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RESEARCH

Predisposing, enabling, and need factors influencing health-related quality of life among people with metabolic syndrome

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ABSTRACT

Background: Metabolic syndrome (MetS) continues to impact the health-related quality of life (HRQoL) of patients despite various available therapeutic interventions. There is a dearth of information on how patient-centered factors holistically predict HRQoL to provide more insights on addressing MetS.

Objective: To predict the HRQoL of patients with MetS in the Southern states, using the predisposing, enabling, and need factors.

Methods: The study adopted a cross-sectional approach in collecting 706 complete surveys on HRQoL assessment using the EQ-5D-5L survey and demographic characteristics based on the predisposing, enabling, and need factors of Andersen's Behavioral model. The study focused on people with MetS in the southern states of the United States. Multinomial logistic regression was conducted to investigate the relationship between the number of comorbidities and each HRQoL dimension. Ordinal regression was used to explore factors predicting HRQoL. Sensitivity analysis was conducted using bootstrapping analysis to evaluate the regression's robustness.

Results: Over 70% were females and 30% had at least a bachelor's degree, while 47% were married. Most respondents (71.1%) had no problem with self-care. However, 20.0% had severe problems with pain, while the highest proportion (8.6%) was observed for extreme problems with anxiety or depression. A unit increase in comorbidities resulted in higher odds of having extreme problems with mobility (odds ratio [OR] = 1.95), usual activities (OR = 1.73), and pain (OR = 1.70). Only 40.8% of the respondents had good HRQoL, compared to 26.2% with poor HRQoL. Age, race, geographical area, marital status, household income, number of prescription drugs, comorbidities, and body mass index were predictors of HRQoL.

Conclusion: An increase in comorbidities significantly increased the odds of having challenges with the HRQoL dimensions. Demographic, socioeconomic, and health-related factors significantly predicted HRQoL. Therefore, health care providers must consider these factors as a component of patient-centered care to address health disparities and promote optimal health outcomes among people with MetS.

Obesity remains a substantial health concern with tremendous impacts on morbidity, mortality, and the cost of health care,[1,2] as well as increasing the likelihood of developing metabolic syndrome (MetS).[3,4] MetS, on the other hand, is a cluster of related metabolic abnormalities such as hypertension, obesity, insulin resistance, atherogenic dyslipidemia, and

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Data availability: The datasets and the studying findings are available with the corresponding author and are assessable on request.

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Key Points

Background:

- People with metabolic syndrome (MetS) are likely to have low health-related quality of life (HRQoL).
- Obesity and MetS have a negative impact on psychological and physical well-being.
- Age, gender, education, and employment status have been individually identified to influence HRQoL of people with MetS.

Findings:

- A unit increase in the number of comorbidities among people with metabolic syndrome (MetS) causes a higher and significant increase in the odds of having health-related challenges with mobility, self-care, usual activities, pain or discomfort, and anxiety or depression.
- Only 4 in 10 people with MetS have good health-related quality of life (HRQoL) in the Southern states of the United States.
- Predisposing, enabling, and need factors holistically predict the HRQoL of people with MetS.
- Age, race, geographical area, marital status, household income, number of prescription drugs, comorbidities, and body mass index are significant predictors of HRQoL.

atherosclerosis,[5] significantly increasing mortality rate as a result of cardiovascular disease, vascular dysfunction, and all other causes of death.[6,7] The prevalence of MetS has been on the increase.[8-10] For instance, the prevalence was 34.7% in 2016[9] and has increased to 39.9% in 2018[10] among adults in the United States. Despite the high prevalence, MetS remains more prevalent among people with obesity (PwO), as evidenced by the prevalence rate of 61.6% in 2020 in the US.[11] These findings reiterate that obesity is associated with MetS development, thus impacting health-related quality of life (HRQoL).[12-15] Consequently, impaired HRQoL among people with MetS may promote unfavorable health outcomes, including therapeutic failure, disease progression, and mortality.[16]

HRQoL is a valuable measure of an individual's overall well-being, encompassing physical and mental health and their impact on quality of life.[17] This multidimensional measure offers a comprehensive evaluation of disease impact, including the extent of burden from injuries and disabilities, and captures patients' perceptions of their health conditions on their physical, social, and psychological well-being.[18] Although metabolically unhealthy patients are considered to have a significant decrease in HRQoL's indicators,[19,20] studies have revealed that MetS patients scored worse on the physical, vitality, and mental dimensions of HRQoL measures than those without the syndrome, thereby indicating poorer physical HRQoL.[21-24] This finding is further substantiated by evidence highlighting obesity's significant impact on psychological well-being and MetS's detrimental impairment of the physical domain of HRQoL.[23,25]

