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## Original Contribution

# The Impact of Long-Term Body Mass Index Patterns on Health-Related Quality of Life

## The Doetinchem Cohort Study

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Overweight is associated with a reduced health-related quality of life (QOL), but less is known about the impact of long-term body mass index (BMI, calculated as weight (kg)/height (m)$^2$) patterns on QOL in adults. In the Dutch Doetinchem Cohort Study (1989–2009) that included 1,677 men and 1,731 women aged 20–66 years, 6 BMI patterns were defined by using 4 measurements over a 15-year period: 1) persistent healthy weight (18.5–24.9, reference pattern); 2) persistent overweight (25.0–29.9); 3) persistent obesity (≥30.0); 4) developing overweight; 5) developing obesity; and 6) switching between BMI categories. For each BMI pattern, adjusted QOL (measured on a 0–100 scale) was estimated at the end of this period. The lowest QOL was observed for persistent obesity of all BMI patterns. It was 5.0 points ($P = 0.02$) lower for 1 mental dimension in men and 6.2–11.6 points ($P < 0.05$) lower for 5 (mainly physical) dimensions in women. Developing overweight or obesity scored 1.8–6.3 points ($P < 0.05$) lower on 2–5 (mainly physical) dimensions. Persistent overweight hardly differed from a persistent healthy weight. In women, switching between BMI categories resulted in a lower QOL on the mental dimensions. Studying long-term BMI patterns over a 15-year period showed that persistent obesity, developing overweight, and developing obesity resulted in a lower QOL—particularly on the physical dimensions—compared with a persistent healthy weight.

adult; body mass index; longitudinal studies; quality of life

Abbreviations: BMI, body mass index; MET, metabolic equivalent of task; QOL, health-related quality of life; SF-36, 36-item Short-Form Health Survey.

Overweight and obesity are known to be associated with a shorter life expectancy, many chronic diseases, and lower quality of life (1–5). Health-related quality of life (QOL), often measured with the standardized 36-item Short-Form Health Survey (SF-36) that includes 8 dimensions regarding physical and mental aspects of health (6), is considered a more general health indicator than mortality or disease rates (7) and therefore a relevant indicator for healthy aging.

The association between weight status and QOL has been explored by both cross-sectional and longitudinal studies. Cross-sectional studies showed that obesity (≥30.0 kg/m$^2$) was associated with lower QOL scores compared with a healthy weight (18.5–24.9 kg/m$^2$), even without apparent diseases (3, 5). However, an important aspect for healthy aging is the impact of overweight and obesity determined on the longer term. So far, longitudinal studies showed that gaining weight (within body mass index (BMI, calculated as weight (kg)/height (m)$^2$) categories) over time was associated with a lower QOL or with larger declines in QOL than having a stable weight (8–12). However, these studies on longitudinal associations between weight and QOL were based on relatively short periods of 2–6 years and/or used self-reported weight (8–12). Thus, the impact of (measured) overweight or obesity over long periods of time on QOL is not known.

One study examined the association between QOL and changing BMI categories over a longer period, that is, 20

years (13). They found that persons who remained obese or developed overweight or obesity had a lower QOL on the physical domain, but not on the mental domain, than persons who remained a healthy weight (13). However, in this study, only 2 measurements were used to classify persons into long-term BMI patterns, and no information was available on (changes in) BMI between these measurements (13). To gain insight into long-term BMI patterns, more measurements are needed. In addition, a number of studies (9–13) failed to examine the association between weight and QOL for men and women separately, although previous studies showed differences in QOL between the sexes (14, 15) and/or did not include all dimensions of QOL. Therefore, we studied, for both men and women, the impact of long-term BMI patterns, that is, over a period of 15 years, on all 8 dimensions of QOL at the end of this period, by using 4 measurements with 5-year intervals.

## MATERIALS AND METHODS

### Population and measurement rounds

The Doetinchem Cohort Study is a Dutch prospective population-based study. The baseline measurement was carried out between 1987 and 1991 involving 12,405 respondents from Doetinchem (initial response of the invitees: 62%). For the second measurement round (1993–1997), a random sample of 7,769 men and women was invited and reinvited for the third (1998–2002) and fourth (2003–2007) rounds. Response rates of the second, third, and fourth rounds were 79%, 75%, and 78%, respectively. The fifth round started in 2008 and was finished at the end of 2012. The Doetinchem Cohort Study is described in detail elsewhere (16). Assessment of QOL has been available since 1995; therefore, for the current paper, measurement rounds were shifted into the following 4 consecutive analysis rounds: 1989–1994 (baseline, round A), 1995–1999 (round B), 2000–2004 (round C), and 2005–2009 (round D) (Figure 1).

