

Family- and school-based correlates of energy balance-related behaviours in 10–12-year-old children: a systematic review within the ENERGY (European Energy balance Research to prevent excessive weight Gain among Youth) project

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Abstract

Objective: To identify family- and school-based correlates of specific energy balance-related behaviours (physical activity, sedentary behaviour, breakfast consumption, soft drink consumption) among 10–12-year-olds, using the EnRG framework (Environmental Research framework for weight Gain prevention).

Design: A literature review to identify observational studies exploring at least one family- or school-based correlate of the specific behaviours, resulting in seventy-six articles.

Setting: Eighteen studies were conducted in Europe, forty-one studies in North America and seventeen studies in Australasia.

Subjects: Healthy children aged 10–12 years.

Results: Parental and maternal physical activity, doing physical activities with parents and parental logistic support were identified as the most important, positive correlates of physical activity. Parental rules was the most important correlate of sedentary behaviour and was inversely related to it. School socio-economic status was positively related to physical activity and inversely related to sedentary behaviour. The available studies suggested a positive relationship between soft drink availability at home and consumption. Soft drink availability and consumption at school were the most important school-based correlates of soft drink consumption. A permissive parenting style was related to more soft drink consumption and less breakfast consumption.

Conclusions: An important role has been awarded to parents, suggesting parents should be involved in obesity prevention programmes. Despite the opportunities a school can offer, little research has been done to identify school-environmental correlates of energy balance-related behaviours in this age group. Obesity prevention programmes can focus on the most important correlates to maximize the effectiveness of the programme. Future research should aim at longitudinal studies.

Keywords

Obesity
Energy balance-related behaviours
Correlates
Children

Overweight and obesity are highly prevalent among children and are associated with several childhood and further life-course physical and psychological problems^(1,2). Subsequently, there is an urgent need to develop effective obesity prevention strategies for children.

Overweight and obesity are caused by a lasting positive energy imbalance⁽³⁾. Because energy intake and expenditure mainly result from specific dietary and physical activity (PA) behaviours, a first step in the development of an obesity prevention programme is to identify these behaviours associated with unnecessary weight gain. The next essential step

is to identify the behavioural correlates of these specific energy balance-related behaviours (EBRB) that can be targeted in intervention programmes^(4–6). The 'European Energy balance Research to prevent excessive weight Gain among Youth' (ENERGY) project aims to develop a theory- and evidence-based intervention programme to prevent unnecessary weight gain among children⁽⁷⁾. One of the objectives of the ENERGY project is therefore to identify the most important correlates of EBRB via a systematic review.

A number of reviews have summarized the available evidence regarding correlates of EBRB in children and

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adolescents^(8–16). These reviews have focused on a wide age range, mostly capturing 6–18-year-olds. However, children in the transition from childhood to adolescence gain more autonomy and decision-making power regarding PA and dietary behaviours⁽¹⁷⁾, making this a critical period for changes in health behaviour^(18,19). Studies show that in this age group children start receiving pocket money that they may use for food purchases, for example, and they have more meals without parental presence⁽¹⁷⁾. Additionally, these children prepare for or will go from primary school to secondary school: a different school environment characterized by a higher likelihood of presence of vending machines and school shops, and with different food and PA policies^(20,21). Finally, a steep increase in the prevalence of overweight and obesity is observed in this age group⁽²²⁾. Because of the specificity of the age group, it is important to gain more insight into the potential drivers of relevant EBRB among 10–12-year-olds. This enables researchers to target the correlates of EBRB specifically for 10–12-year-olds when developing an obesity prevention programme for this age group. Despite the gradually growing independence regarding dietary and PA behaviour choices in this age group, the family environment is still most likely to be of major importance in influencing children's EBRB through a variety of mechanisms such as parental modelling behaviour, encouragement and practices^(17,23). Parents determine both the physical and social environment of their children⁽¹⁷⁾, suggesting effective obesity prevention programmes must consider the family as an intervention target⁽²⁴⁾. Also the school plays a significant role, since schools have the capacity to offer various opportunities to practise healthy dietary behaviours and to engage in PA^(25,26). Moreover, the majority of children (including lower social classes) can be easily accessed through schools and children spend a significant amount of their time in schools. A better understanding of the family- and school-based correlates of PA and dietary behaviours in children will add to better informed obesity prevention programmes. Finally, previous reviews have focused mainly on one or two specific EBRB, but EBRB and their correlates should be studied within an energy balance approach; that is, focusing on energy input as well as output⁽⁶⁾. The present review therefore investigates correlates of several EBRB to focus on both energy intake and expenditure. The EBRB in the current review are PA, sedentary behaviour, breakfast and soft drink consumption. Previous studies and reviews have provided evidence that PA and breakfast consumption are related to overweight and obesity in children^(27–29). For sedentary behaviour and soft drink consumption, the evidence is inconsistent^(30–33) and further research is needed to reveal the mechanism between these behaviours and obesity. However, a review conducted as part of the ENERGY project showed that most evidence for an association with overweight and obesity in 10–12-year-old

children was found for these four EBRB⁽³⁴⁾. Therefore, the present review focuses on correlates of PA, sedentary behaviour, breakfast and soft drink consumption.

A theoretical approach is needed to get insight into the complexity of correlates that are related to EBRB⁽³⁵⁾. Kremers *et al.*⁽³⁶⁾ have proposed the Environmental Research framework for weight Gain prevention (EnRG framework), which integrates potential personal psychological correlates, referred to as 'cognitive' factors in the model, with environmental factors (adopted from the ANalysis Grid for Environments Linked to Obesity (ANGELO) framework) and identifies important moderators, including personal and behavioural factors, to gain insight into the processes that underlie EBRB. Environmental factors can have a direct impact on EBRB or can be mediated by the personal psychological factors. In the ENERGY project, the EnRG framework is adopted with a specific focus on the family and school environment⁽⁷⁾. The specific focus on family and school is important, as the ENERGY project aims to develop a family-involving, school-based intervention to prevent overweight.

