Abegaz and Mohammed *Agric & Food Secur (2018) 7:47*
https://doi.org/10.1186/s40066-018-0199-8

Agriculture & Food Security

RESEARCH

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Healthcare expenditure and GDP in Ethiopia from 1995 to 2014: a time-series analysis

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Abstract

Background: With an increasing attention from researchers, policymakers, and the priority of healthcare aspects, explaining the relationship between healthcare expenditure (HCE) and gross domestic product (GDP) is of great importance to the academics in particular and government policymakers in general. Thus, this study aimed at investigating whether HCE and GDP have a long-term relationship and at measuring the elasticity of HC from 1995 to 2014.

Methods: This study used yearly HCE and GDP data of Ethiopia during the period 1995–2014. Line graph was used to visualize the trend. Augmented Dickey–Fuller and Johansen cointegration tests were carried out to check stationarity and the long-run equilibrium relationship between the variables, respectively. We also examined the elasticity of healthcare expenditure using ordinary least squares, least absolute deviations, least mean squares, and *M*-estimator estimation approach.

Results: The results confirm that there was a significant long-run relationship between the variables. In addition, the results of this study based on the four estimation approaches show that increasing GDP has a significant and positive impact on healthcare expenditure. The income elasticity of total and government healthcare expenditure was less than one nearly 0.05 and 0.028%, respectively.

Conclusions: The results of this study, therefore, suggest that HCE and GDP have a long-term cointegration and that health expenditures were a necessity in Ethiopia. This study finally suggests for government in general and Ministry of Health and the Ministry of Finance in specific to continue on their effort to increase healthcare expenditure not only by increasing government expenditure but also by enabling private health expenditure in healthcare coverage.

Keywords: Healthcare expenditure, GDP, Time-series analysis, Ethiopia

Background

Healthcare financing in general and the relationship between healthcare expenditure (HCE) and gross domestic product (GDP) in particular have been the focus of studies in recent times mainly because understanding the long-run relationship between healthcare expenditures and GDP provides insights into linkages between income factor and demand side of health. Besides, such insight is important from a policy perspective to cover costs and safeguard the achievement of health financing goal [1]. According to Fedeli [2], HCE and GDP attracted much interest in the health economics literature and research confirmed the presence of a relationship between them.

Globally, countries have varied health expenditure patterns based on their national income. Accordingly, high-income countries exhibited a per capita health expenditure of over US dollar (USD) 3000 on average, while resource-poor countries exhibited only USD 30 per capita. Similarly, the proportion of health expenditure to GDP varies from country to country based on their development. Thus, some countries spend more than 12% of their GDP, while less developed countries spend less than 3% of their GDP [3].

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Different efforts have been made by African countries to meet the millennium development goals (MDGs), and one of the major moves can be the increasing investment to improve the health sector. African leaders vowed to continue those efforts by strengthening health financing in their countries and made bold movements at the continental level through different declarations like Abuja Declaration on increasing government funding for health in 2001, the Addis Ababa Declaration on community health in the African Region in 2006, and the Ouagadougou Declaration on primary health care and health systems in Africa in 2008 [4].

Many sub-Saharan African (SSA) countries exhibited a moderate growth during the last decade, which unfortunately was not converted into development in the standard of living of the people. Despite the declining figure of an infant, under five, and maternal mortality, there is still significant lag from MDGs set targets. This was evidenced by the low human development among many SSA countries (an average human development index score of 0.439 in 2011) and the prevalence of growing burden of diseases and a critical shortage of health system resources among those countries [5].

Ethiopia is one of the developing African countries and exhibited low government spending and low private sector participation in healthcare financing. During the previous regimes, the government had much control over the entire economic activity and hence became responsible for the majority of health expenditures in the country. Besides, the "Dergue" regime relied on a communist ideology that limited private sector participation. This was clearly evidenced firstly in the low per capita spending of USD 12 making the country below sub-Saharan African countries, second in the declining government spending of more than 4–2.8% from 1970s to 1980s, and third the low amount of government spending that accounted for only 1% of the GDP in 1991. However, in the mid-1990s shift of political power to the new government increased the government expenditure slightly up to about 2.7 in 1996 and to 5% during 2004–2005 [3].

