of the HIV clinic	Similar to accountability mechanisms for government budget and OOP

different funding flows to make up for inadequacies in sources of funding.

The result also showed that although, government budget contributes the largest share of funding to public hospitals, over three-quarters of the fund is used for payment of staff salaries. This means that what is essentially available to the hospital for the provision of health service is small compared to OOP. This is in keeping with existing evidence which estimate that OOP contributes the most to hospital revenue for actual service delivery (18, 19).

The mechanisms through which funds flowed from purchasers to providers varied by source of funding, services purchased and facility type as was found in this study. Government budget for staff salaries in State-owned hospitals was paid through the Ministry of Finance while that for Federal government-owned hospitals are paid through the Ministry of Health. Similarly, funds for capital projects in state-owned hospitals were managed by the State Project Implementation Unit, unlike in Federal government-owned hospitals. Concerning variations based on the type of service purchased by the same source, funding for HIV treatment and care was provided through implementing partners while funding for other programmes was provided through State or LGA health authority. Generally, majority of the funds did not flow directly

TABLE 7 | Summary of relative attributes of funding flows to public hospitals.

Attributes	Government funding			Out of pocket payment	NHIS		Donor funds
	Salaries (personnel)	Recurrent budget	Capital budget		Capitation	Fee for service	
Relative share of funding	Highest share	Third highest	Fourth highest	Second highest	Fifth highest	Less share	Least share
Duplication or gaps in service coverage	No gaps or duplication	Does not cover highly specialized services	No gaps or duplication	Gaps—many people cannot afford the cost of highly specialized services	Gaps—NHIS drug formulary is restrictive		Duplication—donors run parallel programs as other funding sources
Relative adequacy of funds	Most adequate	Least adequate	Low adequacy—depends on availability of funds	Adequacy is low because services are subsidized	Capitation rate is inadequate but pooled capitation is moderately adequate	FFS rate and payments are highly inadequate	Moderately adequate for earmarked services
Relative flexibility of funding flows	Not at all flexible	Very flexible	Not at all flexible	***Varies***. Highly flexible in tertiary hospitals. Not flexible in secondary hospitals	Highly flexible and centrally pooled with other flexible sources	Highly flexible	Moderate flexibility
Relative predictability	Most predictable in terms of timing and amount	Highly unpredictable	Most unpredictable	Majority opinion is that it is highly predictable	Highly predictable in terms of amount Less predictable in terms of timing	FFS is less predictable in terms of timing and amount	Very irregular and has the least predictability
Relative complexity of accountability mechanisms	Less complex compared to OOP because personnel budget, which contributes the largest share, is earmarked			Most complex. Requires extra vigilance of accounting staff	Less complex than OOP but more complex than GF		Least complex. Funds are earmarked
Acceptability of process of developing and introducing funding sources	Less acceptable Decided by central government and lacking in fairness and accountability			More acceptable. Rates were decided by a committee	Least acceptable. Current design and rates were decided at the national level. Benefit package is not robust		Less acceptable Decision is made by donors.

from purchasers to providers, and for a single hospital, there were multiple actors from different sectors involved in the flow of funds from purchasers to service providers.

An implication of the findings is that multiple funding flows to public hospitals is beneficial as well as constraining to health providers. It provides collateral funding pathways that improve overall flexibility, predictability and adequacy of funding to the hospital. Hospital revenue is increased and more resources (funds) are available for the provision of a wider range of services. As more services are provided with better quality, client patronage improves. These findings corroborate a recent study which found that multiple funding flows reduced the interruption of service delivery as a result of lack of equipment or medical supplies (20) and increased providers' funds and patient flow to the facilities (21). Collateral funding pathways have also been reported to contribute to strengthening organizational resilience (22). The capacity of health facilities to undertake capital projects from their revenue is also enhanced by multiple funding flows.

The characteristics/attributes of individual funding flows are influenced by the presence of multiple sources of funding and this study highlights some of the challenges of multiple funding flows to public hospitals. Providers perceive the size/share, adequacy, predictability, flexibility and complexity in accountability of a funding flow in relation to other sources of funding. In addition to the fact that multiple funding flows result in duplication of services and complicates financial management and accountability, the interaction of attributes of different funding flows sends signals that fuel discriminatory behavior among providers.

Providers' perception of relative adequacy of funding flows shaped their behaviors in health service delivery in this study. For instance, because NHIS capitation and FFS were considered to be inadequate and the benefits package limited, providers shifted patients to direct OOP to maintain the continuation of care. Although this was done with good intentions to ensure that clients got the best quality of care that was available, it could potentially result in inequity in access because those who cannot afford the additional cost of care are denied treatment as has been reported elsewhere (23, 24). Furthermore, providers were found to prioritize resources (personnel, medicines, space, electricity, and water) for those services whose funding flows generated additional revenue for the hospital. The effect of this resource prioritization is that clients whose funding flows were not considered profitable received services that were under-resourced and of poorer quality. A similar finding was reported in Kenya where it was found that resources were preferentially allocated to National Health Insurance Fund beneficiaries by hospitals (25).

TABLE 8 | Evidence of provider behavior, related attributes, and implications for health systems goals.

Types of provider behavior	Evidence of provider behavior	Related attribute/characteristic	Implications for health system goals
RESOURCE SHIFTING (from less valuable to more valuable funding flows)	Assignment of designated doctors, nurses in outpatient department (OPD) and pharmacy for insured (NHIS) clients although the overall doctor/nurse-patient ratio in facility is low. Designated doctors are better qualified. This occurs because NHIS contributes significantly to hospital funds (size of funding). And the hospital needs to ensure continued patronage of NHIS clients, as well as to honor the MoU with NHIS-HMOs (State-owned tertiary hospital) *"Like the NHIS people are being given preference... in the out patients' unit. We have the doctors that are assigned to be seeing the NHIS patients when they come... despite the crowd or whatever. They have assigned doctors that see only them, and they also do it in other clinics. Even when they come with their children, you also give them attention"* (KII /R23)	Relative share of funding	NHIS clients get better quality of care than uninsured clients because waiting times are reduced
	Funds meant for drug revolving fund (DRF) for uninsured clients are used to purchase drugs for the NHIS pharmacy to prevent stock-outs that arise from delays in capitation payments in the Federal government-owned tertiary hospital. This results in depletion of DRF stock and delays in paying suppliers	Relative predictability of funding Relative flexibility	Depletion of the DRF funds for uninsured clients
	Health facility staff are shifted to philanthropy provided services (eye care, dental care, surgeries)	Gaps in service delivery	Improves access to specialized health services for the community
	Cardiothoracic unit is prioritized for resource mobilization (basic amenities, drugs and staff) during the annual free open-heart surgery programme provided by medical missions (VOOM foundation) to UNTH. This programme is valuable to the hospital because it fills a gap in service delivery *"What we are seeing in this current management is that interest is in open heart surgery, we know there are mission people in Diaspora coming to assist but the management attention has completely gone to that place to the detriment of every other aspect...."* (FP/KII/R05)	Gaps in service coverage associated with funding flows	Other health care services are under-resourced for the period resulting in differential quality of care
	In ESUTH, TB, and immunization clinics are under-resourced compared to other clinics because they do not generate any revenue for the hospital (services are provided free of charge) *"I will give you a typical example, immunization unit and the TB clinic are not well funded by the hospital the way they fund the SOP. The reason is that they don't see the money. Now, the quality of services rendered by TB and immunization cannot be compared to anything you run in clinical services because the funding doesn't come directly to them"* (FP/KII/R29)	Relative share of funding	Quality of services is poorer in these clinics (long waiting time & unconducive environment)
PATIENT SHIFTING (from less profitable to more profitable funding flows)	NHIS clients are made to pay user fees (the difference in fees) when drugs are prescribed outside of the NHIS-approved drug formulary. Purpose is to make up for inadequacy of NHIS billing as well as avoid delays in HMOs' authorization process. *"There are some drugs that are not in the list of NHIS approved for their enrolees, so if you have a case like that you have to go and buy the drugs by yourself and pay... At the moment what we actually do is to subtract the amount. For instance, for a brand of Ceftriaxone that is sold at ₦3,600, if the price [on NHIS drug list] is ₦600, we subtract the ₦600 and work out its 10% [co-payment] which is ₦60... So, the person is paying ₦3,060"* (FP/KII/R32)	Relative adequacy and predictability (time) of funding flows	Ensures that clients get the quality of services they require. Also has equity implications for insured clients who cannot afford the user fees
	Some NHIS clients are shifted from capitation to fee-for-service for expensive procedures that are not sufficiently covered by NHIS capitation payment	Relative adequacy of funding flows	Ensures that clients get the quality of services they require
	NHIS clients are made to pay OOP for services that are not covered by capitation due to communication gap between HMOs and health facility	Accountability	Implications for efficiency and equity (cost escalation)
	Free MCH—mothers are made to pay part of the fees to make up for unpredictability (time and amount) of reimbursements	Relative predictability	Implications for equity
	OOP clients are shifted from non-commercialized (public-funded) to commercialized (privately funded) laboratories in the hospital for two reasons: (i) the private laboratory offers wider range of investigations, is accessible at all times and has quicker turn-around time; (ii) the private laboratory generates more revenue for the hospital *"...There is a part of the hospital that runs their laboratory services and charges like a private place and the management knows they can get money directly from there so they do not fund the public typical labs so that these ones are not running and people will go to the private places.... where they pay more so that they can get what they want. Because government is not funding that one* (public labs) *it has made the services to go down. At a point it stopped running some tests"* (FP/KII/R10)	(i)Gaps in service coverage associated with funding flows (ii)Relative share of funding	Improves quality of care for those that can afford but creates inequities in access
	Different fees are charged to out-of-pocket paying clients for the same laboratory tests depending on whether they use the commercialized (privately-owned) laboratories or the non-commercialized (public-owned) laboratories in the hospital	Relative adequacy of funding flows	Improves quality of care for those that can afford but creates inequities in access

(Continued)

TABLE 8 | Continued

Types of provider behavior	Evidence of provider behavior	Related attribute/characteristic	Implications for health system goals
COST SHIFTING (different rates are charged to different funding flows for the same service)	NHIS is charged higher rates than out-of-pocket payment for the same laboratory investigations in UNTH The privately managed laboratory in UNTH charges higher fees than the public laboratories for the same laboratory tests. The private-owned laboratory operates like other for-profit private laboratories outside the hospital	Relative adequacy of funding flows	Inefficiency

Predictability of funding flows was reported in this study by the providers in terms of completeness and timeliness of payments for services delivered (or to be delivered) to clients. Funding flows whose payments were closely aligned with expectations of providers were considered relatively more predictable than others. The relative predictability of these funding flows influenced how providers responded with service delivery to clients. It enabled resource shifting from less predictable sources to more predictable sources. Providers prioritized resource allocation to NHIS over OOP because the later was considered less predictable, being always affected by frequent strike action of health professionals. In one of the hospitals that receive government funding for free MCH programme, patient shifting was also reported because reimbursements are oftentimes delayed and/or incomplete. Suitability for free MCH was sometimes ignored and eligible women and children were made to pay user fees for maternal and child health services. It was reported that unpredictability of a health care programme funds resulted in drug stock-outs in public facilities which compelled providers to introduce informal payments among service users for services that should be provided free of charge in Nigeria (26). This behavior facilitates and widens the inequity gap that already exists in access to maternal and child health services in Nigeria because of the potential higher financing burden on the poor and vulnerable groups. It could potentially reverse the gains in maternal and child health outcomes, particularly those associated with increased utilization of formal health facilities. The equity of a health financing system does not only depend on how pro-poor the distribution of its benefits is but also how the financing burden is shared (24).

Accountability mechanisms reportedly varied across the different funding flows and some funding flows were considered to have more complex mechanisms for accountability than others. Complexity was defined by reporting requirements (content and frequency), processes of authorization, duplications in accounting processes and potential for diversion of funds under funding flows. The perceived complexity of accountability mechanisms sent signals to providers that resulted in patient shifting. The process of authorization from HMOs to providers for delivering services that are outside of the NHIS list was perceived to be highly bureaucratic and prolonged. In order to circumvent this process and reduce delays in service delivery, providers shifted clients from NHIS capitation to fee for service through direct cash payments. Although this behavior had positive implications for quality of care, it could create inequities in access since it preferentially benefits insured clients who can afford to make direct cash payments. In India, it was also found that delay in reimbursements from the National Health Insurance Scheme was also reported, which forced providers to reject enrollees and subsequently deregister themselves from the scheme (27).

The findings concerning the flexibility of funding flows showed that with the exclusion of earmarked government and donor funds, other funding sources had comparative flexibility and were pooled and managed from a central pool. This attribute generated varied behavioral responses from providers. On the one hand, it enabled resource prioritization by providers to more profitable funding flows. Hence, creating differential quality of care. On the other hand, it enabled redistribution of funds and resources across funding flows and this improved fairness in quality of care provided for all groups of clients.

It was found that the fact that the processes of development and introduction of funding sources were decided by authorities other than health providers was unacceptable to the providers. Provider payment rates did not cover the cost of services because NHIS capitation and fee for service rates were decided at the national level while user fees for OOP in public hospitals were handed down to providers without their inputs. In order to cope with the consequent inadequacy of funding flows, providers charged different rates to "vulnerable" funding flows for the same services (28). Specifically, in one of the hospitals, insured clients paid higher FFS rates for some investigations than uninsured clients, and laboratory fees were higher in privately managed laboratories than in the public laboratories. The non-inclusion of health providers in rates-fixing has been reported as detrimental to the quality of care (19). The discriminatory behavior of providers which is elicited has negative implications for efficiency when clients are overcharged for services (28). As posited by the World bank, overall efficiency in the health system can be increased by reforming procedures for purchasing services (29).

The main limitation of this study is that we relied on participants' reports of their perceptions of provider responses to attributes of multiple funding flows. Also, the study employed a non-probability sampling approach (purposive sampling method) in selecting both the study sites and participants which may have introduced bias to the overall findings. Furthermore, although we elicited information about the fund flow system in different health care facilities, we did not explore the financial control mechanisms, which is equally

important for service delivery in low and middle income countries like Nigeria. The exploration of financial control mechanisms for different funding flows should be the subject of future studies.

In conclusion, multiple funding flows to public hospitals are beneficial as well as constraining to health providers. It is important that such multiple flows are better harnessed and channeled for improving health system financing and overall health system strengthening. These consequences of multiple funding flows to public hospitals affect health systems goals of equity, efficiency and quality of care. In the most part, they enabled inequity in access to health services and differential quality of care for different groups of clients.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Nigeria Teaching Hospital Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

OO participated in the conceptualization of the study. OO and NE were involved in the development of the data collection tools. OO, NE, CM, UE, and IA participated in finalizing the data collection tools, data collection, and analysis. The manuscript was drafted by OO but all the co-authors were involved in its revision and finalization.

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A Correlation Study of the Colorectal Cancer Statistics and Economic Indicators in Selected Balkan Countries

*Berislav Vekic[1,2], Viktorija Dragojevic-Simic[3,4], Mihajlo Jakovljevic[5,6,7], Marko Kalezic[1], Zagor Zagorac[1], Sasa Dragovic[8], Rastko Zivic[1,9], Filip Pilipovic[10], Radoje Simic[9,11], Dejan Jovanovic[12], Jovana Milovanovic[13] and Nemanja Rancic[3,4,12]**

[1] Department of Surgery, Clinical Centre Dr. Dragisa Misovic, Belgrade, Serbia, [2] Faculty of Medical Sciences, University of Kragujevac, Kragujevac, Serbia, [3] Centre for Clinical Pharmacology, Military Medical Academy, Belgrade, Serbia, [4] Medical Faculty of Military Medical Academy, University of Defence, Belgrade, Serbia, [5] Department of Global Health Economics and Policy, Faculty of Medical Sciences, University of Kragujevac, Kragujevac, Serbia, [6] Institute of Comparative Economics, Hosei University, Tokyo, Japan, [7] N.A. Semashko Department of Public Health and Healthcare, I.M. Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russia, [8] Clinic for General Surgery, Military Medical Academy, Belgrade, Serbia, [9] Faculty of Medicine, University of Belgrade, Belgrade, Serbia, [10] Institute for Orthopedic and Surgical Diseases "Banjica", Belgrade, Serbia, [11] Department for Plastic Surgery, Institute for Mother and Child Health Care of Serbia Dr. Vukan Cupic, Belgrade, Serbia, [12] Institute of Radiology, Military Medical Academy, Belgrade, Serbia, [13] National Health Insurance Fund, Belgrade, Serbia

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****Correspondence:***
Nemanja Rancic
nece84@hotmail.com

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Colorectal cancer (CRC) is one of the most commonly diagnosed malignant neoplasms. The aim of the study was to evaluate and correlate most important epidemiological and economic indicators of CRC in 11 selected Balkan countries. The number of new CRC cases was 56,960, and the highest 5-year CRC prevalence was in Slovenia, Croatia, and Greece. Age-standardized CRC incidence rates were highest in Slovenia, Serbia, and Croatia, and age-standardized mortality rates were highest in Croatia, Serbia, and Bulgaria. Current Health Expenditure as % of Gross Domestic Product was the highest in Bosnia and Herzegovina and Serbia. The GDP per capita levels have shown positive correlation with the CRC incidence rate and prevalence. Absolute numbers of new and death-related CRC cases and 5-year prevalence in absolute numbers have shown strong positive correlation with GDP in million current US$. It has been shown that various economic indicators can be linked to the rate of incidence and prevalence of the CRC patients in the selected Balkan countries. Therefore, economic factors can influence the epidemiology of CRC, and heavy CRC burden in the Balkan region may be one of the indexes of the economic development.

Keywords: non-communicable diseases, colorectal cancer, Balkan region, economic indicators, epidemiological indicators

INTRODUCTION

Non-communicable diseases are responsible for the majority of global deaths, and cancer is expected to be the leading cause of death and the most important barrier to an increasing life expectancy in the twenty-first century (1). Colorectal cancer (CRC; combined cancers of the colon, rectum, and anus) is one of the most common diagnosed malignant neoplasms, considered to be the third among all cancers in terms of incidence, after lung and breast cancer, as well as on the second place in terms of mortality, after lung cancer (2). In 2018, 1,849,518 (10.2%) newly diagnosed CRC

cases out of total 18,078,957 newly diagnosed all cancer cases, and 880,792 (9.2%) CRC related deaths out of total 9,555,027 cases of all cancer related deaths, are expected to occur worldwide (2). The highest rates are recorded in Australia and New Zealand, and the lowest estimated one in Western Africa.

The 5-year prevalence for CRC expected worldwide is 4,789,635 cases (2). Age-standardized incidence rates are 23.6 in male and 16.3 per 100,000 in female, also expected to occur worldwide. On the other hand, age-standardized incidence and mortality rates which are expected to occur worldwide are 19.7 and 8.9 per 100,000, respectively.

According to the global trend, incidence rate of CRC is constantly increasing, and the number of CRC cases is expected to increase by 60% until 2030 (more than 2.2 million new cases and 1.1 million deaths) (3, 4).

The CRC 5-year survival rate, for example in the United States, was estimated from a 90% cancer cases detected at the localized stage, 70% for regionalized cancers, to 13% for cases diagnosed with distant metastatic cancer (5).

Health expenditures put more and more pressure on public budgets in most of the countries, especially in connection with the occurrence of population aging throughout the entire Northern Hemisphere (6, 7). They are even more challenging for most Balkan countries due to the economic crisis in Balkan populations and prior civil war for most of them (8). As the incidence of CRC increases constantly, the medical costs of treating these patients are also in the constant rise. Very few papers on CRC status in the Balkan countries exist, especially concerning health care expenditure. The most of them are dealing with the costs of treatment and success of various therapeutic modalities, mostly in Serbia (9–12).

The aim of the study was to evaluate and correlate most important epidemiological and economic indicators of CRC in 11 selected Balkan countries since realistic estimates are crucial to ensure an adequate return on investment in CRC care.

MATERIALS AND METHODS

In our study number of new CRC cases was analyzed, number of death related with CRC, as well as 5-year prevalence per 100,000. Also, age-standardized incidence and mortality rates were analyzed. Age-standardized incidence and mortality rates (ASR) are a summary measure of the rate of disease that a population would have if it had a standard age structure. These data are downloaded from the World Health Organization database—GLOBOCAN (https://gco.iarc.fr/).

Selected indicators of health spending analyzed were: Gross Domestic Product (GDP) in million current US$), Gross Domestic Product per Capita in US$; Current Health Expenditure (CHE) as % of Gross Domestic Product (GDP); and Current Health Expenditure (CHE) per Capita in US$. These data are downloaded from the World Health Organization database (https://apps.who.int/nha/database/ViewData/Indicators/en).

Conducted study concerns 11 countries, which belong to the Balkan region, either geographically, or politically: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Montenegro, Romania, Serbia, Slovenia, The Republic of North Macedonia, and Turkey (countries are entirely or mostly/partially within the Balkan region).

Statistical analysis was conducted using IBM SPSS Statistics 19.0 computer program (IBM, USA, 2011). Variables were described in the form of absolute number (%). Relationship between variables was tested by Spearman's rank correlation coefficient. All the analyses were evaluated at the level of statistical significance of $p < 0.05$.

The principles of ICH Good Clinical Practice were strictly followed and the approval from the Ethics Committee was obtained (Approval No 26/04/17 for the study protocol No MFVMA/12/17-19, entitled: Cost-effectiveness and cost-utility analysis of CRC treatment and budget impact analysis from the perspective of the patient, hospital, and third-party payer).

RESULTS

Cancer Statistics in Balkan Countries

Table 1 summarizes the estimated numbers of new CRC cases and CRC deaths in 11 selected Balkan countries in 2018. In the total population of selected Balkan countries of 143,836,740 citizens, number of new cases of CRC was 56,960. The highest number of new CRC cases was in Turkey, Romania and Greece. Total number of CRC deaths was 30,166. The highest number of CRC deaths was also present in these countries. However, the highest percentage of the new CRC cases in comparison to other cancer location was in Slovenia, Croatia, and Romania, while the highest percentage of CRC death cases comparing with other cancer sites was in Croatia, Bulgaria, and Romania. Therefore, Turkey had the highest number of new CRC cases, as well as CRC deaths in selected Balkan countries in 2018, taking also into account that it has the largest total population. Croatia and Romania had both high percentages of new CRC cases and CRC death cases in comparison to other cancer location when taking into consideration all of the Balkan region.

Both the lowest number of new CRC cases and the lowest number of CRC deaths in 2018 was registered in Montenegro, as the smallest country in the region.

The highest 5-year CRC prevalence was in Slovenia, Croatia and Greece (270.84; 215.01; 175.64 per 100,000 persons, respectively) (**Table 1**), while the lowest 5-year prevalence was in Albania.

Age-standardized (World) CRC incidence rates were the highest in Slovenia (41.1), Serbia (36.7), and Croatia (34.1), and age-standardized (World) CRC mortality rates were highest in Croatia (18.9), Serbia (16.8), and Bulgaria (14.9) (**Table 1**). The lowest values of both of these parameters were registered in Albania.

Economic and Health CRC Indicators in Balkan Countries

Gross Domestic Product in Balkan countries was the highest in Turkey (863,712 million current US$), Greece and Romania (**Table 2**). Gross Domestic Product per Capita in US$ was the highest in Slovenia, Greece, and Croatia (more than 10,000 US$).

TABLE 1 | Numbers of new colorectal cancer cases and related deaths, age-standardized incidence, and mortality rates (per 100,000) in selected Balkan countries according to GLOBOCAN in 2018 (2).

Balkan countries	New cases*	Deaths*	5-year prevalence**	ASR incidence#	ASR mortality#
Albania	374 (4.51)	186 (3.96)	928 (31.63)	8.4	3.7
Bosnia and Herzegovina	1,804 (12.54)	1,074 (11.92)	4,441 (126.75)	26.1	13.3
Bulgaria	4,553 (12.87)	2,687 (14.04)	11,751 (166.99)	28.5	14.9
Croatia	3,356 (13.31)	2,174 (15.06)	8,955 (215.01)	34.1	18.9
Greece	7,117 (10.56)	3,384 (10.16)	19,570 (175.64)	26.2	9.7
Montenegro	208 (8.79)	114 (8.86)	548 (87.09)	18.6	9.2
Romania	10,856 (13.01)	6,155 (12.09)	28,364 (144.86)	26.7	13.7
Serbia	6,049 (12.61)	3,187 (11.84)	15,347 (175.15)	36.7	16.8
Slovenia	1,970 (14.59)	737 (11.52)	5,637 (270.84)	41.1	12.5
The Republic of North Macedonia	984 (12.60)	472 (11.47)	2,429 (116.50)	28.4	12.5
Turkey	19,689 (9.35)	9,996 (8.56)	48,725 (59.48)	21.0	10.2

**Absolute number (% of total number of all new/death cancer site cases); **Prevalence was shown as absolute number (as proportion of the population per 100,000 persons); #Age-standardized (World) incidence and mortality rates.*

TABLE 2 | Economic characteristics in selected Balkan countries (2, 13–15).

Balkan countries	Total population	GDP (in million current US$)	GDP per capita in current US$	Current health expenditure as % of GDP	Health expenditure per capita in current US$	Income level
Albania	2,934,345	11,864	4,054	6.70	271.54	Upper middle income
Bosnia and Herzegovina	3,503,565	16,910	4,808	9.23	443.78	Upper middle income
Bulgaria	7,036,852	53,238	7,442	8.23	612.48	Upper middle income
Croatia	4,164,772	51,624	12,319	7.18	884.49	High income
Greece	11,142,158	192,691	17,869	8.45	1510.67	High income
Montenegro	629,217	4,845	8,652	6.00	382.10	Upper middle income
Romania	19,580,628	189,005	9,565	4.98	476.37	Upper middle income
Serbia	8,762,022	38,300	5,412	9.14	494.42	Upper middle income
Slovenia	2,081,259	44,709	21,659	8.47	1834.16	High income
The Republic of North Macedonia	2,085,056	10,755	5,168	6.34	327.84	Upper middle income
Turkey	81,916,866	863,712	10,863	4.31	468.65	Upper middle income

GDP, Gross Domestic Product.

The lowest Gross Domestic Product per Capita was registered in Albania.

However, Current Health Expenditure as % Gross Domestic Product was the highest in Bosnia and Herzegovina and Serbia, but the lowest in Turkey. Current Health Expenditure per Capita in US$ was the highest in Slovenia, Greece, and Croatia (1834.16; 1510.67; 884.49, respectively), and the lowest in Albania. Eight countries of 11 have upper middle income according to income level estimated by the World Bank, while three countries have high income, such as Slovenia, Croatia, and Greece (**Table 2**).

Correlation Analyses Between Economic and Epidemiological CRC Indicators

In the Balkan countries, the GDP per capita levels (Upper middle income and high income countries) have shown positive correlation with the CRC incidence rate and prevalence (**Table 3**). The 5-year CRC prevalence per 100,000 persons and GDP per capita level have shown strong positive correlation (5-year prevalence was higher in the high income countries comparing with the Upper middle income ones); $r = 0.775$, $p = 0.005$. Also, ASR CRC incidence rate was higher in the high income countries in comparison to Upper middle income ones; $r = 0.452$, $p = 0.163$. However, ASR CRC mortality rate has not shown any correlations with selected economic CRC indicators (**Table 3**).

Absolute number of new CRC cases, death-related cases in absolute numbers and 5-year CRC prevalence in absolute numbers have shown strong positive correlation with GDP in million current US$ (these parameters were higher in the countries with higher GDP in comparison to countries with lower GDP); $r = 0.927$, $p < 0.001$; $r = 0.909$, $p < 0.001$; $r = 0.927$, $p < 0.001$, respectively (**Table 3**).

TABLE 3 | Correlation analysis between economic and epidemiological colorectal cancer indicators in selected Balkan countries.

	New cases	New cases (% of all new cancer site cases)	Deaths	Deaths (% of all death cancer site cases)	5-year prevalence	Prevalence (per 100,000 persons)	ASR incidence	ASR mortality	GDP (in million current US$)	GDP per Capita in US$	Current health expenditure as % GDP	Current health expenditure per capita in US$
New cases (% of all new cancer site cases)	$r = 0.291$; $p = 0.385$											
Deaths	$r = 0.991$; $p < 0.001$	$r = 0.236$; $p = 0.484$										
Deaths (% of all death cancer site cases)	$r = 0.236$; $p = 0.484$	$r = 0.809$; $p = 0.003$	$r = 0.255$; $p = 0.450$									
5-year prevalence	$r = 1.000$; $p < 0.001$	$r = 0.291$; $p = 0.385$	$r = 0.991$; $p < 0.001$	$r = 0.236$; $p = 0.484$								
Prevalence (per 100,000 persons)	$r = 0.291$; $p = 0.385$	$r = 0.809$; $p = 0.003$	$r = 0.236$; $p = 0.484$	$r = 0.636$; $p = 0.035$	$r = 0.291$; $p = 0.385$							
ASR incidence	$r = 0.255$; $p = 0.450$	$r = 0.900$; $p < 0.001$	$r = 0.191$; $p = 0.574$	$r = 0.664$; $p = 0.026$	$r = 0.255$; $p = 0.450$	$r = 0.845$; $p = 0.001$						
ASR mortality	$r = 0.364$; $p = 0.270$	$r = 0.779$; $p = 0.005$	$r = 0.378$; $p = 0.252$	$r = 0.916$; $p < 0.001$	$r = 0.364$; $p = 0.270$	$r = 0.588$; $p = 0.057$	$r = 0.747$; $p = 0.008$					
GDP (in million current US$)	$r = 0.927$; $p < 0.001$	$r = 0.273$; $p = 0.417$	r = 0.909; $p < 0.001$	$r = 0.209$; $p = 0.537$	$r = 0.927$; $p < 0.001$	$r = 0.327$; $p = 0.326$	$r = 0.173$; $p = 0.612$	$r = 0.237$; $p = 0.483$				
GDP per capita in US$	$r = 0.482$; $p = 0.133$	$r = 0.464$; $p = 0.151$	$r = 0.400$; $p = 0.223$	$r = 0.145$; $p = 0.670$	$r = 0.482$; $p = 0.133$	$r = 0.645$; $p = 0.032$	$r = 0.400$; $p = 0.223$	r = 0.091; p = 0.790	r = 0.609; p = 0.047			
Current health expenditure as % GDP	$r = -0.127$; $p = 0.709$	$r = 0.291$; $p = 0.385$	$r = -0.109$; $p = 0.750$	$r = 0.345$; $p = 0.298$	$r = -0.127$; $p = 0.709$	$r = 0.573$; $p = 0.066$	$r = 0.464$; $p = 0.151$	$r = 0.333$; $p = 0.318$	$r = -0.136$; $p = 0.689$	$r = -0.082$; $p = 0.811$		
Current health expenditure per capita in US$	$r = 0.518$; $p = 0.102$	$r = 0.691$; $p = 0.019$	$r = 0.455$; $p = 0.160$	$r = 0.491$; $p = 0.125$	$r = 0.518$; $p = 0.102$	$r = 0.918$; $p < 0.001$	$r = 0.709$; $p = 0.015$	$r = 0.451$; $p = 0.164$	$r = 0.609$; $p = 0.047$	$r = 0.809$; $p = 0.003$	$r = 0.418$; $p = 0.201$	
Income code	$r = 0.129$; $p = 0.705$	$r = 0.452$; $p = 0.163$	$r = 0.065$; $p = 0.850$	$r = 0.194$; $p = 0.568$	$r = 0.129$; $p = 0.705$	$r = 0.775$; $p = 0.005$	$r = 0.452$; $p = 0.163$	$r = 0.097$; $p = 0.777$	$r = 0.323$; $p = 0.333$	$r = 0.775$; $p = 0.005$	$r = 0.323$; $p = 0.333$	$r = 0.775$; $p = 0.005$

GDP, Gross Domestic Product; ASR, Age-standardized (World) rates.

Five-year CRC prevalence (as proportion of the population per 100,000 persons) was also higher in the countries with higher Current Health Expenditure per Capita in US$ comparing with the countries with lower Current Health Expenditure per Capita in US$); $r = 0.918$, $p < 0.001$ (**Table 3**).

DISCUSSION

Colorectal cancer is one of the most common cancers worldwide, with one to two million new cases being diagnosed every year, and with 700,000 cancer-related deaths per year (16). Most cases of CRC are detected in Western countries (55%), but this tendency changes due to the fast development of some countries over the past few years (17). On the other hand, 33% of all CRC-related deaths occurred in Western countries in 2010, due to the improvements made in health systems and the implementation of screening programs (18). The burden of colorectal cancer differs widely across populations, varying with geographical region, age, gender, and socio-economic status (19).

Colorectal cancer incidence and mortality are rapidly growing worldwide (16, 20, 21). Risk for developing CRC is associated with personal features (age, chronic disease history, existence of overweight or obesity, and being tall) or habits (for example, consuming red meat, processed meat, alcoholic drinks, diet poor in folic acid, and vitamin B6), increase the risk for CRC (3, 16, 22). Many of the known risk factors for CRC (age, sedentary lifestyle, Western diet, and smoking) are behaviors traditionally associated with high-income countries (23). Some authors showed that "Western lifestyle" and CRC occurrence had a strong correlation, and that increasing rates of CRC is considered a marker of economic transition (24). However, people living in high-income countries who have a healthy lifestyle have lower CRC risk comparing with the general population in less developed countries.

In recent meta-analyses on CRC risk factors a comprehensive risk modeling strategy in order to predict an individual's risk of developing CRC was developed (25). Inflammatory bowel disease and history of CRC in first-degree relatives were associated with high risk of CRC, while increased body mass index, red meat intake, cigarette smoking, low physical activity, low vegetable consumption, and low fruit consumption were associated with moderately increased risk of CRC. Macrae (26) in the latest update on epidemiology and risk fastors concerning CRC also considers specific genetic disorders, associated with a very high risk of developing colon cancer, such as familial adenomatous polyposis and Lynch syndrome, although together these two conditions account for only ∼5% of CRC cases. Ulcerative colitis, Crohn disease and abdominopelvic radiation also significantly increase the risk of subsequent gastrointestinal neoplasms, the majority being CRC. Same author also points out that a large number of clinical, environmental and lifestyle factors often mentioned in the observational studies, such as obesity, diabetes mellitus, taking red and processed meat, tobacco, alcohol, and cholecystectomy are associated with a small and/or uncertain increased risk of CRC (26).

