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Review

The home physical environment and its relationship with physical activity and sedentary behavior: A systematic review

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ABSTRACT

Reviews of neighborhood (macro) environment characteristics such as the presence of sidewalks and esthetics have shown significant correlations with resident physical activity (PA) and sedentary (SD) behavior. Currently, no comprehensive review has appraised and collected available evidence on the home (micro) physical environment. The purpose of this review was to examine how the home physical environment relates to adult and child PA and SD behaviors. Articles were searched during May 2014 using Medline, PsycINFO, PubMed, Scopus, and SPORTDiscus databases which yielded 3265 potential studies. Papers were considered eligible if they investigated the presence of PA (ie. exercise equipment, exergaming devices) or SD (ie. television, videogames) equipment and PA or SD behavior. After, screening and manual cross-referencing, 49 studies (20 experimental and 29 observational designs) were found to meet the eligibility criteria. Interventions that reduced sedentary time by using TV limiting devices were shown to be effective for children but the results were limited for adults. Overall, large exercise equipment (ie. treadmills), and prominent exergaming materials (exergaming bike, dance mats) were found to be more effective than smaller devices. Observational studies revealed that location and quantity of televisions correlated with SD behavior with the latter having a greater effect on girls. This was similarly found for the quantity of PA equipment which also correlated with behavior in females. Given the large market for exercise equipment, videos and exergaming, the limited work performed on its effectiveness in homes is alarming. Future research should focus on developing stronger randomized controlled trials, investigate the location of PA equipment, and examine mediators of the gender discrepancy found in contemporary studies.

Contents

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Context

Regular physical activity has been associated with the prevention of at least 25 chronic diseases (Warburton et al., 2007). Despite these findings, physical activity (PA) remains low and consequently obesity and the comorbidities associated with low PA levels have increased (Shields et al., 2010; Tremblay et al., 2010). Researchers have identified several correlates of PA behavior which can be broadly defined into categories of: demographic, biological, intra-individual/psychological, behavioral, social/inter-individual, environmental and policy (Bauman et al., 2012; Ferreira et al., 2007; Trost et al., 2002). More recently, understanding the correlates of sedentary (SD) behaviors has become an important and emerging issue. Sedentary behavior is defined as energy expenditure at ≤1.5 METs (Pate et al., 2008) (Metabolic Equivalent of Task). Despite meeting PA guidelines, excessive sedentary lifestyle can deteriorate health over time (Owen et al., 2010; Proper et al., 2011). These findings have prompted the creation of sedentary behavior guidelines for Canadian and Australian children (AGDH, 2013; CSEP, 2012).

The importance of the environment on PA and SD behaviors is reflected in social ecological models (Sallis et al., 1998; Spence and Lee, 2003; Wachs, 1992). The physical environment can represent a discriminate stimulus (Skinner, 1954) which can prompt predictable human behavior (Spence and Lee, 2003). Ecological models also posit that individuals adapt or alter their behaviors in response to the resources in the extra-individual environment. Research on how the neighborhood environment predicts PA behavior has seen noticeable growth in the past decade; it has been shown to represent approximately 30% of all published research in PA (Rhodes and Nasuti, 2011). While this evidence clearly demonstrates the importance of the neighborhood environment on PA, some researchers have suggested that understanding the effects of the home, or micro environment also deserves attention (Sirard et al., 2010). Individuals are likely to receive higher exposure to stimuli in their homes compared to their neighborhood environment. For instance, the home environment has been shown to be a determining factor in understanding nutritional choices (Campbell et al., 2007; Hendrie et al., 2013; MacFarlane et al., 2009) and smoking behavior (Hiemstra et al., 2014; Rushton, 2004). With regard to active lifestyle, the convenience and advancements of technology (ie. laptops, video game consoles, tablets, etc.) are likely factors that prompt sitting. An average American spends 8 h/day being sedentary (Matthews et al., 2008) and children spend on average 7.5 h/day using various entertainment media (ie computers, televisions, cell phones) (Prevention CfDCa, 2014). The home provides personal comfort which makes it an ideal environment to engage in common sedentary activities. However, exercise equipment such as treadmills and exergaming can also provide a convenient method for staying active at home. Both of these types of equipment would seem essential to consider for children and adults. Despite this rationale, only one review has been conducted on the home environment (Maitland et al., 2013). The results generally supported the premise that the home environment is reliably linked to PA and SD, but it was limited to children, and thematic analyses were constrained to broad classifications (e.g., equipment vs. no equipment, placement of equipment).

Thus, the purpose of this paper was to create a systematic review (Moher et al., 2010) which would complement the prior review (Maitland et al., 2013) by including adults and updating the contemporary literature on how the home physical environment relates to adult and child PA and SD. It was hypothesized that the physical components of PA and SD equipment (ie. quantity and location) and variables within these components (type, and individual factors) would correlate with SD time and PA time respectively.

Evidence acquisition

Eligibility criteria

Studies that were published in English peer-reviewed journals were considered for this review. The journal articles were considered eligible if they investigated: i) the presence of PA (e.g. treadmill) or SD (e.g. television) equipment, and ii) an outcome of PA or SD behavior.

Exclusion criteria

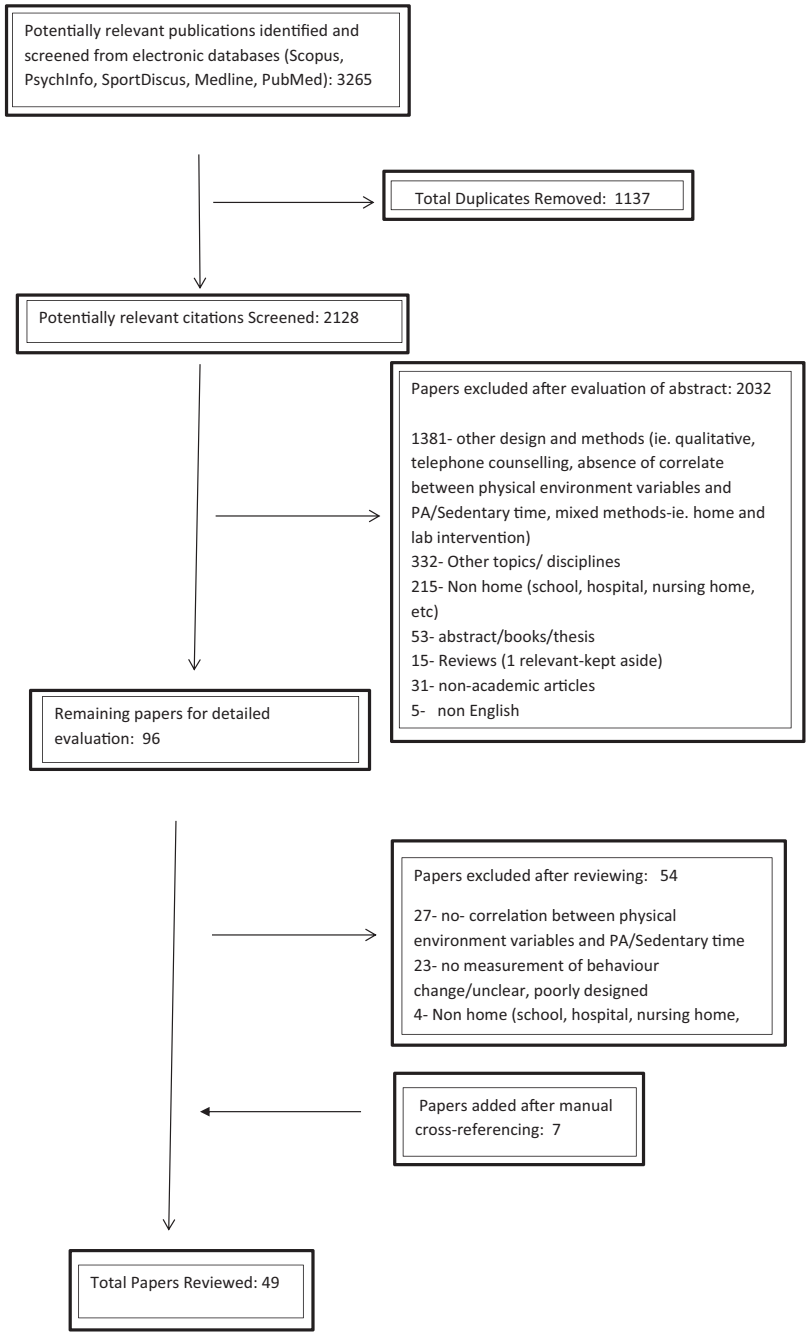
Studies were excluded if the setting was other than a family home (ie. nursing homes, schools, and recreation facilities); the authors wanted to examine a setting in which the individuals have the autonomy to manipulate their surroundings.

