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Race and gender associations between obesity and nine health-related quality-of-life measures

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Abstract

Purpose To assess how health-related quality of life (HRQoL) varies by body mass index (BMI) category among gender and racial subgroups using nine HRQoL measures.

Methods Among 3,710 US adults, we evaluated self-reported height, weight, and HRQoL that was measured by six indexes (EQ-5D; HUI2; HUI3; SF-6D; QWB-SA; HALex) and three summary measures (theta; PCS; MCS). Mean HRQoL was estimated by weighted regression for normal, overweight, and obese subgroups (BMI: 18.5–24.9 kg/m^2; 25–29.9; and 30–50).

Results HRQoL was significantly lower ($P < 0.0001$) with increasing BMI category except for MCS. Obese individuals were 5.3 units lower on PCS (1–100 scale) and 0.05–0.11 lower on the HRQoL indexes (0–1 scale) than those with normal weight. MCS scores were significantly lower for obese than normal-weight among women ($P = 0.04$) but not men ($P = 0.11$). Overweight blacks had higher HRQoL than blacks in other BMI categories ($P = 0.033$).

Conclusions Six commonly used HRQoL indexes and two of three health status summary measures indicated lower HRQoL with obesity and overweight than with normal BMI, but the degree of decrement varied by index. The association appeared driven primarily by physical health, although mental health also played a role among women. Counter to hypotheses, blacks may have highest HRQoL when overweight.

Keywords Body mass index · Obesity · Health-related quality of life · Health status · EQ-5D · SF-6D

Abbreviations

BMI	Body mass index
HRQoL	Health-related quality of life
EQ-5D	EuroQol–5 dimensions
HUI2	Health utilities index mark 2
HUI3	Health utilities index mark 3
SF-6D	Short-form–6 dimensions
QWB-SA	Quality of well-being scale—self-administered
HALex	Health and activities limitations index
kg	Kilogram
m	Meter
PCS	Physical component score of SF-36v2™
MCS	Mental component score of SF-36v2™
N	Total number
CI	Confidence interval
CID	Clinically important difference
SE	Standard error

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Introduction

The United States' prevalence of obesity among adults has more than doubled over the past 30 years [1]. Obesity has been associated with increased mortality, incidence of chronic conditions (e.g., diabetes, stroke, osteoarthritis) and other morbidities and affects separate aspects of general health such as physical functioning, pain, and role functioning [2–6].

In surveys, obesity is usually measured by a surrogate (body mass index [BMI], calculated from weight and height), and the effects of obesity are often estimated using health-related quality-of-life (HRQoL) indexes that combine many aspects of health into a single measure. The relationship between BMI and HRQoL has been shown to vary separately by gender and race [2–15], but the combined effects of race and gender are largely unexplored.

Estimating the magnitude of associations between BMI and HRQoL is complicated by the fact that there are many measures of HRQoL and health status, each with different content, structure, and signal-to-noise ratios for detecting effects. Although each such measure is likely to produce different estimates of these associations, no studies have yet evaluated the robustness of the BMI-HRQoL relationship by considering more than 2–3 measures [2–15]. Understanding the magnitude of effects and how they may differ between measures is important for improving cost-effectiveness analyses and evaluating public health interventions for important gender–race subpopulations.

We therefore compared estimates of BMI-HRQoL associations using US adult HRQoL data from the National Health Measurement Study, a survey that administered a broad panel of HRQoL questionnaires using population sampling with oversampling of telephone exchanges with high percentages of African Americans ("blacks") [16]. Specifically, we used these data to estimate BMI-HRQoL associations for gender-by-race subpopulations and to compare results from six HRQoL indexes, one composite measure, and two physical and mental health status summary measures.

Methods

Data

We used self-reported height, weight, and HRQoL data from the National Health Measurement Study, a random digit-dialed, cross-sectional telephone survey of a US national sample ($N = 3{,}844$) of noninstitutionalized adults aged 35–89 years [16]. Respondents were administered, in randomized order, each of four commonly used HRQoL questionnaires: EuroQol-5 Dimensions (EQ-5D) [17–19]; the Health Utilities Index (HUI) [20–22]; the Brazier utility-weighted SF-36 version 2™ (SF-36v2™) [17]; and the Quality of Well-being Scale—Self-Administered (QWB-SA) [23]. At the end of the interview a fifth questionnaire, the Health and Activities Limitations Index (HALex), was administered to all respondents [24]. The Health Utilities Index Mark 2 and Mark 3 (HUI2 and HUI3) were obtained from the HUI questionnaire, and the SF-6D index was computed from the SF-36v2™.

