Educational Level, Relative Body Weight, and Changes in Their Association Over 10 Years: An International Perspective From the WHO MONICA Project

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ABSTRACT

Objectives. This study assessed the consistency and magnitude of the association between educational level and relative body weight in populations with widely different prevalences of overweight and investigated possible changes in the association over 10 years.

Methods. Differences in age-adjusted mean body mass index (BMI) between the highest and the lowest tertiles of years of schooling were calculated for 26 populations in the initial and final surveys of the World Health Organization (WHO) MONICA (Monitoring Trends and Determinants in Cardiovascular Disease) Project. The data are derived from random population samples, including more than 42 000 men and women aged 35 to 64 years in the initial survey (1979–1989) and almost 35 000 in the final survey (1989–1996).

Results. For women, almost all populations showed a statistically significant inverse association between educational level and BMI; the difference between the highest and the lowest educational tertiles ranged from –3.3 to 0.4 kg/m^2. For men, the difference ranged from –1.5 to 2.2 kg/m^2. In about two thirds of the populations, the differences in BMI between the educational levels increased over the 10-year period.

Conclusion. Lower education was associated with higher BMI in about half of the male and in almost all of the female populations, and the differences in relative body weight between educational levels increased over the study period. Thus, socioeconomic inequality in health consequences of obesity may increase in many countries. (*Am J Public Health.* 2000;90:1260–1268)

Numerous studies have investigated the relationship between socioeconomic status and relative body weight. In general, an inverse association has been observed among women in affluent societies, whereas the association among men is less consistent.[1–6] In less affluent societies, a positive association between obesity and socioeconomic status has been found among both men and women.[1,7–9] The World Health Organization (WHO) MONICA (Monitoring Trends and Determinants in Cardiovascular Disease) Project includes populations with a wide range of per capita income and other socioeconomic indicators, and the prevalence of overweight also varies considerably among the populations.[10–12] Using this unique data set, we explored the extent to which the association between socioeconomic status and relative body weight differs among the MONICA populations. Educational level was used as an indicator for socioeconomic status. We also investigated whether the differences in the association between educational level and relative body weight observed among the populations were related to the prevalence of obesity or to the distribution of education in the population and whether smoking explained the association between educational level and relative body weight.

Remarkable socioeconomic inequalities in self-perceived health, morbidity, and mortality exist in many countries.[13–17] Because excess relative weight is related to the incidence of several chronic diseases and mortality,[18,19] socioeconomic differences in the prevalence of overweight and obesity may act as one factor through which these inequalities in health emerge. Therefore, it is important to know if the association between socioeconomic status and relative body weight has changed among the MONICA populations over the 10-year study period. Hence, we studied the association between educational level and relative body weight and the changes in this association in 26 populations covered by the initial and final MONICA surveys.

Methods

The WHO MONICA Project was designed to measure trends in incidence of and mortality from cardiovascular disease and to assess the extent to which these trends are related to changes in known risk factors. The project is carried out in 39 collaborating centers in 26 countries, with several centers monitoring more than 1 geographically defined study population. Risk factors in the WHO MONICA Project are monitored through independent cross-sectional population surveys over a 10-year period.[10,20] The surveys included random samples of at least 200 people of each sex and in each 10-year age group for the age range 35 to 64 years (or, optionally, 25 to 34 years). This study presents the data from the initial and final surveys. The survey periods ranged from May 1979 to February 1989 for the initial survey and from June 1989 to November 1996 for the final survey. In this re-

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TABLE 1—Age-Standardized Prevalence of Obesity and Median Years of Schooling Among Men and Women (Aged 35 to 64 Years) by Population and MONICA Survey