Search strategy

Articles were searched during May 2014 using Medline, PsycINFO, PubMed, Scopus, and SPORTDiscus databases. A combination of the following terms was used to search in the title, abstract, and key-terms which included: *home*, *home environment*, *physical activity*, *sedentary*, *television*, *screen-time*, *obesogenic*, *obesogenic environment*, *home-based intervention*, *exercise video*, *exercise program*, *exercise dvd*, *treadmill*, *bike*, *exercise bike*, *cues*, *stimulus control*, *exergaming*, *exercise gaming*, *eyetoy*, *dance mat*, and *playstation*.

Screening

The screening process of articles by title, abstract and full article was performed based on the eligibility criteria. Fig. 1 displays the screening process of the articles.



Note. The above diagram depicts values from when search strategies were combined from two independent searches.

Fig. 1. Flow diagram for the literature search. Note. The diagram depicts values from when search strategies were combined from two independent searches.

Quality assessment

Two separate instruments were used to evaluate experimental research and observational studies, respectively. The Cochrane Collaboration Risk of Bias Tool was used for the experimental studies which appeared to be suitable for this review (Armijo-Olivo et al., 2012). The observational studies were evaluated by using a modified version of the Downs and Black's 22-item assessment tool (the modified version excludes items which assess RCTs) (Kirk and Rhodes, 2011).

Data abstraction and analysis

Items for the data abstraction included: primary author and year, participants, inclusion criteria, length/design, intervention (if applicable), relevant primary instruments, correlations/beta and significance and quality rating. Information on participants provided data such as adults/children, sample size, and clinical sample (if applicable). Themes were created on physical factors that could predict behavior: quantity, location, equipment, materials, backyard, and environment interaction. However, themes were established if the findings were present in three

Table 1A
Data extraction of experimental studies: participant and study characteristics.

Primary author and year	Participants	Inclusion criteria	Length/design	Intervention
Baranowski et al. (2012)	78 children	Participants were children 9 to 12 years of age, with a BMI >50th percentile, but <99th	RCT 13 weeks (PA measured for 5 weeks)	Wii console, no prescription
Canning et al. (2012)	20 participants Experimental: n = 10, 60.7 ± 5.9 Control: Experimental: n = 10, 62.9 ± 9.9	Inclusion: patients with Parkinson's disease	RCT 6 weeks (semi-supervised)	Home treadmill walking
French et al. (2011)	90 Households (HH) 158 adults, 75 adolescents ages 12–17 years, 84 children ages 5–11 years, 23 children <5 years.	(i) At least one child ages ≥5 years two HH members ages ≥12 years (ii) Residence in a private house or apartment within 20 miles of the university (iii) HH TV viewing weekly average of ≥10 h per person (iv) No HH members with dietary, medical, psychological, or physical limitations that would prevent their participation in intervention activities; and (v) Willingness to be randomized to active intervention or control group.	RCT 1 year	TV limiting device
French et al. (2012)	153 adults 72 adolescents	1) At least 1 adult and 2 HH members (including the adult) ages > 12 - years; (2) Residence in a private house or apartment within 20 miles of the universi-ty; (3) HH weekly average TV of >10 h per person; (4) No HH members with dietary, medical, psychological, or physical limitations that would prevent their participation in intervention activities; and (5) Willingness to be randomized to active intervention or control group.	RCT 1 year	TV limiting device Implementation of goals in house to reduce soft drink and fast food consumption
Graves et al. (2010)	42 children 8–10 years of age	owned a PS2 or PS3 video game console and self-reported playing these for >2 h/week age range, 8–10 years	RCT 12 weeks	jOG device (add to PS2/PS3) records steps on spot
Jakicic et al. (1999)	148 women 25–45 years old	Exclusion: medical condition	RCT 18 months	3 intervention groups: 1. Long-bout exercise group 2. Short-bout exercise group 3. Short-bout + exercise
Khalil et al. (2012)	15 participants	Inclusion criteria: patients with Huntington's disease	RCT 8 weeks	Home DVD exercise program

Maddison et al. (2011)	322 children 10–14 years of age 11.6 +/− 1.1 years	10–14 years old overweight or obese owned PS2/PS3 no active video games played >2 h/week	RCT 6 months	Sony EyeToy upgrade (camera, dance mat and selection of active games)
Madsen et al. (2007)	30 children 13 +/− 2.6	Children aged 9 to 18 years with a BMI above the 95th percentile who owned videogame consoles	RCT 6 months	Dance Dance Revolution (DDR) video game
Maloney et al. (2008)	60 children 7.5 ± 0.5 years	Inclusion: 7–8 years old Exclusion criteria: debilitating/chronic health problems, played Dance, Dance Revolution more than twice	RCT 28 weeks	Dance Dance Revolution (DDR)
Moore et al. (2009)	20 participants Experimental: n = 10, m = 70.5 Control: n = 10, m = 70	Inclusion: patients with pulmonary disease	RCT 6 weeks	Home DVD exercise program
Ni Mhurchu et al. (2008)	29 children (age 10.4 +/− 0.9)	9–12 years >20 h TV/week	RCT 6 weeks	TV limiting device
Ni Mhurchu et al. (2009)	20 children 12 ± 1.5 years; 40% female	Aged between 10 and 14 years; owned a PS 2; English speaking; and able to provide informed assent and parental consent	RCT 12 weeks	EyeToy camera, EyeToy active games, and dance mat
Oka et al. (2005)	60 years (range = 30–76)	Men and women over 30 years of age, well-compensated heart failure at baseline, with a diagnosis of heart failure >3 months duration,	RCT 12 weeks	Home treadmill walking
Owens et al. (2011)	Adults (n = 9), 37.8 +/− 4.9 children (n = 12), 10.0 +/− 1.	Inclusion: at least 1 adult caregiver and at least 1 child 8–13 years of age living at the same residence, no Wii console or Wii Fit currently in the home	RCT 3 months	Wii fit
Patel et al. (2008)	15 children mean age = 14.7 ± 5.3	Inclusion: pediatric heart transplant recipients	RCT 12 weeks	Exercise bike Elastic bands (strength training)
Paez et al. (2009)	60 children 7- to 8-year old children (n = 60)	Exclusion criteria included individuals with significant somatic or played DDR, StepMania, more than twice before enrollment.	RCT 10 weeks	PS2, DDR Max 2 2 padded dance mats.
Plotnikoff et al. (2010)	48 participants Experimental: 55 ± 12 Control: 54 ± 12	Inclusion: sedentary, obese individuals	RCT 16 weeks (gradual decrease of supervision)	Multigym apparatus (Parabody CM3 Cable Motion Gym and dumbbells)
Rhodes (2013)	Adults (n = 59, m = 37.07 ± 6.56) Children (n = 59, m = 5.95 ± 2.09)	Inclusion: families with two parents and at least one child	RCT 6 weeks	Exercise gaming bike on PSII
Vestergaard et al. (2008)	53 participants Experimental: 81 (3.3) n = 25 Control: 82.7 (3.8) n = 28	Inclusion: women over 75 years of age	RCT 5 months (first session supervised for safety)	Videotape, booklet and exercise bands

or more studies (Sallis et al., 2000). From these themes, common findings which emerged such as gender, ethnicity, and type of exergaming were further grouped within each of the themes when possible. It was later found that there was not sufficient homogeneity of data to conduct a meta-analysis (Hunter and Schmidt, 2004).

Evidence synthesis

The primary author and a research assistant performed two independent literature searches. The initial search yielded 3265 potentially relevant articles. After duplicates were removed (1187 articles), the remaining articles were filtered from the title and abstract by removing studies that did not fit the inclusion criteria such as non-home environment, or intervention which did not include correlates of physical home environment. This shortened the list to 96 articles to further evaluate. The next stage involved thoroughly reading the studies which resulted in finding 42 applicable studies for this review. These studies were manually cross-referenced which yielded 7 new articles for a total of 49 studies with independent datasets for the systematic review. Fig. 1 illustrates the search process.

Table 1B
Data extraction of experimental studies: instruments and analysis.

