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# The association of body mass index and health-related quality of life in the general population: data from the 2003 Health Survey of England

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**Abstract**
*Objectives* The link between obesity/overweight and life-threatening illnesses is well established. The objective of this study was to investigate the relationship between body mass index (BMI) and health-related quality of life (HRQoL), and any differences between men and women, in the general population of England.
*Methods* HRQoL data (from EQ-5D responses of 14,416 individuals aged ≥18 in the 2003 Health Survey for England) were used, and linear regression analyses were conducted to examine the relationship between BMI and HRQoL.
*Results* A significant association between BMI and HRQoL was found after controlling for factors such as gender, age, and obesity-related comorbidities. The maximum HRQoL was reached at a BMI of 26.0 in men and 24.5 in women, demonstrating that BMI is negatively associated with HRQoL for both underweight and obese individuals. At higher BMI values, men reported higher HRQoL than women; at lower BMI values, HRQoL was lower in men than women.
*Conclusions* There is a significant association between BMI and HRQoL in men and women in the general population. Nearly all aspects of HRQoL are adversely affected by elevated BMI.

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**Keywords** Body mass index · Obesity · Assessment · Patient outcomes · Health-related quality of life

**Abbreviations**

| | |
|---|---|
| BMI | Body mass index |
| HRQoL | Health-related quality of life |
| HSE | Health Survey for England |
| WHO | World Health Organisation |

## Introduction

Recent data from the 1990s showed that in most European countries the prevalence of obesity (body mass index [BMI] ≥ 30) in those aged 35–64 was approximately 10–25%, and the prevalence of overweight (BMI ≥ 25) was approximately 40–50% [1]. The World Health Organisation (WHO) predicts that the prevalence will increase in the next decade [2], and in the United Kingdom such increases have clearly been demonstrated since the 1980s [3]. Recent predictions from the International Obesity Task Force suggest that by 2020, 38% of women and 34% of men will be obese in the UK [4].

The link between obesity and being overweight with an increased risk of cardiovascular disease is well established [5, 6], and many other conditions such as type 2 diabetes and the metabolic syndrome (with or without diabetes) are more prevalent in overweight and obese individuals [7]. Several significant cancers are also more prevalent in overweight and obese individuals [8, 9]. These factors contribute towards a strong association between excess weight and decreased life expectancy [10–12]. The estimated years of life lost as a result of obesity differ with race and gender [13], but data

from the Framingham Heart Study showed that 40-year old female non-smokers lost 3.3 years of life and 40-year old male non-smokers lost 3.1 years of life compared to normal-weight non-smokers if they were overweight [10]. Obesity caused even larger reductions in life expectancy—a 40-year old obese female non-smoker lost 7.1 years of life and a 40-year old obese male non-smoker lost 5.8 years of life compared with normal-weight non-smokers [10]. Similar reductions in life expectancy were observed in obese smokers compared with normal-weight smokers.

The effects of obesity and overweight on an individual's ability to live a full and active life and on their psychological well-being are also important. This has been quantified by assessing health-related quality of life (HRQoL) in obese individuals, and in almost all reports (using general measures such as the SF-36 and obesity-specific instruments), HRQoL is lower in people with a higher BMI [14–16]. Information on HRQoL in obese and overweight individuals comes from the general population [17–22], treatment settings [23–26], or specific populations such as the elderly [27, 28] or adolescents [29]. Several cross-sectional studies have shown that both physical and psychological functioning is affected by obesity, but this differs according to gender, age and ethnicity [30–32]. Compared with men, women who are obese have a lower quality of life, which is more likely to impact physical rather than psychological functioning [30]. Age and gender have also been observed to differentially impact aspects of HRQoL whereby younger (18–34 years) men and women who are obese demonstrate poor physical health, whereas older obese women aged 35–64 (but not obese men) exhibit poor HRQoL on aspects of both physical and mental functioning [22].

The Health Survey for England (HSE) is an annual survey commissioned by the UK Department of Health that began in 1991 and is designed to provide the UK government with information on various aspects of the health of the general population of England. The sample population is, therefore, an excellent source of health and sociodemographic variables within the population of England. Due to the paucity of published data available on the relationship between BMI and HRQoL in the UK general population, the aim of this study was to evaluate this association in a representative sample of the English population using data from the HSE 2003, which focussed on cardiovascular disease and associated behavioural risk factors. Differences in BMI-HRQoL associations between men and women were also investigated.

