

Full Title:

Evaluation of the association between health state utilities and obesity in sub-Saharan Africa: Evidence from WHO Study on Global AGEing and Adult Health Wave 2

Short Title: the association between health state utilities and high body mass index in the adult Ghanaian Population

Authors:

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Highlights:

What do we know?

In recent years, Ghana has identified the need to improve the quality and efficiency in its healthcare services to be able to achieve Universal Health Coverage and the Sustainable Development Goal 3 on health. However, some of the key effectiveness measures required for economic evaluations are lacking in Ghana, including health state utilities (HSUs). HSUs are used to calculate quality adjusted life-years (QALYs) for use in cost-utility analyses (CUA): a commonly used methodology to inform more effective prioritisation of scarce healthcare resources.

What does the paper add to existing knowledge?

This paper bridges the gap by reporting the first age and sex- specific HSUs for Ghana, along with HSUs by weight status.

What insights does the paper provide for informing health care-related decision making?

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Running head: HSUS AND OBESITY IN SUB-SAHARAN AFRICA

Obesity affects HSUs in the population and thus, quality of life. Additionally, lower HSUs were associated with older age and being female.

Concise Description of the Article

Our study derived age and sex-specific HSUs, and HSUs by weight status, all of which could be used in future economic evaluations.

Total number of Text pages

There are 28 pages including references, tables (four pages) and appendix (one page).

Word count:

Abstract:	244 words
Key words or phrase:	One word and four phrases
Main body:	3573 words

Abstract

Objectives: To estimate age and sex-specific health state utilities (HSUs) for Ghana, along with HSUs by weight status. Associations between HSUs and overweight and obesity will be examined.

Study Design: Cross-sectional survey of the Ghanaian population.

Methods: Data were sourced from the WHO Study of Global AGEing and Adult Health (WHO SAGE), 2014/15. Using a “judgement-based mapping” method, responses to items from the World Health Organization Quality-of-Life (WHOQOL-100) used in the WHO SAGE were mapped to EQ-5D-5L profiles; and the Zimbabwe value set was applied to calculate HSUs. Post-stratified sampling weights were applied to estimate mean HSUs and a multivariable linear regression model was used to examine associations between HSUs and overweight/obesity.

Results: Responses from 3,966 adults aged 18-110 years were analyzed. The mean (95 % confidence interval) HSU was 0.856 (95% CI: 0.850, 0.863) for the population, 0.866 (95% CI: 0.857, 0.875) for males and 0.849 (95% CI: 0.841, 0.856) for females. Lower mean HSUs were observed for obese individuals and with older ages. Multivariable regression analysis showed that HSUs were negatively associated with obesity (-0.024; 95% CI: -0.037, -0.011), being female (-0.011; 95% CI: -0.020, -0.003) and older age groups in the population.

Conclusions: The study provides HSUs by sex, age and BMI categories for the Ghanaian population, and examines associations between HSU and high BMI. Obesity was negatively associated with health state utility in the population. These data can be used in future economic evaluations for Ghana and sub-Saharan African populations.

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Key Words: Obesity, health state utilities, health economic evaluations, WHO SAGE wave 2,
sub-Saharan Africa.

Introduction

Overweight and obesity, hereafter referred to as high body mass index (BMI), has become a major public health challenge with increasing prevalence reported among adults aged 18 years and above in most parts of the world, including sub-Saharan Africa, between 1980 and 2014 ¹. In particular, the prevalence of obesity amongst adults in urban West African populations has doubled over a period of 15 years since 1990 ^{2,3}, an indication for the need to institute sustainable prevention and management measures. BMI is widely used to determine whether someone is in a healthy weight range for a given height. It is calculated as body mass (measured in kilograms) divided by the square of body height (measured in meters). The World Health Organization (WHO) defines overweight as a BMI ≥ 25.00 and < 30.00 kg/m², and obesity as a BMI ≥ 30.00 kg/m² ⁴. Whilst high BMI is often regarded culturally as a source of beauty and a sign of affluence in some developing countries ^{5,6}, it is associated with many chronic diseases including type 2 diabetes mellitus, hypertension, lipid disorders, osteoarthritis, gallbladder disease, strokes, some cancers, heart disease, obstructive sleep apnoea as well as reduced life expectancy ^{7,8}. Internationally, several studies have reported that high BMI has further been associated with a reduction in quality-adjusted life years (QALYs), and a high economic burden due to the associated medical and treatment costs ⁹⁻¹¹. Health state utilities (HSUs) indicate the numerical strength of preference for a health state, and are globally accepted as health-related quality of life (HRQoL) weights ^{12,13}. Age and sex-specific HSUs for a population can be used to calculate quality adjusted life years (QALYs), a common measure of effectiveness used in cost-utility analyses (CUA) ¹⁴. CUA is a common approach used in health economic evaluations to inform and support decision making ¹⁵. CUA is preferred over cost-effectiveness analysis (CEA) by many health economic evaluation entities, as CUA allows for comparisons across different health interventions and diseases, and incorporates more aspects of health and well-being ^{15,16}.

