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Parental Influence on Sedentary Behavior in Children: A Systematic Review

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ABSTRACT

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The purpose of this systematic review is to appraise and synthesize the evidence regarding parental influences on sedentary behavior (SB) in children and explore associations promoting parent-based interventions. Prominent research in the last decade has established SB as a health risk, but to our knowledge, no systematic reviews observing parent to child SB associations have been conducted. Inclusion criteria required publication in the English language, utilization of objective measures for SB evaluation, and samples that included the 11 to 17 year age range, thus yielding a total of 15 identified studies. PRISMA guidelines were used to lead the search methodology and evaluation of articles. Twelve of 15 studies established significant, quantifiable parental correlates to children's SB, and all published articles reported significance to one or more aspects of parental influence: role modeling, parental support, media time, home environment, access to play, and parent-child level attributes. Success for reducing SB in children is likely most successful when parents and children seek to engage in physical activity (PA) during their time together. Healthcare providers should proactively create awareness of prolonged SB health risks, educate parents of their influential roles that contribute to children's activity levels, and assist with finding strategies to break up sedentary lifestyle habits for parents and their children.

Keywords included: physical activity; exercise; sedentary; child; adolescence; parent; mother; father; support; belief; attitude perception; and influence

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Amongst sedentary societal norms, modern-day conveniences, and the all-encompassing exposure to digital media, today's parents have the daunting task of instilling physical activity (PA) into their children's sedentary lives. Children sit in automobiles rather than walk, sit long hours at school with reduced gym and recess time, sit as they connect with online acquaintances instead of playing outdoors with friends, and sit quietly as parents hand over a digital babysitter, hypnotizing their attention. Incredulously, beyond all this, today's children decide to sit—spending their leisure time playing on a computer, phone, TV, or other device. With these worldwide lifestyle changes in recent years, it is evident why individuals can easily "spend more than 60% of their 16-hour waking time in a sitting situation" (Barnett et al. 2018, para. 1).

Obesity rates for children, ages 5 to 19 years, have exponentially risen tenfold from 1975 to 2016 (NCD Risk Factor Collaboration, 2017, p. 2637). While adverse health outcomes such as obesity are multifaceted, a mounting body of research now links excessive sedentary behavior (SB) to the obesity epidemic, glucose dysregulation, metabolic syndrome, cardiovascular disease, depression, and ultimately premature mortality—these results include individuals who complete their daily PA objective per guidelines (Hoare, Milton, Foster, & Allender, 2016; Same et al., 2016).

The accepted SB definition by Tremblay et al., (2017) is "'any waking behaviour characterized by an energy expenditure ≤1.5 METs while in a sitting or reclining posture'" (p. 5), or in other words, behaviors while awake that involve minimal energy expenditures beyond the resting metabolic rate, such as sitting or lying down. However, Trembley et al., (2017) noted some suggest that 1.5 to 2.0 metabolic equivalents (METs), rather than ≤1.5 METs, may be more appropriate for identifying SB in children ages 7 to 13 years (p. 5).

Individuals typically engage in SB during school, work, or leisure-time technology pursuits (TV, video games, phone, or computer usage); these leisure time pursuits are the chief culprit for increased SB in children's lifestyle today (Pettee, Morrow, & Woolsey, 2012). According to Barnett et al., (2018), approximately 33% of American infants and 44% of adolescents have a TV in their bedroom, and children on average have frequent access to five different screens at home by 10 years of age, and half of infants watch TV or DVDs for two or more hours each day. Unfortunately, though perhaps not clinically realized until years later, many of these children will indeed have detrimental health consequences (Same et al., 2016; Stamatakis et al. 2019).

Current PA guidelines from the United States (U.S.) Department of Health & Human Services recommend that youth, ages 6 to 17 years, exercise a minimum of 60 minutes per day (min/day) in moderate to vigorous physical activity (MVPA); with three of those days per week engaged in muscle-strengthening, bone-strengthening, and vigorous intensity PA (Physical Activity Guidelines Advisory Committee, 2018, p. 391). Conversely, no U.S. or World Health Organization guidelines exist for SB; however, the U.S. Physical Activity Guidelines Advisory Committee (PAGAC) concluded, "a significant relationship between greater time spent in sedentary behavior and higher all-cause mortality rates" was demonstrated with strong evidence (p. 148). Expounding on this research, Katzmarzyk (2019), from the Sedentary Behavior Research Network, explained that individuals accumulating high amounts of sitting times each day require additional MVPA time to combat the increased mortality risk of SB (60–75 min/day). Correspondingly, active individuals accumulating low levels of sitting, require less MVPA to meet the same mortality risk (Katzmarzyk, 2019). Therefore, PAGAC (2018) recommends breaking-up SB periods in addition to PA guidelines.

With no SB guidelines from the World Health Organization or PAGAC, Katzmarzyk et al. (2016) noted that scholars often equate individuals' SB to leisure screen time, an interest notorious for involving sitting behaviors, though potentially not capturing all SB accumulated. With this type of measuring stick for SB, institutions such as the American Academy of Pediatrics and National Heart, Lung, and Blood Institute (2016) strongly recommend that parents of children ages 11 to 17 years "limit total media time to no more than 1–2 hours" per day (p. 83). Unfortunately, 62.8% of U.S. children do not meet this guideline, and 78.4% fall short of PA guidelines, thereby both categories received a D– grade on the 2016 U.S. report card (Katzmarzyk et al., 2016). The article also revealed national statistics that indicate plummeting PA levels as children mature, likely predicting similar habits for adulthood.

Some researchers, such as Stamatakis et al. (2019), have proposed SB as an independent risk factor due to these correlations, thereby suggesting the necessity for quantifiable guidelines for SB. The American Heart Association (AHA), via Barnett et al. (2018), affirmed that each hour of sitting, even with the context of protective PA benefits, is associated with a 2% increase in all-cause mortality risk. Furthermore, multiple hours of persistent sitting, and without meeting the guidelines for daily PA, would have additive effects towards mortality risk. In fact, the AHA reports that 3.8% of deaths worldwide may be attributed to prolonged sitting on a daily basis. Successful strategies should focus on all behaviors done throughout the day, both SB and PA, thereby improving quantity and quality of life for millions (Barnett et al., 2018).

Despite research, guidelines, and implementation plans, global efforts are failing to reduce the epidemic of SB or reduce the prevalence of childhood obesity and chronic diseases. Fortunately, community, school, or family-based interventions have been effective in the past,

therefore permitting exploration of the effectiveness of parental influence on their children (Kothandan, S. K., 2014; Sigmund, Sigmundová, Baďura, & Voráčová, 2015).

2015). Children tend to develop habits and establish patterns of SB and PA within the context of the home (Tandon et al., 2014), thereby rendering parents as the ideal mentors for cultivating healthy activity habits.

Past research examining parental influence on their children's SB and PA often describe the results being collected through a subjective means, such as self-report. Such methods risk the potential for poor-recall or social bias, thus tainting results. Additionally, the majority of studies exploring parent-to-child associations involve children under 10 years of age. For this review, focus was placed on subsequent ages due to the lack of research on these age groups and the researcher's interest in parents' capacity to shape their children during the turbulent transition phases prior to adulthood. Therefore, in this review, children are defined as ages 11 to 17 years old. This age range incorporates two of Erikson's stages: industry vs. inferiority (competency, ages 5–12), and identity vs. role confusion (fidelity, ages 12–18). These stages describe how children learn *what* is industrious and then begin to decide what labels or variables *define* them. For example, they might view their self-identity as "I am an active person"; or conversely, "I am a video gamer."

The debate for establishing SB as a dependent or independent factor continues. Therefore, more information is warranted to help appraise the need for specific SB guidelines, as well as advocating for future research to use objective measures in the search for effective interventions for children's SB. A systematic review of recent literature exploring the impact of parents on their children amidst a critical time in development is needed. Therefore, the purpose of this systematic review is to appraise and synthesize the evidence regarding parental influences

on SB in children and establish significant associations promoting parent-based interventions by using objective measures to validate accuracy and avoid bias.

Methods

Search Strategy

PRISMA guidelines were followed and a two-stage process employed to identify all relevant literature (See Figure 1). First, a search framework was established with the guidance of an expert librarian in nursing literature through a combination of the following keywords: physical activity, exercise, sedentary, child, adolescence, parent, mother, father, support, belief, attitude perception, and influence. This exact search framework was then run through for following electronic databases for the years 2010 to 2018: CINAHL, MEDLINE, Embase, Scopus, ERIC, Academic Search Premier, Biomedical Reference Collection: Basic, Family and Society Studies Worldwide, Health Source- Consumer Edition, Health Source: Nursing/Academic Edition, PsycArticles, PsycINFO, and SPORTDiscus. Second, after the retrieved articles were screened and selected, a manual cross-reference search was conducted through the relevant studies' reference lists was conducted to identify all other pertinent studies.

Study Selection

Fifteen published studies were identified for this analysis. Each stage in the selection process employed a double person review to ensure accuracy. The initial systematic search returned 5,939 total records, from which 5,562 duplicates were observed and removed. Titles and abstracts were screened for the remaining 377 records and an additional 340 records were excluded via a double person review. Subsequent full-text reviews were conducted for the remaining 37 articles in detail, and an additional 24 records were excluded, resulting in 13

remaining articles. A completed hand search from the retrieved articles reference lists contributed two additional articles. (See Figure 1 for the full PRISMA selection flow chart)

The quality of all 15 articles was evaluated by two or more reviewers using the Kmet et al. (2004) standardized criteria for evaluating quantitative research. All articles scored above the a priori standard of greater than 70% on the evaluation tool, thus all were included for analysis in this systematic review.

Methodological Quality Rating

Adhering to PRISMA guidelines, once all full-text articles were selected (n = 15), the quality of evidence for each was appraised using the checklist for assessing the quality of quantitative studies by Kmet, Lee, and Cook (2004) from the Institute of Health Economics. Each study was independently appraised by at least two reviewers to assess the quality of each study. Any disagreements in the scoring of articles were discussed between reviewers until a consensus was reached. All included articles scored above the a priori standard of greater than 70% on the evaluation tool.

Inclusion and Exclusion Criteria

Criteria for inclusion of studies required the following: (1) published between January 2010 to January 2018; (2) publication in a peer-reviewed journal; (3) written in the English language; (4) use of a quantitative tool or objective measure for SB; (5) exploration of children's SB; (6) included children within or crossing the 11 to 17 year age range; (7) examination of parent-to-child correlates in the context of SB or PA; and (8) scoring 70% or greater using the Kmet et al. (2004) evaluation criteria.

Data Extraction

All identified articles were reviewed by at least two authors. This was implemented to ensure accuracy when considering the inclusion and merit of each study. Data extracted from articles was compiled into an Excel spreadsheet for convenient comparison. The following article information was included in the table: author, title, quality score, DOI#, study design, participant characteristics, objective measurement instruments for SB and PA, main findings, discussion, study limitations, parental correlate, definition of sedentary time and PA. A summary of this information is given in Tables 1 and 2.

