Health Behaviours as Mediating Pathways between Socioeconomic Position and Body Mass Index

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Abstract

Background Low socioeconomic position is widely reported to associate with high body mass index (BMI). We, however, lack scientific evidence if health behaviours mediate the association between socioeconomic position and BMI
Purpose The aims of the study were to explore associations of education and income with BMI and to study the mediating pathways through health behaviours.
Method Study population comprised 3,995 Finnish men and women aged 25 to 64 years who participated in a cross-sectional, population-based FINRISK 2002 Study. Participants' height and weight were measured to calculate BMI. Self-administered questionnaire assessed education, household income, leisure time physical activity, sitting behaviour, dietary habits, smoking, and alcohol consumption. Structural equation modelling with latent variables was applied to estimate age-adjusted direct and indirect associations between variables.
Results Most health behaviours mediated the association between socioeconomic position and BMI. Strongest and most consistent mediators were diet and sitting in men and women, as well as leisure time physical activity in women. Health behaviours clustered strongly with each other.
Conclusions The strongest indirect associations between socioeconomic position and BMI were mediated through variables related to energy balance, i.e. diet and sedentariness. To reduce the socioeconomic variation in overweight and obesity, the main focus should be on food and sedentary behaviours while also taking into account the gender differences and clustering of unhealthy behaviours.

Keywords Education · Income · Socioeconomic position · Obesity · Overweight · Health behaviour

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Introduction

Overweight and obesity are commonly explained by poor health behaviours, such as unhealthy diet [1–3], physical inactivity [1, 4–8], or sedentary lifestyle [4, 6–10]. Alcohol consumption [1] and smoking habits [1, 4, 11, 12] also associate with overweight and obesity, yet the evidence is less consistent in terms of directions of the associations and gender differences. Importantly, health behaviours cluster with each others, e.g. smokers tend to use more alcohol [13–16] and exercise less often [11, 17–19] and physically active persons eat healthy foods [15, 16, 19, 20]. This clustering further complicates the understanding of causes of overweight and obesity.

Socioeconomic variation in overweight and obesity is widely reported; individuals with lower education [4, 5, 13] or from the lower social class [4, 21, 22] have higher body mass index (BMI) than individuals with higher education or income. Most studies use either education or income for an indicator of socioeconomic position, but since education and income are interrelated and some of their effects on health may be mediated through different indicators, it is important to include them both in the analyses [23]. Furthermore, in a more theoretical approach, education is seen as an enabler to make healthy choices, while income provides the material means to choose a healthier choice [24].

Maintenance of healthy body weight is a complex phenomenon that has underlying causes both in the behavioural and socio-demographic settings. Since healthy lifestyle is more common in those with a higher socioeconomic position [5, 15, 16, 22, 25–27] and at the same time health behaviours cluster with each others [15, 16, 18, 20], it would be important to know if the socioeconomic variation in BMI could be explained through health behaviours. Yet there is limited number of studies focusing on this topic [2, 28].

Quantitative studies have so far relied mainly on traditional general linear models when exploring the potential causes of overweight and obesity, but other techniques, such as path analysis or structural equations modelling [29, 30] are seldom used. When assessing the mediating role of health behaviours between socioeconomic position and BMI, path analysis serves as a useful tool to assess correlation between health behaviours and their direct and indirect pathways to BMI. We found three studies that used path analysis or structural equations modelling to explain overweight or obesity [2, 21, 28]. Two of them reported inverse associations of socioeconomic position with overweight and obesity, but inconsistently for both genders and no mediation through health behaviours was found [2, 28]. Thus, more studies are needed to fully understand the nature of socioeconomic variation in BMI and potential mediation role of health behaviours. To fill in this scientific gap, we carried out a population-based study using a large sample of Finnish men and women. The aim of this study was to explore health behaviours as mediating pathways between socioeconomic position and BMI.

Methods

This study was part of the National FINRISK 2002 Study, which was conducted in winter and spring 2002 to monitor cardiovascular risk factors among the Finnish adult population aged 25 to 74 years. A stratified random sample by gender and 10-year age group comprised 13 500 subjects and was drawn from the Population Register. The physical activity study sample of the participants aged 25 to 64 years included 8 159 subjects, of which 5 756 participated (71%). The Ethics Committee for the Research in Epidemiology and Public Health approved the study protocol and the participants gave a written consent. The study protocol followed closely the WHO MONICA Project protocol [31] and the later recommendations of European Health Risk Monitoring Project.[32]

In our analyses, we excluded participants who had missing information on any of the used variables; BMI, education, income, or health behaviours ($n=1,761$), leaving

3,995 men and women in our analyses. Characteristics of the study population are described in Table 1.