	Initial Survey				Final Survey			
		Years of Schooling				Years of Schooling		
Population	% Obese[a]	Median	Diff.[b]	n[c]	% Obese[a]	Median	Diff.[b]	n[c]
Men								
CHN-BEI	3	9	4.3	612	4	9	3.0	480
BEL-GHE	9	11	4.0	533	10	12	4.3	487
FRA-TOU	9	10	3.7	678	13	12	3.0	609
SPA-CAT	10	7	3.7	987	16	8	3.0	1398
USA-STA	10	14	2.3	435	20	14	3.0	450
DEN-GLO	11	10	2.0	1456	13	11	2.0	607
ITA-BRI	11	6	2.0	620	14	8	3.3	651
SWE-NSW	11	8	1.7	646	14	10	2.3	568
UNK-BEL	11	10	0.7	929	13	11	2.0	812
UNK-GLA	11	10	0.3	504	23	10	0.7	678
ICE-ICE	12	10	3.3	648	17	12	4.3	693
SWI-VAF	12	13	2.3	627	16	13	2.0	570
FRA-LIL	13	9.5	2.7	646	17	11	3.0	571
POL-TAR	13	7	2.0	1237	15	9	2.0	621
RUS-NOI	13	9.5	3.7	608	15	11	5.0	623
RUS-MOC	14	15	4.3	774	8	15	1.7	557
ITA-FRI	15	8	2.7	722	17	9	3.3	685
FIN-NKA	17	7	1.7	1146	22	8	2.3	508
FIN-KUO	18	8	2.0	977	24	9	2.7	568
GER-AUU	18	11	1.3	711	18	12	2.0	658
POL-WAR	18	11	3.3	1297	22	12	3.0	751
YUG-NOS	18	11	3.3	606	17	12	2.0	566
FIN-TUL	19	8	1.7	1205	22	10	2.3	569
SWI-TIC	19	12	3.3	781	13	12	3.0	733
GER-AUR	20	11	1.3	850	24	12	1.7	819
CZE-CZE	22	11	2.7	948	22	11	1.7	894
Women								
CHN-BEI	10	6	3.3	635	8	9	3.7	643
DEN-GLO	10	9	2.7	1361	12	10	2.0	611
BEL-GHE	11	10	3.3	496	11	10	3.7	517
FRA-TOU	11	11	3.0	645	10	12	3.0	566
SWI-VAF	12	11	2.3	570	9	12	2.3	578
ICE-ICE	14	8	2.3	693	18	10	3.0	718
SWE-NSW	14	9	2.0	614	14	11	2.3	596
SWI-TIC	14	10	2.7	769	16	11	2.7	770
UNK-BEL	14	10	1.3	925	16	11	1.7	797
USA-STA	14	12	2.0	523	23	13	2.7	567
GER-AUU	15	11	1.7	677	21	11	2.0	669
ITA-BRI	15	5	1.3	649	18	5	2.3	666
UNK-GLA	16	10	0.3	480	23	10	0.7	727
FIN-TUL	17	8	2.0	1282	19	10	2.7	627
FRA-LIL	17	8	2.0	544	22	10	2.7	578
ITA-FRI	18	5	1.3	737	19	8	2.3	689
FIN-KUO	20	8	1.3	990	25	9	2.3	610
GER-AUR	22	11	1.7	854	23	11	1.7	872
FIN-NKA	23	8	1.7	1240	24	9	2.3	595
SPA-CAT	23	7	3.3	994	25	8	3.0	1211
POL-WAR	26	11	3.3	1327	28	12	2.0	763
YUG-NOS	30	8	3.3	576	27	11	3.7	601
CZE-CZE	32	10	2.7	990	29	11	2.3	946
POL-TAR	32	7	1.7	1441	37	8	2.0	696
RUS-MOC	33	14	3.3	642	21	15	2.7	527
RUS-NOI	43	10	3.0	659	43	12	3.3	656

Note. BEL-GHE = Belgium–Ghent; CHN-BEI = China–Beijing; CZE-CZE = Czech Republic; DEN-GLO = Denmark–Glostrup; FIN-KUO = Finland–Kuopio Province; FIN-NKA = Finland–North Karelia; FIN-TUL = Finland–Turku/Loimaa; FRA-LIL = France–Lille; FRA-TOU = France–Toulouse; GER-AUR = Germany–Augsburg (rural); GER-AUU = Germany–Augsburg (urban); ICE-ICE = Iceland; ITA-BRI = Italy–Area Brianza; ITA-FRI = Italy–Friuli; POL-TAR = Poland–Tarnobrzeg Voivodship; POL-WAR = Poland–Warsaw; RUS-MOC = Russia–Moscow (control); RUS-NOI = Russia–Novosibirsk (intervention); SPA-CAT = Spain–Catalonia; SWE-NSW = Sweden–Northern Sweden; SWI-TIC = Switzerland–Ticino; SWI-VAF = Switzerland–Vaud/Fribourg; UNK-BEL = United Kingdom–Belfast; UNK-GLA = United Kingdom–Glasgow; USA-STA = USA–Stanford; YUG-NOS = Yugoslavia–Novi Sad.

[a]Body mass index of 30 kg/m^2 or above.

[b]Mean of differences in age-specific tertile cutoff points of years of schooling.

[c]Number of observations.

port, the age range 35 to 64 years is considered. The overall participation rates for the populations included in the present study ranged from 51% to 89% in the initial survey and from 48% to 90% in the final survey. The population sizes, participation rates, and survey periods have been described in more detail elsewhere.[11,21]