Synthesis of Results

An additional data table was constructed for objective findings of parent and/or child SB or PA. This allowed for complete recording and sorting all significant or noteworthy findings or associations from the retrieved studies (see Table 3). Multiple reviews of each study were completed to confirm a comprehensive inclusion of all results and associations thus allowing for valuable assessment and comparison. All findings were evaluated and organized into similar subject matters totaling 44 categories. These categories were further classified and synthesized into six main themes of parental influence.

Results

General Findings

A total of 15 published studies met the inclusion criteria for this systematic review. Of those, two focus solely on children's SB, and thirteen investigated parental influence for a combination of SB and PA (see Tables 2 and 3). Six themes of parental influence were identified: role modeling, parental support, media time, home environment, access to play, and attributes of parents and children. The results for each were further divided into SB findings, and

other findings from synthesized data gathered in Table 3. Reference Table 3 for a full compilation of the retrieved articles' findings.

Significant parent-to-child SB associations were found in 12 of the 15 studies, but 3 did not. However, of the three unable to establish significant parent-to-child SB relationships, all did find negative relationships with children's media time (Määttä et al., 2015) and two of the three also reported increased PA levels (Lawman & Wilson, 2014; Tu, Watts, and Masse, 2015). All 15 articles acknowledged one or more themes of influence within each study, and all reported significant parent-to-child associations through either SB, PA, media time, or a combination.

Characteristics of Children's Studies

The 15 included articles represent a variety of study locations, ethnicities, and socio-demographic characteristics. Six countries were represented with 40.0% of studies taking place in the United States. Ages studied ranged from 6 to 20 years old. 73.3% employed a cross-sectional design, 13.3% used a longitudinal design, and 13.3% mixed methods. Sample sizes ranged from 83 to 1,328 with 20.0% of studies using a sample size of more than 500 participants.

Risk of Bias of Individual Studies

Certain elements of bias are enviable within each and across all studies conducted and thus will be discussed per PRISMA guidelines. Selected articles' sample groups researched diverse ethnicities, populations, number of individuals, age ranges, health objectives, and so on. Additionally, the researchers of the present review noted different asserted emphases within each study and minor variations in SB classification. Although measures were taken to minimize potential bias, caution is still needed when reviewing results from these articles. To start, 86.6% of the studies acknowledged females as the dominate parent representative since mothers traditionally act as primary caregivers. Maher et al.'s (2017) study pointedly researched mothers

in terms of their mental health, thereby utilizing a sample group of 100% mothers within the study; hence, both parental roles may not be equally represented within sample groups. Percentages of female parents from each study are listed in Table 1.

Despite inclusion criteria requirements for studies to utilize objective measures, self-report was still necessary in all studies to report SB time activities. Thus, limited subjective bias is possible in relation to individuals' poor recall or giving socially desirable answers.

The study by Jago, Fox, Page, Brockman, and Thompson (2010) regarding parent-to-child TV time together, noted that more affluent households were more likely to provide data and have increased accuracy. Unfortunately, excluded results, due to a lack of reporting, tended to come from lower social economic status (SES) groups, thus propagating missing information about equally important populations, potentially generating bias (Jago et al., 2010).

Fortunately, Lawman and Wilson's (2014) article explicitly focused on high-risk populations from lower social economic status areas, however results reported were very unlike the general body of studies. Though this study did meet PRISMA quality criteria, Lawman and Wilson acknowledged limitations in their findings due to enrolling a smaller sample group from specifically high-risk health populations which limits the generalization of its findings.

In addition, the article by Izquierdo-Gomez, Veiga, Villagra, and Diaz-Cueto (2014) investigated a group of children with Down Syndrome. Participants did have a higher intelligence quotient (over 35) and had no physical disabilities for performing PA (Izquierdo-Gomez et al., 2014), however, it is still necessary to note. Lastly, Hornby-Turner et al.'s article (2014) explored culture differences on SB, but only among girls.

Results of Individual Studies

Parental Role Modeling

Parental role modeling is defined as behaviors or characteristics exhibited by parents to their children and/or children's perception of their parents' behaviors. Twelve of the 15 studies discussed role modeling as a parental correlate of influence (Table 3). Parental role modeling findings include: SB findings and other findings.

SB findings. Eight studies explored parental role modeling associations to children's SB (Table 3). Six found significant positive parent to child correlations, of which one by Garriguet et al. (2017), examined 1,328 parent-child pairs and found parent-to-child sedentary minutes strongly correlated ($p < 0.0000$) (Dunton et al. 2012; Gillison et al., 2017; Izquierdo-Gomez et al., 2014; Jago et al., 2010; Sigmund et al., 2015). Two studies found no parent-to-child role modeling to SB association but found correlations to children's media time ($p < 0.05$) (Määttä et al., 2015; Tu, Watts, & Masse, 2015), and children's MVPA ($p < 0.05$) (Tu et al., 2015). Dunton et al. (2012) examined parent-to-child activities and found 2.4 ± 4.1 min/day spent in joint MVPA compared to 92.9 ± 40.1 min/day spent in SB. Parent-child SB time accounted for 46.5% of children's total SB performed each day. Additionally, Dunton found that 100% of parent-child pairs spent time in SB verses only 89.4% engaged in MVPA (Dunton et al., 2012).

Other findings. In addition, ten studies found other associations with parental role modeling (Table 3). Seven studies examined positive parent-to-child role modeling to PA correlations. Six studies found profound significance (Dunton et al., 2012; Garriguet et al., 2017; Gillison et al., 2017; O'Connor & Teresia 2013; Sigmund et al., 2015; Tu et al., 2015), and one approached significance (Lau et al., 2015). This was best highlighted by Garriget, Colley and Bushnik (2017) who reported that when parents increased their MVPA by 20 min/day, children's

MVPA increased by five to ten min/day ($p < 0.0009$). In addition, Sigmund et al. (2015), reported that for every 1,000 step count (SC) increase in mothers' (fathers') SC each weekend day, their daughter's SC increased by 523 (386) steps each day ($p < 0.005/0.001$), and increased sons' SC by 508 (435) SC each day ($p < 0.001$) (p. 87). One study that found SB associations between parents and daughters, but no association to daughters' MVPA or counts per minute (Jago et al., 2010), and another found marginal association for girls after-school PA when parents were active with them ($p = 0.09$) (Lau et al., 2015).

Parental Support

Parental support acts as an independent, or supplementary, component which influences activity behaviors in children. Aspects of parental support are included in nine individual studies which discuss SB findings, and other findings.

SB findings. Parental support in relation to children's SB was explored in eight individual studies (Table 3). Six of the eight studies noted parental support given through varying approaches which resulted in different activity outcomes for children. Therefore, findings will be presented by tangible support, intangible support, and general findings.

Tangible support. Tangible parental support, in relation to SB, was included in four studies. Tangible support is defined as objective or demonstrable interventions (e.g. enrolling or watching children in PA activities or transporting children to PA events) which three articles found independently reduced children's SB ($p < 0.05$) (Gillison et al., 2017; Hornby et al., 2014; Izquierdo et al., 2014). One study lacked significance to the reduction of SB (O'Connor & Teresia, 2013).

Intangible support. Intangible support is comprised of parental beliefs, attitudes, instruction, and foremost encouragement. Intangible support, in the context of SB, was discussed

in four articles reviewed. Gillison et al. (2017) found encouragement to be negatively associated with children's SB only on weekends ($p < 0.04$). Two studies exploring intangible parental support found no relation to children's SB, but found significant correlations to media time (Määttä, et al., 2015) or light physical activity (LPA) (Lawman & Wilson, 2014). Lastly, a study by Izquierdo-Gomez et al. (2014), which investigated Down Syndrome children, found that parents who perceived PA as important for their children's well-being actually had increased SB associations for their child by 18 min/day ($p < 0.001$). Likely, although parents may value PA, that does not necessarily lead to less prolonged SB time (Izquierdo-Gomez et al., 2014).

General findings. General findings are a compilation of both tangible and intangible forms of support due to two articles reporting their results in this combined manner (Lau et al., 2015; Tandon et al., 2014). The study by Lau et al. (2015) found a significant reduction in SB for girls when general parental support was provided ($p < 0.05$). And Tandon et al. (2014) found a 19 min/day reduction of SB through general support ($p < 0.05$) as well as 19.33 min/day less SB through dual parent support ($p < 0.01$).

Other findings. Other parental support findings are included in eight articles (Table 3).

Tangible support. Other tangible support findings were included in four studies (Table 3). Two found significant positive correlations between tangible support and children's PA (Garriguet et al., 2017; O'Connor & Teresia, 2013) and the other two had similar outcomes, yet only approached significance (Gillison et al., 2017; Hornby-Turner et al., 2014). The strength of tangible support was best highlighted by Garriguet et al. (2017) who found children's participation of two or more hours per day (hr/day) of sports or lessons was markedly correlated with increased MVPA on weekends ($p < 0.04$) and weekdays ($p < 0.006$).

Intangible support. Intangible support was found to also correlate with PA and media time within four articles. One by Lawman & Wilson (2014) found significance to exclusively LPA, and Määttä et al., (2015) found fathers' encouragement reduced media time consumption. Also, encouragement was found to be more effective in girls in two studies ($p < 0.001$) (Gillison et al., 2017; Lawman & Wilson, 2014). Lastly, the study by Määttä, et al. (2015) found father's encouragement for PA to be negatively associated with children's media time ($p < 0.05$).

General findings. Other general PS findings were included by three studies, all reporting significant positive associations to children's PA (Garriguet et al. 2017; Lau et al., 2015; Tandon et al., 2014). According to Garriguet et al. (2017), PS had an additive effect on children's PA beyond that of role modeling. The effect was greatest for parents with MVPA < 10 min/day ($p < 0.05$) and decreased in significance as the parent's PA level increased. In addition, general support from both parents increased children's MVPA by 11.79 min/day ($p < 0.01$) (Tandon et al., 2014).

Media time

Media time was included in nine studies and involved all parent-to-child screen encounters, such as television time, video games, or any other media use (Table 3). Subcategories include media time findings, SB findings, and other findings.

Media time findings. Parent-to-child media time findings were included in seven studies which all found significant positive correlations (Garriguet et al., 2017; Izquierdo-Gomez et al., 2014; Jago et al., 2010; Määttä et al., 2015; O'Connor & Teresia, 2013; Tandon et al., 2014; Tu et al., 2015). In addition, three studies found the male sex to be positively associated with increased media use (Izquierdo-Gomez et al., 2014; Jago et al., 2010; Määttä et al., 2015). This is supported by Jago et al. (2010), who found that parents who watched between two to four hr/day

of TV increased their daughters' risk of TV watching four or more hr/day by 3.67 times ($p < 0.05$), and parents watching four or more hr/day increased their sons' risk of watching four or more hr/day by 10.47 times ($p < 0.05$). Next, two studies found that a higher social economic status and parental education lowered media time as much as 3.9 min/day (Määttä et al., 2015; Tandon et al., 2015). Bedroom media increased children's media time by 13 min/day ($p < 0.01$), and active video games increased media time by 17.35 min/day and actually decreased MVPA by 5.36 min/day (Tandon et al., 2014). The literature on "exergaming" is mixed, but perhaps Tandon et al.'s (2014) finding is because active video game usage leads to other SB game uses which may be preferred by children for ease and convenience. Lastly, two studies found parents to significantly influence children's media time rather than their SB (Määttä, et al., 2015; Tu et al., 2015). Further research is needed to investigate how closely related media time and SB are.

