Impairment of Health and Quality of Life Using New US Federal Guidelines for the Identification of Obesity

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Background: Estimating total burdens of disease associated with overweight and obesity has been hampered by a lack of consistent published data using standardized body mass index (BMI or Quetelet index [calculated as weight in kilograms divided by the square of the height in meters: weight (kg)/{height·(m)²}]) diagnostic criteria, and by poorly standardized reference populations.

Subjects and Methods: Symptoms of respiratory insufficiency, low back pain, non–insulin-dependent diabetes mellitus, cardiovascular risk factors, and physical functioning using SF-36 questionnaire were determined in a cross-sectional representative survey of 5887 men and 7018 women aged 20 to 59 years from the Netherlands and analyzed using BMI criteria of the National Institutes of Health and the World Health Organization guidelines.

Results: The prevalences of cardiovascular risks were higher in men than women, but the other health outcomes were more frequent in women. Virtually all health outcomes considered were significantly influenced by BMI. A BMI of 25 to 30 kg/m² had a generally greater impact on odds ratios for health outcomes in women than in men. People with BMI below 25 kg/m² were considered the reference group, with low prevalence of symptoms of obesity-related diseases and good quality of life. Between 25 to 30 kg/m², the prevalences of these were all increased, and above 30 kg/m² greatly increased. After adjustments for age and lifestyle factors, odds ratios (95% confidence intervals [95% CI]) in those with a BMI of 30 kg/m² or higher were 3.5 (95% CI, 2.8-4.4) in men and 3.3 (95% CI, 2.8-3.9) in women for shortness of breath when walking upstairs, 4.6 (95% CI, 2.4-8.8) in men and 5.4 (95% CI, 2.8-10.5) in women for non–insulin-dependent diabetes mellitus, 5.3 (95% CI, 4.5-6.6) in men and 2.9 (95% CI, 2.4-3.4) in women for having at least 1 major cardiovascular risk factor. Both men and women with BMI of 30 kg/m² or higher were twice as likely to have difficulties in performing a range of basic daily physical activities. Compared with women with BMI lower than 25 kg/m², those with BMI of 30 kg/m² or higher were 1.5 times more likely to have symptoms of intervertebral disk herniation. Significantly more overweight women had problems associated with low back pain, including hindrance to their daily business, absence from work, and medical consultation.

Conclusions: Health risks for a range of problems are presented using the standard BMI cutoff points. Overweight and obesity are associated with increased risks of chronic diseases, secondary symptoms, and impairment of quality of life.

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Health Service burdens are aggravated by overweight and adverse fat distribution through clusters of symptoms, risk factors, and associated secondary diseases including coronary heart disease, strokes, non–insulin-dependent diabetes mellitus (NIDDM), and several cancers.1-4 However, estimating total burdens of disease in populations and the financial costs associated with overweight has been hampered by a lack of consistent published data using the standardized body mass index (BMI or the Quetelet index [calculated as weight in kilograms divided by the square of the height in meters: weight (kg)/{height·(m)²}] cut-off points on which the diagnoses of overweight and obesity are based, and by poorly standardized reference populations.

Hitherto, data on disease associations of obesity have been customarily analyzed by tertiles of BMI, and divisions by median, tertiles, and quintiles have been performed in epidemiological research for statistical reasons. Data used in health economics analyses are still based on a variety of diagnostic criteria including a BMI higher than 30, higher than 27.7, higher than 25, and even higher than 22 kg/m².5 Some are still based on percentage standard weight which, of course, varies between populations. This study summarizes the prevalence of some major obesity-related diseases and their associated costs.
SUBJECTS AND METHODS

SUBJECTS

Dutch men (n = 5887) and women (n = 7018) aged 20 to 59 years were recruited randomly from civil registries for the MORGEN (Monitoring Cardiovascular Health in the Netherlands) project 1993-1995. The project was undertaken as a public health surveillance to monitor chronic diseases, risk factors, and their consequences in the general population living in various parts of the Netherlands. Aiming to achieve a sample broadly representative of the general population, measurements were made in health centers in Amsterdam (in the west), Doetinchem (a small town in the east), and Maastricht (in the south), with an overall response rate of approximately 50%. To obtain similar numbers of subjects at each age, the sample was stratified by sex and 5-year age groups. Information on quality of life was available in 1885 men and 2156 women, and on low back pain in 2467 men and 3448 women. Those who were of non-Dutch nationality were excluded from analyses.