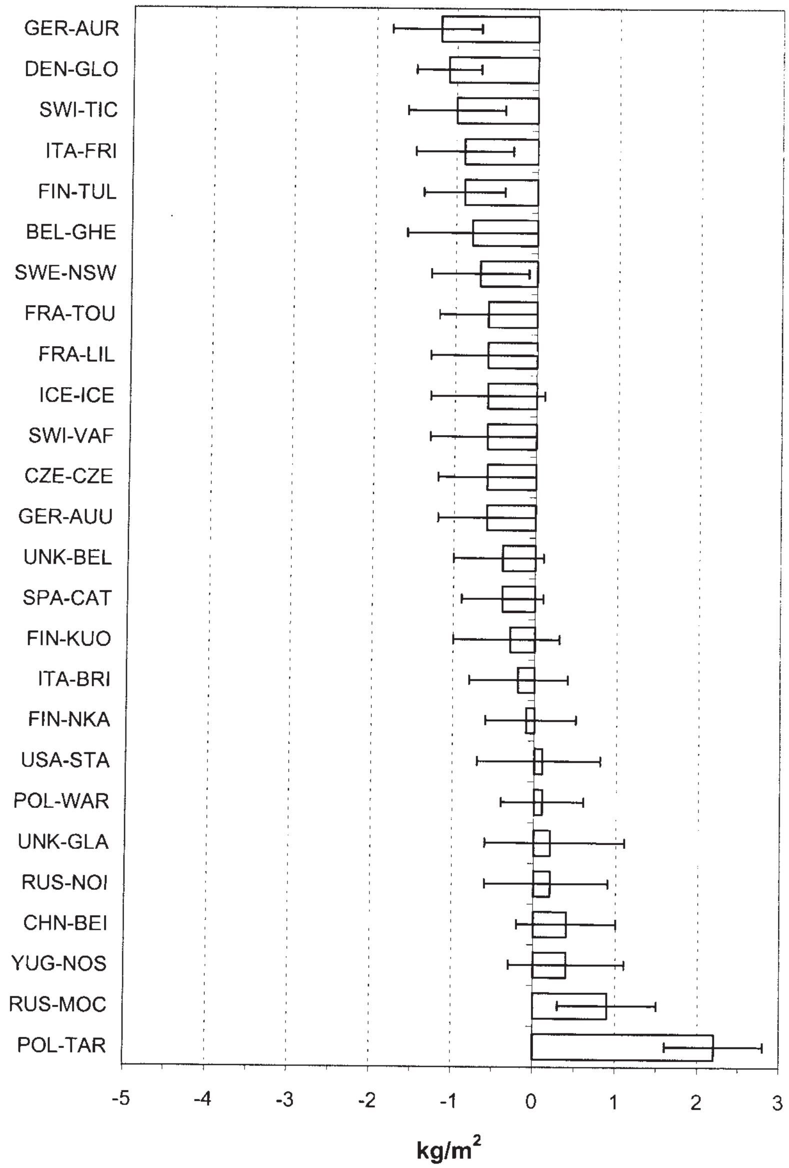
Standard recommendations for the basic anthropometric measurements in MONICA were as follows. Height and body weight were measured with participants standing without shoes and heavy outer garments. Height was recorded to the nearest 1 cm and weight to the nearest 200 g. Body mass index (BMI), used as a measure for relative weight, was calculated as weight in kilograms divided by height in meters squared.

Educational level was measured in years of schooling. Years of schooling were obtained by asking, "How many years did you spend at school or in full-time study?" Because there were large differences in the distributions of years of schooling between populations and also between the sexes and age groups within populations, years of schooling were divided into tertiles, which were calculated separately for each sex and 10-year age group in each population and for each survey. Cutpoints for the tertiles were selected between whole years of schooling in such a way that each tertile would contain, as close as possible, one third of the subjects. Because of clumping of the distributions, this was not always possible; however, the cutpoints were chosen to ensure that the highest and lowest groups comprised at least 15% of the subjects in the sample. Because older age groups often had less education, the cutpoints are usually lower in the older than the younger age groups.

Data on smoking were obtained through a standard questionnaire.[22] In the present analyses, the respondents were classified as (1) heavy smokers (those smoking 20 or more cigarettes per day), (2) light smokers (those smoking 1–19 cigarettes per day), (3) other current smokers (those smoking cigarettes occasionally, at least 1 g of pipe tobacco per week or at least 1 cigar per week), (4) ex-smokers (those reporting having smoked cigarettes daily in the past but not currently), and (5) never smokers (those who were not current smokers and had never smoked cigarettes daily).

The data on weight and height measurements, years of schooling, and smoking were centrally assessed in the WHO MONICA Project, and any population with unsatisfactory quality of data was excluded from this study.