Nevertheless, a modification of lifestyle and/or diet could decrease morbidity, but early detection, such as screening programs (SPs) improves prognosis and reduces mortality (22). Moreover, in the paper concerning CRC SPs in the countries outside the EU-28, which included all the countries we also took into consideration, authors claimed that this health care intervention not only can reduce all types of health care costs, but also decreases the social burden of cancer and protects the most socially endangered members of the society (27).

In the 11 selected Balkan countries, the GDP per capita level (Upper middle income and high income countries), as the best measurement of standard of living in particular country, has shown strong correlation with CRC indicators. The 5-year prevalence was significantly higher in the high income countries, such as Slovenia, Croatia, and Greece comparing to other countries in this region. This especially refer to Albania with the lowest GDP per capita in US$ and lowest 5-year prevalence. Estimation of Current Health Expenditure per capita in the US$ also pointed to Slovenia, Greece and Croatia with highest values, and to Albania with lowest one, in accordance with the fact that this is the indicator of the level of resources channeled to the health relative to other uses. Similarly to our data, in the China, the crude incidence and mortality rates showed positive associations with GDP per capita levels, with high-GDP per capita areas having the highest crude rates, followed by middle- and low-GDP per capita areas (28). The age-standardized incidence rate was highest in the high-GDP per capita areas and lowest in low-GDP per capita areas. In accordance with that this indicator was highest, according to our data, in Slovenia, Serbia, and Croatia. As it was already mentioned, Slovenia and Croatia are High income countries, while Serbia is not. However, Serbia had almost highest Current Health Expenditure as a percentage of GDP in comparison to other Balkan countries in 2018, pointing to the social priority which is given to the health, measured in money resources, including CRC diagnosis. In accordance with this, in the investigation of Altobelli et al. (27) Serbia was included as a country which has population-based SP, implemented despite the crisis and civil war in surroundings, making cancer prevention a priority.

On the contrary, the age-standardized mortality rate was highest in low-GDP per capita areas and lowest in high-GDP per capita areas (28). However, in our study ASR CRC mortality rate has not shown any correlations with selected economic CRC indicators. But when comparison has been made among the selected Balkan countries, ASR mortality rate was the highest in Croatia, High income Balkan country, while Albania as the country with the lowest GDP per Capita in US$ had the lowest value of this indicator. Since our data also showed the lowest values of CRC 5-year prevalence, as well as ASR incidence rate in Albania among the Balkan countries, it can be speculated that insufficient money resources do not allow making a diagnosis in time, as well as monitoring the number of diseased and the deceased patients in an adequate manner. This is somehow supported by the examination of Altobelli et al. (27) who specified that in Albania neither spontaneous nor organized SP was available.

The incidence of CRC worldwide is expected to increase by 80% in the year 2035 (∼2.4 million cases). According to data in 2012, 44.6% of the world CRC incidence and 47.8% of its worldwide mortality stems from the Asian continent (19). The Republic of Korea has the highest ASR incidence in the world (ASR incidence is 45). Slovenia, one of our selected Balkan countries is on the 10th place with ASR incidence 37 (19), which is also high according to our data and accounted 41.1 in 2018. It was actually the highest in Balkan region, and it can be explained by the facts that Slovenia is among EU-28 Member states offering organized screening programmes (27). Moreover, among all of these countries, it was one of the 10 which had registered healthcare expenditure (% of GDP) increase concerning period from 2010 to 2014 (29). In other large study which analyzed economic burden of cancer across the European Union, Slovenia spent 72 Euros for health-care costs of cancer per person in 2009, by health-care service categories, including primary care, outpatient care, accident and emergency care, inpatient care and drugs (30). By comparison, European Union average cancer health-care costs amounted 102 Euros. Moreover, according to WHO regions, the EURO region has the highest CRC burden constituting 34.6% of the worldwide incidence and 32.9% of its mortality. Authors showed that in the future an increase in the population and burden of CRC in the Western Pacific Region will be combined, while the stabilization or decrease in ASR for the incidence in the EURO region is foreseen (19). The "Westernization" of many of the West Pacific countries (China, Japan, Korea) contribute for increase of the number of CRC patients, such as increased prevalence of obesity, smoking, high calorie and high meat diets, and sedentary lifestyles. On the other hand, increased incidence of CRC seen over the past few decades in the European countries with subsequent stabilization could be attributed to the adoption of nationwide screening strategies.

The worldwide mortality of CRC is 693,933 with an ASR value of 8.3 per 100,000 in 2012 (19). Asia is still the continent with highest mortality of 331,615. When age is accounted for, Europe is the continent with the highest mortality with an ASR of 12.5 per 100,000, and Hungary is the country with the highest ASR of 20.8 per 100,000. Among WHO regions, mortality is the highest in the EURO region with an ASR of 12.3 per 100,000. According to ASR for mortality, among the highest 10 countries there are several countries from the Balkan region: Croatia on the 2nd place (18.7 ASR mortality), Serbia on the 4th place (16.6), Slovenia on the 6th place (16.2), Bulgaria on the 7th place (16), and Montenegro on the 8th place (15.9). These figures are more or less similar with those obtained in our study for year 2018. The relationship between socio-economic status and CRC mortality is however complex, but generally speaking, the higher CRC mortality, the lower the socioeconomic status of the country was indicated. Actually, limited access to screening in the society with low socio-economic status contributes to a seemingly lower incidence of CRC in these populations with a subsequent increase in mortality, as these patients are presented late in the course of their disease. This is substantiated by the results of Vrdoljak et al. (31) according to which Slovenia, Croatia, Serbia, Bulgaria, and Montenegro, as the Central and Eastern European countries, have higher mortality-to-incidence ratio in comparison to Western European and Nordic countries (Norway, Finland, Sweden, and Denmark) which have higher health expenditure per capita.

Total costs of diagnosis and treatment in the CRC patients are high throughout the world (32–35) and very much depend on the initial TNM stage—the stage I disease is the least costly, whereas stage III is the most expensive due to the high cost of biological agents—monoclonal antibodies (mAbs) (12, 36, 37). In our earlier study, most of the expenses in the end-of-life stage results from inpatient care and administration of chemotherapy (11). In more recent study it was shown that the relative cost of medication was particularly high, accounting from 25.7% (2015) to 30.9% (2017) of total CRC costs in Serbia, while the cost of mAbs dominated other CRC-related expenses and accounted for 11.3, 12.2, 15.0, and 15.2% of all CRC-related expenses in 2014, 2015, 2016, and 2017, respectively (32). High costs associated with the treatment of metastatic CRC, including total drug expenditure was also reported in Croatia (38) and Turkey (39). The scarce data concerning medical costs of cancer services in the Balkan region can, at least partly, be explained by low resources and lack of high-quality cancer registries, national cancer strategic plans, and cost-utility analyses.

To some extent, situation concerning CRC costs associated with the stage of the disease is similar in Western countries with larger GDP. In the German study authors showed that the mean incremental annual costs for each phase of CRC (initial, intermediate, and end-of-life phases), were 26,000; 2,300, and 51,700 euro, respectively (35). In various earlier studies, stage-specific annual cost estimates ranged from 14,982 to 21,264 Euros for early stages and from 29,770 to 34,909 Euros for late stages (40–43).

Therefore, the CRC is an enormous burden worldwide that is expected to increase due to the growth and aging of the population, as well as the adoption of risky behaviors and lifestyle, especially in economically less developed countries (24, 44), such as the Balkan countries. Low socioeconomic status may be an important factor accounting for differences in incidence, mortality and survival rates for CRC. However, better health-care delivery outcomes depend not only on funding: sociocultural, structural, and organizational determinants should be also taken into account when national investment in CRC care are considered and planned (30).

But, globally, ongoing demographic changes will lead to an increasing number of CRC deaths with a doubling of the number of predicted deaths by 2035 (19, 45). Different health systems are facing the challenge of providing care to an increasing population of patients with cancers of all sites, but evidence on costs is limited due to the lack of large longitudinal databases (46). More cost-effective national reimbursement policies could also provide essential savings to the Balkan health systems (12).

CONCLUSIONS

It has been shown that various economic indicators can be linked to the rate of incidence, as well as prevalence of the CRC patients in the Balkan countries. Namely, the GDP per capita levels

(Upper middle income and high income countries) have shown positive correlation with the CRC incidence rate and prevalence. Absolute number of new CRC cases and death-related cases, as well as 5-year CRC prevalence in absolute numbers have shown strong positive correlation with GDP in million current US$. Five-year CRC prevalence (as proportion of the population per 100,000 persons) was also higher in the countries with higher Current Health Expenditure per Capita in US$ comparing with the countries with lower Current Health Expenditure per Capita in US$.

Therefore, economic factors can influence the epidemiology of CRC, and heavy CRC burden in the Balkan region may be one of the indexes of the economic development. Moreover, surveillance of CRC occurrence and outcomes for the development of control strategies should be implemented referring to the Balkan regional, as well as local country level in the future, in order to provide savings to the national health systems.

DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. This data can be found here: https://gco.iarc.fr/; https://apps.who.int/nha/database/ViewData/Indicators/en; http://apps.who.int/gho/data/node.main; https://data.worldbank.org/country.

AUTHOR CONTRIBUTIONS

BV, NR, MJ, and VD-S jointly designed the study and defined research questions. JM, MJ, FP, and NR did most of the data mining and extraction, purification of files for missing data and artifacts, and statistical analysis. BV, NR, MK, ZZ, DJ, FP, JM, SD, RS, and RZ contributed to the tables and figures creation and interpretation of data. BV, VD-S, MJ, and NR drafted the working version manuscript but all authors contributed to the final version to the extent of important intellectual content.

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Cost-Effectiveness of Gliclazide-Based Intensive Glucose Control vs. Standard Glucose Control in Type 2 Diabetes Mellitus. An Economic Analysis of the ADVANCE Trial in Vietnam

Hai-Yen Nguyen-Thi[1], *Nga TQ. Nguyen*[1,2], *Nguyen Dang Tu Le*[1], *Maud Beillat*[3] *and Olivier Ethgen*[4,5]*

[1] Department of Pharmaceutical Administration, Faculty of Pharmacy, University of Medicine and Pharmacy at Ho Chi Minh City, Ho Chi Minh City, Vietnam, [2] Centre for Public Health, School of Medicine, Dentistry and Biomedical Sciences, Queen's University Belfast, Belfast, United Kingdom, [3] Servier Global Market Access & Health Economics and Outcomes Research, Suresnes, France, [4] SERFAN Innovation, Namur, Belgium, [5] Department of Public Health, Epidemiology and Health Economics, University of Liège, Liège, Belgium

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***Correspondence:**
Olivier Ethgen
o.ethgen@uliege.be

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Introduction: ADVANCE was a large, multinational clinical study conducted over 5 years in type 2 diabetes mellitus (T2DM). In all, 11,140 patients were randomly assigned to receive gliclazide-based intensive glucose control (IGC) or standard glucose control (SGC). IGC was shown to significantly reduce the incidence of major macrovascular and microvascular events (composite endpoint) or major microvascular events compared with SGC, primarily by enhancing renal protection. We assessed the cost-effectiveness of IGC vs. SGC, based on the ADVANCE results, from a Vietnamese healthcare payer perspective.

Materials and Methods: A partitioned survival times model across five health states (no complications, myocardial infarction, stroke, end-stage renal disease [ESRD], and diabetes-related eye-disease) was designed. Time-to-event curves were informed by the cumulative incidence of events and corresponding hazard ratios from the ADVANCE study. Health outcomes were expressed in terms of ESRD avoided and quality-adjusted life years (QALYs). Costs (in US $) comprised treatment costs and health state costs. Utility weights and costs were documented from literature reporting Vietnamese estimates. For sensitivity analyses, all parameters were individually varied within their 95% confidence interval bounds (when available) or within a ±30% range.

Results: Over a 5-year horizon, IGC avoided 6.5 additional ESRD events per 1,000 patients treated compared with SGC (IGC, 3.5 events vs. SGC, 10.0 events) and provided 0.016 additional QALYs (IGC, 3.570 QALYs vs. SGC, 3.555 QALYs). Total costs were similar for the two strategies (IGC, $3,786 vs. SGC, $3,757). Although the total drug costs were markedly higher for IGC compared with SGC ($1,703 vs. $873), this was largely offset by the savings from better renal protection with IGC (IGC, $577 vs. SGC, $1,508). The incremental cost-effectiveness ratio (ICER) of IGC vs. SGC

was $1,878/QALY gained, far below the threshold recommended by the World Health Organization (i.e., 1–3 × gross domestic product per inhabitant ≈$7,500 in Vietnam). The ICER of IGC vs. SGC per ESRD event avoided was $4,559/event. The findings were robust to sensitivity analysis.

Conclusion: In Vietnam, gliclazide-based IGC was shown to be cost-effective compared with SGC from a healthcare payer perspective, as defined in the ADVANCE study.

Keywords: gliclazide, intensive glucose control, type 2 diabetes mellitus, hyperglycemia, end-stage renal disease, cost-effectiveness, Vietnam

INTRODUCTION

Worldwide, over 400 million individuals have diabetes; 90% of these have type 2 diabetes mellitus (T2DM) (1). In particular, increased consumption of unhealthy diets high in red or processed meat, refined grains, and sugar-sweetened beverages have been key to the increasing prevalence of T2DM, and the recent rapid transition to such diets has been linked to the increasing prevalence of T2DM in Asia (1). Asian populations appear to be at higher risk of developing T2DM than other ethnic groups. For example, data from the USA have shown that people of Asian descent are 30–35% more likely to develop T2DM than non-Hispanic whites, despite having lower body mass index (2). The prevalence of T2DM in Vietnam is increasing rapidly, as evidenced by an estimated doubling in national prevalence within 10 years (from 2.7% in 2002 to 5.4% in 2012) (3). This increase has consequently created a considerable and growing economic burden in Vietnam (4). For instance, the estimated annual cost per patient with T2DM was 246.10 US dollars, which equates to around 12% of gross domestic product per capita in 2017 (5). Therefore, a clear need exists to reduce the economic impact of the disease.

Treatment of T2DM focuses on the attainment of good glycemic control. Metformin is the first-line medication, combined with lifestyle changes covering diet and exercise (6, 7). Second-line medications include sulphonylureas, a class of drugs that induce glucose-independent insulin secretion (8). Sulphonylureas have been in use for T2DM for decades and their efficacy is well-established (9). They also remain a lower cost option than newer second-line non-insulin agents (6, 7), and real-world data indicate that they are used in a large number of T2DM patients (10). Consequently, sulphonylureas are still the main second-line treatment globally, despite the emergence of newer classes of drugs for glycemic control (11–13). Gliclazide is a sulphonylurea that has been shown to have a better safety profile than other drugs in its class (9). As such, gliclazide remains an important component of the T2DM treatment pathway (8).

In diabetes, hyperglycemia is strongly linked with micro- and macrovascular complications. Microvascular complications include conditions such as retinopathy, neuropathy, and diabetic nephropathy, while macrovascular complications arise from the formation of atherosclerotic plaques in major blood vessels, leading to outcomes such as myocardial infarction and stroke (14). Current diabetes guidelines recommend a target glycated hemoglobin level ≤7.0% (7); however, there is evidence that intensive glucose control (IGC) regimes may offer benefits to patients, particularly with regard to reducing the risk of microvascular complications (15). The Action in Diabetes and Vascular Disease: Preterax and Diamicron Modified Release Controlled Evaluation (ADVANCE) trial was a global, randomized, controlled trial designed to assess the effects of IGC on major vascular outcomes in a broad cross-section of patients with T2DM. Patients were randomized to standard glucose control (SGC, $n = 5{,}569$) or IGC ($n = 5{,}571$), defined as the use of gliclazide modified release plus other drugs as required to achieve a glycated hemoglobin level ≤6.5%, and were followed-up for a median duration of 5.0 years (16). IGC significantly reduced the risk of combined major macro- and microvascular events (composite endpoint) compared with SGC, largely driven by a 21% relative reduction in the incidence of nephropathy (16, 17). A significant reduction in the risk of end-stage renal disease (ESRD) was also observed with IGC compared with SGC during the in-trial period, which persisted during long-term (total 9.9 years) follow-up (18).

With the rapidly increasing prevalence of T2DM in Asia (and notably Vietnam), and the associated economic burden, it is essential that the most cost-effective interventions are identified. The objective of this analysis is to assess the cost-effectiveness of IGC vs. SGC from a Vietnamese healthcare payer perspective, using clinical outcomes identified from the ADVANCE trial.

Abbreviations: ADVANCE, Action in Diabetes and Vascular Disease: Preterax and Diamicron Modified Release Controlled Evaluation; CV, cardiovascular; DRED, diabetes-related eye disease; DSA, deterministic sensitivity analysis; ESRD, end-stage renal disease; HR, hazard ratio; ICER, incremental cost-effectiveness ratio; IGC, intensive glucose control; LY, life year; MI, myocardial infarction; NA, not applicable; PSA, probabilistic sensitivity analysis; QALY, quality-adjusted life year; SGC, standard glucose control; T2DM, type 2 diabetes mellitus; USD, United States Dollars.

METHODS

Model Structure

A partitioned survival model was developed to assess the cost-effectiveness of IGC vs. SGC in Vietnam. The model included five health states representative of T2DM complications and reflecting the key end points included in the ADVANCE trial:

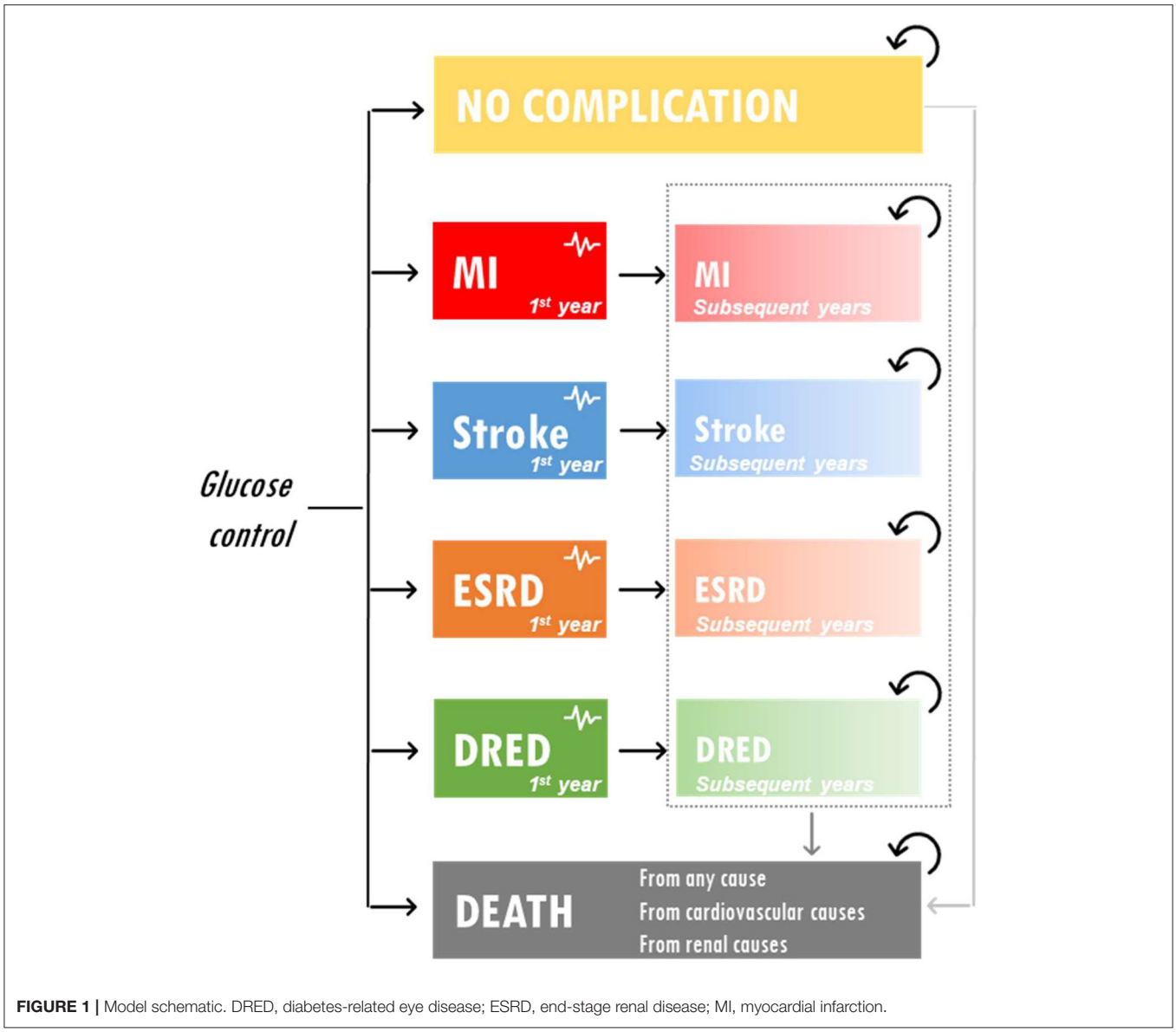

FIGURE 1 | Model schematic. DRED, diabetes-related eye disease; ESRD, end-stage renal disease; MI, myocardial infarction.

TABLE 1 | Patient characteristics at baseline in the ADVANCE trial.

	IGC (*N* = 5,571)	SGC (*N* = 5,569)
Mean (±SD) age, years	66 ± 6	66 ± 6
Female sex, *n* (%)	2,376 (42.6)	2,357 (42.3)
Mean (±SD) age when diabetes first diagnosed, year	58 ± 9	58 ± 9
Mean (±SD) duration of diabetes, years	7.9 ± 6.3	8.0 ± 6.4
Mean (±SD) standardized glycated hemoglobin*, %	7.48 ± 1.65	7.48 ± 1.63

**Laboratories participating in ADVANCE underwent a standardization process using the Wales External Quality Assurance Scheme. Source (16).*

no complications, myocardial infarction, stroke, ESRD, and diabetes-related eye disease. The model structure is presented in **Figure 1**. Costs were reported in US dollars and health outcomes were expressed in terms of life years (LYs), quality-adjusted life years (QALYs), and ESRD events avoided. The model had a time horizon of 5 years to be aligned with ADVANCE. A discount rate of 3% was applied to both costs and outcomes.

Efficacy and Safety Outcomes

Efficacy and safety outcomes for the IGC and SGC treatment approaches were derived from the ADVANCE study (16). For each complication, time-to-event curves were informed by the cumulative incidence of events and corresponding hazard ratios. Baseline patient characteristics and clinical inputs included in the model are presented in **Tables 1**, **2**.

Costs and Health Utilities

Costs were estimated from a national healthcare payer perspective and included treatment costs and health state

TABLE 2 | Clinical inputs included in the model.

	Base case	DSA lower value*	DSA upper value*	PSA distribution	Source
Deaths from any cause					
Standard	9.6%	6.7%	12.5%	Beta	Advance Collaborative Group NEJM 2008 (16)
$HR_{Intensive\ vs.\ standard}$**	0.93	0.83	1.06	Log-normal	Advance-ON Collaborative Group NEJM 2014 (19)
Major macrovascular events					
Standard	10.6%	7.4%	13.8%	Beta	Advance Collaborative Group NEJM 2008 (16)
$HR_{Intensive\ vs.\ standard}$	0.94	0.84	1.06	Log-normal	Advance-ON Collaborative Group NEJM 2014 (19)
Death from CV causes					
Standard	5.2%	3.6%	6.8%	Beta	Advance Collaborative Group NEJM 2008 (16)
$HR_{Intensive\ vs.\ standard}$	0.88	0.74	1.04	Log-normal	Advance-ON Collaborative Group NEJM 2014 (19)
MI					
Standard	3.4%	2.4%	4.4%	Beta	Advance Collaborative Group NEJM 2008 (16)
$HR_{Intensive\ vs.\ standard}$	1.01	0.83	1.24	Log-normal	Advance-ON Collaborative Group NEJM 2014 (19)
Stroke					
Standard	4.4%	3.1%	5.7%	Beta	Advance Collaborative Group NEJM 2008 (16)
$HR_{Intensive\ vs.\ standard}$	0.96	0.81	1.15	Log-normal	Advance-ON Collaborative Group NEJM 2014 (19)
Major microvascular events					
Standard	4.4%	3.1%	5.7%	Beta	Advance Collaborative Group NEJM 2008 (16)
$HR_{Intensive\ vs.\ standard}$	0.86	0.72	1.03	Log-normal	Advance-ON Collaborative Group NEJM 2014 (19)
ESRD					
Standard	1.0%	0.7%	1.3%	Beta	Advance Collaborative Group NEJM 2008 (16)
$HR_{Intensive\ vs.\ standard}$	0.35	0.15	0.83	Log-normal	Advance-ON Collaborative Group NEJM 2014 (19)
Death from renal causes					
Standard	0.4%	0.3%	0.5%	Beta	Advance Collaborative Group NEJM 2008 (16)
$HR_{Intensive\ vs.\ standard}$	0.85	0.45	1.62	Log-normal	Advance-ON Collaborative Group NEJM 2014 (19)
DRED					
Standard	3.9%	2.7%	5.1%	Beta	Advance Collaborative Group NEJM 2008 (16)
$HR_{Intensive\ vs.\ standard}$	0.90	0.74	1.09	Log-normal	Advance-ON Collaborative Group NEJM 2014 (19)
Major hypoglycemia					
Standard	1.5%	1.1%	2.0%	Beta	Advance Collaborative Group NEJM 2008 (16)
$HR_{Intensive\ vs.\ standard}$	1.85	1.42	2.42	Log-normal	Advance-ON Collaborative Group NEJM 2014 (19)

*±30% margins.

**95% confidence interval as reported in the ADVANCE study.

CV, cardiovascular; DRED, diabetes-related eye disease; DSA, deterministic sensitivity analysis; ESRD, end-stage renal disease; HR, hazard ratio; MI, myocardial infarction; PSA, probabilistic sensitivity analysis.

costs. In the absence of reliable Vietnamese estimates, health state costs were derived from published data in Thailand (20) using purchasing power parity exchange rates (21). Cost of death was assumed to be zero (regardless of cause), and drug costs were taken from Vietnamese sources. The Vietnamese national insurance payer reimburses medication costs on a case-by-case basis (22), and drug pricing in each healthcare unit is based on the procurement price published by the Ministry of Health (Drug Administration of Vietnam) or Social Insurance Office in the last 12 months (23). Therefore, drug costs were retrieved from the procurement price list published by the Drug Administration of Vietnam (latest version published September 2018).

In order to adjust LYs gained to produce the outcome of QALYs in the model, health-related quality of life data were required to determine the impact of different health outcomes on patient utility. Utility values are measured on an interval scale with 0 reflecting death and 1 reflecting perfect health. As the ADVANCE study did not evaluate health-related quality of life, utility weights were derived from published health-related quality of life estimates using the EQ-5D-5L instrument in Vietnam (24). Disutility weights were obtained from previous cost-effectiveness studies, notably the Core Diabetes Model (25). All costs and health state utilities included in the model are presented in **Table 3**. For costs and utilities, a distinction was made between the year of occurrence and subsequent year for each health state.

Sensitivity Analyses

Uncertainty surrounding input parameter values was addressed by conducting deterministic sensitivity analyses in which one input parameter value was varied at a time. Base-case values were varied within their 95% confidence interval bounds (when available) or within a ±30% range. Probabilistic sensitivity analyses were also performed in order to determine the impact of parameter uncertainty on the outcomes of the model. In this

TABLE 3 | Summary of costs and utilities included in the model.

	Base case	DSA lower value*	DSA upper value*	PSA distribution	Source
Annual costs of drug regimen (USD)					
Standard glucose control	164	115	319	Gamma	Procurement price list, Drug Administration of Vietnam
Intensive glucose control	319	223	415	Gamma	Procurement price list, Drug Administration of Vietnam
Health state costs (USD 2014)					
Myocardial infarction					Permsuwan et al. (20)
1st year	14,975	10,483	19,468	Gamma	
Subsequent years	3,751	2,626	4,876	Gamma	
Stroke					Permsuwan et al. (20)
1st year	10,051	7,036	13,066	Gamma	
Subsequent years	3,364	2,355	4,373	Gamma	
ESRD					Permsuwan et al. (20)
1st year	86,397	60,478	112,316	Gamma	
Subsequent years	59,411	41,588	77,234	Gamma	
DRED					Permsuwan et al. (20)
1st year	4,352	3,046	5,658	Gamma	
Subsequent years	2,643	1,850	3,436	Gamma	
Major hypoglycemia					Permsuwan et al. (20)
Per event	3,885	2,720	5,051	Gamma	
Health state utilities					
Population norms					Nguyen et al. (24)
Baseline age (i.e., 66 years)	0.810	0.567	1.000	Beta	
5 years after (i.e., 71 years)	0.808	0.566	0.810	Beta	
Events disutilities (%)					
Myocardial infarction					Palmer et al. (25)
1st year	−15.9	−11.1	−20.6	Beta	
Subsequent years	−9.6	−6.7	−12.5	Beta	
Stroke					Palmer et al. (25)
1st year	−22.2	−15.6	−28.9	Beta	
Subsequent years	−33.1	−23.1	−43.0	Beta	
ESRD					Palmer et al. (25)
1st year	−35.5	−24.9	−46.2	Beta	
Subsequent years	−35.5	−24.9	−46.2	Beta	
DRED					Palmer et al. (25)
1st year	−9.8	−6.9	−12.8	Beta	
Subsequent years	−9.8	−6.9	−12.8	Beta	
Major hypoglycemia					Palmer et al. (25)
Per event	−0.6	−0.4	−0.8	Beta	

*±30% margins.

CV, cardiovascular; DRED, diabetes-related eye disease; DSA, deterministic sensitivity analysis; ESRD, end-stage renal disease; PSA, probabilistic sensitivity analysis; USD, United States Dollars.

analysis, multiple parameter values were varied simultaneously and a Monte Carlo simulation was run (1,000 iterations). For utility and proportions, a Beta distribution was assumed, whereas hazard ratios were assumed to follow a Log-Normal distribution and costs a Gamma distribution (26).

RESULTS

Base-Case Analysis

The results of the base-case analysis are presented in **Table 4**. Over 5 years, IGC resulted in the avoidance of 6.5 additional ESRD events per 1,000 patients treated compared with SGC (3.5 events vs. 10 events, respectively). The incremental LYs and QALYs were 0.017 and 0.016, respectively, for IGC compared with SGC (LYs; IGC, 4.777 vs. SGC, 4.760: QALYs; IGC, 3.570 vs. SGC, 3.555). Although the treatment costs were higher for IGC ($1,703) than SGC ($873), this was largely offset by the savings from the reduced number of ESRD events with IGC ($577) vs. SGC ($1,508). This resulted in very similar total costs between the two strategies (IGC, $3,786 vs. SGC, $3,757). The resulting incremental cost-effectiveness ratios (ICERs) were $4,559, $1,764, and $1,878 per ESRD event avoided, LY gained, and QALY gained, respectively.

Deterministic Sensitivity Analyses

Results from the deterministic sensitivity analysis are presented in **Figure 2**. The ICER was most sensitive to variations in

TABLE 4 | Base-case model results.

	Absolute		Incremental	
	Standard	**Intensive**		**% change**
ESRD event (per 1,000 patients)	10.0	3.5	−6.5	−65.0%
LYs	4.760	4.777	0.017	+0.4%
QALYs	3.555	3.570	0.016	+0.4%
Costs (USD)	3,757	3,786	30	+0.8%
Treatment	873	1,703	831	+95.2%
MI	480	493	13	+2.6%
Stroke	463	451	−11	−2.4%
ESRD	1,508	577	−931	−61.7%
DRED	276	272	−5	−1.6%
Hypoglycemic event	157	290	133	+85.0%
Death	0	0	0	NA
ICER ESRD avoided			4,559	
ICER LY			1,764	
ICER QALY			1,878	

DRED, diabetes-related eye disease; ESRD, end-stage renal disease; ICER, incremental cost-effectiveness ratio; LY, life year; MI, myocardial infarction; NA, not applicable; QALY, quality-adjusted life year; USD, United States Dollars.

treatment costs and clinical outcomes, most notably with variations in the risk of experiencing ESRD events. Using the lower range of treatment costs for SGC or the upper range of treatment costs for IGC increased the ICER per QALY gained to $18,463 and $34,248, respectively. Applying the upper range of the treatment costs for SGC or the lower range of the treatment costs for IGC would lead to IGC becoming the dominant strategy. Using the lower range of the hazard ratio (IGC vs. SGC) for ERSD events (i.e., assuming that IGC is more effective than in the base-case analysis) would result in IGC becoming dominant, whereas using the higher range of the hazard ratio (i.e., assuming that IGC is less effective than the base-case analysis) increased the ICER per QALY gained to $45,171. The ICER did not change substantially across the other parameters tested (data not shown), including health state utilities, discounting rates, and most health state costs (with the exception of costs associated with ESRD events and major hypoglycemic events).