MEASUREMENTS

All anthropometric measurements were made according to the WHO recommendations by trained paramedical personnel. Subjects wore light clothes during measurements of body weight to the nearest 100 g using calibrated scales, height in barefoot to the nearest millimeter. Lifestyle factors were obtained from a questionnaire.

SECONDARY SYMPTOMS, DISEASE, AND IMPAIRMENT OF QUALITY OF LIFE

Detailed definitions of symptoms of respiratory insufficiency that included shortness of breath, wheezing, coughing, and bringing up phlegm, cardiovascular risk factors, low back pain, NIDDM, symptoms, and measures of quality of life represented by 10 items of physical functioning from the standardized SF-36 Health Survey and their derived physical health concept have been published previously and presented herein.

The definitions of the following symptoms, secondary chronic disease, and poor quality life have been published elsewhere.

Respiratory Symptoms

Respiratory symptoms were obtained from a selection of questions that were used in the European Respiratory Health Survey. Symptoms selected for analysis include wheezing in the past 12 months when not having a cold, being awakened by shortness of breath during past 12 months, coughing daily (day or night) for a total of 3 or more months per year, bringing up phlegm daily (day or night) for a total of 3 or more months per year, shortness of breath when walking uphill or upstairs, and shortness of breath when walking at normal pace with people of the same age.

Cardiovascular Risk Factors

Sitting blood pressure was measured using the random zero sphygmomanometer. Systolic (Korotkoff phase 1) and diastolic (Korotkoff phase 5) blood pressures were measured twice on the left upper arm and the average used for analysis. Total and high-density lipoprotein cholesterol concentrations were determined enzymatically with a Boehringer kit. High-density lipoprotein was isolated by precipitating apolipoprotein B-containing lipoproteins with magnesium phosphotungstate. All cholesterol analyses were performed at the clinical chemistry laboratory, University Hospital of Dijkzigt, Rotterdam, the Netherlands, under standardization programs (WHO Regional Lipid Centre for Europe, Prague, Czechoslovakia, and the Centers for Disease Control and Prevention, Atlanta, Ga). Hypercholesterolemia was defined as a plasma cholesterol level of 6.5 mmol/L or higher (≥251 mg/dL) and a low high-density lipoprotein cholesterol level of 0.9 mmol/L or lower (<34.8 mg/dL); and hypertension, as systolic blood pressure of

related chronic diseases, symptoms, and impairment of quality of life, and it calculated the odds ratios for the BMI categories adopted by the National Institutes of Health (NIH) and by the World Health Organization (WHO), ie, overweight, BMI, 25 to 30 kg/m²; and obesity, BMI of 30 kg/m² or higher with reference to a BMI lower than 25 kg/m². Our study has examined a wide range of health outcomes related to overweight and obesity as well as the better documented cardiovascular risks.

RESULTS

Men (n = 5887) and women (n = 7018), respectively, had a mean (SD) age of 42.9 (10.7) and 42.2 (11.0) years; weight, 82.0 (12.0) and 68.5 (11.5) kg; height, 178.4 (7.3) and 165.7 (6.7) cm; and BMI, 25.8 (3.5) and 25.0 (4.2) kg/m². Overall prevalences of obesity-related diseases, symptoms, and poor quality of life are shown in Table 1.