Ethiopia exhibited rapid economic development securing the 12th fastest growing economy place globally and reached the average real GDP growth of 9.1% from 1999 to 2012 [6]. Side by side with the growth of GDP, the total health expenditure has also grown to reach USD 1.64 billion by the year 2010–2011. Ethiopia's per capita health expenditure has increased from USD 16.10 in 2007–2008 to USD 21 in 2010–2011 in response to the tough government efforts to put healthcare financing reform in practice [7].

Despite the improvements in the health sector and Ethiopia's 5.2% of government spending on health against GDP in 2010–2011 [7], Ethiopia is far from achieving the 15% share of government expenditure agreed upon by the member states of the WHO Africa region [4]. Additionally, Ethiopia has an infant mortality, under five mortality and maternal mortality rate of 51.5, 77 and 47 per 1000, respectively, that can be categorized as high [8].

With respect to the theoretical aspect of determinants of health expenditure, a large portion of studies investigated the relationship between HCE and income. Additionally, the literature and study findings indicate that there is a strong positive correlation between per capita HCE and income in developed countries, with per capita income explaining high percentage variation in expenditure [9]. Other studies conducted by Gerdtham and Löthgren [10] and Clemente et al. [11] found positive co-integrating relationships between real per capita HCE and GDP.

Despite the reliance of previous studies on panel datasets for multiple OECD countries, using a time-series dataset for one county would be more desirable so that the similarity in social security systems, government healthcare policies, or consumers' behaviors provide stable estimation results [12]. In addition to the above issue, whether the elasticity of HCE is greater or less than 1 has been debatable [13]. Besides, studies over the last years found income elasticity of HCE to be positive and they also found that in some countries the HCE is necessity and luxurious in some other countries [9]. Thus, the debate has changed from the presence of a relationship between HCE and GDP to that of the magnitude of elasticity.

Finally, this study has aimed to identify whether health expenditure is necessity or luxury in Ethiopia and to ascertain whether health expenditure has a long-term relationship with the GDP from 1995 to 2014.

Healthcare expenditure and GDP: an empirical review

The work of Newhouse [14] can be considered to be the pioneering study to understand determinants of healthcare expenditure. In this study, a cross-sectional data from 13 developed countries were used to see the relationship between per capita HCE and per capita GDP using regression. Finally, the work of Newhouse came to a conclusion that income elasticity of HCE is greater than 1, and hence, it was considered a luxury good.

Following Newhouse's work, Leu [15] and Parkin et al. [16] used cross-sectional data from 19 to 18 OECD countries, respectively, to come up with a similar result. Their result indicated that the elasticity of HCE is greater than 1 and it is luxury good.

Another study by Hitiris and Posnett [17] used a panel data of 20 OECD countries and found that income elasticity was close to 1. On the other hand, Hansen and King

[18] took time-series data of 20 OECD countries and found no long-term relationship between HCE and GDP. Another study conducted in the 1990s by Hitiris [19] took data from 10 OECD countries and confirmed that elasticity was greater than 1, indicating that HC is luxury good.

After the millennium, Sen [20] took a panel data of 15 OECD countries and found that panel data elasticity is less than 1, indicating that health care (HC) is necessity good. On the same year, Dreger and Reimers [21] took panel data from 21 OECD countries and used panel cointegration technique. Their result showed that HC is necessity for good scoring elasticity of less than 1. Using similar technique (panel cointegration) but single country data, Wang and Rettenmaier [22] took data from 50 US states and concluded that both HCE and GDP are non-stationary having a co-integrating relationship.

With a multivariate regression model, Chakroun [23] took data from 17 OECD countries and found an elasticity of less than 1, showing that HC is of necessity good. Baltagi and Moscone [24] also took panel data of 20 OECD countries having the elasticity of less than 1 (necessity good). On the contrary, Mehrara et al. [25] and Liu et al. [26] took panel data of 16 and 22 OECD countries, respectively, indicating the elasticity of greater than 1. In similar fashion, Lago-Peñas et al. [9] took panel data of 31 OECD countries to come with income elasticity closer to 1.

Lawanson [5] also used National Health Accounts (NHA) framework to profile the health financing situation in SSA countries and concluded that public facilities dominated the provision of health care in SSA. As a recommendation, the author suggested the increased participation of private sector because of the growing trend of public–private partnership initiatives in the countries.