Apart from the implication of MetS, factors such as the duration and severity of the health conditions negatively impact patients' HRQoL, indicating that health-related factors may play a critical role in their HRQoL.[26] In addition, sociodemographic factors, such as age, gender, education, and employment status, have also been individually identified to influence MetS individuals' HRQoL.[26-29] While these studies have identified these factors, there is a dearth of information available to holistically consider how multiple factors could predict the HRQoL of people with MetS. As a result of this research gap, we sought to assess respondents' HRQoL predictions using the predisposing, enabling, and need factors identified in Andersen's behavioral model (ABM). ABM explains how predisposing, enabling, and needs factors influence individuals' health status, such as customer satisfaction or HRQoL, with respect to access to health care services.[30] Predisposing factors are the sociodemographic characteristics that influence the likelihood of individuals' health conditions and decisions to use health care services.[31] Enabling factors, on the other hand, encompass economic-related determinants such as household income, employment status, savings, and health insurance status, influencing access to health care services.[30] Need factors include perceived health needs that influence the utilization of health care services.[30,31] These factors provide insights for understanding health care access and health outcomes. Therefore, employing these 3 ABM factors could establish an inclusive and holistic investigation of how HRQoL is impacted. We also believe that identifying the factors and predicting the HRQoL would help pharmacists and other health care providers have comprehensive knowledge about addressing cogent indicators to improve health status while implementing pharmacological interventions.

One of the study's objectives was to establish the relationship between MetS comorbidities and having problems with HRQoL dimensions. The second objective assessed the distribution of HRQoL across the respondents' demographics. The last objective was to build a proportional odds model (POM) to predict the HRQoL of people with MetS using predisposing, enabling, and need factors.

Methods

Study design

This study employed a cross-sectional quantitative research method from a population-based perspective, using an online, self-administered survey.

Study area and population

The study area encompassed adult individuals residing in the states in the Southern region of the US, including Washington, DC (Appendix 1), due to the higher prevalence of obesity and MetS in the regions.[1,32,33] The study population of interest was adult individuals with a body mass index (BMI) of at least 30 kg/m^2 suffering from at least two of the MetS, such as high blood pressure, myocardial infarction, hyperlipidemia, stroke, coronary heart disease, type-2-diabetes, insulin resistance, asthma, sleep apnea, cancer, infertility, or osteoarthritis.[5,34] Also, the eligible respondents must be at

least 45 years of age, considering that the median age of adults with MetS typically falls within the range of 44 to 47 years.[35,36]

Sample size and sampling

The study's sample size was calculated using G*Power software (version 3.1.9.7),[37,38] using parameters including a 0.15 effect size, a 0.05 significance level, and a 95% Z-score confidence interval. The sample size was 690 respondents, with an actual power of 0.95 and a critical F value of 3.01. The respondents were selected by sending screening questions on weight in pounds and height in feet and inches (used for calculating their BMI), age in years, diagnosis of at least two comorbidities, and informed consent forms to a database of Qualtrics panels in the Southern states and Washington, DC. Qualtrics panels represent the US patient-care settings and demographic coverage that reflects residence states, geographic areas (rural and urban), age, and gender.

Data collection

The study's data were collected using a self-administered electronic survey link distributed by the Qualtrics XM platform,[39] from April 21st through June 23rd, 2023. The survey was sent to over 4000 Qualtrics panel members, but 706 fully completed surveys were received from the respondents who fulfilled the inclusion criteria. All 4000 plus panel members responded to the survey, however, 4 inclusion criteria screening questions were used to prevent respondents from continuing the survey if they did not meet the inclusion criteria. There were no missing data. Prior to the launch of the data collection, pilot tests were conducted to identify and address possible issues that might arise. Also, the survey incorporated 2 attention-check questions to improve data quality. These were done to identify and filter disinterested responses, such as those not reading the questions attentively, hastily completing the survey, skipping questions, or randomly selecting answers. As a result, incomplete or misleading responses were removed to ensure the data's completeness.

Data collection tools

Respondents' HRQoL was evaluated by using the EQ-5D-5L survey, which assesses the 5 HRQoL dimensions such as mobility (walking), self-care (washing and dressing), usual activities (work, study, housework, family or leisure activities), pain/discomfort, and anxiety/depression.[40] The tool has a 5-point Likert scale in each dimension which includes "1 = no problems", "2 = slight problems", "3 = moderate problems", "4 = severe problems", and "5 = extreme problems" (Appendix 2). Respondents' demographic, economic, and health-related characteristics were assessed based on the predisposing, enabling, and need factors explained in the ABM.[30] The original responses to the 5 dimensions were summed up using the Level Sum Score method to achieve the HRQoL scores with minimum and maximum scores of 5 and 25, respectively.[41] There were 21 possible HRQoL scores, with the best possible HRQoL having 5, while a score of 25 represents the worst health state.[42] The higher the score, the worse the HRQoL.[42] Predisposing factors included the sociodemographic characteristics, such as age, gender, education (high school, associate or bachelor, or higher degree), marital status (single, separated, married, or widowed), geographical area (rural [<20,000 population] or urban [≥20,000 population] areas), and race (white or non-white).[31] Enabling factors included economic-related determinants such as annual household income (≤$40,000, $40,001 - $80,000, $80,001 or higher), employment status (stay-at-home caregiver, permanently disabled, unemployed, employed, and retired), and health insurance status.[30,43,44] Need factors included perceived health needs (number of comorbidities, number of prescription drugs, and BMI value).[31,45] These factors provide insights for understanding health care access and health outcomes.[30,43,44]

