

Evidence synthesis

Where are children and adults physically active and sedentary? – a rapid review of location-based studies

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Abstract

Introduction: Geographical positioning systems (GPS) have the capacity to provide further context around *where* physical activity (PA) and sedentary time (ST) are accrued especially when overlaid onto objectively measured movement. The objective of this rapid review was to summarize evidence from location-based studies which employed the simultaneous use of GPS and objective measures of PA and/or ST.

Methods: Six databases were searched to identify studies that employed the simultaneous use of GPS and objective measures of PA or ST to quantify location of movement. Risk of bias was assessed, and a qualitative synthesis completed.

Results: Searching identified 3446 articles; 59 were included in the review. A total of 22 studies in children, 17 in youth and 20 in adults were captured. The active transportation environment emerged as an important location for moderate-to-vigorous intensity physical activity (MVPA) in children, youth and adults. In children and youth, the school is an important location for MVPA, especially the schoolyard for children. Indoor locations (e.g., schools, homes) appear to be greater sources of lighter intensities of PA and ST. The review was limited by a lack of standardization in the nomenclature used to describe the locations and methods, as well as measures of variance.

Conclusion: Evidence suggests that the active transportation environment is a potentially important contributor of MVPA across an individual's lifespan. There is a need for future location-based studies to report on locations of all intensity of movement (including minutes and proportion) using a whole-day approach in larger representative samples.

Keywords: motor activity, sedentary time, location, built environment, active transportation

Introduction

Greater physical activity (PA) and lower sedentary time (ST) have been shown to independently play a role in the prevention of chronic conditions (e.g., cardiovascular disease, diabetes, obesity and cancer).^{1,2} While the importance of these health behaviours is largely acknowledged, the majority of children and adults do not meet current PA guidelines and spend most of their days engaged in sedentary behaviour.³⁻⁵ Further, PA levels decline

with age, and sex differences in PA are often observed.^{6,7} The built environment refers to our physical surroundings and includes for example parks, workplaces, schools, active transportation infrastructure, and homes among many others. The built environment has been associated with levels of PA and ST.^{8,9}

Much of the evidence around the relationship between the built environment and PA/ST has come from cross-sectional studies which obtain contextual information

Highlights

- The active transportation environment is an important location for physical activity in children, youth and adults.
- Among children and youth, the school (especially the schoolyard) is an important location for physical activity.
- Indoor locations (e.g., schools, homes) appear to be greater sources of lighter intensities of physical activity and sedentary time.

(e.g., presence of parks in the neighbourhood) from either self-report perceptions of environment or by using geographical information systems (GIS) and associations with movement (largely based on self-report).¹⁰⁻¹² While this information can provide an assessment of environmental exposure, it cannot always infer direct causality for *where* an individual's behaviour actually occurs. Context-specific patterns of movement refer to movement that occurs within specific domains or locations. Context-specific studies have examined behaviours which occur in locations such as neighbourhoods¹³ or parks¹⁴ through direct observation or mapping and can provide detailed information about what parts of the environment individuals interact with (e.g., paths within a park, play structures, etc.). However, these studies are often limited to one location/domain and can be time and resource intensive to conduct.

The advent of newer technologies to track an individual's location such as geographic

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positioning systems (GPS) have the capacity to provide further context around *where* PA and ST are accrued.¹⁵⁻¹⁷ Additionally, the overlay of GPS onto objectively measured movement data allows for a more robust quantification of behaviour within locations and has the capacity to provide a more comprehensive picture of an individual's activity space.¹⁸ Providing greater context can facilitate a better understanding of the locations in which behaviours are undertaken and whether they differ across the life span and between sexes. The objective of this review was to identify and summarize evidence from location-based studies which employed the simultaneous use of GPS and objectively measured PA or ST.

Methods

A rapid review was employed; the protocol was prospectively registered with PROSPERO (see: <https://www.crd.york.ac.uk/prosperto/>; #CRD42018084640). A rapid review employs general systematic review methodology but allows modifications for a quicker time to publication. This rapid review employed systematic review methodology but relied upon a single screener and data abstractor with support from data verification checks.

Criteria for considering studies for this review

Population

Data from high-income Organization for Economic Co-operation and Development (OECD) countries¹⁹ and apparently healthy populations were included. Findings were grouped into children (3–11 years), youth (12–17 years) and adults (≥ 18 years).

Exposures

The review included studies that used GPS information to objectively identify location of movement behaviour. GPS technologies included the Global Navigation Satellite System to determine location, direction and speed of the device.²⁰ For the purpose of the review, active transportation was included as a location term to define the location of behaviours that were specific to transportation, that weren't reflected by other locations (e.g., journey from home to school).

Outcomes

Studies must have used an objective measure of movement including pedometers,

heart rate monitors and accelerometers to define time spent sedentary, time spent in light intensity physical activity (LPA), in moderate intensity physical activity (MPA) and in vigorous intensity physical activity (VPA).

Study design

Observational (prospective cohort, cross-sectional and case-control) and experimental (randomized controlled trials, pre-post and quasi-experimental) studies were included. Reviews and qualitative studies were excluded.

Publication status and language

Only publications in English or French, and published studies and indexed dissertations were eligible.

Search strategy

A comprehensive search strategy was developed in collaboration with two research librarians. The following six bibliographic databases were searched: Ovid MEDLINE(R) In-Process (1946 to January 5, 2018); Ovid EMBASE (1974 to January 5, 2018); Ovid PsycINFO (1806 to January Week 1, 2018); EBSCO CINAHL (1982 to January 5, 2018); EBSCO SportDISCUS (1830 to November Week 2, 2017); and, ProQuest Dissertations & Theses Global (1743 to January 5, 2018). The search strategy used for MEDLINE is included in Table 1. Bibliographies of key review papers were also searched.

Selection of studies

Articles were imported into RefWorks (RefWorks, Bethesda, MD, USA) and, after

removal of duplicates, exported to Microsoft Excel for screening. A single reviewer (SAP) screened the titles, abstracts and full texts of all studies. In the event that the reviewer was unsure, a co-author (GPB) was consulted.

Data extraction and analysis

Data abstraction forms were completed in Microsoft Excel by one reviewer (SAP) and a random 10% sample verified by another (AM). Information extracted included: publication details (author, year, location); sample size; study design; participant characteristics (age, sex, population); data collection period (e.g., seven days of wear); GPS monitor; movement monitor and cut-points (e.g., ST < 100 counts/minute); locations assessed (e.g., home, work, school, transportation, park); outcome assessed (e.g., ST, LPA, moderate-to-vigorous intensity physical activity [MVPA], steps); and, description of outcome.

Due to heterogeneity in reporting outcomes across studies and lack of reporting on variance, the review uses a qualitative synthesis. Insufficient data was available to examine differences by level of socioeconomic status, location cost or by country. Sex differences are discussed where available.

Risk of bias appraisal

The risk of bias of individual studies was assessed using a modified version of the *Cochrane Collaboration's Tool for Assessing Risk of Bias*.²¹ Studies were assessed for potential biases including: selection bias

TABLE 1
Ovid MEDLINE search strategy

#	Searches	Results
1	("global positioning" or "gps" or "geographic information system?" or "GIS" or Garmin or Qstarz or Geostats or NAVSTAR).tw,kf.	32 312
2	Geographic Information Systems/	7 617
3	1 or 2	34 947
4	(acceleromet* or inclinomet* or pedomet* or stepscount or piezo* or yamax or "digiwalker" or "digi walker" or "digi-walker" or lifecorder* or accusplit or actigraph or actical* or actimet* or actiheart* or bodymedia or geneactiv* or activinsights or fitbit* or polar* or omron).tw,kf.	249 142
5	exp Accelerometry/	6 695
6	Monitoring, Ambulatory/	8 147
7	((activity or exercise or step? or move*) adj3 (monitor* or track* or count')).tw,kf.	31 451
8	or/4-7	285 476
9	3 and 8	945

(sampling methods); performance and detection bias (measurement issues); attrition bias (incomplete follow-up and > 10% missing data), selective reporting bias (selective/incomplete reporting, rated high if secondary data analyses); and other possible sources of bias (i.e., inadequate adjustment for sex and wear time).

Results

Description of studies

Figure 1 provides details of the literature search and screening process. Of the 3446 originally identified citations, 945 were identified in MEDLINE, 953 in EMBASE, 619 in PsycINFO, 207 in CINAHL, 260 in SPORTDiscus, 459 in Dissertations and Theses, and 3 from other sources. A total of 59 studies met the eligibility criteria. Study characteristics and findings are presented in Table 2. The review includes studies published over a 13-year period (2005 to 2017) and conducted in 12 countries with the majority from the United States (US) and the United Kingdom (UK); three were Canadian. The most widely used GPS and activity monitor devices were the QStarz Q-1000XT and ActiGraph, respectively. The most common locations

included: home, school, workplace, active transportation, parks/playgrounds, and green spaces. Many locations were defined using buffers around the centre of an address (e.g., 50 m around home). MVPA was the most studied behaviour. There are a total of 22 studies in children,²²⁻⁴³ 17 in youth⁴⁴⁻⁶⁰ and 20 in adults.^{28,61-79} Sample sizes ranged from 12 to 1053; 39% were small (N ≤ 100).

Risk of bias assessment

Risk of bias results are summarized in Figure 2. Just over half of the studies had a high risk of selection bias as many included convenience samples. About a quarter had no description of how the study sample was derived. The majority had a low risk of performance and detection bias since they mostly employed GPS technology overlaid using GIS and used accelerometers with valid cut-points to define ST, LPA and MVPA. However, some studies had a high risk of performance bias as there was potential for misclassification of location based on the decisions of coders and/or the use of ‘buffers’ to define spaces. Slightly less than half of the studies had a high risk of selective reporting; many conducted secondary analyses for which the primary objective of the

study was not to examine location of movement. Finally, most studies had a high risk of ‘other’ bias which included the lack of adjustment for wear time and sex in analyses.

Location-based findings for children (3-11 years)

The most commonly reported locations in the child studies were: homes, schools, parks, active transportation, and streets/roads. Results suggest that the active transportation and school environments are important locations for MVPA, while the home environment is less of a contributor.

Many studies focussed on movement patterns within specific sub-sets of environments rather than total-day movement. For example, several studies examined or reported exclusively on time spent in travel to-and-from school.^{26,32,34,41} In these studies, a substantial proportion of time (31-37%) spent commuting to school was spent in MVPA^{26,34} and contributed to 11-22% of total MVPA (especially among walkers).^{32,41} Children who walked to school tended to live closer than those who use passive modes of transit.²⁶

FIGURE 1
Flow diagram of the literature search and screening process

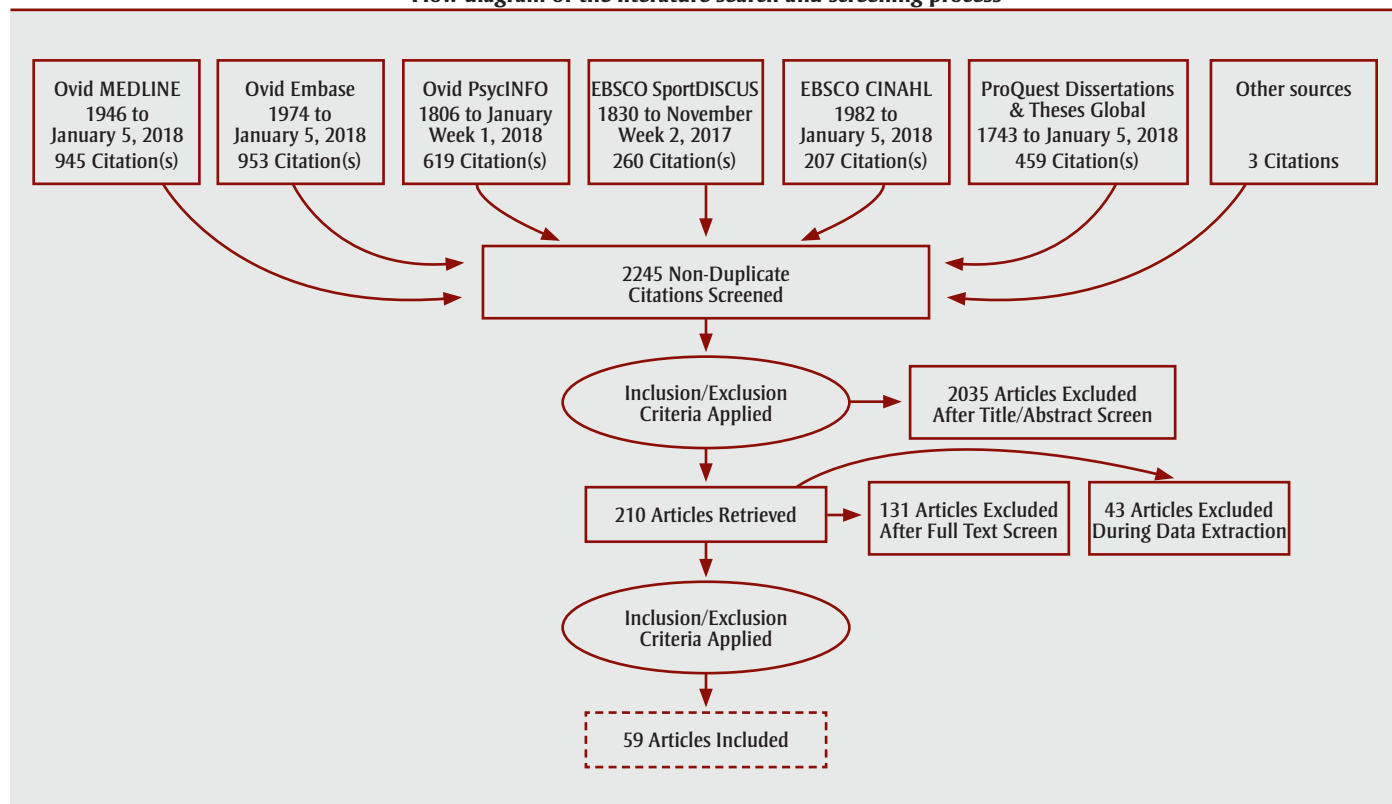


TABLE 2
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Children							
Almanza, 2012 ²²	USA, Healthy PLACES	208 (51–54%)	8–14	ActiGraph GT2M/GloblSat BT-335, 7 days	MVPA (> 500 cpm, continuous)	Home (30 m buffer) and NB (500 m buffer) greenness (vegetation using NDVI data)	<p>ST</p> <ul style="list-style-type: none"> • Often occurred in the home. <p>MVPA</p> <ul style="list-style-type: none"> • Often occurred in proximity to green areas. • Children that experienced > 20 min/day of green space had almost 5 times more MVPA.
Burgi, 2016 ²³	Switzerland NR	83 (48%)	8.5 (0.3), 7–9	ActiGraph GT3X/BT-QStarz Q1000XT, 7 days (median 12.6 h/day)	ST (< 101 cpm), MVPA (≥ 2296 cpm, continuous)	<p>Home (30 m buffer), own school (10 m buffer*), other school (10 m buffer*), sports facilities (10 m buffer*), streets (10 m buffer*), public parks and playgrounds (10 m buffer*), other (others' home, shopping, restaurants), outside urban area</p> <p>* = drawn around the polygons</p>	<p>Median weekly minutes (IQR) and proportion (IQR) of time per location spent sedentary:</p> <ul style="list-style-type: none"> • Home = 529.7 (255.0–798.5) and 60% (52.4%–64.5%) • Own school = 597.7 (509.0–731.7) and 51.7% (47.8%–56.6%) • Other school = 46.7 (4.7–87.3) and 41.2% (30.8%–55.1%) • Park = 15.7 (1.7–57.8) and 37.6% (25.9%–52.2%) • Sport = 8.5 (0.0–52.2) and 42.5% (21.3%–62.4%) • Street = 234.5 (173.3–378.2) and 46.0% (39.9%–49.7%) [may be a result of motorized transport] • Other = 206.5 (130.5–304.2) and 50.3% (43.4%–58.0%) • Outside = 26.5 (0.0–129.8) and 52.5% (42.0%–68.2%) <p>• The locations with the most time spent sedentary were the home (60.0%), own school (51.7%) and outside (52.5%).</p> <p>Median weekly minutes (IQR) and proportion (IQR) of time spent in MVPA in each location:</p> <ul style="list-style-type: none"> • Home = 57.3 (32.2–91.8) and 6.3% (4.8%–9.3%) • Own school = 121.5 (86.2–184.3) and 10.0% (8.1%–13.4%) • Other school = 13.0 (3.3–28.2) and 15.4% (7.1%–23.8%) • Park = 9.3 (1.5–29.5) and 17.3% (7.2%–25.8%) • Sport = 4.3 (0.3–21.3) and 15.4% (5.9%–33.1%) • Street = 90.5 (56.0–127.0) and 15.7% (11.7%–19.7%) • Other = 42.5 (24.7–78.7) and 11.1% (7.8%–15.6%) • Outside = 3.3 (0.0–19.5) and 8.4% (3.2%–16.1%) <p>Proportion of total weekly MVPA:</p> <ul style="list-style-type: none"> • Own school = 30.8% • Streets = 21.4% • Home = 15.2%