Measurement of Socioeconomic Position

Education and income were used as indicators of socioeconomic position. They were assessed with a self-administered questionnaire, which was sent to the participants with the invitation to the study and was asked to be filled in before arriving to the study site. The question on education was formulated as an open-ended question"How many years have you attended school or studied full time (basic levels included)?" and participants responded as full years. Education was included in the analyses as a continuous variable. Income was captured with a question "How large was your household's income last year (before tax deduction)?" with nine pre-defined response options. We calculated the middle point of each income category and created a continuous income variable. Further on, we created a variable on household income per consumption unit by weighing the income by number of adults and children in the family, so that the first adult had a coefficient of 1.0, second 0.5, and each child 0.3.

Measurement of BMI

At the study site, trained nurses carried out measurements on height and weight. Height was measured without shoes by a metallic scale against a wall to an accuracy of 0.1 cm. Weight was determined on a beam balance scale in light clothing to an accuracy of 100 g. BMI was calculated as weight in kilograms divided by height in squared meters (kg/m^2) and was included in the analyses as a continuous variable.

Measurement of Health Behaviours

All health behaviours were self-reported. Food frequency question included 45 separate items on weekly use of cereals, milk products, vegetables, fruit and berries, fish and meat, pizza and hamburgers, and sweets. The questions were formulated "How often do you usually eat the following foods?" with response options: 1) Less than once a month or none, 2) Once or twice a month, 3) Once a week, 4) Twice a week, 5) Almost daily, and 6) Once a day or more. Participants self-rated their quality of diet, based on a question "In your opinion, which of the next alternatives best describe your diet?" Response options were 1) I have healthy eating habits, 2) I have fairly healthy eating habits, 3) What I eat is not particularly healthy or unhealthy, 4) I have fairly unhealthy eating habits, and 5) I have unhealthy eating habits.

Smoking was assessed with a series of questions on tobacco use, with outcome categories non-smoker, former

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Table 1 Characteristics of the FINRISK Study population. Values are means (with standard deviations), medians (with interquartile ranges), or percentages

	Men $n=(1,651)$	Women $n=(2,344)$
Age group (%)		
25–34	22.9	26.4
35–44	26.8	27.1
45–54	25.9	24.2
55–64	24.4	22.3
Education, mean years	13.0 (3.7)	13.6 (3.5)
Household income per consumption unit in Euros (%)		
Less than 10,000	11.1	14.5
10,000–19,999	29.7	31.2
20,000–2,999	34.4	32.4
30,000–39,999	18.2	17.3
40,000 and over	6.6	4.6
Body mass index, mean kg/m2	26.9 (4.0)	25.9 (4.9)
Leisure time physical activity, median MET h/week	19.2 (8.2,35.1)	19.3 (10.4,33.6)
Use of fresh vegetables (%)		
Less than once a month or none	2.8	1.1
Once or twice a month	10.5	5.6
Once a week	12.7	8.0
Twice a week	22.2	18.3
Almost daily	35.0	37.6
Once a day or more	16.9	29.5
Use of fruit (%)		
Less than once a month or none	2.9	1.1
Once or twice a month	10.7	6.0
Once a week	14.8	7.4
Twice a week	23.7	19.1
Almost daily	30.9	33.2
Once a day or more	17.1	33.4
Self-rated quality of diet		
Healthy eating habits	0.2	0.6
Fairly healthy eating habits	3.4	2.6
Not healthy or unhealthy eating habits	37.1	23.4
Fairly unhealthy eating habits	53.2	63.9
Unhealthy eating habits	6.2	9.5
Smoking status (%)		
Non-smoker	43.7	60.5
Former smoker	24.6	16.5
Current smoker	31.7	23.0
Sitting, mean hours	6.9 (3.5)	6.4 (3.3)
Alcohol consumption, median g/week	70.5 (12.0,144.0)	24.0 (0.0,60.0)

smoker, and current smoker. Alcohol consumption was measured with a past week recall on the use of alcohol drinks. Outcome variable was total consumption of alcohol in grams per week that was further log-transformed to overcome the problem of skewed distribution.