In brief, the objective of the present systematic review was to identify family- and school-based correlates of PA, sedentary behaviour, breakfast consumption and soft drink consumption in 10–12-year-old children. The EnRG framework was used to inform the ENERGY project on the most important correlates.

Methods

Search strategy

Medline (PubMed), Web of Science, CINAHL and The Cochrane Library electronic databases were searched from 1990 to September 2010. The search strategy described population, study design, context, predictor variables and outcome behaviour. Only English-language published articles were located. The full search strategy is described in online Appendix A.

Inclusion criteria

To be included, studies had to meet all of the following inclusion criteria: (i) studies were limited to samples comprising healthy 10–12-year-old children (mean age: 9·5–12·5 years); (ii) only observational studies were included, whereas dissertations and studies investigating interventions or with a quasi-experimental design were excluded (with the exception of studies reporting on baseline data from intervention studies); and (iii) studies had to examine at least one family- or school-based correlate of PA, sedentary behaviour, breakfast or soft drink consumption.

Selection process

A first selection was made by screening titles and abstracts by the first author using the aforementioned

inclusion criteria. After screening the full text of those articles, a final selection of articles to be included was made. Additionally, reference lists of the retrieved articles and review articles were checked for additional relevant papers.

Data extraction

Relevant data on author, date, study design, sample size, participants' age, study context, outcome measures, instruments and the examined correlates from the included studies were extracted into detailed summary tables. Information on the studies' characteristics were summarized (see Results).

Categorization of variables

The categorization of the correlates was based on the EnRG framework which includes three main groups: environment, personal psychological mediators and moderators⁽³⁶⁾. Since we specifically focused on family- and school-based correlates only environmental factors were included, divided into family- and school-environmental factors. For a further classification of the variables, the 'types' of environments according to the ANGELO framework – i.e. one of the key inputs for EnRG – was used⁽³⁷⁾. Table 1 provides an overview of all category definitions. The EnRG framework, adopted for the ENERGY project, is described elsewhere⁽⁷⁾. Data were summarized into four tables which give an overview of all family- and school-environmental correlates for PA, sedentary behaviour, breakfast and soft drink consumption, respectively (Tables 3–6). Longitudinal studies were highlighted in bold. Previous studies have solely included correlates examined in at least three studies. Because of the limited amount of studies examining correlates of the four EBRB in 10–12-year-olds, all studied correlates were taken into consideration. This enabled us to identify all variables that have already been investigated for this age group and to provide a comprehensive overview of the correlates by means of a table. Finally, it must be taken into account that one article can investigate a correlate several times, for example when the article investigated correlates of total PA, moderate PA and vigorous PA separately. In that case, the study number

was listed three times in the table, since the association between the correlate and the EBRB has basically been investigated three times. Conceptually similar variables were combined for consistency of interpretation, resulting again in the possibility of one article listed multiple times for one correlate. All correlates and their range of definitions are described in online Appendices B, C, D and E.

Coding and summarizing associations

The coding of results was similar to previous reviews^(8,9,14,16,38) and is also explained in the footnotes to Tables 3–6, where each studied correlate received a final summary association code: no association, an indeterminate association or a positive or negative association. As a consequence of the diversity of variables, samples, measures and analyses in the retrieved studies, we have focused on the consistency of the association and not on the strength of the association. If analyses were conducted separately for male and female participants, 'M' or 'F' was indicated. If analyses were conducted for different time periods (e.g. follow-up of 1 and 2 years), '1' and '2' were indicated.

Results

Papers retrieved

The search for articles in the four databases resulted in 13 258 articles. Based on titles and abstracts, the full text of 316 potentially relevant articles was retrieved and reviewed. This resulted in a total of sixty-six articles that met all inclusion criteria. Another ten articles were included based on the reference lists of retrieved articles and reviews, which brought the final number to seventy-six articles (Fig. 1).

General characteristics of the studies reviewed

Table 2 gives an overview of the characteristics of the studies reviewed. In brief, the majority of articles were cross-sectional (fifty-seven studies); eighteen studies (24%) were conducted in Europe, forty-one studies (54%) in North America and seventeen studies (22%) in Australasia.

Table 1 Categorization of the variables

Category	Definition
Family environment*	The micro-environmental setting of the home and family environment
School environment*	The micro-environmental setting of the school
Physical environment†	Availability and accessibility of dietary, PA and sedentary behavioural choices
Sociocultural environment†	Factors regarding what is socially appropriate, acceptable or desirable as related to dietary, PA and sedentary behavioural choices
Economic environment†	Factors related to the 'affordability' of dietary, PA and sedentary behavioural choices, i.e. financial opportunities regarding, and the costs of, dietary, PA and sedentary behavioural choices
Political environment†	Rules and regulations regarding dietary, PA and sedentary behavioural choices

PA, physical activity.

*EnRG (Environmental Research framework for weight Gain prevention) framework, adopted for the ENERGY (European Energy balance Research to prevent excessive weight Gain among Youth) project.

†ANGELO (ANalysis Grid for Environments Linked to Obesity) framework.