Respondents providing height and weight information for estimation of BMI ($N = 3{,}783$) were classified as normal weight (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2), or obese (30–50 kg/m^2). Respondents reporting a BMI <18.5 ($n = 43$) or a BMI >50.0 ($n = 30$) were excluded, for an analytic sample of $N = 3{,}710$.

Health-related quality of life

Health-related quality of life incorporates multiple domains of self-reported health status such as physical, psychological, and general well-being as well as social and role functions. For this analysis, we considered HRQoL as measured by six commonly used indexes and three summary measures of health status (theta [25]; SF-36v2™ physical component summary score; and mental component summary score [PCS and MCS] [26, 27]). The six indexes are preference-scored generic HRQoL measures representing community weights for health states that yield single summary utility scores. Theta is a summary combining information from the indexes, and the PCS and MCS address physical and mental health status, respectively. These nine measures were chosen to include all of the most commonly used preference-based measures.

The EQ-5D [18, 28] measures five domains (mobility, self-care, usual activity, pain/discomfort, and anxiety/depression) via five items, each with three levels of problem severity; we used US population-based weights for index scoring [29–32]. HUI2/3 use preference-based algorithms to map questionnaire responses to health status classification systems [20]; HUI2 [20, 21] incorporates six attributes (sensation [vision, hearing, speech]; mobility; emotion; cognition; self-care; and pain); and HUI3 [22] incorporates eight attributes (vision; hearing; speech, ambulation, dexterity; emotion; cognition; and pain and discomfort). Each index captures different levels of functioning.

The SF-6D is a preference-based health status classification system computed from an 11-item subset of the SF-36v2™ [33] and incorporates six domains (physical functioning; social functioning; role limitations; pain; mental health; and vitality) [17]. QWB-SA summarizes four domains (self-care/mobility; self-care/usual activity; physical activity; symptoms) into a single summary score, and HALex summarizes two (activity limitation; self-reported health) [16, 23, 24].

Theta is an item-response-theory-derived composite measure of health status that extracts the common variance of five indexes (EQ-5D; SF-6D; HUI2; HUI3; and QWB-SA) into a single, normally distributed summary score [25]. The SF-36v2™ is also used to derive two summary measures of health—PCS and MCS—from its eight domains. The PCS is computed using positive weights for physical functioning, role-physical, bodily pain, and general health domains of SF-36v2™ and negative weights for social functioning, role-emotional, vitality, and mental health domains; the MCS is computed using positive weights for social functioning, role-emotional, vitality, and mental health domains and negative weights for physical functioning, role-physical, bodily pain, and general health domains [27].

Analyses

Post-stratified sampling weights were applied in all analyses to reflect the US Census 2000 population by gender, age (35–44, 45–64, 65–89), and race (black, non-black). BMI groups (normal, overweight, obese) were described with respect to age, race, education, and smoking status by means and percentages and unadjusted means of the nine HRQoL measures.

Ordinary and logistic regression models were fit to test the statistical significance of differences in these characteristics between BMI groups (*F* tests and likelihood ratio chi-square tests). For each of the nine measures, mean HRQoL was further estimated by BMI category by gender (men, women) and race (black, non-black), and by BMI category by race–gender subgroups (black men; black women; non-black men; non-black women). BMI groups were modeled as indicator variables, age was modeled as a continuous variable, race and gender were modeled as binary indicators, and all results were regression-adjusted to the mean age, gender, and race distribution of the US population based on Census 2000. All regression-adjusted means were obtained as the intercepts of models where adjustment variables were centered at US census values. Adjustment for education and smoking did not notably alter results (data not shown).

