

## Original Research

# Predictors of wealth index in Malawi – Analysis of Malawi demographic Health Survey 2004–2015/16



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## ABSTRACT

**Objectives:** To examine the wealth index over a decade utilizing Malawi's Demographic and Health (DHS) survey data from 2004, 2010, and 2015/16, and to explore factors that predict higher wealth.

**Study design:** This was a retrospective descriptive study.

**Methods:** The study utilized DHS data from 2004, 2010, and 2015/2016. The total number of participants was 77,194. Linear regression models were used to assess the effects of the predictors. All analyses were conducted in Stata version 13.

**Results:** Findings showed no significant increase in wealth between the survey years. However, significant increases in wealth were associated with smaller family size ( $-0.09[-0.10, -0.08]$ ), age ( $0.02[0.02, 0.02]$ ), having formal education ( $0.21[0.18, 0.24]$ ), and living in urban areas ( $-1.84[-1.98, -1.70]$ ). Differences in wealth also existed among the different ethnic and religious groups with the Chewa reporting less wealth than other groups, and people with any form of religion reporting more wealth than people with no religion.

**Conclusions:** Minimal changes in wealth have occurred in Malawi between 2004 and 2015/16, and sociodemographic, socioeconomic, and cultural factors are associated with wealth in this population.

## 1. Introduction

Poverty is one of the major contributors to poor health in Malawi. Malawi, a low-income country located in south-east Africa, has an estimated population of 17.5 million people [1]. The World Bank reports significant growth in economic and social reforms in the last decade, but it is not clear how these developments are impacting wealth at the household level [1]. Malawi's gross domestic product (GDP) decreased from 4% in 2017 to 3.5% in 2018, while the fiscal deficit increased from 4.8% to 7.8% in the 2017/2018 fiscal year [1]. Inequalities in wealth distribution also continue to exist with more than half (57%) of the rural population living in poverty compared to 17% of the urban population [2].

The history of economic development in Malawi post-colonial area has been largely influenced by the political environment. Post-independence challenges in political leadership and the economic crisis in the late 1970's contributed to structural adjustment policies in the

nation [3]. These policies, however, did not contribute to sustained economic development and contributed to increased poverty. According to the International Monetary Fund, poverty in Malawi has been further worsened by external and internal shocks including climate (e.g. the large scale 2015 floods followed by draught in 2016), and domestic political and economic shock that have stagnated economic growth [4]. The 2015 Malawi Millennium Development Goals (MDG) Endline Report showed that almost 80% of the population resides in rural areas with nearly 50.7% of the general population living on less than \$1.00 per day [5]. The majority of the rural population depend on subsistence farming as a source of income [6]. Poverty in Malawi, is also gendered with the total percentage of poor female-headed households higher than that of male-headed households [2].

While the Malawi health care is free at government health facilities, people of low-income still cannot afford the costs incurred while receiving treatment [7]. Transportation is challenging as patients often have to travel long distances to a healthcare facility and on occasions

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some have to access services at a small fee at private institutions run by religious institutions [7]. In the event a hospital admission is necessary, the mean household costs also increase, with families incurring charges of almost \$23.43 at religious-based private institutions and \$13.09 at a government hospital where services are presumably free [7]. Frequently, Malawi government health facilities have limited supply of medications and most basic/essential medications are out of stock [8]. As such, patients and their families are often required to purchase their own medication that is prescribed, but unable to be filled at government health facilities that result in significant financial burden to families and impact their health care utilization.

Increase in wealth is also associated with antenatal care attendance as shown by lower utilization of antenatal care services among low-income rural women when compared to higher-income rural women [9]. Similar evidence is seen with lower utilization of HIV voluntary counselling and testing (VCT) services among low-income rural men when compared to higher-income rural men [10,11]. This necessitates the need to understand changes of wealth at household level and incorporate the wealth index in healthcare research. However, measuring income is difficult in low-income countries such as Malawi due to the informal nature of economic transactions that make objective measures of income difficult [12,13]. Thus, the Demographic Health Survey (DHS) reports the Wealth Index, a commonly used indicator for measuring socio-economic status in low- and middle-income countries [12,13].