The study was approved by the external Medical Ethics Committee of the Netherlands Organization of Applied Scientific Research Institute and the University of Utrecht according to the guidelines of the Helsinki Declaration. All participants gave written, informed consent.

### Body mass index

Trained staff measured body weight and height. The participants wore light clothing and no shoes and had empty pockets. Body weight was measured with a calibrated scale to the nearest 100 g. To adjust for clothing, 1 kg was subtracted from the weight before calculating the BMI. The participants were classified into 4 BMI categories: 1) underweight (<18.5 kg/m$^2$), 2) healthy weight (18.5–24.9 kg/m$^2$), 3) overweight (25–29.9 kg/m$^2$), and 4) obesity (≥30.0 kg/m$^2$).

### Health-related quality of life (Short-Form 36)

Health-related quality of life was not measured at baseline (round A). Therefore, we used QOL data from round B to adjust for previous QOL. QOL was evaluated with the Dutch RAND-36 questionnaire (17), which is an adapted version of the standardized SF-36 (6). The RAND-36 includes 8 dimensions of QOL: 1) physical functioning, 2) role limitations due to physical health problems (role, physical), 3) bodily pain, 4) general health perceptions, 5) vitality, 6) social functioning, 7) role limitations due to emotional problems (role, emotional), and 8) mental health. The first 4 dimensions are considered to reflect the "physical dimensions," and the last 4 dimensions, the "mental dimensions." The crude score of each dimension was converted to a 0–100 scale, according to international (SF-36) methodology, with higher scores indicating better QOL (6).

### Potential confounders

Data from round D were used to evaluate potential confounders, because attained levels of a confounder or risk factor are suggested to be more relevant for a health outcome than initial levels (18, 19). Smoking status was categorized as never smoker, former smoker, and current smoker, on the basis of questions referring to past and present cigarette use. Educational level was defined as the highest completed education and was classified into 3 categories: 1) intermediate secondary education or less, 2) intermediate vocational or higher secondary education, and 3) higher vocational education or university. Work status was defined as having a job or not. Household composition was defined as living alone or not living alone (i.e., living with a partner, child(ren), a parent(s) or other adult(s)). Physical activity was assessed with the validated physical activity questionnaire developed for the European Prospective Investigation into Cancer and Nutrition (EPIC), extended with questions on sports and other strenuous leisure-time activities in the preceding year (20). All activities were categorized as light, moderate, or vigorous on the basis of the metabolic equivalent value of task (MET) as reported by Ainsworth et al. (21). Cutoff points for light, moderate, and vigorous activities were <4.0 METs, 4.0–6.5 METs, and >6.5 METs, respectively. Subsequently, the average time spent on moderate and vigorous intensity activities was used to classify persons as inactive (<0.5 hour/week), semiactive (0.5–3.4 hours/week), and normal active (≥3.5 hours/week). Alcohol use was classified as current, former, or never. Current alcohol users were classified as heavy users (mean intake: ≥3 drinks/day for men and ≥2 drinks/day for women), and moderate users (mean intake: 0–2 drinks/day for men and 0–1 drink/day for women).

### Statistical analyses

As we carried out a complete case analysis, data had to be available on BMI at all 4 rounds, demographics and lifestyle variables at round D, and QOL at rounds B and D ($n$ = 3,638). In total, 4,131 respondents were excluded, mainly due to nonresponse at follow-up (Figure 1). The proportion of men did not differ between the excluded respondents and the included respondents ($P = 0.14$). However, the excluded respondents were slightly older by 0.9 years ($P < 0.01$) and had a higher BMI of 0.7 kg/m$^2$ ($P < 0.01$) at baseline (round A). Women who were pregnant ($n = 87$) and underweight