Several outcome measures can be used in CUA, including disability-adjusted life-years (DALYs), health-adjusted life years (HALYs), healthy years equivalent (HYE) and QALYs ¹⁴. QALYs, one of the most commonly used outcomes, combines HSUs with survival time. The HSU scale ranges from 0 (corresponding to death) to 1 (corresponding to perfect health), with negative values representing states worse than death ¹⁴.

Preference-based measures for health outcomes are used to estimate HSUs with a pre-scored multi-attribute health status classifications system ^{14,17,18}. However, generic preference-based measures are not often used in clinical trials of new therapies and it is more common that a non-preference-based measure is adopted to measure the health status of interest. In this case, mapping or cross-walking from non-preference-based measure to preference-based measure can be used to statistically estimate the HSUs ^{14,18-21}. In recent times, many mapping models have been developed to estimate HSUs. These models use a range of statistical methods, including ordinary least squares, two-part models, ordinal logit or multinomial logit regression models, cart analysis, and the Censored Least Absolute Deviation Model (CLAD) ¹⁸.

Whilst HSUs are essential for CUA, they are lacking in most low and middle-income countries (LMCIs) including sub-Saharan Africa, largely because preference-based measures have not been included in data collections ²². In addition, the absence of algorithms/value sets has been a further barrier ²². In such situations, algorithms/value sets from similar populations have previously been adopted as proxies for more precise local utilities ^{10,21,23,24}.

To achieve the Universal Health Coverage and the Sustainable Development Goal three on health, Ghana has identified the need to improve the quality and efficiency in its healthcare services to provide fair and equitable access to health ^{25,26}. However, the lack of parameters including those to measure effectiveness has been a major challenge hindering the course of conducting health economic evaluations in the population ²⁷. Hence the need to develop these parameters. Our study aims to address one aspect of this, by providing HSU estimates for both

the general population of Ghana and for BMI categories. HSU data for the general population can be used across a broad range of health economic evaluations in Ghana and similar countries that lack such data. This can be particularly useful when evaluating new interventions for which short-term trial data is available. As many health economic evaluations adopt medium- to long-term time horizons, estimates of general population HSUs can be used for the period following the trial. For example, in a cost-effectiveness analysis of intensive versus standard blood-pressure control [28](#), long-term HSUs were based on general population HSUs from the Medical Expenditure Panel Survey. Also, in the cost-effectiveness analysis of screening for osteoporosis in Chinese women, the age-specific HSUs for the female general population were retrieved from the National Health Services Survey 2008—a population-wide survey for the comparator [29](#). As such, the HSUs reported in this study will be critical to future health economic evaluations in the Ghanaian population. Thus, our estimated HSUs are intended for use in a range of health economic models including that which will simulate progression through the BMI health states to assess the impact of changing prevalence on clinical and economic outcomes.

HSUs may differ based on factors such as age, sex and BMI status [10,30,31](#). Generating these HSUs could differentiate the quality-of-life of men and women across different ages and BMI categories, and hence improve the accuracy of the cost-effectiveness results. Thus, our study aims to derive the first age and sex-specific HSUs and HSUs stratified by weight status (i.e. healthy weight, overweight, obese) for Ghanaian adults. Additionally, we examine the extent to which HSUs are associated with overweight and obesity.

Methods

Study Population

Data for persons aged ≥ 18 years from Wave 2 of the World Health Organization's Study on global AGEing and adult health (WHO SAGE) in Ghana were used [32,33](#). Briefly, SAGE collected individual-level data from nationally representative households of adults using a stratified, multistage cluster design. The primary sampling units (PSUs) were stratified by region and location of residence (urban/rural) with samples selected from 250 enumeration areas. This study utilized responses from the individual questionnaire in the individual dataset. WHO SAGE was approved by the WHO Ethics Review Committee (reference number RPC149) with local approval from the University of Ghana Medical School Ethics and Protocol Review Committee (Ghana). Further information on WHO SAGE can be found at <http://www.who.int/healthinfo/sage/cohorts/en/>.