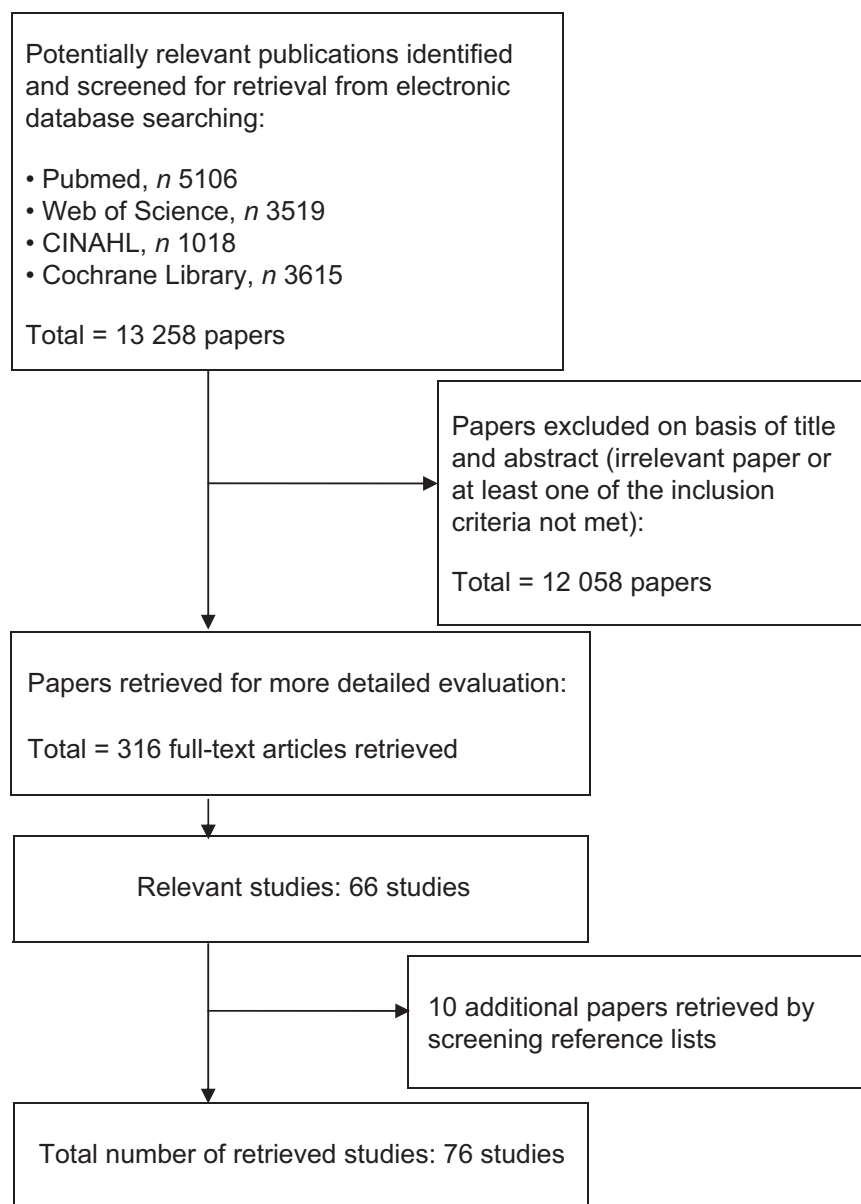


Fig. 1 Flowchart of the study selection process

Sample size ranged from thirty-eight to 16 202. Correlates of PA were studied the most (fifty-five studies).

Correlates of energy balance-related behaviours

Table 3 gives an overview of all correlates found for PA, Table 4 for sedentary behaviour, Table 5 for breakfast consumption and Table 6 for soft drink consumption.

Physical activity behaviour (Table 3)

Family-environmental variables. Thirty-eight family-environmental variables were studied for PA: four physical, twenty-seven sociocultural, four economic and three political environmental variables. Most evidence was found for parental/family PA, maternal PA, doing physical activities with the parents and logistic support. Other positive

associations with PA were found for home equipment/opportunities for sedentary behaviour, sedentary time with parents, parental beliefs towards screen-based behaviours and parental enjoyment of screen-based behaviours. Parental sedentary time, parental enjoyment of PA, parental barriers, parental self-efficacy and parental rules/restriction regarding screen-based behaviours were inversely associated with PA. All other variables showed an indeterminate association or no association with PA.

School-environmental variables. Twelve school-environmental variables were studied: six physical, three sociocultural, one economic and two political environmental variables. Walking to and from school, teacher support and school socio-economic status (SES) were positively associated with PA. Having class problems was inversely