Probabilistic Sensitivity Analyses

The results of the probabilistic sensitivity analysis are shown in **Figure 3**. The cost-effectiveness acceptability curve suggests that IGC becomes the strategy with the highest probability of

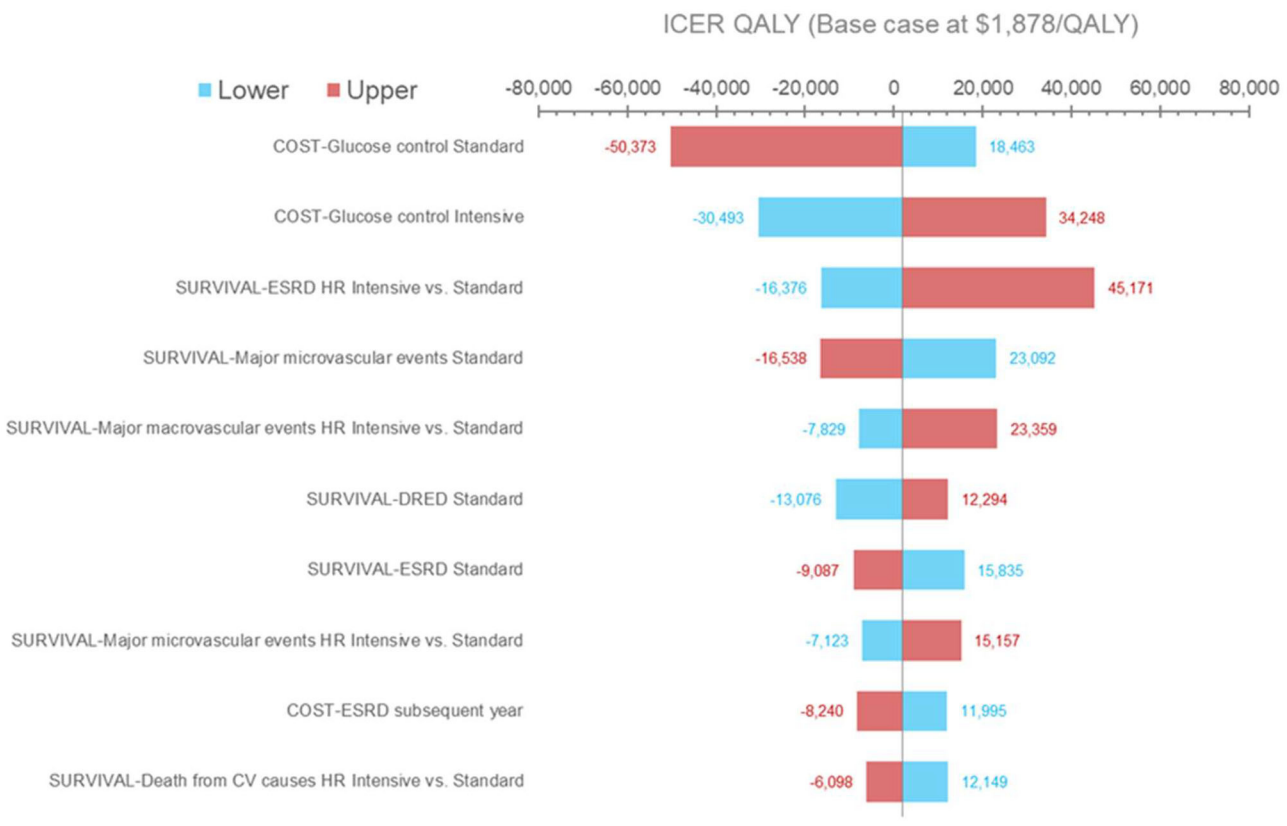

FIGURE 2 | Deterministic sensitivity analysis results (QALYs). Results of the one-way sensitivity analysis in which several model input parameters were varied to determine their effect on output. Blue bars and red bars represent the lower and upper bound of each parameter varied, respectively. The horizontal axis represents the incremental cost-effectiveness ratio value per QALY gained. The vertical center line represents the base case. CV, cardiovascular; DRED, diabetes-related eye disease; ESRD, end-stage renal disease; HR, hazard ratio; ICER, incremental cost-effectiveness ratio; QALY, quality-adjusted life year.

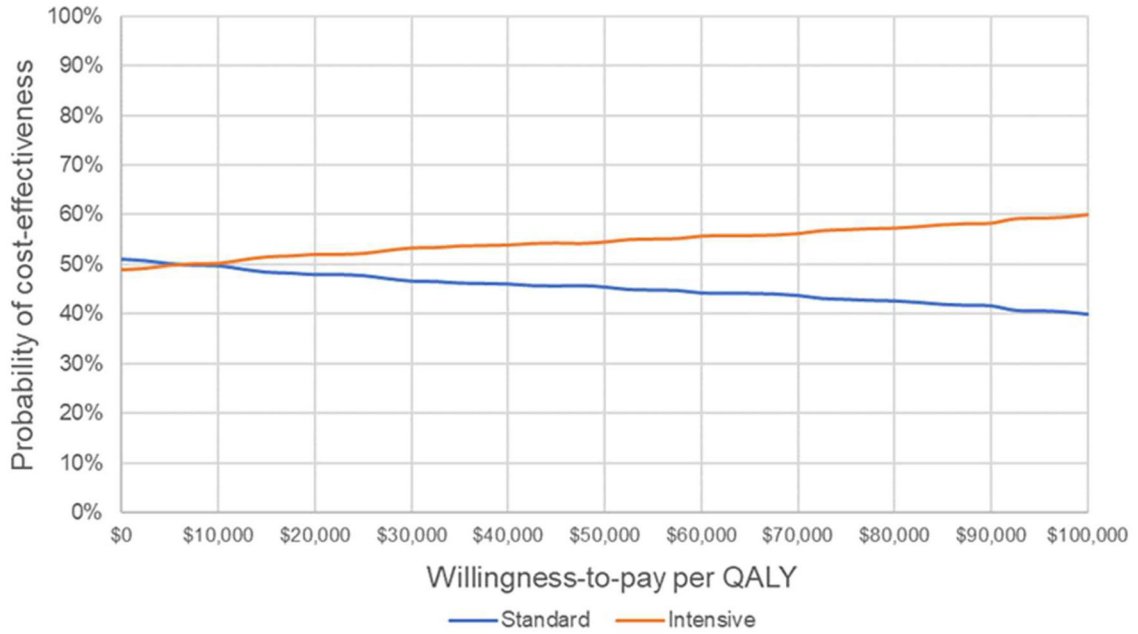

FIGURE 3 | Cost-effectiveness acceptability curve. Probability that each strategy is cost-effective at varying willingness-to-pay thresholds. QALY, quality-adjusted life year.

cost-effectiveness from a willingness-to-pay threshold of ∼$7,000 per QALY.

DISCUSSION

The results of this cost-effectiveness analysis indicate that IGC is cost-effective in Vietnam compared with SGC. The ICERs/QALY gained for the base-case analysis compare favorably with the World Health Organization cost-effectiveness threshold for intervention, which at 1–3 times gross domestic product per capita for intervention (27) is ∼$7,500 in Vietnam [2018 value; (28)]. As a result of the increasing prevalence of T2DM in Vietnam (3), and the considerable and rising economic burden it creates (4), more widespread adoption of effective and cost-effective interventions could have a substantial public health impact. However, knowledge and awareness of T2DM among the general population of Vietnam and similar countries is low (29) and, compliance with treatment and awareness of the importance of diabetes control requires considerable improvement (30). Therefore, disease awareness campaigns and education programs are required alongside effective pharmacotherapies to maximize the potential public health benefit.

There is increasing demand for more efficient allocation of scarce healthcare resources. This demand is particularly great in highly prevalent chronic diseases such as T2DM, due to their potential impact on patient quality of life and healthcare expenditure. Vietnam is in the early stages of adopting health technology assessments to guide decisions on allocation of healthcare resources (31, 32). Therefore, analyses such as the current one will be an important component of health technology assessments needed to support policymakers with decision-making.

The IMS CORE Diabetes Model (CDM) is a widely published and validated simulation model applied to type 1 and T2DM (33). The CDM is used to estimate long-term health and economic outcomes for populations, accounting for detailed past history, disease management and physiological parameters. We therefore developed a partitioned survival model as a more appropriate way to conduct a trial-based cost-effectiveness analysis. The economic analysis presented here has a number of strengths, but also some limitations. Strengths include the fact that it utilizes clinical data from a large, randomized, controlled trial conducted across many countries (with a wide variety of health systems and incomes). In addition, scenario analyses showed that the model used is highly sensitive to variations in treatment costs and clinical outcomes, demonstrating that the model has high internal validity. Furthermore, the adaptation process was thorough and followed published methodological recommendations (34). A potential limitation of the current analysis is that the comparisons and model were based on 5-year data (the duration of the ADVANCE study). No extrapolation beyond 5 years was included, due to the high level of uncertainty involved (for example, with respect to treatments received beyond the in-trial 5-year follow-up, and also an absence of data on adherence/persistence in Vietnam). Furthermore, less than half of patients in ADVANCE were from the Asian region (and none of the included patients were from Vietnam), and

adaption to the Vietnamese population required use of estimates based on published literature. Nevertheless, sensitivity analyses support the utility of the model used. The comparison used in the model also omitted newer classes of drugs available for the management of T2DM (including sodium-glucose co-transporter-2 inhibitors, dipeptidyl peptidase-4 inhibitors, and glucagon-like peptide 1 receptor agonists), which have been shown to provide benefits (35). However, use of these newer drugs may be limited by affordability and accessibility (7). In addition, data from a multi-center study in Vietnam indicate that sulphonylureas are much more widely used for glycemic control (55% of patients) than dipeptidyl peptidase-4 inhibitors (3%; personal communication). Therefore, sulphonylureas are probably more relevant than newer drug classes to emerging countries such as Vietnam (6, 36). Recent analyses based on systematic literature reviews have highlighted that the clinical and economic burdens of T2DM are greater in emerging markets than in established markets (37), further emphasizing the need for affordable and sustainable strategies to reduce these burdens. It is also important to point out that generic versions of gliclazide are available, which would impact the cost (and therefore cost-effectiveness) of gliclazide-based regimens. As information on the type/cost of gliclazide used in ADVANCE is not available, we used the cost of branded/originator gliclazide in our analysis.

In summary, this economic analysis showed gliclazide-based IGC to be very cost-effective compared with SGC. The findings will be informative for policymakers when making decisions on healthcare resource allocation.

DATA AVAILABILITY STATEMENT

The original contributions generated for the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

All authors have contributed substantially to the study. OE designed the study, programmed the analysis, acquired the data from the literature, and ran the analysis. H-YN-T, NN, and NL provided experts' advice and further contributed to the acquisition of data from the literature. All authors checked assumptions ranges and interpreted the results. OE and MB drafted the manuscript that was reviewed and revised by all authors. Lastly, all authors approved the final submitted version of the manuscript.

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REVIEW
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Achieving Sustainable Development Goals (SDGs) in Sub-Saharan Africa (SSA): A Conceptual Review of Normative Economics Frameworks

Michael E. Otim[1,2]*, *Amina M. Almarzouqi*[1], *Jean P. Mukasa*[3] *and Wilson Gachiri*[4]

[1] University of Sharjah, College of Health Sciences, Sharjah, United Arab Emirates, [2] Nexus International University, College of Graduate and Research, Kampala, Uganda, [3] Fatima College of Health Sciences, Ajman, United Arab Emirates, [4] The Birmingham Leadership Development Centre, Dubai, United Arab Emirates

Background: The health status of the Sub-Saharan African (SSA) countries is well below that of the rest of the world. Coupled with low per capita income, these countries have agreed and committed themselves to raising their health status equitable standard by addressing United Nations (UN) Sustainability Development Goal number 3 (SDG3) by 2030. Addressing SDG3 requires increased and equitable funding for universal health coverage, healthcare infrastructure, efficient resource allocation, improved priority setting, reduction in corruption, and other strategies. However, what is urgently needed to improve priority setting processes or meaningful health system reform, among other things. There is therefore a need for the exploration of the economic and non-economic (which includes social justice) explicit criteria that ought to form the normative framework for Decision Making. These explicit criteria include efficiency, burden of disease, equality (strict egalitarianism), equity, and explicit criteria.

Methods: The ultimate aim was to identify explicit values/principles/criteria that can be used to formulate an ideal normative framework to be used to guide decision Making so as to improve SDG3 in SSA. We synthesized selected literature on the normative frameworks for priority setting processes in health in SSA was undertaken, and the explicit criteria which, ought to guide these frameworks were identified. The form of the Social Welfare function and its principles was identified.

Results and Conclusions: The framework and its explicit criteria for priority setting in the SSA countries that ought to be adopted in order to improve their SDG3 was identified—Non-Welfarist framework. This framework allows utility, health and other important social values/attributes/principles to enter the normative SWF. It is argued that such a framework ought to be specified empirically and concurrently by the decision-makers and members of the community representatives. Community representatives ought to be recognized as legitimate claimants of the resources determined, and should therefore be allowed to have a role in specifying the arguments in the SWF and what weights to be attached to the stated arguments. This implies that the selection of options in decision-making should focus on maximizing benefit and minimizing the opportunities forgone as stated in the framework.

Keywords: normative frameworks, social justice, equity, priority setting, resource allocation, Sub-Saharan Africa (SSA), sustainable development goals (SDGs)

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Svetlana Radevic,
University of Kragujevac, Serbia

***Correspondence:**
Michael E. Otim
motim@sharjah.ac.ae

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BACKGROUND

Sub-Saharan African (SSA) countries have significantly poorer health outcomes than the rest of the world in spite their efforts at addressing Millennium Development Goals (MDGs). Later, the United Nations (UN) developed the Sustainable Development Goals (SDGs) to replace the MDGs, with Goal number 3 focusing on health (SDG3). SSA countries signed up and pledged to achieve the specified targets by 2030 while addressing the needs of all persons with disabilities (1). All countries that have signed up to the SDGs aim to achieve goals such as neonatal mortality rates to 12 per 1,000 live births and under-5 mortality rate to at least 25 per 1,000 live births, Non-Communicable Disease (NCDs) and other SDG3 sub-goals. These countries have pledged to increase their investments in health to improve health outcomes such as the reduction of the global maternal mortality indicator (to <70 per 100,000 live births); and end preventable deaths of newborns and children under 5 years of age (1). However, SSA countries face several inequities within themselves and in comparison, with other countries.

SSA is a diverse group by population, size, and income levels. They are economies, according to World Bank, that include countries with gross national income per capita between $1,006 and $3,955 per capita and those between $3,956 and $12,235 (2). The World Bank further reports that SSA account for the 75% of the world's population and 62% of the world's poor. Thirty percentage of the global domestic product and are potentially significant engines of global growth.

The strategies to achieve SDG3 in SSA countries may include the following (1):

1. Addressing the funding issues for providing health care services and enabling people's access to health insurance for services.
2. Employing other strategies that SSA countries ought to employ such as addressing structural challenges in the health care systems and strengthening the human resources for health.
3. Strengthening country's capacities for early warning and awareness, risk reduction and management of national and global health risks.
4. Lastly but not least, SSA countries improving the Decision Making (priority setting) frameworks so as to invest the scarce resources efficiently and equitably, and what normative framework ought to be used to appropriately to inform such decision making.

This paper focuses on the last point above—improving the decision making process from an economics perspective, whilst recognizing the role of non-economic frameworks given that, markets alone fail to allocate resources optimally and in socially desirable manners. From an economics perspective, it is important to maximize health outcomes (SDG3) for the given investments, whereas losers from such investments ought to be compensated, and the community ought to be involved in the decision making process to enhance transparency and accountability. Two major options exist: either the healthcare systems should be reformed and/or; the decision-making (priority-setting) process by government should be improved. Improvement in priority setting ought to include: the use of evidence; equitable allocations of scarce resources; and transparent processes through an appropriate normative framework.

This study aims to develop the explicit criteria or principles to guide decision-making, and develop normative frameworks for Priority Setting as a means to achieve SDG3. Decision making or Priority setting is defined here as a non-market based economic mechanism of allocating resources or "identifying who gets what at whose expense" (3). These strategies are essential for creating physical, social, and policy environments that will sustain and enhance health and well-being. The combination of targets under SDG3 require inter-sectoral collaborations with interdisciplinary approaches. Of course, it is imperative that these countries reform their health systems to improve services delivery and increase financing (such as universal health coverage) to target SDG3—an issue to be investigated later.

The justification for focusing on priority setting in SSA can be traced, to the evidence of failure for markets alone to allocate resources optimally to improve outcomes to achieve SDG3. First, there is clear evidence of inefficiencies in sectors of health systems. Second, expenditure in health does not seem to reflect the scale of the health problem, since access and health coverage is not adequate—hence the call for universal coverage. Finally, priority-setting exercise is often implicit and therefore lack transparency in the allocations and trade-offs of those allocations. Thus, the need for an explicit process. The key challenge however is how to explicitly specify a normative framework, which ought to guide explicit priority setting in health in the SSA given its context. The research question was: What does the explicit normative framework to guide priority setting in SSA look like and what explicit criteria ought to inform it?

Objectives to be addressed included:

- To identify the economic principles which underpin priority setting?
- To identify the forms of the Social Welfare Functions (SWF), which are suitable in the development of the framework for Priority Setting. Social welfare refers to the overall economic welfare of society, and it can be specified using specific principles, with strong assumptions, as the summation of the welfare of all the individuals in the society (4).
- Identify the principles or values that ought to enter the SWF for priority setting.
- Specify the SWF which embodies or has potential to embody non-economic principles such as equity and social justice which ought to guide priority setting.
- Finally, we then present the normative framework which ought to guide SSA in their efforts to achieve SDGs.

METHODS

This paper draws knowledge from the theoretical frameworks in economics, health economics, and social justice. The ultimate aim was to identify the explicit criteria that can be used to

Abbreviations: SDGs, Sustainable Development Goals; SSA, Sub-Saharan Africa; P/S, Priority Setting; UN, United Nations; WHO, World Health Organization.

formulate an ideal normative framework to be used to guide priority-setting so as to achieve SDG3 in SSA.

We searched the electronic databases such as Medline, CINAHL, PubMed, EMBASE, PubMed Central (PMC), and Library book collections for relevant books, book chapters, and peer-reviewed articles. We also did a Google search of the internet in general. The following key words: resource-allocation, normative economics, priority-setting, and values/principles, were used to search the databases and the Internet. Studies done in Low and Middle Income Countries (LMIC), social justice and health, and others were selected and studies done in high income countries were excluded.

The top 200 results from the databases and Google searches were further screened for the relevance. The synthesis of the literature on the normative frameworks for priority setting processes in health in SSA was undertaken, and the principles which, ought to guide these frameworks were identified. The form of the Social Welfare function and its principles was then developed.

CONTRIBUTION FROM ECONOMIC FOUNDATIONS FOR P/S

To achieve SDG3 in SSA, it is critical to identify explicit principles that ought to guide the decision making process. Such principles could involve effectiveness, equity, equality, opportunity costs, and efficiency of interventions and health outcomes to be built into the normative economic framework to drive the priority setting process. It is important therefore, to develop a conceptual normative framework that makes use of such explicit principles to achieve SDG3 in SSA from an economic and social justice perspectives.

Resource Allocation From an Economics Perspective

The foundation of economics is opportunity cost—the benefits of alternative policy actions taken due to choices made in allocations of limited resources. Opportunity cost principles are recognized, on the basis that society's need/wants are infinite yet the resources to address those needs are limited or scarce, constituting the second key principle of economics for PS. It is the notion that, resources for addressing needs and insatiable wants are scarce, and so decision-makers have to make choices or trade-offs. Trade-offs inevitably generate losers and winners from an economic activity. The losers have to be compensated in principle. Decision-making from an economic perspective occurs at the margin as incremental change (hence marginal analysis), and ought to minimize losses and/or maximize gains from the resources allocated (efficiency) (5, 6). Marginal analysis (MA) is a tool for generating efficiency.

Normative economics is often referred to as welfare economics, and uses microeconomic techniques to simultaneously determine allocative efficiency and the income distribution associated with it (4, 7). It links the competitive market mechanism with Pareto optimality, by stipulating a social welfare improvement from one inferior social state to a superior one. A competitive market allows for resource allocation maximization or Pareto optimality to be achieved, allowing an invisible hand of competition to transform private greed into social welfare (5, 8–10). A competitive market assumes that there are infinite number of self-interested agents, they freely enter and exit the market, and have full information about the goods and services. It also assumes that agents pay a full price for their consumption of the normal goods and services in the market (4, 11). When a competitive market exists, the competitive equilibrium occurs via marginal analysis, ensuring that maximization or Pareto optimality is achieved (5, 9, 12, 13). Thus, a competitive market equilibrium ensures that maximization or Pareto optimality is achieved, allowing an invisible hand of competition to transform private greed into social welfare. However, when the above conditions for perfect competition are not present, markets alone fail to allocate resources optimally and equitably in health care (Market Failure).

Justification for Government Involvement in Resource Allocation in Health Care

When market failure occurs in the health, government intervention becomes necessary. SDG3 in particular, is prone to market failure due to information asymmetry and lack of access to healthcare (10, 14–17). Further, market failure occurs due to: people's inability to pay for the services; information asymmetry between consumers and providers; externalities; monopoly power; and pure public goods in the market (6, 10, 14–16).

People's inability to pay for healthcare determines one's access to such services, thus justifying government involvement in the healthcare market. For example, the UN is helping Sub-Saharan African Countries to access funding or loans from different sources to ensure that their citizens have universal health coverage (1). Furthermore, information asymmetry between patients and healthcare providers is inherent in health, since doctors having better information about the consumers' health, health care interventions and risk factors than the patient (8). This asymmetry violates the consumer sovereignty. So, privately determined consumption may lead to inefficient allocations, providing justification for government intervention.

Another important issue is that of externalities. This is when one consumer's actions affects the well-being of other consumers, resulting in market failure. In order to correct these externalities, government intervenes either to restore market competition or takes over the resource allocation (6, 13, 14). Another cause of market failure in health is the concept of pure public goods, a class of goods which private providers may not be able to supply adequately. These goods are characterized by non-excludability and non-rivalry in their consumption (6, 15). In these cases, improving SDG3 in SSA becomes a responsibility of the government.

Equity is another case where the market allocation cannot address due to the uniqueness of health as a good, hence market failure. Equity involves the ethical judgments about the fairness of the distribution of the costs and benefits of the health outcomes

in the community, the fairness of the process of allocation (due process), or identification of the gainers and losers (4, 6, 17–19). To achieve equity in health in SSA requires government intervention, and this may require evidence for policy making to improve decision making, reform of the health systems, and universal health coverage. The challenge however, is how such evidence can be specified and incorporated in the *t* decision-making frameworks and models—a task addressed in this paper. However, challenges exist on how to use economic principles in decision making.

Social Welfare Functions

Given the challenges of choosing between alternative options from an allocation, the achievement of the social optimum shifted to the SWF. The SWF is a function which ranks social states as less desirable, more desirable, or indifferent for every possible pair of social states to aid decision making. Several SWFs have been proposed under the N-C welfarist framework and may include the Bergson-Samuelson SWF, and the axiomatic SWF of Ng, Fleming, Harsanyi, and Nash (4, 7, 11, 20). One popular N-C welfarist SWF is the utilitarian social welfare function, also called a Benthamite welfare function (17). This SWF sums up the utility of each individual in order to obtain society's overall welfare. All people are treated the same, regardless of their initial level of utility. One extra unit of utility for a starving person is not seen to be of any greater value than an extra unit of utility for a millionaire. The N-C Welfarist SWF can be defined as a function of only individual utilities/welfares (4, 7, 11, 20):

$$\begin{aligned} \text{SWF} &= f(U_1, U_2 \ldots U_i) \text{ or SWF} \\ &= f(U_1) + f(U_2) + \ldots\ldots + f(U_i) \end{aligned}$$

Where U_i stands for the utility/satisfaction/happiness of the ith individual.

Thus, individual consumer preferences/utilities would be elicited from the individuals and then aggregated to form one social preference or health constitution (21). Under normative economic frameworks, maximizing the social preference or outcomes for the given resource allocation (efficiency). Thus, the key criterion to be incorporated in an economic normative framework. Under the perfect market mechanism resource allocation occurs at desirable level—equitable distributions automatically occur. However, when market failure occurs, the free market allocation fails to achieve equity as a criterion.

Non-economic Principles

Equity and other social justice principles are unfortunately not clearly articulated in economics, and therefore tend to be left out in normative economic frameworks. Equality for example, is the key principle in egalitarianism and in the Rawlsian theories of social justice. Rawls stated that it is "a standard whereby the distributive aspects of the basic structure of society are to be assessed" (22). According to Rawls, the principles of justice are manifested as part of the social contract that is chosen by free and rational human beings who are behind the "veil of ignorance" of their own places in society. Under Rawls's theory, the equality principle may be expressed as equal rights, liberties, health, and/or opportunities.

The equality principle signifies a relationship between groups of persons that have similar qualities in at least one respect, such as equality of health outcomes. It may be expressed as "equality in outcomes," "equity," "equality in opportunities," "equality in access or use," "equal human rights," or "equal treatment for equal need" (23). Equity principle is a generally used principle in economics, however, it is not clearly articulated. The equality principle contrasts with the equity principle, in that the equality principle seeks to satisfy all needs regardless of effort and socio-economic status. Equity principle may emphasize distributive justice at the expense of procedural justice issues.

In whatever way it is defined, equity principle has been a dominant reason for government intervention in the health sector to reduce inequalities in population health, to achieve a fair and just process of allocation (24). It is generally defined in economics as equality in the distribution of some phenomena in a socially desirable way such as wealth, rights, etc. but with some added qualification such as "equality of need" (25–28). Two approaches are being used by several countries and SSA countries are attempting translate equity principles into practice (29): horizontal equity and vertical equity. Horizontal equity assumes that the groups or individuals being addressed have equal economic and social standards, and therefore their health needs or the ability to pay is the same. The application of horizontal equity is more suited, to a limited extent, to the allocation of resources within countries or regions in the SSA communities themselves. Health problems between SSA communities themselves are highly disparate, such as between rural and remote communities areas (29). It would not seem appropriate to assume that these two groups have the same health needs. The use of horizontal equity criterion between communities vis-à-vis the rest of the country, would be inequitable and unfair. Vertical equity would be the appropriate principle. Vertical equity refers to the notion of unequal but equitable treatment. The vertical and horizontal equity principles would enter the social welfare function.

The equity principle explains the role of justice in social interactions and priority setting that may be motivated by both self-interest and the desire to address perceived inequities. According to the advocates of equity, a fair SSA economic system would be the one that distributes goods to SSA individuals in proportion to their efforts (30). Effort typically comes in the form of productivity, ability, or talent. More effort in an economic activity ought to be rewarded more, and vice versa. A range of economists have offered several concepts to explain the notion of equity in health care and these have been summarized (8). These explanations emerged from the work done in the United Kingdom's National Health Service, and they all lead to the concept of "equal access for equal need" as a guiding principle for resource allocation. Olsen argued that this approach is egalitarian because it emphasizes an equitable distribution of health profiles (31).

NORMATIVE FRAMEWORKS FROM ECONOMICS FOR PS

In economics, the explicit criteria that inform decision making may include opportunity costs, efficiency, and equity. The normative economic frameworks make use of explicit economic criteria to ensure efficient and socially desirable allocation of resources. Other criteria may include: equality; access; needs; and due process. Socially desirable outcomes are often viewed as equitable distribution of outcomes. Equality is often treated as the central principle for social justice. Rawls stated that it is "a standard whereby the distributive aspects of the basic structure of society are to be assessed" (22). The challenge, however, is how to specify it the normative frameworks: N-C Welfarist framework or the Non-Welfarist ones.

N-C Welfarist Normative Economic Frameworks

The N-C welfarist framework is deeply rooted in consequentialism—a moral theory which holds that, a morally right action or rules, and such actions are to be evaluated in terms of their utility—good outcomes or consequences, only (4). Under different normative frameworks, such as the N-C welfarist approach or the non-welfarist approach, arguments in the SWF can be defined in different ways. Furthermore, the aggregation of these welfares can take different forms. Hurley summarizes the key features of the N-C Welfarist approach to normative economics to include the following (32): Welfarism; consumer sovereignty; utility maximization (behavioral assumption); and consequentialism. Welfarism relies on the notion that social welfare is only a function of individual utilities which are derived from only goods and services (32, 33). Utility is defined by revealed preferences which are assumed not to be distorted by ignorance, imperfect foresight, or misinformation because the individuals are "rational" and "responsible" in their choice making (17, 34).

The N-C Welfarist framework further assumes that individuals are the best judges of their welfare (consumer sovereignty) because the market is perfectly competitive. It advocates the reward of individual effort through the market system and it ignores the issue of the overall distribution of resources. This assumption ensures that the free market mechanism is accorded the supremacy to allocate resources efficiently. The policy implication is that with full information and no consumption externalities, consumers are able to maximize their utility (8, 35). However, the N-C welfarist framework for allocating resources is rejected by the non-welfarist approaches on ethical grounds.

Non-welfarist Normative Economic Frameworks

The non-Welfarist frameworks are referred to as extensions beyond Welfarism, and include those approaches that allow non-utility attributes to be used to define the SWF. These approaches may include extra-Welfarist, communitarianism, capability approaches, decision-making approaches (DMA), and others. The development of a non-welfarist framework arose as it became clear that the "merit goods" argument, initially raised by Musgrave in his Theory of Public Finance, could not fit in the N-C welfare framework, necessitating departure from N-C welfarism (36). Attempts were then made by some economists such as Culyer (37) to introduce non-utility attributes into the Welfarist framework but were generally unsuccessful. This led to the development of non-Welfarist frameworks—referred to as extensions beyond Welfarism. These include all those approaches, excluding the N-C Welfarist approaches, which allow non-utility attributes to define the SWF. These approaches may include capability approaches, Extra-Welfarists, communitarianism, decision-making approaches (DMA), and Social Justice frameworks. These approaches themselves markedly differ from one another, but all share one thing in common: that they are not Welfarist (38).

The influence of the capabilities approach on the health care sector started following Sen's notions of functioning and capabilities theory (39). The result was the development of the extra-welfarist approach within health economics. Extra-welfarism is defined as a normative framework which supplements traditional welfare in the SWF with other "non-goods characteristics" of individuals (40, 41). In health care, the relevant characteristic is health and implies that the health status information directly influences the social states that individuals prefer, contrasting sharply with welfarism (18). The function may be defined as:

$$SWF = f(u^1, u^2 \ldots u^i, v^1, v^2 \ldots v^i)$$

Where u^i, and v^i are the utility and non-utility attributes of the ith individual's consumption of goods and services respectively.

Sen had explained that "functionings" might include basic human functions such as "moving, being well-nourished, being in good health, being socially respected" (42). He then described "capability" as the extent to which a person is able to function in a particular way, whether or not he or she chooses to do so (43, 44). For example, according to Culyer, two pivotal concepts that emerge from the characteristics of people (capabilities approach) are "deprivation" and "need" (40). He stated:

- "If the characteristics of people are a way of describing deprivation, desired states, or significant changes in people's characteristics, then commodities and their characteristics are what are often needed to remove their deprivation."
- Characteristics of people refers to attributes that describe a person and these may include their genetic endowment of health; his or her SES; moral-worth and deservingness; utility; severity of pain; and/or equity, fairness and social justice.

It is the non-utility characteristics, such as deprivation and need that create the demand for healthcare. The focus on deprivation and need implies that need and equity determine the demand for a health intervention, and not necessarily the willingness to pay as advocated in the N-C welfarist approach. Culyer advocated the use of Quality Adjusted Life Years (QALYs) as the unit of measure of health, and the weights used in the QALYs are not necessarily derived from utility values (40). The weights

could be based on any factor (such as age, social/occupational roles/family responsibilities, initial health status, etc.) that affects how individuals value health for a person with the characteristic as opposed to a person without. Other authors have argued that other important considerations other than QALYs should be included as attributes of the SWF. The policy implication is that health is the key outcome in the SWF as opposed to utility, and equity attributes based on the key characteristics of people should be included in these outcomes as non-utility attributes of the SWF.

Mooney and Russell argue that communitarianism advocates for the use of community preferences in the SWF, and weights to attach to these preferences should be determined by members of the community (25, 45). Further, the approach emphasizes the need to differentiate individual from community preferences and proposes that the preferences of the disadvantaged groups should be used to address their disadvantage. In the communitarian approach, the theory aims to attain some degree of coherence and transparency in the assessment of equity from an economics perspective. It classifies reasons for a person's claim for a good into two sectors: one being "claims," and the second being "other reasons" (46). "Claims" are defined as reasons backed by a notion of duty for one's claim for a good. Equity is seen to be consistent with community perspectives on how individuals should be treated relative to one another. Communitarianism is especially appealing to SSA health. This is because the sense of the community and community competencies are properties of the community, and it is therefore questionable whether aggregating the effects on individuals can capture the full benefits of community action. Thus, equity is defined by how claims are established, and then how different claims are weighted.

Social Justice Frameworks

Social justice is defined in terms of the distribution of wealth, opportunities, and privileges within a society. Egalitarianism focuses on the equality of outcomes and states that the fairest allocation of resources in the health system is when benefits and costs from the allocation are distributed equally among all people as a key objective to achieve (47). This theory, however, ignores differences in effort, talent, and productivity when resources are being allocated. When all of society receives the same opportunities, then the rights of various groups within it, for example equality of men and women, can be realized (48). This is because equal outcomes are virtually impossible to achieve in practice due to differences in natural endowments, differences in people's capacities to benefit, and differences in people's willingness to participate because their tastes and preferences are not homogenous (30, 49). In practice, however, equality of opportunity should be pursued along with other social justice objectives. Thus, social justice policies should be judged by the equality of opportunities and/or equality of access accorded to the members of society. These policies should be pursued in conjunction with other social justice objectives such as human rights and the basic health needs (48).