Primary author and year	Relevant primary instruments	Correlations/beta and significance
Baranowski et al. (2012)	i) Accelerometer ii) Self-Report Wii use	Overall, intervention did not appear to have any significant changes
Canning et al. (2012)	i) Self-Report	treadmill group appeared to demonstrate better exercise adherence (2.6 session times/week) compared to the control group (1.25 session/week) over 6 weeks
French et al. (2011)		Intervention effect (final and baseline)
	i) Self Report TV and computer use ii) International Physical Activity Questionnaire	Tv Viewing Adult, B = −0.55, SE = 0.20, p = 0.01 TV is on Adult, B = 0.9084, SE = 0.17, p < 0.0001 Adolescent, B = 0.9800, SE = 0.33, p = 0.005 TV on during meals Adult B = −18.04, SE = 7.61, p = 0.02 MVPA (adult) B = 29.633, SE = 12.77, p = 0.02
French et al. (2012)	i) Modified International Physical Activity Questionnaire ii) Three-Day Physical Activity Recall iii) TV Self-Report	This was effective tactic for reducing TV viewing time only in adults β = .55 (p <. 05)
Graves et al. (2010)	i) PA-Self-Report ii) Accelerometer	No intervention effects on PA variables at 6 and 12 weeks (p = 0.17) and (p = .38)
Jakicic et al. (1999)	i). Self-Report ii) Accelerometer	The intervention group, SBEQ demonstrated greater adherence (87%) with moderate–strong effect size compared to the control SB (70.1%; h = .43). Although the number of exercise sessions/week of SBEQ (6.6 +/− 5.3) was significantly greater (p < 0.001) than SB group (5.8 +/− 5.7) the effect size was small (d = .14).
Khalil et al. (2012)	i) Exercise Diary	Adherence: three times over eight weeks, 53%
Maddison et al. (2011)	i) Accelerometer ii) Self-Report	The change in the average daily time spent playing active video games increased by 10 min (95% CI: 6.26, 13.81 min; p = 0.0001) at end of intervention compared with the Control group. The change in average daily time spent in non-active video games Decreased at 24 weeks in favor of intervention group, but was not significant (−9.39 min; 95% CI: −19.38, 0.59 H89; P = 0.06).
Madsen et al. (2007)	i) Self-Report Diary	Few children in this study used DDR regularly, despite frequent telephone encouragement. Even among those who initially played frequently, playing DDR
Maloney et al. (2008)	i) Accelerometer ii) SST—sedentary screen-time	There were no statistical differences between the intervention and the control groups in vigorous, moderate, light, or sedentary PA. However, there was a significant increase in vigorous PA in the intervention Group (from 10 ± 7.7 mpw to 16.2 ± 11.8 mpw, p < 0.0005). The DDR group had decrease in SST of −1.2 ± 3.7 h per week (hpw), p < 0.05, whereas the controls reported an increase of + 3.0 ± 7.7 hpw (non-significant). Difference in SST between the groups was significant, with less SST in the DDR group.
Moore et al. (2009)	i) Self-Report	Adherence to DVD program: 69% at 6 weeks.
Ni Mhurchu et al. (2008)	i) Self-Report TV watching ii) Pedometer	When baseline TV viewing was controlled, there were no significant differences between groups at 6 weeks, F (1, 26) = .09, p = 0.77. However, there was a decrease in total self-reported viewing hours (non-significant) in the intervention group compared to the change in the control group
Ni Mhurchu et al. (2009)	i) Accelerometer ii) Physical Activity Questionnaire for Children	Average PA time was higher in intervention group compared to the control group (difference at 6 weeks = 194 counts/min, p = 0.04, 12 weeks = 48 counts/min, p = 0.06)
Oka et al. (2005)	i) Self-Report	Average total aerobic adherence for the 3 months of the exercise program was highest at 110%, upper body adherence was 87% and lower body exercise adherence was lowest at 75% for all 3 months. Twelve week adherence slowly decreased for all 3 components.
Owens et al. (2011)	i) Actigraph GT1M accelerometer	No significant changes in physical activity were observed in adults (p = 0.051) or children (p = 0.89). 82% reduction in minutes of daily Wii Fit during the second 6 weeks was statistically significant (p < 0.01).
Paez et al. (2009)	i) Accelerometer ii) DDR self-report usage	Participation was significant only absence of other video games OR 3.485 SE 1.427 p = 0.015
Plotnikoff et al. (2010)	i) Self-Report	Mean adherence of their program was 71 ± 22%;
Rhodes (2013)	i) Home exercise log sheet	For children, significant usage of game bikes was found (t36 = 2.61, p = .01, d = .85). NS for parents.
Vestergaard et al. (2008)	i) Dynamometer—hand grip ii) Isobex medical device—Bicep strength iii) Health Related Quality of Life	Adherence: 78 min/week for five months, 89.2%

Table 2A
Data extraction of observational studies: participant and study characteristics.

Primary author and year	Participants	Inclusion criteria	Length/design
Adachi-Mejia et al. (2007)	2 343 child/parent pairs 9–12 years of age	BMI greater or equal to 95th percentile age range, 9–12	Cross-sectional
Atkinson et al. (2005)	102 adults (age = 48.2 +/− 11.6 years)	Age 18–65, absence of medical condition	Prospective 4 years
Barr-Anderson et al. (2008)	781 adolescents	Not clear, previous study cannot be found.	Prospective 5 years
Bauer et al. (2011)	253 parent/adolescent girls age = 15.7 years, range = 14–20.3	Girls with physical activity levels less than one hour/day.	Cross-sectional
Dennison et al. (2002)	2 761 adults with children	Adults with children aged 1 through 5 years participating at a nutritional program	Cross-sectional
Dunton et al. (2003)	87 girls, 14–17 years old (age = 15.02 +/− .72 years)	(1) failure to meet the minimum physical activity recommendations by the American College of Sports Medicine 2) performance at or below 75th percentile of cardiovascular fitness for their age 3) No health problems	Cross-sectional
Gorin et al. (2011)	Overweight (n = 201) Normal weight (n = 213) Adults	Not specified	Cross-sectional
Hoyos Cillero and Jago (2011)	247 primary school children 256 secondary school children	Not specified	Cross-sectional
Jakicic te al. (1999)	194 adults 98 men, 96 women	University faculty and staff	cross sectional
Kerr et al. (2008)	853 parent/child dyad 878 adolescents 853 parents	Exclusion: health conditions	Cross-sectional
Liao et al. (in press)	118 adults (age 27–73)	Exclusion: did not speak English household income greater than $210,000 physical disabilities which limited PA	Prospective 4 days
Maddison et al. (2009)	110 students 12–17 years of age (age = 14.6 +/− 1.55)	Age: 12–17 years	Cross-sectional
Patnode et al. (2010)	294 youth/parent pairs adolescents: 10–17 years of age age = 15.4 +/− 1.7	No specific inclusion criteria mentioned	Cross-sectional
Reed and Phillips (2005)	411 university students	Not specified	Cross-sectional
Ries et al. (2009)	249 adults	Participating in moderate or vigorous Physical activity for 90 min or less	Prospective—1 year
Roemmich et al. (2007)	88 children	Greater than 15 h/week of TV/computer BMI less than 90th percentile	Cross-sectional
Salmon et al. (2013)	613 children 47% boys (age 9.4 +/− 2.2 years)	Exclusion if parent was <17 or >46 And children <5 or >13	Prospective—1 year
Spurrier et al. (2008)	280 households (mean = 4.8 years ± 0.21)	Children less than five and a half years of age	Cross-sectional
Sirard et al. (2010)	613 parent/adolescent dyads	Health Partners members, in grades 6th through 11th in the fall of 2007, residing in one of the randomly selected middle or high-school districts included in the sample.	Cross-sectional
Stuckyropp and Dilorenzo (1993)	121 girls 121 boys (age = 11.2 +/− 0.7)	5th and 6th grades	Cross-sectional
Trang et al. (2009)	2684 children (age—11–16)	Children grades 6–9	Cross-sectional
Van Dyck et al. (2013)	1200 adults (age 20–65) 48% males	None-stratified random sampling Of 24 neighborhoods	Cross-sectional
Van Zutphen et al. (2007)	1926 children 4–12 years of age	Ages 4–12 and part of a nutrition program	Cross-sectional
Wethington et al. (2013)	23,145	Data from 2007 National Survey of Children's Health	Cross-sectional
Williams et al. (2008)	205 adults	Less than 90 min per week of MVPA	Prospective—1 year
Wong et al. (2010)	29,139 children	Secondary schools	Prospective—1 month

Table 2B
Data extraction of observational studies: instruments and analysis.