Interactions between BMI groups and age, race, and gender were added to the adjusted models of each index/score and tested. Based on recent evidence that being overweight may be protective with respect to mortality for blacks [5, 6, 34], a separate test was performed for the interaction of race and overweight. Indexes were also jointly tested in an exploratory repeated-measures model including the above variables and interactions and BMI-by-race interactions. All analyses were done in SAS/STAT 9.1, © 2002–2003 (SAS Institute Inc., Cary, NC). Results of all statistical tests are reported as significant at $P < 0.05$, but exact P values are provided to help assess the strength of the evidence.

Results

The estimated proportions of respondents in normal, overweight, and obese categories among our National Health Measurement Study sample were 26, 45, and 29%, respectively, among men, and 43, 29, and 27% among women. Twice as many blacks were in the obese (42%) as in the normal BMI (21%) group. Among non-blacks, a higher percentage fell in normal and overweight categories (each 37%) than in obese (26%). Weighted BMI means were 28.1 (standard error = 0.23) for men, 27.0 (0.21) for women, 29.5 (0.33) for blacks, and 27.3 (0.17) for non-blacks. For black men, non-black men, black women, and non-black women, these were 29.1 (0.46), 28.0 (0.25), 29.8 (0.47), and 26.6 (0.23), respectively. BMI differences between races were statistically significant for both men ($P = 0.033$) and women ($P < 0.0001$).

Table 1 describes the demographic characteristics by BMI category and measure-specific weighted HRQoL means. There was no statistically significant difference between mean age and the proportion of smokers among BMI categories ($P = 0.24$ and 0.80, respectively), but there was a statistically significant difference between the proportions of men and black among these categories. Obese individuals were more likely to have lower (less than college degree) education whereas those with normal BMI were more likely to have a college degree or higher. There was a statistically significant difference between overweight and obese individuals compared with normal-weight individuals on all HRQoL measures ($P < 0.0001$) except for on the mental component score (MCS; $P = 0.54$), with differences varying considerably by index. For example, normal-obese differences among indexes were smallest for SF-6D (difference of 0.05, in 0–1 scale), largest for HUI3, QWB-SA, and HALex (0.08, 0.07, and 0.11, respectively) and were greater for the PCS than for the MCS (differences of 5.3 vs. 0.5, respectively, in 1–100 scale).

Table 2 shows measure-specific, adjusted weighted mean HRQoL scores and 95% confidence intervals among BMI categories, by gender and race. Differences between BMI categories varied similarly to those in Table 1. The Fig. 1 shows weighted, age-adjusted HRQoL mean scores cross-classified by BMI category, gender and race for nine measures of HRQoL and health status; confidence intervals for these scores were of the same order of magnitude as those shown in Table 2. Mental component scores were

Table 1 Demographic characteristics of study sample and weighted mean HRQoL by BMI category for nine measures

	BMI category (kg/m^2)			
	Normal (18.5–24.9) $N = 1{,}154$	Overweight (25–29.9) $N = 1{,}409$	Obese (30–50) $N = 1{,}147$	*P* value
Population % in category	31	38	31	
Demographic characteristics: mean (SE)				
Age[a] (year)	54 (0.7)	55 (0.6)	54 (0.6)	0.24
% male	36 (2.5)	59 (2.3)	49 (2.5)	<0.0001
% black	6 (0.9)	11 (0.9)	16 (1.2)	<0.0001
% <high school	6 (0.9)	7 (1.3)	12 (1.7)	<0.0001
% = high school	27 (2.4)	26 (2.0)	33 (2.3)	0.0004
% some post-secondary ed.	16 (1.6)	26 (2.0)	26 (2.2)	<0.0001
% ≥college	50 (2.6)	40 (2.2)	29 (2.2)	<0.0001
% current smoker	18 (1.9)	18 (1.8)	18 (1.9)	0.89
HRQoL by measure: mean (SE)				
EQ-5D	0.89 (0.006)	0.87 (0.006)	0.83 (0.008)	<0.0001
HUI2	0.87 (0.006)	0.85 (0.007)	0.81 (0.009)	<0.0001
HUI3	0.84 (0.009)	0.81 (0.011)	0.76 (0.013)	<0.0001
SF-6D	0.81 (0.006)	0.79 (0.006)	0.76 (0.006)	<0.0001
QWB-SA	0.69 (0.008)	0.66 (0.007)	0.62 (0.007)	<0.0001
HALex	0.84 (0.008)	0.80 (0.009)	0.73 (0.010)	<0.0001
Theta[b]	0.18 (0.047)	0.03 (0.043)	−0.24 (0.049)	<0.0001
SF-36 PCS	51.5 (0.4)	49.5 (0.4)	46.2 (0.5)	<0.0001
SF-36 MCS	53.9 (0.4)	54.0 (0.4)	53.4 (0.4)	0.54

