

Factors impacting levels of physical activity and sedentary behavior among young children: A literature review

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Abstract

By reviewing current research, this study aimed to identify the features of effective intervention using a socio-ecological model to improve physical activity (PA) and reduce sedentary behavior (SB) in young children. The databases used for the study were PubMed and Medline, and the effectiveness of the study was assessed based on the levels of PA and SB determinants in the socio-ecological model (i.e., individual, family, social, and environmental factors). Among the studies conducted on children aged six or younger, and published within the last decade, 67 met our criteria. Some individual (gender, body mass index [BMI], age), family and home (parental role modeling, parents' BMI, parents' education), social (socioeconomic status), and built environment (rural/urban, weekday/weekend) variables were found to have an impact on both PA and SB. Results call for further research in non-Western countries as well as for improvement of PA and reduction of SB in young children. Furthermore, additional studies are needed to examine effective, socio-ecological model-based interventions for PA and SB in young children.

Key words: physical activity, sedentary behavior, young children, review

Introduction

According to the sedentary behavior research network, sedentary behavior (SB) is defined as all waking activities with an energy expenditure of less than 1.5 METs and a sitting and supine position, which is distinctly differentiated by lack of physical activity (PA; recommended PA guideline; SBRN, 2012).

In recent times, SB has been reported to lead to

obesity (Saelens et al., 2002), aggressive behaviors (Tremblay et al., 2011), and sleep disorders (Johnson et al., 2004) while adversely affecting school grades and undermining cognitive development (Busch et al., 2014) in young children and adolescents. Therefore, some countries have developed separate guidelines for SB and PA because even very young children who meet their daily PA demands are vulnerable to health problems if they spend prolonged hours sitting to watch TV or play videogames. In these countries, the guidelines to lower SB duration in young children impose restrictions on daily screen time, TV games, and computer usage to

two hours (AAP, 2001). Studies in the United States (Laurson et al., 2008), Canada (Herman et al., 2014), and China (Cui et al., 2011) have shown that compliance with the daily SB guidelines in young children is low overall, mostly below 50%. Thus, understanding the effective regulatory components is important in reducing SB in young children and thereby enhancing their health.

To increase PA in young children, it is important not only to impart knowledge through health education based on psychosocial factors and offer PA programs but also to take a population health approach based on a socio-ecological model. For instance, from a socio-ecological perspective, PA is a complex behavior influenced by independent variables such as personal, psychological, social, and environmental factors (Sallis et al., 2006). According to the behavioral epidemiology framework, identifying factors that influence PA would be useful in developing tailored and effective PA interventions (Sallis et al., 2000). Some systematic reviews have investigated the correlates of PA in adults and identified several factors that contribute to PA participation (Trost et al., 2002; Saelens et al., 2008). However, no reviews exist to shed light on the factors that affect PA and SB in young children based on a socio-ecological model.

Therefore, this study reviewed studies on PA and SB in young children based on a socio-ecological model and identified recent research on improving PA and reducing SB in young children.

Methods

Search strategies and procedures

English articles on the topic published between January of 2000 and December of 2015 were selected from PubMed and Medline via a screening process.

Combinations of the following keywords were used for the literature searches: (“youth” OR “young children”

AND (“physical activity” OR “walking” OR “exercise”). AND (“sedentary behavior” OR “sitting” OR “sedentary time” OR “screen viewing” OR “sedentary lifestyle” OR “physical inactivity” OR “TV” OR “computer” OR “video games” OR “internet” OR “screen-based behavior.”). In addition, for individual correlates, the following search terms were added: (“sociodemographic” OR “demographic”). For family and home correlates, the following search terms were added: (“family” OR “parents”). For social correlates, the following search terms were added: (“social” OR “crime”). For environmental factors, the following search terms were added: (“environment” OR “environmental attributes”).

From the initial search, titles and abstracts were reviewed to exclude articles that did not meet the selection criteria. Next, data (associations with PA and SB based on a socio-ecological model) were collected from the remaining articles.

Inclusion criteria

The search was limited to English articles. Additional inclusion criteria from the cited literature and our literature database were 1) studies in which PA and SB are outcomes (cross-sectional, longitudinal, intervention, and comparative studies), 2) studies in which young children (0–6 years) were the participants, 3) studies published in peer-reviewed journals, and 4) studies with full text available electronically.