Of the 4,735 survey respondents, 229 had missing data for height, 227 for weight and 207 for one or more EQ-5D-5L dimensions. Also, biologically implausible values (BIV) (height < 100 cm or > 250 cm and weight < 30.0 kg or > 250.0 kg) were excluded using listwise deletion [34,35](#). A total of 229 (4.8%) respondents who had missing data and 25 (0.005%) with biologically implausible values were excluded from the analyses. As the focus of this study was on those with high BMI, those who were underweight (weighted proportion=7%) were excluded from our analyses. In total, 16% of observations were excluded from the analyses. Consequently, 3,966 (84%) participants who had complete responses were included in the final estimation sample for this study.

Variables

Outcome Variable: Health State Utilities (HSUs)

Ideally, the collection of primary data using a preference-based measure is used to calculate HSUs. However, preference-based measures have not been used in large population surveys in Ghana: the WHO SAGE employed the WHOQOL-100, a non-preference-based measure. The items on the WHOQOL-100 have been used in more than 100 studies worldwide to measure quality of life ³⁶. However, WHOQOL-100 is a non-preference-based instrument and HSUs cannot be directly calculated. To calculate HSUs, a two-step approach was used. First, using a judgement-based method ^{13,20,37}, items from the WHOQOL-100 questionnaire in the WHO SAGE individual questionnaire were mapped onto the European Quality-of-Life (EQ-5D-5L), a preference-based measure (Appendix 1). Second, according to the responses in the WHOQOL-100, we assigned a HSU for each individual using the EQ-5D-5L scoring algorithm.

A valid judgement-based mapping could be achieved in one of two ways ²⁰: first, the dimensions of the preference-based measure must be included in the source measure, e.g., survey, and items must correspond to those of the preference-based measure. The mapping could be conducted using the dimensions or items. Another approach is to choose specific health states described in the source measure and assign them onto a generic health state descriptive system or the preference-based measure. Due to the subjectivity associated with this method ²⁰, and structural challenges especially, when response levels are condensed, empirical mapping methods ¹⁴ are preferred. However, the ‘judgement-based’ method of mapping is a useful alternative to generate HSUs where a non-preference-based measure is the only measure included in a study, as in the case of WHO SAGE. Despite the usefulness of the ‘judgement-based mapping’ in such conditions, this method should not supersede the empirical methods of mapping when data are available from both preference and non-preference-based

measure for the same population, and this weakness should be considered when interpreting our results.

The EQ-5D-5L instrument is a simple and widely used generic preference-based measure used to estimate HSUs. The EQ-5D-5L comprises five domains: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression, with five response options ³⁸ (1 for no problems, 2 for slight problem, 3 for moderate problems, 4 for severe problems and 5 for extreme problems/unable to perform activity). The WHOQOL-100 instrument is an international, cross-cultural comparable tool that covers 24 facets hierarchically organized within six domains including physical, psychological, level of independence, social relationships, environment and spirituality, with an additional facet representing overall quality of life and health. For each item under the domains, five response options are available (1 for none or no problem, 2 for mild, 3 for moderate, 4 for severe and 5 for extreme) ³⁶. Under the domains, there are items that address mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Thus, the EQ-5D-5L and WHOQOL-100 have domains and response items that closely correspond to each other.

The EQ-5D-5L responses were mapped with 1 through 5 corresponding to 1 through 5 on the WHOQOL-100 item responses. We were then able to assign values/utility weights derived from the EQ-5D-5L value set. Judgement-based mapping of the WHOQOL-100 items to EQ-5D-5L was advantageous because each WHOQOL-100 item had five level responses that corresponded directly to the responses on the EQ-5D-5L. Furthermore, use of the EQ-5D-5L instead of the EQ-5D-3L had the advantage of reducing the ceiling effect and improved the discriminatory effect ^{39,40}. In addition, aside from mapping closely corresponding questions from both instruments, directly mapping five-level WHOQOL-100 to five-level EQ-5D-5L rather than condensing the WHOQOL-100 five level responses to match the EQ-5D-3L three level responses helps to overcome any structural and response rating challenges ^{13,37}. We used

the Zimbabwe EQ-5Q-5L value set and the calculator from the EuroQol Group's crosswalk project ⁴⁰ as Ghana currently does not have its own dataset.