Primary author and year	Relevant primary instruments	Correlations/beta and significance
Adachi-Mejia et al. (2007)	i) Self-Report custom questionnaire	Boys more likely to have televisions in their bedrooms (50.3%) compared to girls (46.2%) ($p < 0.05$)
Atkinson et al. (2005)	i) GLTEQ ii) Accelerometer	Quantity of home exercise equipment was correlated with self-reported total, $r = .34$ ($p <. 05$) and vigorous leisure-time physical activity, $r = .27$ ($p <. 05$).
Barr-Anderson et al. (2008)	i) Modified Leisure Time Exercise Questionnaire ii) Custom items for Sedentary Behavior	Sedentary Time for: i) TV in bedroom and ii) no TV in bedroom 1. Girls i) 20.7 +/− 0.78, ii) 15.2 +/− 0.90, $p < .001$ 2. Boys i) 22.2 +/− 0.78, ii) 18.2 +/− 1.16, $p = 0.005$ Vigorous PA for i) TV in bedroom and ii) no TV in bedroom 1. Girls i) 1.8 +/− 0.17, ii) 2.5 +/− 0.20, $p = .004$ 2. Boys i) 3.8 +/− 0.17, ii) 3.8 +/− 0.25, $p < 0.04$
Bauer et al. (2011)	i) Family Physical Activity Environment ii) Family Television Use Environment iii) 3-Day Physical Activity Recall	Total PA and Home PA resources, $r = 0.51$, $p = .67$ MVPA and Home PA Resources, $r = 0.41$, $p = 0.063$
Dennison et al. (2002)	i) Parent report on TV details	Children with a TV set in their bedroom, compared with those without, spent an additional 4.6 h per week ($p < 0.0001$)
Dunton et al. (2003)	i. Modified Perceived Environments Related to Physical Activity instrument ii. Stanford Usual Physical Activity Scale iii. 2 Day Physical Activity Recall iv. VO2 max test	1. home use availability and home use frequency, $r = 0.216$, $p < 0.05$ 2. home use frequency and home use variety, $r = 0.667$, $p < 0.05$ 3. Fitness and home availability, $r = 0.224$, $p < 0.05$
Gorin et al. (2011)	i) Exercise Environment Questionnaire ii) S-R TV use and access iii) Paffenbarger Physical Activity Questionnaire	In normal weight group, physical activity was associated with aerobic equipment available ($p = .02$). Positive correlation between number of TVs and viewing ($r = .25$, $P < .001$). TVs in bedroom led to significantly longer viewing times ($p < .001$)
Hoyos Cillero and Jago (2011)	i) TV and media scale-custom ii) Screen-time-custom	Older females—bedroom TV (OR: 0.32, $p < .05$), and bedroom console (OR: 0:26, $p < 0.05$) correlated with >2 h/day but not for males. More males in secondary school group than females had a console in their bedroom ($p < 0.01$) Younger females exceeding TV guidelines had 2 TV sets in the home.
Jakicic et al. (1999)	i) Paffenbarger Questionnaire ii) Custom PA environment scale	For women, there were significant correlations between total activity and both recreational equipment ($r = 0.22$) and total amount of exercise equipment ($r = 0.25$), individual sports equipment ($r = 0.20$) and total exercise equipment ($r = .030$) Men—team sport equipment and PA ($r = 0.20$) Women—individual sport ($r = 0.24$), home equipment ($r = 0.24$), total equipment ($r = 0.28$) and recreation equipment ($r = 0.27$)
Kerr et al. (2008)	i) Exercise equipment checklist ii) International Physical Activity Questionnaire iii) 7 day Physical Activity Recall	The presence of more home-use exercise equipment was related to physical activity in adolescent girls (OR = 1.27, 95% CI = 1.1–1.5). There was also a significant interaction between perceived safety and equipment ($p < 0.01$)
Liao et al. (in press)	i. Accelerometer ii. Electronic momentary assessment	Home was the most important context for Physical and sedentary activity Women engaged in PA more when they were at home (pred. prob. = .61, SE = .061) than men (pred. prob. = .24, SE = .077) When at home, men spent more SD time than women whereas when at work, women spent more SD time than men ($p < 0.05$)
Maddison et al. (2009)	i) Perceived ownership and reported use of equipment ii) Accelerometer iii) Physical Activity Questionnaire for Adolescents (PAQ-A)	Of the perceived variables, home ownership of recreation equipment (standardized effect = .26) had a direct effect on physical activity.
Patnode et al. (2010)	i) Accelerometer ii) International Physical Activity Questionnaire iii) Physical Activity and Media Inventory	Home PA equipment was positively correlated with MVPA $r = 0.21$ ($p < 0.001$)

Reed and Phillips (2005)	Questionnaire which measured exercise i) Intensity ii) Frequency iii) Duration	Female—Quantity of home exercise equipment and: I) Total physical activity r = .247, p < 0.05 II) Intensity r = .332, p < 0.05 III) Frequency r = .166, p < 0.05 IV) Duration r = .310, p < 0.05 Male—Quantity of home exercise equipment and: I) Total physical activity r = .039, p > 0.05 II) Intensity r = .009, p > 0.05 III) Frequency r = .093, p > 0.05 IV) Duration r = 0.91, p > 0.05
Ries et al. (2009)	i) 7-Day physical activity recall ii) Home Environment Scale	Associations between home equipment availability and minutes of physical activity. Groups from different populations: A) SIM B = 5.07, SE = 1.83, p < 0.01 B) STRIDE B = 3.52, SE = 10.2, p < 0.001
Roemmich et al. (2007)	i) Self-Report ii) Accelerometer	Number of televisions in the home was correlated to television watching time (r = .31, p ≤ .01).
Salmon et al. (2013)	i). Custom items for television and PA equipment ii) Self-report by parents	TV in child's bedroom and screen-time, B = 1.5 (0.8, 2.3), p < 0005 Home PA equipment and sedentary time, B = −3.4 (−5.9, −0.9), p < .01 Neighborhood road safety concerns moderated screen-time behavior. B = .9 p < 0.054
Sirard et al. (2010)	i) Physical Activity and Media Inventory ii) Accelerometer iii) Self-Report screen time	PAASS (Physical Activity Availability and Accessibility Summary Score) MAASS: Media Availability and Accessibility Summary Score Accelerometer MVPA and (males) i) PA equipment density r = 0.13, p < 0.05; ii) PAASS, r = 0.15, p < 0.05; (females) i) PA equipment density r = 0.16, p < 0.05 ii) PAASS, r = 0.19, p < 0.05 S-R Screen Time and Males—MAASS, r = 0.07, p > 0.05 Females—MAASS, r = 0.12, p < 0.05 Accelerometer and i) PA Density, B = 1.17, SE = 0.42, p < 0.01 ii) PAASS B = 0.03, SE = 0.01, p < 0.01 Televisions in girl's bedrooms positively associated with time and the ratio of activity (r = 0.17, p < 0.05)
Spurrier et al. (2008)	i) The Physical and Nutritional Home Environment Inventory ii) The Outdoor Playtime and Small Screen Entertainment Checklist	Backyard size (p = 0.001) and outdoor play equipment (p = 0.003) were associated with outdoor play Presence of playstation (p < 0.02) was associated with SD time
Stuckyropp and Dilorenzo (1993)	i) The Physical Activity Interview ii) Children's Physical Activity Questionnaire iii) Parental Physical Activity Questionnaire	Number of exercise related items at home predicted PA for girls. Not significant for boys, no data reported. B = 0.26, R2 = 0.08, F = 5.06, p = 0.008
Trang et al. (2009)	i) The Adolescent Physical Activity Recall Questionnaire ii) Home Environment Questionnaire—custom	Backyard predicted less SD time (OR = 0.7, 95% CI = 0.6–0.9)
Van Dyck et al. (2013)	i) IPAQ ii) NEWS iii) Accelerometer	PA equipment in home environment (CI = .057, 0.115) was Associated with vigorous leisure-time PA
Van Zutphen et al. (2007)	Self-Report measure (not validated)	Children who had televisions in their bedrooms significantly watched more TV than their counterparts (p < 0.001)
Veitch et al. (2010)	i) Accelerometer ii) Environment scale-custom	One third of children play in yard per week "stranger danger" predicted yard play OR = 2.32, p < 0.05
Wethington et al. (2013)	Custom PA and screen-time scales	TV in bedroom and screen-time, OR 1.7 (1.4 to 2.1)
Williams et al. (2008)	i) 7-Day Physical Activity Recall ii) Environment Assessment Scale	PA equipment at home predicted PA adoption (OR = 1.73; 95% CI: 1.05, 2.85), but not PA maintenance (OR = 0.88; 95% CI: 0.58, 1.35)
Wong et al. (2010)	Custom PA and screen-time scales	Access to sport facilities was more likely to be physically Active (OR_{boys} = 1.26; OR_{girls} = 1.34), while those who additionally Reported computer/internet use were less likely to be physically active (OR_{boys} = .60; OR_{girls} = .54)

Table 3
Evaluation of experimental studies.

A

Baranowski	Canning	French	French 2012	Graves	Jakicic	Juneau
A) I. 1	A) I. 1	A) I. 1	A) I. 1	A) I. 1	A) I. 1	A) I. 2
II. 1	II. 1	II. 1	II. 1	II. 3	II. 5	II. 5
1—Strong	1—Strong	1—Strong	1—Strong	3—Weak	1—Moderate	3—Weak
B) 1	B) 5	B) 1	B) 1	B) 1	B) 1	B) 1
1—Strong	3—Weak	2—Strong	2—Strong	1—Strong	1—Strong	1—Strong
C) 2	C) 2	C) 2	C) 2	C) 3	C) 2	C) 2
1—Strong	1—Strong	1—Strong	1—Strong	2—Moderate	1—Strong	1—Strong
D) I. 1	D) I. 1	D) I. 1	D) I. 1	D) I. 1	D) I. 1	D) I. 1
II. 3	II. 3	II. 2	II. 2	II. 3	II. 2	II. 3
2—Moderate	3—Weak	2—Moderate	2—Moderate	2—Moderate	2—Moderate	2—Moderate
E) I. 1	E) I. 1	E) I. 1	E) I. 1	E) I. 1	E) I. 1	E) I. 1
II. 1	II. 1	II. 1	II. 1	II. 1	II. 1	II. 1
1—Strong	1—Strong	1—Strong	1—Strong	1—Strong	1—Strong	1—Strong
F) I. 1	F) I. 1	F) I. 1	F) I. 1	F) I. 1	F) I. 1	F) I. 1
II. 1	II. 1	II. 1	II. 1	II. 3	II. 2	II. 1
1—Strong	1—Strong	1—Strong	1—Strong	2—Moderate	2—Moderate	1—Strong
G) I. 1	G) I. 1	G) I. 1	G) I. 1	G) I. 1	G) I. 1	G) I. 1
II. 3	II. 1	II. 1	II. 1	II. 2	II. 1	II. 1
III. 2	III. 2	III. 2	III. 2	III. 2	III. 2	III. 2
1—Strong	1—Strong	1—Strong	1. Strong	2—Moderate	1—Strong	1—Strong
H) I. 1	H) I. 1	H) I. 1	H) I. 1	H) I. 1	H) I. 1	H) I. 1
II. 2	II. 2	II. 2	II. 2	II. 2	II. 2	II. 2
1—Strong	1—Strong	1—Strong	1—Strong	1—Strong	1—Strong	1—Strong
Strong	Weak	Strong	Strong	Moderate	Strong	Moderate