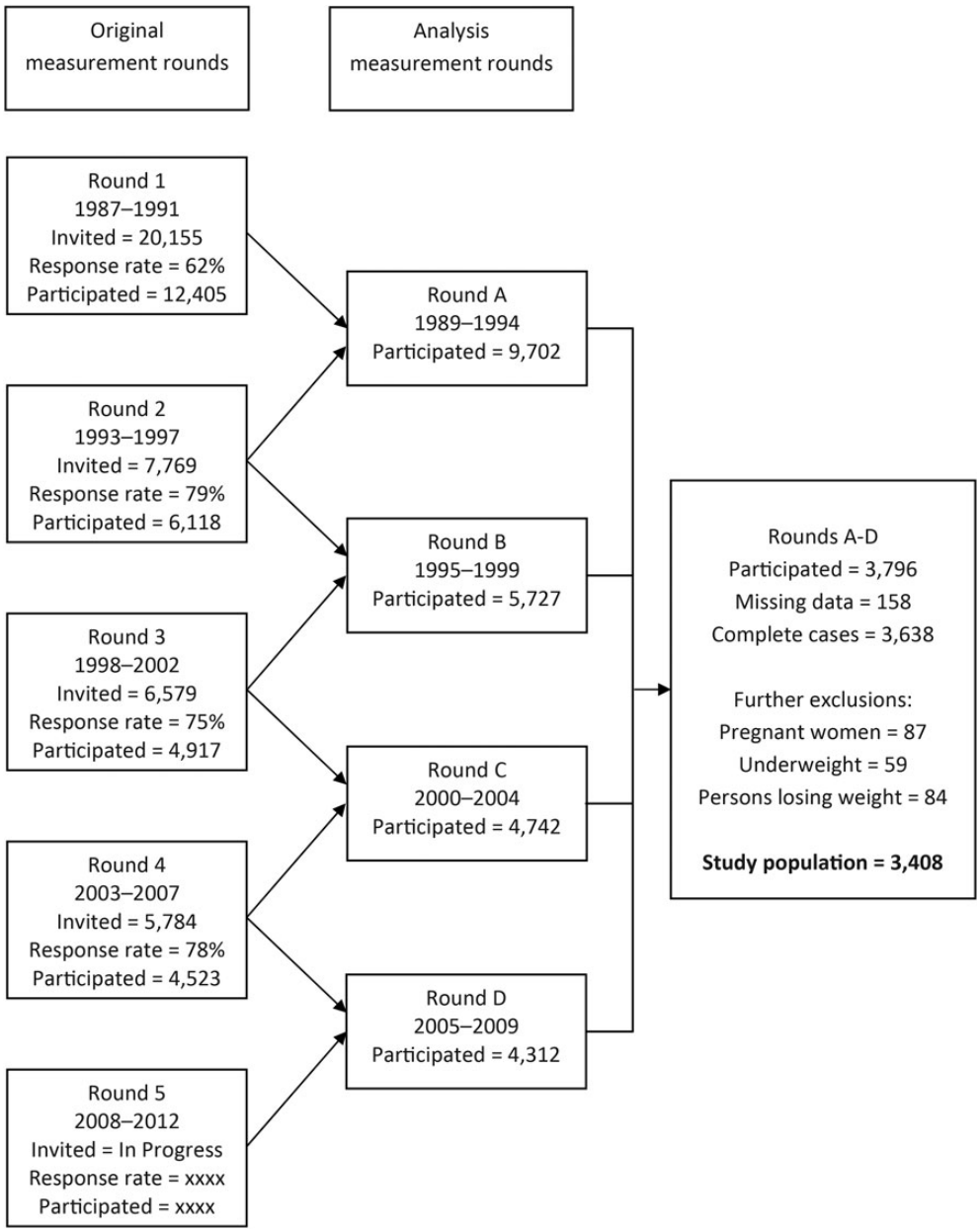


**Figure 1.** Flow chart of the shifted rounds, the Doetinchem Cohort Study, the Netherlands, 1989–2009.

persons ($n = 59$) at 1 of the measurement rounds were excluded from analyses. The number of underweight participants at 1 of the 4 measurements was too low ($n = 59$) to classify them in a separate pattern, and they could not be combined with those with a persistent healthy weight as from exploratory analysis we observed structurally lower QOL scores (data not shown).

The remaining participants ($n = 3,492$) were classified in 1 of the following BMI patterns by using the BMI status of each round: "persistent healthy weight," "developing overweight," "persistent overweight," "developing obesity," "persistent obesity," "switching between categories," "becoming healthy weight," and "becoming overweight" (Figure 2). The latter 2 patterns with participants losing weight were excluded from the analysis because of the low number of participants ($n = 69$ and $n = 15$, respectively). In all, we analyzed the data of 3,408 participants who were classified into 6 long-term BMI patterns.

Descriptive statistics were carried out for study characteristics and QOL, and the differences between sexes were examined with an independent-samples $t$ test for continuous variables and a $\chi^2$ test for categorical variables.