## Methods

All participants in the HSE gave informed consent. A total of 13,690 addresses were selected randomly from the Postcode Address File grouped within 720 postcode sectors. Sixty postal sectors were selected each month to avoid the potential influence of seasonal differences. Questionnaire-based face-to-face interviews were conducted with all adults (aged $\geq$18) and children at each address (when there were three or more children aged 0–15 in a household, two children were selected at random). Information about children less than 13 years of age was provided by the parent/guardian [33]. The EQ-5D [34] was completed by adults at this visit. Height and weight measurements were also taken at this first visit.

Each interview was followed by a nurse visit a few days later, at which measurements such as blood pressure and waist/hip ratio were obtained, and information on prescription drugs was collected. Children between the ages of 4 and 15 were asked to provide a saliva sample, and blood samples (approximately 15 ml) were obtained from adults.

### Sample selection

A sample size of 18,553 people was available in the HSE 2003. For this paper we restricted our analysis to adults ($n$ = 14,416) who were 18 years or older.

### Measurement of HRQoL and BMI

The EQ-5D is a standardised 3-level, 5-dimensional questionnaire for the measurement of health status, which was preselected as a measure in the HSE 2003. The self-classifier five dimensions of the EQ-5D are mobility, self-care, usual activity, pain/discomfort and anxiety/depression, and each dimension is rated by individuals as 'no problem', 'some problem' or 'extreme problem'. These combine to create 243 possible health states. A single utility value based on a British EQ-5D scoring algorithm was used to give a single measure of health status. The EQ-5D utility values range between a full health score of 1 (where the respondent has no problems on any dimension) and the lowest score of −0.239 (where the respondent reports that they are at the bottom level of each dimension). The EQ-5D scores in the HSE 2003 were weighted according to the social preference of the UK population.

Body mass index was determined based on weight and height recorded by trained nurses. The BMI categories used in this study were based on the WHO guidelines [35]: underweight was a BMI $<$ 18.50; normal weight was a BMI of 18.50–24.99; overweight was a BMI of 25.00–29.99; obese was a BMI of 30.00–39.99; and clinically severely obese was a BMI of $\geq$40.00.

### Statistics

Explicit correlations between HRQoL and BMI were investigated. Multiple linear regression analyses were performed,

controlling for influential sociodemographic and clinical parameters. Initially, the following parameters were included to test for significance: gender, age (recorded as age groups 18–24, 25–34, 35–44, 45–54, 55–64, 65–74 and ≥75 years), ethnic background, marital status, age when left school, work activity (manual or non-manual), socioeconomic characteristics (measured by the McClement's household score for equalised income) [36], psychosocial well-being (measured by the General Health Questionnaire [GHQ-12]) [37] and diagnosed morbidities (specifically: type 2 diabetes, heart and circulatory problems, respiratory problems, musculoskeletal problems or cancer). Regression analyses were conducted using EQ-5D utility values as the dependent variable. Multiple linear regressions were undertaken for men and women separately, as the initial regression analysis showed significant differences between genders. All data were analysed using Stata 9.2 (StataCorp, TX, USA).

## Results

The characteristics of the HSE 2003 adult population are summarised in Table 1. There were more women ($n$ = 8,008) than men ($n$ = 6,408) in the sample, and women had a slightly higher mean age and slightly lower mean BMI. There was a higher proportion of the female population who were underweight or normal weight than the male population, while more men were classified as overweight, when categorising the BMI values (Table 2). However, obesity prevalence was similar between genders, and slightly more women than men were clinically severely obese.

### BMI and HRQoL

After adjusting for all relevant confounding factors, there was a clear association between being underweight or being obese and a reduced HRQoL in men and women (Fig. 1).

