Trends in the prevalence of obesity among Belgian men at work, 1977–1992

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OBJECTIVE: To assess trends in average body mass index (BMI) and the prevalence of obesity between 1977 and 1992, in middle-aged Belgian men at work.

SUBJECTS: A subsample of men at work, aged 40–54 y extracted from the base-line data from four independent prospective studies, each representing a period (Physical Fitness Study (1977–1978), Belgian Interuniversity Research on Nutrition and Health (BIRNH) (1979–1984), Multinational Monitoring of Trends and Determinants in Cardiovascular Diseases (MONICA) (1986–1991) and ORCA (1992–1993)).

DESIGN: Linear regression of the average body mass index (kg/m²) and logistic regression of the prevalence of obesity (BMI ≥ 30 kg/m²). Independent variables taken into account in multivariate analysis were: age, educational level, marital status and region.

RESULTS: In this subsample of Belgian men at work, aged 40–54 y, prevalence of obesity increased from 9.2% in 1977–1978 to 14.5% in 1992–1993. This rise was present in each five-year age group, in both regions and in all educational groups, but strongest in the lowest educated. After adjustment for sociodemographic covariables, it was estimated that with regard to 1977–1978, the proportion of men with a BMI ≥ 30 kg/m² doubled over the 15-year period (odds ratio OR (95% confidence intervals, 95% CI): 1.98 (1.40; 2.80)).

CONCLUSION: Keeping in mind that the trends have been calculated from data from four different studies, presenting some shortcomings, prevalence of obesity has increased between 1977–1992 in men aged 40–54 y at work. This rise is particularly pronounced in the lower educated groups.

Keywords: trends; obesity; body mass index

Introduction

Data from a recent World Health Organisation (WHO) report¹ estimated that the prevalence of obesity in Europe has reached 15–20% of the middle-aged population. Moreover, available trend data from European countries (UK,² The Netherlands,^{3,4} Finland,⁵ Sweden,⁶ Germany,⁷ Spain⁸) as well as from affluent countries outside Europe (US,^{9,10} Canada,¹¹ Australia¹²) consistently suggest an increase in the prevalence of obesity.

In Belgium, information on these trends is lacking. In order to confirm the trends described in most industrialized countries, baseline data from four prospective cohort studies (the Physical Fitness study, 1977–1978 (PFS), the Belgian Interuniversity Research on Nutrition and Health, 1979–1984 (BIRNH), the Multinational Monitoring of Trends and Determinants in Cardiovascular Diseases, 1986–1991 (MONICA) and the ORCA study, 1992–1993) were used to investigate trends in body mass index

(BMI, kg/m²) and in the prevalence of obesity between 1977–1992 among middle-aged Belgian working men.

Subjects and methods

The time trends were derived from four independent studies, carried out during successive periods by two collaborating universities. Characteristics of the studies are summarized in Table 1.

In brief, the PFS (1977–1978) was conducted in several factories (including electrical plants, chemical industries and insurance companies) situated throughout Belgium. In total 3179 men aged 40–55 y, regularly employed by factories, were invited to participate and 74.3% attended the screening examination.¹³ The BIRNH study (1979–1984) was performed in a 10 y/gender stratified sample of the general Belgian population aged 25–74 y.¹⁴ Participation rate was 36.5%. The three surveys of the MONICA project (1986–1991) were carried out in three independent general population studies aged 25–64 y of two towns in Belgium (Gent and Charleroi).¹⁵ Average response rate was 41.2%. For the present analysis, data from the three MONICA

Table 1 Characteristics of the studies

Study	Period	Study population	Age range (y)	Region	N subsample
Physical Fitness	1977–1978	Industry, men	40–55	All through Belgium	2224
BIRNH	1979–1984	General population	25–74	Whole Belgium	1659
MONICA	1986–1991	General population	25–64	Two towns (Charleroi + Gent)	648
ORCA	1992–1993	Industry, men	35–59	North Belgium	406

BIRNH=Belgian Interuniversity Research on Nutrition and Health; MONICA=Multinational Monitoring of Trends and Determinants in Cardiovascular Diseases.

surveys were pooled. The ORCA study (1992–1993) concerns 768 men aged 35–59 y (participation rate 83%), regularly employed in four companies (two stations of a train repair and maintenance service company, a privately owned chemical company and a metal plating factory) situated in the North of Belgium.¹⁶

To reach a maximum of comparability between studies, we extracted from the general population studies all men aged 40–54 y, employed or freelance (1659 men in BIRNH and 648 from the MONICA surveys). In the industrial population all men aged 40–54 y were selected (2224 men in PFS and 406 from ORCA).