Parenting practices that reduced media time was included in two studies. Both found that supportive parenting practices, such as limiting media time, instructive TV education, and healthy media time modeling, lowered children's media time as much as 38 min/day ($p < 0.01$) (O'Connor & Teresia, 2013; Tandon et al., 2014). Yet surprisingly, restrictive media time parenting practices were positively associated with children's media time and increased SB by 6 min/day ($p < 0.03$). O'Connor and Teresia (2013) suggested that active children are less likely to have restricted TV time, while children who engage in excessive SB and media time are most likely to have media time restrictions implemented. Furthermore, when TV restrictions are enforced, children may seek out other SB such as computer use or reading rather than PA endeavors (O'Connor and Teresia, 2013).

SB findings. In conjunction with media time being considered another parameter of SB by some experts (Katzmarzyk et al., 2016; Sigmund et al., 2016), three studies indicated strong

associations between parental media time to children's SB (Izquierdo-Gomez et al., 2014; O'Connor & Teresia, 2013; Tandon et al., 2014). However, the study examining children with Down Syndrome found mothers' TV time inversely related to that of their children ($p < 0.05$); likely, mothers may use the TV to distract children while they accomplished tasks around the house (Izquierdo-Gomez et al., 2014). In addition to restrictive media parenting practices positively correlating with children's SB (O'Connor & Teresia, 2013), media time with peers, or increased media access was also noted to significantly increase SB in children as well as their total media time as much as 6 min/day ($p < 0.05$) (Tandon et al., 2014).

Other findings. Other significant findings were included in two studies. First, Lawman and Wilson (2014) found that increased media time limit-setting and monitoring was associated to only increased LPA. Second, Sigmund et al. (2015), found mothers that reduced their media time by 30 min/day on weekends, increased daughter's step count by 494 steps a day ($p < 0.005$), and increased sons' step count by 467 steps a day ($p < 0.05$) (p. 87). Lastly, parents' being less educated, or having a lower social economic status was associated with increased

Home Environment

Parents are the primary architects who construct the home environment which influences children who spend approximately 47.2% of their time in the home (Tandon et al., 2014). Aspects of the home environment are included in 10 studies (Table 3). Subcategories include SB findings, and other findings.

SB findings. The significance of the home environment to children's SB was included in five articles (Table 3). Maher et al.'s (2017) study found that despite similar stress levels experienced, parental stress in single-parent households was positively associated with 33 or more min/day of SB in children compared to their counterparts from dual-parent households; in

addition, single-parent households were associated with 10 min/day less of children's MVPA ($p < 0.02$) (Maher et al., 2017). Two studies found that an increased number of children, or bedrooms per household, was positively associated with increased SB by 12.10 min/day, increased MVPA by 11.18 min/day ($p < 0.01$), and decreased media time by 6.48 min/day (Izquierdo-Gomez et al., 2014; Tandon et al., 2014). Two studies found mixed results for neighborhood support associations: one found nearby shops increased children's SB ($p < 0.01$) (Izquierdo-Gomez et al., 2014), and the other lacked significance for neighborhood support (Lawman & Wilson, 2014). Other significant correlations to SB include a garden or terrace present at home (Izquierdo-Gomez et al., 2014), shorter days and lower temperatures (Määttä et al. (2015), and family safety rules (+7 min/day; $p < 0.05$) (Tandon et al., 2014).

Other findings. Other home environment findings were included in six articles (Table 3). Although no SB association was found regarding supportive neighborhoods, Lawman and Wilson (2014) noted a positive association for children's LPA ($p < 0.05$). Five studies noted positive parent-to-child correlations between the home environment and children's PA (Hornby-Turner et al., 2014), four reaching significance (Lau et al., 2015; Lawman & Wilson, 2014; Maher et al., 2017; Tandon et al., 2014).

Access to Play

Access to play is defined as children's ability to explore their surroundings and neighborhoods independently thereby allowing children to take advantage of home and neighborhood PA play resources. This aspect is discussed in five articles (Table 3). Subcategories include SB findings and other findings.

SB findings. The analysis between SB and access to play associations reached significance in four different studies (Table 3). Lau et al.'s study noted significant SB reduction

in boys with access to home PA resources ($p = 0.005$); girls, on the other hand, lacked SB associations in that way, but rather benefited from parental support (Lau et al., 2015). The presence of a basketball hoop nearby was associated with a 10-minute reduction of SB for boys and girls and increased MVPA by six min/day (Tandon et al., 2014). Girls with access to sports participation, compared to those who did not, showed significantly less SB (($p < 0.01$) (Hornby-Turner et al., 2014). Lastly, children's ability to autonomously explore the outdoors significantly decreased SB for girls, 10.5 min/day less ($p < 0.001$) (Stone, Faulkner, Mitra, and Buliung, 2014).

Other findings. Other findings associated with access to play was included in five articles. Lau et al. found home PA resources significantly correlated with boys' after-school PA, verses only a marginal association for girls (Lau et al., 2015). In addition to Tandon et al. (2014) who found that access to a basketball hoop increased children's MVPA by 6 min/day, two studies noted significant correlations for PA and MVPA in both boys and girls participating in sports by several more hours each week (Garriguet et al., 2017; Hornby-Turner et al., 2014). Lastly, high child independent mobility was associated with 6.2 min/day more PA on weekdays in boys and 7.3 min/day more PA on weekdays for girls ($p < 0.05$) (Stone et al., 2014). With that, Stone et al. (2014) found that children's independent mobility was more significant in urban neighborhoods for boys and suburban neighborhoods for girls.

Attributes of Parents and Children

Attributes of parents and children are defined as static characteristics of individuals which predispose them to undertake certain activity behaviors. Twelve articles noted certain attributes to independently play a role in negotiating children's SB and PA despite other forms of influence (Table 3). Therefore, this aspect is necessary to explore further in order to gain needed

context for fully understanding the previously listed elements of parental influence. SB findings of attributes of parents and children are comprised of the subcategories: sex, age, child motivation, body mass index, and culture.

SB findings.

Sex. Eight studies addressed male/female sex implications that found significance to SB (Table 3). Girls were found to be more inherently sedentary than boys ($p < 0.01$) in seven separate studies (Dunton et al., 2012; Gillison et al., 2017; Lau et al., 2015; Lawman & Wilson, 2014; Sigmund et al., 2015; Stone et al., 2014; Tandon et al., 2014) and four studies described girls SB and/or MVPA being more correlated to that of their parent's activity levels than boys (Dunton et al., 2012; Garriguet et al., 2017; Gillison et al., 2017; Jago et al., 2010). All articles discussing gender differences reported boys being characteristically more active than girls, as much as 24.10 min/day ($p < 0.01$) (Tandon et al., 2014). However, boys also were significantly more prone to media time than girls in several studies (Jago et al., 2010; Tandon et al., 2014; Tu et al., 2015).

Age. Six studies found that older ages for both parents and children increased SB activities as much as 20.68 min/day ($p < 0.01$) (Dunton et al., 2012; Gillison et al., 2017; Izquierdo-Gomez et al, 2014; Lawman & Wilson, 2014; Tandon et al., 2014; Tu et al., 2015); perhaps in part due to similar TV preferences to parents as children age.

Child motivation. The study by Gillison et al. (2017) explored children's motivation in relation to activity levels. Boys were driven by independence, which during weekends was inversely related to SB ($p <0.001$) and associated with higher MVPA levels ($p < 0.05$). On the other hand, girls were motivated by self-efficacy, or their belief in their ability to achieve their

goals, which was positively associated on weekends with both SB and MVPA ($p < 0.05$) (Gillison et al., 2017).

Body mass index. Seven studies examined body mass index with children's activity levels (Table 3). Five associated increased body mass index to increased SB (Gillison et al., 2017; Lau et al., 2015; Lawman & Wilson, 2014; Määttä et al., 2015; Tandon et al., 2014) as much as 11.81 min/day ($p < 0.05$) (Tandon et al., 2014). Additionally, three studies reported reduced MVPA (Garriguet et al., 2017; Gillison et al., 2017; Tandon et al., 2014) by as much as 6.63 min/day ($p < 0.05$) (Tandon et al., 2014), and three studies reported increased media consumption (Määttä et al., 2015; Tandon et al., 2014; Tu et al., 2015) by 24.50 min/day ($p < 0.05$) (Tandon et al., 2014).

Culture. Hornby-Turner and colleagues investigated parental influence in terms of culture between British Pakistani and White British girls' activity levels. British Pakistani girls were 28 min/day more sedentary and 14 min/day less moderately to vigorously active than Westernized White British girls—though no difference in TV time was found (Hornby-Turner et al., 2014). WB parents typically allowed sports participation, active travel to school, and outdoor play; prioritized school over family events; and mothers worked outside the home. British Pakistani parents prioritized attending mosque for two hr/day and contrasted White British parents in every way previously listed (Hornby-Turner et al., 2014).

Discussion

The purpose of this systematic review is to appraise and synthesize the evidence regarding parental influences on SB in children and explore associations for potential interventions. A total of 15 studies were identified from a broad database search and manual cross-referencing selected articles. Each selected study identified one or more elements of

parental influence to their children's activity levels. Twelve studies found parental influence associated with SB, yet all found significance in some regard. Findings were organized and synthesized from which six themes of significant parental influence emerged: role modeling, parental support, home environment, access to play, and attributes of parents and children.

Overall, the summary of our results suggests that parents can use different aspects of influence to predict children's SB and PA in a variety of ways. Currently, parents and children spend a 1:39 time ratio of MVPA to SB together daily (Dunton et al., 2012). Such a disparity illustrates the need for joint parent-child strategies to successfully decrease SB and meet screen time and PA guidelines (Beets et al., 2010, Schoeppe, et al., 2017).

Within the aspects of influence found, several implications for parents are presented. First, to successfully reduce SB and also meet activity and media guidelines, parents should be active themselves and engage in PA with their children as also suggested by other bodies of research (Beets et al., 2010; Pyper, Harrington, & Manson, 2016; Schoeppe et al., 2017). The review by Beets et al. found that direct involvement of parents with children, via role modeling or engaging in PA with them, effectively reduced children's SB and increased PA. Fathers were especially good role models since they typically initiated PA into their play time; however, fathers may be limited in their capacity to influence due to their traditional role of providing for their families (Beets et al., 2010). In this review, the lion-share of studies found role modeling associated with reduced children's SB. Disagreeing studies showed media time reduced, which some would argue to be another parameter of SB (Katzmarzyk et al., 2016; Sigmund et al., 2016). Regardless, the evidence is clear that parents need to model healthy activity behaviors (decreasing their SB and increasing PA) to effectively influence their children's activity levels for the better.