Study variables

The HRQoL category variable was used as the dependent variable. The independent variables included the predisposing (age, gender, education, marital status, race, and geographical area), enabling (employment status, annual household income, and health insurance coverage), and need (number of comorbidities, the number of prescription drugs, and BMI values) factors.

Statistical analysis

All analyses were conducted using the Statistical Package for the Social Sciences (SPSS 28),[46] while visualizations were done using the Microsoft Excel application.[47] All statistical analyses were conducted at a 0.05 significance level and a 95% confidence level. Frequency and percentage were used to present the proportions of respondents having certain degrees of problems with the EQ-5D-5L tool items. The distribution of the HRQoL dimensions was represented graphically. Then, multinomial logistic regression was conducted to investigate the impact of increasing comorbidities on the HRQoL dimensions, namely mobility, self-care, usual activities, pain or discomfort, and anxiety or depression, using "no problem" as the reference category.

Descriptive statistics were explored to describe the distribution of HRQoL scores across the demographics. Furthermore, the HRQoL scores were divided into 3 ordinal categories: poor, fair, and good HRQoL categories, based on previous studies,[48-51] to ensure a balanced distribution of respondents and enhance statistical robustness for ordinal logistic regression. Respondents with HRQoL scores ranging from 5 to 9 were classified as having good HRQoL, while those with scores between 10 and 13 were classified as having fair HRQoL. On the other hand, those with HRQoL scores of 14 and above were classified as having poor HRQoL. Frequency and percentage were used to present the proportions of respondents in each HRQoL category. A chi-square test also explored the distributions of the HRQoL categories across the respondents' demographic characteristics.

Also, ordinal logistic regression analysis was conducted to assess the POM for the HRQoL categories using the independent variables. The log-likelihood and Deviance goodness-of-fit significances were reported to determine the fitness of the model. Similarly, test of parallel lines significance was reported to evaluate the proportional odds assumption, positing that the relationship between each pair of outcome categories remains consistent.[52] Meanwhile, all the model's estimates for

Table 1
Descriptive statistics by demographic characteristics

Variables	Total	HRQoL scores	
	n (%)	Mean (SD)	Median
Age group			
45–64 y	484 (68.6)	11.6 (3.9)	11
Above the age of 65 years	222 (31.4)	9.9 (3.5)	9
Gender			
Male	204 (28.9)	10.1 (3.8)	9
Female	502 (71.1)	11.5 (3.9)	11
Education			
High school or lower	171 (24.2)	11.6 (3.9)	11
Some college-no/associate degree	321 (45.5)	11.4 (4.0)	11
Bachelor's or higher	214 (30.3)	10.2 (3.6)	9
Marital status			
Single (never married)	85 (12.0)	10.9 (3.9)	10
Single (separated/divorced)	204 (28.9)	11.9 (3.9)	12
Married or partnered	333 (47.2)	10.5 (3.7)	10
Widowed	84 (11.9)	11.6 (4.0)	11
Household income			
$40,000 or lower	347 (49.2)	12.1 (3.9)	12
$40,001 - $80,000	235 (33.3)	10.7 (3.7)	10
$80,001 or higher	124 (17.6)	9.1 (3.0)	8
Employment			
Stay-at-home caregiver	19 (2.7)	12.3 (4.7)	12
Permanently disabled	138 (19.5)	13.9 (3.7)	14
Unemployed	60 (8.5)	12.7 (3.6)	12
Employed	220 (31.2)	9.7 (3.3)	9
Retired	269 (38.1)	10.3 (3.6)	10
Race			
Non-White	158 (22.4)	10.4 (4.2)	9.5
Non-Hispanic White/Caucasian	548 (77.6)	11.3 (3.8)	11
Health insurance coverage			
No	42 (5.9)	11.8 (4.1)	11
Yes	664 (94.1)	11.0 (3.9)	10.5
Geographical area			
City/urban area (≥20,000 people)	429 (60.8)	11.0 (3.8)	11
Town/rural area (<20,000 people)	277 (39.2)	11.1 (4.1)	10

Abbreviation used: HRQoL, health-related quality of life.

each category of the independent variables were used to calculate the adjusted odds ratios (aOR) of belonging to any of the HRQoL categories. Lastly, sensitivity analyses were conducted with 5000 bootstrap samples to establish the stability and reliability of the logistic regression model's parameter estimates. The 95% bootstrap confidence intervals (CIs) were compared to that of the ordinal regression outcome to determine the robustness of the HRQoL predictors.

