

ORIGINAL ARTICLE

Skipping breakfast, alcohol consumption and physical inactivity as risk factors for overweight and obesity in adolescents: results of the E-MOVO project

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Objective/Background: To investigate the association between skipping breakfast, alcohol consumption and physical inactivity with overweight and obesity in adolescents. The design comprises cross-sectional electronic health survey (E-MOVO).

Subjects/Methods: Over 35 000 Dutch adolescents in grade 2 (13–14 years of age) and grade 4 (15–16 years of age) of secondary educational schools were recruited by seven community health services. Analyses were performed on 25 176 adolescents. Body mass index was calculated from self-reported body weight and height. Frequency of skipping breakfast per week, amount of alcoholic drinks consumed per occasion, and numbers of physical active days per week were considered as determinants for overweight and obesity.

Results: In grade 2, adjusted odds ratios for the association with overweight were 2.17 (95% CI: 1.66–2.85) for skipping breakfast, 1.86 (1.36–2.55) for alcohol consumption and 1.73 (1.19–2.51) for physical inactivity. Statistically significant associations with overweight were also found in grade 4. In grade 2, dose–response relations (P for trend <0.05) were present between all risk factors and overweight. In a multivariate model containing all risk factors, breakfast skipping showed the strongest relation with overweight (OR 1.68, 95% CI 1.43–1.97 for grade 2, OR 1.32 95% CI 1.14–1.54 for grade 4) and obesity.

Conclusions: Skipping breakfast, alcohol consumption and physical inactivity were associated with overweight in second and fourth grade adolescents. The associations were strongest for younger adolescents. The most important risk factor for overweight and obesity was skipping breakfast.

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Introduction

During recent years, the numbers of overweight and obese adolescents in the Netherlands have increased considerably. In 1997, 7.5% of the boys and in 9.3% of the girls, aged

13–16 years were overweight, compared to 4.1% and 6.2%, respectively, in 1980 (Hirasing *et al.*, 2001). In 2002–2004, the prevalence of overweight in boys and girls was more than doubled as compared to 1997. According to national overweight rates for children aged 13–15 years, prevalences were 15.3–16.8% for boys, and 15.2–20.1% for girls. (Van den Hurk *et al.*, 2006). Body mass index (BMI) values on adolescent age are considered to be predictive for overweight and obesity in adulthood (Guo and Chumlea, 1999). Obesity is a major risk factor for chronic diseases, including type 2

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diabetes, cardiovascular disease, hypertension and stroke and certain forms of cancer (van Oers, 2002; WHO, 2002).

Most important lifestyle factors that are associated with overweight and obesity are food intake and physical activity. The food consumption trend within Dutch adolescents has developed more unfavourably as compared to the whole population as a decrease was observed in frequency of breakfast intake in the age category of 13–19 years (Netherlands Nutrition Centre, 1998). Skipping breakfast is reported to be a risk factor for weight gain. (Ruxron and Kirk, 1997; Health council of the Netherlands, 2002; Berkey *et al.*, 2003; Cho *et al.*, 2003; Keski-Rahkonen *et al.*, 2003; Sjöberg *et al.*, 2003). It is reported that 13% of the Dutch adolescents following secondary education are skipping breakfast before going to school (Brugman *et al.*, 1998). Another possible risk factor for weight gain in adolescents could be a strong decline in physical activity level that is commonly observed in the stage of puberty, especially between the age of 13 and 17 years (Kemper *et al.*, 1999; L'Abée, 2001). In 2002, only 23% of the Dutch adolescents aged 12–17 years met the Dutch norm for healthy exercise, that is set at a minimum of 1 h of average intense activities for 7 days a week (Kemper *et al.*, 2000; Statistics Netherlands, 2003). A total of 51% of the adolescents perform physical activities for 1 h per day for at least 5 days a week (Zeijl, 2003).