Second, the foundation for parents significantly impacting their children is to strengthen their relationships with their children. Girls were found to be more prone to parental influence, compared to their counterparts, based on higher parent-child bonding and activity levels being relationship driven, especially their SB (Dunton et al., 2012; Garriguet et al., 2017; Jago et al., 2010). In addition, girls' motivation via self-efficacy, as Gillison et al. states (or their belief that they can achieve their activity goals), appears to coincide with their activity levels being driven by parental support and family relationships. Perhaps this is why role modeling and parental support was more successful for girls (Li, Xue, Wang, & Wang, 2017; Schoeppe et al., 2017, p. 155) than boys who are motivated by independence. According to Schoeppe et al., boys tend to take after their fathers more, and daughters their mothers; however, maternal influence was found to be stronger due to having more time with children as the traditional caregiver (Schoeppe et al., 2017). Therefore, if parents strive to be activity involved with their children, their influence will likely have a stronger presence and effect in their children.

Third, as children mature through adolescents, parents should encourage healthy activity-related behavioral patterns for older children through supportive means in addition to their role modeling behaviors. This review and other published works clearly established that as children matured through adolescents they engage in more SB pursuits (Beets et al., 2010; Song et al., 2019). This could be due to a number of reasons such as increased scholastic studying pursuits, heightened interest in leisure media time such as social media, TV preferences matching their parents leading to TV pursuits together, etc. In addition, although parents are the gate keepers and advocates for health enhancing and compromising behaviors through the childhood 18 year span, maturing adolescents begin to assert their own independence and seek guidance and ideals from life experiences and other mentors such as teachers, peers, or coaches (Beets et al., 2010, p.

622; Pyper, 2016). Therefore, to compliment the additional avenues of influence, parents can accommodate by providing transportation to sports and other PA events, be a knowledgeable source of SB and PA health outcomes and allow for home and neighborhood access to play when possible.

The developmental theory by Erikson has two stages overlapping the 11 to 17 age range, namely: industry vs. inferiority, and identity vs. role confusion. Within industry vs. inferiority, parental role modeling and support are vital as children, ages 5 to 12 years old, perceive their capabilities through others' encouragement, reinforcement or restriction—thus discerning themselves as industrious or incompetent (Berk, 2007). Emphasis for parental paragon of activity-related behaviors is predicated on children referencing their parents' examples as the standard and expectation children set for themselves; additionally, children spend much time in close proximity to parents during their younger years. Indeed, during this impressionable time, parents are among the primary mentors for both health enhancing or compromising behaviors (Beets et al., 2010; Berk, 2007). During identify vs. confusion, children ages 12 to 18 years search for their identity by experimenting with a plethora of roles and ideas (Berk, 2007). Parents' paragon of activity-related behaviors is still essential but is also supplemented with other external influences and children's own experiences; hence, parents should strive to support children by involving them with other good role models and experiences (Beets et al., 2010).

To briefly review the aspect of parental support, classification and outcomes of tangible versus intangible support were comparable to the work of Beets, Cardinal, and Alderman (2010). As previously mentioned, parental support was found to have an additive effect on role modeling thereby distinguishing support as a powerful tool (Garriguet et al., 2017). In essence, parents that see themselves as poor role models, whether or not in their control, could still use support as an

effective means to reduce children's SB and increase PA; however, tangible and intangible support differed in levels of effectiveness. Analogous to Beets and colleagues review, tangible support (direct parent involvement through transportation, watching, or engaging in activities with children) was found to be the most successful support type. In contrast, intangible support (praise, beliefs, or encouragement) was helpful, but generally insufficient to significantly influence children's PA or SB (Beets et al., 2010).

Fourth, it is imperative for parents to enforce age-appropriate media time rules and hold themselves to good behaviors as well. This is crucial as abundant research has strongly linked SB with media time (Barnett et al., 2018). Regarding media rules, this present review reported mixed results between general media time rules verses restrictive TV parental practices—the latter surprisingly increasing SB. It is possible that self-report features skewed results, but more likely, as proposed by O'Connor & Teresia, restrictive parental practices likely were initiated for children requiring more supervision anyway. Furthermore, those children requiring more rules and supervision may have replaced their media time with other SB endeavors rather than PA. Fortunately, on the other hand, conventional media rules were found to be effective. Comparing to Zhang, Davey, Larson, and Reichs's (2019) study, parenting styles in order of effectiveness with influencing children's health activity levels were noted in the following order: authoritative parenting (leading as the most correlated with reduced SB and higher PA in children) then authoritarian, permissive, and lastly neglectful followed; neglectful parenting associating with the most amount of SB in children. In acknowledgement of the considerable effect of media time on children's SB, Barnett and colleagues (2018) suggest for parents to intervene by implementing "'screen-free'" time during after-school and weekend times, removing all screen-based devices from bedrooms and eating settings, and to encourage outdoor play and face-to-face

interactions (Barnett et al., 2018, p. 152). Akin to other studies, boys engaged in more media time, yet girls still accumulated more sedentary time (Pyper et al., 2016; Schoeppe et al., 2017). Further research is needed to delve into what SB girls participate in rather than watching TV or other media.

Fifth, parents ought to gain awareness of home environment features and influential attributes which correlate to activity-related consequences. Such an understanding would allow parents and their children to be empowered to tailor their individual situations to promote positive and avoid negative consequences—though some elements could be outside one's control. Regarding single-parent households stress, SB findings were likely due to children being allowed to watch more TV than their counterparts. Single-parents generally have less social, financial, and/or material resources to support them in their parenting practices, thus impacting the ability to enforce TV monitoring or other household rules. We are unable to compare other literature to the proceeding findings from Maher et al.'s study as it is one of the only articles of its kind, but which promotes our review to be unique.

In addition to the other parents and children attributes already discussed, parental influence in terms of culture was investigated in a single study by Hornby-Turner et al., which paralleled Beets and colleague's findings. British Pakistani parents were religiously and traditionally inclined as shown by prioritizing mosque and family events over school or sports events. Conversely, White British parents were more Westernized and less religious suggesting that culture and perhaps religiosity may play a determining role daughters' SB and PA levels (Beets et al., 2010).

Lastly, parents should allow and create opportunities for children to access play opportunities when possible. PA resources were more successful for boys than girls likely due to

boys independently instigating their own play on their own versus girls being indoors with parents. As parents engage in PA with children, findings indicate that PA resources would then benefit both boys and girls. The high success found with basketball hoops may be due to their availability and proximity as well as it's ability to cater to audiences of all ages and diversities.

Parental permission for children's independent outdoor mobility was mainly determined by surrounding social networks or the neighborhood type children lived in. Strong correlates of that obtained independent mobility include male sex, older age, and taller height (Stone et al., 2014). Children granted independent mobility had reduced SB and increased PA profiles, which similar with other studies findings, was beneficial for health outcomes (Schoeppe et al., 2017). Within supportive neighborhoods, Lawman and Wilson (2014) noted only LPA to be significantly affected by neighborhood and home environment influences rather than SB or PA. This nonetheless is still advantageous in attempting to avoid SB; however, that study acknowledged limitations to their findings due to their small sample group involving only specific high-risk populations thereby limiting generalization of its findings, therefore caution is needed regarding these results.

Healthcare providers are at the forefront of patient interactions and care and therefore have the ability and responsibility to proactively intervein. Ideally with every well visit, providers should: create awareness of the prevalence of SB and health risks associated, communicate to parents the influential roles they play which contributing to their child's activity levels, and assist parents and children with finding strategies for breaking up sedentary lifestyle habits for them and their children.

Limitations

Despite the evident benefits of conducting a systematic review, some limitations were inevitably encountered. First, it is essential to highlight that the proceeding analysis should be regarded as systematic review for children's SB alone and cannot extend the same endorsement to children's PA per limitations in the search framework and inclusion criteria. Though informative, PA findings were included solely for the purpose of enhanced context of the breadth of influence each parental aspect encompassed, and to further investigate the nature of SB and PA as independent or dependent variables; hence, findings regarding PA should not be considered comprehensive.

Originally, the inclusion criteria age range, 11 to 17 years, required studies to employ age groups within the specified range; however, this age group did not produce enough papers for review. Therefore, inclusion criteria was changed to require sample age groups to include, but not be limited, to the 11 to 17 year age range. Next, despite the extensive database searches, certain studies may have not been included due to language barriers. Additionally, sample sizes ranged from <100 participants to >1000 participants; however, due to this systematic review method, once studies passed the required quality rating needed, all studies were regarded with equal value. Moreover, inconsistencies between study results and/or conclusions are somewhat inevitable due to individual studies using different sample sizes, study designs, etcetera.

Conclusions

Despite national and world implementation plans and guidelines, children across the world are not meeting PA or screen time guidelines, and obesity along with other comorbidities continue to rise. The latest research is now revealing that SB itself is associated with mortality rates, which many are still unaware of, and therefore guidelines and additional research are

needed to address these concerns. The present systematic review utilized PRISMA guidelines to study parental influence on SB in their children, ages 11 to 17, using objective measures. The following aspects of influence were identified: role modeling, support, media time, home environment, access to play, and attributes of parent and children. In essence, success for reducing sedentary behavior in children most likely achieved when parents and children seek to avoid SB and engage in PA during their time together. In addition to parental modeling and support, parents should strengthen relationships with their children by being involved with them. Healthcare providers can proactively create awareness of SB risk factors, communicate to parents the influential roles they play in contributing to their child's activity levels, and assist parents and children with finding strategies for breaking up sedentary lifestyle habits for them and their children.

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Figure 1. **PRISMA Selection Flow Chart**