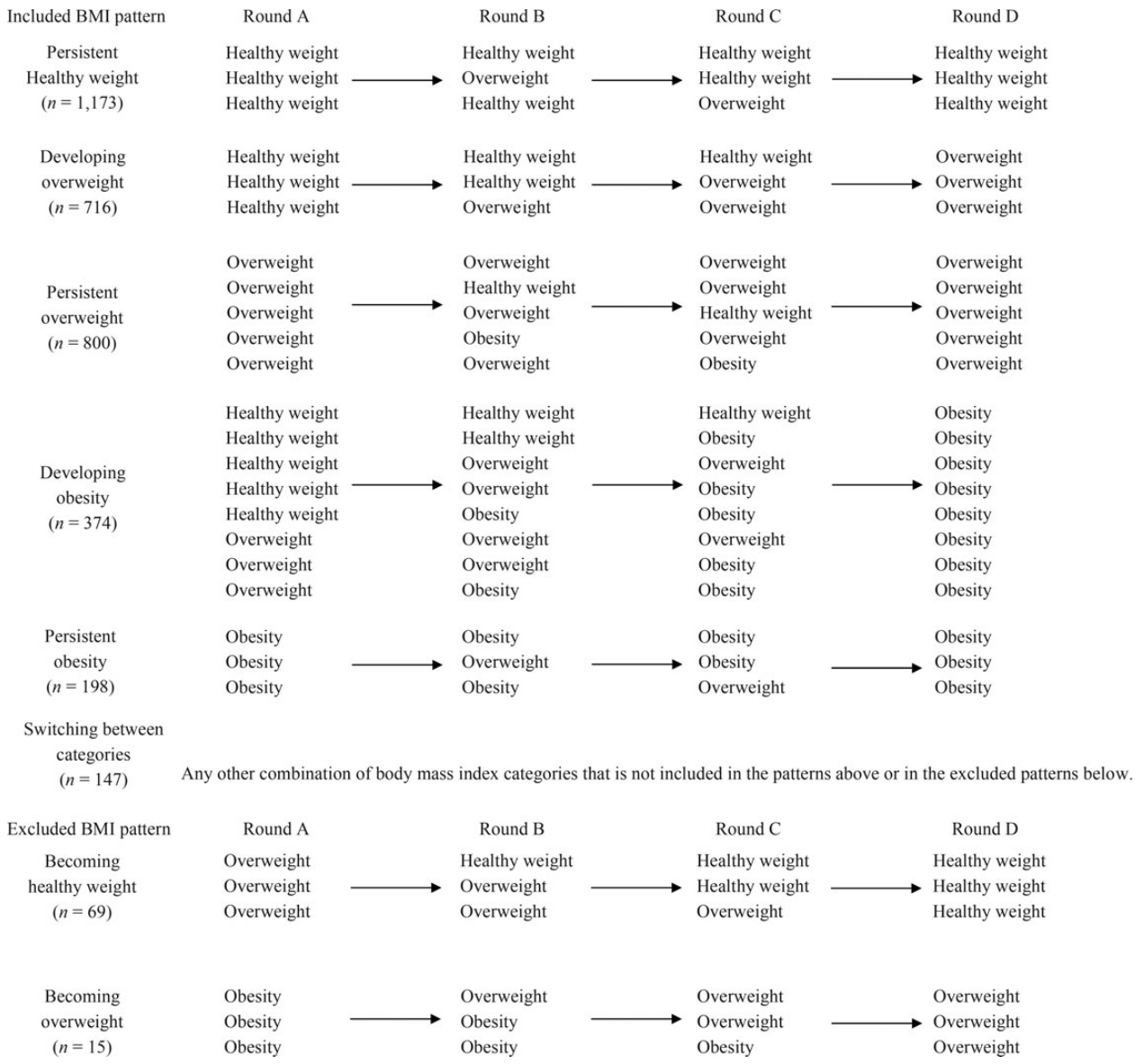


**Figure 2.** Defined long-term body mass index (BMI) patterns, the Doetinchem Cohort Study, the Netherlands, 1989–2009.

To examine the differences between the reference BMI pattern "persistent healthy weight" and the other 5 BMI patterns in QOL at round D, we carried out multivariable linear regression analyses. We used generalized estimated equations with the estimation of robust standard errors to account for the skewed distribution of QOL. The least-squares-means method was used to estimate the adjusted mean of QOL for each BMI pattern. Adjustments were made for age, smoking status, educational level, physical activity, alcohol use, work status, and household composition at round D and for QOL at round B (SAS, version 9.2, software; SAS Institute, Inc., Cary, North Carolina; 2-tailed *P* values are reported for all analyses).

Interaction terms between age (<60 years and ≥60 years at round D) and BMI patterns were entered into the model to test for interaction (significant at $P \leq 0.05$ (2 sided)), since age was expected to be highly associated with (changes in) QOL (22, 23).