In this study, there were 26% men and 20% women who were educated at higher vocational or university level, 29% men and 25% at vocational or higher education, and 47% men and 55% women at secondary education or lower. There were 30% male and 36% female never smokers, 33% male and 26% female former smokers, and 36% male and 37% female smokers. Detailed analyses of these lifestyle factors on body composition of the subjects in this study have been examined and presented elsewhere. The prevalence of cardiovascular risks and NIDDM were greater in men than in women, but most other health outcomes were more prevalent in women. Virtually all health outcomes considered were significantly influenced by BMI. A BMI of 25 to 30 kg/m² had a generally greater impact on odds ratios for health outcomes in women than in men (Table 1; Figure 1). There were 45% men and 31% women with a BMI between 25 and 30 kg/m², and 11% men and 11% women with a BMI above 30 kg/m². The prevalence of these health risks increased with increasing BMI (Table 1), and was highest in those with a BMI above 30 kg/m².

Table 2 shows that after adjustments for age and appropriate lifestyle factors, compared with those with a
BMI below 25 kg/m² as the reference group, the odds ratios in those with a BMI of 30 kg/m² or higher were 3.5 (95% CI, 2.8-4.4) in men and 3.3 (95% CI, 2.8-3.9) in women for shortness of breath when walking upstairs; 4.6 (95% CI, 2.4-8.8) in men and 5.4 (95% CI, 2.8-10.5) in women for NIDDM; and 5.5 (95% CI, 4.5-6.6) in men and 2.9 (95% CI, 2.4-3.4) in women for having at least 1 major cardiovascular risk factor. Both men and women with a BMI of 30 kg/m² or higher were twice as likely to have difficulties in performing a range of basic activities of daily living.

**Figure 2** shows the proportions of subjects whose activities of daily living were affected by low back pain. About a third of men and women reported that, owing to low back pain, their daily business was hindered, they had to be absent from work, and more than 40% sought medical consultation as a result of low back pain. Compared with women with a BMI lower than 25 kg/m², those with a BMI of 30 kg/m² or higher were 1.5 times more likely to have symptoms of intervertebral disk herniation. Significantly more overweight women had problems associated with low back pain including hindrance to their daily business, absence from work, and medical consultation. **Table 3** shows that after adjustments for age and lifestyle factors, the proportions of these consequences of low back pain were increasingly higher in subjects with a higher BMI.

**Both the NIH** and WHO now recommend the classification of BMI using the diagnostic cutoff points of 25 and 30 kg/m² as used in this article (with additional but small categories such as <18.5 kg/m² and within the obese, 35 and 40 kg/m² as additional cutoff points). There is in fact surprisingly limited information on the health risks in these BMI classes, mainly because most large US studies have previously used other criteria (such as percentage relative weight) and other BMI cutoff points (27.3 and 27.8 kg/m²). Even in this relatively large, detailed study, numbers preclude divisions into smaller categories, eg, by a BMI of 28 or higher, or a BMI of 35 kg/m² or higher.
Attempts to quantify the impact of obesity on health and health service costs have been confused by lack of standardization. Commonly, reports on morbidity have been based on a quartile or quintile classification of BMI that are appropriate on purely statistical grounds, but these do not easily translate newly standard diagnostic classification based on BMI cutoff points. For example, the relative risks for NIDDM have been quoted as up to 40 for

**Table 1. Unadjusted Prevalence of Subjects With Chronic Disease, Symptoms, and Poor Quality of Life in Different Categories of BMI, in 5887 Men and 7018 Women (1885 Men and 2156 Women in Quality-of-Life Analysis)**