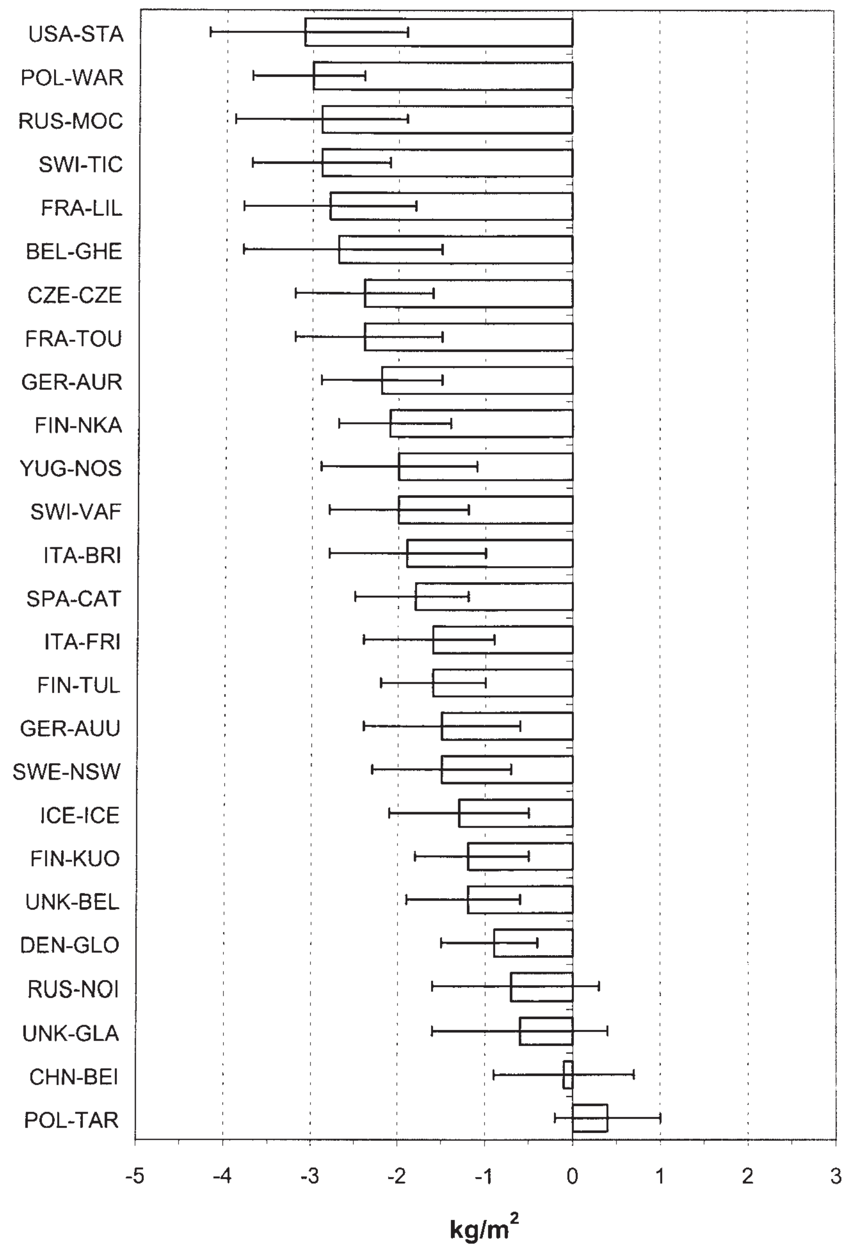
To describe the distributions of BMI and years of schooling in each population, we present the age-standardized prevalence of obesity (BMI $\geq$30 kg/m^2) and the median number of years of schooling for men and women in each survey. Age-standardized prevalences were calculated with the world standard population[23] as the reference population, with weights of 12/31, 11/31, and 8/31 for the 10-year age groups 35–44 years, 45–54 years, and 55–64 years, respectively. Because the difference between the 2 cutpoints for tertiles of years of schooling was narrow in some populations and wide in others owing to the differences in school systems, we calculated the mean of the 3 age-specific differences and used it as an indicator of the variation in levels of education.



Note. For abbreviations, see Table 1.

FIGURE 1—Age-adjusted difference (with 95% confidence intervals) in mean body mass index between the highest and lowest educational tertiles (highest minus lowest tertile) in men aged 35 to 64 years in the initial MONICA survey.

To assess the differences in relative body weight by education, we calculated the mean BMI in the highest tertile of years of schooling and the differences between it and the other tertiles in each population in each survey, adjusting for 10-year age group. These were calculated with the general linear model (GLM) procedure of the SAS statistical software.[24] Confidence intervals for the differences in mean BMI were obtained from the standard errors of the regression coefficients, with the assumption that the coefficients were normally distributed. To assess the extent to which the



Note. For abbreviations, see Table 1.

FIGURE 2—Age-adjusted difference (with 95% confidence intervals) in mean body mass index between the highest and lowest educational tertiles (highest minus lowest tertile) in women aged 35 to 64 years in the initial MONICA survey.

differences in BMI by educational level were explained by smoking, we performed the same analysis with adjustment for smoking category. The statistical significance of the change in the association between BMI and educational level between the 2 surveys within a population was derived by testing the significance of the interaction term between survey and educational tertile in an analysis that included only the highest and lowest tertiles in the model.

Correlation coefficients between the prevalence of obesity and the difference in mean BMI between the highest and the lowest educational tertiles were calculated in each survey to assess whether the association between educational level and BMI was related to the prevalence of obesity in the population. These correlations were ecological where each population presented one observation. To assess whether the differences in the BMI–education relationship between populations could be explained by the extent of the educational gap between the lower and higher educational tertiles, we calculated the correlation between the difference in mean BMI between the highest and lowest educational tertiles and the mean difference of the upper and lower cutoff points of years of schooling in each survey. Because some of the observations were outliers, we used Spearman rank correlations instead of parametric correlations. All the analyses were carried out separately for men and women.

Results

Table 1 shows the age-standardized prevalence of obesity and median years of schooling among men and women by population and survey, listed by the prevalence of obesity in the initial survey. There were wide differences between the study populations in the prevalence of obesity. In the initial survey, the prevalence among men ranged from 3% in Beijing to 22% in the Czech Republic, and the prevalence among women ranged from 10% in Beijing to 43% in Novosibirsk, Russia (intervention). In the final survey, the prevalence among men ranged from 4% in Beijing to 24% in Augsburg, Germany (rural), and Kuopio Province, Finland; among women, the prevalence ranged from 8% in Beijing to 43% in Novosibirsk (intervention). In general, the prevalence of obesity increased in most populations between the 2 surveys. The largest increases, 10 percentage points or more among men and 7 percentage points or more among women, occurred in Glasgow, Scotland, and Stanford, Calif. Only a few populations showed a decline in the prevalence of obesity, with Moscow (control) showing the largest decline among both men (6 percentage points) and women (12 percentage points).

