

Body weight and the prevalence of chronic diseases

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SUMMARY The relation between body mass index and prevalence of 17 chronic diseases or groups of diseases was analysed using data from the 1983 Italian National Health Survey, based on a sample of 72 284 individuals aged 15 or over randomly selected within strata of geographical area, size of place of residence and of household in order to be representative of the whole Italian population. The prevalence of diabetes was directly and strongly related to body weight (age-adjusted relative risk estimates being 1.5 for overweight and 2.7 for obese men compared with normal weight individuals; 1.6 and 2.4 for overweight and obese women). Other conditions directly related to self-reported measures of body weight were hypertension (relative risk = 1.7 for obese men and 1.9 for women), myocardial infarction (relative risk = 1.5 for obese men, 1.6 for women), other heart diseases (relative risk = 1.7 for obese men, 1.5 for women), haemorrhoids or varices (relative risk = 1.2 for obese men, 1.5 for women), cholelithiasis (relative risk = 1.2 for obese men, 1.4 for women), urolithiasis and arthritis. Chronic respiratory disorders showed a U-shaped relation to measures of body weight, since their prevalence was elevated in both under- and over-weight individuals. Anaemias and gastroduodenal ulcer showed an inverse relation to body weight, whereas no association was apparent with allergy, liver cirrhosis, and psychiatric or neurological disorders. Allowance for the two major identified covariates (education and smoking) failed to explain the observed variations between measures of body weight and disease, while separate inspection of various strata of age indicated that for most diseases the elevated risks of obesity were higher in younger age and decreased steadily with advancing age. Thus, the results of this national survey indicate that overweight has a widespread and substantial impact not only on mortality but also on morbidity from different chronic conditions.

There is consistent evidence that body weight is a correlate of mortality. The lowest mortality is repeatedly observed among individuals close to the average weight, and mortality ratios increase substantially in both underweight (<80% of the average weight) and overweight subjects,¹⁻⁴ being over 50% elevated among obese individuals (> 130% of the ideal weight). The major causes of the increased mortality among the overweight and obese are diabetes, cardio- and cerebro-vascular diseases, digestive diseases, and some types of cancers (gallbladder, breast, endometrium, and prostate).⁵

Less information is available on the relation between body weight and prevalence of diseases. The presence of data on height, weight, and prevalence of major chronic conditions within the 1983 National Health Survey conducted by the Italian Central

Institute of Statistics gave the opportunity to examine the relation between body weight and frequency of disease in a large sample representative of the whole Italian population.

Materials and methods

THE 1983 NATIONAL HEALTH SURVEY

The Survey was organised and conducted by the Italian Central Institute of Statistics (ISTAT) during the week of 28 November to 3 December 1983.⁶ The general design of this investigation has already been described.⁷ Briefly, interviews were arranged and conducted by civil servants appointed by each municipality included in the study on a sample of 31 025 households (for a total of 89 753 individuals) randomly chosen within strata of geographical area

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(region), size of the municipality, and size of the household in order to be representative of the whole Italian population. Impossibility of tracing or refusal of the interview led to the substitution of 2 058 households, thus giving an overall participation rate for the original sample of 93.4%. Proxy interviews were permitted for members not present in the house (8.3% of the sample considered).

Information was collected on sociodemographic characteristics including self-reported height and weight; current health status; prevalence of 19 chronic diseases or groups of diseases (including major cardiovascular conditions, respiratory and digestive tract disorders, renal and urinary tract diseases, arthritis, and nervous disorders); health service utilisation during the month (for outpatient procedures) or the year (for inpatient procedures) preceding the interview; smoking habits; and coffee and alcohol consumption.

We obtained copies of the original computer tape from the Central Institute of Statistics including all available information for each individual. Subjects below age 15 were not considered, thus leaving a total of 34 787 men and 37 497 women.

DATA ANALYSIS AND CONTROL OF CONFOUNDING

An index of body mass was computed according to the

standard Quetelet's formula (weight,kg/height,m²) and *a priori* subdivided into four levels: <20, underweight; 20-24.9 normal; 25-29.9, overweight; ≥30 obese. The Quetelet's index is essentially an indicator of weight, and it is uncorrelated to height,⁸

We computed the odds ratios (as estimators of relative risk, RR) for the prevalence of selected diseases, together with their 95% approximate confidence intervals⁹ according to body mass index from data stratified for age in decades by means of the usual Mantel-Haenszel procedure.¹⁰ It is known that social class and smoking habits are correlates of body weight, although in this dataset the relation between smoking and body weight was rather complex (for instance, heavy smokers were more frequently overweight than moderate smokers), and heterogeneous in the two sexes.¹¹ Further allowance (separately or simultaneously) for these covariates, however, did not materially modify any of the risk estimates. Thus, the relative risks adjusted for age only were chosen for presentation unless otherwise specified.