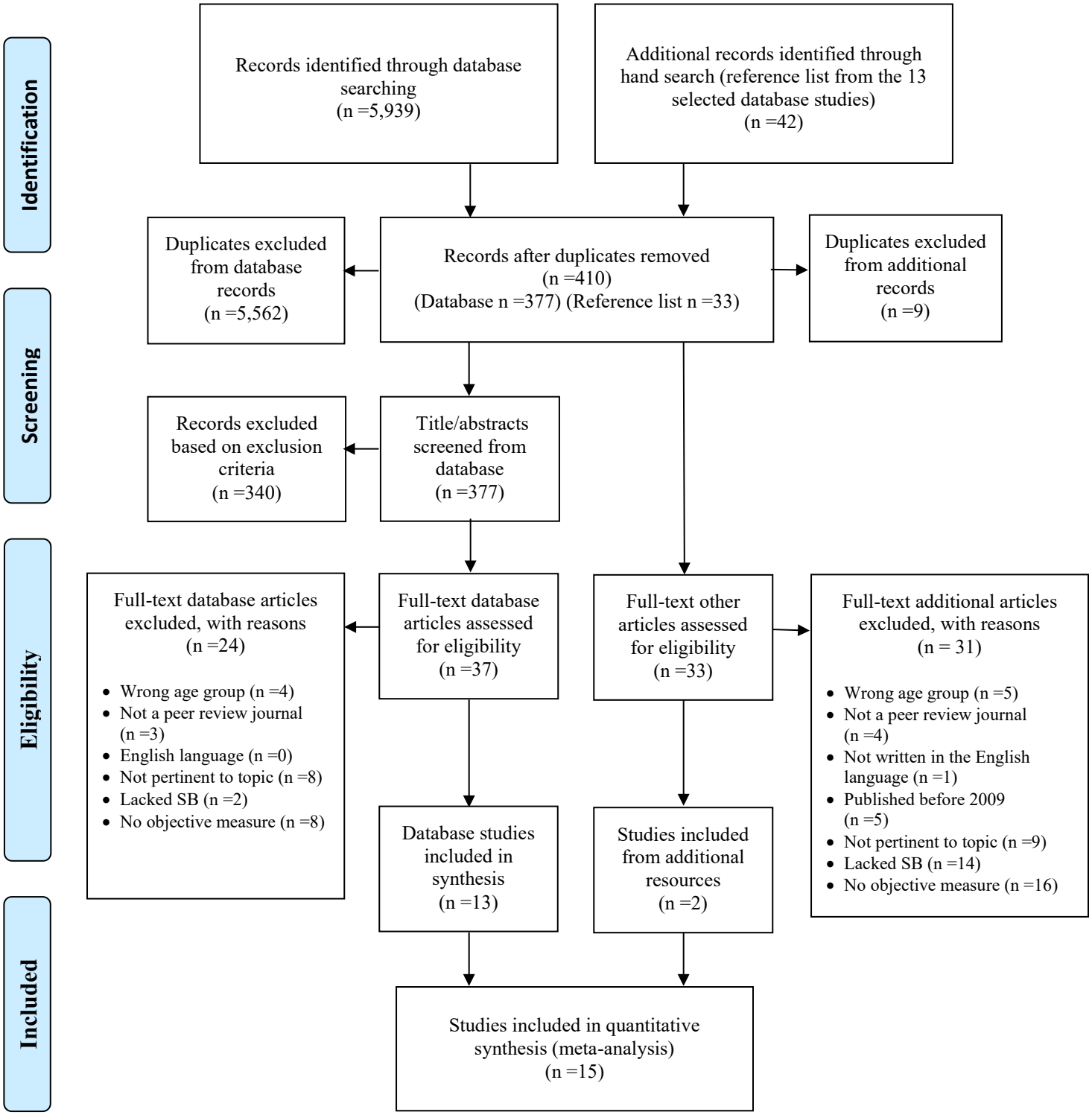

Table 1

Description of Study Characteristics

Reference	Sample Size (*N*)	Child Ages Years (*M*)	Children Sample Type (%)	Other Children Demographics (%)	Measure of Social Economic Status (%)	Country	Body Size (%)	Parents in Household (%)	Parent Ages Years (*M*)	Female Parents
#1Dunton et al. (2012)	291 Parent-child dyads	8-14 (11.2)	Girls (52.2) Boys (47.8)	Hispanic (43.0) Caucasian (26.1) Asian (9.3) AA (3.8) Other (17.9)	Income: <$30,000 (26.5) $30-60,000 (22.1) $60-100,000 (29.7) >$100,000 (21.7)	United States	Children: Overweight or obese (35.9) Parent mean BMI = 28.2	Not reported	26-62 (39.6)	87.6%
#2 Garriguet, Colley, and Bushnik (2017)	1,328 Parent-child dyads	6-11 (8.4)	Girls (49.2) Boys (50.8)	Not reported	Parent's education: < 2nd school graduation (20) Postsecondary- below bachelor's degree (41.9) > Bachelor's degree (37.6)	Canada	Not reported	Lone-parent household (15.7) Dual parent household (84.3)	(39.1)	59%
#3 Gillison et al. (2017)	430 Children	9-11 (10.4)	Girls (57) Boys (43)	87% White	Income < £20,000 (24.4)	England	Overweight or obese: Girls (21.3) Boys (18.8)	Not reported	Not reported	Not reported
#4 Hornby-Turner, Hampshire, and Pollard (2014)	145 Girls	9-11 WB: 9.9 ± 0.7 BP: 10.0 ± 0.7	Girls (100)	White British girls (48.3) British Pakistani girls (51.7)	Mother's employment status: *WB*: Employed/student (54) Unemployed: (22) Looking after home (24) *BP*: (16) Unemployed (14) Looking after home: (70)	England	Children: Normal weight (77) Overweight (13) Obese (7)	*WB* Lone parent household (47) Dual parent household (53) *BP*: Lone parent household (29) Dual parent household (71)	Not reported	51.3%
#5 Izquierdo-Gomez, Veiga, Villagra, and Diaz-Cueto et al. (2014)	98 Children	11-20 (15.3 ± 2.54)	Girls (35.7) Boys (64.3)	Not reported *Adolescents with Down Syndrome	SES: Low – medium (45.3) High (56.1) *SES measuring based on the Family Affluence Scale	Spain	Adolescents: Normal weight (48) Overweight-obese (52) Parents: Normal weight (43) Overweight-obese (57)	Not reported	≤ 49 52.1% ≥ 50 47.9%	50.3%
#6 Jago et al. (2010)	340 Parent-child dyads	10-11	"Sample was equally split between boys and girls"	Children from Great Britain	School SES: Low SES (30) Middle SES (40) High SES (30) *Totals collected and converted from IMD scores (Higher IMD = Lower SES)	England	Children: Average BMI (18.6 ± 2.98)	Not reported	Not reported	81.7% completed surveys

#7 Lau et al. (2015)	671 Children	6th Grade (11.49 ± 0.53)	Girls (53.2) Boys (46.8)	White (40) Black (30) Hispanic (8.4) Other (18.2)	Parental Education Level: ≤ High school (30.4) >High school (69.6)	United States	Average child BMI: 21.75 ± 5.21 Boys: 21.17 ± 4.88 Girls: 11.47 ± 0.54	Lone-parent household (20) Dual parent household (80)	Not reported	87% completed surveys
#8 Lawman and Wilson (2014)	181 Caregiver-child dyads	10-17 (13.3 ± 2.1)	Girls (60) and boys (40)	AA (79) Caucasian (12) Latino (8) Other (1) *88% racial/ethnic minorities	Income < $25,000 (59)	United States	Adolescent average BMI 33.5 ± 7.0 Caregivers average BMI 36.9 ± 9.9.	Not reported	(42.2 ± 10.4)	Not reported
#9 Maatta et al. (2015)	155 Children	11 (11.19 ± 0.33)	Girls (60) and Boys (40)	Finish children; specifics not reported	Education status: *Mothers*: Highly educated: (40.7) Others (59.3) *Fathers*: Highly educated (38.2) Others (61.8)	Finland	Children: Normal weight (81.5) Overweight (18.5)	Not reported	Not reported	51%
#10 Maher et al. (2017)	191 Mother-child dyads	8-12 (9.6 ± 0.9)	Girls (51) Boys (49)	*Children*: Hispanic (54) Caucasian (17.3) AA (9.4) Asian (6.9) Other/Mixed (12.4) *Mothers*: Hispanic (49) Caucasian (18.8) AA (17.3) Asian (4.5) Other/Mixed (19.7) *Assessing maternal correlates	Income: ≤ $35,000 (27.2) $35,001-75,000 (29.2) $75,001-105,000 (19.4) > $105,001 (23.9)	United States	Children: Underweight or normal (61.5) Overweight (21.5) Obese (16.9) Mothers: Underweight/ normal (34.2) Overweight (33.1) Obese (32.7)	Lone-parent household (23.3) Dual parent household (62.4) Multigenerational (14.3)	(40.9 ± 6.1)	100%
#11 O'Connor et al. (2012)	83 Children	9-12 (11.3 ± 1.8)	Girls (48) Boys (52)	AA (43) Caucasian (13) Hispanic (12) Other (6) Mixed heritage (25)	Income $20,000-$59,999 (57.3) Parents completing college or more (46.9)	United States	All children in the 50th-99th percentile BMI range	Not reported	Not reported	86.7% completed self-report question-aires
#12 Sigmund et al. (2015)	485 Children and 388 parents	9-12	Girls (51) Boys (49)	Czech children (100)	Not reported	Czech Republic	Children: Overweight (27.79) Obese (18.77)	Not reported	35-45	63%

#13 Stone, Faulkner, Mitra, and Buliung (2014)	856 Children	10-12 (11 ± 0.6)	Girls (54.6) Boys (45.4)	Not reported	Neighborhood type: Old Built Environment, Low SES (29.9) Old Built Environment, High SES (18.1) New Built Environment, Low SES (12.1) New Built Environment, High SES (39.7)	Canada	Children: Normal BMI (70.8) Overweight or obese (29.1)	Not reported	Not reported	Not reported
#14 Tandon et al. (2014)	713 Parent-child dyads	6-11 (9.2 ± 1.6)	Girls (49) Boys (51)	Parents: White (89) Black (2) Asian (4) Other (4) Hispanic (13) **Aimed to represent balanced typical city*	Income: ≤ $39,000 (9) $40-$89,000 (31) ≥ $90,000 (60)	United states; WA & CA states	Children: Overweight (15) Obese (11)	Not reported	(41.52 ± 5.85)	86% completed self-report surveys
#15 Tu, Watts, and Masse (2015)	98 Parent-child dyads	11-16 (13.1 ± 1.8)	Girls (58.2) Boys (41.8)	Vancouver Metropolitan area of British Columbia	Income ≤ $60,000 (32) $60,001-$100,000 (39.2) ≥ $100,001 (28.9)	Canada	Children: Overweight (62) Obese (38) Parent: Normal (22.5) Overweight (36.7) Obese (40.8)	Not reported	(45.9 ± 6.4)	82%