Results

Selection of papers

Using a combination of keywords, we searched for papers from January 2000 to December 2015 and extracted a total of 2552 papers. Among these, we eliminated 1961 after reviewing the titles and the abstracts. In addition, 46 overlapping ones as well as 361 that included subjects aged 7 years and older were

removed. Then, we perused the remaining 184 that met the selection criteria so far, and decided to exclude 117 as they did not present positive or native associations of physical activity and sedentary behavior. Ultimately, we adopted 67 papers for our study.

Characteristics of the studies

Table 1 shows the determinants of the socio-ecological levels of PA and SB. Recent studies on PA and SB emphasize that a socio-ecological model approach (which includes individual, family and home, social, and built environment factors) can play a central role in determining the broad contextual determinants of health indices in young children.

Of the 67 selected articles, 39 were cross-sectional studies, 20 longitudinal, 7 interventions, and 1 observation. The sample size of the studies ranged from 59 to 6643. Most of the studies selected were conducted in the United States (36), followed by 12 in Europe, 10 in Australia, 5 in Canada, 3 in New Zealand, and 1 in India. The study was limited to young children, with participants aged 0–6 years.

Individual factors

Individual factors were examined in 14 articles related to PA and 17 related to SB in young children. The 14 articles on PA reported gender (Ball et al., 2009; Hinkley et al., 2012; Grontved et al., 2009), body mass index (BMI) (Janz et al., 2005; Metallinos-Katsaras et al., 2007; Moore et al., 2003), and age (Jago et al., 2005; Oliver et al., 2010) as individual factors affecting PA. In one of the articles, a negative correlation was found between PA and BMI (Salbe et al., 2002). The 17 articles on SB reported gender (Anand et al., 2005; Heelan et al., 2006), BMI (Reilly et al., 2005; Jouret et al., 2007), age (Kourlaba et al., 2009; Yalcin et al., 2002; Certain et al., 2003), and ethnicity (Schmidt et al., 2009; Horodyski et al., 2010; Flores et al., 2005) as personal factors affecting SB. Negative correlations with SB were found with all factors except age and ethnicity (Horn et al., 2001; Francis et al., 2003).

Family and home factors

Sixteen articles examined the association between PA and family and home factors, namely parental role modeling (Cleland et al., 2009; Alderman et al., 2010;

Table 1. Determinants of the level of physical activity and sedentary behavior in the socio-ecological model

Level in the socio-ecological model	Examples
Individual factors	Gender, age, BMI, ethnicity, emotional distress, temperament, cognitive ability, impulsivity, cognition, beliefs, attitudes, motivation, sleep time, sport competence, boys better at activity, prefer sedentary activities
Family and home factors	Parents' age, parents' BMI, parents' role-modeling (education, rules, and rewards) and support, healthy eating modeling (eating breakfast), placement of TV, parent screen time, eating meals together, eating while watching TV, number of TVs, bedroom TV
Social factors	Peer support, crime-related safety, neighborhood safety, factors relating to children's safety including strangers, impact of friends, neighbors, PE teacher relationships, low social economic status
Built environment factors	Distances (kindergarten, childcare center), road connectivity, pedestrian access paths, high residential density, mixed land uses traffic control elements, access to public open space (parks, shop, recreational facilities), low population density contribution, weather influence, season, region (urban/rural), weekday/weekend

Taylor et al., 2009), parents' BMI (Reilly et al., 2005; Trost et al., 2003; Oliver et al., 2010), and parents' education (Cleland et al., 2009). Among the several factors related to family, only parents' BMI had a negative correlation with PA (Finn et al., 2002). Twenty-nine articles examined the association between SB and family and home factors. More specifically, parental role modeling (Hinkley et al., 2014; Thompson et al., 2013; Hesketh et al., 2007), parents' BMI (Jouret

et al., 2007; Francis et al., 2003), parents' screen time (Kourlaba et al., 2009; Bleakley et al., 2013; Yalcin et al., 2002), parents' education (Vandewater et al., 2007; De Decker et al., 2012; Gubbels et al., 2011), eating while watching TV (Birken et al., 2011), and the number of TVs at home (Chuang et al., 2013) were the family and home factors related to SB in young children, and all had a negative correlation with SB.