Results

The percent distribution of the 34 787 men and 37 497 women interviewed according to estimated body mass index is shown in table 1. Overall, 51% of the subjects

Table 1 *Percent distribution of 72,284 subjects in the 1983 Italian National Health Survey according to body mass index, sex, age group, educational attainment, and smoking habits.*

	Sex	Percent distribution of body mass index (kg/m ²)				No. of subjects
		<20	20-24.9	25-29.9	≥30	
Age group						
15-44	M	9.3	59.1	26.8	4.8	18 714
	F	28.1	55.9	12.0	3.9	19 099
45-64	M	3.9	41.7	44.5	9.9	10 933
	F	9.2	48.3	31.4	11.1	11 710
≥65	M	8.2	44.0	38.3	9.5	5 140
	F	14.7	43.2	30.3	11.7	6 688
Educational attainment†						
Primary school or less	M	5.1	42.4	42.6	9.9	15 927
	F	11.5	46.5	30.8	11.3	20 381
Middle school	M	4.6	50.0	39.5	6.0	10 705
	F	18.4	60.4	17.0	4.3	9 802
High school or university	M	4.5	57.1	33.5	5.0	7 801
	F	24.7	60.5	11.8	3.1	6 901
Smoking habits						
Never smokers	M	9.9	53.1	30.4	6.6	14 144
	F	19.0	50.1	22.6	8.3	29 779
Ex smokers	M	4.0	41.1	45.1	9.8	4 815
	F	15.6	56.5	21.3	6.6	921
Smokers	M	6.3	53.0	34.0	6.7	15 828
	F	24.2	55.9	15.5	4.4	6,797
Total	M	7.5	51.4	34.1	7.1	34 787
	F	19.8	51.3	21.3	7.6	37 497

† The sum of strata does not add up to the total because of missing values.

of both sexes fell in the normal weight category (Quetelet's index 20 to 24.9, set as the reference category in further analyses). The women were more frequently underweight (overall, 20% of women and 8% of men had a Quetelet's index below 20), and, consequently, less frequently overweight (21% v 34% for the 25 to 29.9 category). The proportion of grossly obese individuals was similar in the two sexes (7.1% men, 7.6% women).

In table 1, the distribution of body mass index for both sexes is further presented in separate strata of age and other major covariates, such as educational attainment (showing a decreasing proportion of overweight subjects with higher education) and smoking habits (indicating that female but not male smokers tended to be lighter than never or ex-smokers).

The estimated overall prevalence of 17 selected diseases or groups of diseases in men, and the corresponding age-adjusted relative risks according to

body mass index are reported in table 2. The prevalence of diabetes was directly and strongly related to body weight: compared with normal weight individuals, the estimated relative risk was 0.8 for underweight, and rose to 1.5 for overweight and 2.7 for obese subjects. Other conditions directly related to self-reported measures of body weight were hypertension, myocardial infarction and other heart diseases, cholelithiasis, urolithiasis, renal insufficiency, and arthritis. Chronic respiratory disorders (bronchitis, emphysema or respiratory insufficiency and asthma) showed a U-shaped relation to measures of body weight, since their prevalence was elevated in both under- and over-weight individuals. Anaemias and gastroduodenal ulcer showed inverse relations with body weight, whereas no association was apparent with allergy, liver cirrhosis, and psychiatric or neurological disorders.