The needs principle gives priority to members of society with the basic minimum of services which they need or are essential for the tolerable living (30, 50). In SSA health, this implies that more resources are needed to raise the health status of community members to a level comparable with people from non-SSA. This would be consistent with their governments' pledges to achieve SDG3. However, the needs principle is sometimes criticized because it does not recognize differences in productive contributions, or distinguish between real needs and manifested needs. For example, Rawls' difference principle has been criticized by many authors such as Arrow (51) and Harsanyi (52) for failing to recognize that people may also seek to maximize other outcomes and not just the distribution of goods and services (24, 30). Additionally, the needs principle does not provide an explanation for resource allocation beyond achieving the minimum standards required for human existence. Indeed the evidence in the literature suggests that although people care about need and show concern for the least disadvantaged, they also care about adverse effects from basing allocations solely on need, thus rejecting need as the sole foundation for a system of distribution (30).

Specifying the Social Welfare Function in Practice

To specify the arguments for the SWF, two approaches are commonly used to elicit arguments that enter the SWF: (a) using a democratic process (using economic criteria, market criteria, or voting in a referendum) to elicit individual preferences and then aggregating them; or (b) imposing it on society—dictatorship (using government, experts, or community/opinion leaders).

Under the democratic process, three major approaches to specifying the SWF may be used: subjective approach; basic axiomatic approach; and moral justice approach (9, 17). The subjective approach completes the functional form of the SWF on subjective ethical grounds. Mishan explains that Bentham and colleagues argued that, social welfare ought to be the sum of individual utilities with a weighting of 1—utilitarian functions (17):

$$W = U^1 + U^2 + \ldots + U^n$$

Where U^n is utility for individual n, and the policy qualifies for implementation when $W > 0$.

Sugden and Williams advocated for the use of directly obtained or inferred values of decision-makers in the specification of the SWF (53). Two methods exist for determining the decision-makers' objectives: government policy documents/guidelines; and carefully elicited/inferred objectives from surveys. There are, however, disagreements amongst the proponents of the subjective approach on the specification of the SWF from the democratic process (9). The disagreements stem from the fact that others have advocated for "normal" distributional judgments and yet what is "normal" is not defined. Some they have advocated for inequality aversion and yet there was not an agreement on the appropriate level of inequality aversion (9). So, other economists pushed forward the use of axiomatic approach.

The basic axiomatic approach, uses mathematics to investigate the existence and form of SWF (9). In response, other authors have suggested that it was the intensity and not the simple rankings that mattered when individual preferences were being

aggregated into a SWF. Still others have suggested that the axiom on "rankings are independent of irrelevant alternatives" ought to be dropped and certain kinds of rank-order voting should be employed (54, 55). This would provide the analyst with the ability to weigh the gains of the winners against the losses of the losers. Just et al. argued that the major practical problem with the axiomatic approach was that, even under weaker conditions where voting works, transactions costs of voting and compiling the ranking would be prohibitive (9).

The proponents of Axiomatic approach argued that, the SWF is based on a set of plausible underlying axioms about individual preferences. These include:

- The domain of decisions is unrestricted;
- The Pareto principle applies; and
- Rankings are independent of irrelevant alternatives.

The Arrow Impossibility Theorem, however, proved that it is difficult to find a rule that satisfies all of the above properties when aggregating preferences into a SWF, unless the decision-making process is a dictatorship. Arrow's Impossibility Theorem states that if a social decision mechanism satisfies all the three assumptions of the SWF, then it must be a dictatorship: all social rankings are the rankings of one individual (54, 55).

The moral justice approach argues that the Arrow impossibility theorem happens as a result of the majority groups acting selfishly—preferring to eliminate consideration for the minority groups. To address this problem requires admitting moral considerations such as impartiality and economic justice in the SWF. Impartiality stands for the Moral concerns for equal treatment of individuals. In these SWFs, a criterion of distributional optimality is suggested which tends to advocate for equality or equal weighting. Slesnick explained that it was Amartya Sen who demonstrated that relaxing the interpersonal comparability assumption expands the spectrum of possible SWFs dramatically. Champions of the moral justice SWFs include Rawls, Harsanyi, Benthamite, Arrow, and others (9, 17).

Efforts to develop a generally accepted SWF have not been successful because there is no objective way of making interpersonal comparisons of individual utilities. In practice, a SWF requires the individual utilities to be cardinally measurable so that intensities of preferences can be compared. In contrast, the Pareto and compensation criterions, in which utility is measured in ordinal units, has many applications but is not useful for identifying a unique social optimum.

IMPLICATIONS FOR P/S IN ACHIEVING SDG3

In making choices for investments in healthcare, it is imperative to have an efficiency criterion as a key principle that guides allocation of resources. Since the markets in health care do not clear and fail to address fair distribution of resources, government has to intervene. However, for government allocations to achieve fair and efficient allocations, there is need for evidence to be used in its priority setting process. Selecting interventions and policy instruments which are efficient and achieve social justice, makes priority setting desirable and fair exercise to achieve SDG3. To do so requires a normative framework that incorporates economic principles and social justice principles.

The Preferred Normative Framework

The preferred framework for resource allocation to achieve SDG3 would be one that would have the potential to address economic issues (efficiency) and social justice issues (equity), resulting into a fair and just outcome of health maximization (24). Such a framework would allow social justice principles to be included either as policy objectives or as variable in the SWF. In practice, the policy objectives could be based on equality and maximization, according to individual/community characteristics. The principle that ought to guide procedural justice in SSA health should be viewed as: the level of people's involvement in the priority setting process; or the extent to which SSA citizens exercise autonomy in determining how resources are spent, which is an objective in its own right (30, 56). It is also consistent with the notion of self-determination or community control. This concept of autonomy in the input to resource allocation is also justified in the sense that it ensures that the community is appropriately informed of the potential health consequences of its choices.

The debate about the notion of social justice mirrors the wider debate within moral philosophy over what the appropriate criterion to achieve fairness in allocation of resources (25, 26). Should it be equity (27) or needs principles? In practice, we need a priority setting framework that incorporates both economic and social justice principles. Such a framework generates efficient outcomes/interventions and takes into account social justice principles. The choice of one form of justice, such as equality of access, can mean sacrificing another form of justice, such as unequal treatment of unequals. At the same time, equality of outcomes and very closely related to equality of opportunities or access can form government objectives that can be targeted by investments to turn into outcomes. For example, the presumption of equality provides an elegant procedure for constructing a theory of distributive justice using the following policy questions (47).

When need is defined by the severity of the disease alone, rather than the existence of the disease, it tends to give priority to those who are severely affected by an illness over those less severely affected, a maximin principle under Rawlsian theory. In this case, those clinically worse off, would get priority treatment, irrespective of the forgone improvements to the less ill. Thus, people with the worst initial health level would be given priority in the allocation of resources in this model. The third form of need is defined by the existence of an effective intervention, often referred to as the "capacity to benefit" by those targeted by the intervention approach (19, 57). It measures the extent to which those people affected by a health intervention itself would benefit from that intervention, by focusing on health gain as opposed to pre- or post-treatment profiles of the populations. The non-welfarist normative economic framework advocates this approach because it involves an epidemiological assessment of a health problem, and the existence of an effective intervention

targeting such a problem. It is therefore a preferred concept of benefit for use in health, since it has potential to allow the selection of interventions that are effective. However, the capacity to benefit (effectiveness) is not a well-described concept for many interventions. It is therefore necessary for increased research to be undertaken in the "measurement of the notion of need," in particular, in the measurement of "need" in SSA health. Thus, such a normative framework would take the form below. SWF $= f(U_1, U_2, ----U_i, V_1, V_2, -----V_i, W_1, W_2, ----W_i)$

Where U_i stands for the ith utility, V_i stands for the ith non-utility attributes and W_i stands for any other ith social justices principles not captured by U and V.

In practice, this would involve aggregating the function of the framework to take two forms:

- SWF = f (health attribute) + f (other attributes) + f (equity) + etc. In this case, if the function of the health attribute is zero, the intervention still has a score, or
- The SWF = (health attribute) [f (other attributes) + f (equity) + etc.] In this case, if the health attribute is zero, then the intervention would score zero thus– not a healthcare interveniton..

Given the arguments by Richardson of laundering society's preferences and Mooney's Claims (communitarian arguments) from the community members affected by the intervention, it would only be fair that the form of the functional form of the intervention would be determined by the community preferences.

Generating Economic Evidence to Support P/S

The common approach to assessment of social welfare improvement (economic evaluation) in Paretian economics is the use of the Kaldor-Hicks efficiency criterion to assess costs and benefits of various options. These benefits (utility or other measure) and costs are then combined to ascertain the overall benefit relative to the costs using Cost Benefit Analysis (CBA) (13, 38, 58). Economic evaluation of health care stems initially from standard Paretian Welfarist views and it follows the basic principles of consumer sovereignty and Pareto optimality (6, 13, 59). In CBA, for example, benefits are measured in monetary units and are based on individuals' willingness to pay for a service and it is theoretically relevant to the compensation principle as the means to achieve both absolute and relative efficiency.

The monetary unit of measure of outcomes such as in CBA overcomes all the weaknesses of the preceding units of outcome measures. However, for health outcomes or benefits valuation in health care—especially in life and death situations, two clear difficulties arise with the use of money metric for measuring welfare in CBA. An example of such valuations is the QALYs. Quality Adjusted Life Years express the sum of individual utility gains from medical interventions elicited using subjective valuation techniques such as time trade-offs. As such, they are potentially a useful measure in deciding how to allocate resources. They should not, however, be equated with the overall value that society places on different health care programmes. The QALYs that society places on different health care interventions is determined by aggregating the number of QALYs gained, but also by a series of distributional and ethical considerations (38). In most cases, the QALYs may be weighted to account of the distributional and other ethical issues before the aggregation takes place (39). This should be made clear in the presentation of QALY-calculations, particularly in cost-per-QALY league tables.

Thus, benefit from an allocation could be measured using one, or a combination, of the three broad units: the natural unit (e.g., life years), subjective values (quality of life), or monetary values (willingness to pay) of the services distributed in the community. Using economic evaluation to measure the relative efficiency of a policy or intervention, demonstrates that all these frameworks, have limitations because of the units employed for valuing benefits/outcomes. For example, when the natural units are used as measures, the results cannot be used across different disease interventions. The use of QALYs overcomes the problem of comparative analysis across different disease interventions and can therefore be used for comparative analysis across the whole health sector but cannot be used outside the health sector. Moreover, issues of measuring the quality of life remain unresolved.

Generating Non-economic Evidence

SSA health policy objectives should be informed by their ordinary people's values and aspirations identified through empirical research. This would involve ethical values being subjectively derived from a sample of each countries' population and then being subjected to ethical analysis and criticism. These values can then be quantified and converted into a scale that can be used to weight the importance of different SDG3 outcomes or some other chosen measure of health improvement. In the event that the social value is shown to lead to abhorrent outcomes, such as racism, sexism, or discrimination, then preferences should be "laundered," and an iterative process undertaken between the ethicist and the public.

For priority setting purposes, Richardson argues that social ethics ought to guide the government health policy objectives, and these ethical issues should be captured using the "empirical ethics" approach. These objectives should be subjected to ethical debate so as to reflect the views of the citizens (60, 61). Subjective values (pleasure, utility, or health) would be elicited using the empirical approaches, since subjective valuations are widely accepted and well-established (30). The cardinal measurement of the elicited values would be undertaken to specify the intensity of preferences, assumed to be the same finite end points, 0–1, on the cardinal health scale. The cardinal measurement would also allow for the elicited preferences to be interpersonally compared to avoid the Arrow impossibility theorem (31, 61). Two approaches are preferred for eliciting public views on health objectives: empirical ethics and communitarianism.

The first issue is related to the distribution of benefits—equity concerns. Knowing that measuring welfare using the willingness to pay concept is determined by the ability to pay, the allocation of health care resources would be "skewed"

toward the wealthy. Empirically, van Doorslaer et al. found that among 10 Organization for Economic Co-operation and Development—a loose organization of 30 countries such as Australia, the United Kingdom, the United States, and others sharing a commitment to democratic government and the free market economy. Countries included in their analysis, there was strong support for equity in health care as indicated in their policy documents (24). Also people have been consistently found to be prepared to sacrifice total benefits to achieve equity, even when they knew that they would be in the group which would be hurt by the redistribution. There are several processes for empirically determining the population ethics of resource allocation including: "communitarian claims" by Mooney (46).

The second issue involves the discomfort society has in valuing life and death issues in monetary terms, resulting in its reluctance to participate in such exercises. This has led to the emphasis on the use of the natural units such as numbers and/or percentages of the outcomes of interest, and the focus on subjective valuations of individual welfare/benefit. Subjective valuations are undertaken using instruments such as rating scales, standard gamble, and time trade-offs to assess the relative severity of the consequences of the diseases. In these valuations, characteristics of severity of diseases such as pain and disability are determined through repeated assessments over time to establish the durations. The data derived may be expressed over an interval scale to estimate the intensity, which would then be attached to the attributes or criteria in Normative Framework.

Limitations of this Study

However, achieving SDG3 requires addressing the whole of the economy since health is affected by issues from all the other sectors of the economy. This study focused on SDG 3, which means that the normative framework identified may be restrictive and only applicable to health sectors. Further, this study did not explore issues in the funding of healthcare, took the organization of healthcare as given and so it did not identify the most appropriate form of reform of the healthcare system to achieve the SDG3. This study ignored the structural and other issues in the delivery of health in SSA countries. It focused on normative frameworks and its principles thereof which ought to inform the decision making process in the health sector to achieve the SDG3.

SUMMARY

In SSA, there are lots of health challenges which requires significant investments. Government ought to have a dominant role in the mobilization of funding resources and regulation of healthcare services, since it has more ability to compare the claims of every one in society, ceteris paribus. The decision context is such that priority should be accorded to those in higher "need" and should reflect social values. Inclusion and recognition of community members as legitimate claimants of the resources allocated would allow communities to determine what weights should be attached to the stated arguments in the SWF. Therefore, the normative framework ought to allow the concept of benefit to reflect the stated policy objectives being pursued.

In SSA where health problems outstrip available resources, it is important for any priority-setting framework designed to achieve SDG3 by maximizing outcomes given the limited budgets. Using economic evaluation evidence assists decision-makers to identify such options for change which, offer value-for-money from investments. The appropriate normative framework should include efficiency and social justice principles. Adoption of Non-Welfarist normative economic framework which, allows utility, health, and other attributes important to the community to enter the SWF is what ought to be done. The SWF should be specified empirically by the decision-makers and the community representatives. Such a function ought to recognize the opportunity costs as a principle, marginal analysis, efficiency, and equity, regardless of how they are defined in order for the decisions makers to choose those strategies, which maximize health outcomes for a given resource allocation.

In conclusion, both economic evidence and social justice principles (distributive and procedural), ought to inform priority setting so as to improve SDG3. The social justice principles which ought to be included in the framework may include equity (both vertical and/or horizontal equity); need (in whatever form it is defined); fairness (in whatever form it ought to be defined, either as distribution of outcomes, autonomy or community control); and/or access (both physical and perceived forms). Such principles may enter the SWF directly, or may stand independently as social/policy objectives which can be pursued to achieve the SDG3. The priority-setting framework that SSA ought to adopt to improve the SDG3 therefore ought to be non-economic normative framework with both economic and social justice principles, regardless of the level of rigor.

AUTHOR CONTRIBUTIONS

MO led the conception and design of the study, reviewed the files where the data for analysis and interpretation was generated from, and drafted the manuscript. AA, JM, and WG read the draft, reviewed the findings, and worked on the manuscript. All authors critically analyzed the paper for important intellectual content, read and approved the final manuscript, contributed to the preparation, and writing of the paper.

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OPINION
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Nigerian Results-Based Financing Fellowship: A Strategic Approach for Sustaining Results-Based Financing in Nigeria

*Olusola Olabisi Ogunseye**

Department of Environmental Health Sciences, Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan, Nigeria

Keywords: results-based financing, input-based financing, technical assistance, primary health care, health system, reform, Nigeria

INTRODUCTION

There is an emergency in the Nigerian primary health care (PHC) system. Majority of PHC facilities are in a sordid and lugubrious state (1). Despite substantial government spending and policy initiatives toward revitalizing the PHC system, it remains largely deplorable across the World Health Organization (WHO) health system building blocks (2). To this end, the government of Nigeria in collaboration with the World Bank launched a Results-Based Financing (RBF) project under the Project Name: Nigeria State Health Investment Project (NSHIP) with the goal of improving service utilization and quality of healthcare services in Nigeria (2, 3). Due lack of in-country capacity, Oxford Policy Management (OPM) was contracted by National Primary Health Care Development Agency (NPHCDA) in 2014 to provide technical assistance to NSHIP for the implementation of RBF in Nigeria. In order to bridge the capacity gap at the exit of OPM in 2018, Nigerian Results-Based Financing Fellowship was conceptualized jointly by OPM and NPHCDA to train 14 Nigerians to a level whereby they are able to take on technical assistance roles in NPHCDA for continued implementation and possible scale-up of RBF in Nigeria (4). This paper describes the 10-months RBF fellowship, the competencies acquired and its usefulness as strategic approach for the sustainability of RBF in Nigeria.

DESCRIPTION OF RBF FELLOWSHIP

The RBF fellowship was conceptualized to train 14 Nigerians over a period of 10 months on technical (health systems, health financing, RBF design, and RBF implementation), professional (project management, presenting scientific data, and managing for efficiency and effectiveness) and behavioral (integrity and collaborative work) competencies through an approach that involved formal learning blocks, supervised and assessed practice, and internship, to ensure the Fellows become professionals capable of continuing and possibly expand RBF in Nigeria's quest to achieve universal health coverage (4, 5). During formal learning blocks, modules were delivered by world-class experts and Results-Based Financing Technical Assistants (RBF-TAs) while Fellows were under the tutelage and mentoring of RBF-TAs during the supervised and assessed practice.

FORMAL LEARNING BLOCKS

Formal learning blocks adopted in-person classroom teaching model where relevant topics were delivered in form of modules. These modules were designed to help Fellows become well-rounded leaders and managers in the Nigerian health system with integrity, efficiency, and effectiveness.

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Chhabi Lal Ranabhat, Policy Research Institute, Nepal
Tissa Wijeratne, The University of Melbourne, Australia

***Correspondence:**
Olusola Olabisi Ogunseye
sholybliss4eva@yahoo.com

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The formal learning blocks targeted the 3-fold competency areas of the fellowship; technical, professional and behavioral competencies.

SUPERVISED AND ASSESSED PRACTICE

Supervised and assessed practice was an avenue for Fellows to apply theoretical knowledge acquired during formal learning blocks in selected pilot RBF implementing States in Nigeria. It provided a platform for Fellows to undertake managerial and administrative roles, involving practical assignments in a routine RBF setting.

PERSONAL DEVELOPMENT PLAN AND REFLECTIVE LEARNING LOG

The Personal Development Plan (PDP) is an interactive, easy-to-read and comprehensive document designed by Fellows during the first formal learning block detailing goals, learning gaps and strategies to achieve objectives of the fellowship across the competency areas. The PDP is a working document that assesses Fellows' competence at baseline, track their progress, evaluate areas of improvements *vis-a-vis* the baseline, appraise capacity gaps and revise strategies for achieving them. Fellows reviewed and updated the PDP at least twice over the course of the fellowship.

The reflective learning log is a personal learning record produced through insightful thinking on what is learned and shows progress toward achieving learning objectives stated in the PDP. Fellows made entries in the log during the formal learning blocks, supervised and assessed practice, and internship. Basically, the PDP and reflective learning log are closely linked and they serve as powerful tools for assessing Fellows' learning trajectory and overall effectiveness of the fellowship.

WORK-BASED WRITTEN ASSIGNMENTS

In addition to practical and field-based assignments during supervised and assessed practice and internship, Fellows were assessed based on three work-based written assignments over the course of the fellowship. Each work-based written assignment is an article of about 2,000 words on specific topics in health financing, RBF design and RBF implementation. These articles were also presented and critiqued by Fellows during State-based tutorial group meetings to enhance scholarship and critical reasoning skills of Fellows.

INTERNSHIP

Internship was a period for Fellows to undertake work-based practical assignments and apply the knowledge acquired from modules and syllabi in formal learning blocks and previous supervised and assessed practice. Fellows performed the roles and responsibilities of RBF-TA during internship with minimal supervision. The period of internship offered great opportunities for hands-on, work-based practical experience. The internship rounded off the transformational process required for Fellows in the 3-fold competency areas targeted by the fellowship.

DISCUSSION

RBF Fellowship as Strategic Approach

Even though Nigeria is not in short supply of health policies, the country has always lacked cutting-edge resolve to fully implement those policies. Evidences suggest that the currently implemented input-based financing mechanism has failed to yield desired results with the country's health system performing poorly in critical maternal and child health outcomes and lagging behind other countries (6–9). While evidences of RBF impact in Nigeria are scanty, there are few studies that indicate RBF offers improvement in access, utilization and quality of health services (7, 9–13). RBF possesses great potential and could serve as a tool to reform the Nigerian health system, particularly primary health care, hence, sustaining the gains of RBF in Nigeria will rely substantially on institutionalizing RBF fellowship as a unique platform for continuous recruitment and training of health professionals with competencies required to drive primary health care policies for the attainment of universal health coverage.

CONCLUSION

This paper documents the 10-months RBF fellowship in light of its objectives, framework, and targeted competencies while emphasizing the need for its utilization as strategic approach for the sustenance and expansion of RBF in Nigeria. The RBF fellowship was an impactful, highly enriching, result-driven, competency-targeted programme. This programme will reinforce RBF approach in Nigeria, which in turn could set the tone for Nigeria's progress toward universal health coverage on adoption as a tool for national policy in healthcare.

AUTHOR CONTRIBUTIONS

OOO conceptualized, documented, wrote, and finalized the manuscript.

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Impact of Healthcare Expenditures on Healthcare Outcomes in the Middle East and North Africa (MENA) Region: A Cross-Country Comparison, 1995–2015

Bander Balkhi[1]*, *Dhfer Alshayban*[2] and *Nawaf M. Alotaibi*[3]

[1] Department of Clinical Pharmacy, College of Pharmacy, King Saud University, Riyadh, Saudi Arabia, [2] Pharmacy Practice Department, College of Clinical Pharmacy, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia, [3] Department of Pharmaceutics, Faculty of Pharmacy, Northern Border University, Rafha, Saudi Arabia

The association between healthcare expenditures and outcomes, mainly mortality and life expectancy, is complex. The real explanation for this association is not clear, especially in the Middle East and North Africa (MENA) region. This study assesses the impact of health expenditures on improving healthcare systems and health status and finds a relationship between health expenditures and health outcomes across different region. Annual time series data on healthcare spending and outcomes from 1995 to 2015 were used for MENA region in comparison to developed and developing countries. Health expenditure was adjusted by the consumer price index equation to the 2015 US dollar eliminate the impact of inflation on our results. For many countries, spending on healthcare continues to rise, Among MENA countries, we found that the United Arab Emirates and Kuwait spent more per capita on health, $1,711 and $1,420, respectively, than any other countries in the region. Although this study demonstrated a relationship between total healthcare expenditure and outcomes, some countries spend more on healthcare but have shorter life expectancy. In most countries, efficient and effective utilization of healthcare resources is the key strategy for improving health outcomes in any country. The lack of a positive correlation between healthcare spending and life expectancy may indicate that health resources are not allocated effectively. In those cases, increasing health spending does not guarantee that there is any kind of improvement in healthcare.

Keywords: healthcare resources, healthcare expenditures trend, Middle East-North Africa, life expectancy, cross-nation comparison

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Olatunde Aremu, Birmingham City University, United Kingdom
Muktar Beshir Ahmed, University of South Australia, Australia

***Correspondence:**
Bander Balkhi
bbalkhi@ksu.edu.sa

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INTRODUCTION

Over the last decades, healthcare expenditure has been increasing in many countries, and Middle East and North Africa (MENA) region follow the same pattern mainly because of the high price of health technology, increased awareness about health, and lifestyle changes. As a result, healthcare systems in MENA region are facing a huge challenge to keep up with the increasing demand for healthcare as results of rapid population growth, steady increase in elderly population and increase prevalence of chronic, non-communicable diseases (1). Population health can be affected by many

elements, such as income, social and physiological factors, epidemiological factors, and accessibility to healthcare services. Healthcare spending as a factor that may have an impact on individual health is essential for effective policy making at the national and regional levels and for the sustainability of health services (2, 3).

There is no doubt that for any country, the healthcare system can play a significant role in the development process. Therefore, the increase in human capital stock investment is considered a vital factor for attaining the anticipated economic development in all countries (3, 4). It is a fact that healthier people can positively contribute to the growth of the economy because they are more productive and can live longer (4). As a result of the increasing life expectancy of the population, other health indicators such as infant and adult mortality rate will be improved.

Therefore, many countries invest a large percentage of their gross domestic product (GDP) on the health of their nations, as such investment could impact economic growth. The World Health Organization (WHO) has demonstrated the impact of improving overall patient health on economic growth. The WHO stated that for every 10% increase in life expectancy at birth, there was a 0.35% increase in economic growth per year. By contrast, sick people might have a negative impact on the economy, which could lead to a decline of about 50% in the growth rate between developed and developing countries (4).

The continued increase in health expenditure has resulted in a need to understand the impact on individual health outcomes as well as the need to know how limited resources can be used most efficiently (5). It is believed that better health outcomes for the population might indicate that a country has a more effective healthcare system, while a less healthy population might indicate that the country has an ineffective healthcare system (2). In other words, health expenditures are always thought to be in a direct relationship with healthcare outcomes, and several studies have assured this relationship; however, in some countries, other factors play important roles along with healthcare expenditures. Efficient resource utilization, environmental factors, education, and income are almost equally important as spending.

Understanding total healthcare expenditures is an important element for effective health care policy-making and strategy planning.

The impact of total health expenditure on the national economy has been addressed in several studies that examine the association between healthcare expenditure and health outcomes in developed and developing countries (6, 7).

The relationship between health expenditure and health outcome is complex and research studies showed controversial results on this association. Thus, the association between healthcare expenditures affect health outcomes is still not clear, especially in the MENA region which faced a major healthcare reform (8, 9). Comparing different countries around the world will be crucial in understanding this association. This study aimed to investigate the impact of healthcare expenditure on several health indicators across different countries, such as improving the healthcare system and overall health status, and to assess the relationship between health spending and health outcomes. Such studies will help policy makers in those countries assess whether they are spending too much on health in relation to health outcomes and promote the efficient use of health resources.

METHODS

Study Design

A time series analysis was conducted to assesses the relationship between health expenditures and life expectancy at birth estimated by a cross-country comparison for the period—1995–2015 in MENA countries.

CROSS-NATION COMPARISON

Data Sources and Data Analysis

The data were collected for a sample of developed and developing countries over 20 years (1995–2015). The countries were grouped according to the geographic region and per capita income.

Health Expenditure

Annual data on health expenditures and life expectancy at birth were extracted from two main databases: the World Bank's World Development Indicators and the WHO Health Statistics. The input for this study was the country's total healthcare expenditure, which is expressed as healthcare expenditures per capita (current US$). Health expenditure was adjusted by the consumer price index (CPI) equation to the 2015 US dollar to eliminate inflation.

Health Outcome

Mortality data is often used to assess population's health. The most commonly measure used to assessed mortality is the life expectancy in which it measures the expected year the person can live based considering person's specific characteristics. In this study, we defined health outcomes as life expectancy at birth. The average years of male and female population was used as an indicator of health status in each country. All required data were obtained from the WHO Health Statistics and World-Bank database. The study analyzed the relationship between healthcare expenditures per capita and health-outcomes. Data analysis was performed to assess the effect of health expenditure on life expectancy at birth.

In this study countries were classified according to their geographic location into seven areas; Europe, North America, Australia, South America, Middle East and North Africa (MENA), Africa and Asia. Our focus was on the Middle East and North Africa (MENA) region in comparison with other countries. In this study MENA countries includes the following countries: Algeria, Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia (SA), Syria, Tunisia, United Arab Emirates (UAE), and Yemen.

Statistical Analysis

Data were analyzed using the Statistical Package for Social Studies (SPSS 22; IBM Corp., New York, NY, USA). Continuous variables were expressed as mean ± standard deviation. The *t*-test was used for continuous variables. Pearson correlation coefficients

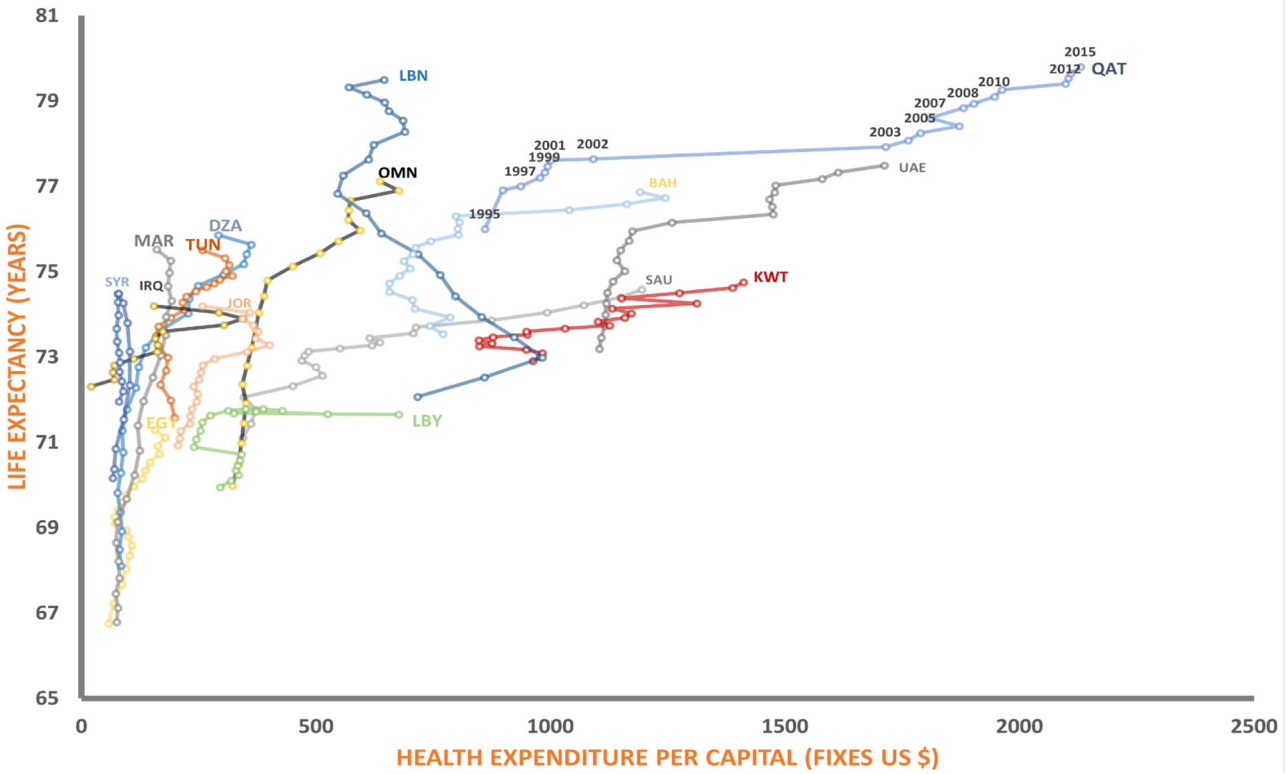

FIGURE 1 | Relationship between health expenditure and life expectancy. SAU, Saudi Arabia; OMN, Oman; UAE, United Arab Emirates; KWT, Kuwait; LBN, Lebanon; JPR, Jordan; IRQ, Iraq; QAT, Qatar; SYR, Syrian; BHR, Bahrain; YEM, Yemen; EGY, Egypt; LBY, Libya; DZA, Algeria; TUN, Tunisia; MAR, Morocco.

were used to assess the relationship between life expectancy and health expenditures for the period−1995–2015. A $p < 0.05$ was considered statistically significant.

Ethical Review

Ethics approval was not required for this study as the study mainly used information freely available to public and do not use patient level data.

RESULTS

Over the study period, we observed an overall improvement in life expectancy at birth in majority of the countries included in this study. **Figure 1** shows the association between per capita health expenditures and life expectancies for MENA countries at different points in time. Overall, the health expenditure and life expectancy has been improved in the MENA region since 1995.

Over the study period (1995–2015), life expectancy increased by an average of 5 years, with a range of 1 year in Iraq to 9 years in Morocco. The average life expectancy at birth in the MENA region in 2015 was 74.8 years, ranging from 64.2 years in Sudan to 79.5 years in Lebanon.

The health care expenditure also on the rise and Qatar, United Arab Emirates, spend more per capita on health $2,029 and $1,420, respectively, than any other country in the region. While Syria and Yemen have the lowest spending per capita on health in the region. From **Figure 1** it is been observed that despite the large variabilities, we noticed that higher expenditure of health not always associated with increase in health outcome, as, some countries spend more on healthcare but have shorter life expectancy and other were spend less on health while they have longer life expectancy.

In order to compare MENA region with other countries, we divided the countries into seven areas, and the total distribution of healthcare expenditure was presented as the mean and standard deviation (SD) for the whole study period (**Table 1**). Our finding indicated that spending on healthcare continued to rise in all regions, the highest per-capita healthcare spending was in the Europe and Australia, with the highest healthcare spending ranging from $4,717 to $4,412 per capita. While the lowest per-capita healthcare spending was observed in Africa region $128.3 per capita. The life expectancy was highest in Europe and Australia 80.2 and 80.5 years in 2015 and only 67.2 years in Africa in 2015 (**Table 2**).

Pearson correlation coefficients were calculated between health spending and outcomes for each regions for the period 1995–2015 are presented in **Table 3**. The overall expenditure on healthcare was significantly correlated with life expectancy. Overall, country spending on health was positively correlated with life expectancy ($r = 0.610$, $p < 0.001$), while the correlation for MENA countries is a higher ($r = 0.624$, $p < 0.001$). This univariate correlation

TABLE 1 | Mean and standard deviation of health care expenditure for a period of 1995–2015 in the seven areas.