Another lifestyle factor that has unfavourably developed in the Netherlands during the last years is alcohol intake. Between 1988 and 1998, the consumption of alcohol in boys (13–18 years) increased with 86% (Health council of the Netherlands, 2002; Kreijl, 2004). It is relatively unclear whether alcohol consumption is a risk factor for overweight, as studies have equally reported a positive, negative or no association (Westerterp, 1999; Lahti-Koski *et al.*, 2002; Bobak *et al.*, 2003; Wannamethee and Shaper, 2003; Suter, 2004; Yeomans, 2004). In addition, no studies were found describing the relations between alcohol consumption and overweight in adolescents.

Therefore, the objective of this research was to investigate the association between skipping breakfast, alcohol consumption and physical inactivity with overweight and obesity in Dutch adolescents.

Methods

Study design and study population

In 2003, a cross-sectional study entitled electronic monitoring and health education (E-MOVO) was performed in the eastern part of the Netherlands. E-MOVO was set up by seven collaborating community health services to monitor the health status and lifestyle of young adolescents by means of the Internet. Every secondary school in the eastern part of the Netherlands was approached by the responsible community health service to take part in the E-MOVO project. Secondary schools providing special education were not invited, as the questionnaire was not specially developed for

children with learning and behavioural difficulties. Out of the 184 school locations that were invited, 151 participated in the study (82.1%). The non-participating schools were mainly from one community area where the community health service had a lack of capacity (11 participating school locations, 44% response). In the other six communities, different reasons for refusal were given; some schools comprise more than one location and had only the capacity to include one location in the study; or had decreased capacity while being in the middle of a rebuilding process. All students in the second and fourth grades were requested to fill in the questionnaire on the computers in their classrooms. Over 35 000 adolescents (17 275 boys and 17 828 girls) from grade two (mean age 13.4 years, standard deviation (s.d.) 0.6) and grade four (mean age 15.5 years, s.d. 0.7) completed the questionnaire. We evaluated individual participation rates in 39 school classes with varying education levels. Of the 983 students, 51 students (5.2%) did not participate in the E-MOVO study. Illnesses of the adolescents were the main reason for non-participation ($n=33$). Only 7 students refused to participate, and 11 students did not participate for other reasons. Supervising teachers did not identify selective drop out during the filling in of the questionnaires.

Data assessment

All data were collected in schools with a detailed Internet questionnaire, under supervision of instructed teachers following a standardised protocol. The questionnaire consisted of about 100 questions concerning social-demographic factors, school-related topics, topics about lifestyle and health-status. It took about 50 min to fill in the questionnaire.

BMI was calculated from self-reported body weight and height (kg per m²). Subjects who indicated that they did not know ($n=9564$) or did not report ($n=23$) body weight and/or height were excluded. BMI values lower than 8 and higher than 45 were excluded ($n=52$). International age and sex-specific cut-off points for BMI were used to define normal weight, overweight and obesity (Cole *et al.*, 2000). In addition, underweight was defined (Van Buuren, 2004).

Extensive questions were used to assess breakfast intake, alcohol consumption and physical activity although they were not validated. Skipping breakfast was assessed by asking the frequency of intake per week, which is also used in other studies (Berkey *et al.*, 2003; Keski-Rahkonen *et al.*, 2003; Sjöberg *et al.*, 2003). Eight response categories were available, ranging from having breakfast at 0–7 days per week. Subjects who did not report an answer were excluded ($n=57$).

Physical activity was assessed according to the Dutch norm for healthy exercise (Kemper *et al.*, 2000). After answering questions on different types of physical activities, like participation in sports—both at school and at a sports club—playing outside, going to school by foot or by bike and vigorously active work, the adolescents were asked on how many days per week they were physically active for a

minimum of 1 h, when adding up all these different activities. Based on the Dutch norm for healthy exercise, five categories were made: norm actives (≥ 1 h per day physically active on 7 days per week), actives on 5–6 days per week (≥ 1 h per day physically active on 5 or 6 days per week), actives on 3–4 days per week (≥ 1 h per day physically active on 3 or 4 days per week), actives on 1–2 days per week (≥ 1 h per day physically active on 1 or 2 days per week) and non-actives (< 1 h per day physical activities on 7 days per week). Subjects who answered none of the questions about physical activity were excluded as well as subjects with estimates of physical activity that exceeded 16 h per day ($n = 411$) (Wendel-Vos *et al.*, 2003).

