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

Michael E. J. Lean, MD, FRCP; Thang S. Han, PhD; Jacob C. Seidell, PhD

**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/m^2 _had_ a generally greater impact on odds ratios for health outcomes in women than in men. People with BMI below 25 kg/m^2 _were_ considered the reference group, with low prevalence of symptoms of obesity-related diseases and good quality of life. Between 25 to 30 kg/m^2, the prevalences of these were all increased, and above 30 kg/m^2 greatly increased. After adjustments for age and lifestyle factors, odds ratios (95% confidence intervals [95% CI]) in those with a BMI of 30 kg/m^2 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, 5.5 (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 BMI of 30 kg/m^2 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/m^2, those with BMI of 30 kg/m^2 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. 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}]) cutoff 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/m^2. Some are still based on percentage standard weight which, of course, varies between populations. This study summarizes the prevalence of some major obesity-related conditions and their impact on health services and 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 90%. 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 barefeet 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 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...
160 mm Hg or higher, or diastolic blood pressure of 95 mm Hg or higher, or use of antihypertensive agents.\(^9\)

**Non–Insulin-Dependent Diabetes Mellitus**

Subjects who reported to have been diagnosed as having diabetes by a physician and were not treated with insulin were considered as having known type 2 diabetes mellitus. Subjects whose random nonfasting blood glucose (measured by WHO standardized laboratory at the Academic Dijkzigt Hospital of the Erasmus University in Rotterdam) concentration was 11.1 mmol/L or higher (\(\geq 199\) mg/dL) were considered as having newly diagnosed type 2 diabetes mellitus. Known and newly diagnosed diabetes were combined together for analyses.\(^9\)

**Low Back Pain**

Symptoms of low back pain were obtained from a questionnaire. Those who responded affirmatively to having low back pain in the past 12 months were then asked whether they had radiating pain to the knees or feet, to indicate symptoms of intervertebral disk herniation. This symptom was only accepted in the presence of low back pain, to avoid including those with other causes of radiated pain. The subjects were asked about the total duration of low back pain in the past 12 months. Those who had low back pain for a total of 12 weeks or more were classified as having chronic low back pain. The reference groups for the 3 classes of low back pain were composed of those who did not fulfill the criteria for the symptom under analysis, thus the reference group when analyzing 1 symptom included some subjects with other symptom(s) of low back pain.\(^9\)

**Quality of Life**

Ten items of reported health were appropriately converted into standardized scores based on the equation described by Medical Outcomes Trust.\(^13\) These items were grouped accordingly to make up the physical functioning concept.

**Definition of “Good” and “Poor” for the Physical Functioning Concept**

Distributions of standardized scores were examined from the plots to determine the cutoff points for the health concepts. It was decided that subjects with less than 66.7% of the standardized score were classified as having a poor health concept, and those with 66.7% or above (ie, upper tertile of the scores) were considered as having a good health concept.\(^11\)

**Definition of Good and Poor Health for the 10 Individual Items of Physical Functioning**

Each item was dichotomized such that scores above average were considered as good health and average or lower as poor health.\(^12\)

**STATISTICAL METHODS**

Logistic regression analysis (SAS statistical software, version 6.10; SAS Institute Inc, Cary, NC) was used to determine the odds ratios and 95% confidence intervals (CIs). Each of the symptoms, disease, or poor quality of life was used as dependent variable in separate regression models. Dummy variables for BMI (independent variables) were created using a BMI lower than 25 kg/m\(^2\) as the reference (ie, BMI1 <25 kg/m\(^2\) = 0; BMI1, 25-30 kg/m\(^2\) = 1; and BMI2, <25 kg/m\(^2\) = 0; BMI2, \(\geq 30\) kg/m\(^2\) = 1). Adjustments were made for age, smoking, education, alcohol consumption, and physical activity. For quality-of-life analyses, additional adjustments were made for employment status, household composition, intimate contact (discussing personal matters with other people), and parity in women. Men and women were analyzed separately because of expected large differences between the sexes in the dependent variables (symptoms, disease, or poor quality of life) and independent variables (BMI).

Both the NIH\(^6\) and WHO\(^7\) now recommend the classification of BMI using the diagnostic cutoff points of 25 and 30 kg/m\(^2\) as used in this article (with additional but small categories such as <18.5 kg/m\(^2\) and within the obese, 35 and 40 kg/m\(^2\) 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/m\(^2\)). 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/m\(^2\) or higher.