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>&lt;25</td>
</tr>
<tr>
<td>Proportions of subjects, %</td>
<td>100</td>
<td>44.0</td>
</tr>
<tr>
<td>Respiratory symptoms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheezing when not having a cold</td>
<td>9.2</td>
<td>8.5</td>
</tr>
<tr>
<td>Awakened by shortness of breath</td>
<td>5.0</td>
<td>4.6</td>
</tr>
<tr>
<td>Coughing for &gt;3 mo</td>
<td>7.7</td>
<td>7.9</td>
</tr>
<tr>
<td>Bring up phlegm for &gt;3 mo</td>
<td>6.8</td>
<td>6.6</td>
</tr>
<tr>
<td>Shortness of breath when walking uphill or upstairs</td>
<td>16.0</td>
<td>11.2</td>
</tr>
<tr>
<td>Shortness of breath when walking with others</td>
<td>4.6</td>
<td>3.1</td>
</tr>
<tr>
<td>Cardiovascular risk factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High total cholesterol ≥6.5 mmol/L (≥251 mg/dL)</td>
<td>14.6</td>
<td>9.4</td>
</tr>
<tr>
<td>Low HDL cholesterol ≤0.9 mmol/L (≤34 mg/dL)</td>
<td>21.3</td>
<td>13.5</td>
</tr>
<tr>
<td>Hypertension§</td>
<td>10.3</td>
<td>3.7</td>
</tr>
<tr>
<td>At least 1 risk factor</td>
<td>38.0</td>
<td>23.6</td>
</tr>
<tr>
<td>Diabetes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non–insulin-dependent diabetes mellitus</td>
<td>1.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Low back pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic low back pain (total ≥12 wk/y)</td>
<td>16.6</td>
<td>14.5</td>
</tr>
<tr>
<td>Symptom of intervertebral disk herniation</td>
<td>13.4</td>
<td>10.9</td>
</tr>
<tr>
<td>“Poor” quality of life, difficulties in physical functioning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vigorous activities</td>
<td>50.1</td>
<td>43.9</td>
</tr>
<tr>
<td>Moderate activities</td>
<td>13.7</td>
<td>10.8</td>
</tr>
<tr>
<td>Lift or carry groceries</td>
<td>17.5</td>
<td>14.2</td>
</tr>
<tr>
<td>Walking several flights of stairs</td>
<td>15.8</td>
<td>10.8</td>
</tr>
<tr>
<td>Walking 1 flight of stairs</td>
<td>6.4</td>
<td>5.3</td>
</tr>
<tr>
<td>Bending, kneeling</td>
<td>25.4</td>
<td>20.9</td>
</tr>
<tr>
<td>Walking, &gt;1 km</td>
<td>15.2</td>
<td>11.5</td>
</tr>
<tr>
<td>Walking several blocks 500 m</td>
<td>8.0</td>
<td>5.8</td>
</tr>
<tr>
<td>Walking 1 block, 100 m</td>
<td>5.5</td>
<td>4.7</td>
</tr>
<tr>
<td>Bathing or dressing</td>
<td>4.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Poor physical functioning¶</td>
<td>8.4</td>
<td>5.3</td>
</tr>
</tbody>
</table>

*BMI indicates body mass index; HDL, high-density lipoprotein.
†P < .05.
‡P < .001.
§Systolic of 160 mm Hg or higher and/or diastolic blood pressure of 95 mm Hg or higher and/or medication for hypertension.
| Single items of physical functioning.
¶Standardized scores of physical functioning concept (<66.7%).

Figure 1. The proportions of shortness of breath when walking uphill or upstairs in male and female smokers and nonsmokers. Asterisks indicate difference between smoker and nonsmokers (P < .001). Body mass index is calculated as the weight in kilograms divided by the square of the height in meters (weight [kg]/[height[m]^2]).
men with a BMI higher than 30 kg/m² or 93 for women with a BMI higher than 35 kg/m², depending on the reference population used.\textsuperscript{16,17} Some use as the reference group all those below the diagnostic BMI cutoff point for obesity (ie, BMI lower than 22 kg/m²) as the reference population. Epidemiological studies that present risks in tertiles of populations, primarily to define relationships, often result in both tertile cutoff points being within the BMI range of 25 to 27 kg/m². Surprisingly few studies\textsuperscript{6,7} have estimated health risks in groups who achieve the NIH and WHO criteria for overweight or obesity (ie, BMI \geq 25 or BMI \geq 30 kg/m²). New data are presented herein in a standardized format, relating prevalences of a range of health problems in the overweight and obese to those in a referent population with BMI lower than 25 kg/m².