Explanatory and other variables

The main explanatory variables were overweight and obesity with normal weight as the base category. In the WHO SAGE, anthropometric measurements of body weight and height of respondents were taken using standard protocols ³². BMI were categorised according to WHO classifications as follows: normal BMI: BMI=18.50 to ≤ 25.00 kg/m²; overweight: BMI=25.00 to ≤ 30.00 kg/m²; and obesity: BMI ≥ 30.00 kg/m² ⁴.

Covariates were included based on previous literature ^{10,41} and these included age, sex, educational level, marital status, locality (rural/urban), household wealth status, smoking status and having been diagnosed with a chronic disease.

Statistical Analysis

Accounting for the post-stratified person's weight, age-, sex- and BMI-specific mean HSUs were generated using the Zimbabwe EQ-5D-5L value set. Sampling weights provided in the WHO SAGE data were used ³³. Univariable and multivariable survey linear regression models were used to examine the association between HSUs and high BMI using normal weight as the reference category ⁴². A two-tailed *p*-value <0.05 was considered as statistically significant. All statistical analyses were conducted using STATA version 15.0 (Stata Corp., College Station, Texas, USA).

Ethics approval and consent to participate

The WHO SAGE study was approved by the WHO's Ethical Review Board and the University of Ghana Medical School Ethics and Protocol Review Committee in Ghana ³³. Therefore, the authors were not required to obtain a separate ethics approval for this study. We used the GhanaINDDataW2 and the SAGE Individual Questionnaire. All files are available from the WHO database.

Results

The sample used in the analyses comprise 3,966 adults aged 18-110 years (84% of the total sample). Sampling weights were applied throughout the analyses. HSUs could not be calculated for 207 respondents who had missing data for one or more EQ-5D-5L dimensions. Of the 207 respondents, 31% were female, 10% obese, 38% overweight and 65% were aged below 50 years. In the final sample of 3,966 adults, the mean (standard deviation) age was 40.2 (14.9) years, and BMI was 25.1 (5.1) kg/m². Most respondents resided in urban areas (52%), were female (55%), had normal BMI (59.5%), with low education (60%) and were from households with the highest level of wealth (28.4%) (Table 1). Table 2 shows the proportion who reported problems for each level of the five EQ-5D-5L domains for the BMI categories. Around one-fifth of the sample respectively reported they experienced slight pain/discomfort (21.9%) and slight anxiety/depression (17.7%). Few respondents reported any problems in the self-care domain. In all, 44% of males and 56% of females reported no problems across all EQ-5D-5L health domains.

Age- and BMI-specific mean HSUs stratified by sex and for the population are presented in Table 3. The mean HSU (95% confidence interval) for the population was 0.856 (95% CI: 0.850, 0.863), 0.866 (95% CI: 0.858, 0.874) for males and 0.849 (95% CI: 0.841, 0.856) for females. In general, while HSUs were slightly higher for persons who were overweight compared to normal weight and higher as household wealth increased, HSUs were lower for females, obese participants and decreased with age. In univariable analysis, factors that were significantly associated with HSU were obesity, sex, age, marital status, household wealth and being diagnosed with a chronic disease (Table 4). These factors were then used in the multivariable regressions. Whilst the inclusion of these variables attenuated the coefficients for the obesity categories, they remained statistically significant. Other factors also remained significantly associated with HSU in the multivariable analysis. Being obese was associated

with significantly lower HSU ($\beta = -0.024$; 95% CI: -0.037, -0.011) while overweight was associated with higher HSU, however, this was not statistically significant. HSUs for females were 0.011 (95% CI: 0.003, 0.020) lower than for males; and higher in those with moderate, high or higher household wealth compared to those within the lowest income quintiles.

Discussion

For the Ghanaian population, few studies have focused on finding the effect of BMI on HRQoL, and to-date, no studies have generated age and sex-specific HSUs and HSUs stratified by weight status or studied the extent to which HSUs are associated with high BMI [2.43.44](#). However, in most low and middle income countries, particularly in sub-Saharan Africa, increasing prevalence of obesity has been reported, which in turn, is a major risk factor for NCDs [45-47](#). The lack of HSUs for the population underscores the difficulties in conducting economic evaluations to support the effective prioritization of health programmes or health technology assessments within the Ghanaian as well as other sub-Sahara African populations. This study bridges this gap by generating age and sex-specific HSUs and HSUs by weight status; and examining the associations between HSUs and high BMI in a sub-Sahara African setting. Most importantly, the weighted age- and sex-specific HSUs can be used to calculate QALYs, which may be used for economic evaluations for the Ghanaian context. Additionally, HSUs generated by weight status can be used to support cost-effectiveness evaluations of measures, policies or interventions to address overweight/obesity in this setting.