Ethical considerations

Ethical approval was obtained from Chapman University's Institutional Review Board with an approval number of Institutional Review Board-23-248. Informed consent was obtained from the respondents. Approval to use a proprietary survey from the EUROQoL management was also granted.

Results

Overall, 706 fully complete surveys were received and used for the analyses. A proportion of 68.6% of respondents were between 45 and 64 year old, compared to 31.4% who were 65 year old or older (Table 1). The proportion of female respondents was 71.1%. Only 30.3% had at least a bachelor's degree, while 45.5% had some college or associate degrees. Proportions of 49.2% and 17.6% earned $40,000 or less and $80,000 or more as their household income, respectively. A proportion of 38.1% were retired, and 31.2% were employed, while 19.5% were permanently disabled at the time of the study. A proportion of 77.6% belonged to the non-Hispanic white or Caucasian race, compared to 22.4% of non-white individuals. The proportions of respondents with high blood pressure and high cholesterol were 79.0% and 68.7%, respectively, while 38.4% and 7.6% had high blood sugar and insulin resistance, respectively (Appendix 2). The lowest proportion (4.7%) of respondents had infertility.

Figure 1 shows that 34.8% and 71.1% had no problem with usual activities and self-care, respectively, while only 8.6% had no problem with pain or discomfort. A total of 35% and 20.0% had moderate and severe problems with pain or discomfort, respectively. Meanwhile, 26.2% and 11.9% of the respondents had moderate and severe problems with anxiety or depression, respectively. The highest proportions of respondents with extreme problems were observed with pain/discomfort (7.5%) and anxiety/depression (8.6%) (Appendix 4).

The multinomial logistic regression analysis revealed a significant association between the number of comorbidities and the reported problem levels of the HRQoL dimensions

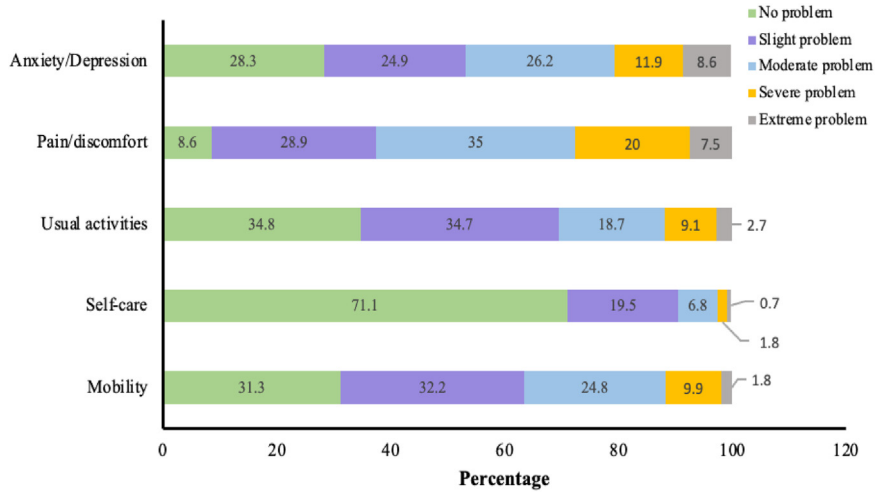

Figure 1. Distribution of HRQoL dimensions. Abbreviation used: HRQoL, health-related quality of life.

(Table 2). With each additional comorbidity, the odds of experiencing slight and moderate problems with mobility increased by 30% (OR = 1.30, $P = 0.002$) and 47% (OR = 1.47, $P < 0.001$), respectively. The effect was more pronounced for extreme mobility problems, with an increase in the odds by 95% (OR = 1.95, $P < 0.001$). Also, individuals with increasing comorbidities were more likely to report slight and moderate problems with self-care, with the odds increasing by 17% (OR = 1.17, $P = 0.038$) and 30% (OR = 1.30, $P = 0.016$), respectively. Furthermore, a unit increase in comorbidities reflected in a 42% (OR = 1.42, $P < 0.001$) increased odds of having slight problems with usual activities. Severe and extreme problems with usual activities were also significantly associated with the number of comorbidities, with a 67% (OR = 1.67, $P < 0.001$) and 73% (OR = 1.73, $P = 0.002$) increase in odds, respectively. Although not statistically significant, the odds of having a slight problem with pain or discomfort significantly increased by 32% (OR = 1.32, 95% CI = 0.98, 1.77).[53] However, moderate and severe pain or discomfort showed a significant 53% (OR = 1.53, $P = 0.004$) and 77% (OR = 1.77, $P < 0.001$) increase in odds per additional comorbidity. Lastly, respondents had a significant 17% and 27% increase in the odds of being slightly (OR = 1.17, 95% CI = 0.98, 1.39) and severely (OR = 1.27, $P = 0.006$) anxious or depressed with a unit increase in comorbidities.