The median years of schooling also varied considerably; in the initial survey, they ranged from 6 years (Area Brianza, Italy) to 15 years (Moscow control) among men and from 5 years (Area Brianza and Friuli, Italy) to 14 years (Moscow control) among women, while in the final survey they ranged from 8 years (North Karelia, Finland; Catalonia, Spain; and Area Brianza) to 15 years (Moscow control) among men and from 5 years (Area Brianza) to 15 years (Moscow control) among women. In the initial survey, the mean of the differences in the age-specific tertile cutoff points for years of schooling ranged from 0.3 years to 4.3 years among men and from 0.3 years to 3.3 years among women, while in the final survey it ranged from 0.7 years to 5.0 years among men and from 0.7 years to 3.7 years among women.

Among men, the difference in mean BMI between the highest and lowest tertiles of years of schooling ranged from –1.2 kg/m^2 to 2.2 kg/m^2 in the initial survey (Figure 1). In 2 populations—Moscow (control) and Tarnobrzeg Voivodship, Poland—educational level had a statistically significant positive association with BMI. In 18 populations, no significant association was found, and in 6 populations there was a statistically significant inverse association.

Among women, the difference in mean BMI between the highest and lowest tertile of years of schooling ranged from –3.1 kg/m^2 to 0.4 kg/m^2 in the initial survey (Figure 2). None of the populations showed a significant positive association, but 22 of the 26 populations had a statistically significant inverse association.

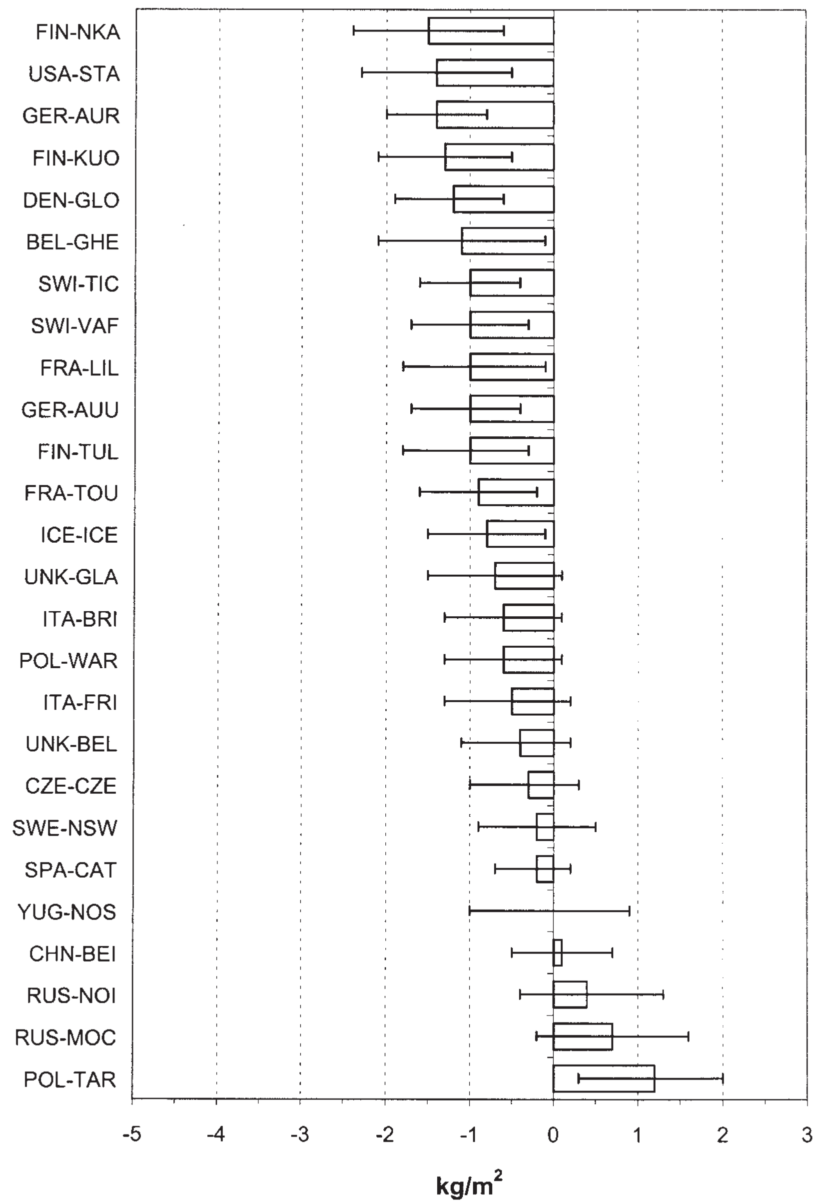
Figures 3 and 4 show the differences in mean BMI between the highest and lowest educational tertile among men and women, respectively, in the final survey. The difference in mean BMI between the highest and lowest tertile of years of schooling ranged from –1.5 kg/m^2 to 1.2 kg/m^2 among men and from –3.3 kg/m^2 to –0.6 kg/m^2 among women. For women, the results were similar to those in the initial survey. For men, the proportion of populations having a significant inverse association increased from 23% (6 populations) in the initial survey to 50% (13 populations) in the final survey.