Sensitivity analyses were carried out by repeating the analyses by further adjusting for the presence of a chronic disease at each round and by excluding persons who had a chronic disease at ≥1 measurement round(s). These chronic diseases were self-reported at each measurement round and included diabetes, myocardial infarction, stroke, cancer, and asthma.

## RESULTS

A persistent healthy weight was found more often among women (40.8%) than among men (27.8%), while persistent

overweight was found more often among men (31.2%) than among women (16.0%) (Table 1). Men had higher scores on all 8 QOL dimensions assessed at round B than women did ($P < 0.05$) (Table 1). Furthermore, men differed from women in all study characteristics assessed at round D ($P < 0.01$), except for physical activity ($P = 0.57$) (Table 1).

The following results are reported as score differences from the mean score of the reference BMI pattern, "a persistent healthy weight" (for men and women separately). In general, persistently obese adults had the lowest scores on all QOL dimensions, and this was most marked for the physical dimensions, especially in women (Web Figure 1 available at http://aje.oxfordjournals.org/). Persistently obese women had statistically significant lower scores ($P < 0.05$) on physical functioning (9.2 points), role limitations due to physical health problems (11.6 points), general health perceptions (6.6 points), vitality (6.2 points), and role limitations due to emotional problems (6.8 points) (Table 2; Web Figure 1A). Persistently obese men had lower scores on all QOL dimensions, but the difference was statistically significant only for social functioning (5.0 points; $P = 0.02$) and borderline statistically significant ($P \leq 0.10$) for physical functioning (3.4 points) and general health perceptions (3.4 points) (Table 3; Web Figure 1B).

Also, adults who developed obesity had lower scores on the physical dimensions, and this was more pronounced in women than in men. Women who developed obesity scored from 3.9 to 6.3 points lower on the physical dimensions ($P < 0.05$) and 3.2 points lower on vitality ($P < 0.01$) (Table 2; Web Figure 1A). Men who developed obesity scored statistically significant lower ($P < 0.05$) on physical functioning (3.5 points), general health perceptions (3.2 points), and borderline statistically significant lower on bodily pain (3.0 points) ($P = 0.08$) (Table 3; Web Figure 1B).

Persistently overweight adults did not score statistically significant lower on QOL, except for a 3.2-points-lower mean score on physical functioning in women ($P < 0.01$) (Tables 2 and 3; Web Figure 1).

For developing overweight, lower scores on some of the QOL dimensions were observed. Women who developed overweight had statistically significant lower scores ($P < 0.05$) on physical functioning (2.8 points), general health perceptions (3.1 points), vitality (2.4 points), and role limitations due to emotional problems (3.9 points) (Table 2; Web Figure 1A). For men who developed overweight, statistically significant lower scores ($P < 0.05$) were observed only on physical functioning (1.8 points) and general health perceptions (3.3 points) (Table 3; Web Figure 1B).

Women who switched between BMI categories had statistically significant lower scores (3.6–9.8 points) on the 4 mental dimensions ($P < 0.05$) (Table 2; Web Figure 1A). In men, higher scores were observed on physical role limitations (6.5 points) ($P = 0.03$) (Table 3; Web Figure 1B).

### Interaction between age and BMI patterns

We found no overall interactions between age and BMI patterns in the association with QOL, with the exception of women and general health perceptions ($P = 0.02$) and role, emotional ($P = 0.04$). However, in persistently obese women aged ≥60 years, we observed consistently (larger) negative differences in QOL scores compared with their persistently healthy weight peers than in women aged <60 years. For physical functioning, role, physical, bodily pain, vitality, social functioning, role, emotional, and mental health, this difference for women aged ≥60 years was −12.5, −16.4, −6.6, −7.7, −3.0, −12.2, and −1.9, while for women aged <60 years this difference was −6.4, −7.2, 0, −3.9, −2.0, 1.1, and 0.4, respectively. For men, no consistent differences between age groups were found (data not shown).

### Sensitivity analyses

Adjustment for the presence of a chronic disease did not affect our main findings (data not shown). After exclusion of persons with a chronic disease, most observed score differences changed with a decrease in score difference of up to 1.6 points, and with an increase in score difference of up to 2.2 points. A larger change was found for persistently obese women and emotional role limitations, which decreased by 4.5 points.

## DISCUSSION

Persistently obese men and women had the lowest scores on almost all QOL dimensions compared with other long-term BMI patterns. Men and women who developed obesity or overweight had lower scores on mainly the physical QOL dimensions than did those with a persistent healthy weight. These findings were most pronounced in women. Women who switched between BMI categories had lower scores on the mental QOL dimensions than persistently healthy weight women.

