

Accepted Manuscript

Title: Peer influence on snacking behavior in adolescence

Authors: Eveline J. Wouters, Junilla K. Larsen, Stef P. Kremers, Pieter C. Dagnelie, Rinie Geenen

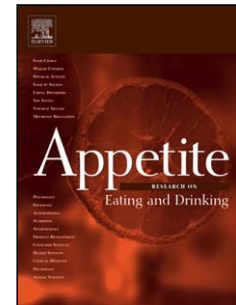
PII: S0195-6663(10)00075-9
DOI: doi:10.1016/j.appet.2010.03.002
Reference: APPET 961

To appear in:

Received date: 16-9-2009
Revised date: 9-1-2010
Accepted date: 1-3-2010

Please cite this article as: Wouters, E. J., Larsen, J. K., Kremers, S. P., Dagnelie, P. C., & Geenen, R., Peer influence on snacking behavior in adolescence, *Appetite* (2008), doi:10.1016/j.appet.2010.03.002

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



Full paper**Peer influence on snacking behavior in adolescence**

Eveline J. Wouters ^{a, e, *}, Junilla K. Larsen ^b, Stef P. Kremers ^c, Pieter C. Dagnelie ^a, Rinie Geenen ^d

^a Department of Epidemiology, Faculty of Health, Medicine and Life Sciences, Maastricht University, PO Box 616, 6200 MD Maastricht, The Netherlands

^b Behavioural Science Institute, Radboud University, PO Box 9104, 6500 HE Nijmegen, The Netherlands

^c Department of Health Education and Health Promotion, Faculty of Health, Medicine and Life Sciences, Maastricht University, PO Box 616, 6200 MD Maastricht, The Netherlands

^d Department of Clinical and Health Psychology, Utrecht University, Department of Rheumatology and Clinical Immunology, University Medical Centre, PO Box 80140, 3508 TC Utrecht, The Netherlands

^e Fontys University of Applied Sciences, PO Box 347, 5600 AH Eindhoven, The Netherlands

* Corresponding author:

Fontys University of Applied Sciences, PO Box 347, 5600 AH Eindhoven, The Netherlands,

E-mail address: e.wouters@fontys.nl (E. J. Wouters)

(Not for publication): telephone +31 40 7877011; Fax: +31 877 875599

Abstract

To examine the association of adolescents' snack and soft drink consumption with friendship group snack and soft drink consumption, availability of snacks and soft drinks at school, and personal characteristics, snack and soft drink consumption was assessed in 749 adolescents (398 girls, 351 boys, age 12.4 - 17.6 years), and their friends, and snack and soft drink availability at schools was measured. In regression analysis, consumption by friends, snack and soft drink availability within school, and personal characteristics (age, gender, education level, body mass index) were examined as determinants of snack and drink consumption. Snack and soft drink consumption was higher in boys, soft drink consumption was higher in lower educated adolescents, and snack consumption was higher in adolescents with a lower body weight. Peer group snack and soft drink consumption were associated with individual intake, particularly when availability in the canteen and vending machines was high. The association between individual and peer snack consumption was strong in boys, adolescents with a lower education level, and adolescents with lower body weights. Our study shows that individual snack and soft drink consumption is associated with specific combinations of consumption by peers, availability at school, and personal characteristics.

Key words: obesity; adolescence; peer groups; social environment; physical environment; snacking behavior

Introduction

Obesity is a complex and often chronic health problem resulting from the interaction of metabolic, genetic, environmental, and psychological factors (Wadden & Stunkard, 2004). Overweight often develops early in life and tracks into adulthood (Daniels, 2006), causing a serious burden during and beyond childhood (Lobstein & Jackson-Leach, 2006). Adolescence, with its rapid changes in body composition (Daniels et al., 2005) and food habits, coinciding with the transition from the direct home influence to the peer-related environment (Von Post-Skagegard et al., 2002), is likely to be a particularly vulnerable period in the onset of obesity.

Ecological models examine the problem of obesity by regarding both the individual disorder and the abnormal environment (Egger & Swinburn, 1997; Giskes et al., 2007). Easily available unhealthy food is an important representative of the so called physical ‘obesogenic’ environment (D. A. Cohen, 2008; Kipke et al., 2007; Martens, van Assema, & Brug, 2005; Zenk & Powell, 2008). Schools play an important role in the consumption of unhealthy food among adolescents. Availability of snacks at school has been associated with unhealthier food habits of secondary school pupils, and changing the canteen policy, e.g. by decreasing portion sizes, influenced energy balance in a favorable way (Cullen, Eagan, Baranowski, Owens, & de Moor, 2000; Cullen & Thompson, 2005).

Besides the physical school environment that supplies food, we propose that also the social environment plays a role in determining unhealthy food intake among adolescents. During adolescence, children spend increasingly more time with friends, and their need to belong to a group and to be accepted by peers is higher than during other periods in life (J. C. Coleman, 1980). Social learning theory specifies that peers may influence each other by observing, modeling, and imitating behavior of important individuals in their environment

(Bandura, 1986). Group norm setting is also a powerful mechanism in determining an individual's behavior (J. S. Coleman & Lal, 1994). Prospective research suggested that peers influence each other in a wide range of health behaviors, e.g., smoking (Gritz et al., 2003), alcohol consumption (Urberg, Degirmencioglu, & Pilgrim, 1997), and disordered eating (Zalta & Keel, 2006). Social networks have also been found relevant for the spreading of obesity in adults (Christakis & Fowler, 2007). The cross-sectional design of the current study cannot disentangle influence processes from selection processes such as similar adolescents choosing each other as friends. However, this is the first study to examine similarities in snack and soft drink consumption within friendship groups. To establish this relationship is an important first step before examining the precise causal mechanisms.

