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ORIGINAL ARTICLE

Exploring subgroup effects by socioeconomic position of three effective school-based dietary interventions: the European TEENAGE project

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Abstract

Objectives The aim of this study was to explore subgroup effects by high and low socioeconomic position (SEP) of three previously conducted, effective European interventions.

Methods Reanalyses stratified by SEP were conducted by the research groups of each study. All studies were school-based: two multi-component interventions targeting intake of fat or fruit and vegetables (FV), and a free breakfast initiative.

Results Computer-tailored advice affected fat intake among low, but not high SEP girls after 1 year. A multi-component intervention affected the total FV intake in both SEP groups, vegetable intake in low SEP and fruit intake in high SEP across three countries after 1 year, whereas free fruit affected total FV and fruit intake equally in both SEP groups in one country after 2 years. Providing a free healthy breakfast increased consumption of healthy food items only in the low SEP group.

Conclusions Reanalysing intervention studies by SEP is a quick and easy way to explore patterns in effects by SEP across interventions. Providing healthy food might be a promising strategy for decreasing social inequalities.

Keywords Diet · Adolescence · Socioeconomic position · Intervention · School

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Introduction

Socioeconomic inequalities in morbidity and mortality in adulthood are robust and seem to widen globally and in Europe (WHO 2008a; Mackenbach et al. 2008). Primary prevention interventions aimed at establishing healthy behaviours at an early age have a potential to prevent or decrease socioeconomic inequalities in health behaviours (Due et al. 2011). However, it has been argued that interventions targeting individual behaviour change are more likely to widen social inequalities than interventions targeting the environmental conditions that may shape these behaviours because the interventions targeting individual behaviour change require more efforts and resources from the individual (McLaren et al. 2010). A recent review of reviews on social inequalities by type of health behaviour intervention reports some evidence to support this proposition (Lorenc et al. 2013). In epidemiological research, it is widely accepted that studies not designed for, and thus lacking statistical power for subgroup analyses, should not be analysed by subgroups. However, there are still good reasons to explore such subgroup analyses from a public health perspective (Petticrew et al. 2012). First, it is plausible that the effects of public health interventions might differ by subgroups because of the complexity of the pathway from intervention to outcome (Petticrew et al. 2012). Second, there are clear hypotheses about which kind of interventions might reduce or increase social inequalities (McLaren et al. 2010; Lorenc et al. 2013). It is, therefore, strongly recommended to effectively use existing data to explore socioeconomic inequalities to start providing policy makers with the evidence-base they are requesting (Petticrew et al. 2012; Magnee et al. 2013).

An unhealthy diet is one of the four main preventable risk factors of the most common non-communicable diseases (WHO 2008b). Socioeconomic inequalities in dietary behaviours have been found in all age groups and across developed countries (Giskes et al. 2010; Currie et al. 2008; Hanson and Chen 2007; van der Horst et al. 2007; Pearson et al. 2009a, b) indicating that people with higher SEP eat healthier diets than those with lower SEP. The strength of the associations varies by food group: in a European study it was found to be strongest for fruit and vegetable intake (Giskes et al. 2010). Adolescents with low SEP are more likely to report an inadequate fruit and vegetable intake (Pearson et al. 2009a) and a higher intake of high fat and sugary foods than adolescents with higher SEP (Hanson and Chen 2007; van der Horst et al. 2007). The pattern for breakfast consumption suggests that low SEP adolescents are more likely to skip breakfast (Moore et al. 2007a), but several studies have not found this difference by SEP (Pearson et al. 2009b). During adolescence deterioration of diet quality has been shown longitudinally (Kelder et al. 1994; Lien et al. 2001a; Lytle et al. 2000). Since these dietary behaviours may remain into adulthood, primary prevention interventions aimed at establishing and reinforcing healthy eating habits often focus on young adolescents. The school is a preferred setting to deliver these interventions because of the potential to reach all children irrespective of their SEP (van Cauwenberghe et al. 2010). Thus far, however, only few studies have explored the differential effect of school-based dietary interventions for adolescents from lower and higher SEP (Oldroyd et al. 2008; Yildirim et al. 2011; van Cauwenberghe et al. 2010).