The minimum and maximum HRQoL scores were 5 and 23, respectively, with a median 11. Approximately 41% of the respondents had good HRQoL, with a median score of 7, while 26.2% and 33.0% had poor and fair HRQoL, with median scores of 16 and 11, respectively (Table 3). The HRQoL category distribution across the demographic characteristics is represented in Table 4. More respondents who were at least 65 year old (55.4%) had good HRQoL compared to 34.1% of those below 65 year old. A proportion of 52.5% of male respondents had good HRQol, compared to 36.1% of females. Meanwhile, 50.9% with bachelor's or higher degrees had good HRQoL, compared to 32.7% with high school or less. Higher proportions of respondents with household incomes of more than $80,000 (62.9%) had good HRQoL, compared to 29.1% of those with $40,000 or lower. Also, 57.7% of employed, 20.0% of unemployed, and 11.6% of disabled respondents had good HRQoL. Only 38.1% of the white respondents had good HRQoL, while 50.0% of non-white respondents had good HRQoL.

The ordinal logistic regression analysis examined the factors influencing HRQoL across 3 ordered categories: poor, fair, and good HRQoL (Table 5). Age showed a positive association with HRQoL, as individuals aged 65 and above had 93% higher odds of having higher HRQoL than the 45-64 years reference group (aOR = 1.93, $P = 0.032$). Gender differences indicated that females had lower but insignificant ($P = 0.409$) odds of having higher HRQoL compared to males, with an adjusted odds ratio of 0.86. Race was a significant predictor, with non-white individuals having 66% (aOR = 1.66, $P = 0.009$) higher odds of higher HRQoL than white/Caucasian respondents. The geographical area also influenced HRQoL, with individuals living in the rural/town areas having 56% (aOR = 1.56, $P = 0.006$) higher odds of having higher HRQoL than those in the urban/city areas. Concerning marital status, single individuals (never married) were twice (aOR = 1.99, $P = 0.040$) as likely to have higher HRQoL compared to the widowed group. Household income was a significant factor, with respondents earning $80,001 or higher having over twice (aOR = 2.18, $P = 0.004$) the odds of higher HRQoL compared to those with $40,000 or lower household income. A unit increase in the number of prescription drugs and comorbidities is associated with a decrease in the odds of having higher HRQoL by 14% (aOR = 0.86, $P < 0.001$) and 16% (aOR = 0.84, $P = 0.008$), respectively. Lastly, there was a 4% (aOR = 0.96, $P < 0.001$) decrease in the odds of having higher HRQoL with a unit increase in the BMI. In summary, age, race, geographical location, marital status, household income, number of prescription drugs, comorbidities, and BMI were significant predictors of HRQoL. Meanwhile, the model's high chi-square value ($X^2 = 273.35$, $P < 0.001$) in the context of model fitting, combined with the Deviance goodness-of-fit ($X^2 = 1255.25$, $P = 0.996$), and the test of parallel lines ($X^2 = 16.63$, $P = 0.677$), demonstrates the robustness of the independent factors in predicting the HRQoL. Similarly, the sensitivity analysis, using the bootstrapping analysis, supports the robustness of the model (Appendix 5). The estimates' bias values were zero or

Table 2
Association between health-related quality of life dimensions and metabolic syndrome comorbidities

HRQoL dimensions	OR	*P* value	95% CI
Mobility (ref = No problem)			
Slight problem	1.30	0.002[a]	1.10, 1.54
Moderate problem	1.47	<0.001[a]	1.24, 1.75
Severe problem	1.46	<0.001[a]	1.17, 1.82
Extreme problem	1.95	<0.001[a]	1.34, 2.82
Self-care (ref = No problem)			
Slight problem	1.17	0.04[a]	1.01, 1.35
Moderate problem	1.30	0.02[a]	1.05, 1.61
Severe problem	1.04	0.86	0.66, 1.64[b]
Extreme problem	1.46	0.20	0.82, 2.61[b]
Usual activities (ref = No problem)			
Slight problem	1.42	<0.001[a]	1.20, 1.68
Moderate problem	1.71	<0.001[a]	1.42, 2.05
Severe problem	1.67	<0.001[a]	1.34, 2.09
Extreme problem	1.73	0.002[a]	1.22, 2.45
Pain/discomfort (ref = No problem)			
Slight problem	1.32	0.07	0.98, 1.77[b]
Moderate problem	1.53	0.004[a]	1.14, 2.04
Severe problem	1.78	<0.001[a]	1.31, 2.39
Extreme problem	1.70	0.002[a]	1.21, 2.38
Anxiety/depression (ref = No problem)			
Slight problem	1.17	0.08	0.98, 1.39[b]
Moderate problem	1.27	0.006[a]	1.07, 1.50
Severe problem	1.27	0.02[a]	1.03, 1.56
Extreme problem	1.23	0.09	0.97, 1.55[b]

Abbreviations used: OR, odds ratio; HRQoL, health-related quality of life.
[a] Significant at 0.05 level.
[b] Significant based on the confidence intervals' precedence.[62]

near zero, indicating that the parameters were similar to the outcomes of the ordinal regression and suggesting that the original estimates are likely to be very close to the true population parameters. Also, the 95% bootstrap CIs were similar to those in the original analysis, suggesting that model estimates were stable and reliable, increasing the confidence in the HRQoL predictors used in the model.