In this study, around two-fifths of respondents reported slight problems with pain/discomfort or anxiety/depression, and the least problems were reported for self-care. We found that HSUs were significantly lower in persons who were obese compared to normal weight, females compared to males, and in older ages compared to younger age groups. In addition, HSUs were significantly higher for respondents who were single compared to married and higher as household wealth increased. While the association was not significant, the results showed that HSUs were positively associated with overweight in the population. HSUs were also not significantly associated with respondents' education, place of residence, smoking or having a chronic disease.

In most countries where HSUs have been calculated, mean individual HSUs were slightly lower than our study reported [10,30,31](#). We found a strong negative association between HSU and obesity; controlling for other factors made only a small difference. Our findings of lower HSUs for obese respondents and for older respondents are consistent with previous studies [9,10,31,41,48,49](#). However, contrary to findings in previous studies, we found that both the unadjusted and adjusted HSUs for overweight were higher compared to normal BMI, although this was not significant [10,30,31](#).

The negative associations found between HSU and obesity but not overweight may be an effect of general awareness of the health consequences of obesity [50](#). In most settings in low and middle income countries like Ghana, the recognition of high BMI as a public health problem is a more recent phenomenon [2](#), however the burden associated with this may have existed over a longer period. Just like in most developing countries, to some people in Ghana, high BMI may be considered as beautiful and as a sign of affluence [5,6](#), despite the associations with many chronic diseases and reduced life expectancy. Whilst recent improvements in public health activities have likely increased awareness around the health problems associated with overweight and obesity, addressing these societal norms will be a critical aspect of future public health initiatives.

The key strength of this study is the attempt to generate age and sex-specific HSUs, as well as HSUs by weight status, and to determine the associations between HSU and high BMI for the Ghanaian population. The set of age and sex-specific HSUs that we have generated can be used to calculate QALYs for CUA in the general Ghanaian population, and in similar sub-Saharan countries. Specifically, the BMI-specific HSUs can be used to calculate QALYs for economic evaluations that are required to guide decision-making around policy, preventative and management measures for overweight/obesity in sub-Saharan Africa. Instead of condensing the WHOQOL-100 responses and mapping onto the EQ-5D-3L responses, we used

“judgement-based” mapping for the WHOQOL-100 five-level responses to the EQ-5D-5L, an instrument which reduces ceiling and floor effects ^{39,40}. We also used objectively measured weights and heights rather than self-reported. Although we used the most current population-based data to calculate HSUs - rarely available in sub-Saharan Africa - our study has several limitations. First, we used a non-preference-based instrument (WHOQOL-100) to indirectly estimate HSUs. Employing mapping models is the second-best method to obtain utility values. In the WHO SAGE, as only a non-preference-based instrument was implemented during data collection, we used the “judgement-based” method to map items and responses to the EQ-5D-5L; this may reduce the precision of the HSUs obtained. Our results only serve as interim results HSUs that will be useful in cost-utility analyses in the Ghanaian population. To provide more reliable HSUs, we recommend that future studies use direct HSU elicitation methods or preference-based measures to generate a better population HSUs in Ghana. The second limitation is the use of the Zimbabwe value set as the surrogate. The Zimbabwe EQ-5D-5L value set was derived from the existing EQ-5D-3L which was based on data collected from 2,488 high-density urban dwellers in 2000 ^{40,51}. Due to the differences in economic and political environment between Ghana and Zimbabwe ⁵² both of which may affect health outcomes in the populations, the preference weights might vary. Health states valued differently in the Ghanaian population will result in biased HSUs in our study. However, this value set was used as the characteristics of this population are much closer to that of the Ghanaian population in comparison to other existing value sets. Finally, the WHO SAGE data is cross-sectional, therefore we could not estimate the effect of changes in high BMI and subsequent HSUs. Although the data are representative of the older adult Ghanaian population, as we omitted participants with missing anthropometric or EQ-5D-5L dimensions data, we may have introduced selection bias. However, missing data accounted for less than 5% of the total sample ⁵³ and our use of sampling weights in the analyses reduced the potential for selection bias.