Alcohol consumption was determined by using questions about the usual number of alcoholic drinks per occasion in an average week. Taking into account the Dutch norm for alcohol drinking for adolescents of 16 years and older, subjects were categorised into four groups: non-drinkers (0 glasses per occasion), moderate drinkers (girls: 1–3 glasses per occasion, boys: 1–5 glasses per occasion), heavy drinkers (girls: 4–6 glasses per occasion, boys: 6–10 glasses per occasion) and excessive drinkers (girls: ≥ 7 glasses per occasion, boys: ≥ 11 glasses per occasion). Further exclusions were not necessary as unreliable data were already excluded by previous removals. The remaining sample size was 25 176 individuals.

Data analysis

To describe characteristics of the subjects, means with standard deviations and percentages were calculated. Differences in continuous variables were assessed using the independent *t*-test. Differences in categories were assessed using the χ^2 square test. To investigate the relation between skipping breakfast, alcohol consumption and physical inactivity with overweight and obesity, logistic regression analyses were used. Odds ratios (ORs) with 95% confidence intervals (95% CI) were calculated as a measure of relative risk. For these analyses, the different categories of underweight, normal weight, overweight and obesity were combined to form two categories. The first category is non-overweight, which includes normal weight and underweight, and was used as the reference category. The second category is overweight, which includes overweight and obesity. Besides the analyses to compare overweight with non-overweight, additional analyses were performed on obesity compared with non-overweight. After investigating all potential effect modifiers and confounders available, stratification by grade was necessary to take into account present interaction with the exposure variables. Gender (male), family situation (single-parent family), ethnic background (non-Dutch origin), education level (low) and smoking (one or more cigarettes per day) were identified as confounders. Adjusting for the different community health services, urbanisation grade and free-time activities like watching television and playing computer games did not

affect the estimates (data not shown). Besides crude ORs, adjusted ORs were computed to control for present confounding. Separate logistic regression models for the different risk factors were computed, as well as one additive model with all risk factors together. A test-for-trend was conducted to evaluate a dose–response relation over the risk factor categories. Statistical calculations were performed using the SPSS for Windows (version 11.5) software program.

Results

Subject characteristics are given in Table 1. Overweight and obesity were more present in boys (9.6%) than in girls (6.3%). The prevalence rates for overweight and obesity were similar for grade 2 (7.8%) and grade 4 (8.0%). Girls (38.7%) and grade 4 students (39.2%) skipped their breakfast more often than boys (30.0%) and grade 2 students (29.3%). Alcohol consumption was more common among boys (69.4%) than girls (65.5%). Fourth grade students consumed more often alcohol (81.5%) than second grade students (52.4%). A total of 53.2% of the adolescents was active for at least 1 h on 5 or more days per week. The percentages of norm-actives were quite similar for grade 2 (21.0%) and grade 4 (21.5%), but slightly more boys (23.2%) were active in line with the Dutch norm for healthy exercise than girls were (19.5%).

Table 2 shows that the obesity prevalence is especially high in Moroccan, Turkish, Suriname and the Netherlands Antillean children, and that overweight and obesity are more common in children with a relatively low educational level. Children from a single parent family were slightly more often overweight or obese, and urbanisation grade was not clearly associated with overweight or obesity.

Skipping breakfast was found more frequently in adolescents who were from a single-parent family (48.4%), from a non-Dutch origin (46.5%), had a low education (40.8%), were no sports club member (40.1) and were a smoker (55.5%). In relation to alcohol intake, 29.9% of the Dutch originated adolescents were non-drinkers. Heavy and very heavy drinking were found more frequently in adolescents who had a low education (33.9%), lived in non-urban areas (33.0%) and were smoking (62.9%). Activity levels according to the Dutch norm for healthy exercise were least met among adolescents with a Turkish background (16.5%) and adolescents who were not a member of a sports club (17.6%). Subjects who were living in non-urban areas were more likely to be active on 5 or more days per week (62.0%).