The DHS program, founded in 1984 and initiated in Malawi in 1992, calculates the composite score wealth index by combining ownership of several household assets (televisions or bicycles), construction materials for the household in which participants live, as well as their accessibility to water and sanitation services [14]. The DHS wealth index is proposed as a measure of socioeconomic status in low-income countries. However, it is important to note that the definition of wealth as defined by the DHS program is limited as it may not fully reflect the actual income of the population. Using the wealth index, we could assume that as an individual's wealth index increases, their living conditions, including access to water and ownership of assets, should also improve. However, these may not reflect the actual buying power of the household. In a previous analysis of Kenya DHS, factors associated with increases in the wealth index included increase in age of head of household and increases in education, with female-headed households reporting less wealth [15]. Understanding the distribution of wealth and its predictors of wealth is necessary in healthcare research and clinical practice to identify target populations at risk of poor health seeking behaviors due to costs. The purpose of this analysis was to examine trends in the wealth index explored over a decade utilizing DHS program data from 2004, 2010 and 2015/16, and to explore factors that are associated with wealth.

## 2. Methods

### 2.1. Study design and data source

The study design involved an analysis of secondary data collected by the Demographic and Health Survey (DHS) program. DHS programs are implemented by ICF International with funding from the United States Agency for International Development (USAID) [16]. The purpose of the DHS is to conduct nationally-representative surveys to monitor and evaluate the impact of indicators in population, health, and nutrition for a specific country [16]. This study used three consecutive survey periods (2004, 2010, and 2015/16) for the country of Malawi. The surveys included information on the household, women's, and men's questionnaires for all years [17]. Participants were eligible for inclusion in the analysis if they had information at the individual level. The final sample were 14,959 from 2004; 30,195 from 2010; and 32,040 from the 2015/16 DHS data. The total number of participants from the data sets combined was 77,194. Ethical approval for DHS surveys were obtained from the Malawi National Health Sciences Research Committee. Approval to utilize the de-identified data was obtained from DHS program.

### 2.2. Study variables

#### 2.2.1. Outcome variable - harmonized wealth index

The DHS wealth index quantifies the household's living standard through a composite measure of assets, construction material, and facilities [18]. The wealth index is generated separately for each survey period in a specific country. Thus, each survey year and country has a different calculation of the wealth index [18,19]. To assess the wealth index over the pooled years of data, a harmonized wealth index was employed based on validated steps from DHS methodology reports [19]. The steps to create such an index were: a) determine variables across all years in relation to household assets; b) generate equivalent categories across all years; and c) conduct a data reduction/factor analysis to generate wealth index values for the individual household.

In Malawi, we identified 15 asset variables that were available across the three pooled survey years: whether the household had a domestic worker, if the household owned agricultural land, number of people sleeping per room, source of drinking water, type of toilet facility, main floor material, main cooking fuel, and if the household had electricity, a radio, television, refrigerator, bicycle, car, motorcycle, or a landline telephone. For all asset variables except number of people sleeping per room, an indicator variable was generated for each category of the variable and missing values were set to zero [18]. For the number of people per sleeping room, any number less than 1 was rounded to zero, while any number greater than 1 was rounded to the nearest integer and missing values were replaced with the average [19]. Based on the DHS methodological report, a factor analysis was performed using principal component analysis and sampling weights (See Table 1) [15,19]. Scores were generated using the "predict" command in Stata.

#### 2.2.2. Explanatory variables

Predictor variables were grouped into four factors: survey year (2004, 2010, and 2015/16), sociodemographic, socioeconomic, and cultural factors. Sociodemographic variables included gender (male or female), age (continuous – number of years), location of residence (urban or

**Table 1**  
Demographic characteristics of the sample.

Characteristic	N = 77,194
Gender, Freq (%)	
Male	17,914 (23.21)
Female	59,280 (76.79)
Age, Mean ± SD	28.20 ± 0.04
Location, Freq (%)	
Urban	14,422 (18.68)
Rural	62,772 (81.32)
Children, Mean ± SD	2.86 ± 0.02
Religion	
No religion	914 (1.18)
Christian	66,444 (86.10)
Muslim	9517 (12.33)
Other	298 (0.39)
Ethnic Groups	
Chewa	26,517 (34.35)
Tumbuka	7162 (9.28)
Lomwe	13,630 (17.66)
Yao	10,075 (13.05)
Ngoni	9501 (12.31)
Other	10,300 (13.34)
Occupation, Freq (%)	
No	21,782 (28.23)
Professional	2606 (3.38)
Clerical/Sales/Services	9370 (12.15)
Agricultural – self employed	28,919 (37.48)
Other	8482 (18.76)
Education, Freq (%)	
No education	10,409 (13.48)
Primary	48,349 (62.63)
Secondary	16,516 (21.29)
Tertiary	1921 (2.49)

rural), and the number of children the respondent had (continuous). The economic predictors included whether the respondent was currently working (no or yes) and education level (no education or any education). The cultural predictors included ethnicity (categorized into Chewa, Tumbuka, Lomwe, Yao, Ngoni, or other) and religion (categorized into no religion, Christian, Muslim, or other).

