Sedentary behavior and dietary intake in children, adolescents and adults: A systematic review

Sedentary Behavior and Dietary Intake in Children, Adolescents and Adults

A systematic review

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Authorship is considered joint

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Context: Sedentary behavior is implicated in youth and adult overweight and obesity. However, the relationship between sedentary behavior and weight status is often small or inconsistent with few studies controlling for confounding factors such as diet and physical activity. Diet has been hypothesized to co-vary with some sedentary behaviors. It is opportune, therefore, to review whether dietary intake is associated with sedentary behavior in young people and adults. This may allow for better interpretation of the diversity of findings concerning sedentary behavior and weight status.

Evidence acquisition: Published English language studies were located from computerized and manual searches in early 2010. Included studies were observational studies assessing an association between at least one sedentary behavior and at least one aspect of dietary intake in children (<11 years), and/or adolescents (12-18 years), and/or adults (>18 years).

Evidence synthesis: 53 studies (k), totaling 111 independent samples were eligible for this review. Sedentary behavior in children (k=19; independent samples=24), adolescents (k=26; independent samples=72), and adults (k=11; independent samples=14) appears to be clearly associated with elements of a less healthy diet including lower fruit and vegetable consumption, higher consumption of energy-dense snacks, drinks and fast foods, and higher total energy intake. Strength of associations were mainly in the range of small-to-moderate.

Conclusions: The association drawn mainly from cross-sectional studies is that sedentary behavior, usually assessed as screen time and predominantly TV viewing, is associated with unhealthy dietary behaviors in children, adolescents and adults. Interventions need to be developed that target reductions in sedentary time to test whether diet also changes.

Context

Sedentary behavior is rapidly emerging as an important issue in public health. Researchers are now investigating the role of sedentary behavior in diverse health outcomes. Typically, researchers have defined 'sedentary' as not meeting a criterion level of physical activity. However, by sedentary behavior we are referring to very low levels of energy expenditure through sitting and lying. Excessive sitting time is essentially the main concern for sedentary behavior researchers.[1, 2]

Studies are now showing associations between sedentary behavior (usually assessed as screen-based behaviors such as TV and computer use), and a range of health outcomes, including all-cause mortality and cardiovascular disease,[3, 4] adverse metabolic profile,[5] and obesity.[6] However, relationships are not always consistent across age, gender or health outcomes. For example, while there has been a longstanding assumption that TV viewing in youth is associated with overweight and obesity,[7] a meta-analysis of mainly cross-sectional studies found that the strength of such an association was actually very small.[8] Moreover, a review of sedentary behavior intervention studies showed inconsistent weight loss for young people.[9] In addition, while cross-sectional data on screen time in 10-16 year olds from 34 countries showed higher degrees of overweight with increased TV viewing in 65% of the countries, this leaves more than one-third having no association.[10] Overall, therefore, sedentary behavior in the form of screen time is implicated in youth overweight and obesity, but findings are less clear cut than some claim.

Prospective observational cohort studies in adults offer stronger evidence of an association between sedentary behavior and weight status in comparison to the cross-sectional studies typical in the literature on young people. For example, parent- and self-reported time spent watching television between 5 and 15 years in New Zealand was shown to predict BMI at 26 years of age. The Nurses Health Study of over 50,000 women [11] showed that those who were normal weight or overweight at baseline had a 23% increased risk of developing obesity during 6 years of follow-up for each 2-hour per day increment in time spent watching TV. In a study of over 18,000 women, Blanck et al[12] reported no significant prospective association between self-reported leisure sitting time and weight gain over 6 years. However, an elevated risk of weight gain was observed in those women who were normal weight at baseline and reporting more than 6 hours of leisure time sitting compared to those who reported less than 3 hours/day. For adults, therefore, associations between sedentary behavior and weight status are suggestive but mixed, although review level, mainly cross-sectional, data support a positive association.[13] However, studies either do not control for confounding factors, such as diet or physical activity, or this is done inconsistently across studies. One variable that has been hypothesized to co-vary with some sedentary behaviors, and in particular TV viewing, is diet.

For adults and young people, during the time spent watching television, little energy is expended,[14] and viewers are exposed to numerous advertisements that can influence the type of food desired and consumed.[15, 16] Furthermore, TV may be a distraction resulting in a lack of awareness of actual food consumption or overlooking food cues, leading to overconsumption.[17] It is opportune, therefore, to review whether dietary intake is associated with sedentary behavior in young people and adults. This may assist researchers in better interpreting the diversity of findings concerning sedentary behavior and weight status.

Evidence Acquisition

This study followed the procedures for a systematic review produced by the NHS Centre for Reviews and Dissemination.[18]

Search strategy

Search strategies were built around four groups of keywords: sedentary behavior, dietary behavior, study type, and sample type. Key terms for sedentary behaviors were used in combination with key terms for dietary behavior, study type and sample type to locate potentially relevant studies. Science Direct, PubMed, PsychINFO, and Web of Science databases were searched using the key terms in early 2010. In addition, manual searches of personal files were conducted along with screening of reference lists of primary studies and identified articles for titles that included the key terms.

Inclusion and exclusion criteria

For inclusion, studies were required to (i) include children aged $\leq$11 years, and/or adolescents aged 12–18 years, and/or adults aged >18 years (or a mean within these ranges) as subjects of study at baseline. Studies that did not state the mean age of participants were classified as pre-school children, school-aged children, adolescents or adults depending on the ages of the majority of the sample; (ii) have a point estimate (mean) of at least one aspect of dietary intake (or data showing prevalence) and have a point estimate (mean) of at least one sedentary behavior (or data showing prevalence); (iii) be observational and assess an association between at least one sedentary behavior and at least one aspect of dietary intake; (iv) be published in peer-reviewed journals in the English language; and (v) be published up

to and including January 2010. Experimental studies that manipulated a sedentary behavior and/or aspects of dietary intake were excluded.

Identification of relevant studies

Potentially relevant articles were selected by (i) screening the titles; (ii) screening the abstracts; and (iii) if abstracts were not available or did not provide sufficient data, the entire article was retrieved and screened to determine whether it met the inclusion criteria.

Data extraction

Data were extracted on standardized forms developed for this review between January and July 2010. This information is summarized in Tables 1 and 2. In addition, the reliability and validity of measures of sedentary behavior and dietary intake, and the response rates of each study were extracted (data not shown in tables).

Identified sedentary and dietary behaviors were tabulated to highlight the state of the literature for the associations between sedentary behavior and diet for children (Table 3), adolescents (Table 4), and adults (Table 5). A large number of dietary behaviors have been studied in association with sedentary behaviors (predominantly television viewing) (see Tables 1 and 2). 20% of the data extraction forms, containing data from the whole data extraction process, were double checked and discrepancies over the extracted data (n=7) were resolved through discussion.

Coding associations between sedentary behavior and diet

An independent sample was used as the unit of analysis and was defined as the smallest independent sub-sample for which relevant data were reported (e.g. boys/girls).[19] The column 'number of samples' displays the number of samples that have been studied for each dietary behavior. The 'summary' column contains the number of samples, and references, finding positive (+), inverse (-) and no (0) associations between sedentary behavior and dietary behaviors.

Study quality

The quality of the studies included in the review was assessed. Studies were given scores (0-2) based on the sample size, sampling methods, response rates, their level of reporting the reliability and validity of measures used to assess sedentary behavior and dietary intake, and whether or not confounders had been included in analyses (full details available from corresponding author). Study quality scores could range from 0 to 16, with higher scores meaning higher quality studies.

In addition, the strength of association with reference to conventions (details and references available from first author) was assessed. Essentially, the strength of association was graded as 'none', 'small', 'medium', or 'large' for data using Pearson correlation (r), standardised regression coefficient (β), multiple regression (R, partial R, R^2, partial R^2), Cohen's d effect size, and odds ratio.

Evidence Synthesis

The literature searches yielded 15,645 titles of potentially relevant articles and 53 (111 samples) were eligible for this review. Results are reported separately for children, adolescents, and adults.

