doi: 10.1111/j.1467-789X.2010.00784.x

Obesity Prevention

Environmental correlates of physical activity and dietary behaviours among young people: a systematic review of reviews

E. de Vet[1], D. T. D. de Ridder[1] and J. B. F. de Wit[2,3]

Departments of [1]Clinical and Health Psychology and [3]Social and Organizational Psychology, Utrecht University, The Netherlands; [2]National Centre in HIV Social Research, University of New South Wales, Sydney, New South Wales, Australia

Received 5 March 2010; revised 13 May 2010; accepted 25 May 2010

Address for correspondence: E de Vet, Clinical and Health Psychology, Utrecht University, P.O. Box 80140, 3508 TC Utrecht, The Netherlands. E-mail: e.devet@uu.nl

Summary

An extensive body of research exists on environmental influences on weight-related behaviours in young people. Existing reviews aimed to synthesize this body of work, but generally focused on specific samples, behaviours or environmental influences and integration of findings is lacking. Hereto, we reviewed 18 reviews representing 671 unique studies, aiming to identify what environmental factors do and do not affect physical activity and dietary behaviours in children and adolescents. Eleven reviews focused exclusively on physical activity, six on diet, and one review focused on both physical activity and dietary behaviours with only small overlap in included studies. Physical activity was more consistently related to school and neighbourhood characteristics than to interpersonal and societal environments. In contrast, interpersonal factors played a pronounced role in dietary behaviours; no school, neighbourhood or societal factors were consistently related to dietary behaviours. This review of reviews adds to the literature by providing a comprehensive synthesis of factors related to physical activity and dietary behaviours that could be targeted in interventions. Moreover, by identifying factors that are unrelated to physical activity and dietary behaviours, this review may help to narrow the scope of future studies and environmental interventions.

Keywords: Youth, diet, physical activity, environment.

obesity reviews (2011) **12**, e130–e142

Introduction

Overweight and obesity are serious public health challenges and prevalence rates have tripled since the 1980s (1). Increases in rates of overweight and obesity have been particularly alarming in children and adolescents; annual increases in prevalence rates today are tenfold those of the 1970s (1). Currently, about one-third of European youth is overweight (2). Childhood overweight is an important predictor of adult overweight; over 60% of children who are overweight before puberty will be overweight in early adulthood (3). Childhood overweight has important consequences for morbidity, disability and quality of life in adulthood. Furthermore, childhood overweight is associated with risk factors for cardiovascular diseases and diabetes, orthopaedic problems and mental disorders during childhood, and may lead to school underachievement and lower self-esteem (4).

Overweight is the result of a long-term energy imbalance characterized by energy intake (through diet) exceeding energy expenditure (mainly from physical activity). As such, physical activity and dietary behaviours are the main determinants of overweight. Unfavourable longitudinal and secular trends have been observed in dietary and physical activity behaviours among youth. Whereas fruit and vegetable intake declines with age (5), fast food intake increases through adolescence (6). Additionally, the amount and frequency of consumption of snacks and fast

food has increased in the past decade (6,7). Similarly concerning trends have been reported for physical activity, which declines with age during youth and from youth to adulthood (8,9). Although physical activity and sedentary pastime do not appear to have changed dramatically across generations, physical activity levels are generally low, whereas much time is spent in sedentary activities (10–13).

Changes in physical activity and dietary behaviours among youth are commonly ascribed to environmental features that encourage excess energy intake and discourage energy expenditure. The energy imbalance that promotes overweight is fuelled by an unsupportive environment, with ever increasing portion sizes, high availability of energy-dense and high-palatable foods and lower accessibility of healthy alternatives (14). The sum of influences outside the individual that surroundings, opportunities or conditions of life have on promoting obesity in individuals and populations has been referred to as the obesogenic environment (15).

A multitude of environmental features (i.e. all factors outside the individual) may play a role in weight and weight-related behaviours. Various theories and frameworks have been proposed to conceptualize this multitude of environmental influences. Social Ecological Theory (16) and Ecological Systems Theory (17) are general models of environmental influences on behaviour, whereas the Analysis Grid for Environments Linked to Obesity (ANGELO) framework (15), the Environmental Research framework for weight Gain prevention (EnRG) framework (18) and the contextual model of childhood overweight (19) specifically describe environmental factors that influence overweight and obesity. These different models have in common that they distinguish interpersonal (e.g. peers and family), organizational (e.g. schools), community (e.g. neighbourhood) and societal influences (e.g. food price and marketing) on behaviours. Moreover, influences at these different levels may interact, thereby enhancing or diminishing each level's separate effects on weight-related behaviours and weight status.

In recent years, the number of studies exploring the impact of environmental factors on physical activity and dietary behaviours, including in children and adolescents, has grown rapidly. Despite the large number of individual studies on environmental factors linked to obesity, it remains to be established whether some environmental factors are more important than others or whether the influences of some environments are better understood than those of others (20). In particular, it remains unknown whether some factors are consistently related to diet or physical activity, but also whether some factors are consistently unrelated to physical activity and dietary behaviours. In addition to understanding which environmental factors are *related* to diet or physical activity, it is also important to understand which factors are *unrelated*, as this will help to narrow the scope of future environmental factors that need to be addressed in research and environmental interventions. Moreover, despite the growing body of research on environmental influences on overweight, a comprehensive, systematic integration of findings is lacking. Several reviews have been conducted to date but each of these adopted their own specific approach, with a focus on particular types of environmental influences, on particular types of outcomes or on specific samples. An integration of findings regarding the wide range of environmental correlates of weight-related behaviours among youth is lacking. We aimed to fill this important gap by conducting a systematic review of reviews to integrate findings on environmental correlates that do and do not influence physical activity or dietary behaviours that will contribute to a comprehensive synthesis of research and help to identify fruitful avenues for future investigation.