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Cerin, 2016 ²⁴	USA, NR	66 (42%)	4.5 (0.8)	ActiGraph GT3X/QStarz Q100X, 1 week (average wear time NR)	ST (< 152 cpm), MVPA (≥ 1680 cpm, continuous)	Home (30 m buffer), childcare/school/daycare (30 m buffer), park/playground (30 m buffer), other without outdoor play area (30 m buffer), other with outdoor play area (30 m buffer). All locations include indoor and outdoor time.	<p>Proportion of time per location (SD) spent sedentary:</p> <ul style="list-style-type: none"> • Home = 45% (50%) • Other locations in apartment complex = 32% (47%) • Other residential home = 41% (49%) • Childcare/school/daycare = 51% (50%) • Childcare/school/daycare in enrolled children only = 51% (50%) • Park/playground = 24% (43%) • Other without outdoor play area = 47% (50%) • Other with outdoor play area = 49% (50%) • Indoors = 46% (50%) • Outdoors = 43% (50%) • In vehicle = 64% (48%) <p>• Children less likely to engage in ST outdoors vs. indoors.</p> <p>Proportion of time per location (SD) spent in MVPA:</p> <ul style="list-style-type: none"> • Home = 12% (33%) • Other locations in apartment complex = 15% (35%) • Other residential home = 13% (34%) • Childcare/school/daycare = 8% (27%) • Childcare/school/daycare in enrolled children only = 7% (26%) • Park/playground = 30% (46%) • Other without outdoor play area = 9% (29%) • Other with outdoor play area = 9% (29%) • Indoors = 11% (35%) • Outdoors = 14% (35%) • In vehicle = 2% (15%) <p>• Children most active in parks/playgrounds and least active in childcare/school settings.</p> <p>• Children more likely to engage in MVPA outdoors vs. indoors.</p>

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Coombes, 2013 ²⁵	UK, SPEEDY	100 (53%)	9–10	ActiGraph GT1M/Garmin Forerunner 205, 4 non-school days (i.e., holidays and included 2 weekend days)	ST (≤ 100 cpm), LPA (101–1999 cpm, continuous), MPA (2000–3999 cpm, continuous), VPA (≥ 4000 cpm, continuous), MVPA (≥ 2000 cpm, continuous), MVPA (5 min bouts)	Beaches, woodland, grassland, farmland, parks, domestic gardens (home yard), roads and pavements, other built land use, buildings. Identified using land-use datasets; each GPS data point was assigned a land use category based on the land parcel it fell within.	<p>Proportion of total daily LPA:</p> <ul style="list-style-type: none"> Buildings = 24.1% Domestic gardens = 29% (26 min per day) Roads/pavement = 13.2% <p>Proportion of total daily MPA:</p> <ul style="list-style-type: none"> Buildings = 20% Domestic gardens = 27% (7 min/day) Roads/pavement = 11.8% <p>MVPA</p> <ul style="list-style-type: none"> Differences in the percentage contributions of land uses to MVPA were observed when bout and non-bout activity compared: significantly greater percentage of non-bout activity undertaken in buildings ($p < .001$, 21.5% vs. 6.9%), equating to +5 min/day; other built land use ($p = 0.015$, 15.7% vs. 10.6%), equating to +3 min/day; domestic gardens ($p < .001$, 29.2% vs. 20.6%), equating to +6 min/day. Significantly greater percentage of bout activity undertaken on roads and pavements compared to non-bout activity ($p < .001$, 17.1% vs. 9.1%) = 36-second difference. <p>Proportion of total daily VPA:</p> <ul style="list-style-type: none"> Buildings = 17.9% Domestic gardens = 31% (4 min per day) Roads/pavement = 9.1% <p>Sex differences</p> <ul style="list-style-type: none"> Boys spend more time in domestic gardens, roads/pavement and farmland vs. girls.
Cooper, 2010 ²⁶	England, PEACH Study	137 (66%)	11.3 (0.3)	ActiGraph GT1M/Garmin Foretrex 201, 2 days of combined wear; between 8:00 and 9:00 a.m.	MVPA (> 3200 cpm, continuous) during journey to school	AT (journey to school – identified as points outside of playground polygon), school playground (polygon drawn around playground)	<p>MVPA</p> <ul style="list-style-type: none"> MVPA levels during journey were significantly higher vs. playground (2131.3 vs. 1089.7 cpm, $p < .001$). One third of journey time was spent in MVPA (1.6 min, 30.8%), remaining time spent on playground (0.6 min or 10.0% in MVPA). Children who walked to school more active compared to those who travelled by car. Shorter linear distance to school in walkers (0.5 miles) vs. car (0.9 miles) and bus (1.12 miles) users.

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Dessing, 2013 ²⁷	Netherlands, SPACE study	76 (58%)	8.6 (1.4), 6–11	ActiGraph GT1M/ QStarz BT-1000X, 7 days (average wear time of 11.2 h/day)	MVPA (> 2296 cpm, continuous)	Schoolyard (10 m buffer of schoolyard polygon), school building (points during class time), outside school environment (> 10 m buffer around school)	<p>Daily minutes (SD) and proportion (SD) of time per location spent in MVPA:</p> <ul style="list-style-type: none"> Boys: schoolyard = 8.8 min (5.1) and 27.3% (12.7%) Boys: inside school = 4.9 min (5.2) and 2.1% (2.1%) Girls: schoolyard = 7.0 min (5.1) and 16.7% (10.4%) Girls: inside school = 7.1 min (8.2) and 2.8% (3.2%) <p>• Very small proportion of time inside school was spent in MVPA.</p> <p>Proportion of total daily MVPA:</p> <ul style="list-style-type: none"> Children most active on schoolyard during recess though children only present in schoolyard for 6% of time and contributed to 17.5% and 16.8% of boys' and girls' MVPA time. <p>Sex differences</p> <ul style="list-style-type: none"> Boys are more active on the schoolyard vs. girls especially during recess.
Dunton, 2013 ²⁸	USA, NR	291 (53%)	11.2, 8–14	ActiGraph GT2M/ GlobalSat BT-335, 7 days (mean = 4.5 days with 310.8 min/day of matched parent-child pairs)	Parent-child ST (< 100 cpm) and MVPA (age-specific thresholds using 4 METs)	Residential (500 m buffer around home neighbourhood, e.g., houses, apartments, condos), commercial (e.g., retail stores, restaurants, personal services, private health club/gym, motels), open space (e.g., parks, gardens, wildlife preserves), educational (e.g., schools), public facilities (e.g., government, health care, religious, libraries, community centres), other (e.g., roads, water)	<p>Proportion of total parent-child ST:</p> <ul style="list-style-type: none"> Residential = 76% Commercial = 10% Open space = 8% Educational = 2% Public facilities = 3% Other = 1% <p>• Parents and children spent 92.9 (SD = 40.1) min/day engaged in ST together.</p> <p>Proportion of total parent-child MVPA:</p> <ul style="list-style-type: none"> Residential = 35% Commercial = 24% Open space = 20% Educational institutions = 14% Public facilities = 7% Mixed/other land uses = 1% <p>• Parents and children spent 2.4 (SD = 4.1) min/day engaged in MVPA together.</p>
Dunton, 2014 ²⁹	USA, Healthy PLACES	135 (50%)	8–14	ActiGraph GT2M/ GlobalSat BT-335, 7 days (average wear time NR)	MVPA (age-specific thresholds ≥ 4 METs)	Parks (within 500 m radial buffer, included national, state, county, city parks and forests)	<p>MVPA</p> <ul style="list-style-type: none"> Only 27% used a NB park; of those with extended park use (> 15 min), 58% engaged in ≥ 15 min of MVPA within the park space. Those with extended use engaged in a median of 44.3 min (IQR: 8.5, 163.5) of MVPA per week in the park space. Park proximity related to use.

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Eyre, 2014 ³⁰	England, NR	64 (53%)	7–9	Garmin Forerunner 305, 4 days (including 2 weekend days; average wear time = 388 ± 179 min)	MVPA (≥ 50% heart rate reserve)	School (indoors and outdoors: school field, school playground, school indoors), home, AT (not defined), indoors (house, other building and school), outdoors (green space and non-green space)	<p>Proportion of total MVPA:</p> <ul style="list-style-type: none"> • School = 43% • Playing outside (street/garden) = 23% • Home = 20% • AT = 14% • Time spent in MVPA indoors greater on weekdays vs. weekends (41 ± 30% vs. 17 ± 20%, p = .01). <p>Proportion (SD) of time per location spent in MVPA:</p> <ul style="list-style-type: none"> • Outdoors = 59% (45%) • Indoors = 27% (27%) <p>Sex differences</p> <ul style="list-style-type: none"> • Girls spent less time outdoors on weekdays vs. weekends (32% vs. 54%). • Boys spent more time outdoors on weekdays vs. weekends (41% vs. 33%). • No significant sex differences in percentage of time indoors or in green space.
Jones, 2009 ³¹	England, SPEEDY	100 (53%)	9–10	ActiGraph GT1M/Garmin Forerunner 205, 4 days (boys: 11.1 ± 2.2 h/day, girls: 10.0 ± 3.2 h/day of wear time)	MVPA (5 min bouts, ≥ 2000 cpm)	Inside (≤ 800 m pedestrian network around home), outside NB (> 800 m network), buildings (domestic residences, shops, indoor sports facilities, covered structure), other built land use, roads and pavement, gardens (private), parks, farmland, grassland, woodland, beaches	<p>Average total minutes (SD) and proportion of MVPA over 4 days:</p> <ul style="list-style-type: none"> • Inside NB = 24.9 (30.1) or 62.5% • Outside NB = 14.9 (25.7) • Buildings = 2.8 (6.0) • Other built land use = 5.5 (10.7) • Roads and pavement/street = 7.5 (11.7) • Gardens = 9.6 (16.5) • Parks = 2.9 (10.0) • Farmland = 5.4 (14.8) • Grassland = 4.7 (12.7) • Woodland = 1.2 (2.8) • Beaches = 0.2 (1.7) <ul style="list-style-type: none"> • Children who spent more time outside were more active. • Among urban children, gardens (28%) and streets (20%) were most commonly used for MVPA bout time. • Among rural children, farmland (22%) and grassland (18%) most frequently used. • Gardens and street environment supported greatest amount of MVPA. <p>Sex differences</p> <ul style="list-style-type: none"> • Boys had higher proportion of MVPA outside NB vs. girls (p = 0.05), girls had more inside NB.

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Lee, 2014 ³²	USA, Why and Why Nots of Active Living	112 (51%)	9.5, 7–12	ActiGraph GT1M or GT3X/Garmin Forerunner 203, 7 days (minimum 8 h/day)	MVPA (≥ 4 METs) total continuous	Home-school trips (AT); walkers (walk to/from school at least once a week, live within ½ mile of school and parents reported distance walkable); captive walkers (walk to/from, distance > ½ mile or parents reported distance too far); non-walkers (did not walk to/from school)	<p>MVPA</p> <ul style="list-style-type: none"> School trips account for an average of 6.9 (10.1) min/day or 11.1% of total daily MVPA. Among those who walked to school, trip MVPA contributed to 13.7 (11.8) min/day or 21.8% (18.8%) of total MVPA vs. 1.4 (1.9) min/day or 2.4% (3.2%) in those using other forms of travel. 'Walkers' had 9.0 min/day of trip MVPA (16.1% of total MVPA) vs. 'captive walkers' (longer distance) had 19.9 min/day (29.4% of total MVPA). All walkers had 12 more min/day vs. non-walkers (13.7 vs. 1.4 min/day, <i>p</i> < .001). Walking to school is a meaningful source of MVPA, especially for those who are less active overall. Majority of trips were motorized and mixed modes; walking and bicycling accounted for 29.1% and 4.7% of trips, respectively. <p>Sex differences</p> <ul style="list-style-type: none"> No significant difference by sex. Children walked faster, straighter and with more intensity on the road vs. open space.
Mackett, 2007 ³³	UK, CAPABLE Study	82 (57%)	8–11	RT3/Garmin Foretrex 201, 4 days (2 week and 2 weekend days)	PA intensity using continuous activity counts (no cut-points used)	Road (e.g., roads, tracks or paths) vs. open space (e.g., public open space: parks, fields, woods)	<ul style="list-style-type: none"> Children walked faster, straighter and with more intensity on the road vs. open space.
McMinn, 2014 ³⁴	Scotland, NR	39 (31%)	8.5, 8–9	ActiGraph GT1M/Trackstick Super, 1 journey home from school	MVPA during AT from home to school (> 2296 cpm)	AT (vehicle transport identified as speeds > 25 km/h excluded), location from home to school: green space; other natural; road/track/path; other human-made	<p>MVPA</p> <ul style="list-style-type: none"> 37.1% of children's time spent actively commuting to school was in MVPA. AT via road/track/path associated with greater MVPA. No significant assoc. between green space and MVPA during commute, but travelling via other natural land uses resulted in lower MVPA. <p>Proportion of total AT time within each separate land-use category spent in MVPA:</p> <ul style="list-style-type: none"> Green space = 36.7% Other natural = 17.6% Road/track/path = 41.5% Other human-made = 35.0% <p>Minutes (SD) of daily MVPA:</p> <ul style="list-style-type: none"> School = 40.2 (35.1) Streets = 28.1 (43.8) Home = 11.8 (18.2) Rural/urban green = 4.8 (14.5)
Moore, 2014 ³⁵	England, NR	28 (61%)	11.8, 11–14	ActiGraph GT3X/QStarz BT-Q1000XT, 7 days (average 10.0 ± 2.7 h/day)	MVPA (≥ 2220 cpm, in bouts of ≥ 3 min)	Home, school, street, rural/urban green space defined by researcher using Google Maps	<p>Minutes (SD) of daily MVPA:</p> <ul style="list-style-type: none"> School = 40.2 (35.1) Streets = 28.1 (43.8) Home = 11.8 (18.2) Rural/urban green = 4.8 (14.5)
O'Connor, 2013 ³⁶	USA, NR	12 (40%)	4.7 (0.8), 3–5	ActiGraph GT3X/QStarz BT 100X, NR	Activity counts/30 seconds, continuous	Home, other home, store, restaurant, church, community center, park, other locations (all used 100 m buffer)	<ul style="list-style-type: none"> Church and parks were significant predictors of greater activity accounts vs. child's home. Children spent significantly more time at home vs. other locations.