**COMMENT**

Both the NIH\(^6\) and WHO\(^7\) now recommend the classification of BMI using the diagnostic cutoff points of 25 and 30 kg/m\(^2\) as used in this article (with additional but small categories such as <18.5 kg/m\(^2\) and within the obese, 35 and 40 kg/m\(^2\) 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/m\(^2\)). 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/m\(^2\) 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>Proportions of subjects, %</th>
<th>BMI</th>
<th>Men</th>
<th>Women</th>
<th>Total</th>
<th>&lt; 25</th>
<th>25-30</th>
<th>≥ 30</th>
<th>χ²</th>
<th>Total</th>
<th>&lt; 25</th>
<th>25-30</th>
<th>≥ 30</th>
<th>χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory symptoms</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Wheezing when not having a cold</td>
<td>9.2</td>
<td>8.5</td>
<td>9.3</td>
<td>12.1</td>
<td>7.9†</td>
<td>8.4</td>
<td>7.1</td>
<td>9.2</td>
<td>13.3</td>
<td>35.8‡</td>
<td>5.0</td>
<td>4.6</td>
<td>5.1</td>
</tr>
<tr>
<td>Coughing for &gt; 3 mo</td>
<td>7.7</td>
<td>7.9</td>
<td>7.6</td>
<td>7.4</td>
<td>0.2</td>
<td>7.5</td>
<td>6.2</td>
<td>8.9</td>
<td>10.7</td>
<td>27.6‡</td>
<td>6.8</td>
<td>6.6</td>
<td>6.8</td>
</tr>
<tr>
<td>Shortness of breath when walking uphill or upstairs</td>
<td>16.0</td>
<td>11.2</td>
<td>16.4</td>
<td>34.3</td>
<td>203.3‡</td>
<td>24.7</td>
<td>18.4</td>
<td>28.5</td>
<td>46.4</td>
<td>304.8‡</td>
<td>4.6</td>
<td>3.1</td>
<td>4.3</td>
</tr>
<tr>
<td>Cardiovascular risk factors</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>High total cholesterol ≥ 6.5 mmol/L (≥ 251 mg/dL)</td>
<td>14.6</td>
<td>9.4</td>
<td>17.2</td>
<td>24.6</td>
<td>122.0‡</td>
<td>13.5</td>
<td>9.4</td>
<td>19.1</td>
<td>19.8</td>
<td>143.4‡</td>
<td>21.3</td>
<td>13.5</td>
<td>24.5</td>
</tr>
<tr>
<td>Low HDL cholesterol ≤ 0.9 mmol/L (≤ 34 mg/dL)</td>
<td>19.3</td>
<td>3.7</td>
<td>13.1</td>
<td>25.7</td>
<td>308.4‡</td>
<td>8.3</td>
<td>3.9</td>
<td>10.6</td>
<td>24.6</td>
<td>395.8‡</td>
<td>38.0</td>
<td>23.6</td>
<td>45.1</td>
</tr>
<tr>
<td>Hypertension§</td>
<td>10.3</td>
<td>3.7</td>
<td>13.1</td>
<td>25.7</td>
<td>308.4‡</td>
<td>8.3</td>
<td>3.9</td>
<td>10.6</td>
<td>24.6</td>
<td>395.8‡</td>
<td>38.0</td>
<td>23.6</td>
<td>45.1</td>
</tr>
<tr>
<td>Body mass index</td>
<td>calculated as the weight in kilograms divided by the square of the height in meters (weight (kg)/(height{m} 2)).</td>
<td></td>
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</tr>
</tbody>
</table>

Diabetes
Non-insulin-dependent diabetes mellitus
Women smokers: 0.6%, 1.8%, 1.8%, 4.7%, 57.9%, 0.9%, 0.4%, 1.0, 3.8%, 82.4%.

Low back pain
Chronic low back pain (total ≥ 12 wk/y)
Symptom of intervertebral disk herniation

“Poor” quality of life, difficulties in physical functioning
Vigorous activities
Moderate activities
Lift or carry groceries
Walking several flights of stairs
Walking 1 flight of stairs
Bending, kneading
Walking, > 1 km
Walking several blocks 500 m
Walking 1 block, 100 m
Bathing or dressing

Poor physical functioning¶

*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)).
BMI

WHO criteria for overweight or obesity (i.e., BMI estimated health risks in groups who achieve the NIH and 25 to 27 kg/m². Surprisingly few studies 6,7 have estimated health risks in groups who achieve the lowest risk group, e.g., a BMI lower than 22 kg/m² as the reference population. Epi-