The focus is specifically on environmental correlates of physical activity and dietary behaviours among youth. Because children and adolescents have less autonomy in their behavioural choices, exploring environmental influences might be specifically relevant for youth (21,22). Moreover, youth might be more often exposed to particular types of environmental influences, such as influences in the school setting or peer influences. As this might also vary across age groups, potential differences in environmental influences for children and for adolescents will be explored.

Methods

Identification of relevant studies

The literature was searched to identify relevant reviews, including systematic reviews as well as meta-analyses. Three electronic databases were searched to identify reviews of environmental correlates of weight-related behaviours and outcomes (EMBASE, Pubmed, Psychinfo) published until June 2009. Broad and more specific search terms were used that related to weight-related behaviours (physical activity, exercise, diet, nutrition, eating, food), weight (overweight, obesity), the social environment (socio-cultural, socioeconomic, cultural, social) and the physical environment (built environment, urban environment, school environment). Criteria for inclusion of papers were that they (i) reported a systematic review or meta-analysis; (ii) reported on studies performed in humans younger than 18 years and (iii) were published in English. Reviews of intervention studies were excluded, as were reviews that did not describe the search strategy or inclusion/exclusion criteria. Also excluded were reviews that focused exclusively on studies of infants, toddlers or pre-schoolers, and studies that did not separately present results for young people and adults. Identified papers were first screened for inclusion based on the title, followed by a

screening of the abstract, and then the full text. The reference lists of included papers were screened for further relevant studies. Any duplicate papers were removed.

Data extraction

Data were separately extracted for reviews of physical activity and dietary behaviours. From each individual review, the following information was obtained: objectives, number of included studies, inclusion and exclusion criteria, environmental correlates, outcome measures and findings. To be consistent with previous reviews, findings were analysed separately for environmental factors at the interpersonal, organizational (school), community (neighbourhood) and macro or societal levels. To review the reviews, a two-step approach was used. First, findings regarding environmental correlates were extracted from each included review separately. The methods for analysing the data varied across reviews. To make sure that findings are interpreted in a similar way across reviews, we re-analysed all individual reviews in the same way. We adopted the approach that was used most often in the included reviews (e.g. (23,24)). Findings for each environmental correlate were coded to indicate a positive, negative or no association, when the correlate was included in at least three studies and results were in the same direction in at least 60% of the studies. When the correlate was included in at least three studies, but results were not consistent in 60% of the studies, the coding indicated mixed results. Second, comparable correlates (e.g. different operationalizations of the same factor) were grouped together under the heading of broader environmental factors. To further integrate findings across reviews, environmental factors for which a majority of the individual reviews reported findings that were in the same direction were labelled as having a positive, negative or no association with weight-related behaviours of young people. Else, findings for environmental factors were labelled as mixed.

Age was explored as a moderator of the association between environmental factors and physical activity or dietary behaviours. If individual reviews allowed, findings were summarized separately for children (aged <12 years) and adolescents (age >12 years).

Quality rating

The included reviews were rated for methodological quality based on eight criteria (i) inclusion of an explicit and clear statement regarding the search strategy that was employed; (ii) comprehensiveness of the search strategy, with at least two databases searched, as well as the reference lists of examined papers; (iii) clarity of the description of inclusion and exclusion criteria; (iv) inclusion of a clear description of the design and the number of studies that were included; (v) report of a quality assessment; (vi) the quality assessment included ratings of at least two of the following aspects: study design, sampling, outcome measures and follow-up assessment; (vii) integration of the findings beyond describing or listing primary studies and (viii) involvement of more than one author in the data abstraction and research synthesis process. Individual reviews were awarded one point for each of the criteria, resulting in a quality score that could range from 0 to 8. Reviews with quality scores ranging from 0 to 4 were labelled as weak. Reviews were labelled as strong if their quality score was between 5 and 8. These quality criteria are similar to those used in previous systematic reviews of reviews (25,26), and were based on the Quality Assessment Tool for Reviews (27) and the Centre for Reviews and Dissemination criteria for quality assessment of reviews (28).

Results

Identification of reviews

The literature search initially identified 816 titles (Pubmed 773, Psychinfo 27, Medline 16). The screening of titles and abstracts of papers identified in the different databases resulted in a selection of 132 publications. Four duplicates were removed, leaving 128 publications for full-text review. Sixteen reviews met the inclusion criteria. Two additional reviews were identified in the reference lists. Main reasons for exclusion were that reviews described the relation between weight-related behaviours and weight without explicitly considering environmental correlates, or that they reflected narrative reviews that did not report any search strategy.

Of the 18 reviews that were included, 11 focused exclusively on physical activity, six on diet, and one review focused on both physical activity and dietary behaviours. In Table S1, the number of included studies, inclusion and exclusion criteria, outcome measures, environmental correlates and findings are described for each review of physical activity. Table S2 provides similar information for each of the reviews of dietary behaviours.

Description of reviews of physical activity in young people

A total of 12 reviews were identified that addressed environmental correlates of physical activity. Seven of these 12 reviews (21,23,29–33) received a quality rating of five or higher and were rated as strong (See Table 1). The number of studies included in the separate reviews ranged from 13 to 150 (Table 1). Together the reviews included 656 studies. The reviews represented 439 unique studies after correcting for studies that are included in more than one review.

