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Body mass index, industrial accidents and sick leave: further evidence of an association

by

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Abstract

Objective. *The authors want to investigate the distribution of Body Mass index (BMI; kg/m²) among the working population in Flanders and the Brussels region of Belgium, and the association of BMI with the occurrence of industrial accidents and sick leave.*

Methods. *Routine data on body height and weight were registered in 1995 in a cross-sectional way at the periodical medical examination of employees in various industrial sectors. Results of 62,136 male and 49,669 female workers, aged 18 to 64 years, were registered on an optical form and stored into a computerized data base.*

Results. *Descriptive statistics for BMI among males were: mean = 25.3 (SD = 4.1), and in females: mean = 24.1 (SD = 4.6). BMI was ≥ 25 in 49%, ≥ 30 in 12%, and ≥ 40 in 0.5% of the males. Among females BMI ≥ 25 was observed in 33%, ≥ 30 in 11%, and ≥ 40 among 0.9%. With females, a trend of increasing year prevalence of industrial accidents with increasing BMI group was found. This association became stronger after adjustment for confounding factors in a logistic regression*

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analysis (age, occupation, blood pressure, smoking behavior and sports habits). With male employees, the association was less obvious, especially after adjustment. With men, the association with sick leave became stronger after adjustment, while with women, it became slightly weaker.

Conclusions. *The high prevalence of BMI ≥ 25, more pronounced with male than with female employees, confirms earlier findings and needs further investigation. Also the cross-sectional association with the prevalence of industrial accidents and sick leave needs confirmation in prospective studies.*

Key-words

Body Mass Index, obesity, industrial accidents, sick leave, working population, Belgium, cross-sectional study

Introduction

Various health implications of obesity have been well studied and it has been shown that obesity adversely affects morbidity and mortality (1-4). Obesity is an important risk factor for major public health problems such as ischemic cardio-vascular diseases, hypertension, diabetes, gout, cholelithiasis, osteoartrosis, menstrual disorder, and impairment of lung function. In a recent cohort study by Froom et al. (5), it was suggested that BMI also could independently influence the accident rate. In that study, 3801 men were followed up for two years for the occurrence of accidents. The main finding was that an elevated BMI increased the risk of reported multiple, but not of single industrial accidents. They found that both BMI and ergonomic stress levels independently predicted involvement in accidents (two or more), with those in the highest BMI quartile who worked in an environment with high ergonomic stress levels having a 4.6 times increased risk of accidents compared with those in the lowest BMI quartile in an environment with low ergonomic stress levels. This association could not be explained by confounding factors such as increased somatic complaints, low educational level, increased age, less smoking and decreased hours of sleep.

We studied recently the association between BMI and various health indicators in 106,495 Flemish employees, examined in 1994, and we also found an association between BMI and sick-leave prevalence, most prominent among females (6).

In this study, we investigated whether obesity is associated with the year-prevalence of industrial accidents and of sick-leave among a large sample of the working population in Flanders in 1995. These studies were made possible by the largest occupational health service in Belgium (IDEWE) where health-related data are collected during periodical medical examination within the legal routine-framework of the Belgian occupational health surveillance activities.

Methods and study population

In 1995, periodical medical examinations were performed by the Occupational Health Service IDEWE on 62,136 male and 49,669 female employees, employed by more than 30,000 institutions or enterprises. This is about 4% of the total working population in Flanders and the Brussels region.

The findings of these medical examinations were recorded on an optical readable form and stored into a database. The recorded data include, among other things, measurements by occupational health physicians and nurses of body height and weight, blood pressure, as well as the registration of self reported health related variables like smoking habits, sick leave, industrial accidents and sports habits. The examinations were performed by approximately 150 occupational health physicians and nurses. This however implicates an inevitable inter-observer variation. This variation was investigated on the data collected since 1992 (7), by calculating 95% confidence intervals for each observer and for each item recorded. Adjustment for the different distribution of gender, age and occupation in the examination groups of each observer was done by using a logistic regression analysis. The results of this investigation were used to improve the standardization procedures. Furthermore, as a part of data quality control, the measuring instruments were centrally calibrated.