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></th>
<th>Women</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR†</td>
<td>95% CI</td>
<td>OR†</td>
<td>95% CI</td>
</tr>
<tr>
<td>25-30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory symptoms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheezing when not having a cold</td>
<td>1.14</td>
<td>0.94-1.40</td>
<td>1.50‡</td>
<td>1.13-2.01</td>
</tr>
<tr>
<td>Woken up by shortness of breath</td>
<td>1.04</td>
<td>0.80-1.35</td>
<td>1.22</td>
<td>0.84-1.79</td>
</tr>
<tr>
<td>Coughing for &gt;3 mo</td>
<td>0.98</td>
<td>0.79-1.21</td>
<td>0.88</td>
<td>0.62-1.25</td>
</tr>
<tr>
<td>Bring up phlegm for &gt;3 mo</td>
<td>1.00</td>
<td>0.79-1.25</td>
<td>1.06</td>
<td>0.75-1.50</td>
</tr>
<tr>
<td>Shortness of breath when walking uphill or upstairs</td>
<td>1.43§</td>
<td>1.20-1.69</td>
<td>3.51§</td>
<td>2.82-4.38</td>
</tr>
<tr>
<td>Shortness of breath when walking others</td>
<td>1.18</td>
<td>0.87-1.59</td>
<td>2.85§</td>
<td>2.01-4.04</td>
</tr>
<tr>
<td>Cardiovascular risk factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High total cholesterol (≥6.5 mmol/L [≥25 mg/dL])</td>
<td>1.58§</td>
<td>1.33-1.88</td>
<td>2.22§</td>
<td>1.76-2.81</td>
</tr>
<tr>
<td>Low HDL cholesterol (≤0.9 mmol/L [≤34 mg/dL])</td>
<td>2.26§</td>
<td>1.94-2.63</td>
<td>4.78§</td>
<td>3.87-5.90</td>
</tr>
<tr>
<td>Hypertension</td>
<td>2.89§</td>
<td>2.27-3.68</td>
<td>5.88§</td>
<td>4.43-7.79</td>
</tr>
<tr>
<td>At least 1 risk factor</td>
<td>2.37§</td>
<td>2.09-2.69</td>
<td>5.45§</td>
<td>4.48-6.63</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1.98§</td>
<td>1.70-2.30</td>
<td>1.42§</td>
<td>1.00-2.01</td>
</tr>
<tr>
<td>Low back pain</td>
<td>1.02</td>
<td>0.88-1.20</td>
<td>1.05</td>
<td>0.83-1.32</td>
</tr>
<tr>
<td>Chronic low back pain (total ≥12 wk/y)</td>
<td>1.31</td>
<td>0.95-1.84</td>
<td>1.12</td>
<td>0.87-1.44</td>
</tr>
<tr>
<td>Symptom of intervertebral disk herniation</td>
<td>1.13</td>
<td>0.92-1.40</td>
<td>1.78§</td>
<td>1.27-2.51</td>
</tr>
<tr>
<td>“Poor” quality of life, difficulties in physical functioning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vigorous activities#</td>
<td>1.15</td>
<td>0.83-1.58</td>
<td>1.38</td>
<td>0.89-2.14</td>
</tr>
<tr>
<td>Moderate activities#</td>
<td>1.15</td>
<td>0.83-1.58</td>
<td>1.38</td>
<td>0.89-2.14</td>
</tr>
<tr>
<td>Lift/carry groceries#</td>
<td>1.06</td>
<td>0.80-1.42</td>
<td>1.42</td>
<td>0.96-2.11</td>
</tr>
<tr>
<td>Walking several flights of stairs#</td>
<td>1.42§</td>
<td>1.05-1.96</td>
<td>2.68§</td>
<td>1.79-4.00</td>
</tr>
<tr>
<td>Walking 1 flight of stairs#</td>
<td>0.86</td>
<td>0.55-1.36</td>
<td>1.46</td>
<td>0.83-2.58</td>
</tr>
<tr>
<td>Bending, kneeling#</td>
<td>0.95</td>
<td>0.74-1.22</td>
<td>2.17§</td>
<td>1.54-3.06</td>
</tr>
<tr>
<td>Walking &gt;1 km#</td>
<td>1.33</td>
<td>0.98-1.81</td>
<td>2.16§</td>
<td>1.44-3.24</td>
</tr>
<tr>
<td>Walking several blocks, 500 m#</td>
<td>1.26</td>
<td>0.84-1.90</td>
<td>1.84§</td>
<td>1.09-3.12</td>
</tr>
<tr>
<td>Walking 1 block, 100 m#</td>
<td>0.86</td>
<td>0.53-1.40</td>
<td>1.68</td>
<td>0.92-3.04</td>
</tr>
<tr>
<td>Bathing or dressing#</td>
<td>1.15</td>
<td>0.65-2.02</td>
<td>1.97</td>
<td>0.99-3.92</td>
</tr>
<tr>
<td>“Poor” physical functioning**</td>
<td>1.36</td>
<td>0.88-2.09</td>
<td>2.55§</td>
<td>1.51-4.30</td>
</tr>
</tbody>
</table>

*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.
‡P<.01.
§P<.05.
¶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.
#Single items of physical functioning.
**Standardized scores of physical functioning concept (≤66.7%).

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.6,16 Some use as the reference group all those below the diagnostic BMI cutoff point for obesity (i.e., all those without the disease), others obtain high relative risks by using the lowest risk group, e.g., a BMI lower than 22 kg/m² as the reference population. Epidemiological studies that present risks in tertiles of popula-

cal 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, e.g., 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 cardiovas-

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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.18 Wellens et al19 have shown how BMI may misclassify people with excessive muscle mass 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 States20 and the United Kingdom.21

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.22

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.23 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. These 2 action levels correspond to a BMI of 25 and 30 kg/m², respectively, and also take central fat distribution into account, so waist circumference can be used as a single indicator to classify health risks.

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.

CONCLUSIONS

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