Social and economic effects of body weight in the United States

Anne M Wolf and Graham A Colditz

ABSTRACT Given that overweight is clearly associated with increased risk of many major chronic diseases, the United States could have saved $45.8 billion or 6.8% of health care expenditures in 1990 alone if obesity were prevented. The question then arises, economically and socially, what is a healthy body weight? Using a prevalence-based approach to cost of illness, we estimated the economic costs (1993 dollars) associated with illness at different strata of body mass indexes (BMIs, in kg/m²) and varying increments of weight gain to address the questions: At what body weight do we initiate preventive services? What are the direct costs associated with weight gain? Second, using the 1988 National Health Interview Survey (NHIS), we evaluated the marginal increase in certain social indexes reflective of functional impairment and morbidity (ie, restricted-activity days, bed days, and work-loss days) as well as physician visits associated with different strata of BMI. With respect to economic and social indexes, a healthy body weight appears to be a BMI < 25, and weight gain should be kept to < 5 kg throughout a lifetime. Am J Clin Nutr 1996; 63(suppl):466S–9S.

KEY WORDS Economics, health care costs, health expenditures, cost of illness, body weight, weight gain, obesity

INTRODUCTION

It is well established that overweight and obesity are major risk factors for many chronic diseases and exacerbate many chronic conditions (eg, hypertension, dyslipidemia, and osteoarthritis) (1). If obesity were prevented, the United States could have saved $45.8 billion in 1990 or 6.8% of health care expenditures that year. Similarly, 52.9 million days of lost productivity would have been averted, saving employers $4 billion in 1990 (2). The relations between low body weights (lower than average) and weight variability, morbidity, and mortality, however, remain controversial. (3) What then is a healthy body weight with respect to economic and social parameters? The health consequences associated with different body weights and the cost of these conditions are therefore important from a health policy perspective as we enter a new decade of cost-containment and preventive services.

METHODS

To address the issue of healthy body weight from an economic viewpoint, we used a prevalence-based approach to the cost of illness associated with the full spectrum of body mass indexes (BMIs) and weight gain. The population-attributable risk percentage, which conveys a sense of how much of the disease can be prevented by containing BMI within the reference category (BMI < 22) relative to the BMI strata in question (BMI 23–24.9, 25–29.9, or ≥ 30), was based on data from the Nurses’ Health Study (4). To calculate the population-attributable risk percentage for the population, multivariate relative-risk estimates (for which age, baseline BMI, smoking status, preexisting disease, physical activity, and diet were controlled for) and the proportion of disease cases within the BMI category were used.

The direct-cost analysis was limited to non-insulin-dependent diabetes mellitus (NIDDM), coronary heart disease (CHD), hypertension, and gallstones because of insufficient cost or prospective data (for which the aforementioned variables were adequately controlled for) for other diseases associated with body weight (eg, breast and colon cancers and arthritis). A similar approach was taken in the analysis of weight gain; however, the reference category was a weight change between −5 and 5 kg from the age of 18 y to the beginning of follow-up in 1976. The direct-cost analysis was limited to NIDDM and CHD for weight gain because of insufficient prospective data for other conditions.

Indirect morbidity costs (lost productivity), days of restricted activity, and days in bed were estimated from the 1988 National Health Interview Survey (NHIS; data deposited in select government depositories by the National Center for Health Statistics, Hyattsville, MD) and were based on the marginal number of days (eg, bed days) attributable to the BMI category relative to the reference BMI category (BMI < 23). Age, sex, and work status (for lost productivity) were controlled for in separate analyses.

The procedures used to estimate the costs of NIDDM and gallstones are presented elsewhere (2, 4). Annual direct costs of CHD and hypertension were extrapolated from data of Hodgson and Kopstein (5). All costs were inflated to 1993 dollars through use of the medical component of the consumer price index. Excess physician services attributable to body weight, although already reflected in the national estimates of direct

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costs, were estimated with the 1988 NHIS and were adjusted for age and sex.

**DIRECT COSTS ASSOCIATED WITH BMI STRATA**

**Diabetes**

The incidence of NIDDM increases with rising BMI (6, 7), a point that is covered in the presentation by Pi-Sunyer (8). The procedures used to estimate costs of NIDDM in the United States were presented previously in detail (9). These costs include routine care for uncomplicated NIDDM: those costs related to morbidity and mortality from complications such as diabetic ketoacidosis, diabetic coma, diabetic retinopathy, and diabetic neuropathy, and those that arise as a consequence of an excess prevalence of other disease conditions in persons with NIDDM, including circulatory, visual, renal, and skin disorders. In 1986, direct costs of health care expenditures relating to NIDDM accounted for $11.6 billion, or $19.05 billion in 1993 once adjusted.

Table 1 illustrates the population-attributable risk percentage of NIDDM that was diagnosed in the three BMI categories. The direct cost of NIDDM that could be attributed to the weight category is shown in Table 2.