Associations between sedentary behavior and diet in children

Nineteen studies (24 samples) of children were eligible for review (see Table 1). The majority of studies were conducted in the USA (n=13). Fifteen studies examined associations between sedentary behaviors and dietary outcomes for boys and girls combined, three examined associations separately for boys and girls, and one examined associations for girls only. The majority used a cross-sectional design (n=13), eight of the studies assessed sedentary behaviors through self-report, eight through parent report, and three using an interviewer, with a questionnaire being the most frequently used measure (n=17). Dietary behaviors were most commonly assessed through self-report (n=9), and parent report (n=8), with a food frequency questionnaire (FFQ) being the most used measure (n=12). The average sample size was 1184 (range 66–6235). Study quality scores for studies (K) including children ranged from 2/16 to 9/16, median=8 (scores: 9: K=3 [20-22]; 8: K=6 [23-28]; 7: K=2;[29, 30] 6: K=3,[31-33] 5: K=2;[34, 35] 4,[36] 3,[37] and 2[38]: K=1 each).

Television viewing was the most commonly assessed sedentary behavior in association with dietary intake, studied in 19 samples (79%). Twenty-five dietary behaviors were identified, and for brevity dietary behaviors that were studied most often and dietary behaviors that are important in their contribution to the healthfulness of overall diet were tabulated (Table 3). Television viewing was inversely associated with fruit consumption in three out of three samples, and with vegetable consumption in three out of four samples. Sedentary behavior

(one study assessed screen time and two assessed TV viewing) was inversely associated with a composite measure of fruit and vegetable consumption (FV) in three out of three samples.

Television viewing was positively associated with energy-dense snack consumption in eleven samples, and not associated in four. Television viewing was positively associated with fast food consumption in seven samples and not associated in one. Television viewing was positively associated with energy-dense drinks in seven out of seven samples, positively associated with total energy intake in eight of eleven samples, and positively associated with percentage energy from fat in two out of two samples.

There were five longitudinal studies (nine independent samples) assessing the association between sedentary behavior and dietary intake in children;[23, 26, 28, 33, 38] three out of these five studies scored higher than the median score for study quality (median =8/16), corroborating the results found from cross-sectional studies showing that TV viewing was inversely associated with fruit and vegetable consumption,[23] and positively associated with total energy intake,[26, 28] energy-dense drinks, snacks and fast foods.[28] Overall, therefore, sedentary behavior in children appears to be clearly associated with elements of a less healthy diet.

Associations between sedentary behavior and diet in adolescents

Twenty-six studies (72 samples) of adolescents were eligible for review (see Table 1). Half of the studies were conducted in the USA (n=13). Fourteen studies examined associations between sedentary behaviors and dietary outcomes for boys and girls combined, 11 examined associations separately for boys and girls, and one examined associations for girls only. The majority used a cross-sectional design (n=21), all of the studies assessed sedentary behaviors through self-report, with a questionnaire being the most frequently used measure (n=25). All

of the studies assessed dietary behaviors through self-report, with a FFQ being the most frequently used measure (n=13). The average sample size was 8356 (range 60–14,407). Study quality scores for studies including adolescents ranged from 2/16 to 12/16, median=8 (scores: 12: K=3;[39-41] 11: K=1;[42] 10: K=3;[43-45] 9: K=; [22] 8: K=3;[24, 27, 46] 7: K=2 ;[47, 48] 6: K=7;[49-55]5: K=1;[56] 3: K=3;[57-59] 2: K=2[60, 61]).

Screen time was the most commonly assessed sedentary behavior in association with dietary intake, studied in 46 samples (64%). Twenty-seven dietary behaviors were identified, and for brevity dietary behaviors that were studied most often and are important in their contribution to the healthfulness of overall diet were tabulated (Table 4). Sedentary behavior was inversely associated with fruit consumption in 30 samples (23 assessed screen time and 7 assessed TV viewing), and not associated with fruit consumption in 18 samples (16 assessed screen time and 2 assessed TV viewing). Sedentary behavior was inversely associated with vegetable consumption in 26 samples (23 assessed screen time and 3 assessed TV viewing), and not associated in 18 samples (16 assessed screen time and 2 assessed TV viewing). Sedentary behavior was negatively associated with a composite measure of fruit and vegetable consumption (FV) in five samples (3 assessed screen time and 2 assessed TV viewing), and not associated in two.

Sedentary behavior was positively associated with energy-dense snack consumption in 42 samples (39 assessed screen time and 3 assessed TV viewing), and not associated in nine (2 assessed screen time and 7 assessed TV viewing). Sedentary behavior was positively associated with fast food consumption in five samples (1 assessed screen time and 4 assessed TV viewing) and not associated in five (1 assessed screen time and 4 assessed TV viewing).

Screen time was positively associated with fried food consumption in three samples, and not associated in one. Sedentary behavior was positively associated with energy-dense drinks in 42 samples (39 assessed screen time and 5 assessed TV viewing), and not associated in five (1 assessed screen time and 4 assessed TV viewing). Sedentary behavior was positively associated with total energy intake in three samples (3 assessed screen time), and not associated in six (4 assessed screen time and 2 assessed TV viewing). Sedentary behavior was positively associated with percentage energy from fat in five samples (5 assessed screen time), and not associated in five (3 assessed screen time and 2 assessed TV viewing). Sedentary behavior was positively associated with total fat in three samples (2 assessed screen time and 1 assessed TV viewing), and not associated in five (1 assessed screen time and 4 assessed TV viewing). Sedentary behavior was inversely associated with fibre in three samples (2 assessed screen time and 1 assessed TV viewing), and not associated in three (1 assessed screen time and 2 assessed TV viewing).

There were five longitudinal studies (ten independent samples) assessing the association between sedentary behavior and dietary intake in adolescents;[39, 43, 44, 46, 54] four out of these five studies scored higher that the median score for study quality (median =8/16), corroborating the results found from cross-sectional studies showing that TV viewing was inversely associated with fruit and vegetable consumption,[43, 44, 46] and positively associated with energy-dense drinks.[39] Overall, therefore, sedentary behavior in adolescents appears to be clearly associated with elements of a less healthy diet, and in particular with higher consumption of energy-dense snacks and drinks and lower consumption of fruits and vegetables.

Associations between sedentary behavior and diet in adults

Eleven studies (14 samples) of adults were eligible for review (see Table 2). The majority of studies were conducted in the USA (n=8). Five studies examined associations between sedentary behaviors and dietary outcomes for men and women combined, two examined associations separately for men and women, three examined associations for women only, and one examined associations for men only. The majority used a cross-sectional design (n=7), and all of the studies assessed sedentary behaviors through self-report, with a questionnaire being the most frequently used measure (n=10). All but one of the studies assessed dietary behaviors through self-report, with a FFQ being the most used measure (n=7). The average sample size was 11,044 (range 74–50,277). Study quality scores for studies including adults ranged from 3/16 to 8/16, median=7.5 (scores: 8: K=4;[62-65] 7: K=1;[66] 5: K=3;[67-69] 4: K=2;[70, 71] 3: K=1 [11]).

Television viewing was the most commonly assessed sedentary behavior in association with dietary intake, studied in 12 samples (86%). Twenty-two dietary behaviors were identified, and for brevity dietary behaviors that were studied most often and dietary behaviors that are important for the healthfulness of overall diet were tabulated (Table 5). Television viewing was inversely associated with fruit consumption in three samples, with vegetable consumption in three samples and with a composite measure of fruit and vegetable consumption (FV) in two samples.

Sedentary behavior was positively associated with energy-dense snack consumption in four out of four samples (1 assessed screen time and 3 assessed TV viewing), with fast food consumption in three out of three samples (3 assessed TV viewing), and with energy-dense drinks in two out of two samples (1 assessed screen time and 1 assessed TV viewing).