Despite these limitations, we have used the most robust statistical methods available to generate HSUs for the population. QALYs, an important outcome measure recommended by national bodies such as National Institute for Health and Care Excellence (NICE), can be estimated by combining HSU and survival/life expectancy. In turn, these QALYs can be used in CUA. Until a population-based study is conducted to determine HSUs for the Ghanaian population, these estimates can provide baseline HSUs for use in future CUA for Ghana.

In conclusion, our study provides age and sex-specific HSUs, and HSUs by weight status, and investigates associations between HSU and high BMI. We found HSUs to be negatively associated with obesity, to be lower among females, and lower amongst those of older age. The age and sex-specific HSU can be used to calculate QALYs which may be used for a range of health economic evaluations for the population. The study also provides HSUs by weight status, which will be important in studies to evaluate the cost-effectiveness of preventative and management actions for overweight and obesity.

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Table 1. Summary statistics of study participants in WHO-SAGE Wave 2 (2014/15)

Number of participants		3966
BMI (kg/m ²)		25.1 (5.1)
BMI Categories	Normal BMI	59.5
	Overweight	26.6
	Obese	13.9
Age, y		40.2 (14.9)
Sex	Males	44.8
	Females	55.2
Age (years)	18-49	77.8
	50-64	15.0
	65+	7.2
Education status	Low	60.1
	High	39.9
Marital status	Married/cohabiting	59.5
	Divorced/separated	15.5
	Single	25.0
Place of residence	Rural	47.9
	Urban	52.1
Household wealth quintile	Lowest	10.6
	Low	17.0
	Moderate	19.0
	High	25.0
	Highest	28.4
Smoking	Never smoked	94.7
	Quitted smoking	2.0
	Currently smokes	3.3
Diagnosed with chronic disease	No	91.9
	Yes	8.1

All values are weighted. Data are mean (standard deviation) for continuous variables and percentages for categorical variables. BMI denotes body mass index calculated as weight in kilograms divided by squared height in meters; total physical activity (minutes per week).

Table 2: EQ-5D-5L dimensions (%) stratified by BMI categories in the Ghanaian adult population (2014/15)

EQ-5D-5L Profiles	Normal Weight	Overweight	Obese	Total
n	2468	960	538	3966
Mobility				
No Problem	80.5	85.0	78.4	81.4
Slight Problem	14.0	10.7	14.0	13.1
Moderate Problem	4.2	3.4	5.5	4.2
Severe Problem	1.2	1.0	2.1	1.3
Unable to do	0.2	0.0	0.2	0.1
Self-Care				
No Problem	88.3	93.8	93.8	90.2
Slight Problem	9.5	5.2	5.2	8.0
Moderate Problem	1.9	0.7	0.7	1.5
Severe Problem	0.1	0.1	0.1	0.2
Unable to do	0.1	0.1	0.1	0.1
Usual Activity				
No Problem	79.0	83.7	81.5	80.6
Slight Problem	14.5	9.8	9.4	12.5
Moderate Problem	4.9	4.5	6.8	5.1
Severe Problem	0.7	0.5	0.7	0.6
Unable to do	1.0	1.4	1.7	1.2
Pain/Discomfort				
No Problem	67.8	71.1	59.0	67.4
Slight Problem	22.7	19.5	22.9	21.9
Moderate Problem	7.7	6.9	14.4	8.4
Severe Problem	1.4	2.2	3.6	1.9
Unable to do	0.3	0.3	0.2	0.3
Anxiety/Depression				
No Problem	72.5	78.6	77.1	74.8
Slight Problem	19.8	14.3	15.5	17.7
Moderate Problem	6.7	6.4	4.6	6.3
Severe Problem	0.9	0.7	4.6	1.1
Unable to do	0.2	0.0	0.2	0.1

All are weighted estimates

Table 3: Age- and Sex-specific health state utilities (HSUs) using EQ-5D-5L in the adult population of Ghana