Table 2

Summary of Findings

Reference	Study design	Characteristics of study participants	Assessment of Activity and Sedentary Behavior	Parental Correlates	Main Findings
1. Dunton et al. (2012)	Cross-sectional over about 2 years	291 parent-child pairs, 52.2% female, 8-14 years old, 43% Hispanic.	Parents and child wore accelerometer and GPS device for the same 7 days. Sedentary activity defined as < 100 CPM	Role modeling, home environment, parent-child attributes	90% of parent-child pairs engaged in joint MVPA for short durations, verses 100% of parent-child pairs spent long periods in SB; Girls engaged in more SB with parents than boys.
2. Garriguet, Colley, and Bushnik (2017)	Linear Regression analyses over 6 years	1,328 biological parent-child pairs, N = 654 girls (49.2%)	Parents and children wore accelerometry for 7 days. Parents' reported screen-based activity. CMP criteria not reported	Role modeling, support, media time, home environment, parent-child attributes	Each 20 min/day increase in parent MVPA, increased child MVPA by 5-10 min/day. Significant RM & PS correlations found. Parental ST associated with daughters ST.
3. Gillison et al. (2017)	Cross-sectional over about 2 years	430 children (6th grade), 9-11 years old, 87% white	Accelerometers worn for 7 consecutive days. Parental and children completed questionnaire. MVPA ≥ 574 counts·15 sec and SB ≤ 25 counts·15 sec	Role modeling, support, media time, access to play, parent-child attributes	Parental encouragement found more beneficial than tangible interventions promoting child's PA. Girls SB decreased when parents provided transportation to active activities or participated in girl's PA.
4. Hornby-Turner, Hampshire, and Pollard (2014)	Mixed Methods	145 girls, 9-11 years old, 48.3% WB British (WB), 52% British Pakistani (BP)	Children wore accelerometers & self-reported PA and SB. Parents answered surveys and 19 participated in interviews. SB defined as <100 CMP, MVPA ≥ 2000 CMP	Role modeling, support, media time, home environment, access to play, parent-child attributes	Despite similar TVT, BP girls more sedentary, less active, & participated less in organized sports than WB girls. BP & WB parents reported constrains in time, family commitments, and fears of physical safety which affected girl's PA.
5. Izquierdo-Gomez, Veiga, Villagra, and Diaz-Cueto (2014)	Cross-sectional study, apart of the UP&DOWN study	110 Adolescence with Down Syndrome. 11-20 years old, with no physical disabilities for doing PA.	Accelerometers worn by both parents and children for 7 days. Parents completed questionnaires. SB defined as <100 CPM	Role modeling, support, media time, home environment, access to play, parent-child attributes	Down Syndrome adolescence ST correlated to mother's age, ST, education, and work status. SES, availability for childcare, mother's TV time, garden being present, home bedroom number, were inversely related to ST.
6. Jago et al. (2010)	Cross-sectional Sample	340 parent-child dyads. Children grade 6, 10-11 years old. 431 parent-child dyads with self-reported TV viewing.	Parents and child wore accelerometers for 5 days, and self-reported TVT. Parental MVPA defined as ≥ 2020 CPM, children's ≥ 3200 CPM Parents' SB <100 CPM and children's <727.	Role modeling, media time	Parent-child TVT correlated. Girls' risk of 4+ hr/day 3.67x more when parental TVT 2-4 hr/day; boys' risk 10.47x more when parents watch 4+ hr/day.
7. Lau et al. (2015)	Cross-sectional study-part of a longitunal study	671 children, 53.2% girls. M = 11.49 years old in 6th grade, 81.4% children at home after school. 70% parents have >high school education	Accelerometry worn by children for 7 days. and parents completed surveys reporting home social and physical environment features. SB defined as <100 CPM	Role modeling, support, home environment, access to play, parent-child attributes	The after-school period is significant for promoting PA. PA resources significantly decreased SB for boys. Children's PA time associate with parental support & monitoring, especially for girls.
8. Lawman and Wilson (2014)	Cross-sectional study	181 children, M = 13.3, low-income, 60% Female, 88% racial/ethnic minorities, and 75% on Medicaid	Accelerometers worn by adolescents for 7 days and parents/caregivers completed surveys. SB defined as <100 CPM	Support, home environment, access to play, parent-child attributes	High levels of parental limit-setting, monitoring, & parent/neighborhood social support significant with youth's LPA rather than SB or MVPA. Age associated with SB.
9. Määttä et al. (2015)	Cross-sectional study	155 11-year-old children in Finland. M= 11.2 yrs. 60 % of the children girls.	Accelerometer worn for 7 days and parental questionnaires used to assess MEDIA TIME. SB defined ≤ 100 CPM	Role modeling, support, media time, home environment, parent-child attributes	Though activities differed, similar SB times noted in both genders. No parental influence found affecting SB, but rather ST. Children's perception of parental PA reduces children's MEDIA TIME.

10. Maher et al. (2017)	Cross-sectional 1st part of MATCH, a longitudinal investigation	191 mother-child dyads, Maternal age M = 41, Children 8-12 years old, 51% female. 49% of mothers Hispanic/Latin, 56% work full-time, 62% dual-parent household	Mother & Child wore accelerometers for 7 days. Mothers completed questionnaires used to assess mental health, well-being, parental stress, demographics, etc. SB defined as <100 CPM	Role modeling, home environment, parent-child attributes	Mothers' parenting stress in single-parent households negatively associated with child's MVPA and + associated with SB when compared to dual and multigenerational households.
11. O'Connor and Teresia (2013)	Cross sectional	84 children, 9- 12 years old, were recruited and enrolled in the 13-week study	Valid accelerometer data collected over 7 consecutive days and questionnaires assessing PA and screen-media parenting practices. SB defined as <100 CPM. Screen time indicated as a SB parameter.	Role modeling, support, media time	Restrictive TV parenting practices associated with child SB and less MVPA. Parental PA logistic support associated with child MVPA. Bedroom or increased general availability of screen-media equipment associated with more SB.
12. Sigmund et al. (2015)	Linear regression	485 children, 9-12 years old, and 388 parents, 34-45 years old were randomly recruited for objective measuring	7-day pedometer-based assessment of Step count (SC) and ST duration (≥ 10 hr/day) and log book recording of activities for both parents and child. SB defined as < 100 CPM. Screen time indicated as a parameter of SB	Role modeling, media time, parent-child attributes	Each 1,000 SC increase in parents each weekday increased SC for sons and daughters. Less ST associated with less SB and more SC.
13. Stone, Faulkner, Mitra, and Buliung (2014)	Multi-disciplinary and mixed method study	856 children: 549 girls and 389 boys, stratified into four neighborhood levels based on time period of building and SES	Accelerometry measured for 7 days on children. Parents reported data in questionnaires to assess for child's allowance of independent mobility. SB & MVPA CPM not defined	Parental support, home environment, access to play, parent-child attributes	Children granted independent mobility had more positive PA profiles and less SB. CIM varied by gender, age, and neighborhood classification.
14. Tandon et al. (2014)	Cross sectional study	713 children, 6-11 years old, sample aimed to represent balanced typical city's race demographics	Child PA/SB measured with accelerometers for 7 days. Parents reported children's activities. SB activity defined as <100 CPM	Support, media time, home environment, access to play, parent-child attributes	Parental support for PA, more children in the home, and owning play equipment associated with MVPA and less SB. Bedroom media devices and exergaming associated with increased SB.
15. Tu, Watts, and Masse (2015)	Cross-sectional study	98 children: 57% female, 11-16 years old, M = 13.1	Accelerometers worn for 4+ weekdays & 1 weekend day. SB defined as <100 CPM	Role modeling, media time	Adolescents more active and less ST than parents on weekdays, reversed on weekends. Parent to adolescent SB not associated, but ST was.

+ = positive, – = negative, ± = greater than or equal to, SD: standard deviation, CPM= counts per minute, BP= British Pakistani, WB= White British, SES= social economic status, CIM = child independent mobility, RM = role modeling, PS = parental support, CIM = child independent mobility, CI= confidence interval, SB = sedentary behavior, PA = physical activity, LPA = light physical activity, MVPA = moderate to vigorous physical activity, TVPP= TV parental practices, VGPP=Videogame, OL=Old built environment, low SES, OH=Old built environment, high SES, NL=New built environment, low SES, NH=New built environment, high SES

Table 3
Objective Measures of Sedentary and Activity Behaviors in Children

	General SB	General LPA or PA	General MVPA	Screen Time	Total CPM
Role Modeling					
RM #1 Sedentary Behavior Findings					
Parent Sedentary Behavior	****+ association with girls on weekends and their sons during after school hours[2]** *****+association both genders each day[2]** *+ association with mother's SB, typically when mothers were older[5] ***+Association to girls' SB[6]** ****Mother's reducing their screen time (a parameter of SB) by 30 min/day on weekends increased daughter's SC by 494 steps and *467 steps for their sons.[12]** Lower number of steps for both parents and children on weekends[12] Parent and adolescent ST per accelerometry was not significantly associated[15]				
Parent-Child Time Together	*****More time during waking hours weekend days (143.9 ± 79.9 min) than non-school waking hours on weekdays (81.5 ± 38.5 min)[1]** **100% of parent-child pairs engaged in SB together[1]** Average of 92.9 ± 40.1 min/day non-school waking hours at home[1] ***Boys and girls SB associated with that of their parents[6]**		Parental MVPA not associated with girls MVPA[6]	*+ parent-to-child correlations for video game and computer time[15]	Parental CPM not associated to girls' CPM[6]
Child's Perception of Parent's PA	Children's SB not affected by parents perceiving PA as important[9]		WB girls allowed to have their dance/club/sports commitments take precedence over family activities had more MVPA[4] Children's SB not affected by parents perceiving PA as important[9]	*Lowered perception of father's PA+ association with TV viewing[9] *Lowered perception of mother & Father's PA + associated with computer use[9]	
RM #2 Other Findings					
Parent General Activity Behavior	*– association in girls when parents took part in sports[3]	Marginally + associated with girls after-school total PA ($p = 0.09$)[7] *****Explicit modeling + associated with PA[11]**	*****Parent MVPA associated to children's on all days.[2]** *****+ 5-10 min/day for every 20 minutes parents exhibited MVPA for girls always and boys after-school[2]** *****Girls' weekday MVPA + associated with parents (in models)[3]**	*Logistic support for PA – associated with less screen time[11]	*Logistic support associated with greater child CPM[11] *****Each 1,000 step increase for mother's on weekdays, + associated with 261more daily steps in their daughters and 413 daily steps in their sons[12]**

			*Logistic support + associated with MVPA[11] *+ associated with adolescent MVPA all days[15] ***1% increase in average parent MVPA + associated with child MVPA increase by 0.18%, 0.21%, or 0.29%[15]**		***Every 1,000 step increase for fathers steps/weekday, + associated with 244 step increase in their sons[12]** No association for father/daughters step count during weekdays[11] *****For every 1,000 step increase in mothers' steps/weekend day, + associated ***523 increased steps by daughters and ***508 for their sons[12]** ****Every 1,000 step increase for fathers on weekend days, + associated to 386 increased steps in daughters and 435 increased steps in sons[12]**
Parent-Child Time Together			*****3.9 ± 8.1 min/day weekend days[1]** **89.4% parent-child pairs engaged in some MVPA together[1]** Average of 2.4 ± 4.1 MVPA min/day during non-school waking hours at home[1] Parental MVPA not associated with girls MVPA[6]		Parental CPM not associated to girls' CPM[6]
Parent/Child in Close Proximity, but Not Engaging Together	Average of 170.7 ± 53.53 min/day during non-school waking hours (46.5% with parent)[1] Parents spend about 191.0 ± 55.5 min/day of SB (41.7% with child)[1] While parents engaged in MVPA nearby, child performed 1.9 ± 2.3 min/day of SB[1]	With parent engaged in MVPA nearby, children's LPA increased by 2.7 ± 4.5 min/day[1]	Children spend about 19.5 ± 15.5 MVPA min/day during non-school waking hours (10.3% with parent)[1] Parents spend about 11.7 ± 11.7 min/day of MVPA (16.0% with their child)[1] *10 min/day[1] When parent engaged in MVPA nearby, child engaged in 2.7 ± 4.5 min/day LPA[1] On average, children engaged in 35.3 min/day of MVPA compared to parents 36.9 min/day[6]		
Parental Support					
PS #1 Tangible Support *Watching/Taking Part*	*– association weekdays[3] *Ability for parent to care for child inversely associated with SB[5] "Logistical support" associated with –4.55 min/day both genders[11]	+3.79 min/day in LPA[11]	Approached significance girls weekdays[3] *Parents with increased logistic support + association with child's MVPA[11] *+1.75 CPM[11]		***Parents who reported higher PA logistic support had children with greater total activity CPM[11]** *High PA support +11.00 CPM[11]
Child Participation in Sports	****Less SB in WB girls whose parents supported more organized sports and clubs during the week[4]**		*****participation in 2+ hrs of lessons/league/team sports significantly related to child's MVPA on all days[2]** In WB families, daughters' sports or club commitments often took precedence over family activities leading to more MVPA[4]		