Table 2. Correlates of physical activity and sedentary behavior among youth

	Association with PA		Association with SB	
	Positive association	Negative association	Positive association	Negative association
Individual factors				
Gender	[1],[2],[3]		[12],[13]	[14]
BMI	[4],[5],[6],[7],[9],[10]	[8]	[15],[16]	[17]
Age	[7],[11],[3]		[12],[18],[19],[20],[21]	
Ethnicity			[20],[21],[22],[23]	
Family and home factors				
Parental role modeling	[2],[24],[25],[26],[27],[28],[29],[30],[31],[32],[45]		[34],[35],[36],[37],[38],[39]	[40]
Parent's BMI	[10],[11],[15]	[33]	[16],[17]	[40]
Parent screen time			[24],[25],[26],[34],[48],[52]	
Parent's education	[24]		[30],[31],[32],[41],[42]	[20]
Eating while watching TV			[41],[34]	[39],[44]
Number of TVs			[43]	[39]
Social factors				
Socioeconomic status	[46]		[52]	
Peer support	[47],[48]			
Crime-related safety	[49],[50],[51]			[20],[53],[54]
Neighborhood safety				
Built environment factors				
Urban/rural	[3]		[18]	
Bedroom TV			[35],[41],[43],[63]	[19],[33],[39],[40]
Weekday/weekend	[2],[55]		[63],[64],[65],[66]	
Season			[67]	
Indoor/outdoor	[11],[24],[31],[45],[47],[56],[57]			
High residential density	[49],[58],[59],[60]			
Access to public open space	[49],[56],[59],[60],[61]			
Heavy local traffic	[48],[58],[62]			
Distances	[48]			
Pedestrian access paths	[43],[49]			
Road connectivity	[59],[60]			

Links between the numbers in Table 2 and the references in the bibliography.

1. Ball K (2009); 2. Hinkley T (2012); 3. Grontved A (2009); 4. Janz KF (2005); 5. Metallinos-Katsaras E (2007); 6. Moore LL (2003); 7. Jago R (2005); 8. Salbe AD (2002); 9. Oliver M (2011); 10. Trost SG (2003); 11. Oliver M (2010); 12. Anand S (2005); 13. Heelan KA (2006); 14. Horn OK (2001); 15. Reilly JJ (2005); 16. Jouret B (2007); 17. Francis LA (2003); 18. Kourlaba G (2009); 19. Yalcin SS (2002); 20. Certain LK (2003); 21. Schmidt ME (2009); 22. H. orodynski MA (2010); 23. Flores G (2005); 24. Cleland V (2009); 25. Alderman BL (2010); 26. Taylor RW (2009); 27. Zecevic CA (2010); 28. Davison KK (2001); 29. Schary DP (2013); 30. Smith BJ (2010); 31. Spurrier NJ (2008); 32. Gubbels JS (2011); 33. Finn K (2002); 34. Birken CS (2011); 35. Bleakley A (2013); 36. Carson V (2012); 37. Hinkley T (2014); 38. Thompson AL (2013); 39. Hesketh K (2007); 40. Wijtzes AI (2012); 41. Vandewater EA (2007); 42. De Decker E (2012); 43. Chuang RJ (2013); 44. Dubois L (2008); 45. Grigsby-Toussaint DS (2011); 46. Lioret S (2008); 47. Brown WH (2009); 48. Timperio A (2006); 49. Timperio A (2012); 50. Edwards B (2009); 51. Aarts MJ (2012); 52. Christakis DA (2006); 53. Burdette HL (2005); 54. Gable S (2007); 55. Cardon GM (2008); 56. Marino AJ (2012); 57. Kimbro RT (2011); 58. Lovasi GS (2011); 59. Roemmich JN (2006); 60. Roemmich JN (2007); 61. Dowda M (2009); 62. Timperio A (2004); 63. Haines J (2013); 64. Dennison BA (2004); 65. Birken CS (2012); 66. Straker LM (2006); 67. Barr R (2010)

Social factors

PA studies examining social factors revealed a positive association between PA and socioeconomic status (Lioret et al., 2008), peer support (Brown et al., 2009; Timperio et al., 2006), and crime-related safety (Timperio et al., 2012; Edwards et al., 2009; Aarts et al., 2012). On the contrary, studies on SB revealed a positive association with socioeconomic status (Christakis et al., 2006) and a negative association with neighborhood safety (Burdette et al., 2005; Gable et al., 2007).