**Table 1** Characteristics of individuals (≥18 years of age) included in the Health Survey for England 2003 ($n$ = 14,416)

| Variables | Men | Women |
|---|---|---|
| Gender, $n$ (%) | 6,408 (44.5) | 8,008 (55.5) |
| Mean age (SD), years | 48.8 (17.5) | 49.4 (18.3) |
| Mean BMI (SD), kg/m$^2$ | 27.2 (4.3) | 27.0 (5.5) |
| Mean EQ-5D | 0.873 | 0.848 |
| Diagnosed morbidities, % | | |
| Type 2 diabetes | 4.4 | 3.4 |
| Heart problems | 14.7 | 12.9 |
| Respiratory problems | 9.4 | 8.7 |
| Musculoskeletal problems | 19.6 | 22.5 |
| Cancer | 4.1 | 4.3 |

**Table 2** Distribution of men and women (≥18 years of age) in the different BMI categories in the Health Survey for England 2003

| BMI categories[a] | Proportion (%) | |
|---|---|---|
| | Men | Women |
| Underweight | 1.0 | 1.6 |
| Normal weight | 30.2 | 40.7 |
| Overweight | 45.4 | 33.8 |
| Obese | 22.4 | 21.0 |
| Clinically severely obese | 1.0 | 2.9 |

[a] *Categories*: underweight = BMI < 18.50; normal weight = BMI 18.50–24.99; overweight = BMI 25.00–29.99; obese = BMI 30.00–39.99 and clinically severely obese = BMI ≥ 40.00

The maximum HRQoL was achieved at a BMI of 26.0 in men and a BMI of 24.5 in women. Furthermore, women have higher HRQoL values than men at BMI lower than 27.5, but men have higher HRQoL than women at BMI greater than 27.5. Table 3 summarises the results of the multiple linear regression analyses. Age (55–64, and >75 years in men; all categories except 18–24 in women), GHQ12 group and comorbid illness were significantly negatively associated with HRQoL at the 5% level for men and women, whereas age (18–24 in men), educational group (above 18 in man and women and 'unfinished' in women only) and non-manual work were positively associated with HRQoL (Table 3). Associations between the HRQoL and the age groups 35–44, 45–54 and 65–74 (versus reference age category of 25–34 years), and the educational groups 'unfinished' and 'finished below aged 15 did not reach significance in men. In women, the insignificant variables were the age group between 18 and 24, the educational group 'finished below aged 15 and the presence of type 2 diabetes (Table 3).

The effect of BMI on the five dimensions of the EQ-5D showed an increase in problems with self-care, usual

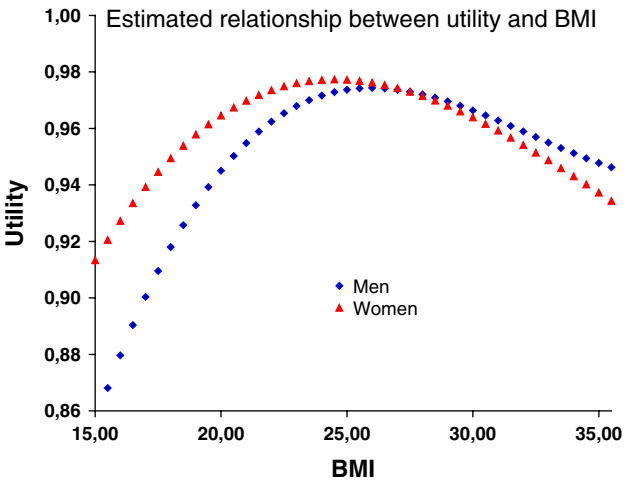


**Fig. 1** Estimated relationship between BMI and EQ-5D score after controlling for confounding factors

**Table 3** Multiple linear regression models of HRQoL for men and women (≥18 years of age). The dependent variable is EQ-5D utility values