PS #2 Intangible Support *Encouragement*	*– association weekends[3] No associations noted for parental influence and overall sedentary time, but do reduce types of SB[9]		*+ association weekdays[3] **+ association weekends[3] ***+ association for girls[3]** No associations noted for parental influence and MVPA[9]	***Father's encouragement for PA inversely associated with TV viewing[9]**	
Other Intangible Support	Support for PA did not appear protective of SB for either gender[3] ***more child SB for children with DS when parents perceived PA as very important[5]** **No significant associations for SB[8]**	*Social support + association with LPA[8] *Girls who received more support demonstrated more PA[8] ***Limit setting/monitoring + association with increased LPA[8]**	In WB families, daughters' sports or club commitments often took precedence over family activities leading to more MVPA[4] No significant associations for MVPA[8]		
PS #3 General Support	Marginally + associated with girls after-school total PA ($p = 0.09$)[7] *Girls receiving less support for PA tended to have more after-school ST than boys[7] ***– associated after school for girls during the afterschool period[7]** *Reduced by 19 min/day[14] ****Dual parent support associated with –19.33 min/day[14]**	*+ association with afterschool PA[7] *Much higher levels of PA for girls with more parental support[7] Marginally + associated with girls after-school total PA ($p = 0.06$)[7]	***Support for child's PA had an additive effect beyond RM. Effect strongest for less active parents[2]** ****+ association with after school MVPA for both genders[7]** ****+ during after school period for girls receiving more parental support then typical[7]** ****Improved PA by 12 min/day [14]** ****Dual parents support associated with + 11.79 min/day[14]**		
Media time					
MT #1 Media Time Findings *General Parental Media Time*	***+ association with father's TV viewing time[5]** ***– association with mother's TV viewing time[5]**			****+ associated with both children's gender MT[2]** **49.7% of parents reported watching <2 hours of TV per day[6]**	****Reduction of ST by 30 min/day on weekends in mothers + associated with increasing daughters step count by 494** and 467* steps a day for their sons[12]**
Parent Computer Time				****+ association with both girl's and boy's computer time[2]** ***+ association with adolescents' computer time, each additional hour parents had, teens increased by 0.42 hours[15]**	
Parent video Game Time			***Parent/children's active VG –5.36 MVPA min/day at home[14]**	****Active VG associated with +17.35 MT min/day[14]** ***+associated with adolescents' video game time on weekends; For each additional hour parents weekend VG time, teens increased by 1.10 hours[15]**	

Parental TV Time < 2 hr/day				**+ association for boys & girls[2] *+ association with Father's TV viewing time[5] *inverse association with Mother's TV viewing time[5] Not significantly associated to adolescents[15]	**Reducing mother's screen time by 30 min/day increased daughters step count by **494 per day, and their sons *467[12]
Parent TV Time 2-4 hr/day				*Risk of girls watching 4+ hr/day is 3.67x higher when compared to reference group of parents watching <2 hr/day[6]	
Parent TV time 4+ hr/day				* Risk for boys watching 4+ hrs is 10.47x higher[6]	
TV Social Co-Viewing With Parents				*+ association, especially for watching during 2+ meals[5] *Significant increase with watching with parents[5] **+ association with siblings/peers[14]	
Restrictive Media Parenting Practices	*+association with restrictive TVPP[11]		*– MVPA association with restrictive VGPP[11]; * –1.01 CPM[11]	***+ associated with child's media viewing[11]	*6.02 less CPM[11]
Bedroom Media	*+ association[11] *Less media access in bedroom less SB[14]	*–2.33 min/day of PA[11]	* –2.33 CPM[11]	**+13 min/day[14]	* –16.86 CPM[11] **–12.32 CPM in LPA[11]
Increased Media Access	Less BP then WB girls reported 2+ hr/day of tv, however BP still collected more SB in other behaviors[4] *+ association[5] *+ association[11] *Screen time with peers + associated with SB (+ 6 min/day)[14]			* Risk for boys watching 4+ is 10.47x higher when parent's watch 4+ hr/day[6] *Boys + associated with increased TV and computer use[9] *Screen time with peers + associated with SB (+ 6 min/day)[14]	
MT #2 SB Findings *General Parental Media time*	*+ association with father's TV viewing time[5] *– association with mother's TV viewing time[5]				
Restrictive Media Parenting Practices	*+association with restrictive TVPP[11]		*– MVPA association with restrictive VGPP[11] * –1.01 CPM[11]	***+ associated with child's media viewing[11]	*6.02 less CPM[11]
Limiting MT	*Parental rules for media – 8 min/day at home[14]	*Higher levels of LPA + associated with parental limit-setting and monitoring[8]	**Decreased[11]	**Parental rules for media –associated with 38 min/day less for children[14]	

Bedroom Media	**+ association[11]** ***Less media access in bedroom less SB[14]**	*–2.33 min/day of PA[11]		**+13 min/day[14]	* –16.86 CPM[11] **–12.32 CPM in LPA[11]
Increased Media Access	**Less BP then WB girls reported 2+ hr/day of tv, however BP still collected more SB in other behaviors[4]** ***+ association[5]** ***+ association[11]** ***Screen time with peers + associated with SB (+ 6 min/day)[14]**			Around half reported <2 hr/day of TV[6] * Risk for boys watching 4+ is 10.47x higher when parent's watch 4+ hr/day[6] *Boys + associated with increased TV and computer use[9] *Screen time with peers + associated with SB (+ 6 min/day)[14]	
MT #3 Other Findings *Limit-Setting and Monitoring*	*Parental rules for media – 8 min/day at home[14]	***Higher levels of LPA + associated with parental limit-setting and monitoring[8]**	**Decreased[11]	**Parental rules for media –associated with 38 min/day less media time for children[14]	
Miscellaneous				*+ Association with parent being less educated[9] Increased SES lowered screen time by 3.9 min/day[14]	****Reducing mother's screen time by 30 min/day increased daughters step count by **494 per day, and their sons *467[12]**
Home Environment					
HE #1 Sedentary Behavior Findings *General Home Environment*	*Garden/terrace present at home + associated with SB[5] *Inverse association with day length, and average temperatures at 2 pm and 8 pm[9] SB at home 46.4% of child's overall SB[14] ***SB performed at home + associated with overall SB[14] *Family safety rules +7 min/day of SB at home[14]		WB parents more likely to place emphasis on sports than BP parents[4] MVPA at home made up of 43.6% of overall MVPA[14] ***MVPA at home +associated with overall MVPA[14] ***SB performed at home –associated with general MVPA[14]		
Higher SES	Positively associated[1] Generally not significant[2] Inversely associated[5] More significantly affected by CIM granted than SES of neighborhood[13]		*Greater SES than $100,000 negatively associated with MVPA[1] *+1.27 min/day[14]	** −3.9 min/day [14]	
Number of Children at Home	*Increase in bedroom number related to SB[5] **+12.10 min/day at home[14]		**Daily over all MVPA +5.15 min/day[14] ****Home MVPA +11.18 min/day at home[14]**	***−6.48 min/day[14]**	
Neighborhood Support	**Nearby shops in neighborhood – associated[5] No significant association with SB[8]	***+ association with LPA[8]**	No significant association with MVPA[8]		

After-School Time (Mean minutes per hour)	****Mean min per hour both genders: 29.45 ± 6.29 min/hr at home[7]	****Mean both genders: 30.74± 6.47 min/hr[7]	****Mean min per hour both genders: 3.89± 3.24 min/hr at home[7]		
Maternal Well-being	* Maternal good self-esteem – associated with SB[10] Maternal financial stress marginally +associated with SB ($p = 0.07$)[10]		Mothers with good self-esteem marginally + associated with MVPA ($p = 0.07$)[10]		
Parenting Stress in Single/Dual/Multigenerational Households	*In single-parent households, parenting stress + associated with SB[10] *Child of single-parent mother experiencing greater parenting stress spent 33 more min/day in SB compared to dual/MG household experiencing similar stress levels[10] *No association to child SB in dual/multigenerational households[10]	*Only in single-parent households, parenting stress – associated with PA[10]	***Only in single-parent households, parenting stress – associated with MVPA[10]** ***Child of a single mother experienced about 10 less min/day of MVPA than another dual/MG households[10]** ***Dual parent/multigenerational households moderated child's lack of MPVA[10]**		
HE #2 Other Findings *General Home Environment*	*Garden/terrace present at home + associated with SB[5] *Inverse association with day length, and average temperatures at 2 pm and 8 pm[9] SB at home 46.4% of child's overall SB[14] ***SB performed at home + associated with overall SB[14] *Family safety rules +7 min/day of SB at home[14]		WB parents more likely to place emphasis on sports than BP parents[4] MVPA at home made up of 43.6% of overall MVPA[14] ***MVPA at home +associated with overall MVPA[14] ***SB performed at home –associated with general MVPA[14]		
Higher SES	Positively associated[1] Generally not significant[2] Inversely associated[5] More significantly affected by CIM granted than SES of neighborhood[13]		*Greater SES than $100,000 negatively associated with MVPA[1] *+1.27 min/day[14]		
Number of Children at Home	*Increase in bedroom number related to SB[5] **+12.10 min/day at home[14]**				
Neighborhood Support	**Nearby shops in neighborhood – associated[5] **No significant association with SB[8]**	***+ association with LPA[8]**	No significant association with MVPA[8]		
After-School Time (Mean minutes per hour)	****Mean min per hour both genders: 29.45 ± 6.29 min/hr at home[7]	****Mean both genders: 30.74± 6.47 min/hr[7]	****Mean min per hour both genders: 3.89± 3.24 min/hr at home[7]		
Maternal Well-being	** Maternal good self-esteem – associated with SB[10]** Maternal financial stress marginally +associated with SB ($p = 0.07$)[10]		Mothers with good self-esteem marginally + associated with MVPA ($p = 0.07$)[10]		