Continued on the following page

TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Oreskovic, 2012 ³⁷	USA, NR	24 (58%)	11–12	ActiGraph GT1/Forerunner 201, 7 days including 2 weekend days	MVPA (≥ 1952 cpm, continuous)	Home (25 m buffer), school (within 100 m from school perimeter), car, indoor/other (non-home or school), park/playground (incl. outdoor rec space), street/walking (all coded by GIS specialist)	<p>Minutes (proportion) of total MVPA:</p> <ul style="list-style-type: none"> Home = 670 (33.5%) Indoors/other = 114 (5.7%) School = 169 (8.4%) Park/playground = 217 (10.8%) Street/walking = 833 (41.6%) <p>Seasonal differences</p> <ul style="list-style-type: none"> Proportion of total MVPA higher at home in winter (43.1%), in streets/walking in spring (43.8%) and in parks/playgrounds in summer (57.4%).
Pearce, 2014 ³⁸	UK, PEACH Study	427 (54%)	10.7 (0.5), 10–11	ActiGraph GT1M/Forerunner 201, 7 days (3:00 p.m.–10:00 p.m. on weekdays)	MVPA (≥ 2296 cpm, continuous)	Indoors vs. outdoors after school	<p>Minutes (SD) and proportion of total daily after school MVPA:</p> <ul style="list-style-type: none"> Girls outdoors = 4.3 (6.4) min and 19.8% Boys outdoors = 4.6 (7.1) min and 18.4% <p>• Who the child was with had an impact; indoors = mom/dad, outdoors = friends.</p>
Pizarro, 2017 ³⁹	Portugal, SALTA Project	374 (54%)	11.7 (0.9)	ActiGraph GT3X/QStarz BT-Q1000XT, 7 days	MVPA (≥ 2296 cpm; 5 min bouts)	Leisure, school (polygon using Google Maps), transport (≥ 100 m buffer with average speed ≥ 1.5 km/hr), home (25 m buffer)	<p>Proportion of total MVPA:</p> <ul style="list-style-type: none"> Transportation (i.e., trips to/from school) = 45.5% School = 30.5% Leisure = 21.3% Home = 2.7% <p>Proportion of time per domain spent in MVPA:</p> <ul style="list-style-type: none"> Leisure = 7.9% School = 12.0% Transport = 18.9% Home = 4.1% <p>Sex differences</p> <ul style="list-style-type: none"> For MVPA, the most important contributors were transport domain in girls and leisure domain for boys. Girls spent significantly more time in transportation (29%) vs. boys (26%). Girls achieved more of their MVPA time in transportation (54.5% vs. 35.2% in boys), boys achieved more MVPA in school than girls (37% vs. 24.7%).
Quigg, 2010 ⁴⁰	New Zealand, CALE Study	184 (54%)	7.6, 5–10	ActiGraph GT1M/GlobalStat DG-100, 7 days (≥ 5 h/day)	PA (accelerometer counts)	Parks/playgrounds (within park boundaries)	<p>Physical activity</p> <ul style="list-style-type: none"> 1.9% of all PA was located within a city park. <p>Sex differences</p> <ul style="list-style-type: none"> PA was higher in city parks for boys vs. girls.

Continued on the following page

TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Southward, 2012 ⁴¹	England, PEACH Study	84	11–12	ActiGraph GT1M/Garmin Foretrex 201, school journey on 4 days	MVPA (≥ 2296 cpm, continuous)	AT: path from home to school and back (within 200 m of home and school)	<p>Minutes and proportion of total daily MVPA:</p> <ul style="list-style-type: none"> 22.2 min/day or 33.7% (each journey contributed 16%–18% of daily MVPA) No difference in MVPA between the journey to and from school. <p>Proportion of AT time spent in MVPA:</p> <ul style="list-style-type: none"> ~50% <p>Sex differences</p> <ul style="list-style-type: none"> MVPA on journey no different between boys and girls, but journeys contributed a greater proportion to daily MVPA for girls (35.6%) vs. boys (31.3%).
Van Kann, 2016 ⁴²	Netherlands, Active Living Study	257 (53%)	8–11	ActiGraph GT3X/QStarz BT-Q1000XT, 5 days (minimum of 5 min/school yard period)	ST (> 101 cpm), MVPA (> 2295 cpm, continuous)	Schoolyard (10 m Euclidian buffer)	<p>Minutes (SD) and proportion of total daily ST:</p> <ul style="list-style-type: none"> Schoolyard = 20.2 (12.0) min/day and 4.1% – they spent an average of 54 min/day in school yard. <p>Minutes (SD) and proportion of total daily MVPA:</p> <ul style="list-style-type: none"> Schoolyard = 8.7 (6.3) min/day and 18.3% <p>Sex differences</p> <ul style="list-style-type: none"> Boys had more MVPA (10.5 min, 19.2% daily MVPA) vs. girls (7.2 min, 17.6%) in schoolyards. No significant sex difference for ST.
Wheeler, 2010 ⁴³	UK, PEACH Study	1053 (53%)	10–11	ActiGraph GT1M/Garmin Foretrex 201, 4 days (after school only)	MVPA (≥ 3200 cpm, continuous)	Indoors vs. outdoors not green space vs. outdoors in green space vs. outdoors out of area	<p>Minutes (SD) and proportion of total daily MVPA:</p> <ul style="list-style-type: none"> Green space = 8.6% boys and 6.1% girls Outdoors not in green space = 24.5% boys and 26.1% girls Outdoors out of area = 2.9% boys and 2.8% girls Indoors = 64.1% boys and 65.0% girls <p>Proportion of time per location spent in MVPA:</p> <ul style="list-style-type: none"> Outdoors in green space = 24.2% boys and 17.7% girls Outdoors not green space = 18.5% boys and 16.4% girls Outdoors out of area = 8.9% boys and 7.4% girls Indoors = 5.0% boys and 4.0% girls <p>Sex differences</p> <ul style="list-style-type: none"> Youth spent majority of time indoors. Time in green space more likely to be spent in MVPA vs. outdoor ‘other’ space. Green spaces important for supporting more intense PA, but majority of time spent outside of these spaces. <p>Sex differences</p> <ul style="list-style-type: none"> Odds of engaging in MVPA in green space vs. outdoor non-green space higher in boys vs. girls.

Continued on the following page

TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Youth							
Andersen, 2017 ⁴⁴	Denmark, NR	Baseline 354, post-renewal: 319	13.2 (1.18), 11–16	ActiGraph GT3X/QStarz BT-Q1000XT, 7 days (~13 h/day)	ST (≤ 100 cpm), LPA (101–2295 cpm), MVPA (> 2295 cpm, continuous)	In-district time pre-post urban renewal project which included 4 new urban green spaces/ playgrounds and renovation of large public park	<p>ST</p> <ul style="list-style-type: none"> Adjusted differences in time spent within district between baseline and post-renewal = +13.1 min/day (95% CI: 1.9–28.2, p = 0.043). <p>LPA</p> <ul style="list-style-type: none"> Adjusted differences in time spent within district between baseline and post-renewal = +7.8 min/day (95% CI: 1.1–14.7, p = 0.012). <p>MVPA</p> <ul style="list-style-type: none"> Adjusted differences in time spent within district between baseline and post-renewal = +4.5 (95% CI: 1.8–7.2, p < .001).
Burgi, 2015 ⁴⁵	Switzerland, NR	119 (57%)	12.5 (0.4), 11–14	ActiGraph GT3X/QStarz Q1000XT, 7 days	MVPA (≥ 2296 cpm, continuous)	Home (30 m buffer), own school (all school property, 10 m buffer), other school, recreation facility (public parks and sports facilities, 10 m buffer), street (10 m buffer), other (others home, shopping, restaurants), outside urban area	<p>Median weekly minutes (IQR) and proportion of total daily MVPA:</p> <ul style="list-style-type: none"> Home = 34.0 (18.5–59.0) Own school = 74.7 (51.2–108.3) and 26.8% Other school = 3.7 (0.3–29.0) Recreation facility = 4.7 (0.3–19.8) Street = 94.3 (57.0–143.7) and 34.5% Other = 25.2 (14.3–39.2) Outside = 0.0 (0.0–4.2) School grounds = 33% <p>Median proportion (IQR) of time per location spent in MVPA:</p> <ul style="list-style-type: none"> Home = 3.0% (1.9%–4.2%) Own school = 8.6% (5.8%–11.7%) Other school = 19.2% (8.5%–33.2%) Recreation facility = 19.4% (6.1%–33.6%) Street = 18.6% (12.3%–26.9%) Other = 7.1% (4.9%–10.1%) Outside = 5.2% (2.3%–12.7%) <ul style="list-style-type: none"> The proportion of time spent in MVPA at recreation facilities was greatest, but less frequently visited. <p>Sex differences</p> <ul style="list-style-type: none"> Boys obtain significantly more MVPA time outside vs. girls. Boys get significantly more MVPA on other school grounds and at own school vs. girls.

Continued on the following page

TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Carlson, 2016 ⁴⁶	USA, TEAN Study	549 (50%)	14.1 (1.4), 12–16	ActiGraph 7164 or 71256 or GT1M or GT3X/GlobalSat DG-100, 7 days	MVPA (≥ 2296 cpm, continuous)	Home (50 m buffer), near home (1 km street network buffer), school (15 m buffer), near school (1 km street network buffer), other locations	<p>Minutes (SD) and proportion of total daily MVPA on school days:</p> <ul style="list-style-type: none"> • Home = 5.5 (6.6) and 13.1% • Near home = 5.4 (9.2) and 12.9% • School = 23.2 (15.0) and 55.2% • Near school = 2.4 (4.3) and 5.7% • Other locations = 5.5 (9.0) and 13.1% • All locations = 42.0 (22.5) <p>Minutes (SD) and proportion of total daily MVPA on non-school days:</p> <ul style="list-style-type: none"> • Home = 12.0 (14.1) and 37.4% • Near home = 6.8 (11.6) and 21.2% • School = 0.6 (11.6) and 1.8% • Near school = 1.7 (4.9) and 5.3% • Other locations = 11.0 (15.4) and 34.3% • All locations = 32.1 (21.8) <p>Minutes (SD) and proportion of total daily MVPA (weighted week):</p> <ul style="list-style-type: none"> • Home = 7.4 (7.4) and 18.7% • Near home = 5.9 (9.0) and 15.0% • School = 16.7 (10.9) and 42.4% • Near school = 2.2 (3.8) and 5.6% • Other locations = 7.2 (8.6) and 18.3% • All locations = 39.4 (20.1) <ul style="list-style-type: none"> • Although more MVPA achieved at school, relative to the proportion of time spent at school it is low. • % of location time spent in MVPA lowest at school and highest near home and near school. <p>Sex differences</p> <ul style="list-style-type: none"> • Girls had fewer min/day of MVPA at all locations except near school.
Collins, 2015 ⁴⁷	England, NR	75 (49%)	13–14	HR monitor/ Garmin Forerunner 305, 4 school days (after-school hours)	MVPA (> 120 bpm, > 140 bpm)	Commute from school to home	<p>Minutes (SD) and proportion of total daily MVPA:</p> <ul style="list-style-type: none"> • Active commuting = 11.7 (13.8) min and 35% (> 120 bpm) • Passive commuting = 3.5 (5.7) min and 18% <ul style="list-style-type: none"> • Commute distance was significantly lower among active vs. passive commuters (0.95 vs. 3.38 miles). • No significant difference in leisure-time MVPA between active and passive commuters, therefore, active commuting is an important contributor to overall PA levels. <p>Sex differences</p> <ul style="list-style-type: none"> • No significant sex differences in active vs. passive commuters MVPA.

Continued on the following page

TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Geyer, 2013 ⁴⁸	Scotland, GAG Study	27 (52%)	13–15	ActiGraph/GPS-enabled Blackberry, 6–7 days	ST (< 1100 cpm), LPA (1100–3200 cpm), MVPA (> 3200 cpm, continuous) during leisure time	Green space (natural environments in urban spaces)	<p>Proportion of total daily MVPA:</p> <ul style="list-style-type: none"> Green space = 8% total PA, 11% of leisure time MVPA Median of 9 min/day or ~1 hr/week spent in green space. <p>Proportion of time per location spent in MVPA:</p> <ul style="list-style-type: none"> Green space = 51.5% in LPA + MVPA; 19.8% in MVPA Non-green space = 18.3%
Klinker, 2014 ⁴⁹	Denmark, WCMC Study	367 (52%)	13.2 (1.2), 11–16	ActiGraph GT3X/QStarz BT-1000X, 7 days (mean 2.5 days, median 12.7 h/day)	MVPA (≥ 2296 cpm, continuous)	School grounds (address), clubs, sports facilities (if offered activities for 10–16-year-olds; address), playgrounds (address), urban green space (geodata), shopping centers (address), other places, school, recess (using school schedule), physical education (using school schedule), transport, home (10 m buffers)	<p>Median minutes (IQR) of total daily MVPA (boys):</p> <ul style="list-style-type: none"> Playgrounds = 0.0 (0.0–0.5) During AT = 10.3 (5.6–15.6) Physical education = 19.5 (9.8–34.8) In sports facilities = 0.2 (0.0–4.8) Urban green space = 1.9 (0.5–4.4) School grounds = 2.8 (1.5–7.3) Recess = 8.3 (5.9–12.3) Passive transport = 0.3 (0.0–4.1) Home = 4.8 (2.3–10.3) Shopping center = 0.0 (0.0–0.0) Other places 5.0 (2.6–11.3) <p>Median proportion of time per location spent in MVPA (boys):</p> <ul style="list-style-type: none"> Playgrounds = 35.4% During AT = 34.7% Physical education = 25.8% In sports facilities = 24.3% Urban green space = 23.8% School grounds = 20.7% Recess = 15.8% Passive transport = 15.5% Home = 3.4% Shopping center = 6.1% Other places = 3.2% <p>Median minutes (IQR) of total daily MVPA (girls):</p> <ul style="list-style-type: none"> Playgrounds = 0.0 (0.0–0.3) During AT = 9.6 (4.5–16.2) Physical education = 14.4 (8.0–23.5) In sports facilities = 0.0 (0.0–0.5) Urban green space = 1.5 (0.3–3.6) School grounds = 2.2 (1.3–4.3) Recess = 6.0 (3.7–8.8) Passive transport = 0.2 (0.0–3.5) Home = 6.5 (3.0–12.8) Shopping center = 0.0 (0.0–0.0) Other places = 4.1 (2.2–7.8)

Continued on the following page

TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
							<p>Median proportion of time per location spent in MVPA (girls):</p> <ul style="list-style-type: none"> • Playgrounds = 20.7% • During AT = 31.3% • Home = 3.6% • Urban green space = 17.1% • Physical education class = 16.6% • School grounds = 12.5% • Clubs = 9.5% • Sports facilities = 13.2% • Shopping center = 2.4% • Recess = 10.7% • Passive transport = 9.6% • Other places = 2.6% <p>• Children accumulated more MVPA primarily via school vs. adolescents.</p> <p>Sex differences</p> <ul style="list-style-type: none"> • Boys accumulated more MVPA in leisure, school and transport vs. girls, $p < .05$.
Klinker, 2014 ⁵⁰	Denmark, WCMC Study	170 (51%)	11–16	ActiGraph GT3X/QStarz BT-1000X, 7 days (≥ 9 h/day)	Outdoor MVPA (≥ 2296 cpm, continuous)	School grounds (10 m buffer), clubs (10 m buffer), sports facilities (10 m buffer), playgrounds (10 m buffer), urban green space (10 m buffer), shopping centers (10 m buffer), other places (10 m buffer), school (10 m buffer), recess (school schedule), physical education (school schedule), transport (active vs. passive), home (10 m buffer)	<p>Proportion of total daily MVPA:</p> <ul style="list-style-type: none"> • Outdoors = 73.8% boys and 65.3% girls <p>Median minutes (IQR) of total daily outdoor MVPA:</p> <ul style="list-style-type: none"> • School grounds = 2.5 (1.2–6.2) • Clubs = 0.0 (0.0–0.2) • Sports facilities = 0.0 (0.0–0.7) • Playgrounds = 0.0 (0.0–0.3) • Urban green space = 1.8 (0.8–8.3) • Shopping centre = 0.0 (0.0–0.0) • Other places = 1.0 (0.4–2.5) • Recess = 5.5 (3.5–8.9) • Physical education = 11.3 (1.8–25.0) • Active transport = 8.3 (3.5–14.6) • Passive transport = 0.4 (0.0–4.2) • Home = 2.3 (0.5–6.8) <p>• Children spent a larger proportion of MVPA outdoors during school hours and recess.</p> <p>• Most daily outdoor MVPA accumulated at school location.</p> <p>Sex differences</p> <ul style="list-style-type: none"> • Girls obtained less of their MVPA outdoors vs. boys.