In all studies, height and weight of subjects without shoes and in underwear or light indoor clothing were measured by trained paramedics. Obesity was defined as a BMI ≥ 30 kg/m². Level of education and marital status were collected in each study using the same standardized questionnaire. Categorical covariables were classified as follows: age (40–44 y, 45–49 y, 50–54 y), educational level according to the highest grade completed (elementary, secondary, university), region (Dutch speaking, French speaking) and marital status (single, married, divorced or separated, widowed). Details on the studies design and sampling have been published elsewhere.^{13–16}

Statistical analysis

Univariate analysis of mean BMI by study periods, and stratified analyses by sociodemographic covariables, were performed by analysis of variance. In addition, multiple means comparisons were performed using the Newman-Keuls Student test.¹⁷ A multiple linear regression model was fitted to evaluate the effect of period on mean BMI, independently from the covariables. Period 1977–1978 was taken as reference and the estimated parameters show the difference with regard to this reference. Regression assumptions were checked through graphical inspection of the Pearson residuals.

For the proportion of obesity, multivariate analysis was performed by estimating the odds ratios (OR) and 95% confidence intervals (95% CI) of the prevalence of a BMI ≥ 30 kg/m² in a multilogistic regression model, adjusted for age, educational level, region

and marital status. The first study period was chosen as reference category. All analyses were performed using the SPSS 4.0 software.

Results

The crude mean BMI increased by 0.94 kg/m² over the 15 y period ($P < 0.0001$), from 25.67 kg/m² in 1977–1978 to 26.42 kg/m², 26.44 kg/m² and 26.61 kg/m², respectively in 1979–1984, 1986–1991 and 1992–1993. This positive trend in mean BMI, contributed substantially to the rise in the prevalence of obesity (shown in Figure 1).

When analyzing these trends in different socio-demographic subgroups, mean BMI and the proportion of men with BMI ≥ 30 kg/m² increased in each five-year age category, in the Dutch speaking, as well as in the French speaking region, especially among single and married men and in every educational level group (Table 2 and Table 3).

In multivariate analysis (Table 4), adjusted for age, region, marital status and educational level, the average difference in BMI between the first and the last study period was estimated at 0.99 kg/m². This represents a 4% increase over the 15 y period and corresponds to a 3.2 kg weight gain for a 1.80 m man. With regard to 1977–1978, the proportion of obese men almost doubled in 1992–1993 (OR (CI): 1.98 (1.40; 2.80)).

Figure 1 Age-adjusted prevalence of obesity (body mass index, BMI ≥ 30 kg/m²) for the four study periods, 1977–1978, 1979–1984, 1986–1991, 1992–1993. Belgian men at work aged 40–54 y. PFS=Physical Fitness Study; BIRNH=Belgian Interuniversity Research on Nutrition and Health; MONICA=Multinational Monitoring of Trends and Determinants in Cardiovascular Diseases.

Table 2 Body mass index (BMI) in Belgian men at work by age, region, marital status and educational level for four study periods, 1977–1984, 1979–1984, 1986–1991 and 1992–1993 (mean standard deviation (s.d.))