From all the above empirical studies, we can conclude that there is no unified conclusion as to whether HC is luxury or necessity good. Besides, there is high tendency to take data from multiple countries that will result in general conclusion to the group rather than a specific conclusion to a single country. There is also variation in methodological aspects among studies ranging from cross-sectional time series to panel cointegration techniques. Thus, we tried to specifically investigate Ethiopia's HCE and GDP relationship using yearly time-series data from 1995 to 2014.

Methods

Data source and data analysis

The current study uses yearly HCE and GDP data of Ethiopia during the period of 1995–2014. The data on these variables were retrieved from the WHO global report on health expenditure and GDP, having variables such as per capita GDP in USD (GDPp), per capita total HCE in USD (THEp), and per capita government HCE in USD (GHEp).

A line graph was used to visualize all the variables and to compare their trend with one another in the specified time period. To estimate whether there is long-term equilibrium relationship between GDP and HCE, the first step was to plot the HCE data and examine its behavior. However, this examination of plots suggests that either the given variables are stationary or not. But, still, it is impossible to say conclusively about the stationary characteristics of these series based on plots. Therefore, we have used a statistical method to test the stationary character, called augmented Dickey–Fuller (ADF) unit root test having a model, as follows:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t;$$

where y_t is variable of interest (HCE or GDP), t is a time index, Δ is the first difference operator, β is a coefficient, α is a constant, ε is error term, and γ is a hypothesis value of $\gamma = 0$ versus $\gamma < 0$.

Once the unit root problem is identified at the level, we took the first difference of time series for each variable and test the unit root again. In case of the first difference, all the variables were stationary, and then, the series is described having integration of order 1 and is denoted $I(1)$. Since the results of this test confirm that all of the variables are integrated of the same order, it implies that the variables as a group may be co-integrated in the long run. Therefore, to check the long-run equilibrium relationship between the variables, Johansen [27] multivariate cointegration test was employed. The appropriate lag length (2) for the unit root and cointegration tests was selected based on the smaller Akaike information criteria (AIC).

Johansen multivariate cointegration tests

Johansen suggested two tests for H_0: At most k CI vectors: the *Trace test* and the *Maximal Eigenvalue test*. Both tests are based on the λ's from $|\lambda I - S_{11}^{-1/2} S_{10} S S_{00}^{-1} S_{01} S_{11}^{-1/2}| = 0$. They are LR tests and a multivariate version of Dickey–Fuller unit root distribution so they do not have the usual χ^2 asymptotic distribution under H_0.

The trace statistic:

$$\mathrm{LR}_{\mathrm{trace}}(k) = -2 \ln \Lambda = -T \sum_{i-k+1}^{m} \ln(1 - \hat{\lambda}_i)$$

where k is rank of integration of the THEp and GHEp with GDPp and $\hat{\lambda}_i$ denotes the descending order eigenvalues $\hat{\lambda}_i = \hat{\lambda}_1 > \cdots > \hat{\lambda}_m > 0$ of $|\lambda S_{11} - S_{10} S_{00}^{-1} S_{01}| = 0$.

Note: The LR_{trace} statistic is expected to be close to zero if there are at most k (linearly independent) co-integrating vectors.

- If $LR_{trace}(k) > CV$ (for rank k), then H_0 (CI rank $= k$) is rejected.
- If $Rank(\Pi) = k_0$, then $\hat{\lambda}_{k_0+1}, \ldots, \hat{\lambda}_m$ should all be close to 0. The $LR_{trace}(k_0)$ should be small since $\ln(1 - \hat{\lambda}_i) \approx 0$ for $i > k_0$.

An alternative LR statistic is given by $LR_{max}(k) = -2\ln\Lambda = -T\ln(1 - \hat{\lambda}_{k+1})$. It is called the *maximal eigenvalue statistic.* It examines the null hypothesis of k co-integrating vectors versus the alternative $k+1$ CI vectors. That is, H_0: CI rank $= k$, versus H_1: CI rank $= k+1$.

Finally, this study empirically examines the income elasticity of HCE using the time-series regression with ordinary least square (OLS) estimation approach. For robustness reason, least absolute deviation (LAD), least median of squares (LMS), and Huber's M-estimation (M) methods were employed.

The *Linear regression* model is also given by: $Y_i = \alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n + \varepsilon_i$, where α is constant, β_is are coefficients, and ε_i are error terms. All the data were presented and analyzed using time-series analysis approach, and STATA-14 was the statistical package.