Continued on the following page

TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Lachowycz, 2012 ⁵¹	England, PEACH Study	902 (53%)	weekday evenings: 12.0 (0.39), weekends: 12.1 (0.40), 11–12	ActiGraph GT1M/Garmin Foretrex 201, 5 days	Weeknight and weekend day ST (< 100 cpm), LPA (100–2296 cpm), MVPA (≥ 2296 cpm, continuous)	Indoors vs. outdoors, green space, parks (all types, park –formal [organized layout, well-maintained], park-informal [informal recreation], park-natural [provide access to nature including heathland, woodland and wetland], park-sports [area used for organized and competitive sports; e.g., playing fields and tennis courts], park-young persons [designed for use by children and youth including play and game equipment]), private gardens (green space around the home), school grounds (grassland around school), other green space (vegetated areas not otherwise defined including private sports and recreation facilities, cemeteries, golf courses, gardens of publicly accessible buildings), roads/pavement, green verges (small fragmented vegetation/grass land e.g., centres of roundabouts and strips alongside pavement) , built surfaces	<p>Minutes (SD) and proportion of total daily ST (3–10 pm of weekday):</p> <ul style="list-style-type: none"> Indoors = 195.7 (90.8) min and 92.5% Outdoors = 14.5 (28.8) and 7.0% <p>Minutes (SD) and proportion of total daily outdoor ST (3–10 pm of weekday):</p> <ul style="list-style-type: none"> Green space = 6.0 (16.1) and 41.1% Parks (all) = 1.1 (6.8) and 7.4% Park-formal = 0.2 (3.0) and 1.5% Park-informal = 0.5 (4.9) and 3.2% Park-natural = 0.1 (2.3) and 0.6% Park-sports = 0.1 (10.2) and 1.0% Park-young persons = 0.2 (4.0) and 1.1% Private gardens = 4.8 (15.1) and 32.9% School grounds = 0.1 (5.5) and 0.7% Other green space = 0.01 (0.5) and 0.1% Roads/pavement = 2.8 (7.2) and 18.9% Green verges = 0.3 (2.7) and 2.0% Built surfaces = 5.5 (12.4) and 38.0% <p>Minutes (SD) and proportion of total daily ST (8 am–10 pm of weekend day):</p> <ul style="list-style-type: none"> Indoors = 363.4 (154.0) and 93.2% Outdoors = 20.7 (41.3) and 5.3% <p>Minutes (SD) and proportion of total daily outdoor ST (8 am–10 pm of weekend day):</p> <ul style="list-style-type: none"> Green space = 9.0 (26.9) and 43.7% Parks (all) = 3.4 (19.1) and 16.4% Park-formal = 0.5 (8.7) and 2.4% Park-informal = 1.0 (11.9) and 5.1% Park-natural = 0.7 (15.2) and 3.6% Park-sports = 0.1 (3.2) and 0.4% Park-young persons = 1.0 (19.1) and 5.0% Private gardens = 5.6 (23.4) and 26.9% School grounds = 0.1 (2.5) and 0.3% Other green space = 0.03 (1.3) and 0.1% Roads/pavement = 3.9 (12.5) and 18.9% Green verges = 0.6 (7.0) and 3.1% Built surfaces = 7.1 (14.1) and 34.3%

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
							<p>Minutes (SD) and proportion of total daily LPA (3–10 pm of weekday):</p> <ul style="list-style-type: none"> Indoors = 68.2 (38.6) and 87.7% Outdoors = 9.1 (14.9) and 11.7% <p>Minutes (SD) and proportion of total daily outdoor LPA (3–10 pm of weekday):</p> <ul style="list-style-type: none"> Green space = 3.5 (7.9) and 38.8% Parks (all) = 1.2 (7.8) and 12.9% Park-formal = 0.3 (4.1) and 3.0% Park-informal = 0.4 (4.1) and 4.4% Park-natural = 0.1 (1.5) and 0.8% Park-sports = 0.1 (10.6) and 1.6% Park-young persons = 0.3 (6.6) and 3.3% Private gardens = 2.2 (4.2) and 24.5% School grounds = 0.1 (5.2) and 1.3% Other green space = 0.01 (0.5) and 0.1% Roads/pavement = 2.0 (3.7) and 21.6% Green verges = 0.2 (2.3) and 2.6% Built surfaces = 3.4 (6.1) and 37.0% <p>Minutes (SD) and proportion of total daily LPA (8 am–10 pm of weekend day):</p> <ul style="list-style-type: none"> Indoors = 135.5 (70.7) and 89.1% Outdoors = 13.0 (24.6) and 8.5% <p>Minutes (SD) and proportion of total daily outdoor LPA (8 am–10 pm of weekend day):</p> <ul style="list-style-type: none"> Green space = 6.1 (15.7) and 46.7% Parks (all) = 3.5 (16.7) and 26.7% Park-formal = 0.7 (8.5) and 5.1% Park-informal = 1.1 (7.7) and 8.3% Park-natural = 0.6 (8.8) and 4.7% Park-sports = 0.1 (1.9) and 0.6% Park-young persons = 1.0 (13.9) and 7.9% Private gardens = 2.5 (7.7) and 19.2% School grounds = 0.1 (5.1) and 0.7% Other green space = 0.01 (0.4) and 0.1% Roads/pavement = 2.2 (7.6) and 17.1% Green verges = 0.5 (5.1) and 3.5% Built surfaces = 4.2 (9.3) and 32.6% <p>Minutes (SD) and proportion of total daily MVPA (3–10 pm of weekday):</p> <ul style="list-style-type: none"> Indoors = 19.3 (17.2) and 72.6% Outdoors = 7.0 (1.4) and 26.4% ~1/2 of outdoor MVPA took place in green space.

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
							<p>Minutes (SD) and proportion of total daily outdoor MVPA (3–10 pm of weekday):</p> <ul style="list-style-type: none"> • Green space = 2.4 (4.8) and 33.6% • Parks (all) = 0.7 (4.7) and 10.1% • Park-formal = 0.2 (3.3) and 2.7% • Park-informal = 0.2 (1.6) and 3.2% • Park-natural = 0.1 (1.1) and 0.8% • Park-sports = 0.1 (7.4) and 1.5% • Park-young persons = 0.1 (3.4) and 2.0% • Private gardens = 1.6 (2.8) and 22.3% • School grounds = 0.1 (3.3) and 1.1% • Other green space = 0.01 (0.4) and 0.1% • Roads/pavement = 1.9 (3.2) and 26.6% • Green verges = 0.2 (1.8) and 2.9% • Built surfaces = 2.6 (4.4) and 36.9% <p>Minutes (SD) and proportion of total daily MVPA (8 am–10 pm of weekend day):</p> <ul style="list-style-type: none"> • Indoors = 33.7 (27.9) and 78.7% • Outdoors = 7.5 (17.2) and 17.6% <p>Minutes (SD) and proportion of total daily outdoor MVPA (8 am–10 pm of weekend day):</p> <ul style="list-style-type: none"> • Green space = 3.5 (9.1) and 46.0% • Parks (all) = 2.2 (10.5) and 29.3% • Park-formal = 0.4 (4.3) and 4.8% • Park-informal = 0.7 (5.0) and 9.9% • Park-natural = 0.5 (6.6) and 6.1% • Park-sports = 0.05 (1.2) and 0.6% • Park-young persons = 0.6 (7.6) and 7.8% • Private gardens = 1.2 (3.2) and 16.1% • School grounds = 0.1 (1.8) and 0.5% • Other green space = 0.01 (0.3) and 0.1% • Roads/pavement = 1.6 (6.5) and 20.9% • Green verges = 0.3 (2.7) and 3.8% • Built surfaces = 2.2 (7.1) and 29.3%

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Maddison, 2010 ⁵²	New Zealand, ICAN Study	79 (42%)	14.5 (1.6), 12–17	ActiGraph 7164/Garmin Forerunner 305, 4 days (2 weekday, 2 weekend; ≥ 10 h/day)	ST (< 1.5 METs), LPA (1.5–2.9 METs), MPA (3.0–5.9 METs), VPA (≥ 6.0 METs), MVPA (10 min bouts)	Home (150 m buffer), school (1 km buffer)	<p>Proportion of time in ST per location:</p> <ul style="list-style-type: none"> School radius (1 km) weekday = 70%, weekend = 69% Home radius (150 m) weekday = 74%, weekend = 69% <p>Proportion of time per location in LPA:</p> <ul style="list-style-type: none"> School radius (1 km) weekday = 13%, weekend = 20% Home radius (150 m) weekday = 12%, weekend = 19% <p>Proportion of time per location in MPA:</p> <ul style="list-style-type: none"> School radius (1 km) weekday = 15%, weekend = 11% Home radius (150 m) weekday = 13%, weekend = 11% <p>Proportion of time per location in VPA:</p> <ul style="list-style-type: none"> School radius (1 km) weekday = 1%, weekend = 0% Home radius (150 m) weekday = 1%, weekend = 1% <p>Proportion of time per location in MVPA bouts:</p> <ul style="list-style-type: none"> School radius (1 km) = 71% Home radius (150 m) = 46% <ul style="list-style-type: none"> Less MVPA time spent in home and school radius on weekends vs. weekdays; on weekends MVPA took place outside of home environment. Weekday MVPA bouts within 1 km of school, 72% took place within school hours. For weekend MVPA bouts, equal numbers occurring within the school and home environments. Home and school environments major contributors to MVPA, especially during the week.
Oreskovic, 2015 ⁵³	USA, NR	80 (56%)	12.6 (1.1), 11–14	ActiGraph GT3X/QStarz BT-Q1000XT, 2 weeks	ST (< 100 cpm), MVPA (≥ 2296 cpm, continuous)	Home (40 m buffer), school (40 m buffer), park (incl. green spaces and open land), playground (incl. areas for public rec such as soccer, football, baseball, golf), streets and sidewalks, other	<p>Median minutes (IQR) of total daily ST:</p> <ul style="list-style-type: none"> School = 87 (63–110) Home = 50 (40–69) <p>Mean minutes (SD) of total daily ST:</p> <ul style="list-style-type: none"> Indoor = 95 (29) Outdoor = 20 (14) Other = 27 (20) <ul style="list-style-type: none"> Streets and sidewalks accounted for greatest amount of daily outdoor ST. <p>Median minutes (IQR) of total daily MVPA:</p> <ul style="list-style-type: none"> School = 8 (5–12) Home = 4 (2–8) Streets and sidewalks = 5 (3–9) Playgrounds = 3 (1–6) Parks = 2 (1–4) <ul style="list-style-type: none"> Compared to being at home, time spent in school, streets, sidewalks, parks and playgrounds associated with greater MVPA.

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Pearce, 2015 ⁵⁴	Scotland, NR	82 (57%)	12.4 (0.4), 11–13	ActiGraph GT3X/QStarz BT-Q1000eX, 7 days (≥ 9 h/day)	MVPA (> 2296 cpm, continuous)	School (verified using school timetable), indoor vs. outdoor, unstructured vs. structured (identified via diary data)	<p>Median minutes (IQR) and proportion of total daily weekday MVPA:</p> <ul style="list-style-type: none"> School = 24.2 (18.9–30.7) and 42.1% (29.7%–50.0%) Unstructured outdoor leisure = 12.2 (5.7–22.5) and 18.2% (11.0%–31.8%) Unstructured indoor leisure = 14.1 (8.4–25.9) and 24.6% (13.9%–40.4%) Structured outdoor leisure = 0.0 (0.0–7.1) and 0.0% (0.0%–12.5%) Structured indoor leisure = 0.0 (0.0–0.9) and 0.0% (0.0%–1.4%) <p>Median minutes (IQR) and proportion of total daily weekend day MVPA:</p> <ul style="list-style-type: none"> Unstructured outdoor leisure = 16.3 (9.1–35.8) and 39.0% (19.6%–48.8%) Unstructured indoor = 23.7 (13.8–40.8) and 44.3% (26.0%–66.0%) Structured outdoor leisure = 0.0 (0.0–23.2) and 0% (0.0%–26.5%) Structured indoor leisure = 0.0 (0.0–0.0) and 0% (0.0%–0.0%) <ul style="list-style-type: none"> Children spent most time and recorded most MVPA at school or in unstructured leisure-time contexts – no recorded structured/organized PA of any kind on weekdays. Children spent very little time and recorded little MVPA in structured leisure-time contexts.
Pizarro, 2016 ⁵⁵	Portugal, NR	155 (55%)	15.9 (1.1), 14–18	ActiGraph GT3X/QStarz BT-Q1000XT, 7 days (school journey)	MVPA (≥ 2296 cpm, continuous)	<p>AT (to and from school) – Walking: classified if they had a 90th percentile of speed < 10 km/h</p> <p>Bicycling: 90th percentile speed between 10–35 km/h</p> <p>Vehicle: 90th percentile of speed ≥ 35 km/h</p>	<p>Minutes/trip (SD) and proportion of time in MVPA bouts per mode of AT:</p> <ul style="list-style-type: none"> Walking = 12.0 (5.6) and 78% Bicycling = 2.2 (2.6) Vehicle = 1.3 (1.6) <ul style="list-style-type: none"> Most frequent mode of travel was walking, followed by vehicle and bicycle. School-to-home significantly higher min of MVPA vs. home-to-school journey. Greater distance between home and school associated with lower odds of AT in boys and girls. AT to and from school “can contribute up to 40% of recommended daily MVPA”.

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Rainham, 2012 ⁵⁶	Canada, NR	316 (47%)	13.2 (0.9), 12–16	ActiGraph GT1M/EM-408 SiRF III, 8 days (> 10 h/day)	MVPA (not defined)	Home, school, commuting, athletic facility, entertainment, green space, military, parking lot, religious, residential, restaurant, retail, services, transportation (all not defined)	<p>Proportion of total MVPA per location:</p> <p>Urban boys:</p> <ul style="list-style-type: none"> • Home = 10.8% • School = 22.8% • Commuting = 57.6% • Athletic facility = 0.3% • Entertainment = 0% • Green space = 0.6% • Military = 0.0% • Parking lot = 0.5% • Religious = 1.3% • Residential = 3.2% • Restaurant = 0.5% • Retail = 1.9% • Services = 0.2% • Transportation = 0.3% <p>Suburban boys:</p> <ul style="list-style-type: none"> • Home = 30.1% • School = 22.6% • Commuting = 27.4% • Athletic facility = 1.8% • Entertainment = 0.0% • Green space = 3.9% • Military = 0.0% • Parking lot = 0.0% • Religious = 0.3% • Residential = 9.9% • Restaurant = 0.6% • Retail = 3.0% • Services = 0.2% • Transportation = 0.1% <p>Rural boys:</p> <ul style="list-style-type: none"> • Home = 25.2% • School = 33.1% • Commuting = 27.0% • Athletic facility = 4.0% • Entertainment = 0.0% • Green space = 5.6% • Military = 0.0% • Parking lot = 0.1% • Religious = 0.0% • Residential = 4.4% • Restaurant = 0.2% • Retail = 0.4% • Services = 0.1% • Transportation = 0.0% <p>Urban girls:</p> <ul style="list-style-type: none"> • Home = 10.6% • School = 23.8% • Commuting = 55.5% • Athletic facility = 2.3% • Entertainment = 0.0% • Green space = 1.3% • Military = 0.2% • Parking lot = 0.2% • Religious = 0.4% • Residential = 3.8% • Restaurant = 0.2% • Retail = 1.0% • Services = 0.0% • Transportation = 0.7% <p>Suburban girls:</p> <ul style="list-style-type: none"> • Home = 20.1% • School = 21.7% • Commuting = 42.5% • Athletic facility = 0.6% • Entertainment = 0.0% • Green space = 2.5% • Military = 0.0% • Parking lot = 0.0% • Religious = 0.3% • Residential = 7.5% • Restaurant = 0.2% • Retail = 3.6% • Services = 0.0% • Transportation = 0.9% <p>Rural girls:</p> <ul style="list-style-type: none"> • Home = 24.8% • School = 40.2% • Commuting = 20.7% • Athletic facility = 2.4% • Entertainment = 0.1% • Green space = 4.8% • Military = 0.0% • Parking lot = 0.0% • Religious = 0.2% • Residential = 2.3% • Restaurant = 0.1% • Retail = 4.0% • Services = 0.1% • Transportation = 0.2%