	PFS 1977–1978		BIRNH 1979–1984		MONICA 1986–1991		ORCA 1992–1993		<i>P</i> ^a
	<i>n</i>	Mean (s.d.)	<i>n</i>	Mean (s.d.)	<i>n</i>	Mean (s.d.)	<i>n</i>	Mean (s.d.)	
Age category (y)									
40–44	799	25.49 (2.91)	544	26.11 (3.37)	225	26.05 (3.92)	212	26.35 (3.35)	**,b
45–49	806	25.75 (3.03)	595	26.75 (3.30)	207	26.56 (3.67)	132	26.92 (3.11)	***,b
50–54	619	25.78 (3.24)	520	26.35 (3.14)	216	26.74 (3.54)	62	26.88 (3.18)	***,c
Region									
Dutch speaking	1579	25.77 (3.10)	1038	26.51 (3.24)	406	26.30 (3.42)	406	26.61 (3.25)	***,b
French speaking	645	25.42 (2.91)	621	26.27 (3.35)	242	26.68 (4.18)	–	–	***,c
Marital status									
Single	82	24.88 (3.15)	80	27.01 (3.85)	67	26.47 (5.04)	30	27.81 (4.50)	**,b
Married	2051	25.72 (3.02)	1484	26.42 (3.24)	535	26.48 (3.55)	359	26.52 (3.14)	***,b
Divorced/separated	69	24.82 (3.06)	66	25.98 (3.17)	41	25.57 (3.16)	14	26.24 (2.73)	NS
Widowed	21	26.82 (4.80)	16	25.93 (3.96)	5	29.18 (4.76)	2	28.97 (1.06)	NS
Educational level									
Elementary	587	25.95 (3.23)	984	26.69 (3.32)	152	27.10 (4.24)	44	26.68 (3.81)	***,c
Secondary	779	25.60 (3.02)	391	26.00 (3.18)	289	26.59 (3.74)	334	26.59 (3.17)	***,d
University	826	25.51 (2.93)	275	26.05 (3.19)	207	25.76 (3.16)	28	26.75 (3.35)	*,e

NS: not statistically significant; **P* < 0.05; ***P* < 0.01; ****P* < 0.0001.

^aSignificant test means: at least two groups differ significantly.

Multiple means comparisons:

^bmean BMI of PFS differs significantly from means of the three other periods;

^cmean BMI of BIRNH and MONICA differ significantly from mean of PFS;

^dmean BMI of PFS and BIRNH differ significantly from mean of MONICA and ORCA;

^emean BMI of BIRNH differs significantly from mean of PFS.

PFS = Physical Fitness Study; BIRNH = Belgian Interuniversity Research on Nutrition and Health; MONICA = Multinational Monitoring of Trends and Determinants in Cardiovascular Diseases.

Table 3 Prevalence of obesity (BMI ≥ 30 kg/m²) in Belgian men at work by age, region, marital status and education level for the four study periods, 1977–1984, 1979–1984, 1986–1991 and 1992–1993

	PFS 1977–1978 (%)	BIRNH 1979–1984 (%)	MONICA 1986–1991 (%)	ORCA 1992–1993 (%)	<i>P</i> trends
Age category (y)					
40–44	7.3	11.0	12.9	9.4	*
45–49	7.9	14.5	15.5	15.9	***
50–54	9.0	11.3	15.3	22.6	**
Region					
Dutch speaking	8.7	12.9	11.8	13.5	**
French speaking	6.4	11.4	19.0	–	***
Marital status					
Single	4.9	20.0	16.4	13.3	*
Married	8.0	11.9	14.4	13.1	***
Divorced/separated	5.8	12.1	9.8	7.1	NS
Widowed	23.8	25.0	40.0	–	NS
Educational level					
Elementary	10.1	14.7	21.7	18.2	**
Secondary	7.6	8.4	13.8	13.2	**
University	6.8	9.5	10.1	10.7	NS

NS: not statistically significant; **P* < 0.05; ***P* < 0.01; ****P* < 0.0001.

PFS = Physical Fitness Study; BIRNH = Belgian Interuniversity Research on Nutrition and Health; MONICA = Multinational Monitoring of Trends and Determinants in Cardiovascular Diseases.

Discussion

Our results have to be considered with caution as methodologically our approach presents some shortcomings. The four samples, each representing a period of years, might not be completely comparable, especially concerning the region represented. Belgium is indeed cut in two by a horizontal language border. The Northern region is Dutch-speaking and the Southern region is French-speaking. Between North and

South, differences in lifestyle factors and biological parameters have been reported^{18–22} (that is, higher butter consumption in the South, higher margarine consumption in the North and higher serum-cholesterol levels in the South); it was therefore important to introduce the variable ‘region’ as a potential confounder in multivariate analysis. We were however concerned by the question: ‘Within the two respective regions, does the BMI of the inhabitants in more specific places (such as the town Charleroi in the South and the Gent in the North) differ significantly