Table 1 Quality assessment of reviews of environmental correlates of physical activity in young people

Quality assessment criteria	Was there a clearly defined search strategy?	Was the search strategy comprehensive?*	Are inclusion/exclusion criteria clearly stated?	Are the designs and number of included studies clearly stated?	Has the quality of primary studies been assessed?	Did the quality assessment include study design, study sample, outcome measures or follow-up (at least 2 of 4)	Does the review integrate findings beyond describing or listing findings of primary studies?	Has more than one author been involved in the data abstraction process?	Sum quality score	No. of included studies
Davison *et al.*, 2008 (35)	+	+	+	–	–	–	–	–	3 (weak)	20
Davison & Lawson, 2006 (29)	+	+	+	+	–	–	+	+	6 (strong)	33
Ferreira *et al.*, 2006 (21)	+	+	+	+	–	–	+	+	6 (strong)	150
Gorely *et al.*, 2004 (30)	+	+	+	+	–	–	+	–	5 (strong)	68
Gustafson & Rhodes, 2006 (31)	+	+	+	+	+	–	–	–	5 (strong)	34
Hanson & Chen, 2007 (32)	+	–	+	+	+	+	+	–	6 (strong)	34
Van der Horst *et al.*, 2007 (33)	+	–	+	+	–	–	+	+	5 (strong)	57
Limstrand, 2008 (36)	–	+	+	+	–	–	+	–	4 (weak)	43
Pugliese & Tinsley, 2007 (34)	+	+	+	–	–	–	+	–	4 (weak)	31
Ridgers *et al.*, 2006 (37)	+	–	+	+	–	–	–	–	3 (weak)	13
Sallis *et al.*, 2000 (23)	+	–	+	+	+	–	+	–	5 (strong)	108
Tomkinson & Olds, 2007 (38)	+	+	+	–	–	–	+	–	4 (weak)	65

*A search is rated as comprehensive if at least two databases and the reference lists of examined papers were searched.

Seven reviews focused on general physical activity as the primary outcome measure (21,23,29,31–34). One review additionally addressed correlates of sedentary behaviour (33). Five reviews focused on specific types of physical (in)activity, such as active commuting (35), TV/Video viewing (30), use of sports facilities (36), physical activity during school play time (37) or fitness test performance (38). Differences were also found in the type of correlates that were reviewed. Six reviews made no a priori selection of the type of environmental correlates (21,23,30,33,35,36), whereas six other reviews focused on specific types of environments, such as the physical environment (29), parental influences (31,34), socioeconomic status (SES) (32), school play time (37) or geographic variables (38). The reviews included young people of varying age, but in most reviews sample age was between 2 and 19 years (21,23,30,31,33–36,38). An age range of 10–21 years old was defined by Hanson and Chen (32), and Ridgers *et al*. (37) reported on young people aged 4–12 years.

Systematic review of environmental correlates of physical activity in young people

The findings of the reviews of physical activity are summarized in Table 2. First, environmental correlates for which consistently positive or negative associations were found are described followed by correlates that were consistently unrelated to physical activity.

Interpersonal level

None of the environmental correlates at the interpersonal were consistently positively or negatively related to physical activity. Modelling of friends and siblings, family size and home opportunities for physical activity (e.g. home equipment) were unrelated to physical activity across reviews.

School level

At the school level, teacher SES was positively related to physical activity, although only one review included teacher SES as a correlate. None of the school factors were negatively associated with physical activity across reviews. School support was unrelated to physical activity.

Neighbourhood level

Neighbourhood appearance, availability of exercise facilities and general accessibility (i.e. having easy access and short distances to common destinations) were positively related to physical activity across reviews. None of the neighbourhood factors were negatively related to physical activity. Across reviews, characteristics of neighbourhood residents, traffic safety and personal safety were unrelated to physical activity.

Societal or macro level

Exercise culture was positively related to physical activity, but only one review included this correlate. No macro or societal factors were negatively related to physical activity. Exposure to sports media was unrelated to physical activity in two reviews.

Summary of consistent findings for physical activity in young people based on strong reviews only

Below are consistent positive and negative correlates of dietary behaviours reported, as well as correlates that are consistently unrelated to dietary behaviours in young people. Only reviews rated as strong quality are included in this analysis.

Positive

Teacher SES, specific school types (i.e. public schools, higher level schools), school facilities for physical activity, neighbourhood facilities for physical activity and traffic safety were positively related to physical activity.

Negative

No factors were negatively related to physical activity.

Unrelated

Modelling of friends and siblings, support of parents, family size and home opportunities for physical activity, school support, characteristics of neighbourhood residents, personal safety and exposure to sports media were unrelated to physical activity.

Differences between children and adolescents

Six of the 12 reviews enable exploring the moderating role of age with respect to environmental influences on physical activity, but only for three types of environmental influences on physical activity (i.e. parental SES, parental modelling and parental support). For parental SES, all three reviews that compared findings on the relation between SES and physical activity in children and adolescents concluded that parental SES might be more relevant for adolescents than for children (21,32,33). Three reviews examined the moderating role of age of the relation between parental physical activity and young people's physical activity. In general, these reviews indicate that parental activity appears to be more important in childhood than in adolescence (21,32,33).

Three reviews examined the moderating role of age of the relation between parental supportive behaviours and physical activity in young people, but the results were inconclusive (23,31,34).

Table 2 Overview of findings from reviews of environmental correlates of physical activity in young people