In this study, the association of the year prevalence of industrial accidents and of sick leave with the BMI was analyzed. This index was calculated as the ratio of body weight to the square of body height (kg/m^2). For classification of BMI, we refer to Garrow (8): a BMI below 20 is considered as too low, between 20 and 24.9 as acceptable. When the BMI is between 25 and 29.9, the person has overweight, between 30 and 39.9 he suffers from obesity and with a BMI of 40 and more, there is morbid obesity.

Statistical testing was done using the chi-square test, and analysis of variance (ANOVA). As we used very large data bases, the underlying assumption about the normal distribution of the data which is required for a valid application of ANOVA is less strict. Using a logistic regression analysis, the association was controlled for confounding factors. All statistical analyzing was done using the SPSS 6.1 package (9).

Results

The mean BMI among female employees varied with age from 23.1 for women younger than 25 years, up to 26.8 for the women of 55 years and older. Among men, a similar evolution with age was found: the BMI

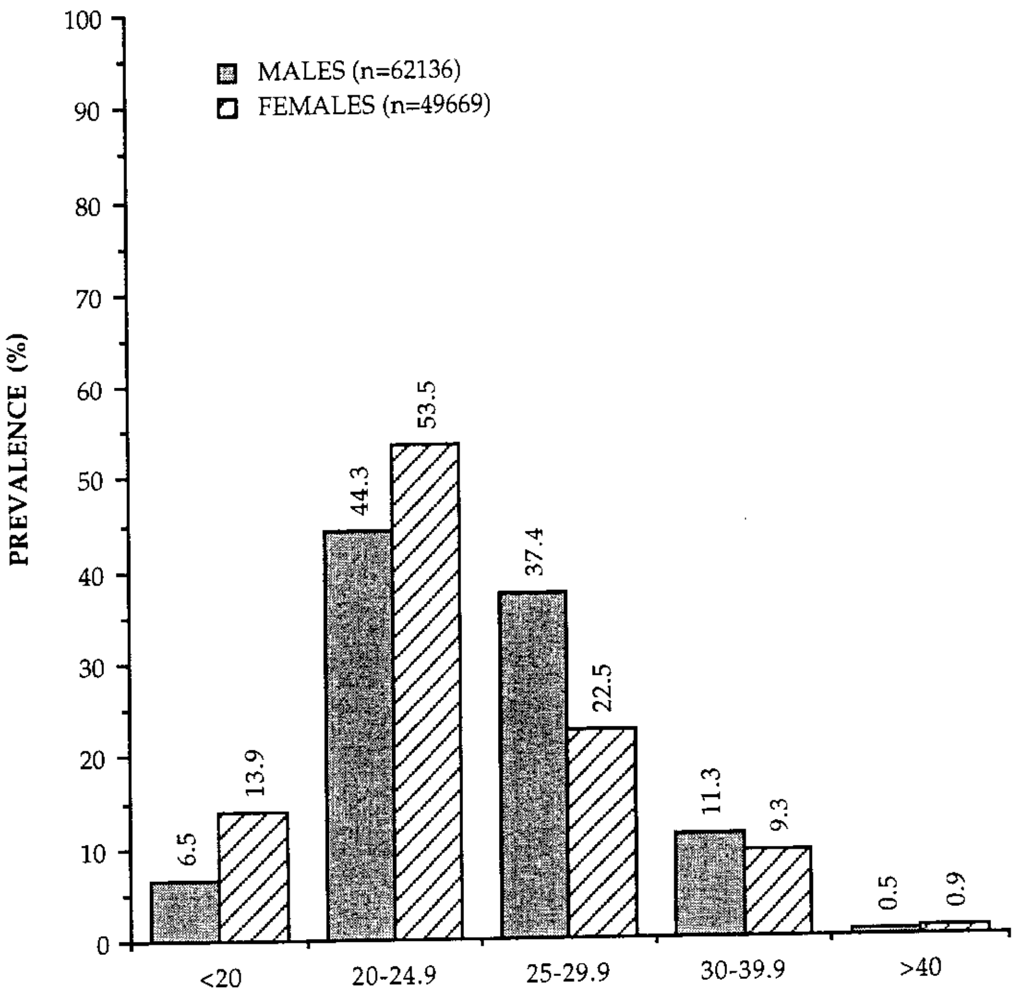

Fig. 1: Prevalence of BMI categories among a sample of Flemish employees (1995)