Adolescent who were excluded from the analyses because of not reporting their body weight and height ($n = 9564$) had a higher share of grade 2 subjects (64.1%) when comparing them to the 25 176 adolescents included in the analyses (48.4%). Furthermore, in the excluded group more adolescents had a low education level (60.1%) compared to 50.2% of adolescents following lower education in the analytical sample. With regard to other background characteristics,

Table 1 Age, height, weight and lifestyle factors of the E-MOVO subjects by gender and grade ($n = 25\,176$)

	Girls		Boys		Test of gender difference	Test of grade difference
	Grade 2 ($n = 6134$)	Grade 4 ($n = 6760$)	Grade 2 ($n = 6062$)	Grade 4 ($n = 6220$)		
Age (mean \pm s.d.)	13.3 (0.5)	15.5 (0.7)	13.4 (0.6)	15.6 (0.7)	$P < 0.05$	$P < 0.05$
Body height (cm) (mean \pm s.d.)	165.4 (7.1)	169.3 (6.6)	167.9 (10.0)	179.7 (8.4)	$P < 0.05$	$P < 0.05$
Body weight (kg) (mean \pm s.d.)	51.2 (8.8)	57.8 (8.3)	52.9 (10.7)	66.3 (11.4)	$P < 0.05$	$p < 0.05$
BMI (%)					$P < 0.05$	$P < 0.05$
Underweight	16.0	10.9	12.3	6.6		
Normal weight	77.5	83.0	78.1	83.7		
Overweight	5.8	5.4	8.5	8.3		
Obese	0.7	0.7	1.0	1.5		
Breakfast intake (%)					$P < 0.05$	$P < 0.05$
7 days per week	66.5	56.6	74.9	65.3		
5–6 days per week	13.4	16.7	12.6	15.2		
3–4 days per week	6.1	8.4	4.1	5.7		
1–2 days per week	9.0	11.8	5.2	8.1		
0 days per week	5.0	6.4	3.3	5.7		
Alcohol consumption (%)					$P < 0.05$	$P < 0.05$
Non drinkers	50.0	20.4	45.1	16.4		
Moderate drinkers	40.3	36.2	46.2	36.8		
Heavy drinkers	6.7	27.6	5.0	23.6		
Excessive drinkers	2.9	15.8	3.6	23.2		
Physical activity (%)					$P < 0.05$	$P < 0.05$
Norm active	19.1	19.8	24.0	22.4		
Active on 5–6 days/week	32.8	31.7	31.4	31.9		
Active on 3–4 days/week	25.4	23.6	25.0	23.5		
Active on 1–2 days/week	20.0	21.0	17.1	18.8		
Non-active	2.7	4.0	2.5	3.4		

Abbreviations: BMI, body mass index; E-MOVO, electronic monitoring and health education.

among the excluded adolescents were higher shares of males (50.3 versus 48.8%), single-parent families (8.6 versus 8.0%) and non-Dutch ethnicities (17.1 versus 14.4%).

Table 3 shows that skipping breakfast, alcohol consumption and physical inactivity were associated with overweight. After adjustments were made for gender, family situation, ethnic background, education level and smoking, the relations were slightly attenuated. A dose–response relation was found for all risk factors with overweight in grade 2 (P for trend < 0.05). In grade 4, the associations with overweight were less strong compared to the second grade. Still, a strong association was present between skipping breakfast and overweight. Alcohol intake was not clearly associated with overweight in grade 4. Regarding physical activity, only the category of non-actives was positively associated with overweight.

The relations of the risk factors with obesity alone were less clear than with overweight, probably due to the small number of obese subjects (data not shown). In grade 2, crude and adjusted risks for obesity were statistically significantly higher for subjects who had skipped breakfast every day, who were excessive alcohol drinkers, and who were active on 2 days or less per week. In grade 4, statistically significant

increased risks for obesity were found in subject who had skipped breakfast on 7 days per week, and who were physically non-active. No positive relations between alcohol consumption and obesity were found in grade 4.

Table 4 shows ORs for overweight by the different risk factors, adjusted for each other. The risks for overweight were still increased for all risk factors. Skipping breakfast showed the highest significantly increased risks for overweight. Concerning obesity separately, significantly increased risks were found for skipping breakfast in both grades and for physical inactivity in grade 2 (data not shown).