Year	Europe		North America			Australia			South America			MENA			Africa			Asia		
	Mean	SD	Mean	SD	*P*-value[1]	Mean	SD	*P*-value[2]	Mean	SD	*P*-value[3]	Mean	SD	*P*-value[4]	Mean	SD	*P*-value[5]	Mean	SD	*P*-value[6]
1995	3641.5	1488.4	2295.0	2698.4	0.2	2474.5	0.0	0.5	374.2	162.0	0.014*	520.3	395.1	<0.001*	87.6	89.9	<0.001*	608.0	1448.2	<0.001*
1996	3629.6	1392.0	2296.6	2721.5	0.2	2702.8	0.0	0.5	418.9	147.3	0.011*	540.0	405.4	<0.001*	93.2	93.8	<0.001*	542.0	1212.2	<0.001*
1997	3216.3	1108.1	2341.9	2761.3	0.4	2639.7	0.0	0.6	443.4	110.8	0.007*	554.4	417.8	<0.001*	92.9	96.4	<0.001*	511.6	1122.8	<0.001*
1998	3253.9	1115.7	2371.2	2833.1	0.4	2345.4	0.0	0.5	401.7	117.6	0.006*	538.4	402.7	<0.001*	95.9	95.6	<0.001*	445.6	1040.5	<0.001*
1999	3240.1	1087.7	2450.8	2898.6	0.5	2525.6	0.0	0.5	304.6	52.7	0.004*	531.7	371.1	<0.001*	89.5	100.4	<0.001*	512.2	1209.4	<0.001*
2000	2888.3	938.5	2538.1	2958.8	0.7	2402.9	0.0	0.6	281.3	113.6	0.004*	514.7	348.0	<0.001*	87.2	101.0	<0.001*	546.8	1278.7	<0.001*
2001	2897.2	962.9	2625.1	3078.0	0.8	2228.4	0.0	0.5	246.6	78.5	0.004*	521.0	364.1	<0.001*	87.7	100.8	<0.001*	494.6	1107.9	<0.001*
2002	3181.9	1055.2	2773.8	3285.9	0.7	2481.1	0.0	0.5	220.5	62.9	0.003*	542.1	390.5	<0.001*	79.8	74.3	<0.001*	488.8	1056.0	<0.001*
2003	3882.4	1177.4	2994.8	3469.5	0.5	3053.8	0.0	0.5	221.7	71.4	0.002*	623.6	543.0	<0.001*	87.7	76.8	<0.001*	535.3	1136.8	<0.001*
2004	4337.6	1237.5	3164.1	3603.9	0.4	3680.1	0.0	0.6	251.9	95.0	0.001*	634.8	554.7	<0.001*	96.9	82.1	<0.001*	575.8	1202.8	<0.001*
2005	4364.0	1185.1	3356.1	3659.8	0.4	3900.3	0.0	0.7	356.9	166.8	0.001*	650.3	550.0	<0.001*	100.4	80.2	<0.001*	597.6	1172.3	<0.001*
2006	4436.9	1129.0	3512.1	3778.8	0.5	4022.8	0.0	0.7	418.6	215.1	0.001*	670.8	539.0	<0.001*	110.4	83.1	<0.001*	606.0	1099.8	<0.001*
2007	4872.5	1182.7	3729.0	3834.3	0.4	4662.1	0.0	0.9	509.8	248.4	0.001*	697.2	518.2	<0.001*	130.3	91.4	<0.001*	635.7	1089.9	<0.001*
2008	5214.4	1342.7	3758.2	3846.4	0.3	4855.0	0.0	0.8	592.5	277.9	0.001*	737.6	524.5	<0.001*	149.6	103.8	<0.001*	687.2	1182.7	<0.001*
2009	5111.2	1472.7	3806.8	3962.2	0.4	4703.1	0.0	0.8	603.8	289.8	0.002*	793.9	577.5	<0.001*	155.6	115.1	<0.001*	738.8	1348.4	<0.001*
2010	5019.9	1589.4	4018.5	4112.5	0.5	5785.9	0.0	0.7	729.2	382.1	0.004*	742.6	497.1	<0.001*	167.0	124.4	<0.001*	826.6	1465.5	<0.001*
2011	5481.4	1998.9	4070.3	4120.7	0.4	6711.1	0.0	0.6	808.7	428.8	0.010*	790.1	564.7	<0.001*	166.9	113.3	<0.001*	911.7	1603.7	<0.001*
2012	5136.4	1966.7	4050.7	4175.2	0.5	6754.6	0.0	0.5	790.5	319.9	0.013*	842.1	623.9	<0.001*	205.3	195.7	<0.001*	926.8	1603.3	<0.001*
2013	5302.3	2054.2	4053.6	4142.6	0.5	6367.1	0.0	0.6	784.8	319.5	0.014*	860.0	639.1	<0.001*	194.4	156.5	<0.001*	857.5	1346.2	<0.001*
2014	5272.0	2016.9	4051.5	4168.9	0.5	6037.8	0.0	0.7	759.2	267.8	0.012*	892.8	656.9	<0.001*	179.9	127.1	<0.001*	828.1	1266.6	<0.001*
2015	4717.4	2066.2	3644.3	4412.0	0.5	4535.8	0.0	0.9	577.3	287.2	0.021*	822.7	628.1	<0.001*	128.3	94.7	<0.001*	784.1	1271.6	<0.001*

Europe was used as a reference when we calculated p-values for other areas.

**Significant p-value.*

[1]*P value was calculated between Europe & North America.*

[2]*P value was calculated between Europe & Australia.*

[3]*P value was calculated between Europe & South America.*

[4]*P value was calculated between Europe & Middle east.*

[5]*P value was calculated between Europe & Africa.*

[6]*P value was calculated between Europe & Asia.*

TABLE 2 | Mean and standard deviation of life expectancy for a period of 1995–2015 in the seven areas.

Year	Europe		North America			Australia			South America			MENA			Africa			Asia		
	Mean	SD	Mean	SD	*P*-value[1]	Mean	SD	*P*-value[2]	Mean	SD	*P*-value[3]	Mean	SD	*P*-value[4]	Mean	SD	*P*-value[5]	Mean	SD	*P*-value[6]
1995	77.3	1.1	75.4	2.1	0.1	77.8	0.0	0.6	68.5	1.3	<0.001*	70.7	4.4	0.001*	60.3	9.6	<0.001*	67.3	6.3	0.001*
1996	77.6	1.1	75.8	2.1	0.1	78.1	0.0	0.7	68.9	1.2	<0.001*	71.0	4.4	<0.001*	60.5	9.7	<0.001*	67.8	6.3	0.002*
1997	77.8	1.1	76.1	2.1	0.1	78.5	0.0	0.6	69.3	1.0	<0.001*	71.3	4.3	<0.001*	60.7	9.8	<0.001*	68.2	6.3	0.002*
1998	78.0	1.1	76.3	2.0	0.1	78.6	0.0	0.6	69.7	0.9	<0.001*	71.6	4.3	<0.001*	60.9	9.9	<0.001*	68.6	6.2	0.002*
1999	78.2	1.1	76.5	2.0	0.1	78.9	0.0	0.6	70.1	0.8	<0.001*	71.9	4.3	0.001*	61.2	9.9	<0.001*	68.8	6.2	0.002*
2000	78.5	1.1	76.7	2.0	0.1	79.2	0.0	0.5	70.5	0.7	<0.001*	72.1	4.3	<0.001*	61.5	9.9	<0.001*	69.2	6.3	0.002*
2001	78.8	1.1	76.9	2.0	0.047*	79.6	0.0	0.5	70.9	0.6	<0.001*	72.4	4.2	<0.001*	61.8	9.9	<0.001*	69.5	6.4	0.002*
2002	78.9	1.1	77.1	2.0	0.1	79.9	0.0	0.4	71.2	0.5	<0.001*	72.7	4.2	0.001*	62.2	9.8	<0.001*	69.8	6.4	0.003*
2003	79.0	1.1	77.3	2.0	0.1	80.2	0.0	0.3	71.5	0.4	<0.001*	72.9	4.2	0.001*	62.7	9.7	<0.001*	70.2	6.5	0.003*
2004	79.5	1.2	77.6	2.1	0.045*	80.5	0.0	0.4	71.8	0.3	<0.001*	73.2	4.2	<0.001*	63.1	9.5	<0.001*	70.5	6.5	0.003*
2005	79.7	1.1	77.7	2.1	0.039*	80.8	0.0	0.3	72.1	0.2	<0.001*	73.4	4.1	<0.001*	63.6	9.4	<0.001*	70.8	6.5	0.003*
2006	80.0	1.1	77.9	2.0	0.025*	81.0	0.0	0.4	72.4	0.1	<0.001*	73.6	4.1	<0.001*	64.0	9.2	<0.001*	71.3	6.5	0.003*
2007	80.2	1.1	78.1	2.0	0.029*	81.3	0.0	0.4	72.7	0.0	<0.001*	73.8	4.1	<0.001*	64.5	9.1	<0.001*	71.6	6.4	0.004*
2008	80.4	1.1	78.3	2.0	0.026*	81.4	0.0	0.4	73.0	0.1	<0.001*	74.0	4.0	<0.001*	64.9	8.9	<0.001*	71.9	6.3	0.004*
2009	80.6	1.1	78.5	2.1	0.027*	81.5	0.0	0.4	73.3	0.2	<0.001*	74.1	4.0	<0.001*	65.3	8.7	<0.001*	72.2	6.3	0.004*
2010	80.9	1.1	78.7	2.1	0.023*	81.7	0.0	0.5	73.5	0.3	<0.001*	74.2	4.0	<0.001*	65.7	8.6	<0.001*	72.4	6.2	0.003*
2011	81.4	1.0	78.8	2.2	0.001*	81.9	0.0	0.6	73.8	0.5	<0.001*	74.3	4.1	<0.001*	66.0	8.5	<0.001*	72.7	6.1	0.003*
2012	81.4	1.0	79.0	2.1	0.011*	82.0	0.0	0.5	74.0	0.6	<0.001*	74.4	4.1	<0.001*	66.3	8.4	<0.001*	73.0	6.1	0.003*
2013	81.6	1.1	79.1	2.2	0.010*	82.1	0.0	0.6	74.3	0.6	<0.001*	74.5	4.2	<0.001*	66.6	8.3	<0.001*	73.3	6.1	0.003*
2014	82.0	1.0	79.2	2.2	0.005*	82.3	0.0	0.8	74.5	0.7	<0.001*	74.7	4.2	<0.001*	66.9	8.1	<0.001*	73.6	6.1	0.003*
2015	82.2	1.0	79.3	2.2	0.004*	82.5	0.0	0.8	74.7	0.7	<0.001*	74.8	4.2	<0.001*	67.2	8.0	<0.001*	73.8	6.1	0.003*

**Significant p-value.*

[1]*P value was calculated between Europe & North America.*

[2]*P value was calculated between Europe & Australia.*

[3]*P value was calculated between Europe & South America.*

[4]*P value was calculated between Europe & Middle east.*

[5]*P value was calculated between Europe & Africa.*

[6]*P value was calculated between Europe & Asia.*

is shown in **Figure 2** for all countries included in the study. The correlation was more significant for Australia and MENA countries compared to other regions included in this study.

TABLE 3 | Relationship between life expectancy and health expenditures for a period of 1995–2015.

Areas	*r*	*P*-value
World	0.610**	<0.001
Europe	0.396**	<0.001
North America	0.426**	<0.001
Australia	0.872**	<0.001
South America	0.555**	<0.001
MENA	624**	<0.001
Africa	0.671**	<0.001
Asia	0.769**	<0.001

***Correlation is significant at the 0.01 level (2-tailed).*
r = Pearson Correlation coefficient.

DISCUSSION

In this study, we examine the health expenditures of MENA countries and focusing on investigate the relationship between healthcare expenditures and health outcomes, which are measured as life expectancy here. We observed a large variation in health expenditure and health outcome across different countries.

Overall we noticed that for majority of the countries the total health expenditure was increased overtime and at the same time life expectancy tend to be improved over years. Our results demonstrated that among MENA countries Lebanon appears to hold the most successful position in terms of highest life expectancy at a reasonable level of healthcare expenditure. Qatar and UAE were outlier as they spend more and their life expectancy is similar to some MENA counties that spend less.

On the other hand, Europe demonstrate somewhat variable, but mostly comparable curves. The health expenditures have been increased in Europe over years from $3,641.5 in 1995 to $4717 per capita in 2015. Over the same period, the average life expectancy area has increased from 77.3 years to 82.8

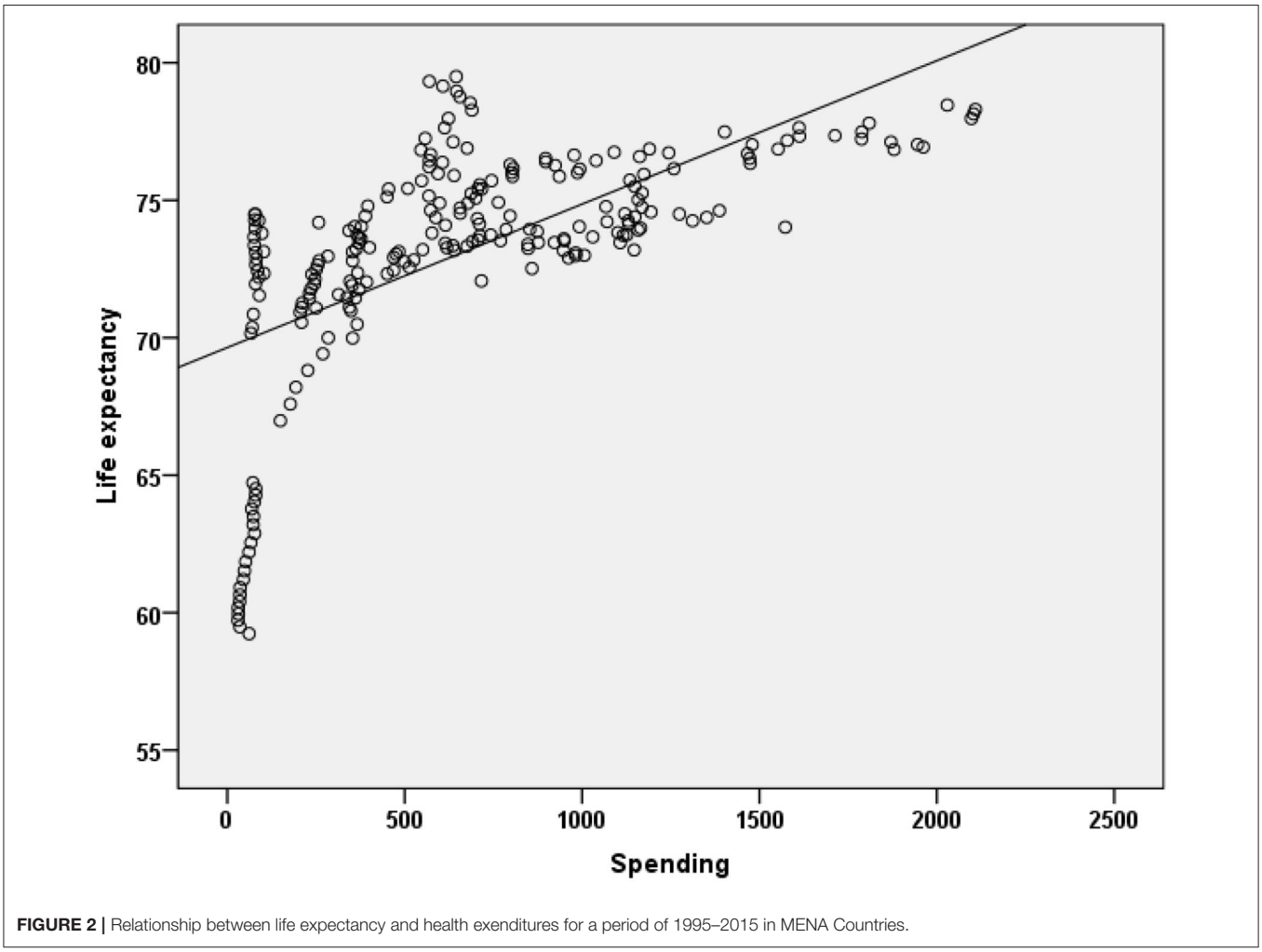

FIGURE 2 | Relationship between life expectancy and health exenditures for a period of 1995–2015 in MENA Countries.

years. The UK eventually reducing the per capita costs while maintaining the desired life expectancy level. Other countries appear to achieve the same level of life expectancy with additional investments. This results are in line with previous studies that find a positive relationship between increase spending on health and health outcome in Europe countries.

MENA countries spend less on healthcare compare to high income countries. According to the latest report of the world bank the average healthcare expenditure as a percentage of GDP in MENA countries is 5.96% of GDP which is lower than other regions North America 16.42%, OCED 12.46% and Europe 10.14% and East Asia and Pacific 6.67% as share of GDP. Within MENA region we notice a large variation of health care spending as percentage of GDP. Lebanon, Tunis and Saudi Arabia spend 8.35, 7.29, and 6.36% of GDP on health, respectively, which is relatively higher compared to other MENA countries UAE (3.3%), Kuwait (2.7%), Oman (2.3%), and Qatar (2.49). The lower healthcare spending in MENA region compared to others, could be an incentive for policy maker to improve healthcare expenditure in order to improve population health.

The two countries utilizing the greatest healthcare resources are Switzerland and the US, with a striking difference in life expectancy given the same healthcare investments.

The population in the US has demonstrated higher mortality and morbidity indices than other high-income countries. Excess death rates in the age groups younger than 40 years have been thought to largely contribute to the large variation in life expectancy between the US and other developed countries (10, 11).

US healthcare spending constituted 17.8% of the gross domestic product, whereas the figures were dramatically lower in Australia and Switzerland (9.6 and 12.4%, respectively).

US also ranked lower in overall health insurance and highest (55%) in private health insurance coverage. US healthcare costs per capita are almost twice as high as those of its European counterparts (12). The main reason for such different between MENA countries and US is due to the differences in work-force financing strategies, drugs and medical equipment being marketed at substantially higher prices in US, deliberate ordering of expensive medical investigations, and perhaps lack of governmental regulation. The comparative analysis by Papanicolas et al. (12) revealed that the salaries of healthcare providers were almost double in US compared to their European counterparts. Furthermore, the administrative costs (accounting for 8%) were significantly higher in US compared to a range of 1–3% in the peer countries. Another reason for high healthcare costs is that in the US, more subspecialty consults are ordered, which results in dramatically increased overall healthcare costs (12, 13).

During the study period we observed that the average life expectancy in MENA area has increased by about 5 years with Lebanon stands out with the highest achieved life expectancy at the lowest per capita expenses, as demonstrated by the almost vertical curve topping its contemporaries.

The slopes of the curves acquired from the other MENA countries (i.e., Saudi Arabia, Kuwait, and the United Arab Emirates) are more reminiscent of Japan and Germany, indicating a similar pace of development. This perhaps stems from the fact that, in contrast to the previously mentioned MENA counterparts, these represent developed countries, which are likely to follow the curves of their European peers given that the appropriate healthcare systems are most efficiently integrated.

Our results show a positive effect for health expenditure on the life expectancy for MENA region. This relationship were consistent with the previous study which indicated that a unit increase in per capita health expenditure in MENA countries reduces the mortality rate by almost 9.5 deaths per 1,000 live births (7, 14). Although, we observed an improvement in life expectancy in MENA countries, the progress in Iraq, Yemen and Syria is quite low. For countries with lower spending on health previous study indicated that even a small amounts of health expenditure, would have a bigger impact on health outcome (15). A study that pooled a data for 50 developing countries indicated a strong association between health expenditure and infant mortality rates (16). Another studies demonstrated that health expenditure has statistically significant effect impact on under-five mortality and maternal mortality. This should be taken into consideration by health policy maker when allocate health funding (17).

The role of the government's involvement in healthcare acquisition is a widely recognized factor in healthcare cost generation and can be exemplified by the Canadian and German healthcare systems. It appears that systems utilizing government provision and insurance achieve lower per capita costs and universal accessibility. By contrast, 40 million US citizens are deprived of health insurance and must pay out of pocket for treatment. Furthermore, Canada and Germany have demonstrated higher life expectancies and lower infant mortality rates compared to US (13).

It follows from the discussion above that the differences in healthcare system organization can affect the life expectancy / per capita healthcare expenditure ratio; therefore, this should be considered for MENA countries, especially for those with developing healthcare systems. As can be seen from **Figure 1**, in countries at the lowest end of per capita healthcare spending (Yemen, Egypt, Bahrain, and Lebanon) even small investments in healthcare can substantially boost the population life expectancy and catch up with modern standards (18). This stems from the substantial differences in the healthcare problems that these countries are currently facing. Minor improvements in overall living conditions as well as providing widely accessible primary preventive healthcare, can dramatically increase the overall survival rate and therefore the health expectancy at birth (19). This contrasts with cancer prevention and management of chronic conditions that require continuous specialized medical attention. In other words, the current healthcare systems in these countries appear to have an evolutionary disadvantage, but when modern medical knowledge and achievements are properly provided, these countries may quickly transition to a state similar to their counterparts in Europe.

A study that assessed inefficiency of health systems in MENA region demonstrated that most MENA countries appear to have reasonably high degree of technical efficiency with Morocco, Lebanon and Qatar, are in the top of the countries in term of

technically efficiency. On the other hand, worst performers were observed in Yemen and Sudan. This indicate that there is still a room for healthcare system efficiency improvement in MENA region (20).

In general our results were in line with previous studies about the positive impact of health spending on health outcome.

Increasing in life expectancy on the other hand is associated with increasing in the utilization of health service by aging population who is the largest users of health services. In terms of life expectancy previous studies found that females gained on average 4–6-year over men on the OCED countries this may due to the fact many prevention health program were focusing on female like breast and cervical cancer screening and other educational program (15).

Other studies demonstrated a positive relationship between increase spending on pharmaceutical product have a positive impact on health outcomes (21, 22). This association required further investigation specially with many countries shift to value based health care and use both clinical and economic evaluation in medication reimbursement decision which can improve efficiency in health funding and resource allocation (23). Health Technology assessment is still in early phase in MENA region but it anticipates to play a major role in the near future in optimize healthcare resource allocation specially with the high cost of innovative health technology (24). The current health reforms program in many MENA countries would play an important role in improve health outcome while maintains health costs. Future research should examine the impact of such program and identified factors that contribute to the large variation of health outcomes in the region.

CONCLUSION

A large variation was demonstrated between health expenditures per capita and life expectancy in MENA countries, and this variation is growing with time.

Overall our study demonstrated that health expenditure is an important factors in improving health outcome in MENA region. Efficient allocation of health resources is crucial for stability of any health care system and finding of this study have important policy implications for MENA countries. Policymakers are concerned with measuring the extent to which the increase in health expenditure is keeping pace with the increase in health outcome, which is an important factor for assessing if a country has an efficient health system and determining the gap to reach optimum levels for MENA countries with poor health status.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

BB, DA, and NA design the study. DA and NA collect the data and edit and proof read the manuscript. BB and DA analyzed the data. BB wrote the article. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2020.624962/full#supplementary-material

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BRIEF RESEARCH REPORT
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Rising Catastrophic Expenditure on Households Due to Tuberculosis: Is India Moving Away From the END-TB Goal?

Banuru Muralidhara Prasad[1]*, *Jaya Prasad Tripathy*[2], *V. R. Muraleedharan*[3] and *Jamhoih Tonsing*[1]

[1] International Union Against Tuberculosis and Lung Disease, The Union South East Asia Office, New Delhi, India, [2] Department of Community Medicine, All India Institute of Medical Sciences, Nagpur, India, [3] Humanities and Social Science Department, Indian Institute of Technology Madras, Chennai, India

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***Correspondence:**
Banuru Muralidhara Prasad
drprasadbm@gmail.com

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Introduction: One of the targets of the END-TB strategy is to ensure zero catastrophic expenditure on households due to TB. The information about household catastrophic expenditure is limited in India and, therefore difficult to monitor. The objective is to estimate household and catastrophic expenditure for Tuberculosis using national sample survey data.

Methods: For arriving at out-of-pocket expenditure due to tuberculosis and its impact on households the study analyzed four rounds of National Sample Survey data (52nd round-1995–1996, 60th round-2004–2005, 71st round-2014–15, and 75th round 2017–2018). The household interview survey data had a recall period of 365 days for inpatient/ hospitalization and 15 days for out-patient care expenditure. Expenditure amounting to >20% of annual household consumption expenditure was termed as catastrophic.

Results: A 5-fold increase in median outpatient care cost in 75th round is observed compared to previous rounds and increase has been maximum while accessing public sector. The overall expense ratio of public v/s private is 1:3, 1:4, 1:5, and 1:5, respectively across four rounds for hospitalization. The prevalence of catastrophic expenditure due to hospitalization increased from 16.5% (52nd round) to 43% (71st round), followed by a decline to 18% in the recent 75th round.

Conclusion: Despite free diagnostic and treatment services offered under the national program, households are exposed to catastrophic financial expenditure due to tuberculosis. We strongly advocate for risk protection mechanisms such as cash transfer or health insurance schemes targeting the patients of tuberculosis, especially among the poor.

Keywords: catastrophic expenditure, household, tuberculosis, national sample survey, India

KEY POINTS

The nationally representative survey sample data from 1995–96 to 2017–18 was analyzed to estimate household and catastrophic expenditure for TB. The expenditure ratio public v/s private was about 5-folds for outpatient care and similar trend was observed for hospitalization. Poor household face more catastrophic expenditure while hospitalization services are accessed in private sector and there is a need for risk protection mechanisms.

INTRODUCTION

Over the decades, Tuberculosis (TB) disease continues to cause suffering and is still one of the leading causes of death in the world. In 2019 alone, more than 10 million people had suffered due to TB, which has claimed nearly 1.2 million lives (1). Given this scenario, the global community has pledged to End-TB by 2035 with one of the main targets is to ensure households face "zero" catastrophic costs due to TB (2).

Systematic reviews across low- and middle-income countries showed mean total costs of TB ranging from $1 to 8,198, with >60% accounting for indirect cost (3–5). There is a need to quantify and understand the financial burden on TB patients in-order to adopt appropriate policies to realize the global target of having zero households incurring catastrophic costs because of TB disease.

India has nearly one-quarter of the global TB burden. Despite free TB diagnosis and treatment in the public sector, TB morbidity and mortality pose an enormous economic burden to patients, household, and society. Limited evidence shows that each year, a TB patient loses on average 3–4 months of work and up to 30% of household earnings (6–9). These studies were limited to a specific geographical area or a particularly vulnerable group of patients. The studies mainly included patients who were enrolled in the National TB Program for treatment. However, patients availing diagnostic and treatment services from private sector and those on non-DOTS regimens are often missed, thus limiting the representativeness of the estimates to the entire population of patients with TB.

In a country like India, where government spending on health is low and with a larger presence of private providers; patients often spend out-of-pocket (OOP) to meet the health care needs. In this scenario, we have limited estimates of expenditure due to TB, both in the public and in the private sector. The data of nationally representative surveys conducted by the National Sample Survey Office (NSSO), provides us an opportunity to understand household expenditure patterns. As the NSSO conducts periodic surveys, it also allows us to compare out-of-pocket expenditure for TB care across different periods.

The objective of the current study is to estimate household and catastrophic expenditure for Tuberculosis using national sample survey data. In addition, the study also estimates the expenditure for out-patient care and hospitalization due to TB and its catastrophic impact on households in both the public and private sectors, compared across periods.

METHODS

Study Design

This is a secondary data analysis of four rounds of surveys conducted by the NSSO from 1995–1996 to 2017–2018 – (a) Survey on Health Care: NSS 52nd Round, 1995–1996 (b) Survey on Morbidity and Health Care: NSS 60th Round, January 2004 - June 2005, (c) Social Consumption - Health Survey: NSS 71st Round, January - June 2014, (d) Social Consumption in India – Health: NSS 75th Round, July 2017-June 2018. The periodic surveys with similar methodology for health is commissioned by Ministry of Statistics and Program Implementation, Government of India.[1]

Data Source

The NSSO surveys collect data on morbidity profile of the population, utilization of public and private health care facilities, and expenditure incurred on various ailments requiring hospitalized and non-hospitalized care. The surveys collected household details, socio-demographic particulars, and details of ailments and medical treatment received. Though the methodology used across surveys are similar, there are few variations in the design and sampling were present across the four rounds, these variations are focused on improving the data quality and do not affect our analysis of the data with regards to TB.

Out of Pocket Expenditure (OOPE) for each episode of hospitalization (as inpatient care –in-patient department- IPD) and outpatient or day-care was recorded. Detailed expenditure was available for both direct and indirect costs. Direct costs included expenditure related to drugs (allopathic and other systems of medicine), diagnostic tests (including ECG, X-ray, and pathological tests); professional fees for doctors; payments to hospital/institution; other medical expenses (physiotherapy, personal medical appliances, blood, oxygen, attendant charges, etc.). Indirect costs included transport for patients and other accompanying persons, food-related expenses, lodging charges, and others.

The data from respondents were collected for hospitalization and outpatient. The recall period was 365 days for assessing inpatient hospitalization expenditure, 15 days for outpatient

[1]The Ministry of Statistics and Programme Implementation of Government of India, through National Sample Survey Office which was established as a survey organization in 1950 to conduct periodic surveys on various aspects around social, economic development, employment etc. The survey sampling framework is uniform across the survey -rounds. The 52nd Round titled as "Survey on Health Care: NSS 52nd Round, 1995–1996"adopted a two stage sampling design and collected data from a total of 120,942 households (71,284 in rural areas and 49,658 in urban areas). The subsequent surveys 60th Round titled as "Survey on Morbidity and Health Care," 71st Round titled as "Social Consumption - Health Survey," and 75th Round titled as "Social Consumption in India – Health" conducted stratified multistage sampling method. The methodology is detailed in the reports "Note on Sample Design and Estimation Procedure of NSS 75th Round." In 60th round a total of 73,868 households were covered (in rural 47,302 and in urban 26,566) and in 71st round 65,932 households were covered with 36,480 from rural and 29,452 from urban areas. In the recent 75th round, the data was collected from 113,823 sample of households with 64,552 from rural areas and 49,271 from urban areas. The household interviewquestionnaires included 58 self-reported morbidity in 52nd round, 42 in the 60th round, and 61 in both 71st and 75th round.

expenditure, and one month for household consumption expenditure. OOP expenditure for hospitalization and outpatient care was considered separately. The OOP expenditure, either due to outpatient care or hospitalization amounting to more than 20% of annual household consumption expenditure was termed as "catastrophic" (10). Catastrophic expenditure assessed thus was for each episode of outpatient care or hospitalization. Ascertainment of TB in the survey was based on self-report by the respondent. All those who reported hospitalization or having availed outpatient care due to TB within the said reference period as mentioned above were included in this study.

Data Analysis

Data were imported into STATA version 12.0 for analysis (STATA IC/12.0 for Windows, StataCorp LP, USA). The master data sheets were then analyzed using SPSS 16.0 (SPSS Inc. Released 2007. SPSS for Windows, Version 16.0. Chicago, SPSS Inc.). Each episode of hospitalization or outpatient visit due to TB was the unit of analysis. The study population was divided into five quintiles based on monthly per capita consumption expenditure (MPCE). Median (interquartile range) expenditure and the median proportion of catastrophic expenditure across four rounds of the survey are presented for each of the five MPCE quintiles and type of health facility (public and private). The cost of outpatient care and hospitalization has been given separately. Due to the complex multistage sampling design, estimates were derived by applying sampling weights provided in the data sets.

The expenditure estimates of the 52nd round, 60th round, and 71st round have been equated to the estimates of the 75th round using the Consumer Price Index (CPI) published by the World Bank for India (11). Accordingly, the conversation rate values for the 52nd round, 60th round, and 71st were 4.23, 2.52, and 1.139 respectively. The values in Indian rupees are converted to US dollars (USD) at the annual average rate of 65.12 for the reference year 2017 as published by The World Bank (12).

Ethics Approval

The Ethics Advisory Group of the International Union Against Tuberculosis and Lung Disease (The Union), Paris, France, determined that ethics clearance was not required for this study as it involved analysis of secondary data available in the public domain.

RESULTS

Cost of Outpatient Care

A total of 580, 671, 299, and 275 members of household in the 52nd, 60th, 71st, and 75th rounds, respectively, who accessed outpatient care in the last 15 days due to TB were included in this analysis. The outpatient care proportion in public sector increased from 46, 59, 55, and 61% in respective rounds.

In the recent rounds 71st & 75th round, the overall median cost incurred per outpatient care was USD 4 (3–15) & USD 22 (7–61) a five-time increase in cost incurred. In the public sector, each episode of outpatient care cost US$ 12 (1–141) as per the latest 75th round and US$ 2 (1–4) in the 71st round. Outpatient care costed more than twice in the private sector in the 75th round [US$ 22 (16–31)] compared to the 71st round [US$ 9 (4–21)]. The cost of outpatient care has seen a downward trend when compared to previous rounds of surveys in both the public and private sectors except for the recent 75th round (**Table 1**).

From all four rounds, on an average 53% of the participants sought outpatient care in the public sector and 44% in the private sector. The outpatient services in the public sector were mostly accessed by the population from the 1st quintile, while the private sector was accessed mainly by the 5th quintile across

TABLE 1 | Comparison of cost of each episode of outpatient care due to tuberculosis across wealth quintiles in four national surveys of India from 1995–1996 to 2017–2018.