The aim of this study was to conduct secondary analyses to explore effects by SEP for three European school-based intervention studies aimed at changing adolescents' dietary behaviours and which had previously been shown to have an effect on the main outcomes.

Methods

As part of the EU funded TEENAGE project, a systematic literature search was conducted to find dietary interventions among European adolescents (aged 11–18 years), carried out after 1990 and published after 1995 in English in the scientific literature (van Lenthe et al. 2009). This resulted in 17 dietary intervention studies, mainly from Western and Northern Europe. Of the 17 studies identified, the majority (15) were school-based. The studies were sorted by intervention methods, health education (7), environmental interventions (1) or policies and laws (none found) or combinations (9) (van Lenthe et al. 2009). Further selection criteria for reanalyses were that a measure of SEP was collected, that the intervention had had an effect on the dietary outcome of the study and that differential effects by SEP had not already been reported. Only six studies indicated that they had collected a measure on SEP of which four had effects, but one had tested for differential effects by SEP (Bere et al. 2006a, see "Discussion"). The three studies remaining are briefly described below and summarised in Table 1, but detailed descriptions of the design, sampling, methods, intervention content and primary effects are published elsewhere (Haerens et al. 2006, 2007; te Velde et al. 2008; Perez-Rodrigo et al. 2005; Moore et al. 2007b; Murphy et al. 2011). Each study was reanalysed separately using statistical methods appropriate for the study design and closest to the analyses used for the overall effect evaluation, and the data were stratified by SEP in accordance with the aim of the TEENAGE project. Interaction effects were tested for SEP by condition (intervention or control) on the dietary behaviour outcomes in all three studies, but approached significance ($p < 0.1$) only for the breakfast study. The results were not pooled due to the heterogeneity of the studies.

Study 1: the Belgian multi-component intervention: effect on fat intake

Design, sample and main effect

Participants were pupils in the 7th and 8th grade of a random sample of 15 out of 65 technical and vocational schools in West Flanders. Schools were randomly allocated to a control group ($n = 5$) or one of two intervention groups: intervention alone ($n = 5$) or intervention with parental support ($n = 5$). The Ethical Committee of Ghent University approved the study. A final sample of 2,840 boys and girls was included in the study due to lack of parental consent for 151 pupils (Haerens et al. 2007). Pre-tests took place in September 2003, after which the intervention started. Children were then measured again after the first (May/June 2004) and second school year (May/June 2005)

Table 1 Brief overview of the study designs, interventions and outcomes of three European school-based interventions reanalyzed for differences in effect on dietary behaviours by socioeconomic position in the TEENAGE project

	Study 1: the Belgian multi-component intervention	Study 2: the Pro Children intervention	Study 3: the Primary School Free Breakfast Initiative
Design			
Type of study	School-based cluster-randomised controlled trial (n = 15 technical and vocational schools)	School-based cluster-randomised controlled trial (n = 62 primary schools)	School-based cluster-randomised controlled trial (n = 111 schools) with repeated cross-sectional data collections
Dietary outcome and method	Fat intake (g/day)—validated food frequency questionnaire	Fruit/vegetables intake (g/day)—validated 24 h recall	Breakfast—dietary recall over 2 days (pupil), frequency (parents)
Measure of socioeconomic position	Parental occupation reported by pupils, grouped as high or low SEP according to Hollingshead (1957)	Parental length of education reported by parents	School socioeconomic position: Percentage entitled to free breakfast
Country	Belgium	Norway, Spain, the Netherlands	Wales (UK)
Participants			
Age at pre-test	11–15 years	10–12 years	9–11 years
Invited/consent or at pre-test	n = 2,991/2,840	n = 2,106/1,801	n = 4,888/4,335 pupils
Attrition analyses	No significant differences by gender, SEP or fat intake	Dropouts more likely: older, boys, have reported higher vegetable intake at baseline, from the intervention group, Dutch	
Post-test (months after pre-test)	8 and 20	7 and 19	4 and 12
Intervention components			
Duration	1 school year + booster activities year 2	1 school year + booster activities year 2	12 months
Health education/classroom	Computer-tailored advice	Computer-tailored advice, worksheets and activities	None
School environment	Increased availability of healthy and reduced availability of unhealthy foods	Provision of fruit (free or through subscription)	Free breakfast
Parental involvement	Intervention with parent: computer-tailored advice, newsletter	Newsletters, computer-tailored advice, school events/meetings	None
	Intervention alone: nothing		
Overall results	1 year: lower intake of fat among girls only in the intervention + parent group	1 year: higher intake of total FV, F alone and V alone in the intervention group	1 year: more healthy food items chosen for breakfast, fewer breakfasts at home 5 days/week and more at school ≥2 days/week
	2 year: lower intake of fat among girls only in the combined intervention and intervention + parent group	2 year: Higher intake of total FV and F alone in Norway only	