Our findings of an association between long-term BMI patterns and the physical dimensions of QOL were comparable to the findings by Kozak et al. (13). They examined the association between 6 BMI patterns and QOL, comparable to our patterns, over a 20-year period by using the change in BMI category from 2 measurements (13). In contrast to Kozak et al. (13), we also found an association between lower scores on mental dimensions (1 in men and 2 in women). This might be explained by the difference in population (i.e., younger, other country) and applied methods (e.g., defining patterns by only 2 measurements and adjusting for different variables, such as general health instead of an earlier QOL score). Our results as to developing overweight or obesity were also in agreement with studies that found an association between weight gain and a lower QOL on the physical dimensions compared with a stable weight (10–12). In addition, in women, we found consistent associations between the switching BMI pattern and lower scores on the mental dimensions compared with a persistent healthy weight. These associations have not been examined before.

The differences in QOL between a persistent healthy weight and other BMI patterns were strikingly larger in women than in men and were in agreement with previous cross-sectional and longitudinal studies (22, 24, 25). The sex difference was largest for the switching BMI pattern. An explanation for the sex difference regarding the mental dimensions might be that, compared with men, women have a greater drive to look thin

**Table 1.** Study Characteristics, the Doetinchem Cohort Study, the Netherlands, 1989–2009

| | Men ($n = 1,677$) | | Women ($n = 1,731$) | | *P* Value* |
|---|---|---|---|---|---|
| | % | Mean (SD) | % | Mean (SD) | |
| BMI patterns | | | | | <0.01 |
| Persistent healthy weight | 27.8 | | 40.8 | | |
| Developing overweight | 22.9 | | 19.2 | | |
| Persistent overweight | 31.2 | | 16.0 | | |
| Developing obesity | 10.0 | | 11.9 | | |
| Persistent obesity | 5.0 | | 6.6 | | |
| Switching between categories | 3.1 | | 5.5 | | |
| 8 dimensions of QOL at round B | | | | | |
| Physical functioning | | 91.1 (13.9) | | 87.6 (16.7) | <0.01 |
| Role, physical | | 86.2 (28.0) | | 81.4 (32.9) | <0.01 |
| Bodily pain | | 83.5 (20.2) | | 77.9 (22.1) | <0.01 |
| General health perceptions | | 68.4 (16.8) | | 67.3 (16.9) | 0.04 |
| Vitality | | 70.1 (16.2) | | 65.3 (16.7) | <0.01 |
| Social functioning | | 89.4 (17.6) | | 84.3 (20.8) | <0.01 |
| Role, emotional | | 89.9 (25.0) | | 85.7 (30.9) | <0.01 |
| Mental health | | 79.3 (14.0) | | 74.9 (14.8) | <0.01 |
| Age[a] | | 57.8 (10.0) | | 57.2 (9.9) | 0.09 |
| Smoking status[a] | | | | | <0.01 |
| Current smoker | 17.6 | | 19.4 | | |
| Former smoker | 50.9 | | 40.1 | | |
| Never smoker | 31.5 | | 40.6 | | |
| Educational level | | | | | <0.01 |
| Low | 32.3 | | 49.6 | | |
| Moderate | 36.8 | | 27.6 | | |
| High | 31.0 | | 22.8 | | |
| Physical activity[a] | | | | | 0.57 |
| Inactive | 3.6 | | 3.0 | | |
| Semiactive | 15.9 | | 16.4 | | |
| Normal active | 80.4 | | 80.7 | | |
| Alcohol use[a] | | | | | <0.01 |
| Never drinker | 4.7 | | 14.7 | | |
| Former drinker | 2.2 | | 1.7 | | |
| Moderate use | 80.0 | | 76.1 | | |
| Heavy use | 13.2 | | 7.5 | | |
| Job[a] | | | | | <0.01 |
| No | 39.2 | | 51.4 | | |
| Yes | 60.8 | | 48.6 | | |
| Living alone[a] | | | | | <0.01 |
| No | 89.4 | | 85.0 | | |
| Yes | 10.6 | | 15.0 | | |

Abbreviations: BMI, body mass index; QOL, health-related quality of life; SD, standard deviation.

* $P < 0.05$ (2 sided).

[a] Study characteristics were displayed for round D (2005–2009), because our analyses were adjusted for these variables at round D.