Discussion

The study findings highlighted the multidimensional impact of MetS, exploring demographic, economic, and health-related characteristics associated with HRQoL. Although less than 30% of the respondents with MetS showed challenges with self-care activities, such as washing and dressing, at least 60% indicated having slight to extreme problems with mobility, pain or discomfort, usual activities (work, study, housework, family, or leisure activities), and anxiety or depression, respectively. This information reiterates the fact that a higher burden of morbidities plays a significant role in physical and mental health dimensions, as indicated by studies that supported a significant negative impact on psychological well-being and the physical domain of well-being.[23,25] In addition to this, the study highlighted pain or discomfort and anxiety or depression as the dimensions with the highest proportion of respondents with severe and extreme problems, underscoring the complex interplay between physical and mental health dimensions.[54] Further analysis revealed a strong relationship between the increasing number of comorbidities and the odds of having health-related difficulties with the HRQoL dimensions.[55] This is evident in the fact that as the number of comorbidities increased, the increased likelihood of facing health-related problems may be due to a decrease in vitality and mental health.[21-24] While this might be true for individuals experiencing certain levels of problems with all the HRQoL dimensions, notable associations were observed between comorbidities and increased problems with mobility, usual activities, and pain or discomfort. This observation, thereby, suggests that individuals with multiple health conditions may be at a greater risk of diminished functional status, emphasizing the need for comprehensive health care interventions to address the disease burden and promote overall well-being.

Table 3
Distribution of health-related quality of life categories

HRQoL categories	n (%)	HRQoL scores	
		Mean (SD)	Median
Poor HRQoL	185 (26.2)	16.4 (2.2)	16
Fair HRQoL	233 (33.0)	11.4 (1.1)	11
Good HRQoL	288 (40.8)	7.4 (1.3)	7

Abbreviation used: HRQoL, health-related quality of life.

In addition, the study advances our understanding of the compound interplay between predisposing, enabling, and need factors and health status by building POM to predict respondents' HRQoL. Overall, the model has shown that predisposing factors such as age, race, geographical location, and marital status significantly predicted respondents' HRQoL, consistent with previous studies.[26,28,29,56,57] These factors underscore the significant implications of adopting a holistic approach to targeted and patient-centered interventions to improve these diverse populations' well-being. Although our study confirmed that older respondents had higher odds of having higher HRQoL, other studies reported that age had no relationship with HRQoL,[58] while others indicated that HRQoL worsened with increasing age.[59,60] This discrepancy may align with the fact that age often conveys wisdom and potentially a more stabilized perspective on life, which promotes adaptive coping strategies, healthy lifestyles, and therapeutic modifications, positively impacting overall well-being.[61] Regarding gender, females had lower odds of having a higher HRQoL despite studies showing that male patients were more likely to have poor HRQoL.[24,27,62] Nevertheless, a different study revealed that women were more likely to have poor HRQoL,[15] which was consistent with our findings. Also, white individuals had lower odds of having higher HRQoL than non-white respondents. However, these two observations could be attributed to female and white respondents having higher comorbidities than male and non-white respondents, impacting their well-being.[21,55] Furthermore, respondents residing in rural areas had higher odds of having higher HRQoL, which is quite different from previous literature.[63,64] One may argue that people living in urban regions may have more accessible health care and pharmacy services than those living in rural areas, which should have promoted their health status. Our study revealed that the reverse was the case, thereby suggesting further research. Overall, the findings suggest that gender, racial, and geographical context may play pivotal roles in influencing well-being and prompt a deeper exploration into the social and contextual determinants contributing to the observed disparities.