HRQoL Health-Related Quality of Life, *BMI* Body Mass Index, *kg* kilogram, *m* meter, *EQ-5D* EuroQol-5 Dimensions, *HUI2* Health Utilities Index Mark 2, *HUI3* Health Utilities Index Mark 3, *SF-6D* Short-Form–6 Dimensions, *SE* Standard Error, *SF-36v2*™, Brazier Utility-Weighted SF-36 version 2™, *QWB-SA* Quality of Well-Being Scale—Self-Administered, *PCS* Physical Component Summary score of SF-36v2™, *MCS* Mental Component Summary score of SF-36v2™

[a] Age as continuous variable

[b] Theta standardized to mean = 0, SD = 1

higher among non-black obese men and higher among overweight but not obese black men and were lower among non-black and black obese women. There was indication of an inverted U-shaped HRQoL–BMI relationship among black men and women. Black men had higher HRQoL scores in overweight than in normal or obese BMI categories in six (EQ-5D, HUI2, HUI3, HALex, PCS, and MCS) of the nine measures, black women in four (HUI2, HUI3, MCS, and theta) of the nine measures.

Subgroup interactions were statistically significant in few instances. Men and women had different patterns across BMI categories in mental health (MCS: $P = 0.019$), with obese women ($P = 0.04$) but not men ($P = 0.11$) having lower mental health scores than normal-weight individuals. EQ-5D and HUI2 had different patterns across BMI category for blacks and non-blacks. Combining the indexes with theta or via a repeated-measures analysis did not indicate that blacks differed from non-blacks or that women differed from men in patterns across BMI categories.

Repeated-measures analyses combining all 6 indexes indicated that blacks who were overweight had higher HRQoL than did those with normal or obese BMI ($P = 0.033$). Among individual measures, overweight non-blacks had significantly lower scores for all indexes, whereas overweight blacks had scores that were not significantly higher than normal-weight blacks for all indexes except the QWB-SA and PCS.

Discussion

Using cross-sectional US population-based data for older adults, we found that six commonly used HRQoL indexes and two of three health status summary measures—all but the mental health summary score—detected statistically significantly lower (worse) HRQoL associated with obesity than with normal BMI. The preference-scored indexes differed in magnitude of decrement, with HUI3 and HALex having the largest HRQoL-BMI differences and EQ-5D