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
							<ul style="list-style-type: none"> Urban students achieved more MVPA time in home, school and while commuting vs. suburban and rural students. For urban students, majority of MVPA occurred while commuting (usually to and from school). For rural students, majority of MVPA occurred at school. <p>Sex differences</p> <ul style="list-style-type: none"> No sex differences in urban boys and girls. Suburban boys spent more MVPA time at home vs. girls (30% vs. 20%). Suburban girls engaged in more MVPA while commuting vs. boys (42.5% vs. 27.4%). Rural boys engaged in more MVPA while commuting vs. girls.
Robinson, 2013 ⁵⁷	USA, NR	31 (71%)	11–14	ActiGraph GT3X, 14 days	MVPA (≥ 2296 cpm, continuous)	NB (youth identified vs. census defined)	<p>Minutes of total daily MVPA:</p> <ul style="list-style-type: none"> Census-defined NB = 9.5 min vs. Youth-identified NB = 14.7 min, $p < .0001$
Rodriguez, 2012 ⁵⁸	USA, TAAG study	293 (100%)	15–18	ActiGraph 7164/Garmin Foretrex 201, 6 days	ST (< 100 cpm), LPA (≥ 100 to < 3000 cpm), MVPA (≥ 3000 cpm, continuous)	PA facilities (businesses that support PA including bowling alleys, dance studios, swimming pools, yoga studios, exercise facilities, sports clubs), food outlets, parks, population density (all 50 m buffer)	<p>ST, LPA and MVPA</p> <p>In <u>San Diego</u>, presence of each item within 50 m buffer of each GPS/accelerometer point significantly associated with:</p> <ul style="list-style-type: none"> Park: 41% higher odds of LPA vs. ST (95% CI: 1.15–1.74) Population density: OR = 1.01 (95% CI: 1.00–1.02) MVPA vs. ST Schools: OR = 1.69 (95% CI: 1.29–2.20) MVPA vs. ST Road length: OR = 0.38 (95% CI: 0.25–0.51) with MVPA vs. ST Number of food outlets: OR = 0.73 (95% CI: 0.67–0.80) MVPA vs. ST <p>In <u>Minneapolis</u>, presence of each item within 50 m buffer of each GPS/accelerometer point significantly associated with:</p> <ul style="list-style-type: none"> Road length OR = 0.43 (95% CI: 0.25–0.74) for LPA vs. ST and MVPA vs. ST Higher population density: OR = 1.04 (95% CI: 1.02–1.07) of MVPA vs. ST Presence of parks: OR = 1.86 (95% CI: 1.51–2.31) MVPA vs. ST Schools: OR = 2.14 (95% CI: 1.30–3.53) with MVPA vs. ST <ul style="list-style-type: none"> Higher PA intensity associated with parks, school, high population density and during weekdays and lower in places with more roads.
Voss, 2014 ⁵⁹	Canada, ASAPJ Study	43 (~37%)	13.8 (0.6)	ActiGraph GT3X/QStarz BT-Q1000XT, 7 days (during trip)	MVPA (≥ 2296 cpm, continuous)	AT: transportation to and from school	<p>Minutes (SD) of total daily MVPA per trip:</p> <ul style="list-style-type: none"> Transportation from home to school = 6.8 (4.0) Elsewhere to school = 5.5 (2.6) School to home = 8.4 (5.1) School to elsewhere = 10.6 (5.5)
Voss, 2015 ⁶⁰	Canada, ASAPJ Study	42 (36%)	13.8 (0.6)	ActiGraph GT3X/QStarz BT-Q1000XT, 7 days	MVPA (≥ 2296 cpm, continuous)	AT: transportation mode for school trips	<p>Minutes (SD) of total daily MVPA per trip:</p> <ul style="list-style-type: none"> Walk = 9.1 (5.1) Transit = 9.5 (5.1) Car = 4.2 (5.6) <ul style="list-style-type: none"> Transit trips significantly longer in distance and duration vs. walk trips, but with similar amounts of MVPA. Greater walk distance associated with lower walking MVPA.

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Adults							
Audrey, 2014 ⁶¹	England, Walk to Work Study	103 (57%)	36.3 (11.7)	ActiGraph GT3X/QStarz BT-Q1000XT, 7 days (≥ 10 h/day)	MVPA (> 1952 cpm, continuous)	AT: walk to work (based on home and work address and included other destinations if taken as part of journey)	<p>Minutes and proportion of total daily MVPA per trip:</p> <ul style="list-style-type: none"> • 38.0 min and 47.3% • Average PA on walking days substantially higher vs. car days (583.1 ± 182.4 vs. 319.7 ± 148.5, p < .001). • Walking to work associated with higher levels of PA.
Chaix, 2016 ⁶²	France, RECORD GPS Study	227 (32%)	≥ 35	ActiGraph GT3X/QStarz BT-Q1000XT, 7 days	Walking (> 200 steps/10 min, continuous)	AT: trip distance, mode, and characteristics	<p>Walking:</p> <ul style="list-style-type: none"> • 90% of trips less than 0.5 km in length were achieved by walking vs. below 10% for trips > 4 km. • Mid-level distances included a mix of walking, public transport and some personal vehicle use. • Odds of walking > 200 steps/10 min of a trip increased with the number of services accessible and density of green space at the beginning and end of the trip. • Trip-level characteristics stronger than residential characteristics; important to consider outside NB characteristics.
Chaix, 2014 ⁶³	France, RECORD GPS Study	234 (35%)	Median 58 (IR: 41–73)	ActiGraph GT3X/QStarz BT-Q1000XT, 7 days (median 12h, 35 min)	ST (< 150 cpm), MVPA (≥ 2690 cpm, continuous) – vector magnitude	AT (trip = travel from one destination to the next destination)	<p>Median (interdecile range) proportion of total daily ST:</p> <ul style="list-style-type: none"> • Transportation = 13% (5%–23%) • Public transportation trips associated with more ST vs. personal motorized vehicle time. <p>Median (interdecile range) proportion of total daily steps:</p> <ul style="list-style-type: none"> • Transportation = 38% (16%–58%) <p>Median (interdecile range) proportion of total daily MVPA:</p> <ul style="list-style-type: none"> • Transportation = 33% (12%–52%)

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Costa, 2015 ⁶⁴	UK, Commuting and Health in Cambridge Study	41 (56%)	24–62	Actiheart/QStarz BT-Q1000X, 7 days	ST (< 1.5 MET), LPA (1.5–3 MET), MPA (3–6 MET), VPA (> 6 MET, continuous)	AT: commuting journeys by mode of transportation (car, bus, car + walk, car + cycle, walk, cycle)	<p>Median proportion of time per mode spent in ST:</p> <ul style="list-style-type: none"> • Car only = 59% • Bus only ~41% • Car + walk ~25% • Car + cycle ~15% • Walk only = 0% • Cycle = 0% <p>Median proportion of time per mode spent in LPA:</p> <ul style="list-style-type: none"> • Car only = 38% • Bus only ~29% • Car + walk ~33% • Car + cycle ~35% • Walk only = 0% • Cycle ~4% <ul style="list-style-type: none"> • Trips that used a combination of cycle or walking had about 33–35% spent in LPA. <p>Median proportion of time per mode spent in MVPA:</p> <ul style="list-style-type: none"> • Car only = 0% • Bus only ~21% MPA • Car + walk ~21% MPA • Car + cycle ~19% MPA + 2% VPA • Walk only = 100% MPA • Cycle ~56% VPA + 33% MPA <ul style="list-style-type: none"> • Trips that used a combination of cycle or walking had ~20% spent in MVPA (~8 min).
Dewulf, 2016 ⁶⁵	Belgium, NR	180 (48%)	59–65	ActiGraph GT3X/QStarz BT-Q1000XT, 1 week (≥ 4 days, ≥ 6 h/day)	ST (0–100 cpm), LPA (101–1951 cpm), MVPA (1952–100 000 cpm, continuous)	Home (50 m buffer), NB (51–1000 m buffer), outside NB (> 1000 m buffer), green areas (including agriculture, grassland, forest, swamp, health land, coastal dune, park, recreation and sport terrains)	<p>Mean proportion of time per location spent in ST:</p> <ul style="list-style-type: none"> • Within NB green area = 48.1% • Within NB non-green area = 63.0% <ul style="list-style-type: none"> • Higher in non-green areas vs. green areas and in homes. <p>Mean proportion of time per location spent in LPA:</p> <ul style="list-style-type: none"> • Within NB green area = 29.0% • Within NB non-green area = 22.6% <ul style="list-style-type: none"> • Higher in non-green areas and in homes. <p>Mean proportion of time per location spent in MVPA:</p> <ul style="list-style-type: none"> • Within NB green area = 13.8% • Within NB non-green area = 7.3% <ul style="list-style-type: none"> • Higher in green areas (vs. non-green areas), greater MVPA outside of NB. <p>Sex differences</p> <ul style="list-style-type: none"> • For men, greater time spent in non-green areas was related to more MVPA, the opposite was true in women.

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Dunton, 2013 ²⁸	USA, NR	291 (88%)	39.6 (6), 26–62	ActiGraph GT2M/GlobalSat BT-335, 7 days	ST (< 100 cpm), MVPA (≥ 2020 cpm, continuous)	Residential, commercial (retail stores, restaurants, personal services, private health club/gym, motels), open space (parks, gardens, wildlife preserves), educational (schools), public facilities (government, health care, religious, libraries, community centres), other (roads, water)	<p>Proportion of total daily ST (joint parent-child):</p> <ul style="list-style-type: none"> Residential = 75.9% Commercial = 10.1% Open space = 7.7% Educational = 2.1% Public facilities = 3.4% Other = 0.7% <p>Proportion of total daily MVPA (joint parent-child):</p> <ul style="list-style-type: none"> Residential = 34.9% Commercial = 23.8% Open space = 19.7% Educational = 13.7% Public facilities = 6.7% Other = 1.2%
Evenson, 2013 ⁶⁶	USA, SOPARC Study	238 (56%)	40.4, 18–85	ActiGraph GT1M/QStarz BT-1000X, 3 weeks (average 11.5 h/day)	ST (≤ 100 cpm), LPA (101–759 cpm), MPA (2020–5998 cpm), VPA (≥ 5999 cpm), MVPA (≥ 2020 cpm, 10 min bouts)	Parks, AT (to and from parks)	<p>Proportion of total daily ST:</p> <ul style="list-style-type: none"> Parks = 2.4% ST higher on days with a park visit. <p>Proportion of time per location spent in ST:</p> <ul style="list-style-type: none"> Parks = 49.3% Mean, median and IQR of min/day spent during a park visit = 9.9, 3.8 (0.6–11.0). <p>Proportion of total daily LPA:</p> <ul style="list-style-type: none"> Parks = 3.1% <p>Proportion of time per location spent in LPA:</p> <ul style="list-style-type: none"> Parks = 23.1% Mean, median and IQR of min/day spent during a park visit = 5.1, 1.9 (0.3–5.5). <p>Proportion of total daily MPA + VPA:</p> <ul style="list-style-type: none"> Parks: MPA = 8.2%; VPA = 9.4% MVPA higher on days with a park visit. <p>Proportion of time per location spent in MVPA:</p> <ul style="list-style-type: none"> Parks = 12.0% Mean, median and IQR of min/day spent during a park visit: VPA = 0.1, 0.0 (0.0–0.0); MPA = 2.2, 0.5 (0.0–2.7), MVPA = 2.3, 0.5 (0.0–2.7). AT to and from a park added an additional 3.7 to 6.6 min of MVPA per visit.

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Hillsdon, 2015 ⁶⁷	England, FAST Study	195 (58%)	18–91	ActiGraph GT1M/QStarz BT-1000X, 7 days (≥ 10 h/day)	Outdoor LMVPA (≥ 500 cpm)	Inside home NB (800 m buffer) vs. outside home NB	<p>Proportion of total daily outdoor LMVPA:</p> <ul style="list-style-type: none"> • Outside the NB: men = 64.7% (95% CI: 57.9–71.4); women = 57.4% (95% CI: 52.2–62.7) • Rural adults spent significantly more LMVPA outside NB vs. urban and town participants. • Those with a car also spent significantly more LMVPA outside NB vs. those without. • Adults spent majority of time indoors. <p>Sex differences</p> <ul style="list-style-type: none"> • Men spent a significantly greater proportion of LMVPA outside of the NB vs. women, $p < .05$.
Holliday, 2017 ⁶⁸	USA, SOPARC GPS Study	223 (57%)	18–85	ActiGraph GT1M/QStarz BT-1000X, 3 weeks (≥ 4 days, ≥ 10 h/day)	MVPA (used three different cut-points: Matthews' MVPA (≥ 760 cpm, bouts ≥ 10 min); NHANES' MVPA (≥ 2020 cpm, bouts ≥ 10 min); NHANES' VPA (≥ 5999 cpm, bouts ≥ 10 min))	Home (address), roads, parks, commercial (retail locations, strip malls, malls, dense commercial districts, restaurants, gas stations), school (pre-K to university), other (services, offices, golf courses, factories, places of worship, entertainment), fitness (pay gyms, private tennis/soccer facilities, swim clubs, dance/martial arts studios), residential (excluding participant homes), footpath/trail, motorized	<p>Median (IQR) and proportion of total daily MVPA over 3 weeks:</p> <ul style="list-style-type: none"> • Home = 116 (40–242) and 29.4% (Matthews), 6 (0–43) and 20.3% (NHANES) • Road = 25 (0–105) and 15.1% (Matthews), 6 (0–48) and 27.6% (NHANES) • Park = 11 (0–72) and 13.4% (Matthews), 0 (0–12) and 12.5% (NHANES) • Commercial = 14 (0–42) and 8.5% (Matthews), 0 (0–3) and 3.4% (NHANES) • School = 0 (0–32) and 7.6% (Matthews), 0 (0–0) and 9.1% (NHANES) • Other = 0 (0–23) and 5.1% (Matthews), 0 (0–0) and 3.6% (NHANES) • Fitness = 0 (0–0) and 4.2% (Matthews), 0 (0–0) and 7.7% (NHANES) • Residential = 0 (0–17) and 3.5% (Matthews), 0 (0–0) and 2.2% (NHANES) • Footpath/trail = 0 (0–1) and 1.4% (Matthews), 0 (0–0) and 2.9% (NHANES) • Motorized travel = 0 (0–0) and 0.1% (Matthews), 0 (0–0) and 0.2% (NHANES) <p>Median (IQR) and proportion of total daily VPA (NHANES) over 3 weeks:</p> <ul style="list-style-type: none"> • Home = 0 (0–0) and 17.8% • Road = 0 (0–0) and 23.6% • Park = 0 (0–0) and 4.3% • Commercial = 0 (0–0) and 3.9% • School = 0 (0–0), 12.0% • Other = 0 (0–0) and 1.4% • Fitness = 0 (0–0) and 19.3% • Residential = 0 (0–0) and 2.1% • Footpath/trail = 0 (0–0) and 9.0% • Motorized transport = 0 (0–0) and 0.3% <ul style="list-style-type: none"> • Fitness facilities and schools are important locations for NHANES VPA. • Parks accounted for 4% of park bouts VPA. • NHANES total VPA: together, homes and roads accounted for > 40% of bout-based MVPA across all three PA intensities.

Continued on the following page

TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Hurvitz, 2014 ⁶⁹	USA, TRAC Study	611 (61%)	≥ 18	ActiGraph GT1M/GlobalSat DG-100, 7 days	ST (≤ 150 cpm), LPA (151–1951 cpm), MPA (1952–5274 cpm, continuous), VPA (≥ 5275 cpm, continuous)	Home (< 125 m), near home (125–1666 m), away (> 1666 m)	<p>Mean (SD) and proportion of total daily ST:</p> <ul style="list-style-type: none"> • Home = 183.3 (90.7) and 36.0% • Near home = 29.9 (25.1) and 5.9% • Away = 125.5 (79.7) and 24.7% <ul style="list-style-type: none"> • ~55% of sedentary/low physical activity time was spent at home, and 37% spent at away locations. • At home and away locations, most time spent in sedentary/low physical activity (96% and 88%, respectively) vs. only ~65% of time at near locations was spent in sedentary/low physical activity, with 35% spent in MVPA. <p>Mean (SD) and proportion of total daily LPA:</p> <ul style="list-style-type: none"> • Home = 68.6 (34.3) and 13.5% • Near = 11.4 (9.4) and 2.2% • Away = 43.2 (29.1) and 8.5% <p>Mean (SD) and proportion of total daily MVPA:</p> <ul style="list-style-type: none"> • Home = 7.1 (4.9) and 1.4% • Near = 13.2 (9.0) and 2.6% • Away = 13.1 (10.3) and 2.6% <ul style="list-style-type: none"> • Almost 80% of MVPA occurred in non-home locations (i.e., near and away locations). <p>Proportion of time per location spent in MVPA:</p> <ul style="list-style-type: none"> • Home = 20.7% • Near = 40.0% • Away = 39.3% <p>Mean (SD) and proportion of total daily VPA:</p> <ul style="list-style-type: none"> • Home = 2.0 (0.7) and 0.4% • Near = 6.0 (2.5) and 1.2% • Away = 5.4 (2.5) and 1.1%
Hwang, 2016 ⁷⁰	USA, NR	106 (76%)	41.7 (10.5), 24–70	ActiGraph GT3X/QStarz TR-Q1000XT, 2 weeks (12–14 valid days)	Walking bouts (> 2000–6166 cpm for at least 7 min)	Inside (1-, 2- and 3-km radii around home) vs. outside NB	<p>Walking</p> <ul style="list-style-type: none"> • More walking occurred outside vs. inside NB. • More walking in "walkable" areas vs. car dependent and 'somewhat' walkable areas.