Quintile	Overall expenditure				Public sector				Private sector			
	52nd round	60th round	71st round	75th round	52nd round	60th round	71st round	75th round	52nd round	60th round	71st round	75th round
	N = 375	*N* = 127	*N* = 287	*N* = 275	*N* = 172	*N* = 75	*N* = 159	*N* = 168	*N* = 180	*N* = 52	*N* = 128	*N* = 89
First quintile	2 (0–17)	6 (1–17)	3 (3–5)	16 (10–61)	3 (2–6)	3 (1–14)	3 (1–3)	2 (2–17)	20 (7–42)	6 (3–19)	4 (3–10)	16 (16–61)
Second quintile	10 (0–17)	6 (2–9)	9 (4–21)	26 (22–141)	10 (4–20)	2 (2–5)	3 (1–10)	141 (141–141)	14 (14–17)	9 (6–14)	11 (4–21)	22 (22–26)
Third quintile	1 (0–16)	13 (3–21)	16 (6–16)	8 (2–9)	1 (1–5)	1 (1–9)	6 (1–54)	8 (4–8)	20 (12–59)	13 (12–22)	16 (7–16)	6 (2–9)
Fourth quintile	7 (0–15)	62 (37–66)	4 (1–25)	1 (1–10)	15 (7–23)	74 (6–74)	1 (1–4)	1 (1–1)	13 (9–23)	62 (62–62)	25 (16–25)	10 (10–30)
Fifth quintile	13 (3–33)	44 (15–58)	1 (1–4)	48 (8–372)	8 (3–12)	44 (15–206)	1 (1–1)	0 (0–3)	49 (16–130)	46 (19–46)	14 (9–27)	372 (35–372)
Overall	7 (0–20)	12 (3–37)	4 (3–15)	22 (7–61)	7 (3–14)	3 (1–15)	2 (1–4)	12 (1–141)	16 (13–42)	14 (8–62)	9 (4–21)	22 (16–31)

52nd Round was conducted b/w 1995 and 96 and CPI unit used is 4.23 to equate to 2017 value. 60th Round was conducted b/w 2004 and CPI unit used is 2.52 to equate to 2017 value. 71st Round was conducted b/w 2014 and 2015 and CPI unit used is 1.139 to equate to 2017. The annual average of USD exchange rate for 2017 is 65.12 to INR is used across the rounds. The figures are in median expenditure and interquartile range (IQR) is in parentheses.

TABLE 2 | Prevalence of catastrophic expenditure as a result of one episode of outpatient care due to tuberculosis across wealth quintiles in four national surveys of India from 1995–1996 to 2017–2018.

	Overall expenditure				Public sector				Private sector			
	52nd round	60th round	71st round	75th round	52nd round	60th round	71st round	75th round	52nd round	60th round	71st round	75th round
First quintile	0	2.6	4.5	0	0	0	5.4	0	0	10	3.8	0
Second quintile	0	0	3.8	0	0	0	0	0	0	0	6.9	0
Third quintile	0.8	0	0	0	0	0	0	0	3	0	0	0
Fourth quintile	0.8	0	0	0	0	0	0	0	2	0	0	0
Fifth quintile	0	0	0	0	0	0	0	0	0	0	0	0
Overall	0.3	1	2.3	0	0	0	1.7	0	1	2.7	3.1	0

all four rounds. The total overall medical expenditure due to outpatient visit has shown a drop in the 71st Round compared to the previous rounds. The overall expenditure ratio Public v/s Private is 1:3, 1:4, 1:5, and 1:5 across 52nd, 60th, 71st, and 75th round respectively.

Overall, 2.3% of households faced catastrophic expenditure toward outpatient care as a result of TB, 1.7% in the public sector, and 3.1% in the private sector as per the NSSO 71st round. In the recent 75th round, the prevalence of catastrophic expenditure was zero in both the public and private sectors. The prevalence of catastrophic expenditure has increased from 0.3% (52nd round) to 2.3% (71st round), dipping to zero in the 75th round (**Table 2**).

Cost of Hospitalization

A total of 756 (500 public, 241 private), 901 (550 public, 352 private), 610 (310 public, 210 private), and 610 (412 public, 198 private)participants from the 52nd, 60th, 71st, and 75th round, respectively, who were hospitalized in the last 365 days due to TB were included in this analysis. A total of 66%, 61%, and 60% of the participants sought hospitalization in the public sector in the 52nd, 60th, and the 71st round, respectively. In the 75th round, the hospitalization increased to 67% in the public sector; population from 1st quintile accessed more of the public sector and 5th quintile accessed the private sector for inpatient care across four rounds (**Supplementary Table 1**).

In the 52nd round & 75th round, the median total cost as a result of hospitalization due to TB has remained the same at USD 111(40–286) toUSD110 (34–279). The median cost of hospitalization in the public has shown a decline from USD 79 (27–172), 87 (32–221), 44(20–149), and a slight increase in the 75th round to USD 56 (18–140). The hospitalization expenses in the private sector have increased from US$ 231 in the 52nd round to US$ 261 in the 75th round (**Table 3**). Medicines form the major proportion of medical care costs of hospitalization. The expenditure on medicines was 31% of total hospitalization cost in the 71st round, and this declined to 29% in the 75th round. A gross reduction in expenditure on medicines was seen in the 1st quintile, while the services were availed in the public sector (41% in 71st round to 26% in 75th round). Given this, the overall expenditure ratio – Public v/s Private is at 1:3, 1:4, and 1:6 times across 52nd, 60th, and 71st rounds, respectively.

Overall, 43% of the households faced catastrophic expenditure due to hospitalization as a result of TB in the 71st round, 32% in the public sector, and 62% in the private sector, whereas it declined to 18% in the 75th round. The prevalence of catastrophic expenditure has been increasingacross the three surveys from 16.5% in the 52nd round to 43% in the 71st round. A similar increase has been observed both in the public and the private sector (**Table 4**).

DISCUSSION

This study estimates the cost of each episode of outpatient care and hospitalization due to TB in both the public and private sectors and its catastrophic impact on households. The study also compares the cost estimates across four surveys conducted in different periods. The main findings of the study are (a) there is an increase in household expenditure especially when the services are accessed in private sector (b) catastrophic expenditure is evident among the poor households while accessing hospitalization services.

First, every two out of five episodes of hospitalization due to TB have a catastrophic impact on households according to the 71st round of survey in 2014. This has declined to 18% as per the latest 75th round in 2017–18. A similar finding has also been observed in the case of expenditure due to outpatient care. This is encouraging and could be attributed to the various scheme and health system strengthening under the National TB Elimination Program (NTEP), although further studies are required to confirm this. Previous studies in India, China, Peru, and few African countries have also reported significant cost of care and impact on households due to TB care (3, 7–9, 13–17). A recent cross-sectional study of 455 individuals with TB in South India showed that despite the implementation of free diagnostic and treatment services under a national TB control program, one-third of TB-affected households still experienced catastrophic costs (18). A similar cross-sectional study among 450 TB patients in New Delhi, India reported that 7% of patients registered under the national TB program experienced catastrophic expenditure, with a large proportion being accounted by indirect costs (19). Poornima et al. also reported significant cost of care due to TB in programmatic settings with one in eight patients experiencing catastrophic expenditure (17). A direct comparison of the figures

TABLE 3 | Comparison of cost of each episode of hospitalization due to tuberculosis across wealth quintiles in four national surveys of India from 1995–1996 to 2017–2018.

	Overall expenditure				Public sector				Private sector			
	52nd round	60th round	71st round	75th round	52nd round	60th round	71st round	75th round	52nd round	60th round	71st round	75th round
	N = 755	*N* = 901	*N* = 520	*N* = 610	*N* = 500	*N* = 550	*N* = 310	*N* = 610	*N* = 241	*N* = 351	*N* = 210	*N* = 610
First quintile	66 (26–133)	103 (45–285)	72 (35–171)	76 (34–346)	60 (20–130)	69 (21–199)	54 (15–135)	65 (15–172)	81 (36–184)	202 (82–359)	175 (84–733)	281 (110–748)
Second quintile	98 (41–218)	165 (66–310)	84 (28–194)	88 (27–249)	68 (23–105)	94 (46–172)	28 (28–101)	34 (4–146)	286 (107–481)	310 (198–600)	192 (84–297)	249 (161–825)
Third quintile	144 (33–312)	116 (35–275)	91 (46–264)	169 (48–304)	73 (7–260)	62 (12–213)	70 (25–199)	65 (28–120)	237 (144–377)	231 (116–349)	161 (98–358)	261 (261–396)
Fourth quintile	136 (62–293)	331 (97–721)	116 (15–337)	100 (33–217)	130 (62–218)	96 (43–395)	17 (6–88)	58 (28–150)	137 (34–345)	581 (314–2,014)	252 (126–675)	260 (130–439)
Fifth quintile	375 (183–985)	236 (106–910)	332 (65–350)	110 (43–338)	504 (189–985)	181 (50–910)	334 (21–350)	49 (18–134)	293 (183–1,014)	271 (153–910)	332 (105–341)	244 (110–619)
Overall	111 (40–286)	170 (60–411)	91 (28–285)	110 (34–279)	79 (27–172)	87 (32–221)	44 (20–149)	56 (18–140)	231 (81–390)	310 (143–620)	233 (93–364)	261 (163–484)
Equity ratio	5.7	2.3	4.6	1.4	8.4	2.6	6.2	−0.8	3.6	1.3	1.9	−0.9

52nd Round was conducted b/w 1995 and 1996 and CPI unit used is 4.23 to equate to 2017 value. 60th Round was conducted b/w 2004 and 2005 and CPI unit used is 2.52 to equate to 2017 value. 71st Round was conducted b/w 2014 and 2015 and CPI unit used is 1.139 to equate to 2017. The annual average of USD exchange rate for 2017 is 65.12 to INR is used across the rounds. The figures are in median expenditure and interquartile range (IQR) is in parentheses.

TABLE 4 | Prevalence of catastrophic expenditure as a result of one episode of hospitalization due to tuberculosis across wealth quintiles in four national surveys of India from 1995–1996 to 2017–2018.

	Overall expenditure				Public sector				Private sector			
	52nd round	60th round	71st round	75th round	52nd round	60th round	71st round	75th round	52nd round	60th round	71st round	75th round
First quintile	6.2	33.7	56	25	5	27	46	16	11	44	81	46
Second quintile	14.8	33	43	20	8	24	33	10	35	49	56	30
Third quintile	18.5	40.1	32	26	13	29	22	7	28	55	47	49
Fourth quintile	17.6	32.6	34	13	15	21	15	4.5	21	52	62	24
Fifth quintile	36.6	21.2	32	20	38	20	20	6	36	22	46	33
Overall	16.5	33.5	43	18	12	25	32	9	26	46	62	36

in these studies would not be fair as they involved different cut-offs of catastrophic expenditure, varying periods of follow-up and different methodologies. Nevertheless, it is unequivocal that despite free diagnosis and treatment offered for TB in the public sector, patients with TB incur huge healthcare costs.

Second, despite the various initiatives taken by the Government of India in the last few decades toward TB control, the cost of care, and its financial impact on their households has been increasing. This is alarming, especially at a time when we have set ourselves a target of zero catastrophic expenditure. A recent study from south India, highlighted that, 31% of households face catastrophic cost even when the services are provided free of cost (20).

There were a few strengths in this study. First, this was a population-based study including TB patients from both public and the private sector, thereby lending representativeness of the estimates to the entire population of patients with TB. Second, a standard robust methodology was adopted in all the four surveys also allows valid comparison. Third, a comparison of estimates from four different surveys allows analysis of trends over the last three decades.

There were some limitations as well. First, the cost estimates presented in this study did not capture expenditure during the entire duration of TB treatment which is a minimum of 6 months. This might have underestimated the study results. Second, over-reporting of expenditure is common which could have led to overestimating the proportion of households experiencing catastrophic health costs. However, over-reporting of household consumption expenditure, which is the denominator for estimating catastrophic expenditure, is also likely. This could cause underestimation of the catastrophic impact, thereby nullifying the above effect. Third, there is no information on the clinical profile of TB patients such as type of TB, drug resistance pattern, other co-morbidities, and disease

severity which would have confounded the results. Fourth, data on household income loss (loss of income of patient and caregivers) could not be assessed as it was not captured in the survey data. Fifth, the reasons for high OOP expenditure and catastrophic expenditure could not be explored as it was the beyond the scope of this study.

Despite these limitations, the study findings have important policy implications. First, financial support in terms of cash transfer or health insurance is needed to offset the impact of expenditure due to TB. With the Direct Benefit Transfer (DBT) Scheme and the Ayushman Bharat insurance scheme, it seems that things are moving in the right direction. However, targeting the needy and the poor is essential under these schemes. Previous assessments in India have highlighted several challenges to the implementation of the DBT scheme which needs to be addressed to improve uptake and efficiency (21, 22). Also, considering the burden of expenditure due to TB, the amount transferred under DBT would not be enough to provide sufficient compensation for most patients as echoed in other studies (18).

Second, the median OOP expenditure in the private sector was nearly 5 times higher than the public sector. This is due to the burgeoning growth of the private sector in the health care market in the last few decades. The predominant role of the private sector in TB care is also echoed by previous studies. The private sector manages more than 50% of all TB cases, which cannot be ignored (18). Thus, the public sector needs to work together with the private players to provide TB care which is affordable and accessible to all. The public-private partnership initiatives under the TB program is a step in the right direction, although, it needs to be scaled-up using the recent guidance document (23).

CONCLUSION

The study shows that a household with a member suffering from TB is exposed to significant financial risks which lead to catastrophic household expenditure, with a worsening trend over the last few decades. This is despite free diagnostic and treatment services offered under the national TB program. We strongly advocate for risk protection mechanisms targeting the poor; such as cash transfer or health insurance schemes. Future research is required to explore the reasons for high OOP expenditure due to TB in different settings, both quantitatively and qualitatively. We also need to understand the uptake and impact of various social protection schemes that are aimed at protecting catastrophic expenditure and correlate to subsequent rounds of National Sample Surveys.

DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. This data can be found here: http://www.icssrdataservice.in/Health_care.php.

AUTHOR CONTRIBUTIONS

BP, JPT, and VM conceptualized the paper and interpreted the data and critically reviewed the manuscript. BP and JPT analyzed and interpreted the data, drafted, reviewed, and edited the manuscript and took lead in drafting the manuscript. JT reviewed and provided key inputs to the manuscript. All the authors have read and approved the final version of the manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.614466/full#supplementary-material

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The Influencing Factors of Participation in Online Timebank Nursing for Community Elderly in Beijing, China

Yan Wu[1], *Yanran Ding*[1], *Cong Hu*[2]* *and Lei Wang*[1]

[1] School of Economics, Beijing Technology and Business University, Beijing, China, [2] School of Economics and Resource Management, Beijing Normal University, Beijing, China

This study uses the logit model through questionnaire data of Beijing in 2019 to investigate the participation willingness of online timebank elderly care, especially to discover different influencing factors on the participation willingness between the youth group and the elderly group. We find that: First, the health status of elderly people and the number of elder families of young people have significant positive impacts on their willingness to participate in online timebank. Second, the experience of participating in voluntary activities has a significant positive effect and it has a far greater impact in the young group than that in the elderly group. Third, the more the free time, the higher the participation willingness in the young group, but it is the opposite in the elderly group. Fourth, the years of education and party member have significant promoting effects on the participation willingness in both groups. Such heterogeneous influencing factors can help develop online timebank nursing for dealing with the increasingly serious population aging problem in China and also other developing countries.

Keywords: timebank, elderly care, questionnaire survey, logit model, China

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***Correspondence:**
Cong Hu
bshida@126.com

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INTRODUCTION

The process of population aging in China is accelerating, especially in big cities. By the end of 2019, the number of elderly people over 60 years old has reached 254 million, accounting for 18.1% of the Chinese total population. Taking the capital city Beijing as an example, the city's registered elderly population above 60 years old is ∼3.49 million, accounting for 25.4% of the city's total population. In addition, with the increase of one-child families and a large number of young adults leaving the country to work in cities, the proportion of empty nest families in China has also increased sharply. The proportion of empty-nest elderly in China has reached 49.17% in urban areas and 38.13% in rural areas, which has led to a serious social issue in China.

It should be admitted that the aging population, migration, and empty nest are the global drivers for change and are not specific for China, but the situation in China is very special. Due to the implementation of the family planning and one-child policy for many years, the proportion of young people in China has decreased rapidly, and the feature "old before getting rich" has emerged in China, that is, people's income has not reached a certain level but the aging problem is becoming more and more serious. For example, China's newborn falls abruptly in 2020.1.76 million fewer

babies were born in 2020 than that in 2019, a drop of about 15 percent[1]. In addition, due to the lack of labor rights protection and the diligent characteristic, Chinese young people are often overtime at work, leaving little time to care for the elderly families, especially young people who work and live far away from their hometown.

However, Chinese institutional care is difficult to become the main care model of the elderly due to limited numbers and unaffordable fees for most Chinese. This is also the case in some other developing countries like Russia and Argentina. In this context, the new community-based care "timebank" may become a feasible elderly care model and can play an important role in solving this serious problem of public health in China and also other developing countries. "Timebank" means that the participator deposits the time which they spent on taking care of other community elderly in the timebank. When they encounter difficulties in their elderly age in the future, they can withdraw the deposited time and get corresponding time nursing from others (1). In the concept of timebank, time as a currency can be stored and exchanged. The purpose of the timebank is to use the time of payment in exchange for the care of others, and the bank is a channel for the circulation of time.

With the trend of miniaturization of families in China, most people have no enough energy or time to support their parents or other elderly relatives. In 2010, some members of the Chinese People's Political Consultative Conference proposed the establishment of a timebank that uses the community as a unit to serve the elderly in the community. On July 4, 2015, China issued the "Guiding Opinions on Actively Promoting the "Internet +" Action," which clarified the full play of the role of the Internet in the optimization and integration of social resource allocation in China. Therefore, the online timebank model may play a positive role in improving the elderly care system in the future. Therefore, this study uses logit model through questionnaire data of the youth group and the elderly group to investigate the participation willingness of online timebank elderly care, especially to discover the influence factors as well as the potential problems, so as to propose countermeasures to promote the wide development of online timebank and deal with the increasingly serious population aging problem in China and also other developing countries.

In the next section, we will analyze the mechanism and operation mode of the Chinese timebank and give a literature review. Section The Survey Process and Data Analysis introduces the survey process and makes a short data analysis. Section Methods describes the logit model, variable selection, and model specification. Section Exploring the Influencing Factors of Participation Willingness empirically assesses the effects of different factors on participation willingness in online timebank. Section Discussions discusses the results based on the interview information. Finally, section Conclusions and Policy Implications provides the conclusion and policy implications.

[1]https://www.mps.gov.cn.

TIMEBANK MECHANISM AND LITERATURE REVIEW

Timebank Mechanism in China

Timebank is different from the ordinary bank because it is not money, but the time that is deposited and withdrawn. Through this mechanism, people can not only store time but also consume the stored time. After years of development, timebank has gradually been used in community mutual assistance scenarios, mainly retired young elderly to provide daily assistance to the elderly to store time, and then withdraw time when they need healthcare in the future and receive the same time service. In general, the timebank can alleviate the huge pressure on the only child to support their parents in China and provide a new community healthcare method for themselves to meet the needs in the future. Relying on the community, timebank is conducive to creating a more harmonious community-neighbor relationship. By using the internet platform to provide more accurate nursing healthcare services and medical services for the elderly, in addition to integrating the community, online timebank can also integrate with elderly care institutions and medical institutions. Therefore, online timebank is a useful platform that can better match the demand side and supply side of elderly healthcare services.

First, under the traditional concept, for the elderly who need nursing care, it is generally based on family or relatives' nursing care. Public welfare services and market-oriented services are only a supplement. Many of the laws related to social security take the family and family support relationship as a precondition. However, intergenerational relations and intergenerational conflicts are unavoidable problems in Chinese society. Although family care can make it easier for the elderly to feel family and spiritual comfort, it can also internalize intergenerational conflicts. Therefore, the old-age care transition from the family to the society can alleviate the contradiction between the elderly and the young population within the family. Adopting a community-based care model can also take care of the elderly's desire to live in a familiar environment and enjoy their old age (2).

Second, the problem of aging in China is increasing, and the government alone cannot solve the problem fundamentally. It is imperative to develop a diversified model. Timebank age care services can arouse the enthusiasm of community residents and attract volunteers to participate, which is a useful supplement to the home care model (3). The reason is that this model can provide a way for some elderly people with low incomes and insufficient ability to purchase care services independently, which is conducive to saving the social cost of pensions and effectively alleviating the financial demand pressure of elderly services.

Third, after the low-age elderly withdraw from the job market according to the national legal retirement ages of 55 years old for man and 50 years old for woman, a large part of them still have the potential to continue working. However, due to insufficient physical conditions, knowledge, and skills, most of the low-age elderly can only use their spare time to serve the other elderly in the community (4). Therefore, the timebank model can use market-oriented means to mobilize their enthusiasm.

Fully basing on the existing social human resources, especially the human resources of low-wage elderly to broaden the group of elderly service personnel, can solve the problem of insufficient elderly service personnel caused by the aging society under Chinese huge population base.

Fourth, the needs of the elderly in China are transforming from low-level and single to high-level and diversified. The focuses of the elderly care problem are not only the satisfaction of the basic living needs of the elderly and the guarantee of money alone but also the development of a higher level of diversification in the Chinese present situation. The timebank can play a positive role in alleviating this contradiction between supply and demand through the "timesaving" mechanism in a broad population group (5).

At present, there are many problems in the development of the timebank model in China. First, the low popularity and small scale of existing timebanks hinder the transfer and conversion of time currency (6). Second, the young generation's participation is quite low in most of the Chinese timebanks (7). Third, the lack of transfer mechanism and the difficulty of general deposit and withdrawal are common problems for Chinese timebanks (8). However, the main reasons for the lagging and insufficient development of China's timebank are the lack of relevant policy support from the government, the lack of a unified network information system, and the lack of a service value measurement standard that is suitable for China.

Operation Mode of Chinese Timebank

The earliest timebank model in China appeared in the Jinyang Neighborhood Committee of Tilanqiao Street, Hongkou District, Shanghai in 1998, which called on the young elderly to provide services for the other elderly. The earliest "time savings card," also appeared in the Jinyang neighborhood committee, which includes labor time savings date, content, and time. At present, the development of the timebank is no longer limited to the big cities along the eastern coast, but further expanded to Hubei, Inner Mongolia, Sichuan, Guizhou, and other inland provinces, though, almost all the time banks are small community time banks. This paper takes the Zhaoyuan community timebank in Nanjing, a rapidly developing one, as an example to illustrate the typical operation mode of China's timebank at present.

In August 2005, a community timebank was set up in the Zhaoyuan community in Nanjing. The idea behind the timebank is that the elderly population in the community is growing, and most of the younger ones are idle. By the end of 2020, the number of members has reached more than 2,000 people, most of whom are retired old people in the community, as well as college students practicing volunteer service. In the process of continuous exploration and operation, the Zhaoyuan community timebank has gradually formed its own complete operating system.

Relevant Supporting Institutions

Zhaoyuan timebank uses the time currency to record the accumulative service of its members and sets up corresponding institutions to ensure its normal operation, including time currency maintenance and management department, time currency evaluation and arbitration department, time currency coordination and development Department, and time currency credit and trading department.

Contents of the Service Provided

Zhaoyuan timebank not only provides services for the elderly, but also help the vulnerable groups in the community, such as the seriously ill, the injured, and the mentally ill. Now there are more than 30 service items including household appliances, computers, and bicycle repair, hairdressing, health consultation, housekeeping services, legal aid, elderly psychological counseling, emergency patient rescue, on-site physical examination, photography, flower care, marriage introduction, cultural and recreational activities and so on, which basically include every aspect of daily life needs for the community elderly residents.

Selection of Members

In addition to the elderly and other poor groups, the general people to enjoy the service of Zhaoyuan timebank must first accumulate 60 h of time currency. In addition, according to the cumulative length of time currency, the participator will get the star rating. Zhaoyuan community timebank divide the participators into five levels of member honor, and corresponding reward measures are given for each honor level.

Timebank Credit System

The time currency can be overdrawn, that is, if the time currency accumulation is not enough, or no accumulation when meeting the need for emergency services, the members can enjoy the service by paying a certain amount of security fund, and then provide services for others to offset the overdraft. The timebank also set up a families guarantee system, which is also used control to overdraft risk.

Literature Review

Timebank, like traditional banks, is the service institution that supplies to clients store and withdrawal service of laboring time. The researches on timebank mainly focused on three aspects, including operation mechanism, participation willingness, and development situation of timebank. However, each aspect is in its early study period and their conclusions are inconsistent.

For the studies of the operation mechanism of timebank, scholars have, respectively, analyzed different problems like credit, labor supply, and demand distribution. The new pattern of old-age care can be explored according to the operation of the timebank under the new sharing economy (9). It can be a prominent non-profit counterpart of commercial peer-to-peer service exchange businesses, such as Airbnb, Lyft, and TaskRabbit, which are expanding rapidly (10). It is also a "currency community" which uses the hour as the unit of exchange, where every single person's input is valued equally (11). Timebank's most commonly cited benefits are building social capital and empowering members (12). It is found to be successful at engaging socially excluded and vulnerable groups of people in community activities, boosting their confidence, social networks, skills, and well-being (13). Furthermore, timebank

developed a significant communication and social network that members activated to solve diverse practical problems facing the community (14). It offers a great opportunity for solving various intercultural issues, especially by enabling the skills and offer-demand based exchange without taking the cultural background much into consideration (15). For example, based on three cases study, Dash and Sandhu found that the obstacles can be addressed by hybrid models between timebank and volunteering efforts (16). Based on the data collected from timebanks in three European metropolitan areas, Laamanen et al. considered that timebank as a collaborative consumption lifestyle that challenges the traditional monetized ideology of exchange in orthodox economic theory and the hegemonic understandings of consumption (17). Besides, based on a 2013 ruling by the Finnish tax authority and the Timebank's responses to it, Matti concluded that to what degree the choice of a particular standard can be taken as a moral choice (18). For the studies on China, Zheng introduced the concept of time currency to timebank, which is mainly issued by the government, as the accounting unit, transaction currency, payment currency, and deposit currency of timebank services. According to the actual situation of the elderly, the government grants time and currency subsidies as appropriate, which greatly promotes the development of timebank (19). From the perspective of aging, Lu and Wu do not regard the elderly as a burden to society, but one of the valuable social labors who contribute to society. Timebank can let the elderly better integrate into the political, economic, technological, and cultural development of society, and provide their own strength for social development (20). Based on the above, we set up relevant questions in the questionnaire to investigate the willingness of the elderly in the community to provide services through an online timebank.

For the studies of the people's willingness to use timebank, in addition to the middle-aged and elderly as the main body of aging, there are also community volunteers such as young people who are willing to participate in the healthcare services through timebank. For example, by introducing a timebank smartphone application and present a 5-week user study with 32 young adults, Han et al. highlighted the potential of timebank for the young population with an application that facilitates access to communications and transaction-management activities and strengthens social connection and the sense of community attachment (21). Based on 87 months' worth of transaction data from a timebank, which has had a total of 950 members, the elderly were found to be as active as other members (22). Besides, how to improve the willingness to participate in timebank is also a topic of concern for scholars. A movement is gaining traction in New Zealand around timebanks, networks of support in which members exchange favors such as gardening, lifts to the supermarket, pet care, language lessons, career advice, or smartphone tutorials (23). By analyzing a combination of service exchange records from the three largest timebanks in the world, Shih et al. suggested that the idea of "equal time, equal value" that is at the foundation of timebank is a source of tension between members with instrumental vs. idealistic and altruistic motivations (24). Some scholars have also found that online timebank can increase the willingness to participate. For example, based on the survey study over 120 timebanks across the USA, Chien et.al. found that perceived ease of use in timebank platforms was positively associated with positive attitudes toward both requests and offers (25). By exploring the potential of an online timebank, Nind et al. consider that, while the concept is some way from becoming a reality, a hybrid digital-physical timebank, if accessible and flexible enough to attract usage, has the potential for supporting democratized, inclusive research in practice (26). For the studies on China, Ding took urban retired healthy elderly people as the research object, investigated the willingness of this part of the population to participate in timebank and found that the willingness of urban retired healthy elderly to participate in timebank has reached about 40%. It is believed that more and more people will recognize and accept the social age care service model especially the timebank (27). Zhang and Han explored the feasibility of constructing a "shared living model." They believe that the concept of "Internet +" can be used as a link to join the elderly and young people. In addition to the traditional youth providing services and the elderly enjoying services, they also proposed a two-way supply-demand relationship in which the elderly impart experience and knowledge to young people (28).

For the studies of the development situation of timebank, the low popularity and small scale of development hinder the transfer and exchange of time currency. For example, based on the Data collected from interviews from 84 timebank members, and semi-structured interviews with 13 timebank staff, Ruth et al. found that Timebanks faced significant implementation challenges including managing risk and safeguarding and the associated bureaucracy, a paternalistic professional culture and the complexity of the timebank mechanism which required adequate resources (29). By investigating 892 community residents' willingness and their perception of timebank in Hangzhou, Shao et al. considered that we should strengthen the application of intelligent technology to enhancing the ability to meet the demand of mutual volunteer assistance for the elderly, and perfecting the timebank model to enhance the sustainable development ability of mutual volunteer service (30). In addition, Hooper et al. introduced a kind of social machine, which is an online timebank and a time-based way for people with learning disabilities to give and receive services (31). For the studies on China, after summarizing the innovations of China's timebank, Chen and Huang concluded that the shortcomings of the timebank's early development mainly include narrow community coverage, the value measurement problem of specific services, the operation problem of timebank and especially the low participation of the young generation (7). Qi and Gao studied the problems encountered in the development of timebank and pointed out that the government's superstructure support is the main shortcoming. At the same time, there are many other problems such as the value measurement of service items, the time savings of population changes, the lack of transfer mechanisms, and the difficulty of universal deposit and withdrawal (8).

In summary, the literature has no questionnaire investigation on the willingness of online timebank participation and its influencing factors, especially for China where the

development of timebanks lags behind. Therefore, this study uses questionnaires for the young and the elderly to investigate the potential elderly care needs, participation willingness and feasibility of the online timebank healthcare model, and discover the problems in the development of timebank thus putting forward specific countermeasures and policy suggestions.

THE SURVEY PROCESS AND DATA ANALYSIS

Questionnaire Design

Based on the current situation of the rapid development of the internet industry, this article conducted a questionnaire survey among people of two different ages for internet timebank participation willingness. This survey was conducted in October 2019 and divided people of different ages into youth group under 50 years old and elderly group over 50 years old. For the two groups, different questionnaires are designed and issued for different questions such as gender, age, occupation, and income to reflect the influence of different factors on people's willingness to participate in the online timebank.

In this questionnaire, a total of 16 questions were set in the young group, including 6 basic questions such as gender, age, and occupation in the beginning. After that, there are four questions about the daily arrangement of time and the basic situation of the elderly at home, mainly including the daily leisure time of the elderly at home, the number of the elderly, and what they do in the leisure time. Through these questions, the free time of the elderly and their activities in free time can be effectively understood, so as to better integrate these activities into the time bank system. Questions 11–14 analyze the implementation process and the relationship between supply and demand of time bank by understanding the young people's willingness to serve the elderly and what kind of return they hope to get. The last two questions directly focus on the concept of the online timebank, and investigate the conversing methods of the online time bank, such as the time conversion for different labor intensity standards and time and currency conversion standards.

For the elderly group, a total of 19 questions were set, including eight basic questions in the beginning. According to the characteristics of the elderly, two questions were added in the basic ones, namely whether they retired or not and their health status. Questions 9–11 mainly investigate what the elderly do in their leisure time, so as to know their needs more accurately. Questions 12–17, from the perspective of public welfare, investigate the attitudes and views of the elderly toward the time bank, and at the same time investigate the multi-level needs of the elderly, that is, the spiritual needs of the elderly in addition to the living needs, and the work needs of the elderly after retirement, so as to better develop the human resources, especially the human resources of the young elderly. Finally, questions 18-19, like the young group, analyze the acceptance of different pricing methods of online time banking and the acceptable conversion standard of time and currency in the online timebank.

Investigation Process

The investigation was conducted in groups in 2019. The investigation of the young group was conducted by the online questionnaire program, which was promoted by the social tool WeChat. However, the online questionnaire program is hard to operate in the elderly group. Therefore, we took the offline investigation. There are six members in our investigation team. We went to the main parks, large communities, and vegetable and fruit areas of some supermarkets in Beijing separately in groups of two to conduct one-on-one interviews and questionnaire survey with the elderly randomly. Among them, what impresses us more is that two elderly people with relatively higher education (referred to here as A and B) hold opposite attitudes toward timebank, which has caught our attention.

Both Mr. A and Mr. B have a master's degree or above. After we explained our purpose, Mr. A gave a very positive attitude toward our investigation work, carefully understood our research topic, and expressed some concern about the aging population. Mr. A believes that the model of time bank is worth popularizing, and he has affirmed the possible activities that the elderly want to participate in our questionnaire survey. Here is a summary of Mr. A's thoughts on the Time Bank and some suggestions. Mr. A believes that the timebank, as an institution of public welfare, is easy to win the trust of the elderly. Second, the model of time exchange in the time bank effectively use the old labor surplus. For example, the old people's skills and experience can be used to help their neighbors solve problems, and sometimes they can also help the neighbors who go to work to do some physical labor within his capacity. These not only affirm the value of the elderly, but also improve their happiness. Mr. A said he is willing to use his knowledge and skills to help more people. Third, the model of time bank also reflects the traditional Chinese moral concept—filial piety comes first. Young people's efforts provide time storage for the elderly and provide different ways to express their filial piety to the elderly. However, Mr. A put forward that the tim bank model also has a lot of normative problem and security problem. The first one is the institutional guarantee. Old people pay more attention to if there are any support and encouragement from the government. If there is national support or national coercive protection, it will give the elderly a considerable degree of security and make them trust the time bank more. Second, as for the security issue of timebank, just like the new thing insurance that was unknown in the 1980s, how does it maintain the protection of people's labor? How is the time store in the time bank recorded and protected? This is also an area where it takes time for the time banking institutions to be further improved. Third, regarding the implementation of online timebank, it is necessary to make relevant planning and design for the elderly users who are not accustomed to using computers and mobile phones to participate in time bank more conveniently. Finally, there is the issue of the publicity of the timebank. Although there are a small number of time banks in first-tier cities such as Beijing, Shanghai, Guangzhou, and Shenzhen, they have not formed a considerable scale, and the common people are not familiar with the concept of time bank itself. Getting people to accept such a new concept in a short period of time seems to be the first issue we need to consider in developing the timebank.