Table 2 General characteristics of the studies reviewed

	Bibliography no.
Sample size	
<100	15, 51, 75
100–199	4, 9, 17, 28, 37, 43, 59, 60, 70
200–299	11, 23, 25, 26, 61, 69
300–499	2, 10, 13, 19, 20, 36, 39, 48, 49, 54
500–999	1, 5, 6, 14, 16, 18, 22, 29, 30, 33, 52, 53, 55, 56, 57, 58, 65
1000–2999	3, 12, 32, 35, 38, 40, 42, 45, 46, 47, 62, 63, 64, 66, 67, 68, 72, 73, 74, 76
3000–4999	7, 31, 41, 44, 71
>5000	8, 21, 24, 27, 34, 50
Study design	
Cross-sectional	1, 5, 6, 7, 8, 9, 10, 16, 19, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, 32, 33, 36, 37, 39, 40, 41, 46, 49, 42, 43, 44, 45, 47, 48, 50, 51, 53, 54, 55, 56, 57, 58, 59, 60, 63, 64, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76
Longitudinal	2 (+3y), 3 (+1y, +2y), 4 (+1y), 11 (+5y), 12 (+20y), 13 (+5y), 14 (+1y), 15 (+2y, +4y), 17 (+3y), 18 (+2y), 20 (+5y), 26 (+3y), 34 (+1y, +8y), 35 (+4y, +7y), 38 (+2y), 52 (+20m), 61 (+1y), 62 (+1y), 65 (+3y)
Country	
Europe	4, 7, 23, 26, 36, 39, 40, 41, 46, 47, 49, 50, 65, 66, 67, 68, 71, 76
North America	3, 5, 6, 8, 15, 16, 17, 18, 20, 21, 22, 25, 27, 28, 29, 30, 31, 34, 35, 37, 38, 42, 43, 44, 45, 48, 51, 52, 54, 55, 56, 59, 60, 61, 62, 69, 70, 72, 73, 74, 75
Australasia	1, 2, 9, 10, 11, 12, 13, 14, 19, 24, 32, 33, 53, 57, 58, 63, 64
Behaviour	
PA	1, 2, 3, 4, 7, 9, 11, 12, 13, 15, 17, 18, 19, 20, 22, 23, 25, 26, 28, 31, 32, 33, 34, 35, 36, 37, 38, 39, 42, 43, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 57, 58, 59, 60, 61, 62, 65, 66, 68, 69, 71, 72, 75, 76
Sedentary behaviour	2, 7, 8, 30, 37, 51, 53, 55, 56, 64, 71, 74, 76
Breakfast consumption	10, 24, 40, 41, 63, 67, 76
Soft drink consumption	5, 6, 14, 16, 21, 27, 29, 44, 67, 70, 73
Gender	
Boys and girls combined	4, 5, 6, 8, 10, 14, 16, 20, 21, 22, 24, 25, 27, 28, 29, 30, 31, 32, 33, 37, 39, 40, 41, 42, 44, 46, 47, 48, 49, 50, 54, 56, 62, 63, 64, 66, 67, 68, 72, 73, 74, 75, 76
Boys and girls reported separately	1, 2, 3, 7, 9, 11, 12, 13, 17, 19, 23, 26, 34, 36, 45, 51, 52, 53, 57, 58, 59, 60, 61, 65, 71
Girls only	15, 18, 35, 38, 43, 55, 69, 70
Date of the study	
Before 2000	3, 7, 12, 14, 15, 17, 21, 23, 25, 26, 27, 29, 34, 35, 36, 37, 38, 39, 45, 48, 52, 54, 59, 60, 61, 65, 72, 74
2000 or after	1, 2, 4, 5, 6, 8, 9, 10, 11, 13, 16, 18, 19, 20, 22, 24, 28, 30, 31, 32, 33, 36, 40, 41, 42, 43, 44, 46, 47, 49, 50, 51, 53, 55, 56, 57, 58, 62, 63, 64, 66, 67, 68, 69, 70, 71, 73, 76
Data collection method	
Child report	3, 5, 6, 7, 8, 10, 14, 16, 17, 19, 21, 23, 24, 25, 26, 27, 29, 30, 31, 33, 34, 35, 38, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 54, 55, 56, 61, 62, 63, 64, 65, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76
Parent report	11, 57, 58
Objective measurement	1, 9, 13, 15, 18, 36, 39, 50, 59, 60, 66
Parent report + child report	4, 22, 32, 37
Child report + objective measurement	2, 12, 20, 28, 51
Parent report + objective measurement	53
Parent report + child report + objective measurement	52
Reliability/validity of child and parent reports	
Unknown/Not reported/Poor	8, 16, 21, 22, 26, 29, 37, 42, 46, 47, 56, 63, 64, 73, 76
Acceptable	2, 3, 4, 5, 6, 7, 10, 11, 12, 14, 17, 19, 20, 23, 24, 25, 27, 28, 30, 31, 32, 33, 34, 35, 38, 40, 41, 43, 44, 45, 48, 49, 51, 52, 53, 54, 55, 57, 58, 61, 62, 65, 67, 68, 69, 70, 71, 72, 74, 75
Theoretical framework*	
Social Cognitive Theory ⁽³⁹⁾	16, 18, 20, 41, 48, 52, 54, 59, 60, 61, 69, 70
Theory of Reasoned Action ⁽⁴⁰⁾	41, 48, 54, 60
Social Learning Theory ⁽⁴¹⁾	17, 40
Youth PA Promotion Mode ⁽⁴²⁾	19, 72
Family Influence Model ⁽⁴³⁾	43
Social Determinants of Health and Environmental Health Promotion Model ⁽⁴⁴⁾	22
Health Promotion Model ⁽⁴⁵⁾	25
Kohl and Hobbs' model ⁽⁴⁶⁾	7, 31, 37
Socio-ecological models	11, 29, 38, 39, 42, 46, 55, 56, 57, 47 ⁽⁴⁷⁾ 13, 53, 58 ⁽⁴⁸⁾ 30 ⁽⁴⁹⁾
Model of achievement-related choice ⁽⁵⁰⁾	4
Ferraro's model ⁽⁵¹⁾	9

Table 2 Continued

	Bibliography no.
Specific PA behaviours	
Total MPA	2, 2, 22, 43, 60
Total VPA	2, 2, 7, 17, 22, 37, 43, 55, 60
Total MVPA	3, 4, 9, 13, 15, 18, 19, 34, 50, 51, 55, 59, 62, 66
Total PA	2, 2, 12, 20, 22, 25, 33, 36, 39, 42, 45, 50, 51, 53, 65, 68, 69, 72, 75, 76
Leisure-time VPA	61
Leisure-time MVPA	42, 61
Leisure-time PA	12, 22, 23, 26, 28, 31, 32, 35, 37, 38, 48, 49, 52, 54, 71
Leisure-time: time spent outdoors	11
MVPA at school	42
Active transportation to school	2, 22, 46, 47, 57, 58
Number of steps	12, 28
Number of steps at school	1
Number of steps in weekend	1
Sports participation	22, 23, 28, 37
Participation in other organized PA/lessons	22, 31
Specific sedentary behaviours	
TV	2, 37, 51, 56, 64
TV + computer + games	7, 8, 30, 53, 55, 74, 76
TV + computer + games + reading	71
Time spent sedentary	2
Recall period PA and sedentary behaviour	
1 d	8, 25, 32, 33, 48, 51, 52, 54, 55, 61, 75, 76
3 d	17
7 d	3, 4, 7, 19, 20, 22, 30, 31, 43, 45, 62, 64
Past month	49
Past year	34, 35, 37, 71
Usual week (or other time period)	2, 11, 23, 26, 28, 38, 42, 46, 47, 53, 56, 57, 58, 65, 68, 69, 72, 74
No recall (objective measurement)	1, 2, 9, 12, 13, 15, 18, 36, 39, 50, 59, 60, 66
Measurement instrument breakfast/soft drink consumption	
24 h recall	5, 6, 40
7 d recall	21, 63, 73
5 d food record	14
FFQ	27, 67, 70
Other questionnaire	10, 16, 24, 29, 41, 44, 76

PA, physical activity; MPA, moderate physical activity; VPA, vigorous physical activity; MVPA, moderate-to-vigorous physical activity, TV, television; y, year(s); m, months.