SEP socioeconomic position, *FV* fruit and vegetables, *F* fruit, *V* vegetables during which the intervention took place. Attrition analyses showed no significant difference by gender, SEP or fat intake after 2 years (Haerens et al. 2006). The overall aims were to increase the intake of fruit and water, and reduce soft drink and fat intake. The only significant effects were found on fat intake among girls both at the first and second year post-test (Haerens et al. 2006, 2007), but there was no difference in the girls' fat intake between the intervention arms at the second year post-test (Haerens et al. 2007). At baseline 1,095 girls were invited to participate of whom 1,039 returned parental consent. At the first year post-test, 932 girls reported their age [mean 12.95 years (SD = 0.80)], SEP and dietary fat intake, at the second year post-test 789 girls completed all measurements.

Intervention description

During classes, the pupils received personalised computer-tailored advice regarding fat and fruit intake once a school year. The schools/teachers were encouraged to arrange other supporting activities (i.e. healthy breakfast). In the group with parental support, the parents received the personalised computer-tailored advice for fat intake of adults. Parents were invited to an interactive meeting at school on healthy food and the parents' role in shaping their child's dietary behaviour. Environmental changes in schools were aimed at increasing the availability of healthy and decreasing the availability of unhealthy foods.

Methods

An estimate of family SEP was obtained by classifying open-ended answers from the adolescents about the occupation of the father and mother into "white" and "blue" collar (Hollingshead 1957). If one of the parents got a "white" collar code, the child was ranked as high SEP. Fat intake was measured using a 48-item, validated frequency questionnaire developed based on knowledge of all important fat sources in the Belgian diet, resulting in a total fat intake score (g/day) (Vandelanotte et al. 2004; Haerens et al. 2006, 2007).

Statistical analyses

Linear mixed models were conducted in 1- and 2-year post-intervention measures of fat intake among girls stratified by SEP. Condition (control or intervention) was entered as a factor in the model. School was nested within condition to take into account school variance. Analyses were adjusted for pre-intervention values of dietary fat intake and age. The significance level was set at $p \leq 0.05$. Statistical analyses were performed using IBM® SPSS® Statistics, version 15 (IBM Corp., Somers, NY, USA).

Study 2: the Pro Children intervention to increase FV among adolescents

Design, sample and main effect

The Pro Children study was a cluster-randomised controlled trial among 5th and 6th graders [mean 10.8 years (SD = 0.54)] from 62 schools in the Netherlands (city of Rotterdam), Spain (Bilbao region) and Norway (Buskerud county). Ethical approvals were obtained from the medical ethical committees in each country. Out of the 2,106 pupils eligible to participate in the study, 1,472 were included in the effect evaluation as they had valid data on all three measurement times (te Velde et al. 2008). The reanalyses reported in the current paper included 1,245 pupils with valid data on all three measurements and level of parental education to be categorised as low or high SEP. Pre-test was conducted in the fall of 2003, first year post-test in spring 2004 and second year post-test in spring 2005. Attrition analyses showed that at first post-test those who dropped-out were significantly more likely to be older, boys, report higher vegetable intake at baseline and be in the intervention group. Dropouts between first and second post-test were more likely to be Dutch and older. No difference in dropouts by SEP was found (te Velde et al. 2008). The overall aim was to increase FV intake. After 1 year, there were effects in the total sample for all three outcomes (intake of fruit, vegetables and total FV), but after 2 years the effects differed by country. The intervention only reached a significant effect on total FV in Norway and this became stronger after adjustment for SEP (te Velde et al. 2008).