Built environment factors

Twenty-eight and sixteen studies, respectively, examined PA and SB in relation to environmental factors. Among the 28 studies, the factors that influenced PA were urban/rural settings (Grontved et al., 2009), weekday/weekend (Hinkley et al., 2012; Cardon et al., 2008), indoor/outdoor (Marino et al., 2012; Kimbro et al., 2011), high residential density (Roemmich et al., 2006; Timperio et al., 2012), and access to public open spaces (Roemmich et al., 2007; Dowda et al., 2009). The 16 studies on SB revealed that SB was associated with urban/rural settings (Kourlaba et al., 2009), bedroom TV (Haines et al., 2013; Bleakley et al., 2013), weekday/weekend (Birken et al., 2012; Straker et al., 2006), and season (Barr et al., 2010). One study found a negative association between SB and bedroom TV viewing (Hesketh et al., 2007; Wijtzes et al., 2012).

Discussion

This study reviewed 67 studies on PA and SB in young children under the age of six using a socio-ecological model. These studies were published between January 2000 and December 2015. The review generally supported the evidence found in previous reviews.

We examined personal factors related to PA and SB in young children. Among them, age (older children

were more active), culture (African Americans showed longer SB durations), sex (girls engaged in less PA), and BMI had an impact on both PA and SB. More specifically, the overall level of PA was found to have a strong correlation with pediatric obesity in seven studies. We found that overweight children were more likely to engage in lower levels of PA and higher levels of SB. Further, we found an association between daily walking and the weight of children. However, Salbe et al. (2002) reported a negative correlation between these factors. Age was shown to have a strong positive association with PA and SB in several reports. However, the outcomes differed depending on the type of kindergarten or care center program (sedentary program/dynamic program) or the manner of implementation of education programs, for example, by using various media. Specific methodologies must be established to investigate this matter.

Family and home factors related to PA and SB were parental role modeling, parents' BMI, and parents' education. Furthermore, the greatest volume of evidence was found to support family and home factors among the variables of the socio-ecological model. Unlike previous studies that focused only on parenting practices, these studies investigated the effect of parents' education, rules, and rewards on young children's behaviors. Considering that parental role modeling has been studied extensively in association with PA and SB, it is a particularly important factor for developing effective PA and SB intervention strategies in young children. Additionally, an increase in parents' self-efficacy has been associated with a reduction in screen time and an increase in PA among children, as seen in recent studies on PA and SB. However, only one study reported findings on the effects of parents' self-efficacy on PA (Vandewater et al., 2005). Additionally, most studies that examined the effects of parents' self-efficacy on SB were cross-sectional (Carson et al., 2012; Kourlaba et al., 2009), necessitating longitudinal and intervention studies in the future.

Among the social factors, crime-related safety and

peer support were found to be important factors in determining PA and SB in young children. Although crime and safety measures have been studied widely in general, studies investigating their association with PA in young children are limited (Wijtzes et al., 2012; Edwards et al., 2009; Aarts et al., 2012). Further, it is difficult to distinguish crime-related safety with traffic safety in reviews on crime-related safety as they mostly used self-report questionnaires. Combining safety in different areas may cloud their association with PA (Foster et al., 2008). For this reason, although some studies include crime-related safety as an environmental factor, we considered crime-related safety as a social factor to distinguish it from traffic safety.

Overall, prior to 2000, few studies focused on the environmental determinants of PA and SB in young children. This is supported by Ferreira et al.'s study (2007). In this study, some of the environmental factors (e.g., high residential density, access to public open spaces, heavy local traffic, pedestrian access paths, road connectivity) were found to be associated with PA, a finding supported by objective measurement and relevant evidence. However, there is only one report about the distance to a kindergarten or daycare being a factor and as this is a perceived environmental variable, more objective data must be collected.

Extensive evidence exists to support the association between SB and environmental factors, such as the variables of bedroom TV watching and weekday versus weekend. Studies report both positive and negative associations between bedroom TV watching and SB; apparently, bedroom TV viewing generally has a negative effect on SB in young children, but environmental limitations come into play among low-income families. Further, environmental variables such as self-reporting and acceleration measurement have also been associated with PA and SB. Despite such methodological limitations, findings on PA and SB duration vary depending on the participants' age and sex, requiring more objective data collection in the future (Treuth et al., 2004).

Further, more research is needed in non-Western countries aiming to develop effective PA and SB interventions to prevent pediatric obesity, which has attracted increasing interest in recent times. Future studies must examine the effects of perceived environmental factors on PA and SB. Understanding the impact of such socio-ecological factors contributes to research that ultimately seeks to increase PA and reduce SB in young children.

Acknowledgments: This paper was supported by the SU Research Program of Sendai University. The authors declare that there is no conflict of interest.

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