*For theoretical frameworks, superscript number in parentheses refers to reference in the reference list.

associated. An inconsistent association with PA was found for participation in school sports (team). The other school environmental variables were not related to PA.

Regarding all studied correlates of PA, one remarkable finding was noticed. The studies that did not find an association between maternal and child PA were North American studies. In contrast, four European studies and one Australian study revealed a positive relationship between maternal and child PA. For all other correlates, no relevant differences were found between European, North American and Australasian results.

Sedentary behaviour (Table 4)

Family-environmental variables. Twenty-eight family-environmental variables were examined: four physical, eighteen sociocultural, five economic and one political environmental variable. Most evidence was found for a negative relationship between parental rules/restriction regarding screen-based behaviours and sedentary behaviour. Living in a two-parent household, parental ethnicity, parental PA preferences, parental knowledge about recom-

mendations and having family dinners were negatively related to sedentary behaviour. A positive association was found for number of televisions (TV) in the household, eating in front of the TV, parental overweight, parental and maternal sedentary time, sedentary time with parents, parental enjoyment of screen-based behaviours, and household income. All other variables showed an indeterminate association or no association with sedentary behaviour.

School-environmental variables. Two school-environmental variables were studied: one physical and one economic environmental variable. School SES was inversely associated with sedentary behaviour. The after-school context was not associated.

Generally, no relevant differences were found between European, North American and Australasian results. One study had a longitudinal design.

Breakfast consumption (Table 5)

Family-environmental variables. Fourteen family-environmental variables were studied: eleven sociocultural, two economic and one political environmental variable.

Table 3 Correlates of physical activity behaviour in 10–12-year-old children: bibliography numbers of studies reporting a positive correlation (+), a negative correlation (–) or no correlation (0) among the studies reviewed

Physical activity	+	–	0	n/N	Assoc. code
Family environment					
Physical					
Home equipment/opportunities for PA	48, 59(F)		11, 59, 60, 61, 61	2/7	00
Home equipment/opportunities for sedentary behaviour	39, 53(M)	53(M)		2/3	+
Access or ownership car		46	57	1/2	?
Having a dog	58(M)		11	1/2	?
Sociocultural					
Two-parent household	71(M)	37	7, 20, 22, 22, 22, 22, 22, 22, 22, 22, 26, 32, 32, 35, 37, 37, 39, 45, 45, 45, 49, 52, 57, 76	1/25	00
Number of family members			45, 45, 45	0/3	0
Biological parents living at home			39, 39	0/2	0
Number of siblings	13(F), 71(F)		32, 32, 57	2/5	?
Birth order			32, 32	0/2	0
Parental ethnicity	26(F), 32, 32		32, 32, 32, 32, 45, 45, 45, 62	3/11	00
Parental overweight		71	39, 39	1/3	0
Parental age			39, 39	0/2	0
Parental/family PA*	13(M), 28, 28, 28, 52(M), 71, 72, 72, 75		20, 28, 28, 28	9/13	++
Maternal PA†	4, 13(M), 38(I), 38(II), 39, 45, 45(F), 46, 59(M), 60(M), 61(F), 71	43, 45	34, 43, 48, 59, 61	12/19	++
Paternal PA‡	13(F), 38(I), 38(II), 39(F), 45, 59(M), 71(F)	45	4, 45, 48, 59, 60, 61, 61	7/15	??
PA with parents	13(F), 31, 38(I), 38(II), 39, 52, 52(M), 55, 55		31	9/10	++
Parental sedentary time		53(M), 53(F)		2/2	–
Sedentary time with parents	53(F)			1/1	+
Parental attitudes/beliefs towards PA	31, 31, 31, 31, 46		31, 31, 34, 34	5/9	??
Parental beliefs towards screen-based behaviours	53(M)			1/1	+
Parental enjoyment of PA		17(F)		1/1	–
Parental enjoyment of screen-based behaviours	53(F)			1/1	+
Parental encouragement for PA	11(F), 45, 45, 46, 52(M), 55, 72	45(F), 45, 45	39, 45, 55	7/13	??
Family modelling	68, 72		15, 25	2/4	?
Family support	18, 19, 31, 31, 31, 54, 61(M), 61(M), 72		20, 25, 26, 31, 31, 31, 48	9/16	??
Family norms	59(M), 59(M)		25, 60	2/4	?
Parental barriers		17(F), 31	31	2/3	–
Parental self-efficacy		17(F)		1/1	–
Logistic support (e.g. paying fees, transporting children)	31, 52(M), 52(M), 72		15, 31	4/6	++
Parental perception of child's competence in PA	4		4	1/2	?
Parental smoking			39	0/1	0
Economic					
Parental education	22, 22, 22, 32, 35(F), 38(I), 38(II), 49, 49, 71	13(M), 22, 50	2, 2, 2, 2, 2, 2, 2, 22, 22, 22, 22, 32, 32, 32, 33, 45, 45, 45, 46, 50, 50, 52, 66	10/35	00
Household income			33, 45, 45, 45	0/4	0
Parental employment status	3(F, I), 26(F), 65(F)		3(II), 32, 32, 32, 32, 45, 45, 45, 51, 57	3/13	00
Socio-economic status			23, 23, 37, 37, 37, 49	0/6	00