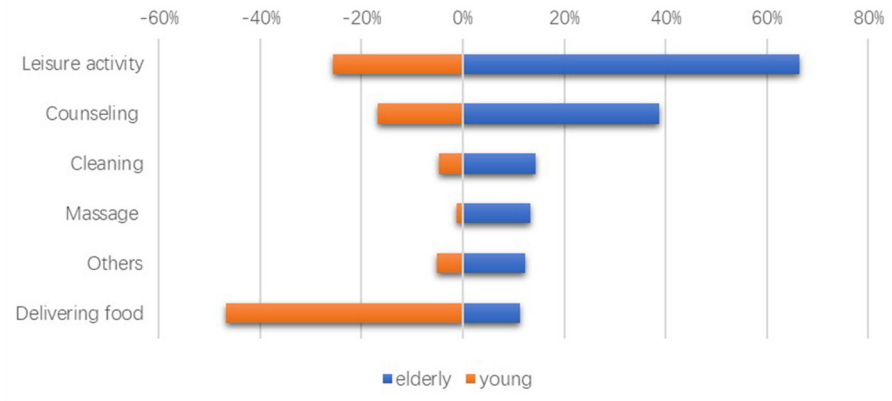

FIGURE 1 | The elderly demands and the young supplies. The unit is number.

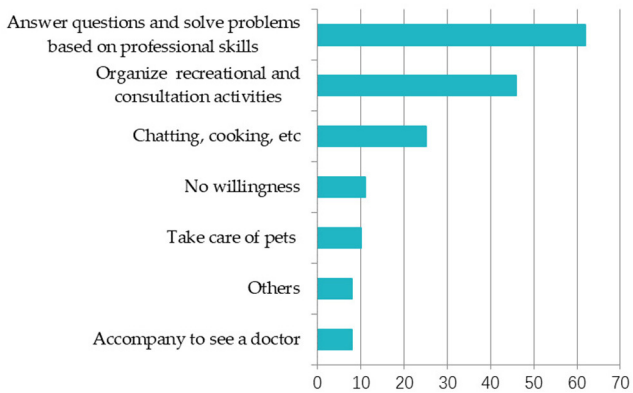

FIGURE 2 | Services that the elderly are willing to provide. The respondent can choose more than one; the unit is number.

Mr. B, on the other hand, holds a completely different view from Mr. A. He believes that when he is strong, he works and lives in a step-by-step manner and nine-to-five jobs. After retirement, he hopes to live at his own pace and enjoy the freedom of time. Therefore, he does not want to participate in community activities, including time banking activities, to accumulate time for his future care. Mr. B hopes that he can travel or do the things he likes, and enjoy life like idle clouds and wild cranes. This situation is not unique. Among the old people, we interviewed in different areas, there are always about 1/3 of them who want to live such a life. It is not just that they reject the time bank model, but that they prefer the freedom of old age life after being "tied down by work" for a long time. Therefore, when promoting the timebank, we should make corresponding propaganda countermeasures for these elderly people. For example, it is not only to save time for their own aged care but also a kind of public welfare activity to help others and increase social communication with community neighbors.

In the course of the investigation, in addition to answering the questions of the questionnaire, some of the elderly people we randomly interviewed also asked us about the implementation method and future development direction of time banking in detail and expressed great expectations for the online development of time bank in particular.

Data Analysis

The elderly group received 115 valid questionnaires, and the young group received 238 valid questionnaires. The sample size is not high for the following two reasons. First, although the online questionnaire survey method is adopted in the young people's group, a few of timebanks founded by some individuals are only scattered in some big cities with a high aging population, and most of the young generation are not clear about the concept of timebank, so they cannot carry out a complete and valid questionnaire. Second, in the process of using a face-to-face interview questionnaire survey for the elderly, it was found that many people did not believe in this mechanism because they could not understand it or had no contact with it. They were unwilling to participate in and refused to accept the investigation. Therefore, it was difficult to collect samples on the whole. However, if the sample size is more than 10 times of the independent variables, generally the Logit regression result has good explanatory power. Therefore, the sample size in this paper meets the standard of the sample size of the Logit model (32).

First, before studying the impact of different factors on timebank's participation willingness, it should also pay attention to whether the demand and supply of services match. Based on the survey data, we found that leisure and recreational activities and seminars and consultation sessions are more in demand by the elderly, and these are also services that young people are more willing to provide. Although more than 80% of young people are willing to participate in the delivery of food and fruit, which ranks first, it is the service that the elderly need least. This shows that online timebank may play an important role in matching the demanded services and supplied services. The above findings are indicated in **Figure 1**.

Second, as shown in **Figure 2**, it should also be noted that the elderly can also serve as the suppliers to provide corresponding

services to other elderly people in the community, which can enable their social value to be embodied to a higher degree while also meeting the psychological needs of the elderly themselves. While providing the services to the elderly as those indicated in **Figure 2**, timebank can make full use of the elderly's own experience and talents to achieve the goal of "I am for everyone, everyone is for me."

Third, in general, the incentive mechanism of timebank is relatively limited because of its non-profit nature. In **Figures 3**, **4**, it was found that transferring time to elderly families in different ways is the most popular way of benefits, with 70% of people willing. The second is as a credit rating certificate and to obtain cash exchange or coupons. For young people, due to the large time span and long redemption time, young people are more willing to transfer their reserve time to elderly families. Therefore, government credit endorsement and transferability of service time are very conducive to the development of timebank.

METHODS

The Logit Model

Based on the researches of previous scholars and combined with the characteristics of this research, we select the logit model in the empirical analysis. The logit model is also called the logistic regression model, which is one of the discrete choice method models and a category of multivariate analysis. It is widely used in various decision analysis because its probability expression is explicit, the solution speed of the model is fast, and the application is more convenient. When there is no change in the selection set of the model but the level of each variable, we can easily solve the selected probability of each selection branch in the new environment. According to the characteristics of the logit model, any increase or decrease of choices will not affect the ratio of the probability of being selected among other choices, so it is possible to directly remove the choices that need to be removed from the model, or add the newly added choice branches to model for prediction. When the dependent variable is a binary variable, such as "whether you will use online timebank as the care model," logit distribution can be used as the distribution function of the classified variable. The logit function and logit regression model are as follows:

$$p\left(y_i = 1|x_i\right) = p\left[\varepsilon_i \le \alpha + x_i'\beta\right] = \frac{1}{1+\exp(-\varepsilon_i)} \quad (1)$$

$$\ln\left(\frac{p_i}{1-p_i}\right) = \alpha + x_i'\beta \quad (2)$$

In the above formula, α is the intercept term, β is the regression coefficient, and x represents the explanatory variable for the selection of online timebank as the care model.

The logit regression model is non-linear, so the maximum likelihood estimation method is generally used to calculate the model parameters. Before using the maximum likelihood estimation method, it is necessary to establish the likelihood function obtained by expressing the probability of selecting the number of times of foreign investment as the unknown model parameter. The maximum likelihood estimation of the model parameters is the parameter estimation value that can maximize the value of this function. The derivation process is as follows:

We assume that the probability of choosing online timebank as the care model is $p(y_i=1|x_i)=p_i$, then the probability of not choosing online timebank as the care model is $p(y_i=0|xi)=1-pi$, so

$$p(y_i) = {p_i}^{y_i}(1-p_i)^{1-y_i} \quad (3)$$

Because each person makes an independent decision, through natural logarithm processing, we finally get its likelihood function:

$$\ln\left[L\left(\theta\right)\right] = \ln[\prod_{i=1}^{n} {p_i}^{y_i}(1-p_i)^{1-y_i}\ ]$$
$$= \sum_{i=1}^{n}\{y_i\left(\alpha + x_i'\beta\right) - \ln[1+\exp(\alpha + x_i'\beta)]\} \quad (4)$$

After taking the logarithm of the likelihood function, the intercept term and regression coefficients of the explanatory variables are, respectively, calculated for partial derivatives, we set it to 0, and overall parameters that make the likelihood function reach the maximum can be obtained by iterative calculation.

Variable Selection

Dependent Variable and Interested Variables

On the one hand, the dependent variable (***OTB***) is in the form of a dummy variable, representing whether the respondent will use online timebank as the care model. If the respondent responded yes, the value of the variable is 1; if not, the value is 0.

On the other hand, there are three key variables, respectively, in both the model of the young group and the model of the elderly group. The core variables in the elderly group are health status, voluntary experience, and daily free time. The core variables in the youth group are elderly families, voluntary experience, and daily free time.

The health status (***Hea***) of the elderly group is a dummy variable, with a value of 1 for good health status and a value of 0 for bad health status. The health status of the elderly affects whether they are able to save time as a service provider in the timebank for the aged care need in the future (16). We predicted that elderly people in good health would be more likely to participate in the timebank, and those in poor health would be less likely to participate.

Voluntary experience (***Vol***) means whether the respondent has participated in voluntary activities, which is also a dummy variable, with a value of 1 for having voluntary experience and a value of 0 for having no voluntary experience. Voluntary experience means that the respondent has volunteered to help others and has a charity heart. The people with voluntary experience is more motivated to participate in a timebank that may exist in a pro bono nature.

The elderly families of the young group (***Eld***) mean the number of elderly families over 55. The more elderly families

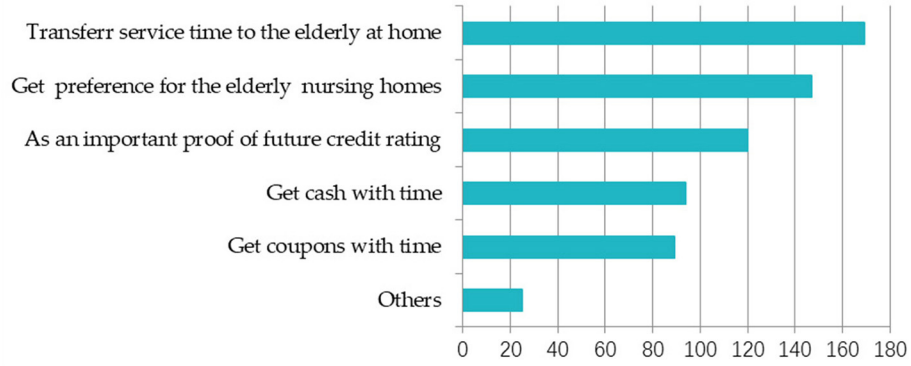

FIGURE 3 | The benefits that young group hope to get. The respondent can choose more than one; the unit is number.

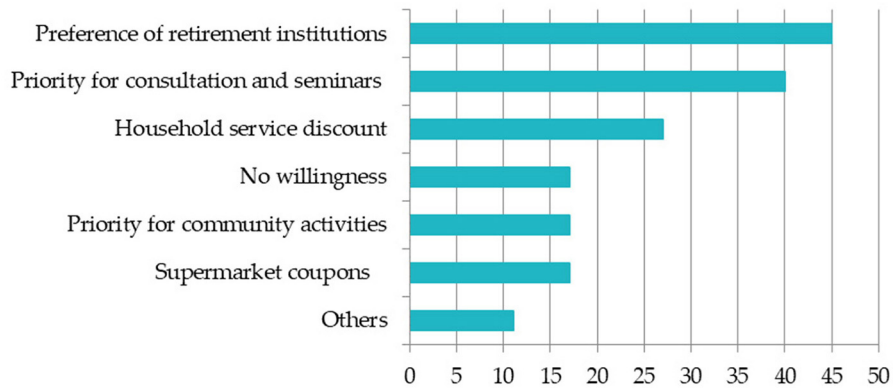

FIGURE 4 | The benefits that elderly group hope to get. The respondent can choose more than one; the unit is number.

young people have, the heavier the burden they have to support or take care of the elderly families, and the more willing they are to participate in the timebank and transfer their reserve time to the elderly families (28).

Daily free time (***Time***) means how much free time the respondent has each day. The more the free time they have every day, the more they are inclined to participate in timebank for time saving. We predicted that it has a positive effect on the online timebank participation willingness in both the elderly group and the young group.

In addition, the control variables representing the other influencing factors of participation in online timebank nursing for community elderly are divided into two aspects: individual and employment. Variables representing individual characteristics are gender, political status, age, and education years; variables representing employment characteristics are occupational income and job type. The following two sections will describe the control variables in detail.

Control Variables for Individual Characteristics

The age (***Age***) may have a significant effect on the online timebank participation willingness in both the elderly group and the young group, but its effect is unclear. The younger they are, the more likely they are to accept and use the online time-banking care model, but they lack their own age care needs and their elderly families are not very old. The older they are, the higher their demand for future care needs will be, but they are not easy to accept and use the new age care model of online timebank. Therefore, we do not prejudge the effect of age on participation willingness.

Gender (***Gen***) is a dummy variable, with a value of 1 for the male and a value of 0 for the female to reflect the gender difference in participation willingness of online timebank. There may be gender differences in the acceptance degree of the online timebank model, but its effect is unclear. Therefore, we do not prejudge the effect of gender on participation willingness.

Political status (***Pol***), with a value of 1 representing party membership, and a value of 0 representing non-party membership. Party membership has a positive effect on the participation willingness of the timebank due to it has somewhat public welfare nature. We predicted that it has a positive effect on the online timebank participation willingness in both the elderly group and the young group.

The education years (***Edu***) represent the educational level of the respondent. Education may have a positive influence on the online timebank participation willingness because the higher the education level is, the higher the acceptance of new things and the internet. According to the definition of the average years of education by the China Bureau of Statistics, we divide years of education into 6 levels: a value of 0 represents those who have not received any education; a value of 6 represents those who have graduated from primary school; a value of 9 means people who have obtained a junior high school education; a value of 12 represents four types of people, that is, people with an education level of ordinary high school, vocational high school, technical secondary school, or technical school; similarly, the value of 16 represents four types of people, that is, those who have obtained adult advanced education and formal higher education include those with a college degree or a bachelor's degree; the value 19 represents the population with a graduate degree or above. We predict that education years have a positive effect on online timebank participation willingness in both the elderly group and young group.

Control Variables for Employment Characteristics

As the income level, occupational income (***Inc***) represents the income from the current employment. Generally, the higher income of the occupational income is, the lower needs for online timebank participation because they can afford the relatively expensive nursing fees like Nursing Home. Therefore, we predicted that it has a positive effect on the online timebank participation willingness in both the elderly group and the young group.

Job ownership (***Job***) means the ownership of the employer including government and public institutions, state-owned enterprise, and private and foreign companies. Influenced by different corporate cultures, Chinese people working in enterprises of different ownership may have different degrees of acceptability to new things. On the whole, the government and state-owned employees are more conservative, while foreign and private employees may be more open and inclusive regarding online timebank.

To sum up, **Tables 1**, **2** show all the variable definitions in the elderly group and the young group as follows.

TABLE 1 | Variable definition: the elderly group.

Variable	Definition	Classification	Percent
OTB	Whether you will use online timebank, 1= yes, 0= no	Yes: 60 No: 55	53.91% 46.09%
Gender	1= male 0= female	Male: 60 Female: 55	52.17% 47.83%
Age	Unit is year	Mean=56.8	
Inc	Monthly income, Unit is RMB	Below 5,000*: 10 5,000–10,000: 49 10,000–15,000: 39 Above 15,000: 17	8.70% 42.61% 33.91% 14.78%
Pol	Whether the respondent is the Party member	Yes: 51 No: 64	44.35% 55.65%
Job	The ownship of the employer	Government: 65 State-owned: 19 Private or foreign*: 31	56.52% 16.53% 26.95%
Hea	Health status of respondent, good = 1, bad = 0	Good: 101 Bad: 14	87.82% 12.18%
Vol	Whether you have participated in volunteer activities before	Yes: 41 No: 74	35.65% 64.35%
Time	Free time every day	<2 h*: 25 3–5 h: 47 More than 6 h: 43	21.74% 40.87% 37.39%
Edu	Years of education	6 years: 9 9 years: 13 12 years: 24 16 years: 65 19 years: 4	7.83% 11.31% 20.86% 56.51% 3.49%

*The * means that it is the benchmark. The percentage retains 2 decimal places. The length of education is converted by education level, specifically 6 years of elementary school, 9 years of junior high school, 12 years of high school, 16 years of university, 19 years of postgraduate, and above.*

Model Specification

Based on the above analyses and the variables selected, the following models are specified:

$$OTB_i = \beta_0 + \beta_1 Hea_i + \beta_2 Vol_i + \beta_3 Time_i + \beta_4 Age_i + \beta_5 Gen_i + B_6 Pol_i + B_7 Edu_i + B_8 Inc_i + B_9 Job_i + u_i \quad (5)$$

$$OTB_j = \beta_0 + \beta_1 Eld_j + \beta_2 Vol_j + \beta_3 Time_j + \beta_4 Age_j + \beta_5 Gen_j + B_6 Pol_j + B_7 Edu_j + B_8 Inc_j + B_9 Job_j + u_j \quad (6)$$

where i (i = 1, 2, …, 115) denotes the elderly respondent and j (j = 1, 2, …, 238) denotes the young respondent; *OTB* indicates online timebank participation willingness; *Hea* in model 1 indicates the health status of the elderly respondent and *Eld* in model 2 means the number of elderly families of the young respondent; *Vol* indicates the voluntary experience; *Time* indicates the free time every day; *Age* indicates the age of the respondent; *Gen* means the respondent's gender; *Pol* represents whether the respondent is the Party member; *Edu* is the educational years of the respondent; *Inc* is the annual income from the employer; *Job* indicates the employer ownership, and u is a random disturbance term. Equations (5) and (6) allow us to test the impacts of various factors on the online timebank participation willingness in both the elderly group and the young group.

EXPLORING THE INFLUENCING FACTORS OF PARTICIPATION WILLINGNESS

Regression Results Analysis

As shown in **Table 3**, the results of model 1 is for the elderly group and the results of model 2 is for the young group. Given

TABLE 2 | Variable definition: The youth group.

Variable	Definition	Classification	Percent
OTB	Whether you will use online timebank, 1 = yes, 0 = no	Yes: 145 No: 93	60.62% 39.38%
Gender	1 = male 0 = female	Male: 131 Female: 107	52.17% 47.83%
Age	Unit is year	Mean = 33.6	
Inc	Monthly income, Unit is RMB	Below 5,000*: 71 5,000–10,000: 72 10,000–15,000: 59 Above 15,000: 36	29.83% 30.25% 24.79% 15.13%
Pol	Whether the respondent is the Party member	Yes: 83 No: 155	34.87% 65.13%
Job	The ownship of the employer or the respondent is student	Government: 49 State-owned: 29 Private or foreign: 82 Student*: 78	20.59% 12.18% 34.45% 32.78%
Eld	Elder families number over 55	Mean = 2.8	
Vol	Whether you have participated in volunteer activities before	Yes = 141 No = 97	59.24% 40.76%
Time	Free time every day	<2 h*: 87 3–5 h: 100 More than 6 h: 51	36.55% 42.02% 21.43%
Edu	Years of education	6 years: 0 9 years: 15 12 years: 20 16 years: 122 19 years: 81	0% 6.3% 8.4% 51.26% 34.04%

*The * means that it is the benchmark. This survey also involves the health status of the youth group, and it is found that nearly 98% of them are in good health, so it is not used as an independent variable for empirical analysis.*

TABLE 3 | Logit regression results: by groups.

Independent variable	Dependent variable: *OTB*	
	Model 1: The elderly Group	**Model 2: The young group**
Eld		0.041*** (0.0013)
Hea	0.368** (0.0443)	
Vol	0.012*** (0.0000)	0.053*** (0.0000)
Time 1 (3–5 h)	−0.021*** (0.0000)	0.022*** (0.0020)
Time 2 (Above 6 h)	0.064** (0.0250)	0.074*** (0.0050)
Gen	0.031*** (0.0002)	−0.038 (0.5002)
Age	−0.003*** (0.0000)	−0.031 (0.5030)
Pol	0.021** (0.0124)	0.010*** (0.0000)
Edu	0.081*** (0.0004)	0.106*** (0.0000)
Job 1 (government)	−0.002 (0.1135)	−0.090* (0.0925)
Job 2 (State-owned)	−0.003 (0.1420)	−0.072* (0.0611)
Job 3 (Private and foreign)		−0.043 (0.1522)
Inc 1 (5000-10,000)	0.013** (0.0420)	0.014 (0.1560)
Inc 2 (10,000-15,000)	0.004 (0.1320)	0.064 (0.3210)
Inc 3 (Above 15,000)	−0.023** (0.0412)	0.083 (0.4311)
Constant	7.013*** (0.0000)	6.013*** (0.0000)
Pseudo R^2	0.4552	0.6062
N	115	238

*The P-value in brackets, *, **, *** indicate statistically significant at the levels of 10, 5, and 1%, respectively.*

other variables remain unchanged, the logit regression results can indicate the following information based on the independent variables in which we are interested.

First, the health status of elderly people is significantly and positively correlated with their willingness to participate in online timebank. When other variables remain unchanged, the probability that the elderly people in good health are willing to participate in online timebank will increase by 36%, and the regression coefficient is the highest among all variables. As the elderly people in good health account for 87.8% of the sample, this conclusion once again confirms that the elderly can also serve as the suppliers of the online timebank elderly healthcare service. Through the online platform, the elderly can make full use of their spare time and experience skills to provide corresponding services to other elderly people in the community.

Second, the number of direct elder families of young people has a significant positive impact on the willingness to participate in online timebank. When other variables remain unchanged, for every increase in the number of direct elder families, the probability that young people are willing to participate in online timebank will increase by 4.1%. This result shows that under the trend of increasing aging, timebank can be used as an effective means under the home care model, which is accepted by young people and meets the urgent needs of the elderly.

Third, the experience of participating in voluntary activities has a significant positive effect on the willingness to participate in the online timebank of the young group. The experience of participating in volunteer activities has a far greater impact in the young group than that in the elderly group because the regression coefficient in the young group is close to 5 times as much as that in the elderly group. When other variables remain unchanged, the young group who has participated in voluntary activities will increase the probability of participating in online timebank services by 5.3%, while the elderly group will only increase by 1.2%.

Fourth, for the elderly group, the free time every day has different effects on the willingness to participate in online timebank. Three to five hours of free time has a significantly positive effect on the willingness to participate in online timebank in the elderly group. Free time of 6 h or more has a significantly negative effect on the willingness to participate in online timebank in the elderly group. The possible reason is that according to the situation in China about 70 percent of children care are assisted by elderly family members, there is not much free time for the elderly[2]. The elderly people are more inclined to take care of their grandchildren or develop their own hobbies

[2]China Research Center on Aging: http://www.crca.cn.

and activities and maybe they have no spare time to participate in online timebank. When the free time reaches more than 6 h per day, elderly people can guarantee the time to participate in other extra activities such as online timebank healthcare activities. For the young group, the variable *Time 1* (3–5 h free time) with the coefficient of 0.021 and the variable *Time 2* (above 6 h free time) with the coefficient of 0.074 both have significantly positive effects on the participation willingness in online timebank.

For the control variables, the results are quite different between the elderly group and the young group. In the elderly group, the male is significantly more willing to participate in online timebank than the female, but in the young group, it is statistically insignificant. The reason may be that Chinese elderly females have relatively conservative thought and the timebank service is relatively not safe for them. Age has a significantly negative impact on the participation willingness of the elderly in online timebank, but in the young group, it is also statistically insignificant. The reason may be also that the older the respondent gets, the more conservative he or she becomes. In the elderly group, the variable of monthly income between 5,000 and 10,000 RMB has a significantly positive impact on the participation willingness and the variable of monthly income above 15,000 RMB has a significantly negative impact on the participation willingness in online timebank, which may be due to that the elderly people with higher incomes can afford institutional care fees without having to participate in a timebank. In the young group, the people who work for the government, state-owned enterprises, and private and foreign enterprises are less willing to participate in the online timebank than the students, which may be due to their higher income and less free time than that of students. Besides, the party members and the educational years both have significant positive impacts on the participation willingness in online timebank, which conform to our predictions.

Robustness Check

We conducted the following robustness check for the regression results.

First, through non-linear OLS regression, as shown in **Table 4**, we compare the results between the two models. It shows that the significance of the core independent variables and most of the control variables are consistent with the previous Logit model results. The R^2-values of the OLS model are 0.38 and 0.41 in model 3 for the elderly group and model 4 for the young group, respectively, while the R^2 of the logit model is 0.45 and 0.60, with Wald value 71.6 and the corresponding *P*-value 0.00, so the overall equation of the logit regression model is more jointly significant.

Second, we conduct the multicollinearity test. We convert the model to a linear form and calculate the variance inflation factor (VIF). As shown in **Table 5**, all the VIF values of the two models are <2.18 and 1.96, respectively. It is generally believed that multiple collinearities exist when the VIF value is >10, or it does not exist. Therefore, it can be assumed that there are no multiple collinearities between the variables.

Third, we conduct a cluster analysis. The number of years of education is used as the cluster unit. The logit model is regressed by clustering standard errors, and the results show that there is almost no difference with the general robust standard errors. It is considered that there is no correlation within the group. Due to space limitation, we do not display here.

After conducting the above robustness tests, this paper further calculated that the logit model is correctly predicted at 87.02%. In summary, it is determined that the models have robust regression results.

TABLE 4 | Non-linear OLS estimation results.

Independent variable	Dependent variable: *OTB*	
	Model 3: The elderly group	**Model 4: The young group**
	0.338** (0.0324)	
Hea	0.012*** (0.0001)	0.036*** (0.0010)
Eld	−0.006*** (0.0000)	0.042*** (0.0000)
Vol	0.002*** (0.0000)	0.024*** (0.0000)
Time 1	0.013*** (0.0000)	0.006*** (0.0002)
Time 2		0.062 (0.3420)
Gen		
Age	−0.019*** (0.0009)	0.022 (0.2421)
Pol	0.007*** (0.0004)	0.003*** (0.0024)
Edu	0.018*** (0.0002)	0.012*** (0.0042)
Job 1	−0.006 (0.2392)	−0.072 (0.1451)
Job 2	−0.007* (0.0946)	−0.033* (0.0721)
Job 3		−0.024 (0.1432)
Inc 1	0.019* (0.0972)	0.033 (0.2420)
Inc 2	0.007 (0.5442)	0.066 (0.2214)
Inc 3	−0.018** (0.019)	−0.043 (0.143)
Constant	10.165*** (0.0000)	12.413*** (0.0000)
	0.3790	0.4140
Pseudo R^2	115	238
N		

*The P-value in brackets, *, **, *** indicate statistically significant at the levels of 10, 5, and 1%, respectively.*

DISCUSSIONS

First of all, although education level has a significant impact on the participation willingness of the elderly, in the survey process we also found that it actually presents a polarized effect, which means for the elderly with a degree below the elementary school, or a graduate degree or above, the participation willingness is lower than those with an intermediate education level. Regarding this phenomenon, we interviewed some elderly people, and the reason is that elderly people with lower education level do not accept the form of online timebank because they do not understand and cannot adapt to this new age care model and even internet lifestyle. Besides, elderly people with higher education believes that in their free time, they are more willing to do what they like and do not want to be constrained by the form of online timebank.

Secondly, as for the elderly families, except for more than 5 elderly family members, the regression results show that the more elderly families, the higher the participation willingness degree.

TABLE 5 | Heteroscedasticity VIF test.

Independent variable	Model 1	Model 2
Hea	2.18	
Eld		1.84
Vol	2.09	1.96
Time 1	2.15	1.93
Time 2	2.03	1.92
Gen	2.05	1.90
Age	2.07	1.85
Pol	2.28	1.82
Edu	2.03	1.83
Job 1	1.95	1.96
Job 2	2.05	1.93
Job 3		1.94
Inc 1	1.79	1.86
Inc 2	1.56	1.84
Inc 3	1.39	1.93

However, based on the interview, we found that there are a few families that support more than five elderly people. Compared with the online timebank age care model, these families need more comprehensive services like nursing institutions. Because of the large number of elderly people who need to be supported, it is difficult to meet the needs of community care or home care.

Third, it is found that online timebank is more likely to be favored by the elderly who like indoor activities, self-entertainment, and family entertainment. In the field interviews, some elderly people said that it would be more convenient if such activities could be made with others through online timebank. However, for the elderly who like to spend time with friends and enjoy outdoor activities, they may not have more time or willingness to participate in online timebank services. Therefore, when we operate the timebank, we can take into account the demands of these elderly people and appropriately increase outdoor activities and other activities which can be cooperated with each other.

Fourth, the analysis of the supply-demand matching found that some aged care services have high matching degrees between the elderly who need healthcare and the young who supply related services, such as organizing suitable entertainment activities and seminars and consultation meetings. However, there are some age care services such as sending fruits and other activities that are simple for young people, which are not necessary for elderly people. Through the interview, we learned that if the elderly are in good health, shopping is not only the necessary activity for daily life but also a way of socializing and exercising. Therefore, the online timebank operation mechanism should be further refined for setting up the appropriate age care item to better match the supply with the demand.

In addition, it should be admitted that there are still many deficiencies and limitations in this study.

For the limitations of the method, first, we don't take into account endogenous problems with the interested variables, such as free time, which may be associated with some unobtainable missing variables. This will be solved later by finding the appropriate instrumental variables for each of them. Second, the sampling process only involves Beijing, ignoring some other regions like the central and western regions where the economic development level is not high and the aging problem is not serious. Third, the number of participants including 115 valid elderly questionnaires and 238 valid young questionnaires in the survey sample obtained is relatively low.

For the limitations of the questionnaire, first, the settings of some questions in the survey are vague, such as the way to convert time currency to physical commodity or real money, and the way to transfer time to the elderly families, which need special research and investigation. This is also the reason why this paper only focuses on respondents' willingness to participate in online timebank. Second, the interview process for the elderly was not prepared and targeted, just recording the interviewees' views and opinions on online timebank by chatting. Third, some issues related to timebank operation were not involved in the questionnaire design stage, such as online platform privacy and security, rights and obligations of service providers and recipients and legal status, which require further data investigation and research.

CONCLUSIONS AND POLICY IMPLICATIONS

This study uses the logit model through questionnaire data of Beijing in 2019 to investigate the participation willingness of online timebank elderly care, especially to discover different influencing factors on the participation willingness between the youth group and the elderly group. We find that: First, the health status of elderly people and the number of elder families of young people have significant positive impacts on their willingness to participate in online timebank. Second, the experience of participating in voluntary activities has a significant positive effect and it has a far greater impact in the young group than that in the elderly group. Third, the more free time the higher participation willingness in the young group, but it is the opposite in the elderly group. Fourth, for other control variables, the years of education and party member have significant promoting effects in both groups. However, compared with private or foreign companies, working for the government and public institutions and state-owned enterprises will decrease the participation probability in the young group. Besides, the results of age, gender, and income are quite different between the two groups.

Such heterogeneous results of the influencing factors can help develop online timebank nursing, especially for dealing with the increasingly serious population aging problem in China.

First, with the single-children generation gradually enters middle age, their parents are getting old. In China, it is increasingly common for a couple to support at least four of their parents. Based on the role of elderly family members in promoting participation willingness, online timebank should be promoted heavily among young people, rather than just attract

the young elderly in the community to provide care services to other elderly people like the existing timebanks.

Second, generally, the retirement ages in China when a man is 55 years old and a woman is 50 years old are still relatively low. With the improvement of China's medical care and residents' health, young elderly retirees have a lot of spare power and time to serve other elderly people through timebank. Therefore, they can still serve as an important participant group in the timebank.

Third, vigorously developing social volunteer service activities, especially elderly care volunteer service activities among young people, is conducive to the participation willingness in online timebank for young people.

Fourth, in view of the positive effects of education years, student status and free time every day on the participation willingness, for young people, the promotion can be conducted among students especially the college students first. On the one hand, the college students have winter and summer vacations so there is more free time; on the other hand, the college students with high education level are more likely to accept the new concept of timebank and the age care model.

Finally, Party members in China are the main force of public welfare activities and the results show that Party members are more willing to participate in online timebank because it is somewhat of public welfare nature. Therefore, timebank can be widely publicized in China's grass-roots Party branches and some other Party organizations.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

This research was conceptualized by CH and YW. YW and YD formulated the methodology. YW and CH: software, validation, and writing—original draft preparation. YW, YD, and LW: formal analysis. YD and LW: data curation. CH, YD, and LW: writing—review and editing and supervision. YW: project administration and funding acquisition. All authors: contributed to the article and approved the submitted version.

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What Drives Outpatient Care Costs in Kenya? An Analysis With Generalized Estimating Equations

Ngugi Mwenda[1]*, *Ruth Nduati*[2], *Mathew Kosgei*[1] and *Gregory Kerich*[1]

[1] School of Aerospace and Physical Science, Department of Mathematics, Physics and Computing, Moi University, Eldoret, Kenya, [2] Department of Pediatrics, University of Nairobi, Nairobi, Kenya

Objective: This study aimed to identify the factors associated with outpatient expenses incurred by households in Kenya.

Background: The problem of outpatient healthcare expenses incurred by citizens in countries with limited resources has received little attention. Thus, this study aimed to determine the predictors of household spending on outpatient expenses in Kenya.

Method: We conducted a cross-sectional analysis on households in Kenya using data from the 2018 Kenya Household Health Expenditure and Utilization Survey. We applied the generalized estimating equations method to determine the best subset of predictors of outpatient care cost.

Findings: The best predictors of outpatient care expenses in Kenya are age, wealth index, and education level of the household head.

Conclusions: There were no differences regarding age in the mean spending on outpatient care. Moreover, we found that the cost of outpatient care changes with age in a sinusoidal manner. We observed that rich households spent more on outpatient care, mostly owing to their financial ability. Households whose heads reported primary or secondary school education level spent less on outpatient costs than households headed by those who never went to school.