Adolescents' snacking behavior is not only expected to depend on aspects of the physical and social environment, but also on personal characteristics (Kremers et al., 2006). Consumption of unhealthy food is more frequent in boys (Bauer, Larson, Nelson, Story, & Neumark-Sztainer, 2008; Von Bothmer & Fridlund, 2005) and in lower educated (Van der Horst et al., 2007) and overweight children (Hill et al., 2008; Kubik, Lytle, & Story, 2005). The aim of the present study was to examine the association of adolescents' snack and soft drink consumption with snack and soft drink consumption in friendship groups (social environment), the availability of snacks at school (physical environment), and personal characteristics. The investigation of the possible influence of the school environment was preliminary considering the design of our study. Our hypothesis was that the consumption in friendship groups, availability of snacks and soft drinks at school, and personal characteristics are associated with individual snack and soft drink consumption.

Methods

Population and design

This cross sectional study was part of a larger survey called '*Mental Health and Health Habits*'. This longitudinal cohort study in adolescents that covers three years, examines the associations between psychosocial factors and health behavior such as food intake, smoking, and alcohol use (Larsen, Otten, & Engels, 2009). Participants were recruited from seven randomly selected secondary schools in suburban (N=3) and urban (N=4) areas from three regions in the Netherlands. Two schools were excluded from analysis, because they changed their food policy and availability of snacks and soft drinks in the interval between the assessments in the adolescents and the observation of availability of snacks and soft drinks at school. A sample of 1330 adolescents (684 boys and 646 girls) completed data collection, with ten percent non participation resulting from parental or participants' denied consent, absence on the day of testing, or moving out of the school system. Adolescents' mean age was 14.9 years (range 12.4 - 17.6 years), and the majority (over 95%) was of Dutch origin. All participants followed regular secondary education. The study received institutional ethical approval.

Procedure

Questionnaires were completed in a classroom during a lesson. Height and weight were measured out of sight of class mates. Adolescent data were collected in spring 2008 and school environment data were collected in summer 2008 during normal school days.

Demographic variables

Age was derived from date of birth and date of measurement. Education of the adolescents was assessed on a six-point scale, level one and two reflecting pre-vocational education, level three and four intermediate education, and level five and six pre-university education.

Height and body weight

Height was measured to the nearest 0.5 cm (Seca 214, Hamburg, Germany), and weight to the nearest 0.1 kg (Mettler PM 3000, Greifensee, Switzerland), with participants wearing light clothes and no shoes. Body Mass Index (BMI, kg/m²), and age and gender standardized BMI (zBMI) scores were calculated. Overweight was defined as zBMI at or above the 85th percentile (Flegal, Wei, & Ogden, 2002; Ogden et al., 2002).

Snacking behavior

Snacking behavior was defined as the consumption of snacks and carbonated soft drinks (Malik, Schulze, & Hu, 2006; Van der Horst et al., 2007). Snack consumption, i.e., consumption of sweet or savory palatable food products, was measured with the five questions of the Fat list (a brief food frequency questionnaire) that refer to energy dense snacks (Van Assema, Brug, Ronda, & Steenhuis, 2001). The questions assess the intake of (1) (pea)nuts, (2) chips, cheese, and sausage, (3) pastry, cake, and large cookies, (4) candy-bars, and (5) chocolate. The Fat list has been shown a valid instrument in populations to classify subjects in broad categories of total and saturated fat intake in grams, and to assess

differences in absolute and saturated fat intake between groups as a result of nutrition education programs (Van Assema et al., 2001). The questionnaire has been frequently used in adolescents (Martens et al., 2005; Martens, Van Assema, Paulussen, Van Breukelen, & Brug, 2008; Van Assema, Glanz, Martens, & Brug, 2007). A study in a small sample suggested that the questionnaire might be more valid in boys compared to girls (Van Assema et al., 2001). Participants were asked how frequently the snack items listed were usually consumed. For each of the five mentioned categories a score from one (less than once a week) to eight (seven days a week) was determined. A total summary score for snack consumption was calculated. The amount of consumed carbonated soft drinks was assessed by a 5-point Likert scale with answering categories ranging from zero glasses each day (score 1) to more than six glasses per day (score 5).

Friendship group snacking behavior was defined as the mean score of snack (or soft drink) consumption for an established friendship group after subtraction of the individual score (Paxton, Schutz, Wertheim, & Muir, 1999).

Friendship group identification

To define peer friendship groups, participants named a maximum of five of their best friends in the class (Urberg et al., 1997), starting with their most important friend, then the second best friend, and so on (Wang, Moreno, & Sun, 2006). Peer group structure was identified by social network analysis, which identifies patterns of relationships between persons (Wasserman & Galaskiewicz, 1994). Friendship group members are adolescents belonging to a peer group of at least three persons (Paxton et al., 1999; Wang et al., 2006). The allocation to friendship group membership was restricted to members with reciprocal ties (bilateral nominations). If

more than one group was eligible, membership was decided by position nomination of the members (giving more weight to friends who were nominated as closer friends).