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Jansen, 2016 ⁷¹	Netherlands, SPACE Project	308 (55%)	56.4 (6.2), 45–65	ActiGraph GT3X/QStarz BT-Q1000X, 7 days (≥ 10 h/day, ≥ 4 days)	MVPA (≥ 3208 cpm, continuous)	Home (25 m buffer), shopping area (25 m buffer), workplace (50 m buffer), small green area (parks and public gardens), larger green area (recreational, agricultural, forest, natural terrain), sports facilities (require membership or subscription), other residential area (25 m buffer around residences)	<p>Median minutes (IQR) of total daily MVPA:</p> <ul style="list-style-type: none"> • Home = 10.4 (16.8) • Other residential area = 5.0 (14.2) • Residential and shopping area = 0.6 (2.8) • Shopping area = 1.0 (4.1) • Small green area = 1.0 (10.1) • Larger green area = 0.9 (6.6) • Sports facilities = 4.2 (19.6) • Workplaces = 9.9 (19.6) • Transport = 4.6 (11.4) • Other = 1.8 (7.1) <p>Median proportion (IQR) of time per location spent in MVPA:</p> <ul style="list-style-type: none"> • Home = 3.8% (4.1%) • Other residential area = 4.5% (6.3%) • Residential and shopping area = 2.9% (6.6%) • Shopping area = 5.0% (10.6%) • Small green area = 4.5% (10.9%) • Larger green area = 3.6% (8.8%) • Sports facilities = 5.9% (21.6%) • Workplaces = 4.2% (5.2%) • Transport = 5.7% (10.9%) • Other = 4.3% (8.5%)
Jansen, 2017 ⁷²	Netherlands, SPACE Project	279 (54%)	46–65	ActiGraph GT3X/QStarz BT-Q1000X, 7 days (≥ 10 h/day, ≥ 4 days)	ST (< 150 cpm), LPA (150–3208 cpm), MVPA (≥ 3208 cpm, continuous)	Parks (e.g., city parks, children's farm), recreational area (e.g., zoo, playground, picnic places), agricultural green (e.g., grassland, orchard), forest and moorland (e.g., forest, moorland, dunes), blue space (e.g., lakes, rivers, water parks, seas)	<p>ST</p> <ul style="list-style-type: none"> • Highest proportion observed in blue space. • Compared to parks, less ST found in recreational and green space. <p>LPA</p> <ul style="list-style-type: none"> • Parks, recreation areas and agricultural green were found to have the highest (and approx. similar) proportions of time spent in LPA. <p>MVPA</p> <ul style="list-style-type: none"> • Highest levels of MVPA in agricultural green and larger natural environments.
Perez, 2016 ⁷³	USA, Faith in Action	86 (100%)	45.4 (9.3), 18–65	ActiGraph GT3X/QStarz BT-Q1000X, 7 days (≥ 8 h/day, ≥ 2 days)	MVPA (≥ 2020 cpm, continuous)	NB outdoor environment (500 m buffer around home) vs. home (50 m radius)	<p>Median (IQR) minutes of total daily MVPA:</p> <ul style="list-style-type: none"> • NB outdoors = 0.18 (2.1) min/day • More MVPA occurred in the home vs. in NB outdoors.

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TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Rafferty, 2016 ⁷⁴	UK, NR	26 (65%)	38, 23–65	activPAL/Amod AGL3080, 7 days	MVPA (> 109 steps per minute, continuous)	Work, AT commute (home to work), work excursion (e.g., out for lunch), home, home excursion (at home but outside or going back home from somewhere), other (shopping mall, restaurant, cinema)	<p>Mean (SD) and proportion of total daily MVPA:</p> <ul style="list-style-type: none"> • Commute = 22.0 (14.1) and 68% • Work excursion = 4.1 (5.0) and 12% • At work = 3.5 (3.8) and 11% • Home = 0.3 (0.7) and 1% • Home excursion = 1.3 (2.9) and 4% • Other = 1.5 (2.1) and 4% <p>• 91% of daily MVPA obtained either commuting to work, at work or during work excursions during work time.</p>
Ramulu, 2012 ⁷⁵	USA, NR	35 (74%)	38, 18–61	Actical/pTrac Pro, 6 days	MVPA (≥ 1535 cpm, continuous)	Home (≤ 536 m buffer) vs. away from home (> 536 m)	<p>Median minutes (IQR) and proportion (IQR) of total daily MVPA on weekdays:</p> <ul style="list-style-type: none"> • Home region = 0 (0–2) min/day and 0.1% (0.0%–0.7%) • Away from home = 19 (9–31) min/day and 3.5% (1.9%–4.6%) <p>Median minutes (IQR) and proportion (IQR) of total daily MVPA on weekend days:</p> <ul style="list-style-type: none"> • Home = 1 (0–4) min/day and 0.3% (0.0%–0.9%) • Away from home = 5 (2–10) min/day and 1.7% (0.7%–3.5%) <p>• Most steps during weekdays taken away from home (median = 4255, IQR: 2921–6444) vs. in home region (median = 848, IQR: 433–1801, p < .001).</p> <p>• On weekends, no significant difference in number of steps taken in home region vs. away.</p>
Rodriguez, 2005 ⁷⁶	USA, NR	35 (60%)	20–61	ActiGraph 7164/Garmin Foretrex 201, 3 days	MVPA (≥ 10 min bouts, threshold not defined)	Indoors (≥ 33% of GPS data located within building footprint), outdoors in NB (1.54 km buffer around home address), outdoors out of NB (all other bouts)	<p>Proportion of total daily MVPA:</p> <ul style="list-style-type: none"> • Outdoors in NB = 35% • Outdoors out of NB = 32% <p>• In-NB bouts were longer and contributed more to total MVPA vs. out of NB bouts.</p>
Stewart, 2016 ⁷⁷	USA, TRAC Project	671 (63%)	≥ 18	ActiGraph GT1M/GlobalSat DG-100, 1 week (≥ 8 h/day)	ST (≤ 100 cpm), park PA (> 1000 cpm), MVPA (≥ 1952 cpm, 5 min bouts)	Parks (publicly owned, freely accessible, outdoor spaces intended for leisure or recreation)	<p>Mean (SD) minutes and proportion (SD) of time per location spent in ST:</p> <ul style="list-style-type: none"> • Park visits = 16.8 (32.9) min and 29.9% (31.4%) <p>• Park visitors had less ST and more park-related PA and MVPA vs. non-visitors (even when excluding park visit time).</p> <p>• Park visitors spent an average of 18.4 fewer min/day of ST/day than non-visitors.</p> <p>Mean (SD) minutes and proportion (SD) of time per location spent in MVPA:</p> <ul style="list-style-type: none"> • Park visits = 11.9 (18.4) min and 38.9% (38.6%) (continuous MVPA), 26.6 (29.5) min and 46.7% (44.0%) (park PA bouts includes PA inside and outside of park boundary) • Park visitors achieved 14.3 min/day of park-related PA and 12.2 min/day of MVPA more than non-visitors. • Park visitors had more daily MVPA even when excluding park PA vs. non-visitors.

Continued on the following page

TABLE 2 (continued)
Included study characteristics and summary of findings

Author, year	Country, study	N ^a (% female)	Age ^b	Monitors, wear time	Behaviour	Location ^c	Results
Troped, 2010 ⁷⁸	USA, NR	148 (53%)	44.0 (13.0), 19–78	ActiGraph 7164/GeoStats GeoLogger, 4 days	MPA (1952–5724 cpm), VPA (≥ 5725 cpm)	Home buffer 50 m, home buffer 1 km, work buffer 50 m, work buffer 1 km	<p>Mean (SD) minutes and proportion (SD) of time per location spent in MPA:</p> <ul style="list-style-type: none"> Home buffer 50 m = 5.7 (7.9) and 9.7% (23.2%) Home buffer 1 km = 12.9 (15.5) and 10.4% (14.6%) Work buffer 50 m = 1.5 (4.0) and 7.8% (22.9%) Work buffer 1 km = 7.6 (8.8) and 7.5% (9.5%) <p>• Men MPA: home buffer 50 m = 6.1 (7.9) and 8.9% (21.3%), home buffer 1 km = 12.0 (15.5) and 10.9% (14.4%), work buffer 50 m = 1.8 (4.2) and 7.2% (22.1%), work buffer 1 km = 7.5 (7.7) and 8.4% (11.5%).</p> <p>• Women MPA: home buffer 50 m = 5.3 (8.0) and 10.4% (24.9%), home buffer 1 km = 13.7 (15.5) and 9.9% (14.8%), work buffer 50 m = 1.3 (3.8) and 8.5% (24.6%), work buffer 1 km = 7.7 (9.9) and 6.5% (6.6%).</p> <p>Mean (SD) minutes and proportion (SD) of time per location spent in VPA:</p> <ul style="list-style-type: none"> Home buffer 50 m = 0.3 (1.1) and 0.1% (0.3%) Home buffer 1 km = 1.1 (3.3) and 1.2% (6.4%) Work buffer 50 m = 0.1(0.6) and 2.8% (16.7%) Work buffer 1 km = 0.9 (2.6) and 0.7% (1.8%) <p>• Men VPA: home buffer 50 m = 0.4 (1.4) and 0.1% (0.4%), home buffer 1 km = 1.5 (4.3) and 1.9% (9.1%), work buffer 50 m = 0.2 (0.9) and 5.0% (22.4%), work buffer 1 km = 1.3 (3.2) and 0.9% (1.8%).</p> <p>• Women VPA: home buffer 50 m = 0.2 (0.7) and 0.1% (0.2%), home buffer 1 km = 0.9 (2.1) and 0.5% (1.3%), work buffer 50 m = 0 (0) and 0% (0%), work buffer 1 km = 0.5 (1.6) and 0.4% (1.7%).</p> <p>Sex differences</p> <ul style="list-style-type: none"> No significant differences between men and women.
Zenk, 2011 ⁷⁹	USA, DASES Study	120 (75%)	> 18	ActiGraph GT1M/Garmin Foretrex 201, 7 days (≥ 3 days, ≥ 10 h/day)	MVPA (≥ 2200 cpm, continuous)	Fast food outlet density (top 50 national quick service restaurants excluding coffee shops, ice cream places, and juice bars), supermarket availability (chained supermarkets), park land use (municipal park land)	<p>MVPA</p> <ul style="list-style-type: none"> Percentage of NB area that was park land did not relate to an individual's level of MVPA.

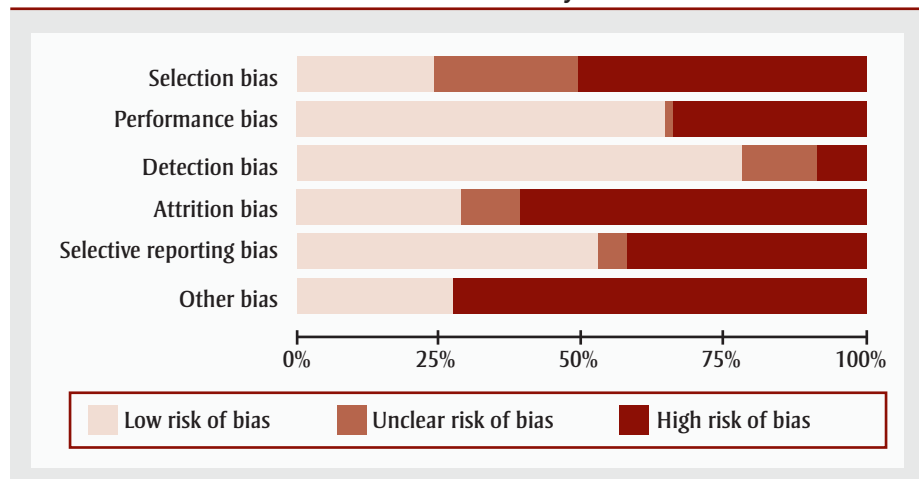
Abbreviations: ASAPJ, Active Streets, Active People Junior Study; assoc., associated; AT, active transportation; bpm, beats per minute; CALE, Children's Activity in their Local Environment; CAPABLE, Children's Activities, Perceptions and Behaviour in the Local Environments; CI, confidence interval; cpm, counts per minute; DASES, Detroit Activity Space Environments Study; F, female; FAST, Forty Area Study; GAG, GPS, Accelerometry and GIS; IQR, interquartile range; km, kilometer; LMVPA, light, moderate and vigorous intensity physical activity; LPA, light intensity physical activity; m, metre; MET, metabolic equivalent; min, minutes; MPA, moderate intensity physical activity; MVPA, moderate-to-vigorous intensity physical activity; NB, neighbourhood; NHANES, National Health and Examination Survey; NR, not reported; OR, odds ratio; PA, physical activity; PEACH, Personal and Environmental Associations with Children's Health; RECORD, Residential Environment and Coronary Heart Disease; SALTA, Environmental Support for Leisure and Active Transport; SD, standard deviation; SOPARC, System for Observing Play and Recreation in Communities; SPACE, Spatial Planning and Children's Exercise; SPEEDY, Sport, Physical activity and Eating behaviour Environmental Determinants in Young people; ST, sedentary time; TAAG, Trial of Activity for Adolescent Girls; TEAN, Teen Environment and Neighborhood; TRAC, Travel Assessment and Community; UK, United Kingdom; USA, United States of America; VPA, vigorous intensity physical activity; WCMC, When Cities Move Children.

^a Number analyzed.

^b Presented as mean (standard deviation) and/or range.

^c Buffers are assumed to represent the radius from the centre of the address unless otherwise indicated.

FIGURE 2
Risk of bias summary



Additional studies identified streets/roads as great sources of MVPA among children,³⁵ largely owing to their use for active transit to-and-from school.³⁹

Consistent evidence suggests that the school environment is one of the greatest sources for total MVPA^{23,27,30,35,39,42} for children. Specifically, the schoolyard appears to be a large contributor to school-based MVPA, especially among boys.^{27,42} The Spatial Planning and Children's Exercise (SPACE) Study in the Netherlands found that children spent a very small proportion of the time (2-3%) inside the school building in MVPA; the schoolyard (especially at recess) was a greater contributor.²⁷ Similarly, children from the Active Living Study obtained 18% of their daily MVPA in the schoolyard.⁴²

While parks and green space were low contributors of total MVPA,⁴⁰ time spent within these spaces was often at higher intensities.^{23,24,29,43} The Children's Activity in their Local Environment (CALE) Study from New Zealand found that only 2% of recorded PA took place in city parks.⁴⁰ Data from the Healthy PLACES study in the US found that only 27% of children used a neighbourhood park and proximity was directly related to use.²⁹

Indoor locations appear to be a substantial source of LPA²⁵ and ST,²² while outdoor locations contribute more to MVPA.^{24,30,43} There is likely a seasonal effect on location of MVPA. Oreskovic et al.³⁷ found that MVPA was higher in the home environment during winter months and higher in parks/playgrounds during the summer months.

Much of time in the home environment is spent sedentary and appears to be a substantial source of ST.^{22-24,28} Dunton et al.²⁸ found that 76% of parent-child ST was spent in the home. A study of preschoolers found that 45% of time spent in the home environment was spent sedentary.²⁴ Burgi et al.²³ found that 7- to 9-year-olds spent a median of 60% of their home time sedentary. Results from the Healthy PLACES study also found that among 8- to 14-year-olds, ST often occurred in the home.²²

Several studies reported on sex differences in locations for MVPA. One study found that boys obtained a higher proportion of their MVPA outside their neighbourhood (> 800 m), while girls obtained a higher proportion inside their neighbourhood.³¹ Two studies observed that active transportation is an important location of MVPA, especially among girls. The home-school journey was found to contribute a greater proportion of daily MVPA among girls compared to boys (36% vs. 31%) in one study⁴¹ while another found that girls engaged in more active transportation compared to boys (29% vs. 26%), which in turn contributed to a greater percent of total MVPA (55% vs. 35%).³⁹ Boys were found to obtain a greater proportion of their daily MVPA at school³⁹ and in schoolyards compared to girls.⁴² Other studies found no sex differences in location of ST, light intensity PA or MVPA.^{25,30,32,38,41}

Location-based findings for youth (12-17 years)

The most commonly reported locations in youth were: homes; schools; recreational facilities; active transportation; and, green

space. Many focussed exclusively on MVPA within the active transportation environment, specifically the commute to-and-from school.^{47,55,59,60} Collins et al.⁴⁷ in their study of youth from England found that active commuting contributed to 35% of daily MVPA. Commuting distance appears to be a significant predictor of active transportation, with active commuters often living closer to the destination than passive commuters.^{47,55,60}

Roads and sidewalks are major sources of youth MVPA,^{45,51,53} largely owing to their use for active transit.^{49,56} A Canadian study found that urban youth accumulated the majority (56% for girls, 58% for boys) of their daily MVPA while commuting (largely to-and-from school); this was greater than for suburban and rural students.⁵⁶

Similar to children, the school environment is one of the greatest sources of MVPA among youth;^{45,46,49,50,53,54,56} likely reflective of the location where they spend a substantial amount of their day. However, Carlson et al.⁴⁶ using data from the US-based TEAN Study, found that although most (55% on school days) MVPA was achieved at school, relative to the proportion of time spent at school, it was a low amount.