Table 3 *Continued*

Physical activity	+	–	0	n/N	Assoc. code
Political					
Parental control/supervision	9(F), 11	9, 9(M)	9, 9, 9	2/7	00
Parental rules/restriction (PA)	9(F), 9(F), 13(F)	9(F)	9, 9, 9	3/7	??
Parental rules/restriction (screen-based behaviours)	53(F)	53(M), 53(F), 53(F)		3/4	--
School environment					
Physical					
Offering school sports	42		42, 42, 42	1/4	0
School team/school sports participation	3(M, I), 3(F, II), 45	45	61, 61	3/6	??
Having a PA-promoting school environment			42, 42, 42, 42	0/4	00
Condition of PA-promoting school environment	42		42, 42, 42	1/4	0
Number of recreational features			42, 42	0/2	0
Walking to and from school	1, 1(F), 1(F)		1	3/4	++
Sociocultural					
Support teacher	26(M), 68			2/2	+
Having class problems		26(F), 26(F), 26(F), 26(F)		4/4	--
PA with friends at school			69	0/1	0
Economic					
School SES	7(F), 36			2/2	+
Political					
Compulsory school PA			12	0/1	0
School PA policy			42, 42, 47	0/3	0

n, number of studies that are related to the behaviour; N, number of studies that have investigated the potential correlate; Assoc. code, association code; (F), association applicable only for girls; (M), association applicable only for boys; longitudinal studies in bold; (I) and (II), analyses conducted for different time periods (e.g. different follow-ups); PA, physical activity; SES, socio-economic status.

Association code: 0 = 0–33% of the findings supporting the association; 00 = ≥4 studies not finding an association; ? = indeterminate finding or 34–59% of the findings supporting the association; ?? = ≥4 studies with indeterminate findings; + = 60–100% of the findings supporting a positive association; ++ = ≥4 studies supporting a positive association; -- = 60–100% of the findings supporting a negative association; -- = ≥4 studies supporting a negative association.

*PA reported by parents: 13, 20, 28, 52, 71, 72, 75; PA reported by child: 3, 55.

†PA reported by parents: 4, 13, 34, 39, 43, 46, 71; PA reported by child: 38, 48, 59, 60, 61.

‡PA reported by parents: 4, 13, 39, 71; PA reported by child: 38, 48, 59, 60, 61.

Table 4 Correlates of sedentary behaviour in 10–12-year-old children: bibliography numbers of studies reporting a positive correlation (+), a negative correlation (–) or no correlation (0) among the studies reviewed

Sedentary behaviour	+	–	0	<i>n/N</i>	Assoc. code
Family environment					
Physical					
Number of TV in the household	51(F), 53, 74			3/3	+
TV in the bedroom	53(F), 74		56, 56	2/4	?
Presence of (cable/pay) TV	8		53	1/2	?
Eating in front of the TV	30			1/1	+
Sociocultural					
Two-parent household		37, 53(F), 71(F)	7, 76	3/5	–
Number of siblings	53	71		1/2	?
Parental ethnicity		8		1/1	–
Parental overweight	71			1/1	+
Parental sedentary time	56, 71		56	2/3	+
Maternal sedentary time	53, 53		71	2/3	+
Paternal sedentary time	53		71	1/2	?
Sedentary time with parents	30, 53(M)			2/2	+
Parental PA behaviour			30	0/1	0
PA with parents		55	30	1/2	?
Parental PA preferences		30		1/1	–
Parental attitude towards screen-based behaviours		30	30, 30, 30	1/4	00
Parental enjoyment of screen-based behaviours	53(F)			1/1	+
Parental knowledge about recommendations		8		1/1	–
Parental/family encouragement for PA			55	0/1	0
Having family dinners		74		1/1	–
Using TV as a reward			53	0/1	0
Parental activity patterns			30	0/1	0
Economic					
Parental education		53, 71	2, 2	2/4	??
Household income		8		1/1	+
Parental employment status			51	0/1	0
Area deprivation			64	0/1	0
Socio-economic status			37	0/1	0
Political					
Parental rules/restriction (screen-based behaviours)	8, 8, 8, 30, 30, 30, 30, 53(M), 53(M), 53(F), 53, 56, 56, 74		8, 30, 30, 30, 30, 30, 30	14/21	– –
School environment					
Physical					
After-school context			56	0/1	0
Economic					
School SES		7		1/1	–

n, number of studies that are related to the behaviour; *N*, number of studies that have investigated the potential correlate; Assoc. code, association code; (F), association applicable only for girls; (M), association applicable only for boys; longitudinal studies in bold; TV, television; PA, physical activity.

Association code: 0 = 0–33% of the findings supporting the association; 00 = ≥4 studies not finding an association; ? = indeterminate finding or 34–59% of the findings supporting the association; ?? = ≥4 studies with indeterminate findings; + = 60–100% of the findings supporting a positive association; – = 60–100% of the findings supporting a negative association; – – = ≥4 studies supporting a negative association.

Table 5 Correlates of breakfast consumption in 10–12-year-old children: bibliography numbers of studies reporting a positive correlation (+), a negative correlation (–) or no correlation (0) among the studies reviewed

Breakfast consumption	+	–	0	n/N	Assoc. code
Family environment					
Sociocultural					
Two-parent household			67, 76	0/2	0
Parental descriptive norms	41			1/1	+
Parental injunctive norms	41			1/1	+
General parenting style			67	0/1	0
Parental permissiveness		67		1/1	–
Parental pressure			67	0/1	0
Parental rewards			67	0/1	0
Parental encouragement through negotiation			67	0/1	0
Parental catering on demands of children		67		1/1	–
Parental avoidance of negative modelling behaviour		67		1/1	–
Parental verbal praise			67	0/1	0
Economic					
Parental employment status			10, 24, 67, 67	0/4	00
Area deprivation		63		1/1	–
Political					
Parental control/supervision	10			1/1	+
School environment					
Sociocultural					
Teacher injunctive norms	41			1/1	+
Economic					
School SES		40		1/1	–

n, number of studies that are related to the behaviour; N, number of studies that have investigated the potential correlate; Assoc. code, association code; SES, socio-economic status.