Table 4
Demographic distribution of health-related quality of life categories

Variables	Total	Poor HRQoL	Fair HRQoL	Good HRQoL	X^2 (*P* value)
	n (%)	n (%)	n (%)	n (%)	
Age group					31.38 (<0.001[a])
45 - 64 y	484 (68.6)	149 (30.8)	170 (35.1)	165 (34.1)	
Above the age of 65 years	222 (31.4)	36 (16.2)	63 (28.4)	123 (55.4)	
Gender					16.87 (<0.001[a])
Male	204 (28.9)	39 (19.1)	58 (28.4)	107 (52.5)	
Female	502 (71.1)	146 (29.1)	175 (34.9)	181 (36.1)	
Education					15.80 (0.003[a])
High school or lower	171 (24.2)	50 (29.2)	65 (38.0)	56 (32.7)	
Some college-no/associate degree	321 (45.5)	93 (29.0)	105 (32.7)	123 (38.3)	
Bachelor's or higher	214 (30.3)	42 (19.6)	63 (29.4)	109 (50.9)	
Marital status					19.59 (0.003[a])
Single (never married)	85 (12.0)	22 (25.9)	27 (31.8)	36 (42.4)	
Single (separated/divorced)	204 (28.9)	66 (32.4)	77 (37.7)	61 (29.9)	
Married or partnered	333 (47.2)	70 (21.0)	104 (31.2)	159 (47.7)	
Widowed	84 (11.9)	27 (32.1)	25 (29.8)	32 (38.1)	
Household income					54.64 (<0.001[a])
$40,000 or lower	347 (49.2)	119 (34.3)	127 (36.6)	101 (29.1)	
$40,001 - $80,000	235 (33.3)	55 (23.4)	71 (30.2)	109 (46.4)	
$80,001 or higher	124 (17.6)	11 (8.9)	35 (28.2)	78 (62.9)	
Employment status					113.69 (<0.001[a])
Stay-at-home caregiver	19 (2.7)	6 (31.6)	6 (31.6)	7 (36.8)	
Permanently disabled	138 (19.5)	72 (52.2)	50 (36.2)	16 (11.6)	
Unemployed	60 (8.5)	24 (40.0)	24 (40.0)	12 (20.0)	
Employed	220 (31.2)	29 (13.2)	64 (29.1)	127 (57.7)	
Retired	269 (38.1)	54 (20.1)	89 (33.1)	126 (46.8)	
Race					7.20 (0.027)
Non-White	158 (22.4)	36 (22.8)	43 (27.2)	79 (50.0)	
Non-Hispanic White/Caucasian	548 (77.6)	149 (27.2)	190 (34.7)	209 (38.1)	
Health insurance coverage					0.18 (0.92)
No	42 (5.9)	12 (28.6)	14 (33.3)	16 (38.1)	
Yes	664 (94.1)	173 (26.1)	219 (33.0)	272 (41.0)	
Geographical area					0.72 (0.70)
City/urban area (≥20,000 population)	429 (60.8)	117 (27.3)	138 (32.2)	174 (40.6)	
Town/rural area (<20,000 population)	277 (39.2)	68 (24.5)	95 (34.3)	114 (40.8)	

Abbreviations used: X^2, chi-square value; HRQoL, health-related quality of life.
[a] Significance at 0.05 level

Apart from the influence of the predisposing factors on HRQoL, the model also revealed that enabling factors such as the respondents' household income significantly contributed to the prediction of their HRQoL. The study showed that respondents with higher household incomes were more likely to have higher HRQoL than those with lower household incomes. This observation could be because individuals with higher household incomes may be more financially stable or willing to use their abundant financial resources to utilize health care services, reflecting a higher HRQoL.[65-68] Therefore, it is pertinent for policymakers to address the pervasive socioeconomic inequalities among patients burdened with comorbidities and polypharmacy to achieve optimum health status, as costly health interventions may be difficult to access, thereby impacting their HRQoL. While socioeconomic factors have been shown to influence the well-being of individuals with MetS, the need factors, which emphasize the health-related requirements of an individual, were significantly influential on HRQoL. Our findings revealed that as comorbidities and prescription drugs increased among people with MetS, there were lower odds of having higher HRQoL, consistent with previous studies showing an inverse relationship between multimorbidity and HRQoL.[69-71] In these studies, it was revealed that PwO with multiple health conditions had a higher burden of disease, which stimulates the use of more medications, negatively impacting their HRQoL. Although our study did not show the effect of polypharmacy, there is a prediction that over-prescription could cause an increased risk of adverse effects, medication errors, and poor medication adherence, ultimately affecting HRQoL.[72] Also, respondents with higher BMI reported lower odds of having higher HRQoL, which supported literature suggesting an inverse relationship between increasing weight status and decreasing HRQoL.[73-75] Therefore, it is vital to embrace the awareness of the impact of obesity, increasing comorbidities, and polypharmacy among patients and to recognize drug-related adverse events and adherence issues.[76] Overall, the study contributes valuable insights into the determinants of HRQoL among people with MetS, emphasizing the complex interplay of demographic, socioeconomic, and health-related factors. These findings have important implications for public health strategies, health care provision, and policy-making to enhance HRQoL across diverse populations by addressing health disparities and their consequences on patients' well-being.