B

Khalil	Maddison	Madsen	Maloney	Moore	Ni Mhurchu 2008
A) I. 1	A) I. 1	A) I. 1	A) I. 2	A) I. 1	A) I. 1
II. 5	II. 5	II. 1	II. 5	II. 1	II. 5
1—Strong	2—Moderate	1—Strong	2—Moderate	1—Strong	2—Moderate
B) 5	B) 1	B) 3	B) 1	B) 1	B) 1
3—Weak	1—Strong	1—Weak	1—Strong	1—Strong	1—Strong
C) 1	C) 2	C) 3	C) 2	C) 2	C) 1
3—Weak	1—Strong	1—Weak	1—Strong	1—Strong	3—Weak
D) I. 1	D) I. 1	D) I. 1	D) I. 1	D) I. 1	D) I. 1
II. 3	II. 2	II. 3	II. 1	II. 2	II. 3
2—Moderate	1—Strong	2—Moderate	2—Moderate	1—Strong	2—Moderate
E) I. 3	E) I. 1	E) I. 1	E) I. 1	E) I. 3	E) I. 1
II. 3	II. 1	II. 1	II. 1	II. 3	II. 1
3—Weak	1—Strong	1—Strong	1—Strong	3—Weak	1—Strong
F) I. 2	F) I. 1	F) I. 1	F) I. 3	F) I. 1	F) I. 3
II. 1	II. 2	II. 3	II. 3	II. 2	II. 1
1—Strong	2—Moderate	2—Moderate	2—Moderate	2—Moderate	1—Strong
G) I. 1	G) I. 1	G) I. 1	G) I. 1	G) I. 1	G) I. 1
II. 3	II. 1	II. 1	II. 2	II. 3	II. 3
III. 2	III. 2	III. 2	III. 2	III. 2	III. 2
1—Strong	1—Strong	1—Strong	2—Moderate	2—Moderate	1—Strong
H) I. 1	H) I. 1	H) I. 3	H) I. 1	H) I. 1	H) I. 1
II. 2	II. 2	II. 2	II. 2	II. 2	II. 2
1—Strong	1—Strong	3—Weak	1—Strong	1—Strong	1—Strong
Weak	Strong	Weak	Strong	Weak	Moderate

C

Ni Mhurchu 2009	Oka	Owens	Paez	Plotnikoff	Rhodes	Vestergaard
A) I. 1	A) I. 1	A) I. 1	A) I. 1	A) I. 1	A) I. 1	A) I. 1
II. 5	II. 1	II. 1	II. 1	II. 3	II. 5	II. 3
3—Weak	1—Strong	1—Strong	1—Strong	1—Strong	2—Moderate	1—Strong
B) 1	B) 5	B) 5	B) 1	B) 1	B) 1	B) 1
1—Strong	3—Weak	3—Weak	1—Strong	3—Weak	1—Strong	1—Strong
C) 1	C) 2	C) 2	C) 2	C) 2	C) 2	C) 2
2—moderate	1—Strong	1—Strong	1—Strong	1—Strong	1—Strong	1—Strong
D) I. 3	D) I. 1	D) I. 1	D) I. 1	D) I. 1	D) I. 1	D) I. 1
II. 3	II. 1	II. 1	II. 1	II. 3	II. 2	II. 3
2—moderate	3—Weak	3—Weak	2—moderate	3—Weak	2—moderate	2—moderate
E) I. 1	E) I. 1	E) I. 1	E) I. 1	E) I. 1	E) I. 1	E) I. 1
II. 1	II. 1	II. 1	II. 1	II. 1	II. 1	II. 1
1—Strong	1—Strong	1—Strong	2—moderate	1—Strong	1—Strong	1—Strong
F) I. 2	F) I. 2	F) I. 1	F) I. 2	F) I. 1	F) I. 1	F) I. 3
II. 1	II. 2	II. 1	II. 1	II. 1	II. 1	II. 3
2—moderate	3—Weak	1—Strong	2—moderate	1—Strong	1—Strong	2—moderate
G) I. 1	G) I. 1	G) I. 1	G) I. 1	G) I. 1	G) I. 1	G) I. 1
II. 1	II. 2	II. 3	II. 3	II. 3	II. 1	II. 3

Table 3 *(continued)*

C						
Ni Mhurchu 2009	Oka	Owens	Paez	Plotnikoff	Rhodes	Vestergaard
III. 2	III. 2	III. 2	III. 2	III. 2	III. 2	III. 2
1—Strong	1—Strong	1—Strong	1—Strong	1—Strong	1—Strong	1—Strong
H) I. 1	H) I. 1	H) I. 1	H) I. 1	H) I. 1	H) I. 1	H) I. 1
II. 2	II. 2	II. 2	II. 2	II. 2	II. 2	II. 2
1—Strong	1—Strong	1—Strong	1—Strong	1—Strong	1—Strong	1—Strong
Moderate	Weak	Weak	Strong	Weak	Strong	Moderate

Note. The Cochrane Collaboration Risk of Bias Tool was used to evaluate these studies. Please see Table 1A in Appendix.

Table 4
Evaluation of observational studies.

A													
Question	Adachi-Mejia	Atkinson	Barr-Anderson	Bauer	Crawford	Dennison	Dunton 2003	Gorin	Hoyos	Jakicic	Liao	Kerr	Kerr
1	1	0	1	0	0	0	0	1	0	0	0	1	0
2	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	0	1	1	1	1	0	0	1	0	1	0
4	1	0	0	1	1	1	0	1	1	0	1	0	1
5	1	1	1	1	1	1	1	1	0	0	1	0	1
6	1	1	1	1	1	1	1	1	1	1	1	1	1
7	1	0	1	1	1	1	1	1	1	0	1	1	1
8	0	1	0	1	0	1	0	1	1	1	0	0	0
9	1	1	1	1	1	1	0—Unable	0—Unable	1	1	1	1	1
10	1	0—Unable	1	1	1	1	1	0—Unable	1	0—Unable	1	1	1
11	0	1	0	1	1	0	1	1	1	1	0	0	0
12	0	1	1	1	Some	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	0	1	0—Unable	1	0—Unable	1
14	1	0—Unable	1	0—Unable	1	1	0	1	0	0—Unable	1	1	1
15	1	1	1	1	1	1	0	1	1	1	1	1	1
Total	12	10	11	13	13	13	9	11	11	11	11	10	11

B												
Question	Maddison	Patnode	Patnode	Reed	Ries	Roemmich	Salmon	Sirard	Spurrier	Stucky-ropp	Tang	Timperio
1	1	0	0	0	1	1	1	1	0	0	0	0
2	1	1	1	1	0	1	1	1	1	1	1	1
3	1	0	0	0	1	1	1	1	1	1	1	1
4	1	1	1	0	1	1	0	1	0	0	1	1
5	1	1	1	0	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	0	1	1	1	0	1	0	1
8	1	1	1	1	0	1	1	1	0	0	1	0
9	1	1	1	1	0—Unable	1	1	1	1	1	1	1
10	1	1	1	1	0—Unable	1	1	1	1	1	1	1
11	Almost	1	1	1	1	1	1	1	1	1	1	0
12	1	1	1	1	1	1	0	1	1	1	1	1
13	1	1	1	1	1	1	1	1	0	1	1	1
14	1	1	1	0—Unable	1	1	1	1	1	1	0—Unable	1
15	0	1	1	1	1	0	1	1	1	0	1	1
Total	13	13	13	10	10	14	13	15	10	11	12	12

C					
Question	Van Zutphen	Veitch	Wethington	Williams	Wong
1	0	0	0	1	1
2	1	1	1	1	0
3	1	1	1	0	1
4	1	1	1	1	1
5	1	0	1	1	1
6	0	0	1	1	1
7	1	1	1	1	0
8	0	1	1	1	0
9	1	1	1	1	0—Unable
10	1	1	1	1	0—Unable
11	0	1	1	1	1
12	0	1	1	1	1
13	1	1	1	1	1
14	Large drop out	0	0	0—Unable	1
15	1	1	1	1	1
Total	9	11	13	13	10

Note. The modified version of the Downs and Black's 22-item assessment tool used to assess these studies. Please see Table 1B in appendix.