Participants recalled the amount of sitting with a question "How much time did you spend sitting on a normal weekday? This includes sitting at work and during leisure time, at home, while visiting friends, studying and travelling. This includes time spent sitting or lying down to read or to watch television." Responses were given hours and minutes and were used in the analyses as a continuous variable in hours per day.

Leisure time physical activity was recalled during the past 12 months with a detailed questionnaire that was

modified from the Kuopio Ischemic Heart Disease Risk Factor Study 12-month Leisure Time Physical Activity Questionnaire [33–36]. Participants filled in the frequency, duration, and intensity of 23 types of most common physical activities carried out among Finns, including events such as jogging, skiing, walking, biking, swimming, gymnastics, aerobics, ball and racket games, gardening, snow shovelling, wood chopping, cleaning, repairing, and other hobbies like fishing, berry and mushroom picking, or hunting. The recall estimated relative energy expenditure using metabolic equivalents (METs). The outcome variable was MET hours per week (MET h/week) that was further corrected for skewed distribution using log-transformation.

Statistical Methods

The associations between socioeconomic position and BMI and the role of mediating factors were studied using structural equation modelling, which estimates the associations between a set of independent and dependent variables using a covariance matrix [29, 30]. In the model, direct associations between independent and dependent variable are reported similarly as regression coefficients and p-values. Indirect, i.e. mediation effects through other variables are reported as a product of the regression coefficients along the path. A confirmatory factor analysis was first carried out as part of the measurement model to identify latent factors among health behaviour variables. Model fit statistics are an essential part of the analyses and commonly used estimates are Chi^2, the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). To obtain an adequate fit, the following cut-off values are recommended for each fit measure: Chi^2 $p<0.05$, which is rarely obtained in samples larger than 200; CFI >0.90; TLI >0.95; RMSEA <0.05, and SRMR<0.08 [37, 38].

Theoretical Framework

The theoretical model was drawn on the basis of assumed causal relations in previous literature, in which education, as an independent variable, is seen as an enabler of a healthy choice, and income, a mediator from education to healthy behaviour, is seen as a chance to make a healthy choice. As part of the confirmatory factor analysis, several factors were tested to create a latent variable on diet. The best model fit for the diet variable was optimized by using weekly use of fruit, fresh vegetables, root crops, and salads, as well as self-rated quality of diet. In the structural model, education was included in the model as an independent variable and BMI as a dependent variable. Income and health behaviour variables were treated both as independent and dependent variables, which enabled us to assess the

direct associations and mediation effects. Age was included in the analyses as a covariate. Men and women were analyzed separately. We allowed health behaviours to correlate freely with each others and this procedure also improved the model fit indices. The structural analysis was implemented in several steps, starting from the full model and ending to a final model where the optimal fit was obtained. Along the process, some non-significant associations were removed in the path model to improve the model fit. Analyses were carried out using Mplus software program (version 5.2, Muthen & Muthen, Los Angeles, CA).

Results

Model Fit Indices

The estimates of model fit were 0.91 for CFI, 0.80 for TLI, 0.01 for RMSEA, and 0.04 for SRMR among men and 0.95 for CFI, 0.88 for TLI, 0.05 for RMSEA, and 0.03 for SRMR among women. The estimates suggested that the model fit was adequate and the path model fitted the data.

Direct Associations with BMI

The associations between health behaviours and BMI varied between genders (Figs. 1 and 2). Among men (Fig. 1), diet had the strongest association with BMI (age-adjusted standardized regression coefficient −0.15), while the effect was of lower magnitude for other health behaviours (−0.06 for leisure time physical activity, 0.06 for sitting, and −0.06 for smoking). Among women (Fig. 2), leisure time physical activity (−0.09), sitting (0.08), diet (−0.06), and alcohol consumption (−0.08) were associated with BMI. Furthermore, education (−0.11) and income (−0.10) had direct associations with BMI among women only.

Mediating Pathways between Socioeconomic Position and BMI through Health Behaviours

Most consistent and strongest mediating pathways from socioeconomic position to BMI were found through diet and sitting in men and through diet, sitting, leisure time physical activity in women (Table 2). This indicated that long hours of daily sitting, low levels of leisure time physical activity, infrequent use of fruit and fresh vegetables, and poor self-rated quality of diet contributed to the higher BMI among participants with a lower level of education and income. These associations also appeared across the three-step pathway from education through income and health behaviours to BMI. Other statistically significant mediating pathways were found through education-smoking-BMI