Table 2 Weighted mean HRQoL by BMI category, gender, and race for nine measures

Index	BMI category[a]	Men[b]	Women[b]	Black[c]	Non-black[c]
N	Normal	421	733	215	939
	Overweight	744	665	400	1,009
	Obese	456	691	433	714
		Weighted mean HRQoL (95% CI)			
EQ-5D	Normal	0.90 (0.88, 0.92)	0.88 (0.87, 0.90)	0.86 (0.82, 0.91)	0.89 (0.88, 0.91)
	Overweight	0.87 (0.86, 0.89)	0.87 (0.86, 0.89)	0.87 (0.85, 0.89)	0.87 (0.86, 0.89)
	Obese	0.85 (0.83, 0.87)	0.82 (0.79, 0.84)	0.78 (0.75, 0.82)	0.84 (0.82, 0.86)
HUI2	Normal	0.87 (0.85, 0.89)	0.87 (0.85, 0.88)	0.81 (0.75, 0.87)	0.88 (0.87, 0.89)
	Overweight	0.86 (0.84, 0.88)	0.85 (0.83, 0.87)	0.85 (0.83, 0.88)	0.85 (0.84, 0.87)
	Obese	0.83 (0.81, 0.86)	0.79 (0.76, 0.81)	0.76 (0.72, 0.80)	0.81 (0.79, 0.83)
HUI3	Normal	0.84 (0.81, 0.87)	0.84 (0.82 0.86)	0.75 (0.66, 0.85)	0.85 (0.83, 0.87)
	Overweight	0.82 (0.79, 0.84)	0.80 (0.77, 0.84)	0.80 (0.76, 0.84)	0.81 (0.79, 0.83)
	Obese	0.78 (0.75, 0.81)	0.74 (0.70, 0.78)	0.69 (0.63, 0.74)	0.77 (0.74, 0.80)
SF-6D	Normal	0.81 (0.79, 0.83)	0.80 (0.79, 0.82)	0.79 (0.74, 0.84)	0.81 (0.80, 0.82)
	Overweight	0.80 (0.78, 0.81)	0.79 (0.77, 0.80)	0.79 (0.77, 0.81)	0.79 (0.78, 0.80)
	Obese	0.78 (0.77, 0.80)	0.74 (0.72, 0.76)	0.73 (0.70, 0.75)	0.77 (0.75, 0.78)
QWB-SA	Normal	0.71 (0.68, 0.73)	0.69 (0.66, 0.71)	0.71 (0.66, 0.77)	0.69 (0.68, 0.71)
	Overweight	0.67 (0.65, 0.69)	0.65 (0.63, 0.67)	0.66 (0.63, 0.69)	0.66 (0.64, 0.67)
	Obese	0.65 (0.63, 0.66)	0.59 (0.58, 0.61)	0.61 (0.58, 0.64)	0.62 (0.61, 0.63)
HALex	Normal	0.84 (0.82, 0.86)	0.84 (0.81 0.86)	0.77 (0.71, 0.83)	0.85 (0.83, 0.86)
	Overweight	0.80 (0.78, 0.82)	0.80 (0.79, 0.83)	0.78 (0.75, 0.81)	0.81 (0.79, 0.83)
	Obese	0.76 (0.73, 0.78)	0.72 (0.69, 0.75)	0.68 (0.64, 0.72)	0.74 (0.72, 0.76)
Theta[d]	Normal	0.24 (0.07, 0.41)	0.12 (0.02, 0.23)	0.07 (−0.27, 0.41)	0.19 (0.10, 0.29)
	Overweight	0.07 (−0.04, 0.18)	−0.005 (−0.14, 0.13)	0.08 (−0.09, 0.26)	0.02 (−0.07, 0.12)
	Obese	−0.08 (−0.22, 0.05)	−0.37 (−0.50, −0.23)	−0.44 (−0.62, −0.25)	−0.21 (−0.31, −0.10)
PCS	Normal	51.9 (51.0, 52.9)	51.1 (50.1, 52.0)	50.0 (47.8, 52.2)	51.7 (51.0, 52.4)
	Overweight	50.0 (49.0, 50.9)	49.2 (48.1, 50.5)	49.8 (48.3, 51.2)	49.6 (48.7, 50.5)
	Obese	47.0 (45.7, 48.3)	45.6 (44.3, 46.9)	45.0 (43.1, 46.9)	46.4 (45.4, 47.4)
MCS	Normal	53.8 (52.6, 54.9)	53.8 (52.8, 54.8)	50.9 (47.6, 54.2)	54.2 (53.4, 54.9)
	Overweight	54.1 (53.0, 55.1)	53.8 (52.8, 54.8)	52.2 (50.5, 53.9)	54.1 (53.3, 54.9)
	Obese	55.0 (54.0, 56.0)	52.3 (51.1, 53.4)	49.9 (48.0, 51.8)	54.0 (53.2, 54.9)

HRQoL Health-Related Quality of Life, *BMI* Body Mass Index, *kg* kilogram, *m* meter, *EQ-5D* EuroQol-5 Dimensions, *HUI2* Health Utilities Index Mark 2, *HUI3* Health Utilities Index Mark 3, *SF-6D* Short-Form–6 Dimensions, *SE* Standard Error, *SF-36v2*™, Brazier Utility-Weighted SF-36 version 2™, *QWB-SA* Quality of Well-Being Scale—Self-Administered, *PCS* Physical Component Summary score of SF-36v2™, *MCS* Mental Component Summary score of SF-36v2™