Study characteristics

Of the 49 studies reviewed, 20 were experimental and 29 were observational studies. Characteristics of experimental and observational studies can be found in Tables 1A, 1B, 2A, and 2B respectively. The length of interventions ranged from 6 weeks to 16 months and length of passive prospective designs ranged from 1 to 5 years. In the 20 experimental studies, three focused on reducing sedentary behavior and 17 focused on increasing PA. Quality evaluation of experimental studies resulted in eight strong, five moderate, and seven weak interventions (see Table 3A–C). In the observational studies, 15 focused on SD behavior and 14 focused on PA behavior. Quality evaluation of the studies revealed that half were high (score: 12–15) and the other half were medium (score: 9–11). Table 4A–C displays the study characteristics of all observational studies. Appendix 1A and 1B provide a summary of the items from the two instruments.

Decreasing sedentary behavior

Studies which manipulated the physical environment to reduce sedentary behavior were placed in this category. Three studies were identified, and all used the same intervention approach which involved the implementation of a TV limiting device (French et al., 2011, 2012; Ni Mhurchu et al., 2009). The first two studies (French et al., 2011, 2012) which were evaluated as high quality interventions (see Table 3) spanned for over a year. Two of the three studies found TV limiting devices to be an effective method for reducing television time among children with medium effect sizes (French et al., 2012; Ni Mhurchu et al., 2009) and the only study that measured adults also found it to be a successful tactic for reducing TV viewing time (French et al., 2011).

Increasing physical activity—implementation of exercise equipment

A total of seventeen intervention studies focused on facilitating physical activity in homes (Baranowski et al., 2012; Canning et al., 2012; Graves et al., 2010; Jakicic et al., 1999; Khalil et al., 2012; Maddison et al., 2011; Madsen et al., 2007; Maloney et al., 2008; Mark and Rhodes, 2013; Moore et al., 2009; Ni Mhurchu et al., 2008; Oka et al., 2005; Owens et al., 2011; Paez et al., 2009; Plotnikoff et al., 2010; Rhodes et al., 2009; Vestergaard et al., 2008). The method of environment manipulation used was categorized as either: i) the implementation of exercise equipment (Canning et al., 2012; Jakicic et al., 1999; Khalil et al., 2012; Moore et al., 2009; Oka et al., 2005; Plotnikoff et al., 2010; Vestergaard et al., 2008), or ii) the modification of sedentary equipment (Baranowski et al., 2012; Graves et al., 2010; Maddison et al., 2011; Madsen et al., 2007; Maloney et al., 2008; Mark and Rhodes, 2013; Ni Mhurchu et al., 2008; Owens et al., 2011; Paez et al., 2009). In the first category, the equipment could be subdivided into exercise machines (Canning et al., 2012; Jakicic et al., 1999; Oka et al., 2005; Plotnikoff et al., 2010) and exercise videos (Khalil et al., 2012; Moore et al., 2009; Vestergaard et al., 2008). Among exercise machines, three of these interventions implemented a treadmill in houses (Canning et al., 2012; Jakicic et al., 1999; Oka et al., 2005) and one implemented a multi-functional exercise machine (Plotnikoff et al., 2010); all studies involved adult samples. One study was a true randomized controlled trail (Jakicic et al., 1999) and the other three were quasi-experimental designs (Canning et al., 2012; Oka et al., 2005; Plotnikoff et al., 2010). In the RCT, the intervention group which received a treadmill demonstrated greater adherence compared to the control group with a medium sized difference (70.1%; $h = .43$). In Canning et al. (2012), the treadmill group appeared to demonstrate better exercise adherence (2.6 sessions/week) compared to the control group (1.25 sessions/week) over 6 weeks; however the effect size is unknown as standard deviations were not provided. Finally Plotnikoff et al. (2010) found that the mean adherence of their program was 71 ± 22%; although this may appear adequate, the lack of a control group limits interpreting the effectiveness of their intervention.

Three studies were found that used exercise DVDs as home PA interventions among adults (Khalil et al., 2012; Moore et al., 2009; Vestergaard et al., 2008). These experiments were difficult to compare as the quality of each exercise DVD could mediate motivation. Moreover, the interventions were rated weak with only one earning a moderate score (see Table 3A). In the three studies that provided exercise videos, the length of intervention and adherence rates found were: 6 weeks, 69% (33/48) (Moore et al., 2009); eight weeks, 53% (Khalil et al., 2012); and five months, 89.2% (Vestergaard et al., 2008). It's important to note that all studies used different clinical samples, which could attribute to variability in barriers to continue performing. Overall, providing exercise DVDs could be an economical procedure to start PA; however, further research with stronger methodology would lead to more conclusive findings.

Increasing physical activity—modification of sedentary equipment

Studies that modified a SD device with the objective of increasing PA were categorized under this heading. The most common studies were those that modified a standard video game console into an exergaming system (Baranowski et al., 2012; Graves et al., 2010; Maddison et al., 2011; Madsen et al., 2007; Maloney et al., 2008; Mark and Rhodes, 2013; Ni Mhurchu et al., 2008; Owens et al., 2011; Paez et al., 2009). Three of the studies earned a strong quality rating (Baranowski et al., 2012; Maddison et al., 2011; Mark and Rhodes, 2013), and the remainder were moderate. Nine studies targeted children, and two included both adults and children (Mark and Rhodes, 2013; Owens et al., 2011). The length of interventions ranged from 6 to 28 weeks with adherence rates spanning from 69 to 100%. The majority of the experiments (seven studies) compared the effectiveness of the intervention to a control group (Baranowski et al., 2012; Graves et al., 2010; Maddison et al., 2011; Maloney et al., 2008; Mark and Rhodes, 2013; Ni Mhurchu et al., 2008; Paez et al., 2009).

The types of devices and effect sizes are as follows: exercise bikes $d = .85$ ($p < 0.01$) (Mark and Rhodes, 2013); no significance for Nintendo Wii (Baranowski et al., 2012; Owens et al., 2011); significance for Dance–Dance Revolution (DDR) with the latter study showing OR of participating increase from 1.2 to 3.485 ($p < 0.05$) if other video games were absent (Maloney et al., 2008; Paez et al., 2009); and no significance for peripheral devices (Sony Eyetoy and Wii jOG) (Graves et al., 2010; Maddison et al., 2011; Ni Mhurchu et al., 2008). However, the use of inactive games significantly decreased in the group that received the Sony Eyetoy (Maddison et al., 2011; Ni Mhurchu et al., 2008). Overall, it appears that devices which provide cardiovascular type of exercises such as exercise bikes or DDR were effective in facilitating PA.

Observational studies

Sedentary equipment

Quantity of SD equipment and SD time

Ten studies investigated the correlation between the quantity of media resources and total TV viewing/sedentary time (Adachi-Mejia et al., 2007; Barr-Anderson et al., 2008; Bauer et al., 2011; Dennison et al., 2002; Gorin et al., 2011; Hoyos Cillero and Jago, 2011; Roemmich et al., 2007a; Salmon et al., 2013; Sirard et al., 2010; Van Zutphen et al., 2007). Of these, two conducted analysis with children (Bauer et al., 2011; Van Zutphen et al., 2007) and six conducted gender analysis (Adachi-Mejia et al., 2007; Barr-Anderson et al., 2008; Dennison et al., 2002; Hoyos Cillero and Jago, 2011; Roemmich et al., 2007; Sirard et al., 2010). All studies were cross-sectional designs. Four studies scored high quality ratings (Bauer et al., 2011; Roemmich et al., 2007a; Salmon et al., 2013; Sirard et al., 2010) and two scored a moderate rating (Hoyos Cillero and Jago, 2011; Van Zutphen et al., 2007).

Some studies indicated mixed results on the relationship between the number of television sets and viewing time (Bauer et al., 2011; Gorin et al., 2011; Van Zutphen et al., 2007); however, when the researchers conducted separate gender analysis, adolescent girls were associated with a greater number of media equipment in homes and higher viewing time r = 0.12–0.29 (Barr-Anderson et al., 2008; Dennison et al., 2002; Hoyos Cillero and Jago, 2011; Roemmich et al., 2007a; Sirard et al., 2010b). These results suggest that quantity of media equipment in homes is more likely to have a behavioral effect (increase sedentary time) for girls compared to boys.

Location of sedentary equipment

Eight studies examined the relationship between the location of the equipment and behavior (Adachi-Mejia et al., 2007; Barr-Anderson et al., 2008; Dennison et al., 2002; Sirard et al., 2010; Van Zutphen et al., 2007); all of these studies investigated the behavior effects of children having a television in their bedrooms. Five studies were high quality (Adachi-Mejia et al., 2007; Dennison et al., 2002; Sirard et al., 2010b; Salmon et al., 2013; Wethington et al., 2013) and three were moderate (Barr-Anderson et al., 2008; Van Zutphen et al., 2007; Hoyos Cillero and Jago, 2011). Two studies were prospective designs (Barr-Anderson et al., 2008; Salmon et al., 2013), while the remaining six were cross-sectional (Adachi-Mejia et al., 2007; Dennison et al., 2002; Sirard et al., 2010b; Van Zutphen et al., 2007; Hoyos Cillero and Jago, 2011; Wethington et al., 2013).