Parenting Stress in Single/Dual/Multigenerational Households	***In single-parent households, parenting stress + associated with SB[10]** ***Child of single-parent mother experiencing greater parenting stress spent 33 more min/day in SB compared to dual/MG household experiencing similar stress levels[10]** ***No association to child SB in dual/multigenerational households[10]**	*Only in single-parent households, parenting stress – associated with PA[10]	***Only in single-parent households, parenting stress – associated with MVPA[10]** ***Child of a single mother experienced about 10 less min/day of MVPA than another dual/MG households[10]** ***Dual parent/multigenerational households moderated child's lack of MPVA[10]**		
Access to Play					
AP #1 Sedentary Behavior Findings					
Presence of Basketball Hoop	*–10 min/day[14]	***Increased[14]**	***+6 min/day[14]**		
Portable Play Equipment/Playsets	*– association with boys[7] **Boys with more PA resources had lower levels of after-school ST[7]	***+ association with boys[7]** ****Boys with more PA resources had more after-school PA[7]**			
Home PA Resources	* – associated with after school SB in boys[7]	***+ associated boys/girls[7]** ****+ associated boys[7];** **Marginal – association for girls[7]**			
Child Participation in Lessons/Team Sports	**Less SB in WB girls whose parents supported more organized sports and clubs during the week[4] More SB in BP girls with more limitations to organized sports or exercise[4]		***results in 2-3 hr/wk more for boys[2]** ****results in 4-6 hr/wk more for boys and girls[2]** ******7+ hr/wk for girls[2]** In WB families, daughters' sports or club commitments often took precedence over family activities leading to more MVPA[4]		WB parents more supportive of organized sports and clubs during the week which was + associated with increased CPM and less SB for WB girls[4]
Low CIM Girls	Girls considered more vulnerable than boys and thus granted less access to play outdoors[4] OL: 3.2% increase afterschool period[13]	WB more likely than BP to report playing outdoors[4] OL: 2.4% decrease afterschool period in LPA[13] High SES: Lessened PA on weekends[13]	OL: –6.1 min/day weekdays, 95% CI[13]; 1.3% decrease afterschool period[13]		
Low CIM Boys	NH: 1.8% increase, 95% CI[13] OL: +5.3% afterschool hours, 95% CI[13] OH: +10.4% afterschool hours, 95% CI[13]	OL: Lessened LPA on weekdays[13]; 2.9% decrease in LPA during afterschool hours, 95% CI[13] OH: –30.2 min/day in LPA on weekend days (95% CI)[13]; 8.2% decrease in LPA during afterschool hours[13] OL/OH: Lessened PA on weekdays[13]	OL: –7.0 min/day; 95% CI on weekend days[13]; 2.4% decrease afterschool hours, 95% CI[13] OH: Lessened MVPA on weekdays[13]; 2.2% decrease afterschool hours 95% CI[13]		
High CIM Girls 54.4%	***-10.5 min/day weekday[13] *All SES: Lower on weekends[13]	***+7.3 min/day weekday[13]** *All SES: Increased on weekends[13] ; *All SES: Increased LPA on weekends[13]	***WB more likely to play outside than BP girls[4]** ***+6.2 min/day on weekdays[13]** ***All SES: Increased on weekends[13]**		

High CIM Boys 69.4%; generally older and taller	Lower, but not significantly[13]	*+6.2 min/day weekdays *+3.7 min/day weekends[13]	***+3.4 min/day on Weekends[13]**		
AP #2 Other Findings *Presence of Basketball Hoop*	***–10 min/day[14]**	*Increased[14]	*+6 min/day[14]		
Portable Play Equipment/Playsets	*– association with boys[7] **Boys with more PA resources had lower levels of after-school ST[7]	*+ association with boys[7] **Boys with more PA resources had more after-school PA[7]			
Home PA Resources	* – associated with after school SB in boys[7]	*+ associated with both genders[7] **+ associated specifically boys[7]; Marginal – association for girls[7]			
Child Participation in Lessons/Team Sports	**Less SB in WB girls whose parents supported more organized sports and clubs during the week[4] More SB in BP girls with more limitations to organized sports or exercise[4]		*results in 2-3 hr/wk more for boys[2] **results in 4-6 hr/wk more for boys and girls[2] ****7+ hr/wk for girls[2]		WB parents more supportive of organized sports and clubs during the week which was + associated with increased CPM and less SB for WB girls[4]
Low CIM Girls	Girls considered more vulnerable than boys and thus granted less access to play outdoors[4] OL: 3.2% increase afterschool period[13]	WB more likely than BP to report playing outdoors[4] OL: 2.4% decrease afterschool period in LPA[13] High SES: Lessened PA on weekends[13]	OL: –6.1 min/day weekdays, 95% CI[13]; 1.3% decrease afterschool period[13]		
Low CIM Boys	NH: 1.8% increase, 95% CI[13] OL: +5.3% afterschool hours, 95% CI[13] OH: +10.4% afterschool hours, 95% CI[13]	OL: Lessened LPA on weekdays[13]; 2.9% decrease in LPA during afterschool hours, 95% CI[13] OH: –30.2 min/day in LPA on weekend days (95% CI)[13]; 8.2% decrease in LPA during afterschool hours[13] OL/OH: Lessened PA on weekdays[13]	OL: –7.0 min/day; 95% CI on weekend days[13]; 2.4% decrease afterschool hours, 95% CI[13] OH: Lessened MVPA on weekdays[13]; 2.2% decrease afterschool hours 95% CI[13]		
High CIM Girls 54.4%	***-10.5 min/day weekday[13] *All SES: Lower on weekends[13]	***+7.3 min/day weekday[13]** *All SES: Increased on weekends[13] *All SES: Increased LPA on weekends[13]	*WB more likely to play outside than BP girls[4] *+6.2 min/day on weekdays[13] *All SES: Increased on weekends[13]		
High CIM Boys 69.4%; generally older and taller	Lower, but not significantly[13]	*+6.2 min/day weekdays *+3.7 min/day weekends[13]	*+3.4 min/day on Weekends[13]		
Attributes of Parents and Children					
APC #1 Sex *Female Sex*	**Girls inherently more sedentary compared to boys[1]** ****Girls significantly more sedentary compared to boys [3, 7, 8]**	**Less PA in girls than boys [7, 13]**	**Girls performed more MVPA with parents than boys[1, 2]** ***Girls engaged in 18 min/weekday less of MVPA than boys, and 17.4 fewer min/weekend day[3]	*Risk of girls watching 4+ hr/day is 3.67x higher when compared to reference group of parents watching <2 hr/day[6]	*less step counts for girls on weekends then week days[12] **Weekday:** **Mother's 1,000-step increase = 261 SC increase for daughters[12]

	***Girls more + associated with parents' SB than boys[1,2,3,6]** ***Parental SB predicted girls' SB[6]** ***+0.07 min/day while at home[14]** *Increased daily SB by 11.64 min/day[14]		*****Girls weekday MVPA predicted by parent influence[3]** No MVPA association for girls to parents[6] **Girls had less MVPA than boys[7]** ** −10.47 min/day at home in girls[14] ****Overall daily MVPA −24.10 min/day[14]**	−2.28 min/day[14]	*Father's SC not significant on weekdays for daughters[12]* **Weekend days:** ***Mother's 1,000-step increase = 523 SC increase[12] **Father's 1,000-step increase = 386-step increase for daughters[12]
Male Sex	*****Gender alone had an effect on SC in children, boys obtaining more step counts both weekdays and weekends[12]** −0.07 min/day at home in boys[14] *−11.64 overall min/day[14]		***+ association[3] ** +10.47 min/day at home[14] **Overall daily MVPA +24.10 min/day[14]	*** Risk for boys watching 4+ hrs is 10.47x higher[6]** *+ associated with TV viewing and computer use[9] *****Male parents significantly had more MT than female parents[12]** +2.28 min/day[14] *Boys more likely to spend time playing video games than females during weekends[15]	***Less step counts of weekends then weekdays for boys[12] **Weekday:** ***Mother's 1,000-step increase = 413 SC increase in sons[12] *Father's 1,000-step increase = 244-SC increase for sons[12] **Weekend:** ***Mother's 1,000-step increase = 508 SC increase in sons[12] **Father's 1,000-step increase = 435-SC increase for sons[12]
APC #2 Age *Older Parents*	*More time sedentary with children[1]; **Significant + association with older children[1] *+ association with mother's age[5]		**Lessened MVPA with child[1]		
Older Children	**+ association only for girls, especially during weekends[3] *+ association both genders[5, 8] **+ association[1] **+11.43 min/day of SB at home[14] **+20.68 min/day of general SB[14] Older children had more SB on all days than younger children[15]	*Lower LPA with increased age[8]	Marginally – associated[1] *– associated[8] **–11.98 min/day of MVPA at home[14] ** −22.52 min/day less of overall MVPA[14]	*+4.91[14] + associated with more computer time[15]	*Older adolescents more likely to have fewer step counts on weekdays[15]
APC #3 Child Motivation Type	***Autonomy had an inverse relationship for boys on weekends[3] *SB + association of self-efficacy for girls[3]		*Autonomy + association with boys during weekends[3] *Self- Efficacy + associated with girls on weekends[3]		
PCC #4 Higher BMI *higher percentages of obesity in sons (12.34%) then in daughters (6.43%)[15]	*+ association for girls on weekdays[3] Greater time spent in SB[3] *+ association with girls compared to boys[7] *+ association with age[8] *+association with SB[9] *+11.81 min/day[14]		*Increased BMI was −associated with boys' MVPA levels[2] **Parents with higher BMI – association to girls MVPA weekdays and weekends[3] *– association with MVPA weekdays[3] * −6.63 min/day[14] * −5.36 min/day at home[14]	*+ association[9] **+24.50 min/day[14] *Adolescents of obese parents more likely to watch more TV than adolescents of normal weight[15]	
APC #5 Culture *BP vs WB*	***Mean difference: BP 28 min/day more than WB[4] 65% of BP girls attending mosque after school for ~2 hr/day [4] + with BP hesitancies with mixed-sex sports[4]	Activity levels diverged, WB girls with > PA & < ST, on both weekend days and school days after 3 pm[4] BP more family activity exercise rather than organized sports[4]	***On average, WB girls had 14 more minutes compared to BP girls[4] **WB more + associated than BP sports participation[4] *WB more likely to play outdoors[4] **WB more likely to engage in active travel to school[4]	No significant differentiation between BP and WB BP parents more likely to express appreciation of TV occupying children more than WB parents[4]	***On average, WB girls had 102 more CPM than BP[4]

Parental Education/Work Level	*Child SB + associated with mother's education beyond high school[5] *Child SB + associated with mother working[5]			*Parent education level + associated with parent being less educated[9]	

(+) = positive, (–) = negative, min/day = minutes per day, hr/day = hours per day, days/wk = days per week, SD: standard deviation, CPM= counts per minute, BP= British Pakistani, WB= white british, SES= social economic status, CIM = child independent mobility, CI= confidence interval, ST = sedentary time, PA = physical activity, LPA = light physical activity, MVPA = moderate to vigorous physical activity, TVPP= TV parental practices, VGPP=videogame, OL=old built environment, low SES, OH=old built environment, high SES, NL=new built environment, low SES, NH=new built environment, high SES

1. Dunton et al., (2012); 2. Garriguet, Colley, and Bushnik (2017); 3. Gillison et al. (2017); 4. Hornby-Turner, Hampshire, and Pollard (2014); 5. Izquierdo-Gomez, Veiga, Villagra, and Diaz-Cueto et al. (2014); 6. Jago et al. (2010); 7. Lau et al. (2015; 8. Lawman and Wilson (2014); 9. Maatta et al. (2015); 10. Maher et al. (2017); 11. O'Connor et al. (2012); 12. Sigmund et al. (2015); 13. Stone, Faulkner, Mitra, and Buliung (2014); 14. Tandon et al. (2014); 15. Tu, Watts, and Masse (2015)

Each finding's significance (per *p*-value, etc.) was indicated with coding a certain number of asterisks (*), see reference chart below Table 2. Non-significant associations were left with no asterisk marking. Furthermore, significant or recurring results were bolded as they were considered major findings for each theme (see Table 2).

*$p < 0.05$ or less
** $p < 0.01$ or less
***$p < 0.001$ or less
****$p < 0.0001$ or less