Sedentary behavior was positively associated with total energy intake in five samples (1 assessed screen time and 4 assessed TV viewing), and not associated in two. Sedentary behavior was positively associated with percentage energy from fat in one sample, and not associated in three (1 assessed screen time and 2 assessed TV viewing). Sedentary behavior was positively associated with total fat in three samples (1 assessed screen time and 2 assessed TV viewing), and not associated in one. Sedentary behavior was inversely associated with fibre in three out of three samples (1 assessed screen time and 2 assessed TV viewing).

There was one longitudinal study assessing the association between sedentary behavior and dietary intake in adults.[64] This study scored higher that the median score for study quality (median =7.5/16), and corroborated the results found from cross-sectional studies showing that TV viewing was positively associated with consumption of energy-dense snacks.[64] Overall, therefore, sedentary behavior in adults appears to be clearly associated with elements of a less healthy diet.

Potential moderators

Age

Five studies examined age as a potential moderator of the association between sedentary behavior and diet.[22, 24, 27, 35, 39] One study examined differences in the association between sedentary behavior and diet between two groups of pre-school children (aged 2-3.9 years and 4-5.9 years).[35] Three studies examined differences between groups of children (age ranged from 5-10 years or those in school grades 4-5) and adolescents (age 11+ or those in school grades 6-12).[22, 24, 27] One study examined differences between two groups of adolescents (aged 12.8 years and 15.9 years).[39] Overall, there appears to be no clear pattern for age acting

as a moderator. However, the number of comparisons is quite small and the studies too diverse to draw meaningful conclusions.

Gender

Gender differences in the association between sedentary and eating behaviors were examined in three studies of children,[26, 29, 31] 10 studies of adolescents,[40, 42-44, 46, 51, 53-55, 59] and two studies of adults.[65, 66] No gender differences were found in two out of the three studies that examined gender differences among children [26, 31] and no gender difference were found in five out of the ten studies examining gender differences among adolescents.[40, 44, 51, 53, 55] Gender differences were found in one of the two studies among adults.[66] Overall, there appear to be more consistent associations between sedentary behavior and diet for females than for males.

Discussion

The purpose of this systematic review was to assess whether patterns of dietary intake were associated with sedentary behavior. The relationship between sedentary behavior and weight status is often small or inconsistent[8, 13, 72] and this may be explained by the moderating effect of diet, especially dietary intake during certain types of sedentary behaviors, such as TV viewing.

Results show a clear association, usually in the small-to-moderate range, between sedentary behavior and unhealthy dietary intake. This is reflected in higher consumption of energy dense snacks and less consumption of fruits and vegetables, and this is consistent across age groups studied.

For children, television viewing was consistently inversely associated with fruit and vegetable consumption and positively associated with consumption of energy-dense snacks and drinks, total energy intake, and fast foods. Sedentary behavior in adolescents is also clearly associated with elements of a less healthy diet, and in particular with higher consumption of energy-dense snacks and drinks and lower consumption of fruits and vegetables. Overall, therefore, diet and sedentary behavior in young people is coupled and may better explain associations between sedentary behavior and weight status than other behaviors, such as a displacement of physical activity. Review-level data shows the association between weight status and screen time in young people to be quite small [8] and this could be explained by our findings. Given that physical activity can co-exist with screen time [8], and dietary behaviors associated with sedentary time may not necessarily reflect consumption of food and drink at other times, the association between screen time and weight status is likely to exist but be small or inconsistent, notwithstanding the well known problems in the use of self-report measures for both exposure and outcome variables.

Of concern might be the early socializing of children into sedentary habits and the association with poor diet. Young people may associate television viewing with eating from a young age if, for example, parents place their children in front of the television with a snack or a meal while they do other household chores.[73] For some young people a significant proportion of their daily energy intake is consumed while watching television.[74] Experimental studies have shown that watching television while eating may cause a distraction resulting in a delay in normal mealtime satiation and a reduction in internal satiety signals,[75, 76]. It is less likely that console computer games will have the same effect, although data are not able to clearly separate different screen behaviors. If more active computer games are undertaken in place of

seated games, sedentary time could be reduced, energy expenditure will rise,[77] and consumption of unhealthy foods and drinks may decrease. The role of other sedentary behaviors in dietary consumption of young people is much less clear, and warrants further research.

Evidence suggests that an important 'window' of opportunity to reduce sedentary behaviors and increase physical activity in young people is the period immediately after school.[78] If children and adolescents spend a high proportion of these hours sedentary in front of a screen, unhealthy dietary consumption will be more likely and physical activity less likely. This time of the day is thought to be important because it is one of the most obvious times for physical activity involvement, but more evidence is needed, including the role of diet[78]

The association between sedentary behavior and diet in adults was similar to that of young people, although was slightly less pronounced. Influences will be different from that of young people, although there is little evidence on the key correlates of sedentary behavior in adults [1, 79]. Overall sedentary time will be strongly influenced by work as well as leisure time factors, and family structures and rules regarding both sedentary and diet behaviors are more controllable for adults. However, adult behaviors are also associated with the behavior of their offspring, and a review of parental correlates of fruit and vegetable consumption in young people shows that intake of the parent is associated with that of their children.[80] Moreover, TV viewing habits of parents is associated with that of their children.[81] Interventions may need to target adults and children together.[82]

The limitations of this review include the over-reliance on cross-sectional studies and the use of self-report measures of sedentary and dietary behaviors that lack strong validity. Moreover, sedentary behavior is largely operationally defined as screen time, and this is

mainly TV viewing, making it difficult to draw any conclusions regarding non-screen time and dietary intake. Moreover, while ‘screen time’ can include TV and computer use, this does not help in identifying whether it is TV, computer use, or both, that is associated with unhealthy diets.More studies using objective measures of sedentary behaviors and more valid and reliable measures of dietary intake are required.

There is also a need to examine the longitudinal association between sedentary behavior and dietary intake, and the tracking of the clustering of specific sedentary behaviors and specific dietary behaviors. For example, it appears from the mainly cross-sectional evidence presented that TV viewing is associated with unhealthy dietary patterns. Much less is known about diet and either computer use or sedentary motorized transport. It is likely that the main associations will be with TV, but this needs testing. A focus on sedentary behaviors and dietary behaviors that ‘share’ determinants, as well as determinants of the clustering of sedentary and dietary behaviors will aid the development of targeted interventions to reduce sedentary behaviors and promote healthy eating.

In conclusion, the association drawn mainly from cross-sectional studies is that sedentary behavior, usually assessed as screen time and predominantly TV viewing, is associated with unhealthy dietary behaviors in children, adolescents and adults. Notwithstanding the methodological weaknesses of the evidence base, there is sufficient consistency to suggest that this is an important set of results. However, interventions need to be developed that target reductions in sedentary time to test whether diet also changes.

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References

1. Owen N, Healy GN, Matthews CE, Dunstan DW. Too much sitting: The population health science of sedentary behavior. Exerc Sport Sci Rev 2010;38(3):105-113.

2.Tremblay MS. Assessing the level of sedentarism. In: Bouchard C, Katzmarzyk PT, editors. Physical activity and obesity (2nd Edition). Champaign, IL: Human Kinetics; 2010. p. 13-17.

3.Katzmarzyk PT, Church TS, Craig CL, Bouchard C. Sitting time and mortality from all causes, cardiovascular disease, and cancer. Med Sci Sports Exerc 2009;41(5):998-1005.

4.Dunstan DW, Barr ELM, Healy GN, Salmon J, Shaw JE, Balkau B, et al. Television viewing time and mortality: The Australian Diabetes, Obesity and Lifestyle Study (AusDiab). Circulation 2010;121:384-391.

5.Dunstan DW, Salmon J, Healy GN, Shaw JE, Jolley D, Zimmet PZ, et al. Association of television viewing with fasting and 2-hr post-challenge plasma glucose levels in adults without diagnosed diabetes. Diabetes Care 2007;30:516-522.

6. Hancox RJ, Milne BJ, Poulton R. Association between child and adolescent television viewing and adult health: A longitudinal birth cohort study. Lancet 2004;364:257-262.