[a] BMI categories (kg/m^2): normal, 18.5–24.9; overweight, 25–29.9; obese, 30–50

[b] Regression-adjusted to Census 2000 race distribution of US population age 35–89 and to the mean age of each gender

[c] Regression-adjusted to Census 2000 gender distribution of US population age 35–89 and to the mean age of each race group

[d] Theta standardized to mean = 0, SD = 1

and SF-6D the smallest. The summary measures indicated that higher BMI is associated with worse physical but not mental health aspects of HRQoL. Although this confirms prior research [7, 9, 12, 35–39], our results suggested for the first time in a US population that among women, both mental and physical health appeared worse with higher BMI. There was little suggestion of other gender-specific variation in magnitude of associations, yet HRQoL patterns did differ by race, with blacks displaying higher HRQoL associated with overweight than with normal BMI on most measures.

The variation among indexes in estimated differences in HRQoL between BMI groups can have important implications for economic analyses that utilize individual preference-based indexes to value HRQoL. For example, a 0.04 discrepancy in utility difference in the index chosen for

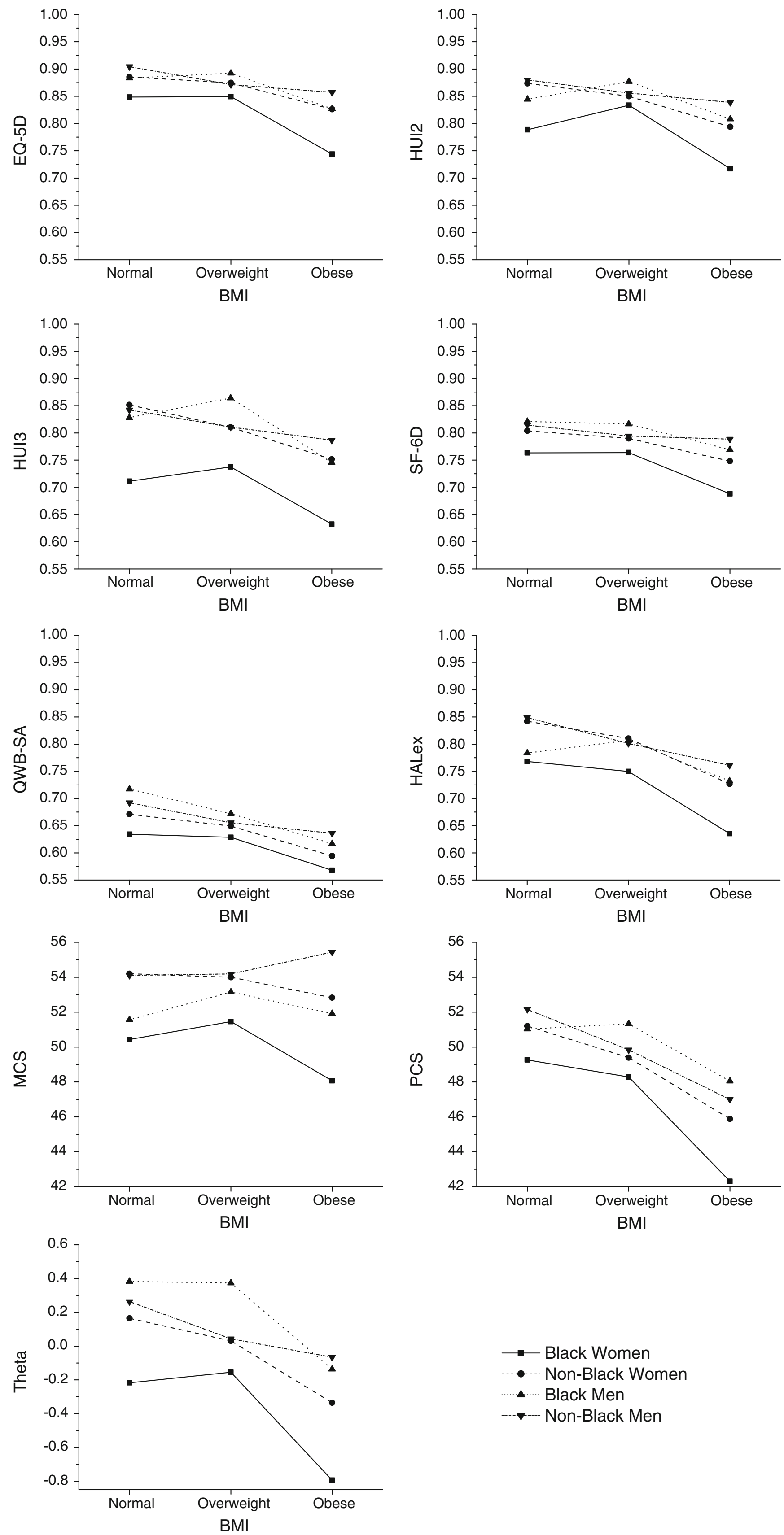

Fig. 1 Weighted health-related quality of life (HRQoL) (Adjusted by weighted regression analysis to Census 2000 mean age of each race by gender subgroup) mean scores by BMI category, gender, and race for nine measures of health-related quality of life and health status

valuation could lead to an intervention being deemed "cost effective" (e.g., valued at less than a society's willingness-to-pay cost-effectiveness threshold) or not cost effective. Of course, cost-effectiveness analyses should always incorporate sensitivity analyses and should not be the sole determinant of decisions [40], but the importance of variation among measures may not always be considered. Our results can provide guidance on the potential range of estimated utility impact that obesity interventions may have, depending on the HRQoL measure used.

We found in our adult sample an overall 38% prevalence of overweight and 31% prevalence of obesity, consistent with other national estimates [1, 2, 41]. There was suggestion of a greater prevalence of *overweight* among men than among women, and a greater prevalence of *normal weight* among women than among men. We also found that blacks were more likely than non-blacks to be overweight or obese, and as shown elsewhere this race difference was greater for women [41, 42].

Our results also suggest that the association between obesity and HRQoL may be stronger among women than among men [12, 13, 38, 39, 43]. And although there has been some emerging evidence that obesity may be negatively associated with mental health among women in non-US settings [44, 45], our analysis is the first to indicate that such an inverse relationship may be significant among American women, while confirming evidence that among men, the association appears significant only with physical health [7, 9, 12, 35–39].