School availability of snacks

The availability and accessibility of energy dense snacks and sugar-sweetened soft drinks in the school were determined by counting all visible items (rows) in the school vending machines and in the school canteen using an instrument from the ENDORSE (ENvironmental Determinants of Obesity in Rotterdam SchoolchildrEn) study (Van der Horst, Oenema, Van de Looij-Jansen, & Brug, 2008). Exposed rows of candy bars, chocolate, chips, cake, ice creams, warm savory snacks, high caloric biscuits, cakes, and energy dense sugar-sweetened beverages were counted. A summary score, both for snacks and for soft drinks, was used for school canteens and for school vending machines. This score was the summation of all the counted high caloric items at school.

Statistical analyses

Descriptive analysis was used for evaluation of demographic variables. Only adolescents who could be assigned to a friendship group were analyzed. Independent samples *t*-tests compared these variables for adolescents who were and were not assigned to a friendship group. Two-level regression analysis with friendship groups nested within schools is the most appropriate technique to predict individual consumption from personal characteristics (age, gender, education level, and zBMI of the participant), friendship group consumption (social environment), availability within schools of snacks and soft drinks (physical environment), and the interaction of friendship group consumption with the availability within school of

snacks and soft drinks. Then the interaction of group consumption with availability of snacks and soft drinks within schools can be examined by cross-level interactions. The low number of five schools prohibits this two-level regression approach, because the number of schools must be at least 10 to analyze at two levels (J. Cohen, Cohen, West, & Aiken, 2003; Snijders & Bosker, 1999). Therefore we applied linear regression analysis with individual snack consumption and individual soft drink consumption as outcome variables and school availability as predictor, besides personal characteristics and friendship group (Aiken & West, 1991).

Continuous predictor variables were centered before computing interaction terms. In step 1, age, gender, education level, and zBMI were entered. In steps 2 and 3 the mean friendship group consumption and availability within schools followed, respectively. In step 4, individual consumption was associated with the above variables, and the interaction of friendship group consumption with the availability within school of snacks and soft drinks, age, gender, education level, and zBMI, respectively. To interpret significant interactions, regression lines for individuals low ($-1\ SD$) and high ($+1\ SD$) on the one predictor variable were plotted for low ($-1\ SD$) and high ($+1\ SD$) values of the other predictor variable (Aiken et al, 1991).

Cohen's d was used as effect size measure: for high ($+1\ SD$) and low ($-1\ SD$) values of either predictor variable, the difference of individual consumption scores of persons with high ($+1\ SD$) friendship group consumption and low ($-1\ SD$) friendship group consumption was divided by the pooled standard deviation (J. Cohen, 1988). Effects sizes are defined as small ($d = 0.2$), medium ($d = 0.5$), and large ($d = 0.8$) (J. Cohen, 1988).

The UCINET program identified friendship groups (Borgatti, Everett, & Freeman, 2002). All other analyses were conducted using SPSS, version 16.0. Alpha values $< .05$ were considered statistically significant.

Results

Description of the sample

Of the original sample of 1330, 749 adolescents with complete data on all variables were part of a friendship group. This sample showed no difference with the non-friendship group sample with respect to age, zBMI, and snack consumption. The friendship group sample, as compared to the non-friendship group sample, included more girls (53% and 46%, respectively) and had a higher education level (4.7 versus 4.4). The education of 749 adolescents belonging to a friendship group was for 15% pre-vocational level, for 29% intermediate level, and for 56% pre-university level. Participants had a mean age of 14.9 ± 0.7 (range 12.4 – 17.6) years, and a zBMI slightly above the norm value (mean 0.12 ± 0.81 , range -3.01 – 2.63). All variables were normally distributed. Friendship group sizes ranged from three to five adolescents: 65% of the groups consisted of three, 30% of four, and 5% of five adolescents.

The mean availability in the school canteen was 21.0 ± 0.8 (range 0-35) visible rows of energy dense snacks and 2.7 ± 3.2 (range 0-9) visible rows of sugar-sweetened soft drinks. For the vending machines, the mean availability was 31.9 ± 26.0 (range 10-94) visible rows of snacks, and 13.6 ± 13.6 (range 4-21) visible rows of soft drinks. Only the score distribution of snacks in the vending machines was not normal. This variable was not transformed, because the somewhat skewed score distribution was based on true variation and logarithmic transformation would inflate unimportant differences between lower scores and deflate meaningful differences between higher scores.

Personal characteristics, friendship group snacking, and availability within schools

Table 1 shows the results of linear regression analyses used to examine whether individual snack and soft drink consumption was associated with personal characteristics, friendship group snacking and availability within schools. In step 1, snack and carbonated soft drink consumption was higher in boys than in girls, soft drink consumption was higher in adolescents with a lower education level, and snack consumption was higher in adolescents with a lower zBMI (snack consumption for step 1: $R^2 = .06, p < .001$; soft drink consumption for step 1: $R^2 = .13, p < .001$). In step 2, friendship group consumption—both of snacks and of soft drinks—was associated with the individual consumption of snacks and soft drinks respectively (snack consumption for step 2: $\Delta R^2 = .02, p < .001$; soft drink consumption for step 2: $\Delta R^2 = .03, p < .001$). In step 3, neither snack availability nor soft drink availability were related to snack or soft drink consumption (snack availability for step 3: $\Delta R^2 = .00, p = .98$; soft drink availability for step 3: $\Delta R^2 = .00, p = .86$).