7. Dietz WH, Gortmaker SL. Do we fatten our children at the television set? Obesity and television viewing in children and adolescents. Pediatrics 1985;75:807-812.

8.Marshall SJ, Biddle SJH, Gorely T, Cameron N, Murdey I. Relationships between media use, body fatness and physical activity in children and youth: A meta-analysis. Int J Obes 2004;28:1238-1246.

9. DeMattia L, Lemont L, Meurer L. Do interventions to limit sedentary behaviors change behavior and reduce childhood obesity? A critical review of the literature. Obesity Rev 2007;8:69-81.

10. Janssen I, Katzmarzyk PT, Boyce WF, Vereecken C, Mulvihill C, Roberts C, et al. Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns. Obes Rev 2005;6(2):123-32.
11. Hu FB, Li TY, Colditz GA, Willett WC, Manson JE. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. J Am Med Assoc 2003;289(14):1785-1791.
12. Blanck HM, McCullough ML, Patel AV, Gillespie C, Calle EE, Cokkinides VE, et al. Sedentary behavior, recreational physical activity, and 7-year weight gain among postmenopausal U.S. women. Obesity 2007;15:1578-1588.
13. Williams DM, Raynor HA, Ciccolo JT. A review of TV viewing and its association with health outcomes in adults. Am J Lifestyle Med 2008;2:250-259.
14. Klesges RC, Shelton ML, Klesges LM. Effects of television on metablic rate: potential implications for childhood obesity. Pediatrics 1993;91:281-286.
15. Dennison BA, Edmunds LS. The role of television in childhood obesity. Prog Pediatric Cardiol 2008;25:191-197.
16. Scully M, Dixon H, Wakefield M. Association between commercial television exposure and fast-food consumption among adults. Public Health Nutr 2009;12(01):105-110.
17. Temple JL, Giacomelli AM, Kent KM, Roemmich JN, Epstein LH. Television watching increases motivated responding for food and energy intake in children. Am J Clin Nutr 2007;85(2):355-361.
18. NHS Centre for Reviews and Dissemination. Undertaking systematic reviews of research on effectiveness: CRD's guidance for those carrying out or commissioning reviews. Report. York: NHS Centre for Reviews and Dissemination, University of York; 2001.
19. Cooper H. Synthesizing Research: A Guide for Literature Reviews. London: Sage; 1998.

20. Campbell KJ, Crawford DA, Ball K. Family food environment and dietary behaviors likely to promote fatness in 5-6 year-old children. Int J Obes 2006;30(8):1272-1280.
21. Dixon HG, Scully ML, Wakefield MA, White VM, Crawford DA. The effects of television advertisements for junk food versus nutritious food on children's food attitudes and preferences. Soc Sci Med 2007;65(7):1311-1323.
22. Utter J, Scragg R, Schaaf D. Associations between television viewing and consumption of commonly advertised foods among New Zealand children and young adolescents. Public Health Nutr 2006;9(05):606-612.
23. Boynton-Jarrett R, Thomas TN, Peterson KE, Wiecha J, Sobol AM, Gortmaker SL. Impact of television viewing patterns on fruit and vegetable consumption among adolescents. Pediatrics 2003;112(6 part 1):1321-1326.
24. Driskell MM, Dyment S, Mauriello L, Castle P, Sherman K. Relationships among multiple behaviors for childhood and adolescent obesity prevention. Prev Med 2008;46:209-215.
25. Miller SA, Taveras EM, Rifas-Shiman SL, Gillman MW. Association between television viewing and poor diet quality in young children. Int J Pediatr Obes 2008;3(3):168-176.
26. Sonneville KR, Gortmaker SL. Total energy intake, adolescent discretionary behaviors and the energy gap. Int J Obes 2008;32:s19-27.
27. Vader AM, Walters ST, Harris TR, Hoelscher DM. Television viewing and snacking behaviors of fourth- and eighth-grade schoolchildren in Texas. Prev Chronic Dis 2009;6(3).
28. Wiecha JL, Peterson KE, Ludwig DS, Kim J, Sobol A, Gortmaker SL. When Children Eat What They Watch: Impact of Television Viewing on Dietary Intake in Youth. Arch Pediatr Adolesc Med 2006;160(4):436-442.

29. Crespo CJ, Smit E, Troiano RP, Bartlett SJ, Macera CA, Andersen RE. Television watching, energy intake, and obesity in US children. Results from the third national health and nutrition examination survey, 1988-1994. Arch Pediatr Adolesc Med 2001;155:360-365.
30. Salmon J, Campbell KJ, Crawford DA. Television viewing habits associated with obesity risk factors: a survey of Melbourne schoolchildren. Med J Aust 2006;184(2):64-67.
31. Fulton JE, Dai S, Steffen LM, Grunbaum JA, Shah SM, Labarthe DR. Physical activity, energy intake, sedentary behavior, and adiposity in youth. Am J Prev Med 2009;37(1s):s40-s49.
32. Manios Y, Kondaki K, Kourlaba G, Grammatikaki E, Birbilis M, Ioannou E. Television viewing and food habits in toddlers and preschoolers in Greece: the GENESIS study. Eur J Paediatrics 2009;168(7):801-808.
33. Phillips SM, Bandini LG, Naumova EN, Cyr H, Colclough S, Dietz WH, et al. Energy-dense snack food intake in adolescence: longitudinal relationship to weight and fatness. Obesity Research 2004;12(3):461-472.
34. Gubbels JS, Kremers SPJ, Stafleu A, Dagnelie PC, de Vries SI, de Vries NK, et al. Clustering of Dietary Intake and Sedentary Behavior in 2-Year-Old Children. J Pediatr 2009;155(2):194-198.
35. Taveras EM, Sandora TJ, Shih M-C, Ross-Degnan D, Goldmann DA, Gillman MW. The Association of Television and Video Viewing with Fast Food Intake by Preschool-Age Children[ast]. Obesity 2006;14(11):2034-2041.
36. Taras HL, Sallis JF, Patterson TL, Nader PR, Nelson JA. Television's influence on children's diet and physical activity. J Dev Behav Pediatr 1989; 10(4).176-80.
37. Grimm GC, Harnack L, Story M. Factors associated with soft drink consumption in school-aged children. J Am Diet Assoc 2004;104(8):1244-1249.

38. Francis LA, Lee Y, Birch LL. Parental Weight Status and Girls' Television Viewing, Snacking, and Body Mass Indexes. Obesity 2003;11(1):143-151.
39. Barr-Anderson D, Larson N, Nelson M, Neumark-Sztainer D, Story M. Does television viewing predict dietary intake five years later in high school students and young adults? Int J Behav Nutr Phys Act 2009;6(1):7.
40. Utter J, Neumark-Sztainer D, Jeffery RW, Story MT. Couch potatoes or french fries: Are sedentary behaviors associated with body mass index, physical activity, and dietary behaviors among adolescents? J Am Diet Assoc 2003;103:1298-1305.
41. Vereecken CA, Todd J, Roberts C, Mulvihill C, Maes L. Television viewing behavior and associations with food habits in different countries. Public Health Nutr 2006;9(02):244-250.
42. Haerens L, Craeynest M, Deforche B, Maes L, Cardon G, De Bourdeaudhuij I. The contribution of psychosocial and home environmental factors in explaining eating behaviors in adolescents. Eur J Clin Nutr 2007;62(1):51-59.
43. Larson NI, Neumark-Sztainer D, Harnack L, Wall M, Story M, Eisenberg ME. Calcium and Dairy Intake: Longitudinal Trends during the Transition to Young Adulthood and Correlates of Calcium Intake. J Nutr Educ Behav 2009;41(4):254-260.
44. Larson NI, Neumark-Sztainer DR, Harnack LJ, Wall MM, Story MT, Eisenberg ME. Fruit and Vegetable Intake Correlates During the Transition to Young Adulthood. Am J Prev Med 2008;35(1):33-37.e3.
45. Verzeletti C, Maes L, Santinello M, Baldassari D, Vereecken CA. Food-related family lifestyle associated with fruit and vegetable consumption among young adolescents in Belgium Flanders and the Veneto Region of Italy. Appetite 2010; In Press, Corrected Proof.