Results and discussion

The trend (for original and log-scaled data) of both per capita total and government HCE and per capita GDP of Ethiopia is displayed in Fig. 1. This graph suggests that per capita HCE and per capita GDP are varying over time and that they have significantly increased from 2005 to 2014. This common increment implies that there was a positive association between per capita HCE and per capita GDP, meaning that both of them are moving in the same path. Even though both the per capita HCE and per capita GDP have increased over time, per capita GDP had a slight decrement from 1995 to 2003, both per capita government and total HCE decreased during 2012–2013, and they started to increase from 2013 again.

Figure 2 presents the status of GDP and HCE at the level, and it also displayed after they are smoothened by first differencing. This smoothness also showed the stationarity of all the variables.

Table 1 presents the summary statistic of the considered variables. The summary statistics show that the average per capita GDP of Ethiopia from 1995 to 2014 was USD255.96 with lowest USD116.7 and highest USD628.34. From the given per capita GDP, the average per capita total HCE and per capita government HCE were USD11.24 and USD6.16, respectively.

The ADF test results are presented in Table 2. The results show that all of the variables were non-stationary (unit root) at the level and became stationary (no unit root) at the first-order difference. This means that all of the variables have the same order of integration, which is $I(1)$. This result, therefore, suggests that there might be a cointegration relationship among variables in the long run. Accordingly, this study has applied Johansen multivariate cointegration test and the findings of this test are reported in Table 3. The findings show that there was a significant cointegration relationship between the per capita GDP and both total and government per capita HCE in Ethiopia, meaning that both per capita GDP and

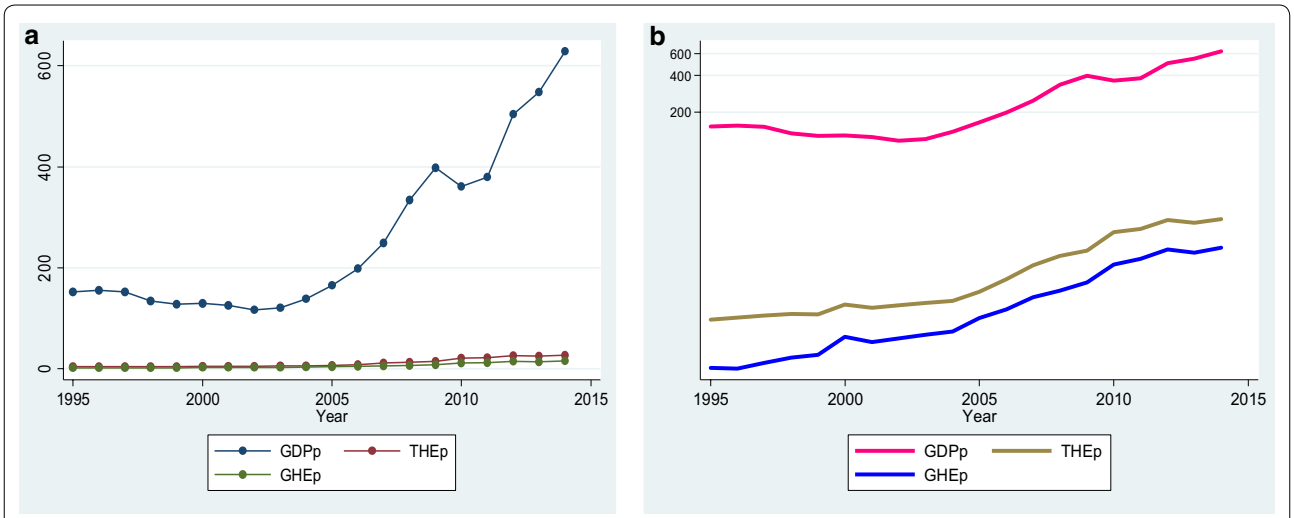

Fig. 1 Trend relationship of GDPp, THEp, and GHEp from 1995 to 2014. **a** Original data. **b** Log-scaled data