Interaction analyses

Individual snack consumption was predicted by the combination of friendship group snack consumption and the availability of snacks in the canteen (standardized regression coefficient of the interaction term $\beta = 0.10, p = .007$): individual snack consumption in adolescents with friends who consumed many snacks was especially high when snacks were readily available, whereas for adolescents with friends with a low snack consumption, availability of snacks was not related to individual snack consumption (figure 1 left). The effect size (d) of the difference between individuals having friendship groups with high versus low snack consumption, in case of high availability of snacks in the canteen, was 0.48. In case of low availability of snacks in the canteen, it was 0.10. Individual snack consumption was not

predicted by the combination of group snack consumption and availability of snacks in vending machines (standardized regression of the interaction term: $\beta = .04$, $p = .29$).

The combination of friendship group soft drink consumption and availability of soft drinks in the canteen was not associated with individual consumption ($\beta = .05$, $p = .11$) but individual soft drink consumption was related to the combination of friendship group soft drink consumption and the availability of soft drinks in the vending machines ($\beta = .09$, $p = .001$): most soft drinks were consumed by adolescents who had soft drink consuming friends, at a school with high availability of soft drinks in the vending machines (figure 1 right). The effect size of the difference between individuals belonging to friendship groups with high versus low consumption was 0.57 in case of high availability, and 0.16 in case of low availability of soft drinks in the vending machines.

Interactions with personal characteristics

Of the personal characteristics, the combination friendship group snack consumption and age did not show an association with individual snack consumption ($\beta = .01$, $p = .73$), but the interactions of gender ($\beta = .10$, $p = .03$), education level ($\beta = .14$, $p < .001$), and zBMI ($\beta = .12$, $p = .001$) with friendship group consumption were related to individual snack consumption. When being part of a group with a relatively high snack consumption, boys (figure 2 left), adolescents with a low education level (figure 2 middle), and normal weight adolescents (figure 2 right), individually consumed most snacks. The effect sizes of high versus low snack consumption in the friendship group were 0.41 (boys) and .01 (girls), 0.44 (low education) and 0.01 (high education), and 0.48 (normal weight) and 0.09 (overweight), respectively. No interactions with personal characteristics were found for group and individual soft drink consumption.

Discussion

Individual snack and soft drink consumption was high when peers proximate to the adolescent had a high consumption combined with readily availability within schools of snacks in the canteen and soft drinks in the vending machines. Individual and peer snack consumption was particularly strongly associated in boys, adolescents with lower education levels, and normal weight adolescents.

Comparable to earlier studies on body image and disordered eating behavior (Hutchinson & Rapee, 2007; Paxton et al., 1999), our study suggests that snack and soft drink consumption are behaviors that are shared by adolescent friendship groups. Experimental studies specifically focusing on food consumption, demonstrated that people adjust their food intake to the consumption of a model (Herman, Roth, & Polivy, 2003; Hermans, Larsen, Herman, & Engels, 2008; Romero, Epstein, & Salvy, 2009). Moreover, overweight children (but not normal weight children) consumed more food when they ate with overweight friends than when they ate with normal weight friends (Salvy, Howard, Read, & Mele, 2009). This modeling mechanism may be one mechanism promoting the association of snacking behavior within peer groups. In adolescents, the opinion of friends about food is related to their own consumption (Van der Horst, Timperio et al., 2008). This suggests that norm setting may also influence food consumption in peer groups. In smoking, both influence of friends on the individual adolescent, and choosing smoking friends, explain individual smoking behavior (Mercken, Candel, Willems, & de Vries, 2007). With respect to food choices, some evidence for resemblance of snack consumption within peer groups has been observed (Feunekes, de Graaf, Meyboom, & van Staveren, 1998), but no consistent results have been found with

respect to the impact of peer influence versus selection of peers on food intake (Rozin, Riklis, & Margolis, 2004; Story, Neumark-Sztainer, & French, 2002). Future studies should further examine the proposed influencing mechanisms, as well as possible selection mechanisms, underlying the resemblance of consumption within peer friendship groups found in the present study. Because friends share their snacking habits in a favorable or unfavorable manner, it appears fruitful in education and intervention to target both the individual snacking behavior and the snacking behavior of friends.

Unexpectedly, but in agreement with recent previous findings in the Netherlands (Van der Horst, Timperio et al., 2008), snack and soft drink availability at school was not associated with individual consumption. However, our study offers the preliminary suggestion that availability of soft drinks in the vending machines and snacks in the canteen at school is a determinant of individual snacking in combination with peer group consumption. When the school has limited or no provision of snacks and soft drinks, adolescents seem to influence each other less strongly. The present study only evaluated the availability and consumption of unhealthy food products. If our results apply to all food, the peer group might help to develop healthy dietary habits when the school supplies healthy food. This indicates the potential importance of attending to the school canteen and vending machine assortment in order to promote healthy eating in adolescents.