Table 4 Body mass index (BMI) and prevalence of obesity (BMI ≥ 30 kg/m²) in Belgian men at work adjusted for age, region, marital status and educational level for the four study periods. For BMI, results are shown as regression coefficients (B) and standard errors (SE). For percentages of BMI ≥ 30 kg/m² results are shown as odds ratios (OR) and 95% confidence intervals (95% CI)

Study period	BMI B (SE) (kg/m ²)	BMI ≥ 30 kg/m ² OR (95% CI)
1977–1978, PFS (ref)	0.00	1.00
1979–1984, BIRNH	0.59 (0.11)***	1.38 (1.11; 1.73)**
1986–1991, MONICA	0.81 (0.15)***	1.97 (1.50; 2.58)***
1992–1993, ORCA	0.99 (0.19)***	1.98 (1.40; 2.80)***

** $P < 0.01$; *** $P < 0.0001$; (ref) = reference group.

from that of the inhabitants in the two respective regions taken as a whole?' We tested this hypothesis on a representative sample of the Belgian adult population (BIRNH) and found no significant differences – neither in mean BMI, nor in the prevalence of obesity – between Charleroi and the Southern region, and between Gent and the Northern region. Therefore, we concluded that the observed trends in obesity over the study periods were probably not due to regional differences between studies. Furthermore, differential participation rates between the four studies may also contribute to the observed differences in mean BMI and in prevalence of obesity over time. For instance, Sonne-Holm *et al*²³ reported that the percentage of non-response was significantly higher in the obese than in the normal weight subjects (42% vs 25%), suggesting a positive relation between BMI and non-response. Applying this concept to our study, the increase in obesity over time cannot be attributed to differences in response rates, as the non-response rate was higher in 1979–1984 and 1986–1991 than in 1977–1978 and 1992–1993.

Finally, to minimize the sociodemographic differences between studies, we tested the effect of study period on mean BMI and the prevalence of obesity in a multivariate model, correcting for potential confounders including age, region, marital status and level of education, which are also associated transversely to obesity. In multivariate analysis, mean BMI still increased by 0.99 kg/m² between 1977 and 1992. Prevalence of obesity had almost-doubled during this period (adjusted OR = 1.98).

From the multivariate analysis, we would postulate that Belgium does not derogate to the general rise in prevalence of obesity reported during the last decade for other European countries,^{2–8} as well as for the US,^{9,10} Canada¹¹ and Australia.¹²

However, in our subsample of working men aged 40–54 y, the rise in mean BMI, as well as the increase in the prevalence of obesity, were most pronounced between 1977–1978 and 1979–1984; between 1986–1991 and 1992–1993 the two obesity indices remained stable.

Similar changes have been reported in neighbouring countries, even though the study population characteristics and age range were different. For instance,

in the Netherlands,³ mean BMI increased by 0.5 kg/m² in men with a mean age of 40 y during the period 1974–1980; this was also reflected by a rise in the prevalence of obesity, from 3.3–5.6%. But no change in mean BMI and in the prevalence of obesity were observed in Dutch men with a mean age of 35 y between 1981–1986. In Germany,⁷ mean BMI remained stable in middle-aged men over the period 1985–1990, and the prevalence of obesity in males aged 40–49 y and 50–59 y, which was already very high in 1985 (16.5% and 22.9%, respectively) only increased slightly between 1988 (16.7% and 21.5%, respectively) and 1990 (17.7% and 23.2%, respectively). In the UK,² prevalence of obesity in men aged 16–64 y increased dramatically from 6% in 1980, 7% in 1986/1987, to 13% in 1991.

The strong time trends we observed in the prevalence of obesity in men with lower levels of education compared to those with a higher educational level, have also been observed in The Netherlands⁴ among younger subjects. In Belgium, the level of education is also inversely related to the incidence of fatal coronary heart disease.²⁴ This relationship could, at least partially, be related to obesity and its constellation of CHD risk factors (low HDL-cholesterol, high triglyceridaemia, diabetes, high plasma fibrinogen).

Although our approach contains some shortcomings, we have some evidence from the multivariate analysis to suggest that obesity has increased in Belgium during the last decade, at least among working middle-aged men. In order to develop national guidelines for prevention and treatment of obesity, our results should be confirmed prospectively and at the general population level.

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