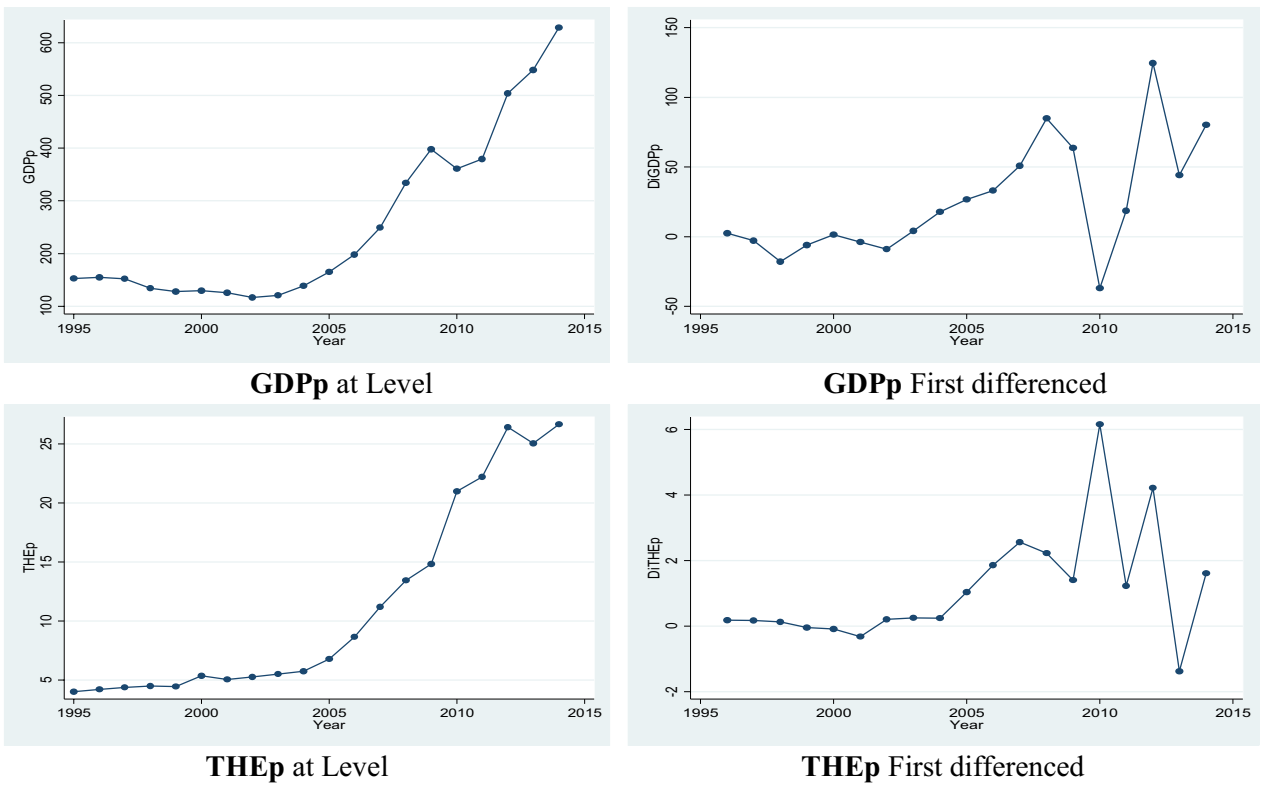

Fig. 2 Trend of GDPp, THEp, and GHEp from 1995 to 2014, at the level and first differenced

Table 1 Summary statistics of the variables

Variables	Mean	SD	Min	Max
GDPp	255.96	161.67	116.7	628.34
THEp	11.24	8.37	4.02	26.65
GHEp	6.16	4.94	1.6	15.64

Table 2 ADF unit root test results

Variables	Level		First difference	
	z-statistic	Prob.	*z*-statistic	Prob.
GDPp	−0.449	0.9853	−3.948***	0.0104
THEp	−1.332	0.8799	−4.666***	0.0008
GHEp	−1.202	0.9101	−4.644***	0.0009

***Significance at the level 0.05%

per capita HCE have an equilibrium relationship in the long run.

Lastly, Table 4 presents the long-run income elasticity of per capita health expenditure. The results of OLS model suggest that a 1% increase in per capita GDP raises per capita total health expenditure by 0.05%. Similarly, the results from LAD, LMS and M indicate that a 1% rise in per capita GDP increases per capita total health expenditure by 0.0473, 0.0453, and 0.0477%, respectively. In addition, a 1% rise in per capita GDP increases per capita government health expenditure of 0.028% on average, according to these four estimation approaches. This implies that all of the models, OLS, LAD, LMS, and *M*, provide almost consistent results.