Boys in our study consumed more snacks and were with respect to snack consumption more comparable to their friends than girls. Female gender is associated with healthier food choices, both in adults (Wardle et al., 2004) and in children (Cooke & Wardle, 2005; Hill et al., 2008). That the quality of food consumed by girls more depends on personal factors and that boys might be more susceptible to the influence of peers (Bauer et al., 2008), suggests that addressing peer groups in boys, rather than in girls, is important to change snacking behavior.

Two findings in our study confirm the importance of considering education level with respect to the diet of adolescents (Matthys et al., 2006). First, lower education was associated with higher consumption of soft drinks, and second, more snacks were consumed by lower educated adolescents who had friends consuming a lot of snacks. In adults mixed effects of peer-based interventions were found with on average small- to medium-sized effects on health-related behaviors including physical activity and smoking (Webel et al., 2009). Also in studies in adolescents, effects of peer group education are mixed with some studies suggesting that peer group education can be successful in preventing unhealthy behavior such as smoking (Campbell et al., 2008; Lo et al., 2008; Vaz, Gloyd, & Trindade, 1996). Our study suggests that peer group education, as previously reported (Vaz et al., 1996) may be stronger in persons with less formal education.

Counterintuitively, adolescents with a higher body weight reported to consume less snacks than normal weight adolescents. This finding is in contrast to experimental studies that suggest that the amount of snacking increases with body weight (Hill et al., 2008). It is possible that snacking consumption at school of overweight adolescents is indeed less. Our study did not measure the entire food intake of the participants, but only the snacks mentioned in the Fat list. Moreover, overweight adolescents are aware of weight stigmatization (Neumark-Sztainer et al., 2002) and energy intake is more often underreported by overweight compared to normal weight persons (Waling & Larsson, 2009; Westerterp & Goris, 2002). This may have affected our results. We also observed that the friendship group effect was dependent on weight: in normal weight but not in overweight adolescents, individual and peer group snacking were associated. This might suggest that overweight adolescents actually eat less snacks in social situations than normal weight adolescents as suggested in experimental studies (Salvy, Coelho, Kieffer, & Epstein, 2007; Salvy et al., 2009), possibly because weight stigmatization results in restrained eating (Neumark-Sztainer et al., 2002). Research linking

self report and observational assessments of snacking is needed to confirm the suggestion that overweight and normal weight adolescents behave differently in groups. An implication is that it is important to target snacking behavior of overweight as well as normal weight adolescents.

Strengths of our study are the large sample size, the objective measurements of weight, height, and snack and soft drink availability within schools, and the concomitant inclusion of social environmental (peer friendship groups), physical environmental (school snack availability), and personal characteristics. Another strong point is that we used reciprocity of friendship nominations from objective sociometric data for establishing snack consumption of the friendship groups.

There are also limitations of our study. First, due to the cross sectional design, no causal inferences can be made. Prospective studies could examine whether peers affect the future snack intake of adolescents, or that adolescents select friends because of their snacking behavior, or both. Only a few studies examined the association between snacking habits of adolescents and peers. After having observed such an association in our cross-sectional study, the next step should be to replicate these results and to clarify the causal factors of this association in prospective and experimental studies. Second, assessment of the intake of new products like energy drinks were included in our observation, but not in the self report measure. Also, we only measured availability of snacks and soft drinks within school, and studied the association between availability within school and snacking in general. We did not take into account the availability outside the school environment, which might account for a substantial part of the individual snacking. This may have resulted in underestimation of the associations found in our study. Third, as suggested by a former study in a small sample, the validity of the Fat list might be relatively low in adolescent girls (Van Assema et al., 2001). And fourth, the inclusion of only five schools hampers the generalizability of results and

prohibited the application of the more appropriate multilevel analysis. Future studies including more schools, are recommended.

In conclusion, our findings suggest that snack and soft drink consumption are behaviors shared by adolescent friendship groups, with the strongest similarities in schools with high availability of snacks in the canteen and soft drinks in the vending machines, and, for snack consumption, in boys, lower educated adolescents, and normal weight adolescents.

Acknowledgements

This study was financed by the Netherlands Organization for Scientific Research (NWO) Veni Grant 451-05-013.

We thank Lieke Woelders for the observations at the schools, Theo van der Weegen, for analyzing the dataset with respect to the peer friendship groups and Ad Vermulst, for his advice on multilevel analysis.

References

- Aiken, L. S., & West, S. G. (1991). *Multiple regression: testing and interpreting interactions*. Newbury Park (Calif): Sage publications.
- Bandura, A. (1986). *Social foundations of thought and action: a social cognitive theory*. Englewood Cliffs, NJ, US: Prentice-Hall Inc.
- Bauer, K. W., Larson, N. I., Nelson, M. C., Story, M., & Neumark-Sztainer, D. (2008). Socio-environmental, personal and behavioural predictors of fast-food intake among adolescents. *Public Health Nutrition*, 1-8.
- Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). *UCINET for Windows: software for social network analysis. Version 6.105: Analytic Technologies*. Harvard, M.A.
- Campbell, R., Starkey, F., Holliday, J., Audrey, S., Bloor, M., Parry-Langdon, N., et al. (2008). An informal school-based peer-led intervention for smoking prevention in adolescence (ASSIST): a cluster randomised trial. *Lancet*, 371, 1595-1602.
- Christakis, N. A., & Fowler, J. H. (2007). The spread of obesity in a large social network over 32 years. *New England Journal of Medicine*, 357, 370-379.
- Cohen, D. A. (2008). Obesity and the built environment: changes in environmental cues cause energy imbalances. *International Journal of Obesity*, 32 Suppl 7, S137-142.
- Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (2nd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.
- Coleman, J. C. (1980). *Friendship and the peer group in adolescence*. New York: Wiley.