Overall, seven studies found that televisions in bedrooms were related to SD and PA behavior (Barr-Anderson et al., 2008; Dennison et al., 2002; Sirard et al., 2010; Van Zutphen et al., 2007). Of these studies, six found a significant difference of SD time between children who had TVs in their bedrooms compared to those who did not with very large effect sizes (d = 7.2–11.16) (Sirard et al., 2010; Barr-Anderson et al., 2008; Dennison et al., 2002; Van Zutphen et al., 2007; Salmon et al., 2013; Wethington et al., 2013) indicating a strong positive correlation between television in bedrooms and SD time. Four studies further revealed a negative association between television in bedrooms and PA time (Bauer et al., 2011; Barr-Anderson et al., 2008; Sirard et al., 2010b). In Barr-Anderson et al. (2008), televisions in bedrooms were significantly different in "moderate/vigorous activity" (d = 3.27) and "vigorous activity" (d = 3.77). However, households with boys were a predictor of having television sets in their bedrooms and greater viewing time (Adachi-Mejia et al., 2007; Barr-Anderson et al., 2008; Dennison et al., 2002). All seven studies found households with children to be correlated with quantity and television sets in bedrooms. These findings suggest that television sets located in a bedrooms are correlated with unhealthy behavior—both, an increase in SD and decrease in PA time.

Finally, three studies were found that investigated the moderating role of ethnicity and television in bedrooms with behavior (Adachi-Mejia et al., 2007; Barr-Anderson et al., 2008; Dennison et al., 2002). Dennison et al. (2002) showed that more Black children (51%; h = .66) and more Hispanic children (50%; h = .64) had a TV set in their bedroom than White children (20%) or other race children (31%; h = .25), and these results were parallel to Adachi-Mejia et al. (2007). Interestingly, in Barr-Anderson et al. (2008), the researchers found TVs in bedrooms in Asian children (39%) to be lower than White (60.2%; h = .42), Black (81.5%; h = .90), Hispanic (66.3%; h = .55) and other racial groups (78.8%; h = .83). Overall, these results suggest that children from white families have a lower prevalence of televisions in their bedrooms than most other racial groups, with the potential exception of Asians.

Physical activity equipment and materials

Quantity of physical activity equipment and usage

Fourteen studies investigated the association between the quantity of home PA equipment and behavior (Bauer et al., 2011; Sirard et al., 2010b; Gorin et al., 2011; Ries et al., 2009; Kerr et al., 2008; Patnode et al., 2010; Dunton et al., 2003; Stuckyropp and Dilorenzo, 1993; Reed and Phillips, 2005; Maddison et al., 2009; Atkinson et al., 2005; Spurrier et al., 2008; Van Dyck et al., 2013; Williams et al., 2008). Six of these studies examined adult samples (Gorin et al., 2011; Ries et al., 2009; Reed and Phillips, 2005; Atkinson et al., 2005; Van Dyck et al., 2013; Williams et al., 2008) and the remaining studied children/adolescents (Bauer et al., 2011; Dunton et al., 2003; Kerr et al., 2008; Maddison et al., 2009; Patnode et al., 2010; Sirard et al., 2010b; Spurrier et al., 2008; Stuckyropp and Dilorenzo, 1993). The results in this category are divided into: exercise equipment and physical activity materials. We define exercise equipment as objects designed for repetitive exercise behavior such as a treadmill, exercise bike, weights, or other exercise machines. PA materials were identified as either mobile or require a partner for use (ie. Frisbee, tennis racket).

Exercise equipment

Seven studies assessed behavior based on the presence of exercise equipment in the home (e.g., treadmill, bicycle, trampoline and weights) (Gorin et al., 2011; Kerr et al., 2008; Dunton et al., 2003; Reed and Phillips, 2005; Atkinson et al., 2005; Van Dyck et al., 2013; Williams et al., 2008). Six studies administered the Perceived Environment Related to Physical Activity questionnaire (Sallis et al., 1997) or a modified version (Atkinson et al., 2005; Dunton et al., 2003; Kerr et al., 2008; Reed and Phillips, 2005; Van Dyck et al., 2013; Williams et al., 2008). Dunton et al. (2003) sampled adolescent girls and found that use frequency correlated with availability (r = .22) and variety (r = .67) of equipment. Reed and Phillips (2005) assessed the quantity of exercise equipment in the home with adults and separated their findings into specific components of PA behavior. Significance was found for all types of PA equipment as predictors of behavior, but only for adult females. Overall these results suggest that the presence of exercise equipment at home appears to be more likely used by adolescent and adult females.

Physical activity materials

Six studies were found that investigated the presence of PA materials (Bauer et al., 2011; Maddison et al., 2009; Patnode et al., 2010; Ries et al., 2009; Sirard et al., 2010b; Stuckyropp and Dilorenzo, 1993). All studies used adolescents with a cross-sectional design, with the exception of Ries et al. (2009), who used adult samples with a prospective follow-up after one year. Two studies investigated the presence of PA materials by administering the Physical Activity and Media Inventory (PAMI) (Patnode et al., 2010; Sirard et al., 2010b) and other measurements include Physical Activity Interview (Stuckyropp and Dilorenzo, 1993), Perceived Environment Related to Physical Activity (Ries et al., 2009), Home Equipment Scale (Rosenberg et al., 2010) and custom scales (Maddison et al., 2009).

The majority of studies found correlations between exercise behavior and the presence of PA materials at home; however, the results were often moderated by gender. Patnode et al. (2010) found that availability and accessibility of PA materials significantly predicted MVPA among boys but not girls. Sirard et al. (2010b) found the availability of equipment to correlate with the PA of both boys and girls with small effects. Analysis by categories revealed that sport materials also correlated with MVPA accelerometer minutes for boys and girls, while outdoor materials was found to only correlate with girls but not for boys. The researchers also found that the strongest association with MVPA was predicted by total PA material density (total number of items divided by the total number of rooms/locations). Maddison et al. (2009) found that ownership of PA materials predicted PA for undergraduate students, and the effect size was similar to Stuckyropp and Dilorenzo (1993) who identified the quantity of these items predicted PA only for girls. Similar to exercise equipment, the measurement of PA materials in various environmental factors (accessibility, density, quantity, etc.) predominantly predicted PA in girls.

Backyards as predictor of behavior

A total of eight studies were found that investigated the relationship between PA and a backyard for children (Bauer et al., 2011; Dunton et al., 2003; Liao et al., in press; Patnode et al., 2010; Ries et al., 2009; Spurrier et al., 2008; Trang et al., 2009; Veitch et al., 2010) Two studies reported that 30–33% of physical activity took place in the yard (Liao et al., in press; Veitch et al., 2010). The presence of a backyard alone decreased SD time, d = .38 (Trang et al., 2009) and yard size also demonstrated a small positive correlation with PA (r = .17) (Spurrier et al., 2008). Of the five studies that included backyard equipment in their measures (Bauer et al., 2011; Dunton et al., 2003; Patnode et al., 2010; Ries et al., 2009; Spurrier et al., 2008), only one study conducted a separate analysis on yard equipment and found it to correlate with PA (r = .20) (Spurrier et al., 2008). The presence of a backyard and PA materials appears to provide an opportunity for children to engage in PA or reduce their SD behavior.

Micro and macro environment interaction

The interaction between the home physical (micro) and neighborhood (macro) environment for predicting behavior was found in four studies (Kerr et al., 2008; Salmon et al., 2013; Veitch et al., 2010; Wong et al., 2010). All four studies used cross-sectional designs and only one was an adult sample (Kerr et al., 2008). Evaluation of these studies revealed only one to have strong score (Salmon et al., 2013), and the other three were medium quality (Kerr et al., 2008; Veitch et al., 2010; Wong et al., 2010).

Three studies found neighborhood safety to moderate PA at home; in particular, safety concerns correlated with greater PA at home rather than away from home (Kerr et al., 2008; Salmon et al., 2013; Veitch et al., 2010). For instance, Kerr et al. (2008) found a significant interaction between perceived safety and equipment usage, where home equipment use was not related to PA in safe neighborhoods (OR = 1.07) but was strongly related to PA in dangerous neighborhoods (OR = 4.40). Veitch et al. (2010) echoed similar findings with the prediction of playing in the home yard, when there was a "stranger danger" concern (OR = 2.32) or road safety concerns (Salmon et al., 2013). Finally, the availability of sport facilities in neighborhood was significantly associated of PA only if video game consoles were absent in home (OR_{boys} = 1.26; OR_{girls} = 1.34) (Wong et al., 2010). Overall, home equipment use was predictive of PA more if there were neighborhood safety concerns.