Intervention description

The intervention consisted of worksheets with classroom activities, personalised computer-tailored advice, a parent component and provision of FV. In the Netherlands, pupils received free FV 2 days/week. In Spain, the intervention schools received free fruit for the first 2 months. In Norway, all schools could subscribe to the national fruit programme, but the booster activity in the second half of year 2 was free FV for all the intervention children. The family component involved parents through the children's homework, parental newsletters and a CD with the personalised computer-tailored advice for adults.

Methods

Family SEP was assessed by five pre-coded answer categories to a question in the parental questionnaire about how many years of education (s)he and their partner reported to have completed. The parent with the highest educational level was used, or else the one available. Low SEP included those with '<7', '7–9' or '10–12 years' and high SEP comprised those with '12–16 years' and 'more than 16 years'. A validated questionnaire-based 24-h recall was used to assess FV consumption in terms of pieces, slices or portions during three time intervals of the previous day, and standard measures were used to convert these units into grammes of FV per day (Haraldsdottir et al. 2005).

Statistical analyses

Multilevel modelling with random intercept using MlwiN (version 2.27) was conducted with a two-level data structure [pupil (level 1) and school (level 2)]. The estimated regression coefficients reflect the difference between the control (0) and the intervention (1) groups. Positive direction indicates greater intake at follow-up in the intervention group. All regression models were adjusted for baseline intake, (country in year 1), gender, and age. The analyses of the 2-year follow-up results were stratified by country, as the original effect analyses revealed that effects differed by country (based on a significant interaction term between country and intervention condition) (te Velde et al. 2008).

Study 3: the Primary School Free Breakfast Initiative

Design, sample and main effect

The initiative was formed from a Labour Party manifesto commitment to make free healthy breakfasts available to primary schools in Wales, UK. The evaluation study was a cluster-randomised controlled trial. The study received ethical approval from the Cardiff University Social Science Ethics Committee. Out of the 608 schools approached, 111 schools agreed to participate: 58 schools from areas prioritised for social and economic programmes in phase 1 (pre-test in January 2005) and 53 schools from all other areas in phase 2 (pre-test in October 2005). The schools were randomised to the intervention ($n = 55$) or control condition ($n = 56$). Data were collected at pre-test, after 4 months (first post-test) and 12 months (second post-test) in a repeated cross-sectional design, therefore inflow and outflow of students was allowed. In each school, one year 5 (age 9–10 years) and one year 6 (age 10–11 years) class were randomly selected to answer the questionnaires. Almost 90 % of the pupils ($n = 4{,}350$) participated at pre-test and second post-test ($n = 4{,}472$). No data are available on non-participating pupils. The overall aim was to encourage breakfast intake and improve its nutritional quality. The primary outcomes were breakfast skipping (during the last 2 days) and number of healthy and unhealthy items consumed at breakfast. The only significant effect was a higher number of healthy food items consumed at breakfast in the intervention group (Murphy et al. 2011).

Intervention description

Breakfast should be provided before school every day, be free of charge and healthy. Scheme guidelines, 25 pence per child for each breakfast and separate funding for staff were provided by Welsh Assembly Government. Schools were encouraged to involve pupils and parents in organising the breakfast.