The data on the other two groups of diseases, ie, cancer and rheumatoid arthritis, were not considered

Table 2 *Relative risk estimates (and 95% confidence intervals) for the prevalence of selected diseases or groups of diseases according to body mass index among Italian males aged 15 or over. The 1983 National Health Survey.*

Disease or group of diseases	Estimated overall prevalence/1000 males aged 15 or over	Relative risk estimates† among males with body mass index (kg/m ²)			
		< 20	20-24.9	25-29.9	≥ 30
Diabetes	35.7	0.77 (0.56-1.04)	1 ≠	1.54 (1.35-1.75)	2.69 (2.27-3.18)
Hypertension	67.9	0.80 (0.64-0.98)	1 ≠	1.37 (1.25-1.51)	1.74 (1.51-2.00)
Myocardial infarction	18.0	1.06 (0.74-1.52)	1 ≠	1.16 (0.98-1.33)	1.48 (1.14-1.92)
Other heart diseases	39.5	1.19 (0.95-1.49)	1 ≠	1.03 (0.90-1.16)	1.72 (1.35-2.19)
Haemorrhoids or varices	42.8	0.68 (0.53-0.89)	1 ≠	1.09 (0.97-1.22)	1.17 (0.96-1.41)
Chronic bronchitis	75.9	1.19 (1.00-1.41)	1 ≠	1.07 (0.98-1.17)	1.24 (1.08-1.43)
Emphysema or respiratory insufficiency	25.4	1.48 (1.14-1.91)	1 ≠	0.92 (0.79-1.07)	1.37 (1.10-1.71)
Bronchial asthma	40.4	1.42 (1.15-1.76)	1 ≠	1.15 (1.02-1.30)	1.70 (1.42-2.02)
Allergy	31.9	0.84 (0.65-1.08)	1 ≠	0.95 (0.83-1.08)	1.01 (0.79-1.28)
Anaemias	5.4	1.25 (0.75-2.09)	1 ≠	0.76 (0.55-1.06)	0.46 (0.23-0.94)
Gastroduodenal ulcer	65.6	0.94 (0.78-1.13)	1 ≠	0.88 (0.80-0.97)	0.83 (0.71-0.98)
Cholelithiasis	19.3	0.77 (0.52-1.12)	1 ≠	1.11 (0.94-1.31)	1.24 (0.95-1.61)
Liver cirrhosis	5.2	1.06 (0.58-1.95)	1 ≠	0.87 (0.63-1.21)	1.14 (0.69-1.88)
Urolithiasis	15.4	0.73 (0.46-1.14)	1 ≠	1.25 (1.04-1.50)	1.58 (1.20-2.08)
Renal insufficiency	11.5	0.85 (0.55-1.32)	1 ≠	0.78 (0.62-0.97)	1.20 (0.87-1.67)
Arthritis	168.9	0.80 (0.69-0.92)	1 ≠	1.35 (1.27-1.44)	1.36 (1.22-1.51)
Psychiatric and neurological disorders	45.7	1.23 (1.02-1.48)	1 ≠	0.96 (0.86-1.07)	0.96 (0.79-1.17)

† Mantel-Haenszel estimates adjusted for age in decades.
 ≠ Reference category.

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on account of their potential low reliability (for instance, it is possible that some subjects who had a cancer were not even informed of the nature of their disease) or widespread misclassification (ie, between rheumatoid and osteo arthritis).

The corresponding prevalences and risk estimates for women are reported in table 3. The overall pattern was largely similar to that described in men, with direct relations between body weight and prevalence of diabetes, heart conditions, chronic respiratory diseases, cholelithiasis, kidney disease and arthritis, and inverse relations for anaemias and gastroduodenal ulcer.

Further allowance for education as an indicator of socioeconomic status and smoking had limited influence on the risk estimates presented. For instance, in obese men, the relative risk for diabetes changed from 2.69 to 2.88 and that for hypertension from 1.74 to 1.75. In obese women, the changes in risk for diabetes after allowance for education and smoking

were from 2.40 to 2.32, and for hypertension from 1.91 to 1.83. It is possible that the modifying effect of these two covariates was in different directions, since smokers had elevated prevalences of several diseases,¹² but, at least for women, smoking was more frequent among more educated subjects¹³ who, in turn, had a lower prevalence of most diseases.¹⁴

Table 4 gives stratified risk estimates for obese individuals in three separate age groups for the diseases whose overall prevalence was significantly elevated in the obese: for most conditions considered, the relative risks tended to be higher at a younger age and decreased steadily with advancing age.