Contrary to findings for children, the home environment was found to be a large contributor of MVPA in several studies,^{45,46,52} especially on non-school days⁴⁶ and in suburban and rural compared to urban youth.⁵⁶ A couple of studies, however, noted that the home environment was less of a contributor.^{49,53}

Evidence around green space as a contributor of total MVPA is mixed. Results of the GAG Study in Scotland found that green space accounted for only 11% of leisure time MVPA.⁴⁸ Whereas, the When Cities Move Children (WCMC) Study in Denmark found urban green space was a major contributor of daily outdoor MVPA.⁵⁰ Lachowycz et al.⁵¹ reported that green space and parks were responsible for 46% and 29% of all weekend outdoor MVPA, respectively.

Very few youth studies reported on locations for LPA and ST.⁵¹⁻⁵³ Similar to findings for children in this regard, indoor locations appear to be greater sources of LPA⁵¹ and ST.^{51,53}

Few studies reported on sex analyses. Boys were found to achieve more MVPA outside compared to girls.⁴⁵ Studies have found that boys obtain more MVPA compared to girls at school,^{45,46,49} in transport⁴⁹ and at home,⁴⁶ but that girls had more MVPA near school.⁴⁶ Rainham et al.⁵⁶ found sex differences in suburban and rural, but not urban youth. Suburban boys obtained more of their MVPA at home than suburban girls (30% vs. 20%). While suburban girls spent more of their MVPA time commuting compared to suburban boys (42.5% vs. 27.4%), rural girls spent less of their MVPA time commuting compared to rural boys (20.7% vs. 27.0%).⁵⁶ Collins et al.⁴⁷ found no sex differences in active commuting.

Location-based findings for adults (≥ 18 years)

The most commonly reported locations in adult studies were: home neighbourhood; home; outside home neighbourhood; parks; green space; active transportation; and, commercial destinations. Evidence suggests that among adults the active transportation environment is one of the greatest sources while the home environment is one of the least common locations of MVPA.

Several studies examined or reported exclusively on time spent in active transportation.^{61-64,74} Commuting/active transportation accounted for between 33% and 68% of total daily MVPA.^{61,63,74} Chaix et al.⁶³ found that in general transportation accounted for a median of 13% of ST, but public transportation trips were associated with significantly more ST compared to personalized motor vehicle trips. Costa et al.⁶⁴ found that the mode of transportation during a journey was related to the median proportion of time spent in ST, LPA and MVPA. Journey time spent in ST was highest in car- (59%) and bus-only (~41%) journeys, time spent in LPA was greatest among trips that used a combination of car (38%) or car and cycling or walking (~33-35%) or bus-only trips (~29%), and journey time spent in MVPA was greatest in walking- (100%) or cycling-only (~33% MPA + 56% VPA) trips. Approximately 20% of bus-only trip time was spent in MVPA.⁶⁴

Several studies examined time spent in the home environment.^{65,68,69,74,75,78} The home environment appears to be associated with ST and LPA,^{28,65,69} but not MVPA

with most MVPA occurring outside of the home area,^{69,74,75} especially on weekdays.⁷⁵ In contrast, the US-based System for Observing Play and Recreation in Communities (SOPARC) Study found that homes accounted for 20-29% of bout-based MVPA, whereas roads and fitness facilities were important locations for VPA.⁶⁸

The evidence around parks and green space was mixed, but generally identified that both locations are potential sources of MVPA⁶⁵ (though not necessarily substantial amounts^{66,71}) among adults, depending on whether they are actually used.^{66,77} Data from the SOPARC study found that only 12% of time in parks was spent engaged in MVPA⁶⁶ and that this represented ~13% of total daily MVPA.⁶⁸

While few studies commented on the workplace environment, two found that the workplace and workplace neighbourhood were substantial contributors to MVPA, but much of this was likely owed to transportation to-and-from work and daily time spent at work.^{71,74} Interestingly, Troped et al.⁷⁸ found most MVPA occurred outside of home and work buffers than within them.

Three studies conducted sex-specific analyses. Troped et al.⁷⁸ found no significant differences in the location of MVPA by sex. Hillsdon et al.⁶⁷ found that men accrued significantly more PA outside of the neighbourhood than women (64.7% vs. 57.4%). Dewulf and colleagues⁶⁵ found that among men, greater time spent in non-green areas was associated with more MVPA; the opposite was true in women.

Discussion

This rapid review examines and synthesizes the available literature around locations of PA and ST in children, youth and adults. Findings provide guidance for the design of future studies by understanding *where* individuals engage in PA and ST and areas of uncertain/weak evidence. Results can be used to support the current knowledge base around correlates and determinants of PA and ST and subsequently inform direction for new interventions by identifying environmental settings of importance.

Only one other review to date has looked at location-based studies. McGrath et al.⁸ conducted a systematic review of objectively

measured environmental features and MVPA in children and youth. They found that walking on local streets accounted for the greatest proportion of children and youth's daily activity spent outdoors (~40%). They also found that a large proportion of PA occurred in non-green space/other urban areas (26-27%). Similar to our results, they found that streets, roads, car parks, hard surface play areas, pedestrian pathways and shopping areas contributed more to outdoor PA than green spaces, parks and other grassland areas.⁸ Our results also underscore the importance of active transportation to-and-from schools and schoolyards as major contributors to daily PA levels in children and youth. Important to note, however, is that McGrath et al.⁸ excluded studies which examined citywide data rather than that of neighbourhood areas or data that used school locations as proxies for residential neighbourhoods. Our review builds on this previous work by including: studies regardless of type of location; other intensities (LPA, ST); updated literature; and, adults.

Findings of the present review support and contrast previous systematic reviews looking at the correlates and determinants of PA. The evidence for associations between aspects of the built environment and PA has been mixed, but with the most consistent evidence derived from studies using objectively measured environments and domain-specific PA.⁸⁰ In children and youth, evidence suggests a positive association exists between access to recreation facilities, playgrounds/parks, measures of walkability (including sidewalks) and PA.^{80,81} Findings from our review suggest that schoolyards and active transportation are substantial contributors to child/youth daily PA rather than parks, especially on weekdays. Similar to our findings, systematic review evidence suggests that distance to school is negatively associated with PA in children.⁸¹

In adults, systematic review evidence suggests that in general, access to recreation facilities is positively associated with PA.^{80,82,83} Only one⁶⁸ of the location studies used in our review commented specifically on indoor recreation facilities (e.g., fitness centres, pools). There is mixed evidence on the association between sidewalks and PA.^{82,83} Among adults, factors in the built environment are likely relevant to different domains of PA. For example, sidewalks may be integral to the active

transportation environment or to the workplace environment. Similar to our findings, evidence also suggests that the transportation environment is a correlate and determinant of total PA in adults.⁸⁰

Much less previous work has examined the associations between factors in the built environment and ST.^{9,84,85} In children, contrary to popular assumption, a higher playground density and availability of sports equipment in the school has been shown to be associated with greater ST,⁸⁵ whereas increasing the length of breaks at school and providing safe road crossings are associated with lower ST.⁸⁵ The studies in our review highlight the impact of the school environment on ST. For instance, most ST is recorded in the home and school environments,²³ emphasizing the importance of activity breaks in these environments and providing an opportunity for active transportation to-and-from school for regular MVPA. In adults, evidence suggests that proximity or density to green spaces is negatively associated with objectively measured sitting time.⁸⁴ Only one study in the present review looked at a measure of area 'greenness' and found that ST was higher in non-green areas compared to greener areas.⁶⁵ Mixed findings have been found around the association with neighbourhood walkability, walking/cycling infrastructure and recreation facilities and ST.^{9,84} While the presence of active transportation supportive environments (e.g., lockers, bike storage, shower facilities) in the workplace have been shown to be positively associated with total objectively measured ST, they are also associated with greater levels of PA.⁸⁴ This finding suggests and supports the idea that interventions designed to increase PA may not always result in significant reductions of ST.⁸⁶

This review serves to provide direction for future location-based studies. Many of the studies did not employ a full-day perspective and instead reported on results related to specific locations. For example, many focussed exclusively on time spent in travel to-and-from school or work. In recognition of the importance of movement across the 24-hour spectrum, future studies should report on locations across all intensities of movement including LPA and ST. Future studies would also benefit from reporting results by sex to understand if girls/women and boys/men spend their time in different locations at different intensities.

Strengths and limitations

The strengths of this review include a comprehensive search strategy developed with two research librarians, an *a priori* established protocol and the assessment of risk of bias. The review also took a life-course approach by looking at the findings separately in children, youth and adults and reporting on sex differences where available. Unfortunately, none of the included studies reported on findings specifically in older adults. Given that many included this population in their overall sample, we encourage future researchers to report on this segment of the adult population separately.

One of the major limitations of the review is the heterogeneity of the studies and their reporting. There was little standardization of the nomenclature used to describe the locations and many studies did not report measures of variance, preventing the conduct of a meta-analysis; future studies would benefit from reporting both on daily minutes and proportion per location. We were also not able to distinguish whether home environment behaviours occurred inside or outside of the home. Nor were we able to discern the location characteristics (e.g., road, path, and sidewalk) for many studies that focussed on active transportation. As this is an important domain of PA, we felt it was important to include these studies under a general "active transportation" location. Other studies reported movement behaviours in locations often associated with active transportation (e.g., roads), but the purpose/domain of this activity was not distinguishable. There will always be a limitation with being too specific in these efforts as active transportation takes place over a heterogeneous set of street geographies. As an example, it might start on a quiet residential street, continue on a shared-use walk/bike path, move to a painted bike lane and finish on a dedicated bike lane. In this example, only 3 out of 4 components of the journey occurred on a "road", and even then the types of roads differ. In our opinion, the key point is that PA occurred in the "travel" environment. Many of the studies were based on small and biased samples; there is a need for larger representative samples. Using GPS overlaid onto GIS helps to increase the accuracy of identifying locations of movement, but it is important to understand that the quality of GIS data can be variable and can

ultimately introduce a source of measurement bias.⁸⁷ Findings from the literature have also identified that 12-14 days of monitoring are needed to provide reliable estimates of PA, and that time in the home or commercial environments require substantial monitoring times (> 19 days).^{88,89} The majority of the included studies assessed movement over a 7-day period and many only required 4 days of valid data. Therefore, the findings may not be reliable. Future studies should consider the evidence around monitoring time requirements for reliable estimates. There was also substantial heterogeneity in the measures of activity and ST including the different devices, wear time requirements and cut-points used to define intensity. Finally, while GPS devices improve our understanding of the location of PA and ST, they also have their own limitations: there is the potential for large data loss due to signal drop outs, inadequate battery power and wear time adherence.¹⁶ Many of the studies experienced substantial data loss.

Conclusion

In conclusion, this review provides a summary of the evidence around the locations where children, youth and adults obtain their ST, LPA and MVPA. There is limited evidence around the location of LPA and ST compared to MVPA. Evidence suggests that the active transportation environment is a potentially important contributor of MVPA across an individual's lifespan. There is a need for future location-based studies to report on locations of all intensity of movement using a whole-day approach in larger more representative samples.

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Conflicts of interest

We declare that we have no conflicts of interest related to this work.

Authors' contributions and statement

SAP was responsible for the conceptualization, design, acquisition, analysis, interpretation of the data, and drafting and revising of the paper. GPB, DPR and WT were responsible for the conceptualization, interpretation of the data, and revising of the paper.

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References

1. Warburton DE, Charlesworth S, Ivey A, et al. A systematic review of the evidence for Canada's Physical Activity Guidelines for Adults. *Int J Behav Nutr Phys Act.* 2010;7:39. doi: 10.1186/1479-5868-7-39.
2. Biswas A, Oh PI, Faulkner GE, et al. Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis. *Ann Intern Med.* 2015;162(2):123-132. doi: 10.7326/M14-1651.
3. Garriguet D, Carson V, Colley RC, et al. Physical activity and sedentary behaviour of Canadian children aged 3 to 5. *Health Rep.* 2016;27(9):14-23.
4. Colley RC, Garriguet D, Janssen I, et al. Physical activity of Canadian adults: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Rep.* 2011;22(1):7-14.
5. Colley RC, Carson V, Garriguet D, et al. Physical activity of Canadian children and youth, 2007 to 2015. *Health Rep.* 2017;28(10):8-16.
6. Caspersen CJ, Pereira MA, Curran KM. Changes in physical activity patterns in the United States, by sex and cross-sectional age. *Med Sci Sport Exerc.* 2000;32(9):1601-1609.
7. Bauman A, Bull F, Chey T, et al. The international prevalence study on physical activity: results from 20 countries. *Int J Behav Nutr Phys Act.* 2009;6(1):21. doi: 10.1186/1479-5868-6-21.
8. McGrath LJ, Hopkins WG, Hinckson EA. Associations of objectively measured built-environment attributes with youth moderate-vigorous physical activity: a systematic review and meta-analysis. *Sports Med.* 2015;45(6):841-865. doi: 10.1007/s40279-015-0301-3.
9. Prince SA, Reed JL, McFetridge C, et al. Correlates of sedentary behaviour in adults: a systematic review. *Obes Rev.* 2017;18(8):915-935. doi: 10.1111/obr.12529.
10. Davison KK, Lawson CT. Do attributes in the physical environment influence children's physical activity? A review of the literature. *Int J Behav Nutr Phys Act.* 2006;3:19. doi: 10.1186/1479-5868-3-19.
11. Ding D, Sallis JF, Kerr J, et al. Neighborhood environment and physical activity among youth: a review. *Am J Prev Med.* 2011;41(4):442-455. doi: 10.1016/j.amepre.2011.06.036.
12. Ding D, Gebel K. Built environment, physical activity, and obesity: What have we learned from reviewing the literature? *Health Place.* 2012;18(1):100-105. doi: 10.1016/j.healthplace.2011.08.021.
13. Fitzhugh EC, Bassett Jr DR, Evans MF. Urban trails and physical activity: a natural experiment. *Am J Prev Med.* 2010;39(3):259-262.
14. Evenson KR, Jones SA, Holliday KM, et al. Park characteristics, use, and physical activity: A review of studies using SOPARC (System for Observing Play and Recreation in Communities). *Prev Med.* 2016;86:153-166.
15. Jankowska MM, Schipperijn J, Kerr J. A framework for using GPS data in physical activity and sedentary behavior studies. *Exerc Sport Sci Rev.* 2015;43(1):48-56. doi: 10.1249/JES.0000000000000035.
16. Krenn PJ, Titze S, Oja P, et al. Use of global positioning systems to study physical activity and the environment: a systematic review. *Am J Prev Med.* 2011;41(5):508-515. doi: 10.1016/j.amepre.2011.06.046.
17. Maddison R, Ni Mhurchu C. Global positioning system: A new opportunity in physical activity measurement. *Int J Behav Nutr Phys Act.* 2009;6:1479. doi: 10.1186/1479-5868-6-73.
18. Chaix B, Meline J, Duncan S, et al. GPS tracking in neighborhood and health studies: A step forward for environmental exposure assessment, a step backward for causal inference? *Health Place.* 2013;21:46-51. doi: 10.1016/j.healthplace.2013.01.003.
19. Organization for Economic Co-operation and Development. Members and partners [Internet]. 2017 [cited 2017 Oct 24]; Available from: <http://www.oecd.org/about/membersandpartners/>
20. Maddison R, Ni Mhurchu C. Global positioning system: a new opportunity in physical activity measurement. *Int J Behav Nutr Phys Act.* 2009;6:73. doi: 10.1186/1479-5868-6-73.
21. Poitras VJ, Gray CE, Borghese MM, et al. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Appl Physiol Nutr Metab.* 2016;41(6 Suppl 3):S197-239. doi: 10.1139/apnm-2015-0663.
22. Almanza E, Jerrett M, Dunton G, et al. A study of community design, greenness, and physical activity in children using satellite, GPS and accelerometer data. *Health Place.* 2012;18(1):46-54. doi: 10.1016/j.healthplace.2011.09.003.
23. Burgi R, Tomatis L, Murer K, et al. Spatial physical activity patterns among primary school children living in neighbourhoods of varying socioeconomic status: a cross-sectional study using accelerometry and Global Positioning System. *BMC Public Health.* 2016;16:282. doi: 10.1186/s12889-016-2954-8.
24. Cerin E, Baranowski T, Barnett A, et al. Places where preschoolers are (in) active: an observational study on Latino preschoolers and their parents using objective measures. *Int J Behav Nutr Phys Act.* 2016;13:29. doi: 10.1186/s12966-016-0355-0.
25. Coombes E, van Sluijs E, Jones A. Is environmental setting associated with the intensity and duration of children's physical activity? Findings from the SPEEDY GPS study. *Health Place.* 2013;20:62-65. doi: 10.1016/j.healthplace.2012.11.008.