It is also displayed in Table 4 that all the coefficients of the four estimation approaches, OLS, LAD, LMS, and M, were less than one, nearly 0.05%. This shows that all the coefficients of GDPp in four estimation approaches were less than 1, which implies that expenditure on health care was a necessity good in Ethiopia during the period of 1995–2014.

The results of this study confirmed that all the variables were non-stationary at the level and became stationary (no unit root) at the first-order difference using ADF test. This result came to the conclusion that there is a cointegration relationship among variables (per capita GDP, total government per capita HCE, and government per capita HCE) in the long run after using Johansen multivariate cointegration test. This finding is in line with [22] who took data from a single country (50 US states).

Table 3 Johansen multivariate cointegration (CE) test results

THEp and GHEp = f(GDPp)				
Hypothesized no. of CEs	Trace test		Max-Eigen test	
	Statistic	5% critical value	Statistic	5% critical value
None*	39.7048***	29.68	28.4655***	20.97
At most 1*	11.2393***	15.41	9.9256***	14.07
At most 2	1.3136	3.76	1.3136	3.76

* Number of ranks with cointegration

*** Significance at the level 0.05%

Table 4 Long-run elasticity of per capita HCE result

Model	Estimation methods	Estimation results	
		Coefficient of GDPp	Prob.
THEp	OLS	0.05***	0.000
	LAD	0.0473***	0.000
	LMS	0.0453***	0.000
	MM	0.0477***	0.000
GHEp	OLS	0.0293***	0.000
	LAD	0.0271***	0.000
	LMS	0.0286***	0.000
	MM	0.0286***	0.000

***Significance at the level 5%

In their study, they attested that both HCE and GDP are non-stationary having a co-integrating relationship.

HC is one of the essential services that people consume for the sake of ensuring their health safety. According to Mankiw [28], the consumption of goods and services is dependent on income status and the rising income helped many to improve their living standard as well as their consumption. Accordingly, the result of this study revealed that, even though the amount is very small, increasing per capita GDP has played an important role in bringing the expenditure on health care in Ethiopia. The results of OLS, LAD, LMS, and M suggest that a 1% increase in per capita GDP raises per capita total health expenditure by nearly 0.05%, indicating that HC was a necessity good in Ethiopia during the period of 1995–2014. This was in line with the result of [20, 21, 23, 24] who found an elasticity coefficient of less than 1 and hence concluded that HC is a necessity.

Conclusions and recommendations

This study took data from a single country (Ethiopia) to indicate that HCE and GDP are non-stationary and they are co-integrated in the long run. Besides, HC is found to be a necessity with elasticity much less than 1. Additionally, the authors recommend for the government in general and Ministry of Health and the Ministry of Finance in specific to continue on their effort to increase healthcare expenditure not only by increasing government expenditure but also by enabling private health sector participates in HC coverage.

Abbreviations

ADF: augmented Dickey–Fuller test; AIC: Akaike information criteria; GDP: gross domestic product; GDPp: per capita gross domestic product; GHEp: per capita government healthcare expenditure; HC: health care; HCE: healthcare expenditure; HSDP: health sector development planning; LAD: least absolute deviation; LMS: least median of squares; M: Huber's *M*-estimation; MDGs: millennium development goals; NHA: National Health Accounts; OECD: Organization for Economic Co-operation and Development; OLS: ordinary least square; SSA: sub-Saharan Africa; THEp: per capita total healthcare expenditure; USD: United States Dollar; WHO: World Health Organization.

Authors' contributions

KHA and AAM designed the study, and KHA selected the attributes and performed the analysis. Both authors read and approved the final manuscript.

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Acknowledgements

None.

Competing interests

The authors declare that they have no competing interests.

Availability of supporting data

The dataset was retrieved from http://apps.who.int/gho/data/view.main.HEALTHEXPCAPETH.

Consent for publication

Not Applicable.

Ethical Approval and Consent to participate

Ethics approval and participant consent were not necessary as this study involved the use of a previously published de-identified database by World Health Organization global report.

Funding

No any organization funded for this research.

Publisher's Note

Received: 16 June 2018 Accepted: 4 July 2018
Published online: 13 July 2018

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