**Table 2.** Adjusted Mean Difference in 8 Dimensions of Health-Related Quality of Life at the End of the 15-Year Period Compared With Persons With a Persistent Healthy Weight by Body Mass Index Pattern in Women, the Doetinchem Cohort Study, the Netherlands, 1989–2009

| | Mean Persistent Healthy Weight Score (SE) | Developing Overweight | | Persistent Overweight | | Developing Obesity | | Persistent Obesity | | Switching | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean Difference[a] | *P* Value | Mean Difference[a] | *P* Value | Mean Difference[a] | *P* Value | Mean Difference[a] | *P* Value | Mean Difference[a] | *P* Value |
| Physical functioning | 86.7 (0.5) | −2.8* | <0.01 | −3.2* | <0.01 | −6.3* | <0.01 | −9.2* | <0.01 | −1.2 | 0.44 |
| Role, physical | 83.2 (1.2) | −2.5 | 0.25 | −3.7 | 0.14 | −5.8* | 0.03 | −11.6* | <0.01 | −2.5 | 0.47 |
| Bodily pain | 76.2 (0.7) | −1.6 | 0.20 | −1.9 | 0.19 | −4.6* | <0.01 | −3.3 | 0.17 | −0.6 | 0.80 |
| General health perceptions | 71.1 (0.6) | −3.1* | <0.01 | −0.3 | 0.76 | −3.9* | <0.01 | −6.6* | <0.01 | −1.9 | 0.23 |
| Vitality | 68.5 (0.5) | −2.4* | 0.01 | −0.8 | 0.42 | −3.2* | <0.01 | −6.2* | <0.01 | −5.2* | <0.01 |
| Social functioning | 87.8 (0.7) | −1.8 | 0.11 | −1.2 | 0.34 | −0.9 | 0.52 | −2.7 | 0.18 | −4.8* | 0.05 |
| Role, emotional | 90.1 (1.0) | −3.9* | 0.04 | 0.0 | 0.98 | 0.0 | 0.98 | −6.8* | 0.03 | −9.8* | 0.01 |
| Mental health | 76.9 (0.5) | −0.2 | 0.80 | 0.5 | 0.59 | 0.3 | 0.76 | −1.0 | 0.43 | −3.6* | 0.02 |

Abbreviation: SE, standard error.

* $P < 0.05$ (2 sided).

[a] Difference compared with reference category: Persistent healthy weight, adjusted for age, smoking status, educational level, physical activity, alcohol use, work status, and household composition at round D and for health-related quality of life at round B.

because of external pressure (e.g., media) and the stigmatization of obesity is more pronounced (26–28). Thus, women are more likely to try to lose weight through dieting and, when dieting fails, their self-esteem and body image may get negatively affected (26, 27).

In addition to the factors mentioned for the mental dimensions, the sex difference for the physical dimensions might also be explained by men being physically stronger than women, with men being more likely to recover from disabilities, with the possibility that men have more muscle mass than women for the same BMI, and the tendency by men to underreport health problems (29–31).

Strengths of our study include the large, population-based sample that allowed us to investigate the relation between 6 long-term BMI patterns and QOL in the general population. Trained personnel measured the participants' weight and height. We had data on all 8 dimensions of QOL at several measurement rounds, as well as data on demographics and

**Table 3.** Adjusted Mean Difference in 8 Dimensions of Health-Related Quality of Life at the End of the 15-Year Period Compared With Persons With a Persistent Healthy Weight by Body Mass Index Pattern in Men, the Doetinchem Cohort Study, the Netherlands. 1989–2009

| | Mean Persistent Healthy Weight Score (SE) | Developing Overweight | | Persistent Overweight | | Developing Obesity | | Persistent Obesity | | Switching | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean Difference[a] | *P* Value | Mean Difference[a] | *P* Value | Mean Difference[a] | *P* Value | Mean Difference[a] | *P* Value | Mean Difference[a] | *P* Value |
| Physical functioning | 89.8 (0.6) | −1.8* | 0.03 | 1.4 | 0.07 | −3.5* | <0.01 | −3.4 | 0.10 | 0.5 | 0.74 |
| Role, physical | 86.6 (1.3) | 0.8 | 0.67 | 0.7 | 0.72 | 0.7 | 0.76 | −4.3 | 0.26 | 6.5* | 0.03 |
| Bodily pain | 81.9 (0.8) | −1.3 | 0.30 | −0.1 | 0.92 | −3.0 | 0.08 | −2.5 | 0.26 | 1.8 | 0.43 |
| General health perceptions | 71.6 (0.7) | −3.3* | <0.01 | 0.1 | 0.94 | −3.2* | 0.03 | −3.4 | 0.08 | 1.6 | 0.41 |
| Vitality | 73.2 (0.6) | −1.1 | 0.26 | −1.1 | 0.24 | 0.0 | 0.97 | −2.5 | 0.15 | −0.8 | 0.64 |
| Social functioning | 91.4 (0.7) | −0.4 | 0.68 | −0.7 | 0.53 | −0.3 | 0.83 | −5.0* | 0.02 | −0.3 | 0.90 |
| Role, emotional | 92.8 (1.0) | 0.2 | 0.89 | −0.3 | 0.84 | −1.0 | 0.64 | −3.8 | 0.24 | −6.5 | 0.13 |
| Mental health | 81.9 (0.5) | −0.1 | 0.90 | −1.2 | 0.10 | 0.2 | 0.85 | −2.5 | 0.12 | −1.6 | 0.34 |

Abbreviation: SE, standard error.