Factor	Operationalization	+	0	–	?
Interpersonal					
SES	Family SES	*8*	7a, 3a		5,6, 3c
	Parental occupational status		*9*,3c,3a	*1*	3c,a,4
	parental education	4,7a,3a	3c,a, 7c		3c
	Family income	3a			
Family size	Single parent household		3c,a,7c	4	
	Number of household members		3c,a		
Modelling parents	Parents'/mother's physical activity	*9,1,8*	3c,a,7a,11a		5,7c,11c,3c,a
	Number of active parents	5			
	Parents' instrumental behaviours	*9*,11a	11c		
	Parents' TV viewing habits			4	
Modelling others	Sibling physical activity	11a	3a		
	Friends' physical activity		3c,a,11a		
	Peer influence		11c		
Parental support	Parenting styles		3c,a		
	Parental encouragement	*9*	3c,11c		3a
	Parental support	5,7c,*8*	3c,*9*,11a		3a
Support of others	Friends' support	7a,*8*	3a		11a
	Support of significant others	11a			3a
Social norms	Social norms		3c		3a
Home facilities	Family car ownership		*1*,3c		*8*
	Family dog ownership		3a		
	Home equipment for activity	*8*	2,3c,3a,7c,7a,11a		
	TV set in bedroom			4	
School					
School type	Public vs. private	3c	3a		*1*
	High school vs. vocational/alternative	3a			
School location	Large distance to school			*1,2*	
	Low population density			*1*	
	Large school enrolment		2	*1*	
	School urbanization level		*8*		
School facilities	Instruction on sport/health benefits		3a		
	School physical education programmes/school sports	7a	3a,*12*		
	Equipment school play areas	*2*			
	Time allowed for free play/field trips	3c,*10*			
School support	Teacher support		11a		3a
	School support		3a		
	Coach support/modelling		11a		
	Problems with classmates/teasing				3a
	Teacher physical activity		3a,11a		
Teacher SES	Teachers educational level	3c			
Neighbourhood					
SES	Neighbourhood SES				3c
	% upper occupational status		3a		
	% dwellings provided by employer		3a		
	% owner occupied housing				3a
	% unemployment among residents				3a
	Length of unemployment			3a	
Residents' characteristics	Involvement in community physical activity organizations		3c		
	% married couples		3a		
	% youth		3a		
	Presence of neighbourhood exercisers		3a		
Infrastructure	Road and sidewalk infrastructure	*1,2,8*	3c		
	Ease to cycle	*8*			
	Presence of bike lanes				2
	System of streets with multiple routes and connections				2
	Limited public transport				3c

Table 2 *Continued*

Factor	Operationalization	+	0	–	?
Accessibility	Access to destinations (e.g. shops)	2, *8*			
	Short distance	*8*			
	Proximity of playgrounds and parks	*8*			2
Facilities	Opportunities to exercise	11a			
	Availability recreational facilities	2,*8*,11c	3c,a		
Traffic safety	Low traffic density	*2*			
	Perceived traffic safety		*1*		
	Safe roads		*8*		
Personal safety	Neighbourhood hazards		3c		
	Concerns for crime		*1*		
	Perceived safety	*8*	2,3c,a, 11c		
	Low crime incidence	3a			
	Area deprivation and crime			2	
	Dogs unattended		3a		
Appearance	Condition	*8*			
	Number of trees/green space		*8*		
	Area type/features/improvements	*8*			
	Aesthetics	*8*			
Macro/societal					
Climate	Unsuitable weather		*1,2*	*8*	3a
	Month of the year (average temperature)			2,*12*	
	Latitude	*12*			
	Season		*8*		3c,a,11c
	Climate				*8*
	Sun exposure			*8*	
Location	Rural residence		3a	*1*	2,3c,4,11c
	Population density				2
	Urban vs. suburban				3c,a,*8*
	Region within country		*8*		
Culture	National exercise psyche	*12*			
Media	Exposure to sports media		3a,11a		

Numbers in italics are reviews that were rated as weak.
Numbers correspond to individual reviews: 1 = Davison *et al.*, 2008 (35); 2 = Davison & Lawson, 2006 (29); 3 = Ferreira *et al.*, 2006 (21); 4 = Gorely *et al.*, 2004 (30); 5 = Gustafson & Rhodes, 2006 (31); 6 = Hanson & Chen, 2007 (32); 7 = Van der Horst *et al.*, 2007 (33); 8 = Limstrand, 2008 (36); 9 = Pugliese & Tinsley, 2007 (34); 10 = Ridgers *et al.*, 2006 (37); 11 = Sallis *et al.*, 2000 (23); 12 = Tomkinson & Olds, 2007 (38).
+, positive association; 0, no association; –, negative association; ?, mixed results.
a, adolescents; c, children; SES, socioeconomic status.

Description of reviews of dietary behaviours in young people

Seven reviews were identified that addressed environmental correlates of dietary behaviour (24,32,39–43). Five of these reviews (24,32,40,41,43) received a quality rating of five or higher and were rated as strong (see Table 3). The number of studies included in the separate reviews ranged from 7 to 99 (Table 3). All reviews combined included 298 studies. The reviews represented 232 unique studies after correcting for studies that are included in more than one review.

Three reviews focused on healthy eating in general (32,42,43), whereas two other reviews specifically focused on fruit and vegetable consumption (39,41). One review focused on breakfast consumption (40). One review included fruit and vegetable consumption, fat intake, snacking and fast food, and soft drink intake (24). Differences also existed in the types of environmental correlates that were included in the review. Three reviews included environmental correlates at the interpersonal, school, neighbourhood and societal level (24,39,42). A further three reviews focused on family influences (40,41,43) and one review focused on SES (32). One review focused on children aged 6–12 (39), one focused on adolescents aged 13–19 (43) and one on the broader age group of 10–21 (32).

Systematic review of environmental correlates of dietary behaviours

The findings of the reviews of dietary behaviours are summarized in Table 4. Findings are reported in the same way as the findings for physical activity.