| Variable | Model 1, men | | Model 2, women | |
|---|---|---|---|---|
| | Coefficient | Robust SE | Coefficient | Robust SE |
| Age | | | | |
| 18–24 | 0.0287† | 0.0073 | 0.0055 | 0.0075 |
| 35–44 | −0.0028 | 0.0064 | −0.0213† | 0.0059 |
| 45–54 | −0.0081 | 0.0071 | −0.0336† | 0.0068 |
| 55–64 | −0.0430† | 0.0077 | −0.0425† | 0.0072 |
| 65–74 | −0.0223 | 0.0089 | −0.0619† | 0.0092 |
| 75–00 | −0.0565† | 0.0121 | −0.0754† | 0.0114 |
| BMI[a] | | | | |
| BMI | 0.0990† | 0.0265 | 0.0572‡ | 0.0183 |
| $BMI^2$ | −0.0032† | 0.0009 | −0.0018‡ | 0.0006 |
| $BMI^3$ | 0.0000‡ | 0.0000 | 0.0000‡ | 0.0000 |
| GHQ12 | | | | |
| Group 1–3 | −0.0727† | 0.0056 | −0.0695† | 0.0050 |
| Group 4+ | −0.2507† | 0.0117 | −0.2192† | 0.0090 |
| Age when finished education | | | | |
| Below 15 | −0.0204 | 0.0103 | −0.0202 | 0.0105 |
| Above 18 | 0.0234† | 0.0049 | 0.0227† | 0.0046 |
| Unfinished | 0.0100 | 0.0107 | 0.0180‡ | 0.0090 |
| Non-manual work | | | | |
| Non-manwork | 0.0236† | 0.0048 | 0.0268† | 0.0050 |
| Long standing illness | | | | |
| Type 2 diabetes | −0.0528† | 0.0145 | −0.0325 | 0.0183 |
| Heart problems | −0.0486† | 0.0084 | −0.0278‡ | 0.0085 |
| Respiratory problems | −0.0242‡ | 0.0084 | −0.0430† | 0.0097 |
| Musculoskeletal problems | −0.1721† | 0.0078 | −0.2014† | 0.0074 |
| Cancer | −0.0946† | 0.0237 | −0.0724† | 0.0184 |
| Constant | −0.0228 | 0.2575 | 0.4010 | 0.1786 |
| Observations | 5,475 | | 6,445 | |
| *df* | 20 | | 20 | |
| *F*-value | 83.52 | | 114.18 | |
| $R^2$ | 0.3952 | | 0.4066 | |

† $P < 0.001$; ‡ $P < 0.01$

[a] *BMI categories*: continuous variable (BMI), allowing for diminishing effects on the mean ($BMI^2$) or a non-symmetrical relationship between the BMI and the mean ($BMI^3$)

Omitted variables represent the 'reference individual'. The reference individual in this study is age 24–34, GHQ-12 score 0, age 15–17 when left school, working with manual work, and has no longstanding illness

activity, pain and anxiety in underweight men compared with normal-weight men (Table 4). In women, all dimensions except pain were more frequently the problem in underweight than normal-weight individuals. In women, being overweight, obese or clinically severely obese increased the proportion of individuals with problems in all five dimensions of the EQ-5D, with the exception of anxiety in overweight women compared with those of normal weight. In men, a similar result was noted.

## Discussion

This analysis of data from the HSE 2003 shows that in the general adult population of England, there is a strong association between BMI above normal (and below normal) and decreased HRQoL. HRQoL was reduced in underweight, overweight, obese and clinically severely obese individuals compared with normal-weight individuals. In men, the BMI that produced the maximum HRQoL was 26.0, and in women it was 24.4. Interestingly, a BMI above 27 had more of a negative impact on HRQoL of women than of men, whereas low BMI had more of an impact on HRQoL in men than women. In all five dimensions of the EQ-5D, the increase in the proportion of obese individuals having problems was proportionally greater in women than in men. Previous studies have shown that obesity or being overweight can have a more significant impact on most aspects of HRQoL in women than in men [22, 30, 38]. For example, in a sample of the Swedish population aged between 35 and 64

**Table 4** The proportion of individuals reporting 'some problem' or 'extreme problem' with the five dimensions of the EQ-5D questionnaire

| Dimension | Individuals reporting 'some problem' or 'extreme problem' (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | BMI < 18.5 | | BMI 18.5–24.99 | | BMI 25–29.99 | | BMI 30–39.99 | | BMI ≥ 40 | |
| | Men | Women | Men | Women | Men | Women | Men | Women | Men | Women |
| Mobility | 11.3 | 20.6 | 11.1 | 10.1 | 14.6 | 17.2 | 21.8 | 28.0 | 30.5 | 35.4 |
| Self-care | 7.6 | 7.6 | 3.0 | 2.6 | 3.3 | 3.5 | 4.5 | 5.7 | 10.2 | 9.8 |
| Usual activity | 20.8 | 15.9 | 11.7 | 11.2 | 12.2 | 15.1 | 18.3 | 22.0 | 20.3 | 22.6 |
| Pain | 28.3 | 25.5 | 24.4 | 25.4 | 27.3 | 35.2 | 36.9 | 44.4 | 40.7 | 48.0 |
| Anxiety | 28.3 | 31.1 | 15.6 | 21.3 | 14.5 | 20.4 | 16.6 | 23.8 | 10.2 | 30.6 |

($n = 3475$), only the physical functioning and general health domains of the SF-36 were adversely affected by obesity in men, while all ten domains were adversely affected by obesity in women [22].