Method

School SEP was defined based on the percentage of students entitled to free school meals provided by the Welsh Assembly Government; below national median (24 % entitled to free school meals) was classified as high SEP. The free meal is a means tested benefit on the basis of household income/receipt of other state benefits. On a dietary recall questionnaire children recorded all foods and drinks they had consumed during the day resulting in measures such as the number of healthy and unhealthy food items eaten at breakfast (Moore et al. 2007b; Murphy et al. 2011).

Statistical analyses

The outcome variable at second post-test was analysed as a school-level weighted linear regression model adjusting for baseline score and four stratification variables and conducted on an intention to treat basis (Murphy et al. 2011). In the reanalyses IBM® SPSS® Statistics, version 16 (IBM Corp., Somers, NY, USA) was used.

Results

In the Belgian study, intervention effects on dietary fat intake after the first year were found among girls of low SEP only (Table 2); fat intake decreased more among girls of the intervention with parental support, compared to girls in the intervention alone ($p = 0.046$) or the control ($p < 0.001$).

In the Pro Children study, there were positive effects on total FV intake in both SEP groups, on vegetable intake in the low SEP group and on fruit intake in the high SEP group after 1 year (Table 3). After 2 years, there were significant effects in Norway on the intake of fruit and total FV in both SEP groups with slightly larger differences between intervention and control group in the low SEP group. The differences in the intake of fruit were almost

Table 2 Study 1: the Belgian multi-component intervention: difference in fat intake (g/day) among girls of high and low SEP after year 1 and year 2 (2003–2005)

	n	Prefat intake *M* (SD)	Postfat intake *M* (SD)	*F* value	Post hoc	$F_{post\ hoc}$	*p*	
Year 1 of intervention								
Low SEP				6.5				0.002
Intervention with parent	290	98 (39)	85 (37)		$I = C$	1.0	0.391	
Intervention alone	82	110 (45)	99 (39)		$I + P > I$	4.0	0.046	
Control	208	104 (43)	98 (43)		$I + P > C$	11.5	<0.001	
High SEP				2.8				0.137
Intervention with parent	142	94 (36)	84 (33)		NA			
Intervention alone	26	102 (50)	97 (44)		NA			
Control	184	94 (33)	92 (36)		NA			
Year 2 of intervention								
Low SEP				2.3				0.190
Intervention (parent/alone)	317	101 (42)	80 (36)		NA			
Control	169	100 (41)	88 (38)		NA			
High SEP				4.3				0.093
Intervention (parent/alone)	139	95 (39)	77 (27)		NA			
Control	164	91 (33)	83 (31)		NA			

Linear mixed models with school nested within condition and adjusted for baseline values of dietary fat intake and age

Socioeconomic position measured by children's report of parental occupation (Hollingshead 1957)

SEP socioeconomic position, *NA* not applicable

equal to the differences in total FV intake in both SEP groups indicating that only fruit intake had increased.

In the Primary School Free Breakfast Initiative, a significant increase in consumption of healthy breakfast items was only found in the low SEP group (Table 4).

Discussion

The TEENAGE study aimed to investigate differences by SEP groups in effect of different types of interventions—health education, environmental interventions and policies and laws (van Lenthe et al. 2009). Reanalyses by SEP of three effective school-based dietary intervention studies involving European adolescents showed that increasing the availability of fruit in schools without parental payment seemed to have an equal effect on fruit intake for adolescents from low and high SEP groups, and providing breakfast without parental payment increased the number of healthy food items eaten at breakfast in the low SEP school group. The multi-component classroom-centred intervention-targeting fruit and vegetable intake had the same effect on total FV intake on both groups, whereas the computer-tailored advice was associated with effect on fat intake in the low SEP group only. The general lack of dietary studies using environmental interventions or polices and laws as the only type of intervention, should be taken into consideration in future studies aimed at understanding which interventions work better or equally well across SEP groups.