Table 3 Quality assessment of reviews of environmental correlates of dietary behaviours in young people

Quality assessment criteria	Was there a clearly defined search strategy?	Was the search strategy comprehensive?*	Are inclusion/exclusion criteria clearly stated?	Are the designs and number of included studies clearly stated?	Has the quality of primary studies been assessed?	Did the quality assessment include study design, study sample, outcome measures or follow-up (at least two of four)	Does the review integrate findings beyond describing or listing findings of primary studies?	Has more than one author been involved in the data abstraction process?	Sum quality score	No. of included studies
Blanchette & Brug, 2005 (39)	+	–	+	–	–	–	–	+	3 (weak)	20
Hanson & Chen, 2007 (32)	+	–	+	+	+	+	+	–	6 (strong)	30
Van der Horst *et al.*, 2007 (24)	+	+	+	+	–	–	+	+	6 (strong)	58
Pearson *et al.*, 2009 (40)	+	+	+	+	–	–	+	+	6 (strong)	24
Pearson *et al.*, 2008 (41)	+	+	+	+	+	+	+	–	7 (strong)	60
Taylor *et al.*, 2005 (42)	+	+	–	–	–	–	–	–	2 (weak)	99
Woodruff & Hanning, 2008 (43)	+	+	–	+	+	+	–	–	5 (strong)	7

*A search is rated as comprehensive if at least two databases and the reference lists of examined papers were searched.

Interpersonal level

Family cohesion (i.e. emotional bonding between family members), modelling and parental monitoring were positively associated with dietary behaviours across reviews, although the latter was only examined in one review. None of the interpersonal factors were negatively related to dietary behaviours. Family SES, family composition and family meal habits were unrelated to diet across reviews.

School level

No school-level factors yielded consistent findings.

Neighbourhood level

No neighbourhood-level factors showed consistent findings.

Societal or macro level

None of the macro-level factors were positively associated with dietary behaviours. Exposure to food advertising on TV was negatively related to healthy diets across reviews, as well as food price although the latter was examined in only one review.

Summary of consistent findings of for dietary behaviours in young people, based on strong reviews only

Below are consistent findings on correlates of dietary behaviours reported, based on reviews rated as strong quality only.

Positive

Family cohesion, modelling and parental monitoring were positively associated with dietary behaviours.

Negative

None of the factors was consistently negatively related to dietary behaviours.

Unrelated

SES, family composition and family meal habits were unrelated to dietary behaviours.

Differences between children and adolescents

Differences between children and adolescents in environmental influences on healthy eating could only be explored in three of the seven reviews (24,32,41). However, no clear differences emerged in environmental influences between children and adolescents.

Table 4 Overview of findings from reviews of environmental correlates of dietary behaviours in young people

Factor	Operationalization	+	0	–	?
Interpersonal					
SES	Family income		4,5cfv,5av,3afa,3afvj,3asn,3ce,3cfa,3csn		5af
	General SES	2,*6*	5cfv,5av,3afa, 3asn,3csn		4,5af,3afvj
	Parental/household education	3afvj,	4,5cfv,3ae,3afa,3cfvj	3cfa	5afv, 3asn, 3ce
	Socioeconomic deprivation		3cfvj	4	
	Parental occupational status	5af	4,5av		
	Hours worked by mother		5c,3cfvj		3csn
Family composition	Family size		5afv,3afa,3ce,3cfa		
	Two parent family	4	5fv,5av		
	Male head of household				3afa
	Residence with family				5af
	Single-mother family		3afa		3ae
Family cohesion	Family connectedness/cohesion	3afvj,4,5afv			
Modelling	Parental eating behaviour	*1*,3cfvj,3a,4,5cf,5afv, 7,3ae,3afa,3csn, 3cfvj,3cfa	5cv,3ce,		
	Sibling intake	3ae,3af,4			
Peer influence	Peer influences				*1*
General parenting	Parental monitoring	4			
Food-related parenting	Control over intake	3cfa	3cfvj,3ce	3c,*6*	
	Encouragement of intake	3c,5cfv	3cfvj	3ce	
	Child-feeding practices (authoritative, supportive)	*1*,3afvj,			
	Family food rules	5cfv,7	5af		4
	Pressure to eat		5cfv		3cfvj
	Restriction of food choice		5cfv	7	
	Family facilitation of intake				5cfv
Availability	Home availability of food, vegetables and juice	*1*,5c,*6*	5afv	3afvj	3cfvj
	Availability and accessibility breakfast items				4
	Accessibility of food and vegetables	3cfvj	5c		
	Availability of unhealthy foods		5af		
	Availability of healthy foods	7			5af
	Food poverty			4	
Family meal habits	Frequency of family breakfast	5cf,3cfvj	5afv,3afvj	3cso	5cv,3csn
	Frequency of family diner		5cfv,5af,3aso,3afvj,3cfvj,3csn		3cso
	Frequency of family meals	5af,6,7	5av,3afvj		3aso
	TV during meals		5c		
School					
Meal location	Meals at home vs. school		3asn		
	Lunch at other site than home or school			3asn	
Neighbourhood					
SES	Area deprivation index				3csn
Macro/societal					
Region	Non-metropolitan residence				3ce,fa,
	Geographic region				3ae,sn,
	Degree of urbanization		3afa,		
	City vs. county	3afvj	3aso		
Price	Food price			*6*	
Media	Exposure to food advertising on TV			*1*,*6*,7	

Numbers in italics are reviews that were rated as weak.
Numbers correspond to individual reviews : 1 = Blanchette & Brug, 2005 (39); 2 = Hanson & Chen, 2007 (32); 3 = Van der Horst *et al.*, 2007 (24); 4 = Pearson *et al.*, 2009 (40); 5 = Pearson *et al.*, 2008 (41) ; 6 = Taylor *et al.*, 2005 (42); 7 = Woodruff & Hanning, 2008 (43).
+, positive association; 0, no association; –, negative association; ?, mixed results.
a, adolescents; c, children; e, total energy intake; f, fruit; fa, fat inake; j, juice; SES, socioeconomic status; sn, snacking; so, soft drink intake; v, vegetable.

Discussion

The present review integrated findings from 18 published systematic reviews and meta-analyses that together synthesized findings from 671 unique studies regarding potential environmental influences on physical activity or dietary behaviours in children and adolescents. Despite the heterogeneity in measures, samples, specific behaviours or countries in the extensive body of research, the present review of reviews identified factors that are consistently related or unrelated to physical activity and dietary behaviours in young people. The consistency of results irrespective of heterogeneity suggests that these associations are more robust.