varied from 23.4 up to 27.0. The overall mean in the male population was 1.2 units higher than in the female population (25.3 versus 24.1). In Figure 1, the prevalence of the five BMI categories is displayed for both genders: 33% of the female population has a BMI ≥ 25, 10% has a BMI ≥ 30, and 0.9% a BMI ≥ 40. With males, the results are even worse, with 49% having a BMI ≥ 25, 12% a BMI ≥ 30 and 0.5% a BMI ≥ 40.

In Figure 2, the year-prevalences of industrial accidents and sick leave are displayed according to the BMI group. The prevalences are much higher for sick leave than for industrial accidents. In both genders, the prevalences increase overall with BMI group. The differences between the BMI group are statistically significant for female employees but not in the male population.

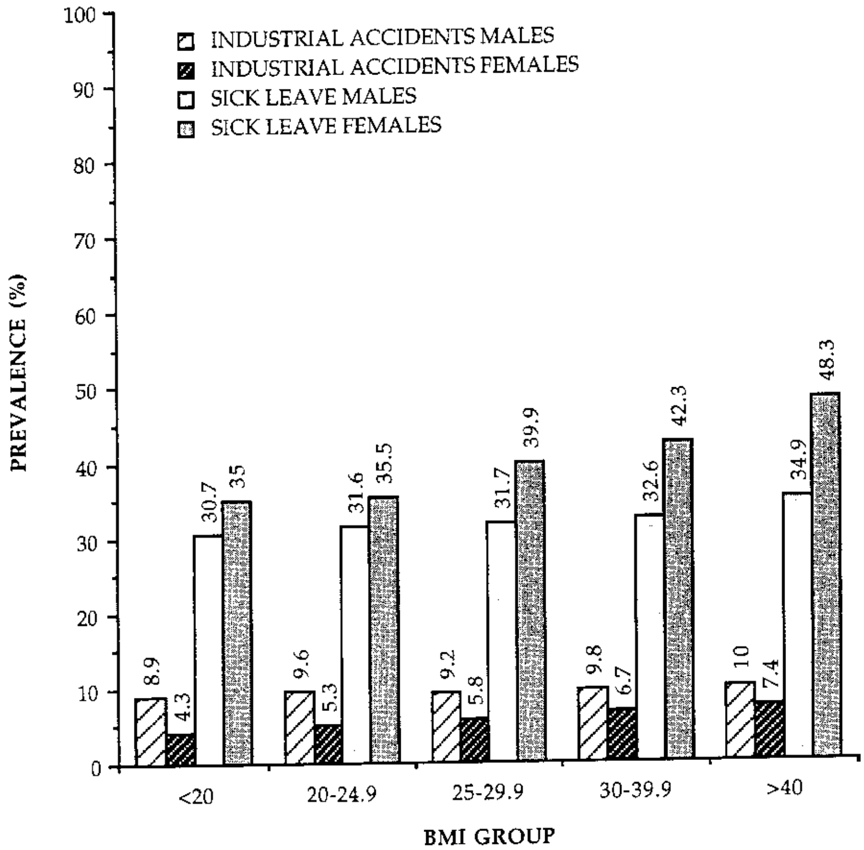

Fig. 2: Prevalence of industrial accidents and sick leave (during the past 12 months) according to BMI group among Flemish employees (1995) Industrial accidents males: differences between groups not statistically significant; chi-squared test: p=0.3. Industrial accidents females: differences between groups statistically significant; chi-squared test: p<0.001. Sick leave males: differences between groups not statistically significant; chi-squared test: p=0.2. Sick leave females: differences between groups statistically significant; chi-squared test: p<0.001

As a measure of impact of industrial accidents and of sickness we also calculated the number of absence days from work. In table 1, it can be seen that for sick leave, the mean number of days of absence increases with rising BMI, except for a slight decrease in group 5. As the mean number of days of absence is influenced by extreme values, the median is a better measure. The median doubled from 7 to 14 days in both genders. For industrial accidents, nearly similar evolutions of the means and medians were found.