Fig. 1 The standardized regression coefficients between socioeconomic position (education and income), health behaviours, and body mass index (BMI) in men. Each arrow is an estimate of a direct association between the independent and dependent variable. Arrows without coefficient: no association was found and the path was not included in the final model. Statistical significance: *** $p<0.001$, ** $p<0.01$, * $p<0.05$, † $p<0.09$. Note. Associations between the health behaviours are given in the text
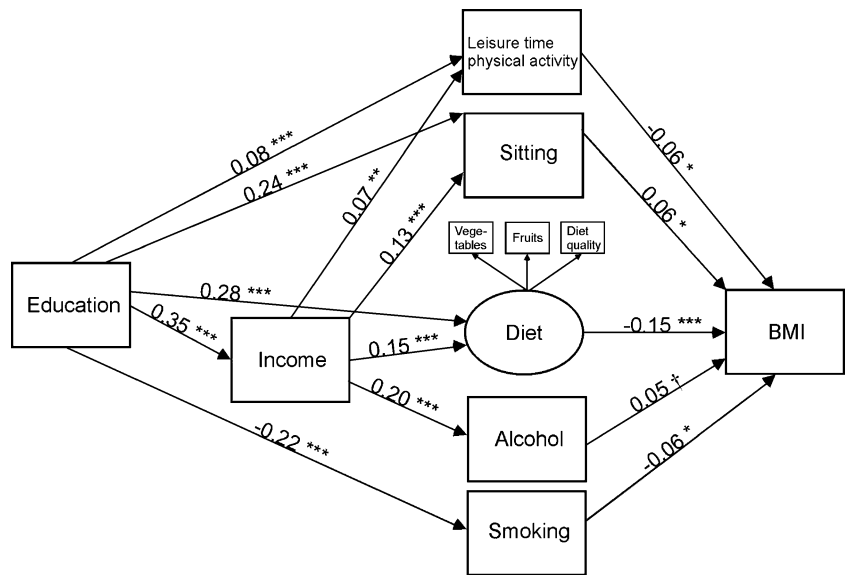
among men and through education-income-BMI, income-alcohol-BMI, and education-income-alcohol-BMI among women.

Clustering of Health Behaviours

Health behaviours had strong associations between each other, particularly diet and leisure time physical activity (age-adjusted standardized regression coefficients 0.23 in men and 0.24 in women), and diet and smoking (−0.24 in men and −0.18 in women). Other statistically significant relationships were also found between smoking and alcohol use (0.13 in men and 0.18 in women), sitting and leisure time physical activity (−0.09 in men and −0.08 in women),

and smoking and leisure time physical activity (−0.12 in men and −0.06 in women). Additionally, some health behaviours clustered among women only; diet and sitting (−0.08) and sitting and alcohol use (0.07).

Discussion

Main Findings

Most health behaviours mediated the association between education, income, and BMI. While diet and sitting were the mediators commonly found among men and women, other mediators were only found among women and

Fig. 2 The standardized regression coefficients between socioeconomic position (education and income), health behaviours, and body mass index (BMI) in women. Each arrow is an estimate of a direct association between the independent and dependent variable. Arrows without coefficient: no association was found and the path was not included in the final model. Statistical significance: *** $p<0.001$, ** $p<0.01$, * $p<0.05$, † $p<0.09$. Note. Associations between the health behaviours are given in the text
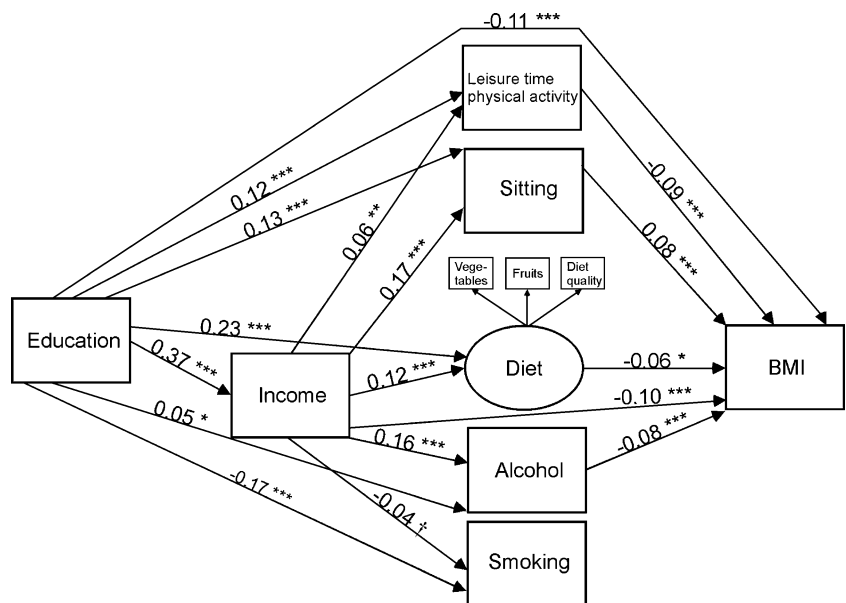
Table 2 Indirect associations of socioeconomic position with BMI in men and women