- Coleman, J. S., & Lal, D. (1994). *The demand for effective norms*. Cambridge, Massachusetts: Harvard University Press.
- Cooke, L. J., & Wardle, J. (2005). Age and gender differences in children's food preferences. *British Journal of Nutrition*, 93, 741-746.
- Cullen, K. W., Eagan, J., Baranowski, T., Owens, E., & de Moor, C. (2000). Effect of a la carte and snack bar foods at school on children's lunchtime intake of fruits and vegetables. *Journal of the American Dietetic Association*, 100, 1482-1486.
- Cullen, K. W., & Thompson, D. I. (2005). Texas school food policy changes related to middle school a la carte/snack bar foods: potential savings in kilocalories. *Journal of the American Dietetic Association*, 105, 1952-1954.
- Daniels, S. R. (2006). The consequences of childhood overweight and obesity. *Future Child*, 16, 47-67.
- Daniels, S. R., Arnett, D. K., Eckel, R. H., Gidding, S. S., Hayman, L. L., Kumanyika, S., et al. (2005). Overweight in children and adolescents: pathophysiology, consequences, prevention, and treatment. *Circulation*, 111, 1999-2012.
- Egger, G., & Swinburn, B. (1997). An "ecological" approach to the obesity pandemic. *British Medical Journal*, 315, 477-480.
- Feunekes, G. I., de Graaf, C., Meyboom, S., & van Staveren, W. A. (1998). Food choice and fat intake of adolescents and adults: associations of intakes within social networks. *Preventive Medicine*, 27, 645-656.
- Flegal, K. M., Wei, R., & Ogden, C. (2002). Weight-for-stature compared with body mass index-for-age growth charts for the United States from the Centers for Disease Control and Prevention. *American Journal of Clinical Nutrition*, 75, 761-766.
- Giskes, K., Kamphuis, C. B., van Lenthe, F. J., Kremers, S., Droomers, M., & Brug, J. (2007). A systematic review of associations between environmental factors, energy and fat

- intakes among adults: is there evidence for environments that encourage obesogenic dietary intakes? *Public Health Nutrition*, 10, 1005-1017.
- Gritz, E. R., Prokhorov, A. V., Hudmon, K. S., Mullin Jones, M., Rosenblum, C., Chang, C. C., et al. (2003). Predictors of susceptibility to smoking and ever smoking: a longitudinal study in a triethnic sample of adolescents. *Nicotine & Tobacco Research*, 5, 493-506.
- Herman, C. P., Roth, D. A., & Polivy, J. (2003). Effects of the presence of others on food intake: a normative interpretation. *Psychological Bulletin*, 129, 873-886.
- Hermans, R. C., Larsen, J. K., Herman, C. P., & Engels, R. C. (2008). Modeling of palatable food intake in female young adults. Effects of perceived body size. *Appetite*, 51, 512-518.
- Hill, C., Llewellyn, C. H., Saxton, J., Webber, L., Semmler, C., Carnell, S., et al. (2008). Adiposity and 'eating in the absence of hunger' in children. *International Journal of Obesity*, 32, 1499-1505.
- Hutchinson, D. M., & Rapee, R. M. (2007). Do friends share similar body image and eating problems? The role of social networks and peer influences in early adolescence. *Behaviour Research and Therapy*, 45, 1557-1577.
- Kipke, M. D., Iverson, E., Moore, D., Booker, C., Ruelas, V., Peters, A. L., et al. (2007). Food and park environments: neighborhood-level risks for childhood obesity in east Los Angeles. *Journal of Adolescent Health*, 40, 325-333.
- Kremers, S. P., de Bruijn, G. J., Visscher, T. L., van Mechelen, W., de Vries, N. K., & Brug, J. (2006). Environmental influences on energy balance-related behaviors: a dual-process view. *International Journal of Behavioral Nutrition and Physical Activity*, 3, 9.

- Kubik, M. Y., Lytle, L. A., & Story, M. (2005). Schoolwide food practices are associated with body mass index in middle school students. *Archives of Pediatric & Adolescent Medicine*, 159, 1111-1114.
- Larsen, J. K., Otten, R., & Engels, R. C. (2009). Adolescent depressive symptoms and smoking behavior: The gender-specific role of weight concern and dieting. *Journal of Psychosomatic Research*, 66, 305-308.
- Lo, E., Coles, R., Humbert, M. L., Polowski, J., Henry, C. J., & Whiting, S. J. (2008). Beverage intake improvement by high school students in Saskatchewan, Canada. *Nutrition Research*, 28, 144-150.
- Lobstein, T., & Jackson-Leach, R. (2006). Estimated burden of paediatric obesity and co-morbidities in Europe. Part 2. Numbers of children with indicators of obesity-related disease. *International Journal of Pediatric Obesity*, 1, 33-41.
- Malik, V. S., Schulze, M. B., & Hu, F. B. (2006). Intake of sugar-sweetened beverages and weight gain: a systematic review. *The American Journal of Clinical Nutrition*, 84, 274-288.
- Martens, M. K., van Assema, P., & Brug, J. (2005). Why do adolescents eat what they eat? Personal and social environmental predictors of fruit, snack and breakfast consumption among 12-14-year-old Dutch students. *Public Health Nutrition*, 8, 1258-1265.
- Martens, M. K., Van Assema, P., Paulussen, T. G., Van Breukelen, G., & Brug, J. (2008). Krachtvoer: effect evaluation of a Dutch healthful diet promotion curriculum for lower vocational schools. *Public Health Nutrition*, 11, 271-278.
- Matthys, C., De Henauw, S., Maes, L., De Bacquer, D., Verbeke, W., & De Backer, G. (2006). Adolescents' education and their diet recorded by 7-day food records. *Social and Preventive Medicine*, 51, 80-90.