26. Cooper AR, Page AS, Wheeler BW, et al. Mapping the walk to school using accelerometry combined with a global positioning system. *Am J Prev Med.* 2010;38(2):178-183. doi: 10.1016/j.amepre.2009.10.036.
27. Dessing D, Pierik FH, Sterkenburg RP, et al. Schoolyard physical activity of 6-11 year old children assessed by GPS and accelerometry. *Int J Behav Nutr Phys Act.* 2013;10:97. doi: 10.1186/1479-5868-10-97.
28. Dunton GF, Liao Y, Almanza E, et al. Locations of joint physical activity in parent-child pairs based on accelerometer and GPS monitoring. *Ann Behav Med.* 2013;45:S162-S172. doi: 10.1007/s12160-012-9417-y.
29. Dunton GF, Almanza E, Jerrett M, et al. Neighborhood park use by children: Use of accelerometry and global positioning systems. *Am J Prev Med.* 2014;46(2):136-142. doi: 10.1016/j.amepre.2013.10.009.
30. Eyre E. Environmental influences on physical activity and weight status in children from deprived multi-ethnic backgrounds in Coventry [online PhD thesis]. Coventry (UK): Coventry University; 2014. Available from: <https://curve.coventry.ac.uk/open/items/d2080789-8c3b-4775-a41f-d2dc2a2df687/1/>
31. Jones AP, Coombes EG, Griffin SJ, et al. Environmental supportiveness for physical activity in English schoolchildren: A study using Global Positioning Systems. *Int J Behav Nutr Phys Act.* 2009. doi: 10.1186/1479-5868-6-42.
32. Lee C, Li L. Demographic, physical activity, and route characteristics related to school transportation: an exploratory study. *Am J Health Promot.* 2014; 28(3 Supplement):S77-S88. doi: 10.4278/ajhp.130430-QUAN-211.
33. Mackett R, Brown B, Gong Y, et al. Children's independent movement in the local environment. *Built Env.* 2007; 33(4):454-468.
34. McMinn D, Oreskovic NM, Aitkenhead MJ, et al. The physical environment and health-enhancing activity during the school commute: global positioning system, geographical information systems and accelerometry. *Geospat Health.* 2014;8(2):569-572. doi: 10.4081/gh.2014.46.
35. Moore HJ, Nixon CA, Lake AA, et al. The environment can explain differences in adolescents' daily physical activity levels living in a deprived urban area: cross-sectional study using accelerometry, GPS, and focus groups. *J Phys Act Health.* 2014;11(8):1517-1524. doi: 10.1123/jpah.2012-0420.
36. O'Connor TM, Cerin E, Robles J, et al. Feasibility study to objectively assess activity and location of Hispanic preschoolers: a short communication. *Geospat Health.* 2013;7(2):375-380. doi: 10.4081/gh.2013.94.
37. Oreskovic NM, Blossom J, Field AE, et al. Combining global positioning system and accelerometer data to determine the locations of physical activity in children. *Geospat Health.* 2012;6(2): 263-272. doi: 10.4081/gh.2012.144.
38. Pearce M, Page AS, Griffin TP, et al. Who children spend time with after school: associations with objectively recorded indoor and outdoor physical activity. *Int J Behav Nutr Phys Act.* 2014;11(1):45. doi: 10.1186/1479-5868-11-45.
39. Pizarro AN, Schipperijn J, Ribeiro JC, et al. Gender differences in the domain-specific contributions to moderate-to-vigorous physical activity, accessed by GPS. *J Phys Act Health* 2017;14(6): 474-478. doi: 10.1123/jpah.2016-0346.
40. Quigg R, Gray A, Reeder AI, et al. Using accelerometers and GPS units to identify the proportion of daily physical activity located in parks with playgrounds in New Zealand children. *Prev Med.* 2010;50(5-6):235-240. doi: 10.1016/j.yjmed.2010.02.002.
41. Southward EF, Page AS, Wheeler BW, et al. Contribution of the school journey to daily physical activity in children aged 11-12 years. *Am J Prev Med.* 2012;43(2):201-204. doi: 10.1016/j.amepre.2012.04.015.
42. Van Kann DH, de Vries SI, Schipperijn J, et al. Schoolyard characteristics, physical activity, and sedentary behavior: combining GPS and accelerometry. *J Sch Health.* 2016;86(12):913-921. doi: 10.1111/josh.12459.
43. Wheeler BW, Cooper AR, Page AS, et al. Greenspace and children's physical activity: a GPS/GIS analysis of the PEACH project. *Prev Med* 2010;51(2): 148-152. doi: 10.1016/j.yjmed.2010.06.001.
44. Andersen HB, Christiansen LB, Klinker CD, et al. Increases in use and activity due to urban renewal: effect of a natural experiment. *Am J Prev Med.* 2017;53(3):e81-e87. doi: 10.1016/j.amepre.2017.03.010.
45. Burgi R, Tomatis L, Murer K, et al. Localization of physical activity in primary school children using accelerometry and global positioning system. *PLoS ONE.* 2015;10(11):e0142223. doi: 10.1371/journal.pone.0142223.
46. Carlson JA, Schipperijn J, Kerr J, et al. Locations of physical activity as assessed by GPS in young adolescents. *Pediatrics.* 2016;137(1):e20152430. doi: 10.1542/peds.2015-2430.
47. Collins P, Al-Nakeeb Y, Lyons M. Tracking the commute home from school utilizing GPS and heart rate monitoring: establishing the contribution to free-living physical activity. *J Phys Act Health.* 2015;12(2):155-162. doi: 10.1123/jpah.2013-0048.
48. Geyer J. Developing an understanding of greenspace as a resource for physical activity of adolescents in Scotland [online PhD thesis]. Edinburgh (UK): The University of Edinburgh; 2013. Available from: <https://www.era.lib.ed.ac.uk/handle/1842/7917>
49. Klinker CD, Schipperijn J, Christian H, et al. Using accelerometers and global positioning system devices to assess gender and age differences in children's school, transport, leisure and home based physical activity. *Int J Behav Nutr Phys Act.* 2014;11(1):8. doi: 10.1186/1479-5868-11-8.
50. Klinker CD, Schipperijn J, Kerr J, et al. Context-specific outdoor time and physical activity among school-children across gender and age: using accelerometers and GPS to advance methods. *Front Public Health.* 2014; 2:20. doi: 10.3389/fpubh.2014.00020.
51. Lachowycz K, Jones AP, Page AS, et al. What can global positioning systems tell us about the contribution of different types of urban greenspace to children's physical activity? *Health Place.* 2012;18(3):586-594. doi: 10.1016/j.healthplace.2012.01.006.
52. Maddison R, Jiang Y, Vander Hoorn S, et al. Describing patterns of physical activity in adolescents using global positioning systems and accelerometry. *Ped Exerc Sci.* 2010;22(3):392-407.

53. Oreskovic NM, Perrin JM, Robinson AI, et al. Adolescents' use of the built environment for physical activity. *BMC Public Health* 2015;15:251. doi: 10.1186/s12889-015-1596-6.
54. Pearce M. Combining measurement tools to understand the context of children's indoor and outdoor leisure-time physical activity [online PhD thesis]. Edinburgh (UK): The University of Edinburgh; 2015. Available from: <https://www.era.lib.ed.ac.uk/handle/1842/20408>
55. Pizarro AN, Schipperijn J, Andersen HB, et al. Active commuting to school in Portuguese adolescents: Using PALMS to detect trips. *J Transport Health*. 2016;3(3):297-304. doi: 10.1016/j.jth.2016.02.004.
56. Rainham DG, Bates CJ, Blanchard CM, et al. Spatial classification of youth physical activity patterns. *Am J Prev Med*. 2012;42(5):e87-e96. doi: 10.1016/j.amepre.2012.02.011.
57. Robinson AI, Oreskovic NM. Comparing self-identified and census-defined neighborhoods among adolescents using GPS and accelerometer. *Int J Health Geo*. 2013;12:57. doi: 10.1186/1476-072X-12-57.
58. Rodriguez DA, Cho G, Evenson KR, et al. Out and about: association of the built environment with physical activity behaviors of adolescent females. *Health Place*. 2012;18(1):55-62. doi: 10.1016/j.healthplace.2011.08.020.
59. Voss C, Winters M, Frazer AD, et al. They go straight home - don't they? Using global positioning systems to assess adolescent school-travel patterns. *J Transport Health*. 2014;1(4):282-287. doi: 10.1016/j.jth.2014.09.013.
60. Voss C, Winters M, Frazer A, et al. School-travel by public transit: Rethinking active transportation. *Prev Med Rep*. 2015;2:65-70. doi: 10.1016/j.pmedr.2015.01.004.
61. Audrey S, Procter S, Cooper AR. The contribution of walking to work to adult physical activity levels: a cross sectional study. *Int J Behav Nutr Phys Act*. 2014;11(1):37. doi: 10.1186/1479-5868-11-37.
62. Chaix B, Kestens Y, Duncan DT, et al. A GPS-based methodology to analyze environment-health associations at the trip level: case-crossover analyses of built environments and walking. *Am J Epidemiol*. 2016;184(8):579-589. doi: 10.1093/aje/kww071.
63. Chaix B, Kestens Y, Duncan S, et al. Active transportation and public transportation use to achieve physical activity recommendations? A combined GPS, accelerometer, and mobility survey study. *Int J Behav Nutr Phys Act*. 2014;11(1):124. doi: 10.1186/s12966-014-0124-x.
64. Costa S, Ogilvie D, Dalton A, et al. Quantifying the physical activity energy expenditure of commuters using a combination of global positioning system and combined heart rate and movement sensors. *Prev Med*. 2015; 81:339-344. doi: 10.1016/j.yjmed.2015.09.022.
65. Dewulf B, Neutens T, Van Dyck D, et al. Associations between time spent in green areas and physical activity among late middle-aged adults. *Geospatial Health*. 2016;11(3):411. doi: 10.4081/gh.2016.411.
66. Evenson KR, Wen F, Hillier A, et al. Assessing the contribution of parks to physical activity using global positioning system and accelerometry. *Med Sci Sports Exerc*. 2013;45(10):1981-1987. doi: 10.1249/MSS.0b013e318293330e.
67. Hillsdon M, Coombes E, Griew P, et al. An assessment of the relevance of the home neighbourhood for understanding environmental influences on physical activity: How far from home do people roam? *Int J Behav Nutr Phys Act*. 2015;12(1):100. doi: 10.1186/s12966-015-0260-y.
68. Holliday KM, Howard AG, Emch M, et al. Where are adults active? An examination of physical activity locations using GPS in five US cities. *J Urban Health*. 2017;94(4):459-469.
69. Hurvitz PM, Moudon AV, Kang B, et al. How far from home? The locations of physical activity in an urban U.S. setting. *Prev Med*. 2014;69:181-186. doi: 10.1007/s11524-017-0164-z.
70. Hwang LD, Hurvitz PM, Duncan GE. Cross sectional association between spatially measured walking bouts and neighborhood walkability. *Int J Environ Res Public Health*. 2016;13(4):412. doi: 10.3390/ijerph13040412.
71. Jansen M, Ettema D, Pierik F, et al. Sports facilities, shopping centers or homes: What locations are important for adults' physical activity? A cross-sectional study. *Int J Environ Res Public Health*. 2016;13(3): 287. doi: 10.3390/ijerph13030287.
72. Jansen FM, Ettema DF, Kamphuis CBM, et al. How do type and size of natural environments relate to physical activity behavior? *Health Place*. 2017; 46:73-81. doi: 10.1016/j.healthplace.2017.05.005.
73. Perez LG, Carlson J, Slymen DJ, et al. Does the social environment moderate associations of the built environment with Latinas' objectively-measured neighborhood outdoor physical activity. *Prev Med Rep*. 2016;4:551-557. doi: 10.1016/j.pmedr.2016.10.006.
74. Rafferty D, Dolan C, Granat M. Attending a workplace: its contribution to volume and intensity of physical activity. *Physiol Meas*. 2016;37(12): 2144-2153.
75. Ramulu PY, Chan ES, Loyd TL, et al. Comparison of home and away-from-home physical activity using accelerometers and cellular network-based tracking devices. *J Phys Act Health*. 2012;9(6):809-817.
76. Rodriguez DA, Brown AL, Troped PJ. Portable global positioning units to complement accelerometry-based physical activity monitors. *Med Sci Sports Exerc*. 2005;37(11 SUPPL):S572-S581.
77. Stewart OT, Moudon AV, Fesinmeyer MD, et al. The association between park visitation and physical activity measured with accelerometer, GPS, and travel diary. *Health Place*. 2016; 38:82-88. doi: 10.1016/j.healthplace.2016.01.004.
78. Troped PJ, Wilson JS, Matthews CE, et al. The built environment and location-based physical activity. *Am J Prev Med*. 2010;38(4):429-438. doi: 10.1016/j.amepre.2009.12.032.

-
79. Zenk SN, Schulz AJ, Matthews SA, et al. Activity space environment and dietary and physical activity behaviors: A pilot study. *Health Place*. 2011;17(5):1150-1161. doi: 10.1016/j.healthplace.2011.05.001.
80. Bauman AE, Reis RS, Sallis JF, et al. Correlates of physical activity: why are some people physically active and others not. *Lancet*. 2012;380(9838):258-271. doi: 10.1016/S0140-6736(12)60735-1.
81. Sterdt E, Liersch S, Walter U. Correlates of physical activity of children and adolescents: A systematic review of reviews. *Health Educ J*. 2014;73(1):72-89. doi: 10.1177/0017896912469578.
82. Choi J, Lee M, Lee JK, et al. Correlates associated with participation in physical activity among adults: a systematic review of reviews and update. *BMC Public Health*. 2017;17(356). doi: 10.1186/s12889-017-4255-2.
83. Trost SG, Owen N, Bauman AE, et al. Correlates of adults' participation in physical activity: review and update. *Med Sci Sports Exerc*. 2002;34(12):1996-2001. doi: 10.1249/01.MSS.0000038974.76900.92.
84. O'Donoghue G, Perchoux C, Mensah K, et al. A systematic review of correlates of sedentary behaviour in adults aged 18-65 years: a socio-ecological approach. *BMC Public Health*. 2016;16:163-016-2841-3. doi: 10.1186/s12889-016-2841-3.
85. Stierlin AS, De Lepeleere S, Cardon G, et al. A systematic review of determinants of sedentary behaviour in youth: a DEDIPAC-study. *Int J Behav Nutr Phys Act*. 2015;12:133. doi: 10.1186/s12966-015-0291-4.
86. Prince SA, Saunders TJ, Gresty K, et al. A comparison of the effectiveness of physical activity and sedentary behaviour interventions in reducing sedentary time in adults: a systematic review and meta-analysis of controlled trials. *Obes Rev*. 2014;15(11):905-919. doi: 10.1111/obr.12215.
87. Porter DE, Kirtland KA, Williams JE, et al. Considerations for using a geographic information system to assess environmental supports for physical activity. *Prev Chron Dis*. 2004;1(4):A20.
88. Holliday KM, Howard AG, Emch M, et al. Deriving a GPS monitoring time recommendation for physical activity studies of adults. *Med Sci Sports Exerc*. 2017;49(5):939-947. doi: 10.1249/MSS.0000000000001190.
89. Zenk SN, Matthews SA, Kraft AN, et al. How many days of global positioning system (GPS) monitoring do you need to measure activity space environments in health research? *Health Place*. 2018;51:52-60. doi: 10.1016/j.healthplace.2018.02.004.