### 2.3. Statistical analysis

Participant characteristics are presented as means and frequencies. Factor analysis was performed to obtain the factor loadings, scoring coefficients, and the harmonized wealth index. Creation of the harmonized wealth index was completed at the household level utilizing the household level weights. Since the data were pooled over three years, the sampling weight was divided by 3 to account for the combination of data years. [5] Sample characteristics were calculated for the entire population.

Linear regression models were used for the purpose of predicting the wealth index. The models were developed with a hierarchical approach that entered the variables in 4 blocks: block 1, survey year; block 2, demographic (gender, age, location, children); block 3, economic (working, education); block 4, culture (ethnicity, religion). To account for the complex survey design, individual weights, stratification, and clustering were used in the survey design statement. All analyses for this study were conducted using Stata version 13 (StataCorp, College Station, TX) and evaluated at the 0.05 significance level.

## 3. Results

### 3.1. Demographic characteristics of the sample

Table 1 presents the demographic characteristics for the entire sample. Out of the 77,194 participants 17,914 (23.21%) were male and

59,280 (76.79%) were female. The average age for all participants was 28.20. Only 2.49% completed tertiary education with the majority of the population having completed primary education (62.63%). The majority of the population was either not working or were farmers, with 21,782 (28.23%) reporting not having any form of employment and 28,919 (37.48%) self-employed in agricultural activities. The majority of the respondents lived in rural areas (81.32%). The mean number of children each respondent had was  $2.86 \pm 0.02$ . The majority of the populations identified as Christians (86.10%), followed by Muslim (12.33%), then no religion (1.18%), and having other forms of religion (0.39%).

### 3.2. Harmonized wealth index

Table 2 presents the variables used to create the wealth index with their factor loadings and scoring coefficients. The harmonized index included data from three DHS survey years: 2004, 2010, and 2015/2016. The negative factor loadings corresponded with scoring coefficients showing that less wealth is associated with owning agricultural land, increases in the number of people sharing a room, source of drinking water (using a well, surface water, truck/carted water, and other sources besides piped water), natural floor material (usually dirt), and cooking with wood/straw. This is consistent with other studies cited in the methodology report [19].

Fig. 1 presents wealth index trends from 2004 to 2015/2016. The weighted means show that the average wealth of Malawians increased from 2004 to 2010 and from 2010 to 2015/2016 with a greater increase seen between 2010 and 2015/2016.

### 3.3. Predictors of wealth

Table 3 presents the four-variable model that was used to examine the difference in wealth between the survey years (model 1), effects of