The data in this study can probably be generalized with caution since the Dutch sample studied has physiological characteristics similar to those of most Western/white populations. The patterns of health problems overall were different between men and women as expected, men had greater cardiovascular and NIDDM risks, while women had generally higher prevalences for other conditions and symptoms studied. Virtually all were affected by BMI category. The aggravating effect of overweight on shortness of breath was the same in smokers and nonsmokers (Figure 1). For some symptoms, the increased prevalence with a BMI of 30 kg/m² or higher is particularly striking, eg, shortness of breath when walking upstairs or uphill is present in 46% of women and 34% of men, chronic low back pain in 25% women and 20% men. It is also clear that the BMI range of 25 to 30 kg/m² is not benign, with respect to elevated cardiovascular risk factors in both sexes, and significantly increased odds ratios for a wide range of important symptoms especially in women (Table 2). Table 3 presents new data on some major social consequences of being over-

### Table 2. Odds Ratios for Chronic Disease, Symptoms, and Poor Quality of Life in Categories of BMI in 5887 Men and 7018 Women (1885 Men and 2156 Women in Quality-of-Life Analysis), Adjusted for Age, and Lifestyle Factors*  

<table>
<thead>
<tr>
<th>BMI</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR† 95% CI</td>
<td>OR† 95% CI</td>
</tr>
<tr>
<td>25-30</td>
<td>25-30</td>
<td></td>
</tr>
<tr>
<td>Wheezing when not having a cold</td>
<td>1.14 (0.94-1.40)</td>
<td>1.13 (1.00-1.50)</td>
</tr>
<tr>
<td>Woken up by shortness of breath</td>
<td>1.04 (0.80-1.35)</td>
<td>0.94 (0.62-1.42)</td>
</tr>
<tr>
<td>Coughing for &gt;3 mo</td>
<td>0.98 (0.79-1.21)</td>
<td>1.00 (0.80-1.25)</td>
</tr>
<tr>
<td>Bring up phlegm for &gt;3 mo</td>
<td>1.00 (0.79-1.25)</td>
<td>0.98 (0.75-1.25)</td>
</tr>
<tr>
<td>Shortness of breath when walking up or upstairs</td>
<td>1.43 (1.20-1.69)</td>
<td>2.52 (2.23-2.84)</td>
</tr>
<tr>
<td>Shortness of breath when walking with others</td>
<td>1.18 (0.87-1.59)</td>
<td>1.44 (1.14-1.81)</td>
</tr>
</tbody>
</table>

Cardiovascular risk factors:

- High total cholesterol (\(\geq 6.5 \text{ mmol/L} \geq 25 \text{ mg/dL}\))
- Low HDL cholesterol (\(\leq 0.9 \text{ mmol/L} \leq 34 \text{ mg/dL}\))
- Hypertension
- At least 1 risk factor

Diabetes

- Non–insulin-dependent diabetes mellitus
- Low back pain
- Chronic low back pain (total \(\geq 12 \text{ wk/y}\))
- Symptom of intervertebral disk herniation

**Poor** quality of life, difficulties in physical functioning

- Respiratory symptoms
- Walking 1 block, 100 m
- Walking 1 flight of stairs
- Lift/carry groceries
- Moderate activities
- Vigorous activities
- Hypertension
- Shortness of breath when walking uphill or upstairs
- Wheezing when not having a cold
- Coughing for >3 mo
- Coughing for >3 mo
- Bring up phlegm for >3 mo
- Shortness of breath when walking up or upstairs
- Shortness of breath when walking with others

*See the text for details. BMI indicates body mass index; OR, odds ratio; CI, confidence interval; and HDL, high-density lipoprotein.
††Odds ratio with reference to BMI.
**Systolic blood pressure of 160 mm Hg or higher and/or diastolic blood pressure of 95 mm Hg or higher and/or medication for hypertension.
†P < .05.
§P < .01.
#Single items of physical functioning.
**Standardized scores of physical functioning concept (\(\leq 66.7\%\)).
weight. Again it is clear that a BMI of 25 to 30 kg/m², after appropriate adjustments for age, smoking, and education, has a more significant impact among women, although these problems only become apparent with a BMI of 30 kg/m² or higher in men (Table 2).