Our analysis found a consistent pattern of differences between blacks and non-blacks in the overweight-and-HRQoL relationship, suggesting that overweight blacks may have a higher HRQoL than do normal-weight and obese blacks (Fig. 1). This inverted U-shape parallel patterns indicated in prior research in which lower HRQoL was associated with obesity among blacks compared with non-blacks [12] as well as with published results on mortality suggesting that blacks experience a smaller association between increasing BMI and mortality than do non-blacks [8, 46–48]. Although seemingly paradoxical, this effect may be caused by inverse causality and a resetting of "normal" BMI due to increased obesity rates in the US, whereby individuals with compromised health may be more likely to stay in the "normal" BMI range.

Low weight may be a marker for poor health and covert health conditions, possibly more so in certain population groups than in others. The mechanisms by which overweight and obesity affect daily living and mortality may also differ between races. Lifestyle, roles, bodily pain, or vitality may simply be less affected by overweight among blacks than they are among non-blacks. There may also be greater competing mortality risks among blacks obscuring the impact of overweight and obesity on survival. Regardless of the cause of the inverse U-shape phenomenon, future analyses must evaluate in greater detail the nature of the relationship between HRQoL and overweight and its variations by gender, race, and age.

The results of our analysis must be considered in light of its limitations. Future research is needed to determine how differences between measures arise and must consider issues such as the relative contribution of specific domains and ceiling or floor effects. The normal-obese and overweight-obese HRQoL differences that we found in the preference-scored indexes in general exceeded the guideline of 0.03 for a clinically important difference (CID) [49], and the differences in the PCS were close to its CID guideline of 5 [33] or more points. The normal-overweight HRQoL differences found among blacks exceeded these CID thresholds only as measured by the HUI2 and HUI3 indexes. Statistically significant differences in HRQoL between BMI categories did not, in all cases, correspond with larger score differences between categories. This suggests that the magnitude of HRQoL decrement is influenced not only by index-specific sensitivity and classification system but also by its scoring function, which may result in differences in overall scores among indexes for certain health states.