**Coronary heart disease**

The risk of coronary heart disease rises with BMI in both men and women (10, 13), as Kannel et al (14) discuss. By inflating costs from 1980 (5), we estimate that the direct costs of CHD were $39.3 billion in 1993. The proportion of CHD costs attributable to the weight category are presented in Table 1 and the direct cost of CHD by BMI category is shown in Table 2.

**Hypertension**

The risk of hypertension, which is presented by McCarron and Reusser (15), increases with BMI in both men and women (11, 16). By inflating costs from 1980 (5), we estimate that the direct costs of hypertension were $12.1 billion in 1993. The proportion of hypertension costs attributable to each weight category is presented in Table 1 and the direct cost of hypertension by BMI category is shown in Table 2.

**Gallstones**

The incidence of clinically symptomatic gallstones rises continuously with increasing BMI (12). The proportion of the estimated $9.9 billion spent in 1993 on gallbladder disease attributable to each weight category is presented in Table 1 and the direct cost of gallbladder disease by BMI category is shown in Table 2.

**TABLE 2**

Annual direct cost of disease (1993 dollars) in the United States and indirect cost indexes within three BMI categories compared with lean individuals.

<table>
<thead>
<tr>
<th>BMI (kg/m²)</th>
<th>23–24.9</th>
<th>25–29</th>
<th>≥30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct cost ($)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5.89 billion</td>
<td>12.06 billion</td>
<td>22.62 billion</td>
</tr>
<tr>
<td>NIDDM</td>
<td>1.83 billion</td>
<td>4.02 billion</td>
<td>11.66 billion</td>
</tr>
<tr>
<td>CHD</td>
<td>2.4 billion</td>
<td>4.99 billion</td>
<td>6.8 billion</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1.4 billion</td>
<td>1.38 billion</td>
<td>2.08 billion</td>
</tr>
<tr>
<td>Gallstones</td>
<td>0.26 billion</td>
<td>1.67 billion</td>
<td>2.08 billion</td>
</tr>
<tr>
<td>Excess physician visits (per person)²</td>
<td>-0.3</td>
<td>-0.07</td>
<td>1.37</td>
</tr>
<tr>
<td>(population/yr)²</td>
<td>-9,959,948</td>
<td>-3,880,390</td>
<td>33,323,077</td>
</tr>
<tr>
<td>Excess work-loss days (per person)²</td>
<td>-0.02</td>
<td>0.42</td>
<td>1.07</td>
</tr>
<tr>
<td>(population/yr)²</td>
<td>-663,996</td>
<td>23,282,343</td>
<td>26,026,053</td>
</tr>
<tr>
<td>Excess restricted-activity days (per person)²</td>
<td>-0.63</td>
<td>0.703</td>
<td>7.2</td>
</tr>
<tr>
<td>(population/yr)²</td>
<td>-20,915,890</td>
<td>38,970,207</td>
<td>175,130,000</td>
</tr>
<tr>
<td>Excess bed days (per person)²</td>
<td>-1.49</td>
<td>-0.52</td>
<td>2.87</td>
</tr>
<tr>
<td>(population/yr)²</td>
<td>-49,467,741</td>
<td>-28,825,757</td>
<td>69,808,198</td>
</tr>
</tbody>
</table>

¹ Based on the 1988 National Health Interview Survey. Variables are uncontrolled for age, sex, smoking status, and preexisting disease. Lean is defined as a BMI < 22 for NIDDM, < 21 for CHD, < 23 for hypertension, and < 20 for gallstones. NIDDM, non-insulin-dependent diabetes mellitus; CHD, coronary heart disease.

² BMI categories for the direct-cost estimates are the same as those in Table 1: 23–24.9, 25–29.9, and ≥29.

³ Per person represents the difference between the average number of days per person in the specified BMI category compared with the leanest category (BMI < 23).

⁴ Population/yr represents excess days or visits per year in the population within the specified BMI category compared with the leanest category (BMI < 23).

Although direct costs represent most of the costs associated with excess body weight, indirect costs have a greater effect at the individual and societal levels because they reflect the value of lost health and vitality caused by morbidity. On the basis of data from the 1988 NHIS, Table 2 illustrates the average marginal number of days per person (eg, work-loss days, restricted-activity days, and bed days) and the excess physician visits in the specified BMI category compared with the leanest category (BMI < 23). For example, persons whose BMI was between 23 and 24.9 had 0.3 less physician visits per person than did those with a BMI < 23. Persons with a BMI > 30 had, on average, 2.87 more bed days per person than did persons with a BMI < 23.

In the population of people with BMIs > 30, 2.87 bed days per person amounts to 69,808,198 bed days per year. Overall, a mild J-shaped curve was evident for excess physician visits,

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**TABLE 1**

Population-attributable risk percentage (PAR%) of specified disease by BMI category.