Our study was not without some limitations. First, most of the study respondents were female (71.1%) and of white or Caucasian race (77.6%). Also, over 90% of the patients had health insurance coverage, while 60% resided in the urban or

Table 5
Ordinal regression between health-related quality of life categories and independent factors

Model	−2 log likelihood	X^2 value	df	*P* value
Intercept only	1528.60			
Final	1255.25	273.35	20	<0.001[a]
	B	aOR	*P* value	95% CI
Threshold				
Poor vs fair or good HRQoL	−2.40			−4.58, −0.22
Poor or fair vs good HRQoL	−0.47			−2.64, 1.71
Age in years	0.03	1.03	0.095	−0.004, 0.05
Age group				
Above the age of 65 years	0.66	1.93	0.032[a]	0.06, 1.26
45–64 y (*ref*)				
Gender				
Female	−0.15	0.86	0.409	−0.50, 0.20
Male (*ref*)				
Race				
Non-White	0.51	1.66	0.009[a]	0.13, 0.89
Non-Hispanic White/Caucasian (*ref*)				
Geographical areas				
Rural/town	0.45	1.56	0.006[a]	0.13, 0.76
Urban/city (*ref*)				
Marital status				
Single (never married)	0.69	1.99	0.040[a]	0.03, 1.34
Single (separated/divorced)	0.02	1.02	0.936	−0.51, 0.56
Married or partnered	0.28	1.32	0.293	−0.24, 0.79
Widowed (*ref*)				
Education status				
Bachelor's or higher	0.07	1.07	0.758	−0.38, 0.52
Associate or some college	0.01	1.01	0.946	−0.37, 0.39
High school or lower (*ref*)				
Employment status				
Permanently disabled	−0.76	0.47	0.119	−1.72, 0.20
Unemployed	−0.72	0.49	0.163	−1.72, 0.29
Employed	0.57	1.78	0.224	−0.35, 1.50
Retired	−0.21	0.81	0.667	−1.19, 0.76
Stay home caregiver (*ref*)				
Health insurance coverage				
Yes	−0.07	0.93	0.822	−0.72, 0.57
No (*ref*)				
Household income				
$80,001 or higher	0.78	2.18	0.004[a]	0.26, 1.31
$40,001 - $80,000	0.17	1.18	0.376	−0.20, 0.53
$40,000 or lower (*ref*)				
Number of prescription drugs	−0.15	0.86	<0.001[a]	−0.20, −0.10
Number of comorbidities	−0.19	0.84	0.008[a]	−0.31, −0.05
BMI (Kg/m^2)	−0.04	0.96	<0.001[a]	−0.06, −0.02

Abbreviations used: X^2, chi-square value; df, degree of freedom; aOR, adjusted odds ratio; HRQoL, health-related quality of life.
[a] Significant at 0.05 level; Goodness of fit deviance significance = 0.996; Test of parallel lines significance = 0.677.

city area. Therefore, over-representing these categories may generate inequality and bias while interpreting the study outcomes, making extrapolation of the findings to a general population difficult. Second, the study was not a nationwide survey but a regional one. Therefore, the study outcomes may not represent the actual picture in the US. Another limitation was using self-reported heights in feet and inches and weight in pounds to estimate respondents' BMI to identify PwO. While there could be bias in the estimated BMI due to the subjective report, BMI remains a valuable index for identifying individuals at risk for comorbidities among PwO. Another limitation was the low sample size of the study. Despite the potential of a higher prevalence of PwO and MetS in the Southern region, our study could only access 706 respondents who met the inclusion criteria. Lastly, using Qualtrics panels in the study might have stimulated the possibility of response bias from the participants, even though the panels reflect the US patient-care settings and the overall census numbers regarding residence, geographic area (rural and urban), age, and gender. Despite these limitations, the study has contributed to the body of knowledge by establishing the influence of increasing MetS comorbidities on HRQoL and providing an inclusive approach to develop a model predicting HRQoL. Nevertheless, further patient-centered interventions are required to improve health care accessibility among certain demographics to access health care interventions and promote well-being.

Conclusion

The study findings showed the complex relationship between HRQoL and MetS. While people with MetS were more

likely to experience increased odds of having problems in all HRQoL dimensions, they are likely to have severe and extreme challenges with mobility, usual activities, and pain. Additionally, predisposing factors such as age group, race, geographical areas, and marital status significantly predicted HRQoL. Also, respondents with higher household incomes were more likely to have higher HRQoL, while the increase in comorbidities, prescription drugs, and BMI predicted worse HRQoL. A comprehensive framework integrating sociodemographic, economic, and health-related factors may be needed to improve patients' HRQoL.

Authors Contribution

Olajide A. Adekunle, Lawrence M. Brown: Conceptualization, Methodology Olajide A. Adekunle: Data collection, Formal Analysis, Writing- Original Draft preparation Lawrence M. Brown: Supervision, Funding Acquisition Lawrence M. Brown, Yun S. Wang, Ismaeel Yunusa, Marc L. Fleming, Enrique Seoane-Vazquez: Writing − Reviewing and Editing

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Supplementary data

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