Physical activity in young people was found to be positively influenced by teacher SES, specific school types (e.g. more activity in public and high schools than private or vocational schools), facilities at school as well as in the neighbourhood for physical activity and traffic safety in the neighbourhood. Physical activity in young people was unrelated to modelling of friends and siblings, support of parents for physical activity, family size, home opportunities for physical activity, school support for physical activity, characteristics of neighbourhood residents, personal safety (e.g. neighbourhood hazards, concerns about crime) and exposure to sports media. Together these findings suggest that, physical activity is more consistently influenced by characteristics of the school and community environment than by features of the interpersonal environment. A likely explanation is that many physical activities occur outside the home environment (e.g. active transport, playing outdoors and sports classes in schools), thereby reducing the influence of the home environment. When schools and neighbourhoods facilitate physical activity, family and peer influences might not have additional effects. It might also well be that parents select specific schools and neighbourhoods to live in, so that family might have a more indirect relation with physical activity. Despite extensive research on the interpersonal environment, it appears to have no direct influence on physical activity. The school and neighbourhood environments may provide more promising avenues for future research and interventions.

In contrast to physical activity, factors at the interpersonal level play a pronounced role in young people's dietary behaviours, whereas none of the correlates at school, neighbourhood or societal levels are consistently related to dietary behaviours. Family cohesion, modelling and parental monitoring positively influence young people's dietary behaviours, but family SES, family composition and family meal habits were unrelated to dietary behaviours. These findings might indicate that healthy diets go hand in hand with having a positive family atmosphere, in which parents give the right example, have a good understanding of their children's lives and in which parents and children feel emotionally connected. Such a positive context might be more important than actual family composition, affluence or meal habits, which all are unrelated to dietary behaviours.

Generally, little is currently known of the role that macro-environmental factors (e.g. media, industry, marketing, policy) play in physical activity and dietary behaviours in young people. Studies on macro-level influences are largely lacking, whereas precisely these factors have the potential to impact on populations at large (20). An interesting exception is a cross-national study that found correlations between country-specific obesity prevalence rates and macro-environmental factors in the economic, physical and policy domain in 24 European countries (44). Given that this cross-national comparison focused on adults only, a similar approach might provide insight into macro-environmental influences on overweight in young people.

As noted before, only few factors were found to be consistently related or unrelated to physical activity and dietary behaviours in young people despite the extensive body of research. This illustrates that mapping these environmental influences is a complex affair, which at least in part could be attributed to methodological and theoretical challenges (45–47). A first challenge is on deciding how to measure specific environmental correlates. Assessments of environmental correlates may, for instance, reflect key statistics, data from geographical information systems or perceived environmental characteristics as rated by the target group (e.g. young people or their parents). The choice of assessment method has been shown to influence the associations between a specific correlate and weight-related behaviours (47–49). Also in the present review of reviews, we observed some different results according to the type of indicator that was used (see for instance Table 2). Notably, a negative association was found between crime incidence as derived from statistics and physical activity, whereas young people's concerns about crime appeared unrelated to physical activity. The distinction between objective and perceived indicators of aspects of the environment has important practical implications as perceptions about the environment are more amenable to change than the actual environment is.

A second complexity in documenting environmental influences on physical activity and dietary behaviours among youth pertains to the lack of understanding of causal mechanisms. The growing body of research regarding environmental correlates of weight-related behaviours largely consists of cross-sectional studies that aim to identify empirical associations, but these studies generally do not contribute to the conceptual understanding of causal mechanisms. Consequently, it remains unclear exactly *how* and *why* environmental factors exert their influence on weight-related behaviours. It is remarkable that within the

abundance of studies of environmental influences on overweight, clear, conceptually sound hypotheses of the underlying process by which environmental factors impact on behaviour are lacking. Theoretical models are required that conceptualize the mechanisms that can link (combinations of) environmental factors to specific behaviours (50). Moreover, more insight is needed whether these mechanisms are similar across age, gender, ethnic background or SES. Not only does it need to be disentangled *how* and *why* environmental factors contribute to physical activity and dietary behaviours, but also *for whom* these processes are more or less likely. This might help to identify target groups for environmental interventions. In line with this point, it should be acknowledged that environmental factors do not influence physical activity or dietary behaviours in isolation. In the present review, we focused on whether or not specific environmental variables are directly associated with behaviour. However, it is very likely that individual and environmental influences interact and synergistically affect behaviours (51). Future research should explore how patterns of different internal and external factors exert their influence on behaviours.

Limitations

In the present paper, a systematic review of reviews is presented. Some limitations that are inherent in this procedure should be acknowledged. First of all, the findings do not refer to individual studies, but to aggregated findings across studies included in individual reviews. Methodological variation in individual studies may exist, that remain obscured in the present review. Systematic review of reviews generally cover a large number of individual articles ($n = 671$ in the present review of reviews). This makes it unfeasible to extract additional information about sample sizes, country of research or other characteristics from the individual articles that might be of interest. Data are extracted from reviews. A critical appraisal of reviews showed that reviews differed substantially in quality, which may have introduced a bias in our study (52). However, we took care in taking the quality of individual reviews into account and whether or not a quality assessment of studies had been performed was one of the quality criteria of the included reviews. A systematic review of reviews is a useful way of integrating findings when a large number of studies have been conducted and when individual reviews have focused on particular types of influences, on particular types of outcomes or on specific samples. The fact that only limited overlap existed between the studies included in the separate reviews provides a clear indication that these criteria are met in the domain of environmental influences on weight-related behaviours of young people. Reviewing reviews hence is a suitable method to more comprehensively identify environmental factors that do and do not influence weight-related behaviours of young people.