Discussion

The findings of the 1983 Italian National Health Survey indicate that a substantial proportion of Italian men (34%) and women (21%) is overweight and over 7% of both sexes is grossly obese, on the basis

Table 3 *Relative risk estimates (and 95% confidence intervals) for the prevalence of selected diseases or groups of diseases according to body mass index among Italian females aged 15 or over. The 1983 National Health Survey.*

Disease or group of diseases	Estimated overall prevalence/1000 females aged 15 or over	Relative risk estimates† among females with body mass index (kg/m ²)			
		<20	20-24.9	25-29.9	≥30
Diabetes	43.8	0.71 (0.59-0.78)	1 ≠	1.59 (1.41-1.79)	2.40 (2.09-2.77)
Hypertension	96.5	0.78 (0.69-0.89)	1 ≠	1.54 (1.41-1.67)	1.91 (1.71-2.13)
Myocardial infarction	7.3	1.19 (0.83-1.70)	1 ≠	0.92 (0.68-1.23)	1.56 (1.30-1.87)
Other heart diseases	57.1	1.11 (0.96-1.28)	1 ≠	1.28 (1.15-1.43)	1.50 (1.30-1.73)
Haemorrhoids or varices	58.8	0.77 (0.67-0.89)	1 ≠	1.36 (1.22-1.50)	1.46 (1.26-1.69)
Chronic bronchitis	35.3	1.11 (0.94-1.32)	1 ≠	1.01 (0.88-1.15)	1.43 (1.20-1.70)
Emphysema or respiratory insufficiency	13.4	1.63 (1.28-2.06)	1 ≠	1.07 (0.86-1.34)	1.40 (1.06-1.86)
Bronchial asthma	24.8	0.98 (0.79-1.20)	1 ≠	1.17 (1.00-1.38)	1.99 (1.65-2.40)
Allergy	36.2	0.96 (0.83-1.11)	1 ≠	0.98 (0.85-1.13)	0.96 (0.77-1.19)
Anaemias	19.9	1.21 (1.01-1.45)	1 ≠	0.78 (0.64-0.95)	0.65 (0.47-0.90)
Gastroduodenal ulcer	28.9	1.06 (0.89-1.25)	1 ≠	0.89 (0.77-1.04)	0.79 (0.62-1.00)
Cholelithiasis	39.3	0.83 (0.70-0.98)	1 ≠	1.31 (1.16-1.48)	1.38 (1.16-1.64)
Liver cirrhosis	2.0	0.81 (0.39-1.69)	1 ≠	1.31 (0.79-2.17)	0.93 (0.41-2.13)
Urolithiasis	12.2	0.85 (0.63-1.13)	1 ≠	1.62 (1.31-2.00)	1.67 (1.25-2.24)
Renal insufficiency	12.9	1.38 (1.06-1.81)	1 ≠	1.34 (1.07-1.68)	2.17 (1.67-2.82)
Arthritis	214.7	0.75 (0.69-0.81)	1 ≠	1.35 (1.27-1.44)	1.56 (1.42-1.70)
Psychiatric and neurological disorders	72.8	1.09 (0.98-1.22)	1 ≠	1.09 (0.99-1.21)	1.13 (0.98-1.30)

† Mantel-Haenszel estimates adjusted for age in decades.
 ≠ Reference category.

Table 4 Sex- and age-specific relative risk estimates of selected diseases in obese individuals (body mass index ≥ 30) v average weight ones (body mass index 20 to 24.9). Data from the National Health Survey conducted by the Central Institute of Statistics, Italy, 1983.

Disease or group of diseases	Sex	Age group		
		15-44	45-64	≥ 65
Diabetes	M	2.61	3.11	2.21
	F	4.16	3.14	1.81
Hypertension	M	3.43	2.10	1.10
	F	2.46	2.48	1.36
Myocardial infarction	M	2.48	1.46	1.46
	F	—	2.47	1.11
Other heart diseases	M	1.17	1.81	1.40
	F	2.02	1.78	1.25
Emphysema or respiratory insufficiency	M	1.09	1.86	0.86
	F	2.38	2.17	0.83
Cholelithiasis	M	2.07	1.27	0.94
	F	1.53	1.74	0.95
Urolithiasis	M	2.53	1.23	2.06
	F	1.46	1.85	1.49

of self reported measures of body weight and standard cut-off points of Quetelet's index adopted in epidemiological studies.^{15 16} Using the same criteria, a recent Canadian Survey¹⁵ estimated that 31.3% of population aged 20 to 69 was overweight and 6.1% obese. The American National Health and Nutrition Examination Survey¹⁷ found that 26% of US adults were overweight, using a body mass index of 27.8 or greater for men and 27.3 for women to define overweight.