Discussion

Skipping breakfast, physical inactivity and alcohol consumption were investigated as risk factors for overweight and obesity in 25 176 adolescents. The results showed that skipping breakfast, physical inactivity and alcohol consumption were positively related to overweight and obesity. Dose–response relations were found between skipping breakfast and overweight, and in grade 2 between both alcohol consumption and physical inactivity and overweight.

Table 2 Socio-demographic factors and leisure time activities in relation to body weight categories

	Number of subjects	Underweight (%)	Normal weight (%)	Overweight (%)	Obese (%)
Total	25 176	11.4	80.7	7.0	1.0
<i>Family situation</i>					
No single-parent family	23 170	11.5	80.8	6.8	0.9
Single-parent family	2006	10.8	79.0	8.8	1.4
<i>Ethnic background</i>					
Dutch	21 553	11.7	81.0	6.5	0.8
Turkish	721	5.4	77.0	14.7	2.9
Moroccan	221	10.9	76.9	10.4	1.8
Surinamese	187	10.2	75.4	10.2	4.3
The Netherlands antillean, Aruba	145	10.3	79.3	6.9	3.4
Other	2346	11.1	79.6	7.9	1.4
<i>Education level</i>					
High	6481	13.0	81.9	4.5	0.5
Medium	6055	11.0	82.4	5.8	0.8
Low	12 640	10.8	79.2	8.7	1.3
<i>Urbanisation grade</i>					
Non-urban	3262	11.7	79.6	7.9	0.9
Minor urban	9587	11.2	81.2	6.8	0.8
Average urban	6441	11.3	81.1	6.7	0.9
High urban	5313	11.4	80.5	7.0	1.1
<i>Leisure time activities</i>					
Watching television/video > 7 h per week	9310	11.1	80.7	7.2	1.1
Playing computer games > 3 h per week	10 078	11.1	80.3	7.4	1.2
Surfing on the Internet > 3 h per week	12 804	10.8	80.9	7.2	1.0
E-mailing/chatting > 3 h per week	13 554	10.6	81.8	6.6	0.9
Member of a sports club	14 868	11.2	81.8	6.3	0.7

Of the invited school locations, 82.1% had participated in the E-MOVO project. Moreover, individual response rates were 73–93% for six of the seven community health service areas, which indicate that the study population was a good representative sample of the adolescents living in the eastern part of the Netherlands. Although our community health service database served a considerably large region in the Netherlands, we are not sure whether extrapolation of the results to the rest of the Netherlands is accepted. Caution should be taken concerning low socio-economic status (SES) groups, as this study was conducted in an area where there is less variation in SES as compared to the rest of the Netherlands (Knol, 1998). Furthermore, adolescents following special secondary education (for children with learning and behavioural difficulties) did not participate in this study because of the length of the questionnaire and the complexity of the questions. It is likely that adolescents in low SES groups, including adolescents following special education, are more likely to be involved in health-risk behaviour like skipping breakfast, lack of physical activity and heavy alcohol consumption than higher SES groups (Hulshof *et al.*, 2003; Wardle *et al.*, 2003).

Furthermore, in this study 9931 subjects from the original population of 35 107 adolescents were excluded (28.3%). Most of them (96.5%) did not report body weight and/or

height, probably because we included an answer category 'I don't know' in our questionnaire to reduce misreporting. Compared to the included participants, this excluded group had a higher share of grade 2 subjects and subjects with a low education level. Since low education level was associated with overweight and obesity, selection bias caused by under-representation of overweight and obese adolescents could be possible, though we controlled for low education level in our adjusted models.