To investigate whether the associations of BMI with industrial accidents and with sick leave are influenced by confounding variables, we used a logistic regression analysis. Age, occupation, smoking behavior, blood pressure and sports habits were investigated as possible confounders (6). For the different BMI categories, the odds ratios (OR) for industrial accidents and for sick leave prevalence were calculated as an estimate of the relative risk, using the 'acceptable' BMI category (20-<25) as the reference group. The results of these analyses are presented in table 2. Among males, no significant increase of the OR for industrial accidents and sick leave prevalence with BMI is found, even after adjustment for the confounding factors. However, the association slightly improved for sick leave. In female employees and for industrial accidents, the association was stronger and improved after adjustment. For sick leave, the association became slightly weaker but remained significant in all BMI categories ≥ 25. These findings are in accordance to the results of Moens et al (6).

However, because the OR is an overestimate of the prevalence ratio when the prevalences are high (10% or more — as it is the case with sick leave prevalence) (10), the analysis in this case has only to be taken as indicative of the possible influence of confounding factors on the association.

Discussion

In our sample, we found an increasing prevalence of reported sick leave and industrial accidents with increasing BMI at the medical examinations among female employees in 1995. This finding is important because it indicates that obesity could be a possible risk factor for an increased sensitivity to industrial accidents and sickness. The relationship became even stronger for industrial accidents after controlling for confounders. Among male employees, the association was less obvious, especially for industrial accidents. In their cohort study, Froom et al. (5),

Table 1

Mean and median number of days of absence of work as a result of industrial accidents and of sick leave according to BMI group in Flemish employees reporting an accident or sick leave during the past 12 months (1995)

	INDUSTRIAL ACCIDENTS						SICK LEAVE					
	MALES			FEMALES			MALES			FEMALES		
BMI GROUP (kg/m^2)	n	Mean	Median	n	Mean	Median	n	Mean	Median	n	Mean	Median
< 20	286	28.4	10.5	179	18.0	7	1015	17.5	7	1978	20.6	7
20-<25	2065	24.2	10	908	23.3	10	6895	18.9	7	7740	21.9	7
25-<30	1646	27.9	14	454	25.7	10	5880	23.3	8	3674	26.6	10
30-<40	545	31.5	14	215	28.6	14	1853	24.8	10	1653	30.8	14
≥ 40	21	29.7 (a)	14 (d)	24	21.8 (b)	14 (e)	76	24.1 (c)	14 (d)	170	30.6 (c)	14 (d)
TOTAL	4563	26.7	14	1780	24.0	10	15719	21.2	7	15215	23.8	8

(a) Differences between means statistically significant; $p = 0.04$; analysis of variance.
(b) Differences between means statistically not significant; $p = 0.3$; analysis of variance.
(c) Differences between means statistically significant; $p < 0,001$; analysis of variance.
(d) Differences between medians statistically significant; $p < 0,001$; median test (9).
(e) Differences between medians statistically significant; $p < 0,01$; median test (9).

Table 2

Crude and adjusted odds ratios (OR) for the prevalence of industrial accidents – sick leave (outcome variable) calculated from a logistic regression with the 'acceptable' BMI category (20-<25) as the reference category (exposure variable); Flemish employees (1995)