- Mercken, L., Candel, M., Willems, P., & de Vries, H. (2007). Disentangling social selection and social influence effects on adolescent smoking: the importance of reciprocity in friendships. *Addiction*, *102*, 1483-1492.
- Neumark-Sztainer, D., Falkner, N., Story, M., Perry, C., Hannan, P. J., & Mulert, S. (2002). Weight-teasing among adolescents: correlations with weight status and disordered eating behaviors. *International Journal of Obesity and Related Metabolic Disorders*, *26*, 123-131.
- Ogden, C. L., Kuczmarski, R. J., Flegal, K. M., Mei, Z., Guo, S., Wei, R., et al. (2002). Centers for Disease Control and Prevention 2000 growth charts for the United States: improvements to the 1977 National Center for Health Statistics version. *Pediatrics*, *109*, 45-60.
- Paxton, S. J., Schutz, H. K., Wertheim, E. H., & Muir, S. L. (1999). Friendship clique and peer influences on body image concerns, dietary restraint, extreme weight-loss behaviors, and binge eating in adolescent girls. *Journal of Abnormal Psychology*, *108*, 255-266.
- Romero, N. D., Epstein, L. H., & Salvy, S. J. (2009). Peer modeling influences girls' snack intake. *Journal of the American Dietetic Association*, *109*, 133-136.
- Rozin, P., Riklis, J., & Margolis, L. (2004). Mutual exposure or close peer relationships do not seem to foster increased similarity in food, music or television program preferences. *Appetite*, *42*, 41-48.
- Salvy, S. J., Coelho, J. S., Kieffer, E., & Epstein, L. H. (2007). Effects of social contexts on overweight and normal-weight children's food intake. *Physiology & Behavior*, *92*, 840-846.
- Salvy, S. J., Howard, M., Read, M., & Mele, E. (2009). The presence of friends increases food intake in youth. *The American Journal of Clinical Nutrition*, *90*, 282-287.

- Snijders, T. A. B., & Bosker, R. (1999). *Multilevel Analysis: an introduction to basic and advanced multilevel modeling*. London: Sage publications.
- Story, M., Neumark-Sztainer, D., & French, S. (2002). Individual and environmental influences on adolescent eating behaviors. *Journal of the American Dietetic Association, 102*, S40-51.
- Urberg, K. A., Degirmencioglu, S. M., & Pilgrim, C. (1997). Close friend and group influence on adolescent cigarette smoking and alcohol use. *Developmental Psychology, 33*, 834-844.
- Van Assema, P., Brug, J., Ronda, G., & Steenhuis, I. (2001). The relative validity of a short Dutch questionnaire as a means to categorize adults and adolescents to total and saturated fat intake. *Journal of Human Nutrition and Dietetics, 14*, 377-390.
- Van Assema, P., Glanz, K., Martens, M., & Brug, J. (2007). Differences between parents' and adolescents' perceptions of family food rules and availability. *Journal of Nutrition Education and Behavior, 39*, 84-89.
- Van der Horst, K., Oenema, A., Ferreira, I., Wendel-Vos, W., Giskes, K., van Lenthe, F., et al. (2007). A systematic review of environmental correlates of obesity-related dietary behaviors in youth. *Health Education Research, 22*, 203-226.
- Van der Horst, K., Oenema, A., Van de Looij-Jansen, P., & Brug, J. (2008). The ENDORSE study: research into environmental determinants of obesity related behaviors in Rotterdam schoolchildren. *BMC Public Health, 8*, 142.
- Van der Horst, K., Timperio, A., Crawford, D., Roberts, R., Brug, J., & Oenema, A. (2008). The school food environment associations with adolescent soft drink and snack consumption. *American Journal of Preventive Medicine, 35*, 217-223.