<table>
<thead>
<tr>
<th>BMI (kg/m²)</th>
<th>23–24.9</th>
<th>25–28.9</th>
<th>≥29</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAR% (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NIDDM (7)</td>
<td>9.6</td>
<td>21.1</td>
<td>61.2</td>
</tr>
<tr>
<td>CHD (10)</td>
<td>6.1</td>
<td>12.7</td>
<td>17.3</td>
</tr>
<tr>
<td>Hypertension (11)</td>
<td>11.5</td>
<td>11.4</td>
<td>17.1</td>
</tr>
<tr>
<td>Gallbladder disease (12)</td>
<td>2.6</td>
<td>16.9</td>
<td>21.0</td>
</tr>
</tbody>
</table>

¹ Data from the Nurses' Health Study; NIDDM, non-insulin-dependent diabetes mellitus; CHD, coronary heart disease.
restricted activity, and bed days and less so for work-loss days (Table 2). When the data were stratified by age and sex and controlled for working status (work-loss days), the J-shaped curve became more accentuated in males and in the older male and female populations (Figure 1). Because these variables reflect morbidity and eventual mortality, they are subject to the same confounding variables as noted for the mortality and body weight controversy (3). Both smoking status and preexisting disease were not controlled for in this analysis and could be a central factor contributing to the excess bed days, restricted activity, and physician visits observed in the lowest BMI category (< 23).

A closer look at the age-stratified analysis illustrates a mild J-shaped curve in the younger populations and an exaggerated U-shaped curve in the older populations, suggesting that preclinical disease, which becomes more evident with age, was a major confounding variable. It must be emphasized, however, that an excess number of days for each variable was observed in the heaviest group. Therefore, a BMI > 25 has immense economic and social consequences.

DIRECT COSTS ASSOCIATED WITH WEIGHT GAIN: NIDDM AND CHD

The estimated percentages of the direct costs of NIDDM and CHD that are attributable to a particular weight gain (5–10, 11–19.9, or ≥ 20 kg) are shown in Table 3. Also shown are the associated direct costs for 1993. Data are from the Nurses' Health Study (7, 10).

DISCUSSION

We presented an economic analysis of the direct and indirect costs of disease at different BMIs and amounts of weight gain. On an individual level, there are health risks and subsequent costs associated with body weights different from one’s genetically predetermined body weight, even when the body weight is low. We observed total direct costs of $5.89 billion attributable to a body weight that is considered healthy (BMI 23–24.9). The direct costs, however, continue to rise with increasing BMIs, reflecting the elevated risk of disease even at a moderate BMI of 25. When direct costs by disease are examined, it appears that the health risks of NIDDM associated with body weight rise steadily with increasing BMI but have a significant economic effect at a BMI > 30, whereas the economic effect of body weight for CHD is significant at a BMI > 25. The total direct cost of illness attributable to body weight becomes economically significant at a BMI ≥ 25. We observed increased economic costs associated with adult weight gains as little as 5 kg, though the costs appear greatest at weight gains of 11–20 kg.

The direct cost analyses of BMI strata and weight gain, however, are limited and are an underestimate of the true costs. Not all the necessary components to estimate the direct health care costs associated with BMI strata were available for arthritis and breast and colon cancers—diseases that have been associated with increased body weight as presented by Felson (17), Ballard-Barbash and Swanson (18), and Shike (19), respectively. Similarly, there are little data on health risks associated with adult weight gain; therefore, population-attributable risk percentages were not calculated. Another caveat is that these costs are simply estimates and are a function of the incidence of a disease in a given "exposed" group and the proportion of cases in the exposed group. Therefore, the population-attributable risk percentage is dependent on the study population, length of follow-up, and how narrowly the exposure was defined. In this analysis, we used data from one prospective study of women, and so the results may not be generalizable to men or to the general population. However, the incidence of disease and the distribution of body weights in the Nurses' Health Study population are similar to those in other large prospective studies.

The indirect-cost analysis, although performed with national data, may be confounded by smoking status and preexisting illness. Smoking and preexisting illness are associated with lower body weights and increased mortality. Failure to control for these factors produces an artifactualy high mortality rate for lean persons (3). Many of our indirect measures represent functional impairments that are suggestive of but not always accounted for by morbidity measures. Therefore, the increased restricted-activity days for leaner men and older women in Figure 1 (relative to persons with greater BMIs) may be secondary to confounding factors and may not be an accurate picture. In terms of true morbidity, we did observe the lowest
morbidity from NIDDM, CHD, hypertension, and gallstones at the lower BMI strata in studies in which smoking and preexisting illness were controlled for. Clearly, a BMI > 30 was associated with the greatest amount of disability.

CONCLUSIONS

Further analyses are needed to accurately and fully complete the economic picture of what is a healthy weight for Americans. Specifically, there is a great need for updating the economic costs of CHD, hypertension, gallbladder disease, and breast and colon cancers to better reflect current clinical management strategies and a need to investigate the economic costs of musculoskeletal disorders such as osteoarthritis. Also, economic analyses are subject to the same biases and confounding variables as are epidemiologic analyses. Given these limitations, we have a conservative economic estimate for a healthy body weight and for where to focus preventive services. On the basis of the data currently available, a healthy body weight with respect to economic and social indexes appears to be a BMI < 25. Furthermore, weight gain should be kept modest (< 5 kg) throughout life.

REFERENCES