	Mediator 1	Mediator 2	Men Indirect regression coefficient (p value) [1]	Women Indirect regression coefficient (p value) [1]
Total effect			−0.023 (0.09)	−0.167 (<0.001)
Total indirect effect			−0.023 (0.09)	−0.058 (<0.001)
Education	Income		Not specified	−0.036 (<0.001)
	Leisure time physical activity		−0.005 (0.064)	−0.011 (0.001)
	Sitting		0.015 (0.015)	0.010 (0.001)
	Diet		−0.041 (<0.001)	−0.014 (0.036)
	Smoking		0.012 (0.032)	Not specified
	Alcohol consumption		Not specified	−0.003 (0.065)
Education	Income	Leisure time physical activity	−0.002 (0.072)	−0.002 (0.023)
	Income	Sitting	0.003 (0.025)	0.005 (0.001)
	Income	Diet	−0.008 (0.002)	−0.003 (0.051)
	Income	Smoking	Not specified	Not specified
	Income	Alcohol consumption	0.003 (0.061)	−0.004 (0.001)

[1] Age-adjusted and standardized. Calculated using structural equation modelling as a product of the independent, direct regression coefficients as presented in Fig. 1 and 2

included income, leisure time physical activity, and alcohol consumption. These findings suggest that long hours of daily sitting, low levels of leisure time physical activity, infrequent use of fruit and fresh vegetables, and poor self-rated quality of diet contributed to the higher BMI among participants with a lower level of education and income. Additionally, some mediators were gender-specific, such as smoking in men and income and alcohol in women, suggesting that socioeconomic variation in BMI is gender-specific and health behaviours that contribute to BMI are different in men and women and may be guided by different mechanisms.

Health behaviours that predicted socioeconomic variation in BMI clustered strongly with each other. This suggests that health behaviors form an entity, lifestyle. Commonly people make choices of food, physical activity, smoking, alcohol and drug use, but their decisions are limited by the life chances they have [24]. Life chances are mainly socioeconomic but also include other forms of social division such as gender [24]. It s clear that social inequity in obesity cannot be tackled changing behaviors among people only. Society and environment that promotes healthy choices for weight management should be brought into the agenda of the policy makers.

Comparisons to Previous Literature

Socioeconomic position is previously reported to associate with health behaviours [5, 15, 16, 25–27] and health behaviours with BMI [1–16], which was also the case in our study when the detailed individual paths were examined.

We found that health behaviours clustered with each other, which is commonly observed in other studies [15, 16, 18–20] and more so among the lower educated [13, 39]. We found only two previous studies that reported the path associations from socioeconomic position to obesity through health behaviours using similar statistical tool as we did [2, 28]. Compared to our findings, they found less consistent associations. Ward et al. [2] reported statistically significant associations of education or income with fruit and vegetable use, leisure time physical activity, and smoking, but only infrequent fruit and vegetable use predicted higher adiposity directly, and this was found only among women. Other health behaviours had no associations with adiposity and no mediating pathways were found. Dollman et al. [28] found the most consistent associations between low socioeconomic position and TV watching and between fat intake and overweight, but the indirect association from socioeconomic position to overweight was found only among boys through fat intake. Our results are vastly different from the two previous studies, as our data suggest that several health behaviours are significant mediating factors between socioeconomic position and BMI.

The strongest pathways from socioeconomic position to BMI ran through diet and sitting and in women also through leisure time physical activity. Thus, the fact that people with lower education or income are more often obese or overweight is partly caused by their unhealthy dietary habits and time spent in sedentary activity. Therefore, even the higher educated people may be overweight or obese if their amount of sitting is high, which may even be interpreted from our data, as both of the

regression coefficients from education and income to sitting and from sitting to BMI were positive. Sitting was measured as the total amount of sedentary time during a weekday, which is biased by occupation. Unfortunately our data did not separate occupational sitting from leisure time sitting. Previous studies are inline with our findings, as they reported both total daily sitting and leisure time sitting, particularly TV watching to be more common among the more obese [6, 9, 10]. Also the number of pauses during sedentary time is reported to beneficially associate with abdominal obesity [40]. It is important that sedentariness itself, regardless of leisure time physical activity, contributed to overweight and obesity, because it conveys a message to avoid sitting itself. Avoiding sedentariness could be implemented in many ways, not just by increasing leisure time physical activity that is commonly promoted in weight maintenance programs.