Both a BMI of 25 to 30 kg/m² and 30 kg/m² or higher have more marked effects on cardiovascular risks among men than women, but respiratory symptoms, low back pain, and poor physical functioning are more affected by a high BMI among women than men. The apparently greater adverse impact of a BMI of 25 to 30 kg/m² among women deserves further comment. At the same BMI, women have a greater percentage of body fat than men. Wellens et al. have shown how BMI may misclassify people with excessive muscularity rather than excessive fatness. In this study, more men (45%) than women (31%) had a BMI between 25 and 30 kg/m² (Table 1), which may be partly attributable to the greater contribution of muscle mass relative to fat mass in men than in women over this range of BMI. The same sex difference in BMI distribution showing an excess of women with a BMI of 30 kg/m² or higher but an excess of men with a BMI of 25 to 30 kg/m² has also been observed in recent cross-sectional surveys in the United States and the United Kingdom.

There are several reasons for analyzing the sexes separately in our study. First, this is a conventional way to adjust for the possible confounding effect of sex differences on the relationship between obesity and health risks, as used in the Framingham studies. Second, data can be made available for each sex so that future calculations of the burdens and costs of obesity can be made. Third, there are large differences in the distribution of risks between the sexes for some variables (especially cardiovascular risks), such that subjects of both sex cannot be considered as belonging to a single population for statistical analysis.

A possible weakness of our study is that the age limits meant that relatively fewer postmenopausal women were included. Since the greatest coronary heart disease risk is in women in the postmenopausal group, it is possible that odds ratios for cardiovascular risks of older women might be more similar to those of men. This issue cannot be resolved within this study with an upper age of 60 years. Some of the conditions and symptoms studied (eg, NIDDM, shortness of breath) are well known to be much more prevalent in the elderly—indeed most patients with NIDDM are older than 60 years. The odds ratio may change in postmenopausal women because of hormonal changes and associated central fat distribution. Herein we did not examine specifically this effect. The use of hormone replacement therapy and its influence on odds ratios for cardiovascular risk might be of similar interest. In this study there were too few subjects with NIDDM for subgroup analysis, but compared with the reference group (BMI < 25 kg/m²), the odds ratios for respiratory symptoms and cardiovascular risk factors in the overweight (BMI, 25-30 kg/m² or ≥30 kg/m²) remained similar in different age bands. In the absence of directly comparable data in elderly subjects, it therefore seems reasonable to apply standard figures of odds ratios for men and women, of all ages. Odds ratios are likely to be overestimated if the prevalence approaches 50%. Thus, the results of some items of the physical functioning health concept (Table 1) in this study should be interpreted with caution. Most prevalences in the low-risk category are less than 20% and only difficulties with “vigorous activities” has a high prevalence. A rule of thumb is that when initial risks multiplied with the odds ratio is less than 100%, the odds ratio will not overestimate the relative risk more than 2-fold.

There have been suggestions that the BMI and waist-hip ratio should be used together to characterize people at high health risks, since these 2 indexes are related to diseases independently from each other. We have previously examined the contributions of the BMI and waist-hip ratio to cardiovascular risk factors in detail. Combining BMI and waist-hip ratio improved the prediction of cardiovascular risk factors over either the BMI or waist-hip ratio alone, but by only a small percentage. It is now recognized that the use of complex indexes in health promotion is not ideal because of the lack of understanding of their calculations and concept. Waist circumference cutoff points based on the previously defined “action levels” (action level 1: 94 cm for men; 80 cm for women;
action level 2: 102 cm for men; 88 cm for women) have been proposed as a more practical alternative particularly for health promotion directed at the general public.6,9,14,24 These 2 action levels correspond to a BMI of 25 and 30 kg/m², respectively, and also take central fat distribution into account,24 so waist circumference can be used as a single indicator to classify health risks.14

CONCLUSIONS

The results of this study extend the literature on the health hazards of overweight and obesity, using a BMI of 25 and 30 kg/m² as cutoff points to indicate medical concern for a range of complications. The data allow the prediction of several contributors to the burden of disease from obesity to be made in a consistent way using standard NIH and WHO cutoff points of BMI.6,7

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REFERENCES