	INDUSTRIAL ACCIDENT				SICK LEAVE			
	MALES		FEMALES		MALES		FEMALES	
BMI GROUP (kg/m²)	Crude OR (95% CI)	Adjusted OR (a) (95% CI)	Crude OR (95% CI)	Adjusted OR (b) (95% CI)	Crude OR (95% CI)	Adjusted OR (c) (95% CI)	Crude OR (95% CI)	Adjusted OR (d) (95% CI)
< 20	0.92 (0.82-1.04)	0.91 (0.76-1.07)	0.80 (0.70-0.91)	0.76 (0.64-0.91)	0.96 (0.89-1.03)	0.93 (0.84-1.03)	0.98 (0.92-1.04)	1.04 (0.96-1.11)
20-< 25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
25-< 30	0.95 (0.89-1.01)	0.99 (0.91-1.08)	1.10 (0.99-1.21)	1.11 (0.98-1.25)	1.00 (0.96-1.04)	1.01 (0.60-1.69)	1.21 (1.15-1.26)	1.21 (1.14-1.28)
30-< 40	1.02 (0.93-1.12)	0.97 (0.85-1.10)	1.28 (1.12-1.46)	1.37 (1.17-1.60)	1.05 (0.99-1.11)	1.07 (0.50-2.31)	1.33 (1.24-1.42)	1.32 (1.22-1.43)
≥ 40	1.04 (0.69-1.58)	1.25 (0.73-2.12)	1.43 (0.98-2.10)	1.54 (0.95-2.51)	1.16 (0.90-1.49)	1.27 (0.90-1.79)	1.69 (1.39-2.06)	1.56 (1.21-2.01)

(a) Adjusted for age, smoking habits, occupational group, diastolic blood pressure; other variables did not significantly improve the model (Residual chi-square: p = 0,2244; Wald-statistic for BMI group in the final model: p = 0.6927).

(b) Adjusted for age, smoking habits, occupational group; other variables did not significantly improve the model (Residual chi-square: p = 0,1570; Wald-statistic for BMI group in the final model: p < 0.0001).

(c) Adjusted for age, smoking habits, occupational group, sports habits; other variables did not significantly improve the model (Residual chi-square: p = 0,2495; Wald-statistic for BMI group in the final model: p = 0.1177).

(d) Adjusted for age, smoking habits, occupational group, sports habits; other variables did not significantly improve the model (Residual chi-square: p = 0,7901; Wald-statistic for BMI group in the final model: p < 0.0001).

found only an increasing risk of reported multiple but not of single industrial accidents with an increased BMI. However, we have to be careful in comparing the results because of the different study designs. Their study population contains only male employees and they studied different confounders. Their data on accidents were compiled from the personal records of the employees, whereas in our study the self-reporting of accidents is used. This means that recall bias has to be considered, as it will be discussed below. Froom et al. (5) mentioned that the relation between BMI and industrial accidents theoretically could be explained by fatigue and altered arousal states possibly related to sleep disturbances, which is a well known phenomena in obese people, related to the sleep apnoea syndrome. According to them, it is also possible that those with an increased BMI may be less mobile or have more chronic diseases, leading to an increased risk of accidents. Arguments in support of this last hypothesis can be found in different publications on the adverse effects of obesity on morbidity and mortality (1-4). As mentioned in the introduction, obese persons are more at risk for chronic health problems such as ischemic cardio-vascular diseases, hypertension and diabetes. These impairments are also known for their possible influence on the level of consciousness, and are therefore playing a role in accident proneness. A possible explanation for the more apparent association among females is harder to find. An excess weight could provide a mechanical advantage in heavy jobs, which are predominantly occupied by male workers, and therefore lower to a certain extent the risk of an industrial accident for these workers. The results for sick leave were in accordance to the results presented by Moens et al. (6). It is also noteworthy that no other investigations of BMI with the occurrence of industrial accidents and sick leave are known to us.

Finally, concerning the evolution of obesity, we found that the prevalence of obesity (BMI $\geq$ 30) among the employees was 11% in 1995 compared to 10% in 1994 (6): a slight increase.