Association code: 0 = 0–33% of the findings supporting the association; 00 = ≥4 studies not finding an association; + = 60–100% of the findings supporting a positive association; – = 60–100% of the findings supporting a negative association.

Table 6 Correlates of soft drink consumption in 10–12-year-old children: bibliography numbers of studies reporting a positive correlation (+), a negative correlation (–) or no correlation (0) among the studies reviewed

Soft drink consumption	+	–	0	n/N	Assoc. code
Family environment					
Physical					
Availability at home	16, 29, 70			3/3	+
Sociocultural					
Two-parent household			67	0/1	0
Parental consumption	29			1/1	+
General parenting style			67	0/1	0
Permissive parenting practice	67			1/1	+
Parental pressure			67	0/1	0
Parental rewards			67	0/1	0
Parental encouragement through negotiation			67	0/1	0
Parental catering on demands of children			67	0/1	0
Parental avoidance of negative modelling behaviour			67	0/1	0
Parental verbal praise			67	0/1	0
Having family dinners		27		1/1	–
Economic					
Household income		21		1/1	–
Parental employment status		67, 67		2/2	–
Political					
Parental limits		44		1/1	–
School environment					
Physical					
Availability at school	21, 69			2/2	+
Access to snack bars/competitive foods at school		14	6	1/2	?
Healthful school lunches			6	0/1	0
Sociocultural					
Promotion of healthful eating at school			6	0/1	0
Participation in healthy school lunch		5		1/1	–
Soft drink consumption at school	44, 73		16	2/3	+
Economic					
School type			21	0/1	0

n, number of studies that are related to the behaviour; N, number of studies that have investigated the potential correlate; Assoc. code, association code; longitudinal studies in bold.

Association code: 0 = 0–33% of the findings supporting the association; ? = indeterminate finding or 34–59% of the findings supporting the association; + = 60–100% of the findings supporting a positive association; – = 60%–100% of the findings supporting a negative association.

Parental descriptive norms, parental injunctive norms and parental control/supervision were positively related to breakfast consumption. Parental permissiveness, parental catering on demands of children, parental avoidance of negative modelling behaviour and area deprivation were inversely associated. All other variables were not associated with breakfast consumption.

School-environmental variables. Two school-environmental variables were investigated: one sociocultural and one economic environmental variable. Teacher injunctive norms was positively related and school SES was negatively related to breakfast consumption.

Generally, no studies on correlates of breakfast consumption in 10–12-year-olds have yet been conducted in North America. All studies had a cross-sectional design.

Soft drink consumption (Table 6)

Family-environmental variables. Fifteen family-environmental variables were studied: one physical, eleven sociocultural, two economic and one political environmental variable. Availability of soft drinks at home, parental soft drink consumption and permissive parenting style were positively related to soft drink consumption. Having family dinners, household income, parental employment status and parental limits were inversely related. The other variables were not associated with soft drink consumption.

School-environmental variables. Seven school-environmental variables were investigated: three physical, three sociocultural and one economic environmental variable. Availability of soft drinks at school and soft drink consumption at school were positively associated with general soft drink consumption. Participation in healthy school lunches was inversely associated. The other variables showed an indeterminate association or no association with soft drink consumption.

Due to the low number of studies investigating correlates of soft drink consumption in this age group, no relevant comparisons could be made between European, North American and Australasian results.

Discussion

The objective of the present review was to identify family- and school-based correlates of PA, sedentary behaviour, breakfast consumption and soft drink consumption in 10–12-year-olds. To our knowledge, no review has ever investigated correlates of PA, sedentary and dietary behaviour together. The majority of the studies investigated correlates of PA behaviour, resulting in most evidence found for variables related to PA, but also in more inconsistencies between the study results. Those inconsistent results could possibly be due to methodological issues, such as the use of different instruments (child *v.* parent report, objective *v.* self-report), differences in validity and reliability of the measurements, differences in

the specific sub-behaviours of PA, etc. For sedentary behaviour and especially for breakfast and soft drink consumption, few studies were available; many correlates have hardly been studied or not at all. Our study results further showed that most studies have investigated sociocultural family-environmental variables. One of the most important contributions is the specific evidence found for 10–12-year-old children. The review enables us to say with confidence that the correlates found are specifically related to EBRB of 10–12-year-olds. In previous reviews^(8–16), a much broader age range was used, but it is clear that correlates related to health behaviour of a 6-year-old will not be similar to the correlates influencing health behaviour of a 16-year-old, for example⁽⁵²⁾. The influence of parental behaviours varies with age⁽²³⁾ and the school environment goes through significant changes in the course of the school years of a child^(20,21).

Physical activity

The most consistent evidence was found for an association of children's PA with parental/family PA, doing PA together with the parents and parental logistic support. Regarding parental PA, our results revealed that the association between mothers' and children's PA is more consistent than for fathers', suggesting mothers may be more influential for PA behaviour in this age group. There was no relevant difference by gender in the association between maternal and child PA, while the significant positive associations found between paternal and child PA mostly occurred in girls. The specific reasons why the influence of maternal and paternal PA might differ between boys and girls should be further examined. Additionally, our review demonstrated that doing physical activities together with the child is even more important, since nine out of ten studies confirmed the positive association with the child's PA level. This correlate might be less important in an older adolescent population: in a recent review⁽⁵³⁾, parental involvement (i.e. parents doing PA with their child) was only associated with overall PA and leisure-time PA in children, not in adolescents. This emphasizes the importance of studying correlates separately for different age groups. Apart from being active role models for their children's physically active lifestyle^(54,55), parents providing logistic support might influence children's PA as well. In brief, parents play an indispensable role in PA promotion among 10–12-year-old children.

Although twelve school-environmental variables were examined, results did not yield a better understanding of the association between the school environment and children's PA behaviour. For example, having class problems was inversely related to PA, but this was only based upon one study, so cannot be considered to provide strong evidence.