A potential limitation of this study is that the results were depending on self-reported measures. BMI calculated from self-reported body weight and height in adolescents is reported to be less valid because of possible under-reporting of weight and overestimation of height (Crawley and Portides, 1995; Strauss, 1999; Wang *et al.*, 2002; Brener *et al.*, 2003; Shapiro and Anderson, 2003). Therefore, the number of overweight adolescents is likely to be underestimated in current study. As compared to the national prevalence rates for children aged 13–15 years in 2002–2004, we found lower prevalences for overweight including obesity for boys (15.3–16.8%) and girls (15.2–20.1%) (Van den Hurk *et al.*, 2006). In addition, in our study prevalences for boys were higher as compared to girls, which was not supported by the national prevalences. This may indicate that girls tend to under-report their weight more than boys (Strauss, 1999; Brener *et al.*, 2003).

Table 3 Associations between skipping breakfast, alcohol consumption and physical activity and overweight in adolescents, analysed in three separate models

	Number of subjects	Grade 2		Grade 4	
		Crude OR (95% CI)	Adjusted ^a OR (95% CI)	Crude OR (95% CI)	Adjusted ^a OR (95% CI)
<i>Breakfast skipping</i>					
0 days per week	16 506	1	1	1	1
1–2 days per week	3663	1.54 (1.28–1.85)	1.51 (1.25–1.82)	1.14 (0.95–1.37)	1.15 (0.95–1.38)
3–4 days per week	1544	2.21 (1.73–2.83)	2.00 (1.55–2.58)	1.12 (0.87–1.45)	1.05 (0.81–1.37)
5–6 days per week	2170	1.79 (1.43–2.25)	1.63 (1.29–2.06)	1.50 (1.22–1.83)	1.37 (1.11–1.69)
7 days per week	1293	2.53 (1.95–3.27)	2.17 (1.66–2.85)	2.05 (1.64–2.57)	1.75 (1.39–2.21)
<i>P</i> for trend:		<0.01	<0.01	<0.01	<0.01
<i>Alcohol intake</i>					
Non-drinkers	8203	1	1	1	1
Moderate drinkers	10 011	1.10 (0.96–1.27)	1.07 (0.92–1.23)	0.78 (0.65–0.93)	0.82 (0.68–0.99)
Heavy drinkers	4052	1.56 (1.21–2.02)	1.34 (1.02–1.76)	0.69 (0.57–0.84)	0.71 (0.57–0.87)
Excessive drinkers	2910	2.40 (1.80–3.20)	1.86 (1.36–2.55)	1.22 (1.01–1.47)	1.11 (0.90–1.36)
<i>P</i> for trend:		<0.01	<0.01	0.05	0.40
<i>Physical activity</i>					
Norm-active	5359	1	1	1	1
Inactive on 1–2 days per week	8038	1.16 (0.95–1.40)	1.24 (1.02–1.50)	0.97 (0.81–1.17)	1.02 (0.85–1.23)
Inactive on 3–4 days per week	6128	1.25 (1.02–1.53)	1.25 (1.02–1.54)	1.10 (0.91–1.34)	1.11 (0.91–1.34)
Inactive on 5–6 days per week	4853	1.54 (1.25–1.90)	1.50 (1.22–1.85)	1.04 (0.85–1.28)	0.99 (0.80–1.21)
Non-active	798	2.06 (1.43–2.96)	1.73 (1.19–2.51)	1.72 (1.26–2.34)	1.58 (1.16–2.16)
<i>P</i> for trend:		<0.01	<0.01	0.02	0.15

Abbreviations: CI, confidence intervals; OR, odds ratio.

^aAdjusted for gender, family situation, ethnic background, education level and smoking.**Table 4** Associations between skipping breakfast, alcohol consumption and physical activity and overweight in adolescents, analysed in one additive model

	Number of subjects	Grade 2		Grade 4	
		Crude OR (95% CI)	Adjusted ^a OR (95% CI)	Crude OR (95% CI)	Adjusted ^a OR (95% CI)
Breakfast skipping >2 days per week	21 713	1.79 (1.54–2.09)	1.68 (1.43–1.97)	1.46 (1.26–1.68)	1.32 (1.14–1.54)
Alcohol intake >moderate	6962	1.53 (1.26–1.86)	1.38 (1.12–1.71)	1.03 (0.90–1.17)	0.98 (0.86–1.13)
Physical inactivity >2 days per week	11 779	1.25 (1.09–1.42)	1.20 (1.05–1.37)	1.11 (0.98–1.27)	1.06 (0.93–1.21)

Abbreviations: CI, confidence intervals; OR, odds ratio.