The adjustment for smoking attenuated the difference in mean BMI between the highest and lowest educational tertiles by an average of 0.2 kg/m^2 in those populations where the difference in BMI between the educational levels was positive (not shown). In those populations where the difference in BMI between educational levels was negative (i.e., in most populations), the difference in BMI between the tertiles increased on average by 0.1 kg/m^2 when smoking was adjusted for.

Next, we calculated the ecological correlation coefficients for the difference in mean BMI between the highest and lowest educational tertiles and the age-standardized prevalence of obesity in men and women in each survey. The correlation coefficient was –0.19 (P=.36) for men and –0.08 (P=.70) for women in the initial survey and –0.41 (P=.04) for men and 0.01 (P=.98) for women in the final survey. The negative association observed among men means that in populations where the prevalence of obesity was relatively high, men with high education were leaner than men with low education, whereas in populations where obesity was rare, men with high education tended to be heavier than men with low education.

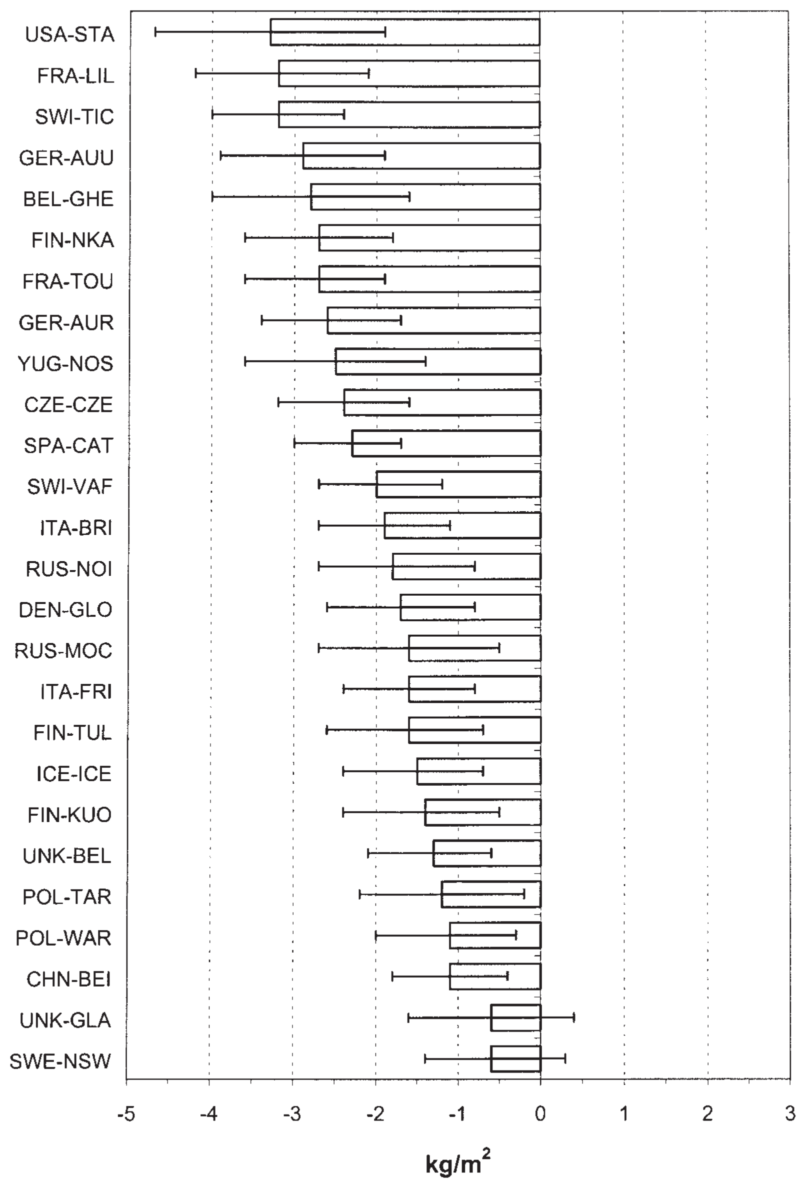
The correlation coefficient between the difference in mean BMI between the highest and lowest educational tertiles and the mean difference between the upper and lower cutoff points of years of schooling was 0.21 (P=.28) for men and –0.35 (P=.08) for women in the initial survey; in the final survey, it was –0.02 (P=.92) for men and –0.30 (P=.13) for women. Although not statistically significant, the correlations were negative among women, suggesting that in populations where the gap in education between the high and low educational levels was relatively wide, the negative association between educational level and BMI was strongest.