46. Larson NI, Neumark-Sztainer D, Story MT, Wall MM, Harnack LJ, Eisenberg ME. Fast food intake: Longitudinal trends during the transition to young adulthood and correlates of intake. J Adolesc Health 2008;43:79-86.
47. Ambrosini GL, Oddy WH, Robinson M, O'Sullivan TA, Hands BP, de Klerk NH, et al. Adolescent dietary patterns are associated with lifestyle and family psycho-social factors. Public Health Nutr 2009;12(10):1807-1815.
48. Scully M, Dixon H, White V, Beckmann K. Dietary, physical activity and sedentary behavior among Australian secondary students in 2005. Health Promot Int 2007;22(3):236-245.
49. Ayala GX, Baquero B, Arredondo EM, Campbell N, Larios S, Elder JP. Association Between Family Variables and Mexican American Children's Dietary Behaviors. J Nutr Educ Behav 2007;39(2):62-69.
50. Barker M, Robinson S, Wilman C, Barker DJP. Behavior, body composition and diet in adolescent girls. Appetite 2000;35(2):161-170.
51. Campbell KJ, Crawford DA, Salmon J, Carver A, Garnett SP, Baur LA. Associations Between the Home Food Environment and Obesity-promoting Eating Behaviors in Adolescence. Obesity 2007;15(3):719-730.
52. Kremers SP, Horst K, Brug J. Adolescent screen-viewing behavior is associated with consumption of sugar-sweetened beverages: The role of habit strength and perceived parental norms. Appetite 2007;48(3):345-350.
53. Lowry R, Wechsler H, Galuska DA, Fulton JE, Kann L. Television Viewing and its Associations with Overweight, Sedentary lifestyle, and Insufficient Consumption of Fruits and Vegetables Among US High School Students: Differences by Race, Ethnicity, and Gender. J School Health 2002;72(10):413-21.

54. Rosenberg DE, Norman GJ, Sallis JF, Calfas KJ, Patrick K. Covariation of Adolescent Physical Activity and Dietary Behaviors Over 12 Months. J Adolesc Health 2007;41(5):472-478.
55. Snoek HM, van Strien T, Janssens JM, Engels RC. The effect of television viewing on adolescents' snacking : Individual differences explained by external, restrained and emotional eating. J Adolesc Health 2006;39(3):448-451.
56. van Kooten M, de Ridder D, Vollebergh W, van Dorsselaer S. What's so special about eating? Examining unhealthy diet of adolescents in the context of other health-related behaviors and emotional distress. Appetite 2007;48:325-332.
57. de Bruijn GJ, van den Putte B. Adolescent soft drink consumption, television viewing and habit strength. Investigating clustering effects in the Theory of Planned Beahviour. Appetite 2009;53:66-75.
58. Giammattei J, Blix G, Marshak HH, Wollitzer AO, Pettitt DJ. Television watching and soft drink consumption. Associations with obesity in 11- to 13- year-old school children. Arch Pediatr Adolesc Med 2003;157:882-886.
59. Ortega RM, Andrés P, Requejo AM, López-Sobaler AM, Redondo MR, González-Fernández M. Influence of the time spent watching television on the dietary habits, energy intake and nutrient intake of a group of Spanish adolescents. Nutr Res 1996;16(9):1467-1470.
60. Lake AA, Townshend T, Alvanides S, Stamp E, Adamson AJ. Diet, physical activity, sedentary behavior and perceptions of the environment in young adults. J Human Nutr Diet 2009;22(5):444-454.
61. Zabinski MF, Norman GJ, Sallis JF, Calfas KJ, Patrick K. Patterns of Sedentary Behavior Among Adolescents. Health Psychol 2007;26(1):113-120.

62. Bowman SA. Television-Viewing Characteristics of Adults: Correlations to Eating Practices and Overweight and Health Status. Prev Chronic Dis 2006;3(2):1-11.
63. French SA, Harnack L, Jeffery RW. Fast food restaurant use among women in the Pound of Prevention study: dietary, behavioral and demographic correlates. Int J Obes 2000;24(10):1353-1359.
64. Panagiotakos DB, Pitsavos C, Lentzas Y, Skoumas Y, Papadimitriou L, Zeimbekis A, et al. Determinants of Physical Inactivity Among Men and Women From Greece: A 5-Year Follow-Up of the ATTICA Study. Ann Epidemiol 2008;18(5):387-394.
65. Shields M, Tremblay MS. Sedentary behavior and obesity. Health Rep 2008;19(2):19-30.
66. Jeffery RW, French SA. Epidemic obesity in the United States: are fast foods and television viewing contributing? Am J Public Health 1998;88(2):277-80.
67. Gore SA, Foster JA, DiLillo VG, Kirk K, Smith West D. Television viewing and snacking. Eat Behav 2003;4(4):399-405.
68. Hu FB, Leitzman MF, Stampfer MJ, Colditz GA, Willett WC, Rimm EB. Physical activity and television watching in relation to risk for type 2 diabetes mellitus in men. Arch Intern Med 2001;161:1542-1548.
69. Thomson M, Spence JC, Raine K, Laing L. The Association of Television Viewing with Snacking Behavior and Body Weight of Young Adults. Am J Health Promot 2008;22(5):329.
70. Harris JL, Bargh JA. Television viewing and unhealthy diet: Implications for children and media interventions. Health Commun 2009;24:660-673.
71. Rehm C, Matte T, Van Wye G, Young C, Frieden T. Demographic and Behavioral Factors Associated with Daily Sugar-sweetened Soda Consumption in New York City Adults. J Urban Health 2008;85(3):375-385.

72. Saelens BE. Helping individuals reduce sedentary behavior. In: Andersen RE, editor. Obesity: Etiology, assessment, treatment, and prevention. Champaign, IL: Human Kinetics; 2003. p. 217-238.
73. Lemish D. Viewers in diapers: The early development of television viewing. In: Lindlof TR, editor. Natural audiences: Qualitative research of media uses and effects. Norwood, NJ: Ablex; 1987. p. 33-57.
74. Matheson DM, Killen JD, Wang Y, Varady A, Robinson TN. Children's food consumption during television viewing. Am J Clin Nutr 2004;79(6):1088-1094.
75. Blass EM, Anderson DR, Kirkorian HL, Pempek TA, Price I, Koleini MF. On the road to obeisty: Television viewing increases intake of high-density foods. Physiol Behav 2006;88:597-604.
76. Bellissimo N, Pencharz PB, Thomas SG, Anderson GH. Effect of television viewing at mealtime on food intake after a glucose preload in boys. Pediatr Res 2007;61(6):745-749.
77. Graves L, Stratton G, Ridgers ND, Cable NT. Comparison of energy expenditure in adolescents when playing new generation and sedentary computer games: cross sectional study. BMJ 2007;335(7633):1282-4.
78. Atkin AJ, Gorely T, Biddle SJ, Marshall SJ, Cameron N. Critical hours: physical activity and sedentary behavior of adolescents after school. Pediatr Exerc Sci 2008;20(4):446-56.
79. Owen N, Leslie E, Salmon J, Fotheringham MJ. Environmental determinants of physical activity and sedentary behavior. Exerc Sport Sci Rev 2000;28(4):153-8.
80. Pearson N, Biddle SJ, Gorely T. Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review. Public Health Nutr 2009;12(2):267-83.
81. Gorely T, Marshall SJ, Biddle SJ. Couch kids: correlates of television viewing among youth. Int J Behav Med 2004;11(3):152-63.

82. Pearson N, Atkin AJ, Biddle SJ, Gorely T. A family-based intervention to increase fruit and vegetable consumption in adolescents: a pilot study. Public Health Nutr 2010;13(6):876-85.