^aAdjusted for gender, family situation, ethnic background, education level and smoking.

In this study, skipping breakfast, physical inactivity and heavy alcohol consumption were positively related to overweight and obesity. In relation to breakfast intake, risks for overweight increased as the adolescents skipped their breakfasts more often, which was also reported elsewhere (Berkey *et al.*, 2003; Cho *et al.*, 2003; Keski-Rahkonen *et al.*, 2003). In addition, relations between skipping breakfast and overweight in grade 2 were even statistically significant for skipping 1–2 days per week. In grade 4, significant relations were found for skipping breakfast on 5 or more days per week. Sjöberg *et al.* (2003) found adolescent girls (15–16 years) that omitted breakfasts also had a less healthy food choice and poorer nutrient intake. Factors that were associated with skipping breakfast in our study were family situation (single parent), ethnicity (non-Dutch origin), low

educational level, and membership of a sports club (not being a member) and smoking.

The positive relation between physical inactivity and overweight in adolescents found in this study was also supported by other studies (Kemper *et al.*, 1999; Trost *et al.*, 2001). In grade 2, strongest associations with overweight were found for being active on 1–2 days per week and for being non-active. Activity levels according to the Dutch norm for healthy exercise were in this study least met among adolescents with a Turkish background and adolescents who were not a member of a sports club. Subjects who were living in non-urban areas were more likely to be active on 5 or more days per week.

The directions of the relations between alcohol consumption in average amount per week and overweight are not

consistent in literature; positive, negative and no associations were reported (Lahti-Koski *et al.*, 2002; Bobak *et al.*, 2003; Wannamethee and Shaper, 2003; Suter, 2004; Yeomans, 2004). A study by Breslow and Smothers (2005) that distinguished between amount of consumed alcohol and frequency of drinking occasions in adults, reported different results for the relation between amounts of alcohol consumed with BMI and between frequencies of alcohol consumed with BMI. Frequency was negatively associated with BMI, whereas amount of alcohol consumed per drinking occasion, as in our study, was positively associated with BMI. We found that alcohol consumption was significantly positive related to overweight and obesity for heavy and excessive drinkers in grade 2. It is possible that excessive alcohol consumption is more a risk behaviour in second grade students than in fourth grade students, as in older adolescents the intake of alcohol is more common. A higher risk category of excessive alcohol consumption would probably better illustrate the relation between excessive drinking behaviour and overweight among fourth grade students. Furthermore, heavy and excessive drinking were found more frequently in adolescents who had a low education, lived in non-urban areas and were smoking.

Besides alcohol consumption, the associations found in this study between skipping breakfast and physical inactivity with overweight were also less strong in grade 4 compared to grade 2. In the second grade, when adolescents are younger, risk factors for overweight were not as prevalent as compared to the fourth grade. In our study, the prevalence of risk factors for overweight in grade 4 was higher, which may have weakened the associations with overweight (Paavola *et al.*, 2004). More research in different age groups of adolescents is necessary, as this study showed that the strengths of the associations that were found are different between grades. Another possibility that may explain the differences between grades is that underestimation of BMI was more present in grade 4. As these adolescents are older, they could be more aware of social desirability, resulting in more under-reporting of body weight, which leads to greater misclassification that possibly could have lead to attenuation of the relationships with overweight.

No statements about the causality of the relations between the risk factors and overweight or obesity could be made, as this study is cross sectional. For example, lack of physical activity may have resulted in overweight, or overweight may have resulted in physical inactivity. Moreover, risk behaviours like skipping breakfast and consuming alcohol are probably characteristics of an unhealthy lifestyle among adolescents that is also characterised by being overweight or obese.

Longitudinal studies are necessary to indicate causality between the lifestyle determinants and overweight and obesity in adolescents, and more research is warrant to investigate individual and environmental determinants of obesity in adolescents.

Present study showed that skipping breakfast, physical inactivity and alcohol consumption were positively related

to overweight and obesity in adolescents. The associations were stronger in younger adolescents.

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