* $P < 0.05$ (2 sided).

[a] Difference compared with reference category: Persistent healthy weight, adjusted for age, smoking status, educational level, physical activity, alcohol use, work status, and household composition at round D and for health-related quality of life at round B.

lifestyle. Therefore, we were able to adjust for important characteristics and an earlier score of QOL.

A limitation of our study is the loss to follow-up that resulted in a relatively healthy population that remained in the Doetinchem Cohort Study (32). Because of the higher BMI at baseline in the excluded respondents, as presented in Materials and Methods, we examined whether the cross-sectional associations (at round B) between BMI status and QOL were different for included and excluded persons by examining the interaction between inclusion and BMI. We found only small and mostly insignificant differences, which suggest that the lack of data for the excluded respondents had little effect on our findings.

Our study did not have data on stressful life events, which have been shown to be associated with weight gain (33) and could be an explanatory factor for the finding of the lower scores on the mental dimension of QOL in women who switched between BMI categories. However, illness-related life events have been shown to be an important predictor of BMI in a British population (34). We accounted for the presence of chronic diseases at each round, which did not affect our main findings.

Because of the observational nature of our study, we cannot establish the underlying pathway or direction of the association between the BMI patterns and QOL. A recent study by Cameron et al. (22) found associations between baseline BMI and changes in QOL and between baseline QOL and changes in BMI over 5 years, which suggests a bidirectional relationship between BMI and QOL. However, for the physical dimensions, a clear dose-response relationship between baseline BMI and changes in QOL was observed, while for baseline QOL and changes in BMI, this was not observed (22). We also observed a dose-response relationship between the BMI patterns (excluding switching pattern) in women especially and QOL on the physical dimensions. With each increasing pattern, thus from becoming overweight to having persistent obesity, the QOL at the end of the 15-year period became lower, and thus the difference with those who had a persistent healthy weight became larger (Web Figure 1).

In our study, the period between measurements was 5 years, which can be assumed to be more accurate than an interval of 20 years. However, the amount of measurements needed to capture relevant BMI changes in order to explain the impact on health is unknown. In addition, the definition of our BMI patterns was not overly restrictive (Figure 2). We allowed, for example, one deviation to another BMI category at round B or C in the persistent weight patterns. In preliminary analyses, we also examined other definitions of persistent weight patterns in which no deviation was allowed, or of developing patterns in which progression to a higher BMI category that occurred at the final round was not allowed. This did not change our results substantially, indicating that our results are robust. Therefore, we think that we captured the global changes in BMI during the life course that give a good indication of the consequences of exposure or developments of overweight or obesity on the longer term.

Differences in the 8 QOL dimensions are considered clinically important if between 3 and 5 points (35). However, this applies to clinical samples, while we examined "healthy" participants in a population-based study. In population-based samples, smaller differences can impact public health (36). Therefore, our results of several BMI patterns scoring at least 3 points lower compared with a persistent healthy weight may be of importance for public health. Moreover, in persistently obese women aged ≥60 years, we observed larger negative differences in QOL scores compared with their persistently healthy weight peers than in women aged <60 years. This might be explained by a longer exposure to obesity in the elder group. This stresses again the importance of prevention of overweight and especially obesity and implies that prevention should be implemented early in adulthood. Furthermore, women who switched between BMI categories had lower scores on the mental dimensions, ranging from −4 to −10, than persistently healthy weight women. This indicates that prevention of weight cycling is especially relevant for women.

Only persistently overweight persons did not show lower scores on QOL than persistently healthy weight persons, except for women. This suggests that, to retain a good QOL in later life for persons who are overweight, they do not necessarily have to lose weight, although they should avoid the development of obesity.

In conclusion, in this population-based study, adults who developed overweight or obesity or who were persistently obese over 15 years had lower QOL scores—particularly on the physical dimensions—compared with those who were persistently of healthy weight. Women who switched between BMI categories had lower scores on the mental dimensions of QOL than did persistently healthy weight women. Thus, in particular for women, prevention of developing overweight and especially obesity is important not only for preventing specific diseases but also for QOL in general.

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