Age Groups (years)	Males HSU (SD)				Females HSU (SD)				Total Mean HSU (SD)			
	(95% CI)				(95% CI)				(95% CI)			
	Normal weight	Overweight	Obese	Total	Normal weight	Overweight	Obese	Total	Normal weight	Overweight	Obese	Total
Total	0.866 (0.089) (0.857, 0.875)	0.867 (0.081) (0.853, 0.881)	0.849 (0.099) (0.815, 0.941)	0.866 (0.088) (0.858, 0.874)	0.852 (0.092) (0.841, 0.861)	0.857 (0.081) (0.849, 0.866)	0.831 (0.096) (0.815, 0.847)	0.849 (0.090) (0.841, 0.856)	0.860 (0.091) (0.852, 0.867)	0.861 (0.081) (0.853, 0.869)	0.834 (0.097) (0.818, 0.849)	0.856 (0.090) (0.850, 0.863)
18-29	0.895 (0.064) (0.884, 0.906)	0.904 (0.022) (0.895, 0.913)	0.900 (*) (*)	0.896 (0.059) (0.887, 0.906)	0.881 (0.072) (0.864, 0.898)	0.890 (0.040) (0.879, 0.901)	0.892 (0.031) (0.881, 0.903)	0.885 (0.096) (0.875, 0.896)	0.889 (0.068) (0.878, 0.899)	0.894 (0.036) (0.886, 0.902)	0.893 (0.029) (0.883, 0.903)	0.890 (0.060) (0.883, 0.898)
30-39	0.891 (0.062) (0.875, 0.907)	0.879 (0.068) (0.841, 0.918)	0.861 (0.061) (0.786, 0.935)	0.886 (0.064) (0.872, 0.901)	0.870 (0.067) (0.854, 0.887)	0.875 (0.048) (0.862, 0.889)	0.844 (0.094) (0.804, 0.884)	0.866 (0.070) (0.853, 0.879)	0.879 (0.066) (0.867, 0.891)	0.877 (0.055) (0.862, 0.892)	0.847 (0.090) (0.811, 0.882)	0.873 (0.068) (0.863, 0.884)
40-49	0.857 (0.090) (0.839, 0.875)	0.876 (0.065) (0.853, 0.899)	0.875 (*) (*)	0.863 (0.082) (0.849, 0.878)	0.855 (0.083) (0.835, 0.876)	0.856 (0.078) (0.837, 0.876)	0.833 (0.072) (0.809, 0.856)	0.848 (0.078) (0.835, 0.862)	0.856 (0.087) (0.842, 0.871)	0.865 (0.073) (0.849, 0.881)	0.838 (0.070) (0.815, 0.861)	0.856 (0.080) (0.845, 0.867)
50-59	0.837 (0.097) (0.821, 0.852)	0.840 (0.094) (0.813, 0.866)	0.797 (0.162) (0.722, 0.871)	0.834 (0.102) (0.819, 0.850)	0.807 (0.101) (0.792, 0.823)	0.805 (0.103) (0.786, 0.825)	0.795 (0.105) (0.772, 0.818)	0.804 (0.103) (0.792, 0.815)	0.824 (0.099) (0.812, 0.836)	0.821 (0.100) (0.804, 0.839)	0.796 (0.118) (0.772, 0.819)	0.818 (0.104) (0.807, 0.829)
60-69	0.822 (0.101) (0.809, 0.836)	0.815 (0.102) (0.783, 0.847)	0.832 (0.130) (0.764, 0.899)	0.821 (0.102) (0.807, 0.834)	0.793 (0.107) (0.775, 0.810)	0.802 (0.096) (0.782, 0.823)	0.754 (0.132) (0.708, 0.800)	0.786 (0.112) (0.769, 0.803)	0.809 (0.1104) (0.797, 0.821)	0.809 (0.099) (0.790, 0.828)	0.764 (0.134) (0.721, 0.808)	0.803 (0.109) (0.790, 0.816)
70+	0.763 (0.134) (0.743, 0.782)	0.729 (0.176) (0.669, 0.789)	0.715 (*) (*)	0.766 (0.142) (0.736, 0.775)	0.737 (0.132) (0.719, 0.756)	0.733 (0.149) (0.701, 0.765)	0.710 (0.187) (0.654, 0.766)	0.733 (0.144) (0.716, 0.750)	0.750 (0.133) (0.735, 0.764)	0.732 (0.158) (0.702, 0.761)	0.711 (0.218) (0.662, 0.760)	0.743 (0.143) (0.729, 756)

All are weighted estimates

(*), data in this age group were not enough to estimate standard deviation and confidence intervals. The sub-sample for obese males in age group 18-29 years (n=1), 40-49 years (n=7) and 70+ years (n=13).