After adjusting for confounding factors that included gender, age, age when left school, type of work and five obesity-related morbidities, the association between BMI and HRQoL was statistically significant. However, other factors also affected HRQoL. In men, young age (18–24 years), finishing education at over 18 years of age and non-manual work had positive effects on HRQoL, while psychosocial well-being (measured by GHQ-12) and comorbidities all had a negative impact on HRQoL. In women, finishing education at over 18 years of age, unfinished education and non-manual work had positive effects on HRQoL, while any age group above 35 years, psychosocial well-being and comorbidities (except type 2 diabetes) had a negative impact on HRQoL. The negative relationship between increasing age and HRQoL in women was also reported in a recent study that utilised the Impact of Weight on Quality of Life-Lite (IWQOL-Lite) questionnaire [38]. According to the study, overweight and obese women aged 18–24.9 or above specifically demonstrated reduced HRQoL on the sexual life domain of the IWQOL-Lite, whereas men showed a steady decline in HRQoL scores with increasing age.

All five dimensions of HRQoL were negatively affected by obesity except anxiety in men. Furthermore, more overweight people had problems in four dimensions of HRQoL (not anxiety) than normal-weight individuals. In both men and women, increased BMI had the biggest impact on mobility (in terms of the increase in the proportion of overweight or obese individuals stating it was a problem). Twice as many obese men compared to men of normal-weight reported mobility as a problem, while in women, the proportion of obese reporting problems with mobility was 2.77-fold higher than for normal-weight individuals.

Just over 20% of men and women in the HSE 2003 were obese, and 45.4% of men and 33.8% of women were overweight. This high prevalence of obesity is consistent with other findings from WHO that estimated obesity in men to be 18.7, 21.6 and 23.7% in 2002, 2005 and 2010, respectively, and in women 21.3, 24.2 and 26.3% in 2002, 2005 and 2010, respectively, in the UK [1, 2]. If the rise in obesity and being overweight continues in the UK as predicted [4], we can expect to see a significant decrease in HRQoL as more people suffer from weight- and obesity-related problems with mobility, self-care, activity, pain and anxiety.

The HSE 2003 population is a good representation of the English adult population, and the sample size of over 14,000 gives this analysis excellent power. However, due to the cross-sectional nature of the HSE, causality between BMI and HRQoL cannot be inferred despite the clear association. Furthermore, the HSE was designed to provide a representative sample of the population of England living in private households. The population therefore under-represents people in poor health such as institutionalised individuals.

The EQ-5D also has accepted limitations. Each dimension does not take into consideration the importance of specific aspects of HRQoL to the individual (physical limitations will be more important to an active person than a sedentary person) [39]. In addition, BMI as a measure of obesity has some limitations—it does not distinguish between fat mass and lean body mass; and it is age, gender and ethnicity dependent and is less valid in some populations [40]. Another potential limitation of our analysis is that the visual analogue scale (VAS) of the EQ-5D was not utilised in HSE 2003 to support the self-classifier component reported here. However, previous reports using the EQ-5D VAS are consistent with our findings in reporting an association between obesity or underweight status and lower HRQoL [41]. The fact that only five comorbidities were used as confounders may also limit interpretation of the study findings. It is possible that other obesity-related morbidities may have an impact on HRQoL that could diminish the apparent impact of BMI observed in this study. While a previous study reported generally similar confounders to those considered here [18], depression also

numbered among the conditions (coronary heart disease and obstructive lung disease) shown to adversely affect HRQoL in underweight patients in an earlier study [42].

In this study, optimum HRQoL for both genders was achieved at a BMI close to 25, emphasising the importance of every individual aiming to have a normal BMI. Longitudinal population studies would be extremely valuable to assess causal pathways between obesity and HRQoL and differences of certain sub-groups within the general population.

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