Discussion

The home environment can provide ease of access to a variety of equipment which could prompt both PA and SD activities. More importantly, we have the autonomy to modify the equipment in our homes and can essentially shape our own PA and SD behaviors. Hence, understanding how the characteristics of physical equipment in our homes predict our behaviors could provide insight on conducting pragmatic interventions. The purpose of the present review was to summarize and appraise the literature on how the home physical environment affects both PA and SD behaviors. The collated results helped identify some important findings and highlight methodological limitations to consider for future research.

Experimental designs

Currently, the majority of research has focused on facilitating PA by implementing exergaming consoles over providing exercise equipment. The present review found that exercise games that required cardiovascular exercises such as exercise bikes, and DDR were among the most effective in promoting PA. However, the effectiveness of these games was moderated by other environmental factors such as if inactive video games were present (Paez et al., 2009; Maloney et al., 2008) and if adolescents received new active video games to maintain novelty/stimulus strength (Maddison et al., 2011). The present review found only two studies that investigated the effectiveness of exergaming on adults (Owens et al., 2011; Mark and Rhodes, 2013). The adult population deserves more attention considering that: i) the average video game player is 37 years old with 53% belonging to the 18–49 age group (EESA, 2013) and ii) children are likely to model adult behavior (Rhodes and Quinlan, 2014).

Providing exercise equipment, particularly substantive exercise equipment (treadmills, portable exercise systems) showed promise in exercise participation. However, only one intervention was a true RCT and the remaining were quasi-experimental designs with partial analysis. Moreover, in the majority of interventions, it was unclear whether it was equipment or usage prompts which facilitated behavior (Canning et al., 2012; Plotnikoff et al., 2010). The best RCT on the matter showed a medium to large effective size between treadmills in homes and behavior (Jakicic et al., 1999), however, more research employing RCT methodology is needed. Finally, a small set of studies examined exercise DVDs for home use. Although effective and economical, the combination of lack of control groups, variability of types of exercise videos, participant variability in health conditions, and self-reported measures compromise the fidelity of these studies.

The Sport and Fitness Industry Association found that selling exercise equipment is a $4.49 billion business with treadmill sales accounting for 25.5% of the entire category (SFIA, 2012). In addition, the sales for exergaming consoles are projected to reach $40 billion by 2015 (WebMD, 2013). The North American population is making substantial investments on equipment that can facilitate their PA in their homes yet the sparse research on effectiveness of these products is alarming.

In terms of SD behavior, another set of experimental studies examined the effectiveness of TV limiting devices. These devices were generally effective but findings were limited for adults. Television viewing is a common sedentary activity (Rhodes and Dean, 2009) which could become habitual. Maintaining the requirements of a TV limiting device (ie. frequent deposit of coins) complicates the behavior and likely reduces some reward, both which have been shown to be necessary antecedents for habit formation (Lally and Gardner, 2011). Thus, these devices may show efficacy for adults who wish to break SD habits but it is unlikely to thwart SD motivation.

Observational evidence

Overall, 29 observational studies were found that investigated the physical components of the micro environment; this is a limited and disproportionate number compared to research on the macro environment (Rhodes and Nasuti, 2011). Although the physical components of the external or macro environment are important, as evidenced by a substantial amount of research in neighborhood studies (see review of reviews) (Gebel et al., 2014), external physical components are relatively non-mutable (Kaushal and Rhodes, 2014). One of the most interesting findings from the observational studies was a notable gender difference. Although boys and minority children were found to have more TVs in their bedrooms, the total quantity of media equipment in the home was correlated with SD behaviors only for girls. Thus, interventions that inform parents on limiting media equipment, particularly in bedrooms, would be an important preventive measure for healthy homes.

The use of PA equipment showed similar findings to SD equipment; exercise equipment and PA materials both correlated with behavior for females but not males. It has been found that most women do not prefer traditional exercise environments due to gender differences in exercise context (Kruisselbrink et al., 2004). Hence, women may feel more

comfortable exercising in their own homes. With the combined findings, we suggest that PA equipment designed towards women could be effective in facilitating their exercise behavior at home.

Another interesting theme that emerged was the interaction between the physical home and neighborhood. Overall, a perceived lack of neighborhood safety predicted greater use of equipment (PA or SD) at home. However, this is a complex relationship, as low socioeconomic status families usually reside in neighborhoods with safety concerns (Weir et al., 2006). It has been previously suggested that indoor screen-based entertainment is a convenient method for parents to keep children entertained and safe (Tandon et al., 2012). Moreover, it might be unlikely that low SES homes would consist of physical features that correlate with PA such as treadmills or a backyard.

Limitations and future research

A noticeable limitation found in these studies involved methodological issues which could compromise the quality of findings, particularly, study design and measurement validity. Out of the 29 observational studies, six were prospective designs, and only 11/20 experiments were true RCTs. Some studies did not use validated scales and some that did, failed to use the potential of the subscales in the measure (i.e., types of equipment, location, etc.). Finally, the variability of populations could also be a limitation such as clinical populations, ethnic backgrounds and SES.

The present review also consists of some limitations which are also important to address. First, only English peer-reviewed published articles were considered for this study. Therefore, potential studies which could have been relevant (eg. Thesis or Non-English) were not included. Second, the search criterion was limited to the terms and databases described in the method section.

In conclusion, the (micro) home environment represents a potentially important context for PA and SD behavior intervention based on theoretical and pragmatic grounds. Our review identified 49 studies in this context. Interventions that reduced sedentary time by using TV limiting devices were shown to be effective, but results were limited particularly for adults. Overall, prominent exercise and exergaming equipment were found to be more effective than smaller devices. Although exercise DVDs were shown to be effective, future studies should incorporate controlled trial methodology and also consider other modes of exercise video such as Netflix or streaming devices. Observational studies revealed that the location and quantity of televisions correlated with SD behavior with the latter having a greater influence on females. This was similarly found for the quantity of PA equipment which also correlated with behavior in girls. Given the large market for exercise equipment, videos and exergaming, the limited and relatively low-quality work performed on its effectiveness in homes is alarming. Future research should focus on developing stronger RCTs, investigate the location of PA equipment, and examine mediators of the gender discrepancy found in contemporary studies.

Conflict of interest

The authors declare that they have no conflicts of interest in the research.

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Appendix A

Appendix-Table 1A
Summary items from *The Cochrane Collaboration Risk of Bias Tool.*

A) Selection bias
I) Sample representative of population
1. Very likely
2. Somewhat likely
3. Not likely
4. Can't tell
II) Percentage participants agreed to participate
1. 80–100% agreement
2. 60–79% agreement
3. Less than 60% agreement
4. Not applicable
5. Can't tell
B) Study design
1. Randomized controlled trial
2. Controlled clinical trial
3. Cohort analytic (two group pre + post)
4. Case–control
5. Cohort (one group pre + post (before and after))
6. Interrupted time series
7. Other specify
8. Can't tell
C) Were there important differences between groups prior to the intervention?
1. Yes
2. No
3. Can't tell
D) Blinding
I) Assessors were aware
1. Yes
2. No
3. Can't tell
II) Participants were aware
1. Yes
2. No
3. Can't tell
E) Data collection methods
I) Validity of tools—were tools valid?
1. Yes
2. No
3. Can't tell
II) Reliability of tools
1. Yes
2. No
3. Can't tell
F) Withdrawals and drop-outs
I) Drop-outs reported
1. Yes
2. No
3. Can't tell
II) Percentage of completion
1. 80–100%
2. 60–79%
3. less than 60%
4. Can't tell
5. Not applicable (i.e. retrospective case–control)
G) Intervention integrity
I) Percentage participant received allocated intervention
1. 80–100%
2. 60–79%
3. Less than 60%
4. Can't tell

(continued on next page)

Appendix-Table 1A *(continued)*

A) Selection bias
II) Measurement of consistency
1. Yes
2. No
3. Can't tell
III) Potential contamination
1. Yes
2. No
3. Can't tell
H) Analyses
I) Statistical methods appropriate
1. Yes
2. No
3. Can't tell
II) Intervention allocation status rather than actual intervention received
1. Yes
2. No
3. Can't tell

Note. Based on selection rules provided by the instrument directory, each section letter was evaluated as 1) strong, 2) moderate or 3) weak.

Appendix-Table 1B
The modified version of the Downs and Black's 22-item assessment tool.

1. Hypothesis and aim/objectives clearly described
2. Definitions of PA constructs that are validated are clearly described
3. Participants described
4. Confounders described
5. Missing/incomplete data described
6. Main findings clearly described
7. Information provided about variability of data
8. Effect size reported
9. Recruitment sample representative of population
10. Participants' representative of population
11. Appropriate statistical tests used
12. Validation of self-report measure
13. Adjustment for confounding analyses
14. Compliance acceptable

Note. This table provides a summary of items of the modified version of Downs and Black's 22-item assessment tool. Items were assessed as 1 = yes, 0 = no, or unable to determine.

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