The results after year 2 of the Pro Children study, where the booster activity in Norway was free fruit for the last half a year, indicate that changes in availability of healthy food without parental payment are equally effective in high and low SEP groups. The latter finding is concordant with another Norwegian intervention study which found sustained effect after 1 year of providing free fruit for a year and no interaction with parental education (Bere et al. 2006a), but no effect of the classroom component with parental involvement (Bere et al. 2006b). A similar Dutch project providing free fruit twice a week reported a significant interaction with parental education, but no differences were found after stratification, which was attributed to lack of power and the results were not further described (Tak et al. 2007, 2009). However, when fruit is not provided daily the dose may be insufficient to detect the effect. The breakfast initiative in Wales also supports the hypothesis that environmental interventions might work equally well or even better for low SEP groups. In this study, the increase in consumption of healthy food items for breakfast was greater and only statistically significant in the low SEP school group. These results support the idea

Table 3 Study 2: the Pro Children intervention: difference in fruit and vegetable intake after year 1 and year 2 among adolescents stratified by SEP in Norway, Spain and the Netherlands (2003–2005)

	Low SEP			*p*	High SEP			*p*
	n	Coefficient; diff. btw. intervention and control	95 % CI		*n*	Coefficient; diff. btw. intervention and control	95 % CI	
Year 1								
All countries	728				515			
Fruit and vegetable intake (g/day)		**39.9**	6.7 to 73.2	0.022		**56.1**	8.7 to 103.4	0.024
Vegetable intake (g/day)		**16.8**	0.4 to 33.2	0.049		19.3	−4.1 to 42.7	0.111
Fruit intake (g/day)		23.6	−0.8 to 48.0	0.062		**37.8**	5.5 to 70.0	0.025
Year 2								
Norway	252				188			
Fruit and vegetable intake (g/day)		**112.0**	55.4 to 168.7	0.001		**80.7**	16.5 to 144.9	0.025
Vegetable intake (g/day)		11.2	−12.2 to 34.7	0.362		3.0	−26.5 to 32.5	0.842
Fruit intake (g/day)		**100.2**	54.72 to 145.7	<0.001		**79.5**	24.1 to 134.9	0.012
Spain	295				117			
Fruit and vegetable intake (g/day)		9.3	−51.4 to 69.9	0.768		38.7	−34.7 to 112.2	0.319
Vegetable intake (g/day)		11.9	−9.19 to 33.0	0.284		13.3	−12.9 to 39.4	0.337
Fruit intake (g/day)		−3.4	−55.4 to 48.6	0.900		21.8	−38.2 to 81.7	0.488
The Netherlands	181				210			
Fruit and vegetable intake (g/day)		51.6	−20.9 to 124.2	0.699		−10.2	−61.2 to 40.8	0.176
Vegetable intake (g/day)		13.9	−18.8 to 46.6	0.501		−10.2	−39.4 to 19.0	0.412
Fruit intake (g/day)		37.4	−21.1 to 95.9	1.00		0.0	−36.5 to 36.5	0.223

Multilevel regression analyses (regression coefficient and 95 % CI). Regression coefficient reflects the difference between the control (0) and the intervention (1) groups. Positive direction indicates greater intake at follow-up in the intervention group. All regression models were additionally adjusted for baseline intake, sex and age

Family educational level, the highest reported by one of the parents: low SEP $\leq$ 12 years or less, high SEP $>$12 years

Bold values indicate results were significant

SEP socioeconomic position

that environmental changes without an individual/classroom-based component can change food choices in a positive direction in low SEP groups.

In the Belgian study, where the computer tailoring was a main component of the intervention, it seemed as if the low SEP girls within the study arm with parental support in particular benefitted from the combination of personal and environmental components in the first year. This fits the hypothesis that tailoring might make the message more personal relevant, and thus easier to act upon than a standard one-size fits all health education message that is usually provided through classroom curricula. In the first year of the Pro Children study, there was no difference in effect by SEP, but in this study computer tailoring was only one of many components. Furthermore, these studies also differ by the inclusion of only girls in the Belgian study. Recently, similar reanalyses of Dutch studies found that individual level interventions which mostly used computer tailoring either had no differential effect by SEP or worked better in high SEP, but the majority of these studies were conducted in adults (Magnee et al. 2013). These mixed results can only be taken to support the argument that the right combination of health education and environmental interventions needed to decrease socioeconomic inequalities has not yet been found (Frohlich and Potvin 2010).