Keywords: GEE, outpatient, healthcare, QIC_u, cost

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***Correspondence:**
Ngugi Mwenda
samwenda87@gmail.com

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INTRODUCTION

Although Kenya is a lower middle-income country (LMIC), it is one of the fastest growing economies in sub-Saharan Africa (1). To ensure steady economic growth and proper social development, the need has emerged to stabilize the national health systems of Kenya (2).

Although the country continues to strive toward reforming its healthcare system, it faces challenges in the form of financial constraints, high debt (3), a high debt-to-gross domestic product ratio of 70%, weak institutional capacity, and a high unemployment rate [almost 20% (4)], which in turn raises the dependency ratio (5). Thus, there are significant obstacles to effective change. Owing to a constrained budget, funds allocated to the healthcare sector remain low (6). The recent budget allocation of 9.1% to the healthcare sector as a proportion of total government budget (7) is low; this is contrary to the 2001 Abuja Declaration on healthcare in Africa that at least 15% of the budget be allocated to the healthcare sector. Therefore, to achieve any substantial advancement, Kenya's health sector requires comprehensive improvements or even complete reformation (2).

Owing to limited availability of resources in LMICs (8), sound and accurate evidence is needed to formulate and implement health policies that are influenced by the current state of a country's economy (9). Still, the presence of evidence might not be sufficient for the prioritization of resource allocation, given the existence of other more demanding factors, such as political strategies and donor demands on funding (10). Therefore, developing countries have to make difficult choices about how to allocate limited resources and spending with a view to maximizing their output (11).

By contrast, primary healthcare in developed countries has continuously benefited from medical security policies, provided proper medical care to citizens, alleviated the economic burden of disease by reducing catastrophic spending on health, and provided financial support to ease the burden of healthcare by making current data available (12–17).

According to the existing literature, demand for inpatient and outpatient healthcare is likely to increase in the next decade owing to population growth outpacing growth in the supply of health facilities (18). This increased demand is due to cardiovascular diseases, obesity (19), and respiratory illnesses, like COVID-19 (20).

With limited resources due to reduced revenue collection by the government as a result of falling household incomes (21), the need to re-allocate resources gives rise to opportunity costs, leading to gains in one sector and losses in another. This exerts pressure on the governments of developing countries, which have limited resource availability, to take decisions to meet the expected increase in demand.

Prior studies have established that more than 11 million Africans, of whom 0.45 million are Kenyans, are pushed into extreme poverty every year because of out-of-pocket and outpatient health expenses (22). To create awareness about this healthcare spending strain, the Kenyan government has made consistent efforts to insure significantly more of the population through the National Health Insurance Fund (NHIF); however, 83% of the Kenya population of 50 million were uninsured as of 2017 (23).

Measures have been taken to reform the NHIF (24), which could be Kenya's gateway to achieving universal health coverage (UHC) (25). This was accomplished by conducting a pilot study in a few counties (Nyeri, Kisumu, Machakos, and Isiolo), where the state was to meet all the medical costs (26, 27) and advance toward achieving Sustainable Development Goal (SDG) 3 (28). The purpose of the pilot study was to determine the possibility and sustainability of implementing the program in the entire country.

The pilot study is in line with the ongoing global drive toward attaining UHC in LMICs, which has paved the way for health sector reforms to help realize this objective. The main objective of UHC is to cushion citizens against the catastrophic and impoverishing effects of out-of-pocket healthcare payments, such as those in Kenya (22, 29), which have led to household poverty (30), socio-economic inequality, inequity in the use of healthcare services (31), and time wastage from traveling long distances to access healthcare services (2). Unfortunately, when analyzed in the global context, Kenya's achievements remain inadequate (26). The findings from the pilot study indicate that tax revenues collected by the Kenyan government are not sufficient to fully support UHC.

Household spending on outpatient care is an important characteristic of financial expenditure for measuring public health (23). However, existing studies have not focused on this issue, because certain health conditions might not expose the affected to risk. However, it is important to note that if proper medical attention is not provided, some health conditions that may appear insignificant can easily deteriorate with time. Thus, household spending is key to arresting the deteriorating condition of outpatients.

The choice of seeking outpatient care when sick or injured could be influenced by (1) the seriousness of the health condition of the affected person and (2) the person's financial ability to pay for the required healthcare services (32). In this case, key determinants are the characteristics of the household figure or care provider from whom the household member needs to seek help (33–35).

Most often, the head of the household is the breadwinner and makes vital decisions in the household. The education level of the household head in a study in Uganda determined whether birth delivery took place in the presence of a skilled birth attendant (36). A study in Nicaragua showed that in some households, even though the woman earned more, decisions regarding the household, including expenditure, were made by the male household head (37). A study in Nepal found that, although women were involved in decision making in the household, they did not have autonomy with respect to final decisions, as the man was regarded as the household head (38). Although most households regard the man as the household head, this is not always the case, as recent literature in Kenya shows that about 36% of households are female headed. Another study in South Africa indicates that heads have final say over decisions regarding household expenditure, even when they do not earn the most income (39).

Given the tendency of the household head in Africa to influence the members of a household, it is imperative to investigate outpatient care predictors with reference to the characteristics of the household head.

MATERIALS AND METHODS

Study Design and Population

The data were collected through a cross-sectional study carried out from April 9, 2018 to May 19, 2018 across all 47 counties in Kenya, called the Kenya Household Health Utilization Survey (KHHEUS). The survey was household based and designed to provide estimates for various indicators at the national, residence (urban and rural), and county levels. The sample design constituted 1,500 clusters with 923 rural and 577 urban residences spread across the country. The sampling consisted of two stages: the first was a stratified cluster sampling design in which 1,500 clusters were selected, and the second was a uniform sample of 25 households, which were randomly selected.

A questionnaire designed by a technical working group of the Kenya National Bureau of Statistics (KNBS), World Bank

(WB), and Ministry of Health (MoH) was administered to every sampled household, and it was pretested, reviewed, and improved before the training. More information on the questionnaire design can be found elsewhere (40).

Briefly, the KHHEUS questionnaire objectives were set by the MoH, WB, and KNBS officials. Its main aim is to determine household expenditure on health services used for both inpatient and outpatient care. It is the collective responsibility of the technical working group to develop and review the survey tools, recruit and train enumerators, collect data, write reports, and disseminate them.

The questionnaire collected information on the utilization of outpatient and inpatient services. Other details collected that were useful for this study included household composition, health insurance, housing conditions, assets, amenities, household consumption, and expenditure.

The training was organized in three levels. First, the trainers were trained between March 13 and 16, 2018. The trainers then trained the field survey personnel, consisting of 94 enumerators and 357 interviewers, in six regions (Kisumu, Eldoret, Nakuru, Machakos, Nyeri, and Mombasa) from 19 to 23 March, 2018. The training was mainly conducted to assist with the hard copy questionnaire and computer-assisted personnel interview for data collection. In addition, both the interviewers and the supervisors were trained to conduct quality checks and send data to the servers.

After field deployment, the interviewers administered the questionnaire to every sampled household after obtaining consent. Interviewees were reminded that the information was voluntary and that they could terminate the interview at any stage. Monitoring was performed at all levels to ensure data quality; furthermore, both subject matter specialists and programmers were always available to deal with technical questions and device issues, respectively. There was an overall response rate of 95%; of the 37,500 sampled, we had complete household interviews for 33,286.

MEASUREMENTS

Dependent Variable

Using the KHHEUS data collected for individuals and households in 2018, we included costs incurred for any outpatient healthcare in the 4 weeks prior to the survey. Here, outpatient healthcare means any medical procedures and services performed by a health facility and health providers (e.g., chemists and pharmacists) without the requirement of a stay in hospital.

These were collected based on registration cards, medicine/chemotherapy/vaccination, consultations, diagnosis tests (x-rays, lab, etc.), medical checkup, and dialysis. All expenses were calculated in Kenyan shillings (KSh) and then converted to American dollars (US$) using the mean exchange rate for the period set by the Central Bank of Kenya from January to December 2018 (1 US$ = 100.79 KSh).

Independent Variables

To establish an association between total cost for outpatient care and its covariates, we selected variables that are commonly considered to predict healthcare cost and utilization. We included age, captured as a continuous variable; place of residence divided into urban and rural; and wealth index, divided into five different income groups (*poorest, poor, middle, rich, and richest*). Other selected variables included sex, captured as male or female; level of education, grouped into four categories (*none, primary, secondary, and post-secondary*; employment, captured as employed or unemployed; marital status, grouped into four categories (*single, married, separated, and divorced*; existence of a smoker in the household; and any member suffering from HIV, hypertension, cardiac problems, diabetes, mental health, cancer, TB, asthma, or any other respiratory problems. Employment was used as a proxy for the income of the household head.

We considered households headed only by a person aged 18 years and above. We calculated the total expenditure for people under outpatient care, as we were interested in estimating the healthcare utilization per household out of 11,130 households. In cases in which the respondent was not the head of the household, we considered the person who had the closest relationship with the household head as the head of the household.

Our response variable, that is, the total cost incurred for outpatient care, exhibited some characteristics that are of interest to this study related to users and non-users of outpatient services. Therefore, the response variable may have a discrete mass at zero (for non-users), continuous and right skewed (for users), with correlation for households that belong to the same cluster (county). To model such data, we adopted Tweedie distribution under generalized estimating equations (GEE) with an independent correlation structure.

Thereafter, we adopted the method of Hardin and Hilbe (41), which enabled us to check the best model fit using quasi-likelihood under the independence criterion (QIC_u). QIC_u is a criterion proposed by Hardin and Hilbe (41) as an extension of the QIC proposed by Pan (42) for correlation structure selection, when no known structure of the data is known, or when there is no motivating scientific evidence of a particular correlation structure.

Our work has a predetermined correlation structure according to the guidelines provided by Hardin and Hilbe (41) of selecting the best correlation structure. Considering our panels, the differences in sizes of the number of subjects in each panel, and the fact that spending on healthcare among the panels may have weak correlation, we opted for the independence structure. In selecting the best subset of covariates, we evaluated the model with the lowest value for the QIC_u and the fewest number of covariates among competing models. We also evaluated the logarithmic and canonical links of the selected model.

Statistical Methods

(EDM) has a probability density function that can be written as

$$p(y;\theta,\phi) = bp(y,\phi)\exp\left\{\frac{-d(y,\mu)}{2\phi}\right\} \quad (1)$$

We assume that the cost for outpatient care during the survey period N follows a Poisson distribution with mean λ, such that if the household does not incur any cost, then $N = 0$. Finally, Y represents the total cost incurred by the household, which is represented as the Poisson sum of the gamma random variables, such that $Y = R1+,\ldots,+RN$. Therefore, the resulting distribution may be called Poisson-gamma distribution.

Dunn and Smyth (43) showed that the probability density function for the Tweedie family can be represented as

$$\log fp(y;\mu,\phi) = \begin{cases} -\lambda, & \text{for } y = 0 \\ -\frac{-y}{\Upsilon-\lambda-\log y+\log W(y,\phi,p)}, & \text{for } y > 0 \end{cases} \quad (2)$$

where $\Upsilon = \phi(p-1)\mu^{p-1}$, $\lambda = \frac{\mu^{2-p}}{\phi(2-p)}$, and W is an example identified by the Wright generalized Bessel function (44), which can be expressed as

$$W(y,\phi,p) = \sum j = 1^{\infty} \frac{y^{-j\alpha}(p-1)^{\alpha j}}{\phi^{j(1-\alpha)(2-p)^{j}!\Gamma(-j\alpha)}} \quad (3)$$

where

$$\alpha = \frac{(2-p)}{1-p}$$

with the mean of the Poisson-gamma given as μ and its variance given by

$$\mathrm{Var}[y] = \phi\mu^{p}$$

Approximating Tweedie Densities Using Saddle-Point Approximation

Various methods can be used to estimate a Tweedie density, including saddle-point, inversion, and interpolation (43, 45). In this study, we consider saddle-point approximation under the generalized linear model (GLM) to estimate the starting values for GEE.

A part of the density cannot be expressed in the closed part, $bp(y,\mu)$, as seen in equation 1, but can be replaced by a simple analytical expression, such that

$$p(y \mid \mu,\phi) = \frac{1}{\sqrt{2\pi\phi y^{p}}}\exp\left\{\frac{-d(y,\mu)}{2\phi}\right\}\{1+\omega(\phi)\} \quad (4)$$

as $\phi \to 0$ for the Tweedie densities. The ratio is expressed as

$$\varsigma = bp(y,\phi)\sqrt{2\pi\phi y^{p}} \quad (5)$$

such that

$$fp(y \mid \mu,\phi) = \frac{1}{y}bp(1,\iota)\exp\left\{\frac{-d(y,\mu)}{2\phi}\right\} \quad (6)$$

where $\iota = \phi^{p-2}$, such that the ratio of the density to the saddle-point is expressed as

$$\varsigma = bp(1,\iota)\sqrt{2\pi\iota} \quad (7)$$

This shows that ς is a function of p and not μ, and is a function of y and ϕ through ι.

Using the Chebychev interpolation method (46), we can estimate any value of the parameter. The error is given by

$$f(x) - Pn(x) = \prod 1 = 0^{n}(x - x_i)\frac{f^{(n+1)}(\varpi(x))}{(n+1)!} \quad (8)$$

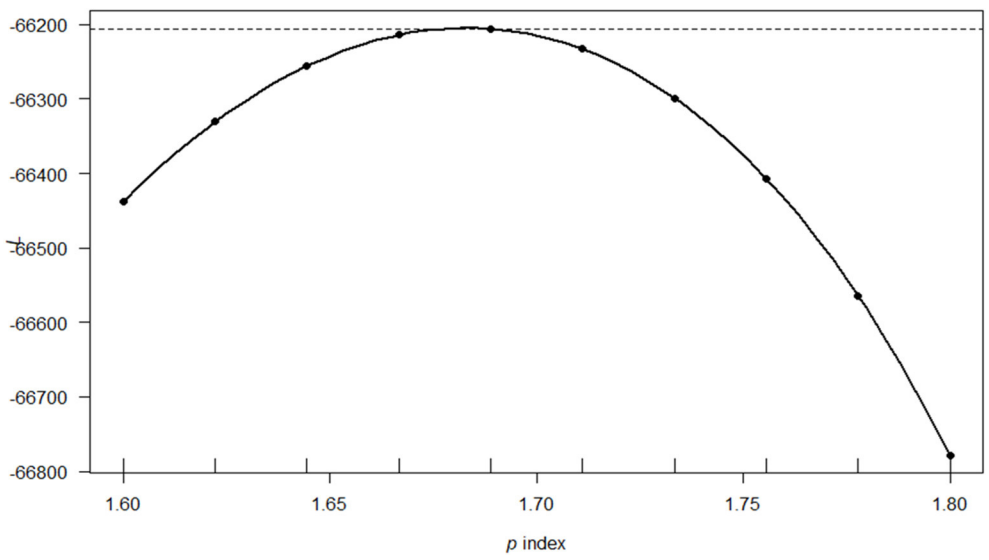

FIGURE 1 | The profile log-likelihood plot for cost of outpatient care in Kenya using the Model 1 covariates. The solid line is a saddle-point approximation of the *P* index from the data with a value of 1.68 and estimated 95% confidence interval [1.67,1.69].

such that we can reduce the interpolation error by choosing xis to minimize.

$$||w(x)|| = \max x \in [a, b]|\prod 1 = 0^n(x - x_i)| \quad (9)$$

Data Analysis

We investigated the following set of six models to understand the influence of covariates on predicting outpatient healthcare expenses in Kenya.

1. $\log \mu = \beta_0 + \beta_1 \text{age} + \beta_2 \text{wealthIndex} + \beta_3 \text{maritalStatus} + \beta_4 \text{education}$
2. $\log \mu = \beta_0 + \beta_1 \text{age} + \beta_2 \text{wealthIndex} + \beta_3 \text{education}$
3. $\log \mu = \beta_0 + \beta_1 \text{age} + \beta_2 \text{wealthIndex} + \beta_3 \text{maritalStatus} + \beta_4 \text{sex}$
4. $\log \mu = \beta_0 + \beta_1 \text{age} + \beta_2 \text{wealthIndex} + \beta_3 \text{maritalStatus} + \beta_4 \text{education} + \beta_5 \text{sex}$
5. $\log \mu = \beta_0 + \beta_1 \text{age} + \beta_2 \text{wealthIndex}$
6. $\log \mu = \beta_0 + \beta_1 \text{wealthIndex}$

Model 6 represents the wealth index as a predictor of outpatient spending. The choice of its modeling lies in its QIC_u value against outpatient care spending, which is the lowest, as found by (32). *Model 5* controls for age and the wealth index. Age is found to have a lower QIC_u value than that of other covariates. Therefore, it is necessary to find its effect on the wealth index. *Model 4* controls for age, the wealth index, marital status, education, and sex of the household head. *Model 3* controls for age, the wealth index, marital status, and sex. *Model 2* controls for age, the wealth index, and education. Lastly, *Model 1* controls for age, the wealth index, marital status, and education.

In this study, we adopted a systematic approach to find the most suitable model, since it was not possible to investigate all possible outpatient cost models. First, a single predictor was developed and the QIC_u value was examined for each model. Second, models with the lowest QIC_u value were further examined. Third, predictors were added successively in order of importance, supported by the existing literature. Fourth, we chose the model that fits the data adequately after comparing the QIC_u values of the final models. We did not follow any specific order while modeling the covariates.

To fit a Tweedie GLM to the outpatient cost data, we estimated the variance power. This was achieved through the profile log-likelihood function of the maximum likelihood estimation (MLE) value corresponding to the most appropriate value of the variance function p with the respective 95% CI. Owing to computational difficulties associated with MLE, the variance parameter was obtained by maximizing the log-likelihood function. However, this was challenged by the presence of an infinity sum in the probability function and non-trivial restrictions on the power parameter space. Therefore, we fitted a cubic spline interpolation through these computed points, which was estimated as 1.68 through the software. **Figure 1** shows the Tweedie profile with the estimated index parameter and the confidence interval for the best fitted model.

All statistical analyses were performed using the R programming language, version 3.6.3 (R Development Core Team, Vienna, Austria) (47). $P < 0.05$ indicates statistical significance.

TABLE 1 | Demographics of respondents (N = 11,130).

Variable	Number	Percentage
Sex of head of household		
Female	4,142	37.21
Male	6,988	62.79
Relationship status		
Single	1,251	11.24
Married	7,635	68.60
Separated	776	6.97
Divorced	1,468	13.19
Residence		
Rural	7,032	63.18
Urban	4,098	36.82
Wealth Status		
Poorest	2,075	18.64
Poor	2,202	19.78
Middle	2,469	22.18
Rich	2,559	22.99
Richest	1,825	16.40
Employment status		
Employed	4,612	41.44
Not-employed	6,518	58.56
Education status		
None	2,157	19.38
Primary	5,029	45.18
Secondary	2,883	25.90
Post-secondary	1,061	9.53
Smoker		
Yes	886	7.96
No	10,244	92.04
Age of household head (Mean ± SD) years	45.57 (19.30)	NA

RESULTS

A total of 11,130 households with heads above 18 years of age were studied. Socio-demographic characteristics of the respondents and their smoking status are shown in **Table 1**. The mean age of the respondents was 45.57 years with a standard deviation of 19.30 years. The majority of the households (62.79%) were male headed, married (68.60%), and residing in rural areas (63.18%). Meanwhile, the majority of the heads had up to primary education level (45.18%) or were unemployed (59.56%), and very few were smokers (7.96%). The wealth status of the households was evenly distributed across five quintiles from poorest to richest.

Household members reporting any of health conditions selected for this study are shown in **Table 2**. There were double the number of people with hypertension (13.76%) compared to those with respiratory problems (7.48%). While the fewest cases were reported for cancer (0.67%), mental health (1.24%), and TB (1.58%), there were similar numbers of those suffering from HIV (4.19%), diabetes (4.20%), and asthma (5.83%).

TABLE 2 | Any household member with the following conditions (N = 11,130).

Variable	Number	Percentage
Hypertension		
Yes	1,532	13.76
No	9,598	86.24
Cardiac		
Yes	232	2.08
No	10,898	97.92
Diabetes		
Yes	467	4.20
No	10,663	95.80
Asthma		
Yes	649	5.83
No	10,481	94.17
Mental Health		
Yes	138	1.24
No	10,992	98.76
Cancer		
Yes	75	0.67
No	11,055	99.33
HIV		
Yes	466	4.19
No	10,664	95.81
Respiratory Illness		
Yes	832	7.48
No	10,298	92.52
TB		
Yes	176	1.58
No	10,954	98.42

TABLE 3 | Summary of total costs of outpatient care incurred by households from the KHHEUS 2018.

Statistic	Total cost ≥ 0 by the household	Total Cost > 0 by the household
Minimum	0	0.01
Maximum	892.94	892.94
Mean	11.32	17.86
Median	1.69	6.35
Standard Deviation	32.07	38.90
Skewness	8.5	7.05
Characteristic of the skewness	Right skewed	Right skewed

Statistics were recorded for the survey month total cost ≥ 0 US$ (all households) and survey month cost > 0 US$ (those who spend money on outpatient care only).

Table 3 summarizes the cost to non-users of outpatient healthcare and continuous costs for users in a household. Non-users do not spend money on outpatient care, while users spend different amounts. Summary statistics when both cases are analyzed together shows that users spend a minimum of 0.01 US$ and a maximum of 892.94 US$. The mean (SD) when users and non-users are analyzed together is 11.31 (32.07) US$ & 17.96 (38.90) US$, respectively, with skewness of 8.5 and 7.05, respectively, with the reference being the survey month.

The resulting output after incorporating the QIC_u criterion, as explained in the six models, is shown in **Table 4**. The model with the lowest QIC_u was chosen as the best model.

The best fitted model with the lowest QIC_u was Model 1. Its coefficients and covariates can be expressed as

$$\begin{aligned}\log \mu = {} & 6.61 + 0.01\text{Age} + 0.04\text{Poor} + 0.09\text{Middle} + 0.41\text{Rich} \\ & + 0.59\text{Richest} - 0.04\text{Married} - 0.24\text{Separated} \\ & - 0.22\text{Divorced} - 0.25\text{Primary} - 0.41\text{Secondary} \\ & - 0.08\text{Post-Secondary}\end{aligned}$$

where μ is the expected cost of outpatient care.

Age of the household head was found to be a significant predictor of outpatient care expenses. A one-unit increase in age results in an increase in healthcare spending by a factor of 1.01 ($p < 0.001$). The cost of outpatient care was found to change with age in a sinusoidal manner. **Figure 2** shows the variation in total cost of outpatient expenses for households with respect to age of the household head during the survey period. A higher cost is associated with higher age of the household head.

Outpatient care costs increase across the wealth quantile with the rich and richest spending more, at 1.50 and 1.80, respectively, than the poorest. Household heads with primary and secondary levels of education spent less at 0.77 and 0.66, respectively, than those who never attended school. The results are significant at $p = 0.05$.

We conducted additional applications on certain probabilities based on Dunn and Syth (43) to demonstrate the usefulness of Tweedie distribution in modeling cost for outpatient care. When $1 < p < 2$, the Tweedie parameters (μ, p, ϕ) can be parameterized into Poisson and gamma parameters $(\lambda, \gamma, \alpha)$, which can be used to provide estimates for comparison with other outputs. This is given in the following equation

$$\lambda = \mu^{(2-p)}/\phi(2-p)$$

$$\gamma = \phi(p-1)\mu^{(p-1)}$$

$$\alpha = (p-2)/(1-p)$$

where λ is the average expenses per month, γ is the shape of the cost distribution when a household pays for outpatient care, and $\alpha\ \gamma$ is the mean expenses per month.

Considering our best fitted model, the parameter index p is 1.68, $\mu = \exp(6.61) = 7.35$ US$, and ϕ is 0.31 US$. Reparameterizing to gamma and Poisson yields the predicted mean cost expenditure per month, calculated as

$$\lambda = \frac{7.35^{(2-1.68)}}{0.31(2-1.68)} = 0.84$$

and

TABLE 4 | Different model outputs with calculated QIC_u.

	Model 1		**Model 2**		**Model 3**		**Model 4**		**Model 5**		**Model 6**	
QIC_u	**976341.2**		976874		977759.3		985834		978755		982713.3	
Coefficient	$\hat{\beta}$	p	$\hat{\beta}$	p	$\hat{\beta}$	p	$\hat{\beta}$	p	$\hat{\beta}$	p	$\hat{\beta}$	p
(Intercept)	6.61	< 0.001	6.59	< 0.001	6.49	< 0.001	6.77	< 0.001	6.37	< 0.001	6.88	< 0.001
Age	0.01	< 0.001	0.01	< 0.001	0.01	< 0.001	0.01	< 0.001	0.01	< 0.001		
Wealth index												
Ref (Poorest)												
Poor	0.04	0.64	0.05	0.59	-0.01	0.87	0.04	0.68	0.00	0.98	−0.02	0.85
Middle	0.09	0.32	0.09	0.34	0.00	1.00	0.09	0.29	0.00	0.96	0.02	0.82
Rich	0.41	< 0.001	0.40	< 0.001	0.30	< 0.001	0.41	< 0.001	0.31	< 0.001	0.31	< 0.001
Richest	0.59	< 0.001	0.58	< 0.001	0.53	< 0.001	0.61	< 0.001	0.53	< 0.001	0.42	< 0.001
Marital status												
Ref (Single)												
Married	−0.04	0.63			0.00	1.00	−0.03	0.76				
Separated	−0.24	0.07			−0.15	0.25	−0.19	0.17				
Divorced	−0.22	0.07			−0.06	0.63	−0.12	0.35				
Education												
Ref (None)												
Primary	−0.25	< 0.001	−0.24	< 0.001			−0.27	< 0.001				
Secondary	-0.41	< 0.001	−0.38	< 0.001			−0.44	< 0.001				
Post secondary	−0.08	0.52	−0.05	0.70			−0.12	0.33				
Sex												
Ref (Male)												
Female					−0.16	< 0.001	−0.19	< 0.001				

The model with the lowest QIC_u was selected as the best fitting model. In our case, Model 1 was selected as the most parsimonious model for predicting outpatient care cost among households in Kenya using the KHHEUS 2018.
Bold values shows the least of QICu for the best model.

$$\gamma = 0.31(1.68 - 1)7.35^{(1.68-1)} = 19.09$$

finally

$$\alpha = \frac{1.68 - 2}{1 - 1.68} = 0.47$$

The mean expenditure per household on outpatient care is $\alpha\gamma = 0.47 * 19.09 = 8.97$ US$.

Following Dunn and Smyth (43), the probability of incurring zero cost on outpatient care by households (i.e., the probability of not seeking outpatient care) is given by

$$\Pr(Y = 0) = \exp(-\lambda) = \exp\left[-\frac{\mu^{2-p}}{\phi(2-p)}\right] \qquad (10)$$

such that, the probability of zero outpatient care is given by $\exp(-0.84) = 0.43$, meaning that 43% of households did not spend on outpatient care in any given month. Therefore, 57% of households spent money on outpatient costs.

Finally, we investigated the deviance obtained from using the two different link functions, as shown in **Table 5**. Using the logarithmic link was appropriate, since it had lower deviance than the default canonical link function.

DISCUSSION AND CONCLUSION

This study analyzed the responses of members of households who attended outpatient facilities in Kenya in 2018; it investigated the best predictors for outpatient care in correlation with the household head characteristics. The best predictors were obtained from the most parsimonious model with the lowest QIC_u. Three key findings emerged: age of the household head, education, and the wealth index were associated with spending on outpatient care.

Households headed by older members were associated with higher spending. This can partly be explained by the fact that higher age could signify (1) the aged suffering from chronic and serious illnesses that are expensive to treat, (2) more members in the household needing these services, and (3) higher incomes to pay for a service. This finding corroborates previous evidence showing that out-of-pocket spending for outpatient care increased correlatively with age in Kenya (40). Additional evidence showed an increase in spending on healthcare among the aged in emerging economies (48). Thus, the burden of healthcare is higher in households headed by older people. Another insight requiring further analysis is that households headed by older people were also the respondents.

The rich and richest wealth quintiles spent more on outpatient services than the poorest did. Similar results have been reported

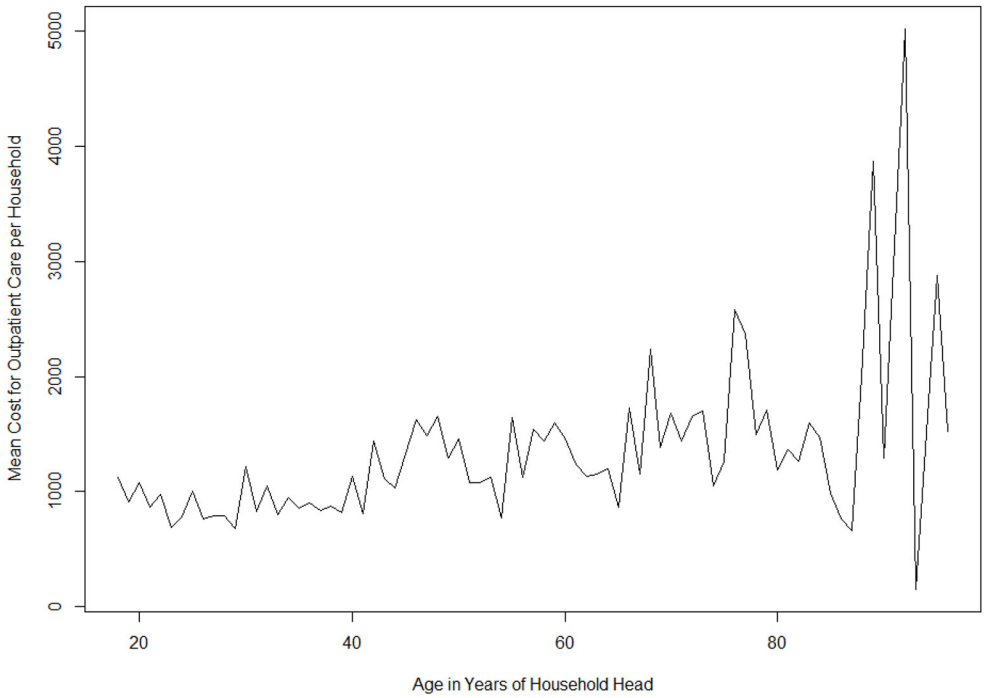

FIGURE 2 | Variations of mean cost for outpatients by household head age.

TABLE 5 | The residual deviance and degrees of freedom for a Tweedie GLM with differing link functions using Model 1 covariates.

Link function	Deviance	DF
Logarithm	404663.6	11118
Canonical	404872.7	11118

in prior studies, where poor utility among the poor was observed in Zimbabwe (49), south west Ethiopia (50), Brazil (51), and in rural areas of Kenya (52). Spending on outpatient healthcare could be influenced by financial health, which leads to choices about where to seek care. Therefore, it is not surprising that the rich and richest households reported higher costs. This is possibly because the rich mostly seek care in private facilities (7), which are expensive. Further evidence published in a technical report on the findings of the KHHEUS survey showed that per capita expenditure increased relative to wealth (per capita expenditure for the rich was 23.58 US$, that for the richest was 32.11 US$, and that for the poorest was 12.01 US$) (40).

Households that have heads with secondary and primary education spent less on outpatient care than did those who never went to school. Previous studies have found that per capita expenditure on outpatient care by group was 15.20 US$ for those with primary education, 20.34 US$ for those with secondary education, and 27.80 US$ for those who had never attended school.

There is emerging evidence of a negative correlation between education and self-medication (53). Self-medication could have lower costs, as it is mostly associated with drug purchase over the counter (54) for less complicated cases, such as headaches and abdominal discomfort (55). Thus, those without education may rely on facilities to diagnose their symptoms, thereby incurring more expenses. A similar observation was observed in Vietnam, that increased education reduced outpatient healthcare utilization (56). It has been argued that an increase in education could have positive impacts on health-related outcomes, such as low risks of illnesses and healthier habits (57).

The results have significant practical implications for Kenya, where much debate revolves around cushioning the public from catastrophic spending. Most of the literature in Kenya on determinants of catastrophic spending have critically considered cash spending on both inpatient and outpatient care. For example, the fourth round of the KHHEUS study found that four times more out-of-pocket spending was witnessed in outpatient than inpatient care (0.929 billion US$ against 0.253 billion US$, respectively) (40).

There has been consistent effort by the government of Kenya and development institutions, such as the WB, to reduce poverty among citizens, so as to raise their socio-economic status and free up household income to spend on healthcare (58). The inability to pay the fees charged at a health facility is a hindrance to Kenyans seeking care (59).

Outpatient spending has been a major source of catastrophic spending in Kenya, and mostly has been paid from household savings and income (60). Similar results have been recorded

elsewhere in developing countries, such as India (61) and Nepal (62). In Kenya, the debate centers on whether to improve public facilities to make them more desirable choices for healthcare treatment, or to provide insurance to households so that members can seek care in either public or private facilities (63). Therefore, policies targeting UHC, especially healthcare affordability, should continue to be implemented, as this would ease the burden of spending on households and direct such resources elsewhere to improve living standards.

This study has a number of limitations. Age is an endogenous variable, and thus, its increase does not necessarily point to severe disease, but could possibly be due to financial freedom that comes with age. A clear analysis stratifying age with wealth is necessary to decode this finding. However, since this work is based on determining the overall best predictors of outpatient spending, it is beyond the scope of this study. In addition, this work focused on spending at the household level; it is possible that most household spending was on the aged. An individual analysis on specific age groups could help shed light on this scenario.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

R CODE FOR REPLICATING OUR RESULTS

We analyzed this study using the R programming language. The R code is archived at GitHub and can be accessed using the link https://github.com/samwenda/Tweedie-and-Indpedent-correlation.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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