In this study, obesity was associated with an elevated prevalence of a large number of important chronic conditions, including diabetes, heart diseases, respiratory conditions, cholelithiasis, kidney disease,⁵ and arthritis. For most of these diseases, the risk estimates for the overweight group were above unity, too, and the overall evidence indicates that even a less severe degree of overweight implies considerable health risks. Using the same cut-off points for the two sexes, the risk estimates were similar, suggesting that, for the diseases considered, overweight and obesity present similar risks to men and women.

Some of these findings (ie, the positive relations of overweight to diabetes, heart conditions, and digestive diseases) are widely recognised, since they have been repeatedly described in cohort studies chiefly on the basis of mortality statistics.¹⁻⁵ There are also a few cross-sectional studies, such as the American National Health and Nutrition Examination Survey¹⁷ which showed elevated prevalences of hypertension, hypercholesterolaemia, and diabetes in overweight individuals. The estimated relative risks in these Italian data were similar to those reported from the American survey (ie, an overall relative risk of 2.9 for diabetes), and in both studies the risk estimates were higher in the younger age groups.

The Dutch Health Interview Surveys¹⁸ showed that, in men, severe overweight was associated with hypertension, especially in younger middle age, whereas in women severe overweight was positively related to hypertension, diabetes, varicose veins, asthma/bronchitis, and haemorrhoids. In that study, too, subjects who were moderately overweight (body mass index 25-29.9) tended to have a relative risk above unity for most diseases considered, and hence intermediate risk between normal weight individuals and obese ones.

Further, a survey based on four Dutch general practices¹⁶ and a study from the US Health Insurance Experiment¹⁹ indicated that subjective health complaints were more common in overweight subjects, particularly in women,¹⁶ and that the General Health Index was slightly poorer as weight increased.¹⁹

Other studies showed that the relation of overweight to disease was lower at older ages. For instance, in the elderly, high body mass index was unrelated to mortality in a cohort study from Finland.²⁰

Other findings of this study are more difficult to interpret. For instance, all three respiratory conditions considered (chronic bronchitis, emphysema or respiratory insufficiency, and bronchial asthma) showed a "U" shaped relation to body weight, chiefly in men. It is possible that the elevated risks in underweight individuals are due to higher smoking rates, since smoking is related to respiratory diseases.²¹ However, underweight rates were reduced among Italian male smokers,¹¹ and hence allowance for smoking did not reduce the estimated relative risk of lung emphysema in underweight men (adjusted RR=1.54, 95% CI=1.19-1.99), nor for chronic bronchitis (adjusted RR=1.25, 95% CI=1.05-1.49). With regard to the elevated risk of respiratory conditions in the obese, it is known that gross obesity is related to hypoventilation, respiratory insufficiency, and cor pulmonale (Pickwickian syndrome), but there is no easy explanation for the elevated risks of chronic bronchitis or bronchial asthma.

It is possible that these apparent associations were due to misclassification bias, since the interviews were conducted by non medically trained civil servants who might not have been able to distinguish between the mucous hypersecretion of chronic bronchitis or the respiratory distress of bronchial asthma and the respiratory insufficiency of lung emphysema.²² Likewise, there is to our knowledge little support from previous studies on the positive associations between body weight and urolithiasis and renal insufficiency that emerged in this survey.

Besides reliability of diagnosis, the other major problem in the interpretation of this dataset pertains

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to validation of data on height and weight, which are based on self-reporting only, in the absence of any objective measurement. Although a systematic tendency towards overestimating height and underestimating weight is known, self-reported measures show generally very high correlations with actual ones.^{23 24} Further, there is little *a priori* reason to assume a differential reporting of height and weight on the basis of health conditions. On the other hand, the importance of this study should be considered in the light of its large dataset, representative of the general Italian population in terms of distribution for age, sex, and region of residence. Further, since less than 7% of the households originally selected had to be substituted, and direct interview was obtained from over 90% of the subjects identified, it is unlikely that the findings are appreciably affected by selection bias.

In conclusion, therefore, the limitations and uncertainties of some of the information collected can hardly, in our opinion, obscure the major findings of a widespread and substantial impact of overweight not only on mortality, but also on morbidity from different serious chronic conditions. Further, it is particularly worrying, in terms of public health and economic implications, that the relative risks of obesity for most diseases were higher in younger and middle aged than in older individuals.

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