**Table 2**  
Harmonized wealth index factor analysis.

Variable	Overall (N = 64,850)	2004 (n = 13,664)	2010 (n = 24,825)	2015/2016 (n = 26,361)	Factor Loadings	Scoring Coefficients
Domestic worker	0.0022	0.0027	0.0022	0.0020	0.2558	0.0427
Owens agricultural land	0.7910	0.7938	0.8342	0.7489	-0.4599	-0.0768
Sleep per room	2.6790	2.7573	2.7295	2.5909	-0.1969	-0.0329
Has electricity	0.0918	0.0580	0.0711	0.1289	0.7807	0.1303
Has radio	0.5028	0.6137	0.5289	0.4208	0.3242	0.0541
Has television	0.0972	0.0427	0.0912	0.1312	0.7164	0.1196
Has refrigerator	0.0445	0.0232	0.0317	0.0675	0.6754	0.1127
Has bicycle	0.4210	0.4193	0.4422	0.4020	0.0100	0.0017
Has car	0.0213	0.0161	0.0147	0.0302	0.4620	0.0771
Has motorcycle	0.0176	0.0091	0.0110	0.0282	0.1551	0.0259
Has phone - landline	0.0245	0.0405	0.0193	0.0210	0.4283	0.0715
Source of drinking water						
Piped	0.2147	0.1731	0.1979	0.2520	0.6942	0.1159
Well	0.7121	0.7078	0.7363	0.6914	-0.5935	-0.0991
Surface	0.0705	0.1178	0.0619	0.0542	-0.0740	-0.0124
Truck/cart	0.0007	0.0010	0.0010	0.0002	-0.0054	-0.0009
Other	0.0019	0.0000	0.0026	0.0022	-0.0013	-0.0002
Type of toilet facility						
Flush	0.0274	0.0256	0.0211	0.0344	0.5965	0.0996
Traditional Pit	0.8485	0.8008	0.8276	0.8929	-0.1634	-0.0273
Ventilated Pit	0.0151	0.0113	0.0234	0.0093	0.0565	0.0094
No facility	0.1047	0.1617	0.1215	0.0593	-0.1534	-0.0256
Other	0.0040	0.0001	0.0060	0.0042	-0.0026	-0.0004
Main floor material						
Natural	0.7685	0.8142	0.7989	0.7162	-0.7434	-0.1241
Rudimentary	0.0010	0.0004	0.0020	0.0003	0.0120	0.0020
Finished	0.2300	0.1847	0.1986	0.2830	0.7436	0.1241
Other	0.0003	0.0001	0.0002	0.0004	0.0056	0.0009
Cooking Fuel						
Electricity	0.0159	0.0141	0.0135	0.0191	0.5492	0.0917
Gas	0.0004	0.0004	0.0002	0.0005	0.0496	0.0083
Charcoal/coal	0.1117	0.0617	0.0819	0.1656	0.5790	0.0966
Wood/straw	0.8697	0.9215	0.9027	0.8118	-0.7592	-0.1267
Other	0.0023	0.0022	0.0015	0.0030	0.0203	0.0034

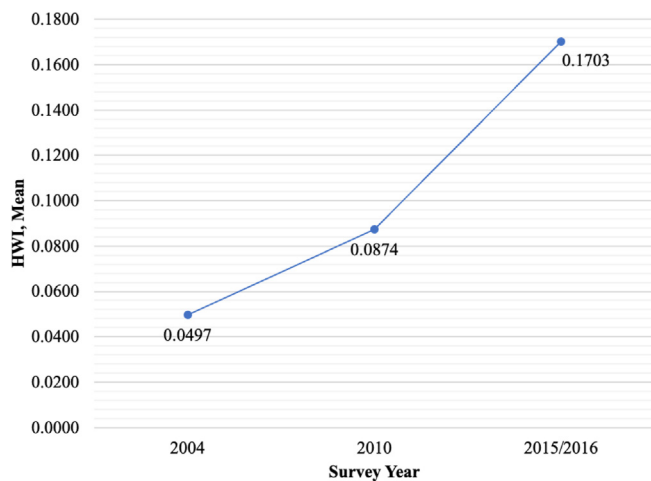


Fig. 1. Harmonized wealth index (HWI) by year – weighted.

sociodemographic variables (model 2), effects of socio-economic variables (model 3), and the effect of cultural and religious factors (model 4). In model 1, the findings showed that there was no significant difference in wealth in 2010 or 2015/2016.

After introducing sociodemographic variables into the model, results showed an increase in wealth in 2015/2016 compared to wealth in 2004 ( $\beta$  [95% CI] = 0.09 [0.00, 0.18]). In addition, an increase in age ( $\beta$  [95% CI] = 0.02[0.02, 0.02]) was associated with an increase in wealth, while living in rural areas ( $\beta$  [95% CI] = -1.88[-2.02, -1.74]) and an increase in number of children ( $\beta$  [95% CI] = -0.09[-0.10, -0.08]) was associated with a decrease in wealth.

Socioeconomic variables were added in model 3 and findings showed no significant difference in wealth between the two subsequent years and 2004. An increase in wealth was associated with female respondents ( $\beta$  [95% CI] = 0.04[0.01, 0.07]), increase in age ( $\beta$  [95% CI] = 0.02[0.02, 0.02]), and having any form of formal education ( $\beta$  [95% CI] = 0.4[0.21, 0.26]). In contrast, a decrease in wealth was associated with living in rural areas ( $\beta$  [95% CI] = -1.85[-2.00,-1.71]), an increase in number of children ( $\beta$  [95% CI] = -0.09[-0.10,-0.08]), and having any form of employment ( $\beta$  [95% CI] = -0.05[-0.08,-0.03]).