In most populations (62% for men and 73% for women), there was an increase of at least 0.1 kg/m^2 in the difference in mean BMI between the highest and the lowest educational tertiles from the initial to the final survey (Table 2), although the increase was statistically significant only in 3 populations (North Karelia, Kuopio Province, and Stanford) for men and in 1 population (Tarnobrzeg Voivodship) for women. An increase (or decrease) of more than about 1.0 kg/m^2 among men and 1.4 kg/m^2 among women was statistically significant. This corresponds to a mean change of about 3.0 kg in a man 1.72 m tall and 3.6 kg in a woman 1.60 m tall.



Note. For abbreviations, see Table 1.

FIGURE 3—Age-adjusted difference (with 95% confidence intervals) in mean body mass index between the highest and lowest educational tertiles (highest minus lowest tertile) in men aged 35 to 64 years in the final MONICA survey.



Note. For abbreviations, see Table 1.

FIGURE 4—Age-adjusted difference (with 95% confidence intervals) in mean body mass index between the highest and lowest educational tertiles (highest minus lowest tertile) in women aged 35–64 years in the final MONICA survey.

Discussion

Among the populations participating in the WHO MONICA Project, we found a statistically significant inverse association between educational level and BMI for women in almost all populations. Women with higher education were leaner than those with lower education. Among men, about one fourth of the study populations in the initial survey and about half in the final survey also showed such a statistically significant inverse association. Only 2 populations and 1 population in the initial and final survey, respectively, had a statistically significant positive association. Among men, the association between BMI and educational level was positive, although not necessarily significantly so, in some Eastern and Central European populations and in Beijing. Among women, no clear geographical pattern emerged. The difference in BMI between the educational levels was greater for women than for men. In addition, in about two thirds of the populations, the difference in mean BMI between the highest and lowest educational levels increased during the 10-year study period.

We investigated whether the association between educational level and BMI was related to the prevalence of obesity in the population. Because the range of educational levels was narrower in some populations than others, we also looked at whether the association between educational level and BMI was related to the variation in educational levels in the population. Furthermore, because smoking behavior is known to be associated with both socioeconomic status[25,26] and relative body weight,[26,27] we assessed the effect of smoking on the association between educational level and BMI.

Among men, the association between educational level and BMI seemed to be related to the prevalence of obesity in the population, although this was statistically significant in the final survey only. In populations where obesity was relatively common, subjects with higher education were leaner than those with lower education, whereas in populations with a low prevalence of obesity, higher education was associated with high BMI. This is in agreement with studies in which an inverse association between educational level and relative weight has been found in affluent societies, whereas a positive association has been found in poorer societies.[1–9] Also, among men, the association between educational level and BMI was positive, although not necessarily statistically significantly so, in some Eastern and Central European populations and in Beijing, which are less affluent than the other MONICA populations. Among women, the association between educational level and BMI did not depend on the prevalence of obesity in the population but was related to the differential in years of schooling between the educational levels, although this correlation was rather weak. Only a small part of the variation in the BMI–education relationship among the populations was, however, explained by the prevalence of obesity in the populations or the differential in years of schooling between the educational levels. The prevalence of obesity explained 17% of the variation in the BMI–education relationship between populations among men in the final survey, and the mean difference in the cutoff points for educational tertiles explained 12% of the variation among women in the initial survey.

We also explored whether and to what extent the possible differences in relative weight by educational level could be explained by smoking. We found that the differences were not explained by smoking. On the contrary, adjusting for smoking increased the differences. This is to be expected, because in low socioeconomic groups smoking is more common and is associated with lower relative weight.[25–27] However, it also implies that if subjects with low education were not smoking more than subjects with high education, the socioeconomic

TABLE 2—Change Between the Initial and Final MONICA Surveys in the Difference in Mean Body Mass Index (BMI) Between the Highest and Lowest Educational Tertiles

Men		Women	
Population	Change[a]	Population	Change[a]
POL-TAR	–0.9	POL-WAR	–1.9*
SWE-NSW	–0.5	RUS-MOC	–1.3
YUG-NOS	–0.5	SWE-NSW	–1.0
ITA-FRI	–0.3	SWI-VAF	0.0
CHN-BEI	–0.3	ITA-FRI	0.0
CZE-CZE	–0.3	FIN-TUL	0.0
RUS-MOC	–0.2	UNK-GLA	0.0
SPA-CAT	–0.1	CZE-CZE	+0.1
SWI-TIC	–0.1	ITA-BRI	+0.1
UNK-BEL	0.0	UNK-BEL	+0.1
DEN-GLO	+0.1	BEL-GHE	+0.1
FIN-TUL	+0.2	ICE-ICE	+0.2
GER-AUR	+0.2	USA-STA	+0.2
ICE-ICE	+0.2	FIN-KUO	+0.3
BEL-GHE	+0.2	SWI-TIC	+0.4
FRA-LIL	+0.3	GER-AUR	+0.4
RUS-NOI	+0.3	FRA-TOU	+0.4
SWI-VAF	+0.3	SPA-CAT	+0.5
FRA-TOU	+0.4	YUG-NOS	+0.5
ITA-BRI	+0.4	FRA-LIL	+0.5
GER-AUU	+0.4	FIN-NKA	+0.6
POL-WAR	+0.7	DEN-GLO	+0.7
UNK-GLA	+1.0	CHN-BEI	+0.9
FIN-KUO	+1.1*	RUS-NOI	+1.1
USA-STA	+1.4*	GER-AUU	+1.3
FIN-NKA	+1.5*	POL-TAR	+1.6*