Some prior studies of the impact of BMI on HRQoL adjusted results for physical activity and/or comorbidities [9–12, 14, 15, 39, 50, 51]. We chose not to do so here for various reasons. Comorbidities may act on the HRQoL–BMI relationship in multiple ways (e.g., as confounders, in interactions, or as mediators), and this effect may vary between comorbidities and between populations. With a lack of consistent evidence regarding the potential impact of comorbidities on the BMI–HRQoL relationship [35], the unknown severity of the conditions, and the possible biases in self-reported data, the direction in which our results could be affected by excluding them is ambiguous.

Similarly, findings of decrements in mental health status associated with chronic illnesses [7, 12, 35] suggest that the BMI–MCS relationship may in part be driven by the impact of obesity-related chronic conditions. Future studies should further evaluate differences in gender-specific associations between BMI and mental health status and consider the impact of chronic illness on such associations. In addition, although some evidence has shown that use of the oblique MCS may provide different results [52], we used for this analysis the standard PCS and MCS scoring methodology, which is based on an orthogonal algorithm [33].

Another methodological concern is that our use of self-reported height and weight may have resulted in underestimates of the BMI values used in our analysis because individuals tend to underestimate their weight and overestimate their height [53]. This bias may have resulted in an overall overestimate of the association between BMI and HRQoL because of the dynamics of which individuals are most likely to be misclassified (overweight individuals who are truly obese) [6, 54]. Although there is an algorithm for adjusting BMI estimates for this self-reporting misclassification [54], its use may introduce new and unknown biases because of not taking into account how different factors, including HRQoL itself, may affect misreporting and how misreporting differs between subgroups.

It is possible that perceived rather than actual height and weight may be important for HRQoL [6]. Future research should further evaluate the impact of self-reported height and weight on estimates of the BMI-HRQoL associations by evaluating results among populations with both self-reported as well as measured values.

Another study limitation is that our necessary use of survey weights may have reduced statistical power and that despite our oversampling of telephone exchanges with large percentages of blacks, the number of blacks surveyed was relatively small. The National Health Measurement Study data also did not have sufficient numbers of Hispanics—who may report their HRQoL differently from non-Hispanics—to allow us to evaluate BMI-HRQoL associations by ethnicity.

Further, our results may not be fully generalizable to the general US adult population because the sampling frame targeted only those who have telephones and survey non-response may have been associated with unmeasured factors affecting the association between BMI and HRQoL. Although it is also possible that our large number of comparisons increased the likelihood of Type 1 error and caused us to overestimate the statistical significance of some associations, these results provide general norms regarding the BMI–HRQoL relationship among older US adults and can suggest directions for future research.

The detrimental effects of overweight and obesity go beyond increased morbidity and shortened life expectancy and in fact include reduced HRQoL. By incorporating multiple indexes, including a composite summary measure and the physical and mental components of the SF-36v2™, and by evaluating results by gender and racial subgroups, this analysis offers insight into aspects of the HRQoL-BMI association that are important for clinicians, researchers, and policymakers. Given that the degree of HRQoL decrement is different between HRQoL indexes, policymakers must exercise caution when using these indexes to draw conclusions regarding the nature of the HRQoL–BMI relationship, especially when applying utilities to economic analyses. Differing epidemiology between genders and races may in part determine physical response and health impact of higher BMI, and knowledge of these differential associations could guide physicians in working with patients to enhance and sustain positive changes in HRQoL.

The surprising finding that overweight blacks report somewhat better HRQoL than normal-weight blacks warrants future research to separate out true effects from other factors such as response bias, differential item functioning, or differences in stigmatization [55]. By enhancing the conceptualization and measurement of obesity's association with HRQoL, the results of this analysis can help improve health and quality-of-life outcomes in the US population.

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Conflict of interest David Feeny has a proprietary interest in Health Utilities Incorporated, Dundas, Ontario, Canada. HUInc. Distributes copyrighted Health Utilities Index (HUI) materials and provides methodological advice on the use of HUI. None of the other authors declare a conflict of interest.

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