Model 4 added the effects of ethnic group and religious affiliation. Increased wealth was associated with increase in age ( $\beta$  [95% CI] = 0.02 [0.02,0.02]), and having any form of education ( $\beta$  [95% CI] = 0.21[0.18, 0.24]). Differences in wealth existed among the different ethnic groups. Findings showed that being Tumbuka ( $\beta$  [95% CI] = 0.24[0.19, 0.30]), Lomwe ( $\beta$  [95% CI] = 0.13[0.09, 0.18]), Yao ( $\beta$  [95% CI] = 0.13[0.07, 0.19]), Ngoni ( $\beta$  [95% CI] = 0.14[0.09, 0.18]), and other ethnic groups ( $\beta$  [95% CI] = 0.14[0.08,0.20]) was associated with increased wealth compared to being Chewa, which is the major ethnic group in the country. Religion also associated with wealth, with Christians ( $\beta$  [95% CI] = 0.19[0.13, 0.26] and Muslims ( $\beta$  [95% CI] = 0.14[0.06, 0.23]) having increased wealth compared to people with no religion, but there was no significant difference between people who had no religion and those from other forms of religions. Living in rural areas ( $\beta$  [95% CI] = -1.84[-1.98, -1.70]), an increase in number of children ( $\beta$  [95% CI] = -0.09[-0.10, -0.08]), and having a form of employment ( $\beta$  [95% CI] = -0.05[-0.07, -0.02]) were associated with decreased wealth.

#### 4. Discussion

Analysis of the harmonized wealth index showed that there was no significant increase in wealth between 2004 and 2015/16 in Malawi. An interesting finding in the factor analysis was that owning land for agricultural purposes was associated with decreased wealth. While land is an asset, its negative association with wealth may have resulted from the fact that majority of agricultural land is in rural areas and poverty is high

**Table 3**  
Linear Regression predicting HWI, Coefficient (95% CI).

Characteristic	Survey Year	Socio-demographics	Socio-economic	Culture
<b>Survey Year</b>				
	2004 (ref)	-	-	-
	2010	0.04 (-0.08,0.15)	0.02 (-0.06,0.10)	0.00 (-0.08,0.08)
	2015	0.12 (-0.00,0.24)	<b>0.09</b> <b>(0.00,0.18)</b>	0.07 (-0.01,0.16)
<b>Gender</b>				
	Male (ref)	-	-	-
	Female	0.03 (-0.00,0.06)	<b>0.04</b> <b>(0.01,0.07)</b>	0.03 (-0.00,0.06)
<b>Age</b>				
		<b>0.02</b> <b>(0.02,0.02)</b>	<b>0.02</b> <b>(0.02,0.02)</b>	<b>0.02</b> <b>(0.02,0.02)</b>
<b>Location</b>				
	Urban (ref)	-	-	-
	Rural	-1.88 <b>(-2.02,-1.74)</b>	-1.85 <b>(-2.00,-1.71)</b>	-1.84 <b>(-1.98,-1.70)</b>
<b>Children</b>				
		-0.09 <b>(-0.10,-0.08)</b>	-0.09 <b>(-0.10,-0.08)</b>	-0.09 <b>(-0.10,-0.08)</b>
<b>Working</b>				
	No (ref)	-	-	-
	Yes	-	-0.05 <b>(-0.08,-0.03)</b>	-0.05 <b>(-0.07,-0.02)</b>
<b>Education</b>				
	No education (ref)	-	-	-
	Any education	-	0.24 <b>(0.21,0.26)</b>	0.21 <b>(0.18,0.24)</b>
<b>Ethnicity</b>				
	Chewa (ref)	-	-	-
	Tumbuka	-	-	0.24 <b>(0.19,0.30)</b>
	Lomwe	-	-	0.13 <b>(0.09,0.18)</b>
	Yao	-	-	0.13 <b>(0.07,0.19)</b>
	Ngoni	-	-	0.14 <b>(0.09,0.18)</b>
	Other	-	-	0.14 <b>(0.08,0.20)</b>
<b>Religion</b>				
	No religion (ref)	-	-	-
	Christian	-	-	0.19 <b>(0.13,0.26)</b>
	Muslim	-	-	0.14 <b>(0.06,0.23)</b>
	Other	-	-	0.02 <b>(-0.14,0.19)</b>

\*p < 0.05.

among the rural population compared to the urban population [2]. As expected, higher wealth was consistently associated with increases in age and education, and decreased wealth was associated with living in rural areas and having more children. Similar findings were seen in Kenyan populations where higher levels of education was associated with higher wealth [15]. Paradoxical findings were seen in the socioeconomic factors (education and occupation) in that education had a positive effect on wealth while occupation had a negative effect on wealth. While occupation may be interpreted as a potential source of income, the results also show the majority of respondents were in low-paying forms of occupation with only a small fraction (3.38%) in professional jobs.