Table 1. Characteristics of child and adolescent studies included in the review

Comment [BL1]: This table is very difficult to read, please revise.

	Children (<11 years)			Adolescents (12-18 years)	
	References	**No. of samples**		**References**	**No. of samples**
Sample size		24			72
<100	35 II, 36, 38 I	3		59 B/G, 60	3
100-199	33 G, 35 I, 38 II	3		42 B, 49, 51 B, 51 G, 54 B, 54 G	6
200-299	26 B, 26 G, 31 B, 31 G	4			
300-499				26, 50, 52, 57, 58 G	5
500-999	20, 21, 23, 28, 37	5		39 I, 41 VI, 43 B, 43 G, 44 B, 44 G, 46 B, 46 G, 61	9
1000-2999	22 I, 24 I, 25, 29 B, 29G, 30, 32, 34	8		22 II, 24 II, 24 III, 39 II, 40 B, 40 G, 41 XXII, 41 XXIII, 41 XXV, 41 XXVIII, 41 XXXI, 47	12
3000-4999				41 I-V, 41 VII-XV, 41 XVIII-XXI, 41 XXVII, 41 XXX, 41 XXXII-XXXV, 55 B, 55 G	26
>5000	27 I	1		27 II, 53 B, 53 G, 48, 56, 41 XVI, 41 XVII, 41 XXIV, 41 XXVI, 41 XXIX, 45	11
Gender					
Girls only	33	1		50	1
Boys and girls combined	20, 21, 22 I, 23, 24 I, 25, 27 I, 28, 30, 32, 34, 35 I II, 36, 37, 38 I II	17		22 II, 24 II III, 27 II, 39 I II, 41 I-XXXV, 45, 47, 48, 49, 52, 56, 57, 58, 60, 61	51
Boys and girls separately	26, 29, 31	6		40, 42, 43, 44, 46, 51, 53, 54, 55, 59	20
Study design					
Cross sectional	20, 21, 22 I, 24 I, 25, 27 I, 29 B/G,	15		22 II, 24 II III, 27 II, 40[4] B/G, 41[5] I-	62

	30, 32, 34, 35 I II, 36			XXXV, 42 B/G, 45[5], 47, 48, 49, 50, 51 B/G, 52, 53 B/G, 55 B/G, 56[5], 57, 58, 59 B/G, 60, 61	
Longitudinal	23[3], 26[2,3] B/G, 28[2,3], 31[1] B/G, 33 G, 38[1] I II	9		39[4] I II, 43[4] B/G, 44[4] B/G, 46[4] B/G, 54[2] B/G	10
Sedentary behavior assessed					
TV viewing	20, 21, 22 I, 23, 25, 26 B/G, 27 I, 28, 29 B/G, 30, 32, 33 G, 34, 36, 37, 38 I II	19		22 II, 27 II, 42 B/G, 43 B/G, 44 B/G, 45, 46 B/G, 47, 48, 49, 50, 51 B/G, 53 B/G, 57, 58, 59 B/G	21
Screen time (TV + video + DVD)	24 I, 26 B/G, 31 B/G, 35 I II	7		24 II III, 39 I II, 40 B/G, 41 I-XXXV, 52, 55 B/G, 56, 60	46
Sedentary time (TV + video + DVD + sitting while talking on phone/listening to music)				54 B/G	2
Computer use	34	1		40 B/G	2
Inactivity (sum of sleeping, lying sitting or standing)	33 G	1			
Reading / doing homework	26 B/G	2		40 B/G, 60	3
Weekend screen time				60	1
Weekend homework				60	1
Sitting in a car (weekday)				60	1
Sitting in a car (weekend day)				60	1
High sedentary cluster (high TV, computer, sitting, homework and reading)				61	1
Assessment of sedentary behavior					
Self-report	21, 23, 24 I, 26 B/G, 27 I, 28, 33 G, 37	9		22 II, 24 II III, 27 II, 39 I II, 40 B/G, 41 I-XXXV, 42 B/G, 43 B/G, 44 B/G, 45, 46 B/G, 47, 48, 49, 50, 51 B/G, 52, 53 B/G, 54 B/G, 55 B/G, 56, 57, 58, 59 B/G, 60, 61	72

Parent report	20, 22 I, 25, 30, 32, 34, 35 I II, 38 I II	10			
Interviewer administered	29 B/G, 31 B/G, 36	5			
Measure of sedentary behavior					
Questionnaire	20, 21, 22 I, 23, 24 I, 25, 26 B/G, 27 I, 28, 29 B/G, 30, 32, 34, 35 I II, 36, 37, 38 I II	21		22 II, 24 II III, 27 II, 39 I II, 40 B/G, 41 I-XXXV, 42 B/G, 43 B/G, 44 B/G, 45, 46 B/G, 47, 48, 49, 50, 51 B/G, 52, 53 B/G, 54 B/G, 55 B/G, 56, 57, 58, 60, 61	70
24-hour recall	31 B/G, 33 G	3		59 B/G	2
Dietary behavior assessed					
Fruit	22 I, 30, 34	3		22 II, 39 I II, 40 B/G, 41 I-XXXV, 42 B/G, 44 B/G, 45, 48, 59 B/G	48
Vegetables	20, 22 I, 30, 34	4		22 II, 39 I II, 40 B/G, 41 I-XXXV, 44 B/G, 45, 48	44
Fruit and Vegetable (FV)	23, 24 I, 25	3		24 II III, 53 B/G, 54 B/G, 61	7
ED drinks / soft drinks	20, 22 I, 25, 28, 30, 34, 37	7		22 II, 39 I II, 40 B/G, 41 I-XXXV, 42 B/G, 48, 49, 51 B/G, 52, 57, 58	49
Light soft drinks	34	1			
Fruit juice	22 I, 25	2		22 II	1
Milk	22 I, 25	2		22 II	1
ED snacks	20, 22 I, 25, 27 I, 28, 30, 34, 38 I II	9		22 II, 27 II, 39 I II, 40 B/G, 41 I-XXXV, 48, 49, 51 B/G, 55 B/G,	47
% fat from ED snacks	38 I II	2			
% energy from ED foods	33 G	1			
Fast food	25, 22 I, 28, 30, 35 I II	6		22 II, 39 I II, 46 B/G, 48, 51 B/G	8
Fried foods	28	1		39 I II, 40 B/G	4
Red meat	25	1			
Total energy intake	20, 25, 26 B/G, 28, 29 B/G, 31 B/G, 32, 36	11		39 I II, 40 B/G, 54 B/G, 59 B/G, 60	9
Total fat				40 B/G, 42 B/G, 49, 59 B/G, 60	8
Total carbohydrate				59 B/G, 60	3

Total protein				59 B/G, 60	3
% energy from fat	25, 32	2		39 I II, 40 B/G, 54 B/G, 59 B/G, 60, 61	10
% carbohydrate	25, 32	2		52	1
% protein	25	1		52	1
% saturated fat	25, 32	2		39 I II	2
% trans fat	25	1		39 I II	2
% monosaturated	32	1			
% polysaturated fat	32	1			
Fiber	25	1		49, 54 B/G, 59 B/G, 61	6
Calcium	25	1		43 B/G	2
Vitamin C				59 B/G, 60	3
Calcium rich foods				39 I II	2
Junk food (sum of ED food and drinks)	21, 27 I, 33 G	3		27 II, 56	2
Whole grains				39 I II	2
Bread	34	1			
Healthy diet				47	1
Western dietary pattern				47	1
Frequency of breakfast				50	1
Assessment of dietary behavior					
Self-report	21, 23, 24 I, 26 B/G, 27 I, 28, 31 B/G, 33 G, 37	11		22 II, 24 II III, 27 II, 39 I II, 40 B/G, 41 I-XXXV, 42 B/G, 43 B/G, 44 B/G, 45, 46 B/G, 47, 48, 49, 50, 51 B/G, 52, 53 B/G, 54 B/G, 55 B/G, 56, 57, 58, 59 B/G, 60, 61	72
Parent report	20, 22 I, 25, 30, 34, 32, 36, 35 I II	9			
Self and Parent report	38 I II	2			
Home interview	29 B/G	2			