Conclusions and implications

This systematic review integrates findings from previous reviews that focused on environmental correlates of weight-related behaviours in young people. Many different environmental factors that are potentially linked to weight-related behaviours of young people have been studied, but only few consistent correlates of physical activity and dietary behaviours in young people were found. Policy and practice regarding the prevention of overweight of young people already address aspects of the obesogenic environment. An analysis of national policy documents on obesity prevention indicated that already in eight countries policies suggested the construction of safe walking and cycling paths, increasing safe and efficient public transport and reducing car use in order to promote physical activity (1). The present review appears to suggest that the role of these factors in physical activity is not yet fully understood. To date, not much evidence is available to support the efficacy of an environmental approach to obesity prevention (53,54). Notably, a meta-analysis of obesity prevention programs for children and adolescents showed that mandated improvements in diet (through direct manipulation of the food school environment) and in physical activity (through direct manipulation of physical education lessons) did not improve the efficacy of obesity prevention (54). Before effective environmental interventions can be developed and implemented, it is crucial to identify *which* environmental factors truly impact on physical activity and dietary behaviours and to carefully disentangle *how* these factors exert their influence on behaviours. Specific attention should be paid to exploring how individual, social and environmental interact so that optimal synergistic interventions could be developed.

Conflict of Interest Statement

No conflict of interest was declared.

Acknowledgement

This research is part of the TEMPEST project, supported by a grant from FP7, theme health (Grant Agreement No. 223488).

References

1. Branca F, Nikogosian H, Lobstein T. *The Challenge of Obesity in the WHO European Region and the Strategies for Response*. World Health Organization: Danmark, 2007.

2. Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. *Int J Pediatr Obesity* 2006; **1**: 11–25.
3. Deshmukh-Taskar P, Nicklas TA, Morales M, Yang SJ, Zakeri I, Berenson GS. Tracking of overweight status from childhood to young adulthood: the Bogalusa Heart Study. *Eur J Clin Nutr* 2006; **60**: 48–57.
4. Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics* 1998; **101**: 518–525.
5. Larson NI, Neumark-Sztainer D, Hannan PJ, Story M. Trends in adolescent fruit and vegetable consumption, 1999–2004. Project EAT. *Am J Prev Med* 2007; **32**: 147–150.
6. Bauer KW, Larson NI, Nelson MC, Story M, Neumark-Sztainer D. Fast food intake among adolescents: secular and longitudinal trends from 1999 to 2004. *Prev Med* 2009; **48**: 284–287.
7. Kerr MA, Rennie KL, McCaffrey TA, Wallace JMW, Hannon-Fletcher MP, Livingstone MBE. Snacking patterns among adolescents: a comparison of type, frequency and portion size between Britain in 1997 and Northern Ireland in 2005. *Br J Nutr* 2009; **101**: 122–131.
8. Armstrong N, Welsman JR. The physical activity patterns of European youth with reference to methods of assessment. *Sports Med* 2006; **36**: 1067–1086.
9. Van Mechelen W, Twisk JWR, Post GB, Snel J, Kemper HCG. Physical activity of young people: the Amsterdam Longitudinal Growth and Health Study. *Med Sci Sports Exerc* 2000; **32**: 1610–1616.
10. Biddle SJH, Gorely T, Stensel DJ. Health-enhancing physical activity and sedentary behaviour in children and adolescents. *J Sports Sci* 2004; **22**: 679–701.
11. Dollman J, Norton K, Norton L. Evidence for secular trends in children's physical activity behaviour. *Br J Sports Med* 2005; **39**: 892–897.
12. Hills AP, King NA, Armstrong TP. The contribution of physical activity and sedentary behaviours to the growth and development of children and adolescents: implications for overweight and obesity. *Sports Med* 2007; **37**: 533–545.
13. Salmon J, Timperio A. Prevalence, trends and environmental influences on child and youth physical activity. *Medicine and Sport Science* 2007; **50**: 183–199.
14. Hill JO, Wyatt HR, Reed GW, Peters JC. Obesity and the environment: where do we go from here? *Science* 2003; **299**: 853–855.
15. Swinburn B, Egger G, Raza F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Prev Med* 1999; **29**: 563–570.
16. Richard L, Potvin L, Kishchuk N, Prlic H, Green LW. Assessment of the integration of the ecological approach in health promotion programs. *Am J Health Prom* 1996; **10**: 318–328.
17. Bronfenbrenner U. *The Ecology of Human Development*. Harvard University Press: Cambridge, MA, 1979.
18. Kremers SPJ, de Bruijn GJ, Visscher TLS, van Mechelen W, de Vries NK, Brug J. Environmental influences on energy balance-related behaviors: a dual-process view. *Int J Behav Nutr Phys Act* 2006; **3**: 9.
19. Davison KK, Birch LL. Childhood overweight: a contextual model and recommendations for future research. *Obes Rev* 2001; **2**: 159–171.
20. Kirk SFL, Penney TL, McHugh T-LF. Characterizing the obesogenic environment: the state of the evidence with directions for future research. *Obes Rev* 2010, **11**: 109–117.
21. Ferreira I, van der Horst K, Wendel-Vos W, Kremers S, van Lenthe FJ, Brug J. Environmental correlates of physical activity in youth – a review and update. *Obes Rev* 2007; **8**: 129–154.
22. Freedson PS, Evenson S. Familial aggregation in physical activity. *Res Q Exerc Sport* 1991; **62**: 384–389.
23. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sports Exerc* 2000; **32**: 963–975.
24. Van der Horst K, Oenema A, Ferreira I, Wendel-Vos W, Giskes K, van Lenthe F, Brug J. A systematic review of environmental correlates of obesity-related dietary behaviors in youth. *Health Educ Res* 2007; **22**: 203–226.
25. Egan M, Tannahill C, Petticrew M, Thomas S. Psychosocial risk factors in home and community settings and their associations with population health and health inequalities: a systematic meta-review. *BMC Public Health* 2008; **8**: 239.
26. Peters LW, Kok G, Ten Dam GT, Buijs GJ, Paulussen TG. Effective elements of school health promotion across behavioral domains: a systematic review of reviews. *BMC Public Health* 2009; **9**: 182.
27. Thomas H, Miccuci S, Ciliska D, Mirza M. *Effectiveness of School-Based Interventions in Reducing Adolescent Risk Behaviours: A Systematic Review of Reviews*. Effective Public Health Practice Project: Hamilton, ON, 2005.
28. Centre for Reviews and Dissemination. University of York. [WWW document]. URL http://www.york.ac.uk/inst/crd/ (accessed 14 June 2010).
29. Davison KK, Lawson CT. Do attributes in the physical environment influence children's physical activity? A review of the literature. *Int J Behav Nutr Phys Act* 2006; **3**: 19.
30. Gorely T, Marshall SJ, Biddle SJH. Couch kids: correlates of television viewing among youth. *Int J Behav Med* 2004; **11**: 152–163.
31. Gustafson SL, Rhodes RE. Parental correlates of physical activity in children and early adolescents. *Sports Med* 2006; **36**: 79–97.
32. Hanson MD, Chen E. Socioeconomic status and health behaviors in adolescence: a review of the literature. *J Behav Med* 2007; **30**: 263–285.
33. Van der Horst K, Paw MJ, Twisk JW, Van Mechelen W. A brief review on correlates of physical activity and sedentariness in youth. *Med Sci Sports Exerc* 2007; **39**: 1241–1250.
34. Pugliese J, Tinsley B. Parental socialization of child and adolescent physical activity: a meta-analysis. *J Fam Psychol* 2007; **21**: 331–343.
35. Davison KK, Werder JL, Lawson CT. Children's active commuting to school: current knowledge and future directions. *Prev Chronic Dis* 2008; **5**: A100.
36. Limstrand T. Environmental characteristics relevant to young people's use of sports facilities: a review. *Scand J Med Sci Sports* 2008; **18**: 275–287.
37. Ridgers ND, Stratton G, Fairdough SJ. Physical activity levels of children during school playtime. *Sports Med* 2006; **36**: 359–371.
38. Tomkinson GR, Olds TS, Borms J. Who are the Eurofittest? *Med Sport Sci* 2007; **50**: 104–128.
39. Blanchette L, Brug J. Determinants of fruit and vegetable consumption among 6–12-year-old children and effective interventions to increase consumption. *J Hum Nutr Diet* 2005; **18**: 431–443.
40. Pearson N, Biddle SJ, Gorely T. Family correlates of breakfast consumption among children and adolescents. A systematic review. *Appetite* 2009; **52**: 1–7.
41. 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**: 267–283.