The results also presented an interesting gender dimension on issues surrounding wealth with female respondents associated with more wealth. Although this finding is not representative of gender of the head of the household, it is important to note that economic activities among rural women in Malawi is high when compared to other developing countries [20]. Our findings also showed that family structure influenced wealth, with having more children was associated with a decrease in wealth. In Malawi, while number of children may increase the size of the

household, this is not a full representation of the financial responsibility of the head of the household as they often are financing extended family members. So, while one may have a small family, it may not truly reflect the number of dependents an individual may have.

The Chewa ethnic group, which is the largest group in Malawi, reported less wealth compared to other ethnic groups, and Muslims and Christians reported increased wealth compared to people with no religion. Christianity and Islam are the two most common religions in Malawi and the large proportion of people identifying with belonging to a religious group may have influenced this finding. Future research needs to examine how social and religious affiliation influence an individual's socioeconomic status and if there are support systems that put some at an advantage compared to their counterparts who may not have the social networks that may result from being affiliated with a religious group. A look at the interaction between education and ethnic group, and education and religious affiliation are also important as some regions had earlier access to formal education activities than others due to missionary settlements.

Living in rural communities also impacts people's wealth. In this analysis, urban-dwelling people experienced an increase in wealth compared to their rural counterparts. People living in rural communities have limited access to resources, making it difficult for them to attain wealth. In our study, more than one-third of respondents reported reliance on farming as a source of employment. The majority of rural dwellers in Malawi are dependent on subsistence farming, whose main food crop is maize (corn), the staple food of the population [6]. Limited wealth among rural households is closely related to food insecurity resulting from poor agricultural productivity, variety of foods, as well as limited access to cash [21]. In rural Malawi, the poorest households have very limited income, own very few assets, and are thus unable to make purchases [22]. Any assets owned by rural dwellers, including livestock or poultry, are frequently used to recover from shocks related to household food shortages, for instance. Limited access to cash among rural households creates difficulty in making purchases of household food commodities that cannot be grown such as salt, cooking oil, and meat products, and creates difficulty in purchasing commodities such as soap, paraffin for lighting households, clothes, shoes, and for paying children's school fees [23].

Finally, according to the International Labor Organization (2009), agriculture is the main sector of employment for at least 80% of the population in Malawi. In our factor analysis, owning agricultural land was associated with decreased wealth. As previously noted, 80% of Malawians live in the rural areas and more than half of the population live in poverty [5]. In addition, the country is dependent on rain-fed agriculture and has only one rainy season [23], resulting in only one maize harvest a year. Reliance on agriculture, coupled with droughts and flooding that Malawi has faced, may have financially impacted rural families, and negatively influenced their economic growth. There is need for Malawians to diversify their major income generating activities and also intensify modern agricultural techniques so that families can produce sufficient food for both subsistence and commercial use. The maize grown by rural households is insufficient to meet the annual caloric needs of most households, thus placing them at risk for poor health.

In conclusion, these results show a minimal increase in wealth between 2004 and 2010 and 2004 and 2015/16 in Malawi. Thus, the majority of Malawians continue to live in extreme poverty despite the increasing costs of living. This poses a challenge to the livelihoods of Malawians and also to their ability to afford health care. Rural areas continue to struggle with poverty, and inequality in wealth distribution exists among people from different ethnic groups. Future economic improvement policies should target those at risk for poor wealth index especially in rural areas. Education continues to be a positive factor in economically empowering Malawians; however, the nature of one's occupation may matter in regard to wealth growth. Religious groups reported increased wealth as opposed to people with no religious affiliations and the Chewas who are a majority have less wealth.

Understanding how these sociodemographic and socio-economic variables influence wealth and health at individual, household, and community level is important as religious and ethnic group affiliations form a strong support system in Malawi.

### Ethical approval

Approval to use the data was obtained from the DHS program. The DHS program obtains ethical approvals from the local research committee to obtain DHS data.

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We did not receive any funding to complete this work.

### Competing interests

None declared.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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