When interpreting these findings, we have to remember that this is a sample of employed persons, who overall are healthier than the general population. The real impact of a lowering of BMI on industrial accident and sick leave figures can not be precisely estimated from our results, due to the limitations of the cross-sectional design and the healthy worker bias (11). However, a crude estimate can be obtained by calculating the attributable fractions (11) based on the mean number of sick leave days (Table 1) and the OR's listed in Table 2. The attributable fraction among the exposed is the fraction of the outcome prevalence (industrial accident and sick leave) among the exposed (high BMI group) which can be attributed to the exposure when compared to the less exposed (lower BMI group). These calculations indicate that the prevalence of industrial accidents could not be lowered in males but could be lowered by 27% in females, and the mean number of days of absence by 23% in males and by 19% in females, if the employees with a BMI between 30 and 40 could succeed in lowering their BMI to levels below 25. The sick leave prevalence could be lowered by 7% and 24%, and the mean number of sick leave days by 24% and 29%. Because of the limitations mentioned above, these figures are likely to be underestimates.

Other limitations have to be pointed out. First, although we studied a very large population, this sample is not representative for all Flemish employees, as it is not a random sample of the total working population. The sample remains however informative about the BMI distribution and its associations. Another consideration concerns the reliability and the validity of the measurements. The data are collected by more than 150 occupational health nurses and physicians, which makes systematic errors and inter-observer variation unavoidable. To minimize these errors and variation, standardization of instruments and procedures is frequently done. In a study of the reliability and validity of these data (7), there were no indications that systematic errors were linked to one of the investigated variables.

Finally, as our study design is cross-sectional and retrospective, the findings are certainly influenced by the 'healthy worker bias' (11) which probably causes an underestimation of the association (obesity is known as a strong risk factor for several major public health problems and thus causes a greater disability of employment over the years). Also recall bias has to be considered, when persons are asked to report their industrial accidents and sick leave over the past year. Nevertheless, research into the validity of our data (7) has shown no underreporting for industrial accidents. For sick leave, it has been shown that this underreporting could amount to 15%. If the underreporting is linked to the BMI, an underestimation of the effect of lowering high BMI values will result. No causal inferences about the associations in this study can therefore be made, but it can be inferred that the real effects are likely larger than these shown.

In conclusion, we have found a significant association between obesity on one hand and the occurrence of industrial accidents and sick leave on the other hand among female employees. Among male employees, no significant association was found. In the general population, where 'healthy worker bias' is less likely to occur, the effects of obesity on accidents and sick leave are likely to be larger than these shown in our study.

Nevertheless, further investigations in a follow-up design are necessary to confirm these findings.

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References

1. TSAI SP, LUCAS LJ, BERNACKI EJ. Obesity and morbidity prevalence in a working population. JOM 1988; 30: 589-.591
2. TROIANO RP, FRONGILLO EA, SOBAL J, LEVITSKY DA. The relationship between body weight and mortality: a quantitative analysis of combined information from existing studies. Int J Obesity 1996; 20: 63-75.
3. SEIDELL JC. Obesity in Europe: some epidemiological observations. In: Ailhaud G, Guy-Grand B, Lafontan M, Ricquier D (ed.). Obesity in Europe 91. London: John Libbey, 1992: 109-112.
4. COLDITZ GA. Economic costs of severe obesity. Am J Clin Nutr 1992; 55: 503S-507S.
5. FROOM P, MELAMED S, KRISTAL-BONEH E, GOFER D, RIBAK J. Industrial accidents are related to relative body weight: the Israeli CORDIS study. Occupational and Environmental Medicine 1996; 53: 832-835.
6. MOENS G, VAN GAAL L, MULS E, VIAENE B, JACQUES P. Body Mass Index and health among the working population: epidemiologic data from Belgium. Eur J Public Health 1998 (in press).
7. IDEWE OCCUPATIONAL HEALTH SERVICES. The health status of the Flemish employees (1992) (research report). Leuven: IDEWE, 1996 (Dutch).
8. GARROW JS. Health implications of obesity. In:Obesity and related diseases. London:Churchill livingstone, 1988: 1-19.
9. NORUSIS MJ. SPSS Advanced Statistics User's Guide. Illinois: SPSS Inc, 1990.
10. LEE J. Odds ratio or relative risk for cross-sectional data? (letter) Int J Epidemiol 1994; 23: 201-203.
11. CHECKOWAY H, PEARCE NE, CRAWFORD-BROWN DJ. Research methods in occupational epidemiology. Oxford: Oxford University Press, 1989.