Note. For population abbreviations, see Table 1.
[a]+ sign denotes that the difference in BMI between educational levels increased and – sign denotes that the difference decreased from the initial survey to the final survey.
*$P < .05$.

differences in BMI would be even bigger. This can be a matter of concern for health promotion, because the most urgent health goal is to encourage smokers to stop smoking. The increase in the differences in BMI between educational levels introduced by adjusting for smoking was, however, relatively small (about 0.1 kg/m^2), suggesting that smoking has only a small effect on the BMI–education relationship.

In most populations, there was an increase in the difference in mean BMI between the educational tertiles from the initial to the final survey. Similarly diverging trends have been reported from eastern Finland for the period 1972 to 1987[28] and from the United States for the period 1960 to 1980.[29,30] These populations also had the largest increases in the difference in BMI between the educational tertiles among men in our data. In general, there was a trend toward an inverse association between BMI and educational level among men and toward a stronger association among women. This has important public health implications. Because excess relative weight is associated with the incidence of many chronic diseases, such as hypertension, cardiovascular diseases, and diabetes mellitus, socioeconomic differences in obesity are likely to contribute to the inequalities in health. The inequalities in health resulting from obesity are therefore likely to increase in many countries. Similar concerns have also been raised in other studies.[4,31,32] The increasing inequalities in health are discordant with the WHO policy goal[33] of providing good health for all.

There are several possible explanations for the increasing differences in BMI between educational levels over the 10-year period. First, the 35- to 44-year age group in the final survey could have a stronger inverse association between education and BMI than the 55- to 64-year age group in the initial survey, which has moved out of the study age range of the final survey. Second, differences in relative body weight between educational levels in the age groups remaining in the study (35–44 years and 45–54 years in the initial survey) might have increased with advancing age. The increase in weight with age may be more pronounced among those with low education than those with high education, as suggested by some studies.[31] Finally, increasing differences in relative body weight between educational levels in all age groups could be due to secular trends. It is possible that all these factors operate at the same time.

We used years of schooling to measure educational level. Systematic measurement of educational level in different populations is complicated because the educational systems of the countries differ. The educational systems in some countries may have changed over time and thus differ even between birth cohorts within a country. The use of age-, sex-, and survey-specific tertiles in this study ensured that the results were adjusted for educational differences between birth cohorts and changes in educational systems within the country. The relative differences in years of schooling between the highest and the lowest tertile can thus vary from one population to another. Therefore, we investigated the association between the mean difference of the cutoff points of years of schooling and the difference in mean BMI between the highest and lowest educational tertile.

In this study, educational level was used as a proxy for socioeconomic status, but in some populations income or occupation may be a better measure of an individual's social status.[34] Unfortunately, we did not have data on the subjects' occupation or income. The level of urbanization of the population may modify the association between relative weight and socioeconomic status. For example, it has been suggested that in China the relationship between obesity and income may be inverse in urban areas (as in other industrialized countries) but positive in rural areas.[35] In our study, Tarnobrzeg Voivodship in Poland, where the association between education and BMI in men was statistically significantly positive in both surveys, is a rural population.

We compared the difference in mean BMI only between the highest and lowest educational tertile. This may be an oversimplification of the relationship. Some researchers have found an inverted-U-shaped relationship between educational level and BMI, especially among men.[36] In our study, there was an inverted-U-shaped relationship between educational level and BMI in about one third of the male populations in the initial survey. Among men in the final survey and women in both surveys, the number of populations showing such a pattern was smaller. The large number of study populations, and the fact that 2 surveys were used, did not allow us to present all descriptive data for all subgroups.

The association between socioeconomic status and relative weight is a complex one; it is probably bidirectional and confounded by other factors such as heredity.[37] The differences in relative weight between socioeconomic groups may also reflect differences in other risk factors such as physical activity, dietary habits, smoking, and alcohol consumption. Some studies, however, have suggested that differences in health behavior only partly explain the association between socioeconomic status and relative weight.[38,39] The differences between socioeconomic groups in relative weight may also be affected by social and cultural norms—such as what is considered "desirable weight"—that vary by population, sex, age, and socioeconomic status.

In summary, we found that low education was associated with a higher BMI in about half of the male and in almost all of the female populations of the WHO MONICA Project. In general, in the course of the 10-year study period, there was a shift toward a stronger inverse association between educational level and BMI and larger differences in relative body weight by educational level. Thus, socioeconomic inequality in health consequences associated with obesity may widen in many countries. Health promotion activities should be designed and directed to decrease such inequalities. □

Contributors

All 5 authors planned the study. A. Molarius analyzed the data and wrote the paper, and J.C. Seidell, S. Sans, J. Tuomilehto, and K. Kuulasmaa contributed to the writing of the paper. J. C. Seidell supervised data analysis and K. Kuulasmaa assisted with statistical methods.

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