42. Taylor JP, Evers S, McKenna M. Determinants of healthy eating in children and youth. *Can J Public Health* 2005; **96**(Suppl. 3): S20–S26.
43. Woodruff SJ, Hanning RM. A review of family meal influence on adolescents' dietary intake. *Can J Diet Pract Res* 2008; **69**: 14–22.
44. Rabin BA, Boehmer TK, Brownson RC. Cross-national comparison of environmental and policy correlates of obesity in Europe. *Eur J Public Health* 2007; **17**: 53–61.
45. Lytle LA. Measuring the food environment. State of the science. *Am J Prev Med* 2009; **36**(4 Suppl.): S134–S144.
46. McKinnon RA, Reedy J, Handy SL, Rodgers AB. Measuring the food and physical activity environments. Shaping the research agenda. *Am J Prev Med* 2009; **36**(4 Suppl.): S81–S85.
47. McKinnon RA, Reedy J, Morrissette MA, Lytle LA, Yaroch AL. Measures of the food environment. A compilation of the literature, 1990–2007. *Am J Prev Med* 2009; **36**(4 Suppl.): S124–S133.
48. Ball K, Jeffery RW, Crawford DA, Roberts RJ, Salmon J, Timperio AF. Mismatch between perceived and objective measures of physical activity environments. *Prev Med* 2008; **47**: 294–298.
49. Prins RG, Oenema A, van der Horst K, Brug J. Objective and perceived availability of physical activity opportunities: differences in associations with physical activity behavior among urban adolescents. *Int J Behav Nutr Phys Act* 2009; **6**: 7.
50. Brug J, van Lenthe FJ, Kremers SPJ. Revisiting Kurt Lewin – how to gain insight into environmental correlates of obesogenic behaviors. *Am J Prev Med* 2006; **31**: 525–529.
51. Lyn R. Physical activity research: identifying the synergistic relationships between individual, social and environmental factors to promote active lifestyles. *Health Educ Res* 2010; **25**: 183–184.
52. Gebel K, Bauman AE, Petticrew M. The Physical environment and physical activity. A critical appraisal of review articles. *Am J Prev Med* 2007; **32**: 361–369.
53. Faith MS, Fontaine KR, Baskin ML, Allison DB. Toward the reduction of population obesity: macrolevel environmental approaches to the problems of food, eating, and obesity. *Psych Bull* 2007; **133**: 205–226.
54. Stice E, Shaw H, Marti CN. A meta-analytic review of obesity prevention programs for children and adolescents: the skinny on interventions that work. *Psych Bull* 2006; **132**: 667–691.

Supporting information

Additional Supporting Information may be found in the online version of this article:

Table S1. Description of included reviews of environmental influences on physical activity among young people.
Table S2. Description of included reviews of environmental influences on dietary behaviours among young people.

Please note: Wiley-Blackwell are not responsible for the content or functionality of any supporting materials supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author for the article.