- Vaz, R. G., Gloyd, S., & Trindade, R. (1996). The effects of peer education on STD and AIDS knowledge among prisoners in Mozambique. *International journal of STD and AIDS*, 7, 51-54.
- Von Bothmer, M. I., & Fridlund, B. (2005). Gender differences in health habits and in motivation for a healthy lifestyle among Swedish university students. *Nursing & Health Sciences*, 7, 107-118.
- Von Post-Skagegard, M., Samuelson, G., Karlstrom, B., Mohsen, R., Berglund, L., & Bratteby, L. E. (2002). Changes in food habits in healthy Swedish adolescents during the transition from adolescence to adulthood. *European Journal of Clinical Nutrition*, 56, 532-538.
- Wadden, T. A., & Stunkard, A. J. (2004). *Handbook of obesity treatment*. New York: The Guilford Press.
- Waling, M. U., & Larsson, C. L. (2009). Energy Intake of Swedish Overweight and Obese Children Is Underestimated Using a Diet History Interview. *Journal of Nutrition*, 139, 522-527.
- Wang, F., Moreno, Y., & Sun, Y. (2006). Structure of peer-to-peer social networks. *Physical Review.E, statistical, nonlinear, and soft matter physics*, 73, 036123.
- Wardle, J., Haase, A. M., Steptoe, A., Nillapun, M., Jonwutiwes, K., & Bellisle, F. (2004). Gender differences in food choice: the contribution of health beliefs and dieting. *Annals of Behavioral Medicine*, 27, 107-116.
- Wasserman, S., & Galaskiewicz, J. (1994). *Advances in social network analysis. Research in the social behavioral sciences*. Thousand Oaks, London, New Dehli: Sage publications.

- Westerterp, K. R., & Goris, A. H. (2002). Validity of the assessment of dietary intake: problems of misreporting. *Current Opinion in Clinical Nutrition & Metabolic Care*, 5, 489-493.
- Zalta, A. K., & Keel, P. K. (2006). Peer influence on bulimic symptoms in college students. *Journal of Abnormal Psychology*, 115, 185-189.
- Zenk, S. N., & Powell, L. M. (2008). US secondary schools and food outlets. *Health Place*, 14, 336-346.

Table 1

Regression analysis of individual snack and soft drink consumption predicted by personal characteristics (step 1), friendship group consumption (step 2), and school availability of snacks and soft drinks in the vending machines and canteen (step 3)

	<i>Individual snack consumption</i>			<i>Individual soft drink consumption</i>		
	B ^a	SE B	β^b	B ^a	SE B	β^b
Step 1						
Age	0.10	0.30	.01	0.09	0.04	.08
Gender (0=boys, 1=girls)	-1.38	0.39	-.13**	-0.47	0.06	-.30**
Education level	-0.23	0.13	-.06	-0.10	0.02	-.18**
Standardized BMI (zBMI)	-1.32	0.24	-.20**	-0.01	0.03	-.01
Step 2						
Age	0.02	0.29	.00	0.07	0.04	.06
Gender	-1.07	0.40	-.10*	-0.36	0.06	-.23**
Education level	-0.21	0.13	-.06	-0.07	0.02	-.13**
Standardized BMI	-1.33	0.24	-.20**	-0.01	0.03	-.01
Friendship group consumption	0.21	0.05	.15**	0.25	0.05	.20**
Step 3						
Age	0.03	0.33	.00	0.06	0.04	.05
Gender	-1.06	0.40	-.10*	-0.36	0.06	-.23**
Education level	-0.21	0.14	-.06	-0.07	0.02	-.13*
Standardized BMI	-1.33	0.24	-.20**	-0.01	0.03	.01
Friendship group consumption	0.21	0.05	.15**	0.25	0.05	.20**
Snacks/drinks in vending machines	0.00	0.02	.00	0.00	0.01	.01
Snacks/drinks in canteen	0.00	0.01	.00	0.00	0.01	.01

^a B: regression coefficient

^b β : standardized regression coefficient

Note 1: * $p < .01$, ** $p < .001$

Accepted Manuscript

FIGURE CAPTIONS

Figure 1: Individual consumption of snacks predicted by friendship group consumption of snacks and availability of snacks in the canteen (left), and individual consumption of soft drinks predicted by friendship group consumption of soft drinks and availability of soft drinks in the vending machines (right); the Y-axes represent snack consumption per week (minimum score 5, maximum score 40) and soft drink consumption per day (minimum score 1, maximum score 5)

Figure 2: Individual consumption of snacks predicted by friendship group consumption of snacks, and gender (left), education level (middle) and weight status (right); the Y-axes represent snack consumption per week (minimum score 5, maximum score 40) and soft drink consumption per day (minimum score 1, maximum score 5)

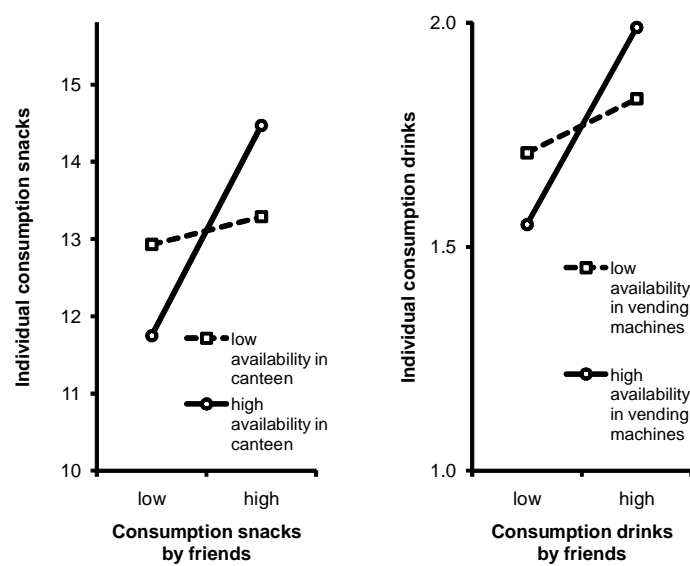
Fig. 1

Fig. 2