Measure of dietary behavior					
Food Frequency Questionnaire (FFQ)	20, 22 I, 23, 24 I, 25, 26 B/G, 28, 30, 31 B/G, 33 G, 34, 36	14		22 II, 24 II III, 39 I II, 40 B/G, 41 I-XXXV, 42 B/G, 43 B/G, 44 B/G, 45, 46 B/G, 47, 51 B/G, 56, 60	56
Other questionnaire	27 I, 29, 35 I II, 37	5		27 II, 48, 49, 50, 52, 53 B/G, 55 B/G, 57, 58	11
24-hour recall	29 B/G, 32, 38 I II	5		54 B/G, 61	3
Weighed food records	32	1		59 B/G	2
Country					
United States (US)	23, 24 I, 25, 26 B/G, 27 I, 28, 29 B/G, 31 B/G, 33 G, 35 I II, 36, 37, 38 I II	18		24 II III, 27 II, 39 I II, 40 B/G, 41, 43 B/G, 44 B/G, 46 B/G, 49, 53 B/G, 54 B/G, 58, 61	21
England				41, 50, 60	3
Australia	20, 21, 30	3		47, 48, 51 B/G	4
New Zealand	22 I	1		22 II	1
Canada				41	1
The Netherlands	34	1		40, 41, 52, 55 B/G, 57	6
Greece	32	1		41	1
Belgium				45	1
Spain				41, 59 B/G	3
Israel				41	1
Denmark				41	1
Finland				41	1
Greenland				41	1
Norway				41	1
Sweden				41	1
Croatia				41	1
Czech Republic				41	1
Estonia				41	1
Hungary				41	1
Latvia				41	1

Lithuania				41	1
Macedonia				41	1
Poland				41	1
Russia				41	1
Slovenia				41	1
Ukraine				41	1
Italy				41	1
Malta				41	1
Portugal				41	1
Austria				41	1
Belgium – Flemish				41, 42 B/G	3
Belgium – French				41	1
France				41	1
Germany				41	1
Ireland				41	1
Scotland				41	1
Switzerland				41	1
Wales				41	1

G, girls only; B, boys only; B/G, boys and girls analyzed separately. I/II, two independent samples.

[1]Longitudinal study but only baseline cross-sectional data used in this review; [2]Intervention studies, analyses for control group only used for this review; [3]Studies from the larger Planet Health study; [4]Studies from the larger Project EAT study; [5]Studies from the larger HBSC study.

For reference 24: I= children in grades 4-5, II = adolescents in grades 6=8, III = adolescents in grades 9-12; for reference 38: I = children from overweight families, II = children from non-overweight families; for reference 35: I = children aged 2-3.9 years, II = children aged 4-5.9 years; for reference 22: I = children aged 5-10 years, II = adolescents aged 11-14 years; for reference 27: I = children in grade4, II = adolescents in

grade 8; for reference 39: I = younger cohort (mean age 12.8 years), II = older cohort (mean age 15.9 years); for reference 41: HBSC study examining associations between TV viewing and diet in 35 countries (each Country is an independent sample I-XXXV).

Reference numbers: see Reference list.

Table 2. Characteristics of adult studies included in the review.

Comment [BL2]: This table is very diffficult to read, please revise.

	Adults (>18 years)	
	References	**No. of samples**
Sample size		14
<100	67 G	1
100-199	66 I	1
200-299	70	1
300-499	66 II	1
500-999	63 G, 66 III, 69	3
1000-2999	64	1
3000-4999		0
>5000	11 G, 62, 65 B, 65 G, 68 B, 71	6
Gender		
Girls only	11, 63, 67	3
Boys only	68	1
Boys and girls combined	62, 64, 69, 70, 71	5
Boys and girls separately	65, 66 I II III	5
Study design		
Cross sectional	62, 63 G, 66 I II III, 65 B/G, 67 G, 69, 71	10
Longitudinal	11[1], 64, 68[1]	3
Retrospective	70	1
Sedentary behavior assessed		
TV viewing	11 G, 63 G, 65 B/G, 66 I II III, 67 G, 68 B, 69, 70, 71	12

Screen time (TV + video + DVD)	62	1
Computer use	65 B/G	2
Total inactivity mins/day	64	1
Assessment of sedentary behavior		
Self-report	11 G, 62, 63 G, 64, 65 B/G, 66 I II III, 67 G, 68 B, 69, 70, 71	14
Measure of sedentary behavior		
Questionnaire	11 G, 62, 63 G, 65 B/G, 66 I II III, 67 G, 68 B, 69, 70, 71	13
IPAQ	64	1
Dietary behavior assessed		
Fruit	11 G, 64, 68 B	3
Vegetables	11 G, 64, 68 B	3
Fruit and Vegetable (FV)	65 B/G	2
ED drinks / soft drinks	62, 71	2
ED snacks	11 G, 62, 68 B, 69	4
Healthy snacks	69	1
Sweets/deserts	68 B	1
Fast food	11 G, 63 G, 68 B	3
Total energy intake	11 G, 62, 66 I II III, 67 G, 68 B	7
Total fat	11 G, 62, 67 G, 68 B	4
Total carbohydrate	62	1
Total protein	62	1
% fat	62, 66 I II III	4
% carbohydrate	62	1
% protein	62	1
% saturated fat	62	1
Fiber	11 G, 62, 68 B	3
Red meat	11 G, 64, 68 B	3
Fish	11 G, 64, 68 B	3
‘Healthy dietary pattern’	70	1
‘Unhealthy dietary pattern’	70	1

Grain mixtures	11 G, 62, 64, 68 B	4
Assessment of dietary behavior		
Self-report	11 G, 63 G, 64, 65 B/G, 66 I II III, 67 G, 68 B, 69, 70, 71	13
Interviewer administered	62	1
Measure of dietary behavior		
Food Frequency Questionnaire (FFQ)	11 G, 64, 66 I II III, 67 G, 68 B, 69, 70	9
Other questionnaire	63 G, 65 B/G, 71	4
24-hour recall	62	1
Country		
United States (US)	11 G, 62, 63 G, 66 I II III, 67 G, 68 B, 70, 71	10
Canada	65 B/G, 69	3
Greece	64	1

G, girls only; B, boys only; B/G, boys and girls analyzed separately. I/II, two independent samples.

For reference 66: I = men, II = low income women, III = high income women.

Reference numbers: see Reference list.

Table 3. Associations between sedentary behavior and diet in children (<12 years)

	No. of samples	**Summary**		
Dietary behavior		**'Positive association (+)'**	**'Inverse association (-)'**	**'No association (0)'**
		n samples [references]	**n samples** [references]	**n samples** [references]
Fruit	3	**n=0**	**n=3** [22 I, 30, 34]	**n=0**
Vegetables	4	**n=0**	**n=3** [20, 22, 34 I]	**n=1** [30]
FV (composite measure of fruit and vegetables)	3	**n=0**	**n=3** [23[I], 24[S] I, 25]	**n=0**
Energy dense snacks	10	**n=11*** [20 (savory snacks), 22 I (crisps, biscuits), 25, 27 I, 28 (baked sweet snacks, candy, salty snacks), 30 (savory snacks), 34, 38 I]	**n=0**	**n=4*** [20 (sweet snacks), 22 I (chocolate), 30 (sweet snacks), 38 II]
Fast foods	6	**n=7*** [22 I (hamburgers, French fries, fried chicken), 25, 28, 35[S] I, 35[S] II]	**n=0**	**n=1*** [30]
Energy dense drinks	7	**n=7** [20, 22 I, 25, 28, 30, 34, 37]	**n=0**	**n=0**
Total energy intake	11	**n=8** [23, 25, 26[I] B/G, 28, 29 G, 32, 36]	**n=0**	**n=3** [29 B, 31[S] B/G]
Percentage energy from fat	2	**n=2** [25, 32]	**n=0**	**n=0**

G, girls only; B, boys only; B/G, boys and girls analyzed separately. [l] = longitudinal study. [§]=all associations with dietary behaviors are for TV viewing unless otherwise stated. [s] = screen time (sum of TV viewing, video/DVD, computer use).