Table 4: Multivariable regression estimates (β) and 95% confidence intervals (CI) of association between HSU and categories of BMI and other covariates in Ghanaian adults, 2014/15

		Univariable		Multivariable	
		β (95% CI)	<i>p</i> value	β (95% CI)	<i>p</i> value
BMI Categories	Normal BMI	Reference		Reference	
	Overweight	0.002 (-0.008, 0.011)	0.720	0.003 (-0.006, 0.012)	0.479
	Obese	-0.026 (-0.042, -0.010)	0.002	-0.024 (-0.037, -0.011)	<0.001
Sex	Males	Reference		Reference	
	Females	-0.017 (-0.026, -0.008)	<0.001	-0.011 (-0.020, -0.003)	0.009
Age (years)	18-49	Reference		Reference	
	50-64	-0.056 (-0.066, -0.046)	<0.001	-0.047 (-0.057, -0.036)	<0.001
	65+	-0.113 (-0.124, -0.100)	<0.001	-0.101 (-0.114, -0.087)	<0.001
Education status	Low	Reference		Reference	
	High	0.026 (0.017, 0.035)	<0.001	0.007 (0.001, 0.016)	0.099
Marital status	Married/cohabiting	Reference		Reference	
	Divorced/separated	-0.019 (-0.032, -0.006)	0.004	0.006 (-0.004, 0.016)	0.261
	Single	0.043 (0.034, 0.053)	<0.001	0.026 (0.016, 0.036)	<0.001
Place of residence	Rural	Reference		Reference	
	Urban	0.011 (-0.002, 0.023)	0.092	-0.001 (-0.014, 0.012)	0.878
Household wealth quintile	Lowest	Reference		Reference	
	Low	0.015 (-0.004, 0.034)	0.131	0.015 (-0.004, 0.033)	0.119
	Moderate	0.021 (0.002, 0.040)	0.026	0.020 (-0.003, 0.038)	0.025
	High	0.033 (0.014, 0.053)	0.001	0.028 (0.009, 0.048)	0.004
	Highest	0.039 (0.019, 0.059)	<0.001	0.035 (0.015, 0.057)	0.001
Smoking	Never smoked	Reference		Reference	
	Quitted smoking	-0.008 (-0.036, 0.019)	0.543	0.010 (-0.016, 0.035)	0.462
	Currently smokes	-0.014 (-0.049, 0.020)	0.416	-0.010 (-0.046, 0.026)	0.580
Diagnosed with chronic disease	No	Reference		Reference	
	Yes	-0.043 (-0.062, -0.023)	<0.001	-0.015 (-0.032, 0.001)	0.068
CONS		-	-	0.847 (0.828, 0.867)	

Appendix

Appendix 1: Mapping from WHOQOL-100 items in WHO SAGE Health State Descriptions to EQ-5D-5L

WHOQOL-100 questions in WHO SAGE	Overall in the last 30 days, how much difficulty did you have...?	EQ5D-5L	Which statement best describes your health state today?
Q2002. ...how much difficulty did you have with moving around?		Mobility	
	1 None	1	I have no problems in walking about
	2 Mild	2	I have slight problems in walking about
	3 Moderate	3	I have moderate problems in walking about
	4 Severe	4	I have severe problems in walking about
	5 Extreme/Cannot do	5	I am unable to walk about
Q2004. ...how much difficulty did you have with self-care, such as bathing/ washing or dressing yourself?		Self-Care	
	1 None	1	I have no problems washing or dressing myself
	2 Mild	2	I have slight problems washing or dressing myself
	3 Moderate	3	I have moderate problems washing or dressing myself
	4 Severe	4	I have severe problems washing or dressing myself
	5 Extreme/Cannot do	5	I am unable to wash or dress myself
Q2039. ...how much difficulty did you have in your day to day work		Usual Activities (e.g., work, study, housework, family or leisure activities)	
	1 None	1	I have no problems doing my usual activities
	2 Mild	2	I have slight problems doing my usual activities
	3 Moderate	3	I have moderate problems doing my usual activities
	4 Severe	4	I have severe problems doing my usual activities
	5 Extreme/Cannot do	5	I am unable to do my usual activities
Q2007. ...how much bodily aches or pains did you have?		Pain/Discomfort	
	1 None	1	I have no pain or discomfort
	2 Mild	2	I have slight pain or discomfort
	3 Moderate	3	I have moderate pain or discomfort
	4 Severe	4	I have severe pain or discomfort
	5 Extreme/Cannot do	5	I have extreme pain or discomfort
Q2019. ...how much of a problem did you have with worry or anxiety?		Anxiety/ Depression	
	1 None	1	I am not anxious or depressed
	2 Mild	2	I am slightly anxious or depressed
	3 Moderate	3	I am moderately anxious or depressed
	4 Severe	4	I am severely anxious or depressed
	5 Extreme/Cannot do	5	I am extremely anxious or depressed