Sedentary behaviour

Most evidence was found for an inverse association between parental rules/restriction related to screen-based

behaviours and children's actual sedentary behaviour. Encouraging parents to set rules and restrictions related to screen-based behaviours (e.g. TV or computer use) is therefore suggested as a possible strategy to reduce 10–12-year-olds' sedentary time^(56,57). Parents might consequently create limits and monitor their children's sedentary behaviour⁽⁵⁷⁾. Considering TV and computer use, children are recommended to spend no more than 2h/d on watching TV and using the computer or a game console⁽⁵⁸⁾. Moreover, the positive association between the number of TV in the household and sedentary behaviour indicates the significant role of the home environment in influencing children's sedentary time. Given that parents have control over the acquisition of TV and computers, this offers possibilities to modify the home environment with parental assistance⁽⁵⁷⁾. Furthermore, parents can be regarded as role models for sedentary behaviour, since sedentary time of the parents was positively associated with children's sedentary behaviour. Moreover, parents spending more sedentary time together with their children was related to more sedentary behaviour among children. The latter two correlates were also related to children's PA level. This accounts for parental enjoyment of screen-based behaviours and school SES as well. So despite the fact that sedentary behaviour and PA are two separate EBRB with each their own specific correlates^(9,59), some correlates were significantly related to both behaviours. These correlates are therefore considered as very important, since they are associated with two EBRB.

Breakfast consumption

Little research has been done in the field of correlates of breakfast consumption among 10–12-year-olds. Despite the limited evidence, parental descriptive and injunctive norms seemed to influence breakfast consumption in a positive way. It shows again evidence for parents as positive role models for their children. Three specific parenting practices were associated with breakfast consumption as well: parental permissiveness, parental catering on demands of the children and parental avoidance of negative modelling behaviour. Moreover, not only parents have an influence on their children's breakfast consumption, but teachers could play a role as well considering the positive relationship between teacher injunctive norms and breakfast consumption. Consequently, schools could possibly be involved in an intervention to promote breakfast consumption among children. Nevertheless, no study has ever investigated other school-environmental correlates of breakfast consumption in this age group, possibly due to the fact that breakfast is an event preferably occurring at home.

Soft drink consumption

Comparable to breakfast consumption, not many studies have already examined family- and school-environmental correlates of soft drink consumption in 10–12-year-olds,

but the few studies found revealed that soft drink availability at home was positively associated with soft drink consumption in three studies. As parents are primary gatekeepers of purchases at home⁽¹⁰⁾, parents could restrict soft drink availability and have a major impact upon children's soft drink consumption. Also, if soft drinks are available at home, parents might set up limits concerning soft drink consumption, since parental limits were related to soft drink consumption. Targeting these factors in an intervention programme could lead to less soft drink consumption among children. Regarding the specific parenting practices, only parental permissiveness was related to more soft drink consumption in one study and already related to less breakfast consumption as well. Parents are therefore advised to adopt a more authoritative parenting style to promote healthy behaviour among children⁽¹⁰⁾. Similar to the other EBRB, parental behaviour was once again positively related to the child's behaviour, although this was investigated by only one study.

The most important school-environmental correlates of soft drink consumption were soft drink availability and consumption at school. This strongly shows that schools can play a central role in an intervention to decrease soft drink consumption. Prohibiting soft drinks at school at that age would engender the decrease in general soft drink consumption.

Limitations

The first limitation lies within the nature of literature reviews of behavioural correlates. Identifying correlates of EBRB through a review can and should inform obesity prevention programmes to contribute to better chances of effectiveness. However, the actual mechanism is a complex web and it should be kept in mind that the present review only revealed associations between single variables and a general outcome measure (covering several specific sub-behaviours), without taking possible moderators and covariates into account. A second limitation is the possibility that not all existing studies on this topic were covered. Some articles might not be found in our databases searched or through our search strategy. The use of only English published data contributes to this limitation too. Conducting subsequent searches on specific correlates that were already identified by the first search strategy could have yielded more studies on this topic. Third, we have focused on the consistency of the association and not on the strength of the association found in primary studies. Further, conceptually similar variables were combined into a single category, even if variables were measured in a different way. Also for the behaviours, we did not differentiate between specific physical and sedentary activities, although correlates can vary depending on the specific activity⁽⁵³⁾. Finally, most studies had a cross-sectional design through which only association could be established and not prediction or causation. Longitudinal and cross-sectional results were

compared with each other, but no real differences were found between the results, which could be due to the low number of longitudinal studies. Future longitudinal research is needed to gain more insight into the correlates of EBRB.

Conclusions

The current review presents an overview of the studied family- and school-environmental variables. Obesity prevention programmes for this specific age group can focus on the most important modifiable correlates to change children's behaviour. Besides modifiable correlates, the review also identified non-modifiable correlates such as school SES. Such insights can help to identify specific groups 'at risk' that can be considered as important target groups for health promotion interventions. Overall, the review provides evidence for the important role that has been awarded to parents, since parental behaviour was related to children's behaviour for all four EBRB. Parents can consequently be considered as key players in the prevention of weight gain among children⁽¹⁷⁾. Interventions could help parents to create a supportive environment for their children to promote healthy behaviour⁽⁶⁰⁾.

Despite all the opportunities a school can offer in health promotion, little research has been done in the field of school-based correlates of EBRB. More research is needed to focus on important school-environmental factors when developing an intervention programme.

Further, this review did not reveal relevant differences between European, North American and Australasian results. However, the number of studies in each region was often too small to make meaningful comparisons. In case of sufficient studies per region no clear differences were observed. Still little research has been executed in Europe on correlates of EBRB in 10–12-year-olds. If future studies do not contradict this finding, it can be concluded that when developing an obesity prevention programme for European schools as the ENERGY project aims to do, one can rely on non-European studies about correlates of EBRB despite the different obesity context in other continents⁽⁶¹⁾.

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