For reference 22: I = children aged 5-10 years; for reference 24: I= children in grades 4-5; for reference 35: I = children aged 2-3.9 years, II = children aged 4-5.9 years; for reference 38: I = children from overweight families, II = children from non-overweight families.

References numbers: see Reference list.

*If in one study, sedentary behavior is examined in relation to two types of energy-dense snack (e.g. crisps and chocolate) and the results differ for the dietary outcomes (e.g. a positive (+) association was found for crisps and no (0) association was found for chocolate), the study is counted once in the ‘No. of samples’ column, and twice in the ‘Summary’ column.

Table 4. Associations between sedentary behavior and diet in adolescents (12-18 years)

	No. of samples	**Summary**		
Dietary behavior		**'Positive association (+)'**	**'Inverse association (-)'**	**'No association (0)'**
		n samples [references]	**n samples** [references]	**n samples** [references]
Fruit	48	**n=0**	**n=30** [39[l, s] I, 39[l, s] II, 40 [s] B/G, 41 [s] I-II, 41 [s] IV-V, 41 [s] VII, 41 [s] X, 41 [s] XX-XXI, 41 [s] XXIII-XXIV, 41 [s] XXVI-XXXI, XXXIII-XXXV, 42 B/G, 44[l] B/G, 45, 48, 59 G]	**n=18** [22 II, 41 [s] III, 41 [s] VI, 41 [s] VIII-IX, 41 [s] XI-IXX, 41 [s] XXII, 41 [s] XXV, 41 [s] XXXII, 59 B]
Vegetables	44	**n=0**	**n=26** [39[l, s] II, 40 [s] B/G, 41 [s] l-II, 41 [s] IV-V, 41 [s] VII, 41 [s] X, 41 [s] XIV, 41 [s] XVIII, 41 [s] XXI, 41 [s] XXIII, 41 [s] XXVI—XXXV, 44[l] B/G, 45]	**n=18** [22 II, 39[l, s] I, 41 [s] III, 41 [s] VI, 41 [s] VIII-IX, 41 [s] Xl-XIII, 41 [s] XV-XVII, 41 [s] XIX-XX, 41 [s] XXII, 41 [s] XXIV-XXV, 48]
FV (composite measure of fruit and vegetables)	7	**n=0**	**n=5** [24[s] III, 53 B/G, 54[l, d] G, 61[d]]	**n=2** [24[s] II, 54[l, d] B]
Energy dense snacks	47	**n=42*** [22 II (chocolate), 27 II, 39[l, s] II, 40 [s] B/G, 41 [s] I-V, 41 [s] VII-XXXV, 48, 55[s] B/G]	**n=0**	**n=9*** [22 II (crisps, biscuits), 39[l, s] I, 41 [s] VI, 49, 51 B/G (sweet snacks, savory snacks)]
Fast foods	8	**n=5*** [22 II (hamburgers, French fries), 39[l, s] II, 46[l] G, 48]	**n=0**	**n=5*** [22 II (fried chicken), 39[l, s] I, 46[l] B, 51 B/G]
Fried foods	4	**n=3** [39[l, s] II, 40 [s] B/G]	**n=0**	**n=1** [39[l, s] I]
Energy dense drinks	49	**n=44** [22 II, 39[l, s] I, 39[l, s] II, 40 [s] B/G, 41 [s] I-V, 41 [s] VII-XXXV, 42 B, 48, 52[s], 57, 58]	**n=0**	**n=5** [41 [s] VI, 42 G, 49, 51 B/G]
Total energy intake	9	**n=3** [39[l, s] II, 40 [s] B/G]	**n=0**	**n=6** [39[l, s] I, 54[l, d] B/G, 59 B/G, 60 [s]]

Percentage energy from fat	10	**n=5** [39[l, s] II, 40 [s] B/G, 60 [s], 61[d]]	**n=0**	**n=5** [39[l, s] I, 54[l, d] B/G 59 B/G]
Total fat (grams)	8	**n=3** [40 [s] B/G, 42 G]	**n=0**	**n=5** [42 B, 49, 59 B/G, 60 [s]]
Fibre	6	**n=0**	**n=3** [54[l, d] G, 59 G, 61[d]]	**n=3** [49, 54[l, d] B, 59 B]

G, girls only; B, boys only; B/G, boys and girls analyzed separately. [l] = longitudinal study. [§]=all associations with dietary behaviors are for TV viewing unless otherwise stated. [s] = screen time (sum of TV viewing, video/DVD, computer use); [d]=sedentary time (sum of TV viewing, video/DVD, sitting while talking/homework/reading).

For reference 22: II = adolescents aged 11-14 years; for reference 24: II = adolescents in grades 6=8, III = adolescents in grades 9-12; for reference 39: I = younger cohort (mean age 12.8 years), II = older cohort (mean age 15.9 years); for reference 41: HBSC study examining associations between TV viewing and diet in 35 countries. Each Country is an independent sample: I = Canada, II = USA, III = Israel, IV = Denmark, V = Finland, VI = Greenland, VII = Norway, VIII = Sweden, IX = Croatia, X = Czech Republic, XI = Estonia, XII = Hungary, XIII = Latvia, XIV = Lithuania, XV = Macedonia, XVI = Poland, XVII = Russia, XVIII = Slovenia, XIX = Ukraine, XX = Greece, XXI = Italy, XXII = Malta, XXIII = Portugal, XXIV = Spain, XXV = Austria, XXVI = Belgium – Flemish, XXVII = Belgium – French, XXVIII = England, XXIX = France, XXX = Germany, XXXI = Ireland, XXXII = Netherlands, XXXIII = Scotland, XXXIV = Switzerland, XXXV = Wales.

References: see Reference list.

*If in one study, sedentary behavior is examined in relation to two types of energy-dense snack (e.g. crisps and chocolate) and the results differ for the dietary outcomes (e.g. a positive (+) association was found for crisps and no (0) association was found for chocolate), the study is counted once in the ‘No. of samples’ column, and twice in the ‘Summary’ column.

Table 5. Associations between sedentary behavior and diet in adults (>18 years)

	No. of samples	**Summary**		
Dietary behavior		**'Positive association (+)'**	**'Inverse association (-)'**	**'No association (0)'**
		n samples [references]	**n samples** [references]	**n samples** [references]
Fruit	3	**n=0**	**n=3** [11 G, 64[l], 68 B]	**n=0**
Vegetables	3	**n=0**	**n=3** [11 G, 64[l], 68 B]	**n=0**
FV (composite measure of fruit and vegetables)	2	**n=0**	**n=2** [65 B/G]	**n=0**
Energy dense snacks	4	**n=4** [11 G, 62[s], 68 B, 69]	**n=0**	**n=0**
Fast foods	3	**n=3** [11 G, 63 G, 68 B]	**n=0**	**n=0**
Energy dense drinks	2	**n=2** [62[s], 71]	**n=0**	**n=0**
Total energy	7	**n=5** [11 G, 62[s], 66 II, 66 III, 68 B]	**n=0**	**n=2** [66 I, 67 G]
Percentage energy from fat	4	**n=1** [66 II]	**n=0**	**n=3** [62[s], 66 I, 66 III]
Total fat (grams)	4	**n=3** [11 G, 62[s], 68 B]	**n=0**	**n=1** [67 G]
Fibre	3	**n=0**	**n=3** [11 G, 62[s], 68 B]	**n=0**

G, girls only; B, boys only; B/G, boys and girls analyzed separately. [l] = longitudinal study. [§]=all associations with dietary behaviors are for TV viewing unless otherwise stated. [s]= screen time (sum of TV viewing, video/DVD, reading and computer use).

For reference 66: I = men, II = low income women, III = high income women.

References numbers: see Reference list.