Conducting secondary analyses of effective dietary interventions by SEP group has both strengths and weaknesses. First, a strength is that multilevel analyses controlling for clustering effects were conducted where relevant, and the research groups responsible for the analyses of the primary effects also conducted the secondary analyses. Second, the dietary outcomes ranged from

Table 4 Study 3: the Primary School Free Breakfast Initiative in Wales: school-level intervention effects for healthy food items consumed at breakfast according to school SEP (2005–2006)

	High SEP schools ($n = 56$)		Low SEP schools ($n = 55$)	
	Estimate	95 % CI	Estimate	95 % CI
Healthy food items consumed at breakfast	0.09	−0.09, 0.26	0.33	0.12–0.54***

Significant difference between intervention and control schools (even-sized groups) for each SEP based on school-level weighted regression analyses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

School SEP was defined by the school having more (low SEP) or less (high SEP) than the sample median of 24 % of pupils entitled to free school meals

SEP socioeconomic position

macronutrient, food level to meal were covered. Third, although not all types and combinations of intervention methods were available, there were both health education and environmental change interventions, but the length of the implementation and the age range of the target group were fairly similar. However, there are also some weaknesses. First, the studies were not powered to conduct subgroup analyses by SEP and probably as a result the interaction of SEP by condition was only approaching significance in the breakfast study. Post hoc power calculations indeed confirmed that the power of the subgroup analyses was not sufficient to show significant effects; however, some estimates were really small and could only have reached statistical significance with a very large study population (data not shown). Therefore, we believe that the obtained effect estimates are still the best estimates of the effects, and that some estimates may have reached statistical significance with a somewhat larger sample. Furthermore, as underlined in the introduction, such exploratory analyses are warranted by the needs of policy makers, the plausibility of the existence of such differences and the proposed mechanisms to explain them (Petticrew et al. 2012; McLaren et al. 2010). Yet, the results should be considered as hypothesis generating and should be supported by other such studies and thereafter confirmed in properly designed and powered studies. Secondly, different measures of SEP were used in the studies and this should be kept in mind when discussing the results in relation to which type of intervention might work better for different SEP groups as education might be more related to knowledge and attitudes, whereas occupation might be more related to material circumstances. In addition, there are methodological issues related to each of these measures. Using parental SEP as an indicator of adolescents' SEP is quite common, but whether asking the children to report in proxy on their parents' occupations or asking the parents about their education, there is likely to be a high number of missing values due to missing answers among the children and non-response to the parental questionnaire (Lien et al. 2001b). This prompts the use of a family SEP measure (as in study 1 and 2) since the likelihood of having complete data on each of the parents is low, but it could be argued that this might have made the high SEP group too large or that differences due to mothers' SEP have been masked. Assigning whole schools to low and high SEP (study 3) is a possible solution, but does not take into account that there is substantial heterogeneity among the population of each school. The Pro Children study further raises the issue of whether one SEP indicator (education) has the same meaning in three different countries. Across the three studies, these methodological issues are likely to have resulted in heterogeneous high and low SEP groups, and thus made the detection of socioeconomic inequalities more difficult. All these methodological challenges contribute to blurring our understanding of the underlying causes of differences in the effects of dietary interventions in adolescence. A weakness of this study as a European project, is that the three studies although including five European countries cannot be taken as a representative of the whole of Europe. The lack of intervention studies from Southern and especially Eastern Europe was noted.

Conclusion

Providing breakfast or fruit without parental payment seemed equally effective in both high and low SEP groups or even more effective in low SEP groups. The general multi-component classroom-centred intervention also had equal effect on FV in both SEP groups, whereas computer tailoring seemed more effective in the low SEP group on fat intake. Due to the exploratory nature of these analyses, the results should be supported by post hoc subgroup analyses of other dietary intervention studies or preferably in studies where such subgroup analyses are integrated into the design.

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