We found several gender differences. In men diet and sitting, but not leisure time physical activity were systematic mediators between socioeconomic position and BMI, while in women the mediators were income, diet, sitting, leisure time physical activity, and alcohol consumption. This could indicate that socioeconomic position, particularly high income, enables or guides towards healthier behaviours and that there is a larger variance in health behaviours in women than in men. Additionally, the independent association between high socioeconomic position and low BMI still remained in the pathway model, whereas this association was not statistically significant in men. This and previous findings on gender differences [1, 11, 12, 16, 41] suggest that different behavioural mechanisms may guide healthy choices in men and women. In our data, for example daily use of vegetables and fruit was more frequent among women than men, suggesting that women eat healthier than men. In contrast, self-rated quality of diet was reported better among men than women. Thus it is evident there are gender specific perceptions in health behaviours.

We included education and income simultaneously in our path analysis and found that both were significant predictors of BMI. Education is thought to bring immaterial capital, such as knowledge and opportunities to adopt a healthy lifestyle [23, 42]. Income has a slightly different function as a measure of socioeconomic position, as income provides material resources that enable choices for a healthier lifestyle and higher education often leads to a higher income [23, 42]. In our path model for women, education and income had strong inverse associations with BMI, despite the mediation effects through health behaviours were accounted for. This suggests that socioeconomic position may have other pathways to BMI, such as issues related to personality [43] or environment [44–49]. As importantly, other health behaviours, such as sleep, were not included in the model.

Methodological Issues

Structural equation modelling usually uses a structure that reminds causal pathways and its statistical framework and testing is often built based on the previous findings that suggest such a causal relationship. It is reminded here that our data were cross-sectional, which limits our findings to include associations only, not causal interpretations. It should also be born in mind that our final pathway model was built as based on model fit indices and the technical demands of structural equation modelling, including the two-step model building from confirmatory factor analysis to measurement model.

Despite that the FINRISK sample represents general population, we know that non-participants were more often younger men and lower educated [36, 50]. We also had a fairly substantial number of missing information on the physical activity questionnaire and it is likely that those most inactive refuse to fill in the questionnaire [36]. It may well be that the associations in our path model would be even stronger if we had the most inactive and least educated population in our sample.

As in most large scale studies, the data collection method was based on self-reported questionnaires. Self-reports are prone to recall bias, which is also likely in our sample, yet all of the measurements on health behaviours and socioeconomic position have shown to associate with BMI [1]. Importantly, height and weight were measured at the study site to overcome the problem of underestimation of BMI [51]. Unfortunately, our measurements were not adequate enough to report energy balance, but we used a latent variable on diet that included two items from food frequency questionnaire and self-rated quality of diet. Many items from the frequency questionnaire were tested in factor analyses and the use of fruit and fresh vegetables fitted the data best.

Conclusions

Higher socioeconomic position predicted lower BMI and its effect was partially mediated through health behaviours, particularly through diet and sitting in men and diet, sitting, and leisure time physical activity in women. The associations and mediations between socioeconomic position and BMI varied between the genders, while health behaviours clustered strongly with each other. To reduce the socioeconomic variation in overweight and obesity, health promotion strategies should seriously target sedentary behaviour, along with healthy diet and leisure time physical activity. Strategies should also take into account the clustering of unhealthy behaviours, e.g. understand that smoking is often accompanied by alcohol use, poor diet, and low level of physical activity. Furthermore,

gender-specific action should include smoking among men and alcohol use among women.

Education was an important factor along the path through health behaviours on BMI, which emphasizes the importance of health and physical education in primary school and the need to target work places that employ manual and other lower educated workers. Providing good knowledge and skills for healthy choices at primary school may be a cost-effective way to prevent obesity in the future. On the other hand, based on our findings, the mediating role of income should not be neglected. Income is an essential factor when making people to choose healthy diet, thus action related to food policy and pricing of healthy foods plays a crucial role.

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