

# BMJ Open Educator engagement and interaction and children's physical activity in early childhood education and care settings: an observational study protocol

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## ABSTRACT

**Introduction:** The benefits of regular physical activity for children are significant. Previous research has addressed the quantity and quality of children's physical activity while in early childhood education and care (ECEC) settings, yet little research has investigated the social and physical environmental influences on physical activity in these settings. The outcomes of this study will be to measure these social and physical environmental influences on children's physical activity using a combination of a real-time location system (RTLS) (a closed system that tracks the location of movement of participants via readers and tags), accelerometry and direct observation.

**Methods and analysis:** This study is the first of its kind to combine RTLSs and accelerometer data in ECEC settings. It is a cross-sectional study involving ~100 educators and 500 children from 11 ECEC settings in the Illawarra region of New South Wales, Australia. A RTLS and Actigraph GT3X+ accelerometers will be concurrently used to measure the level and location of the children's and educators' physical activity while in outside environments. Children and educators will wear accelerometers on their hip that record triaxial acceleration data at 100 Hz. Children and educators will also wear a tag watch on their wrist that transmits a signal to anchors of the RTLS and the triangulation of signals will identify their specific location. In addition to these, up to three random periods (10–25 min in length) will be used to collect observational data each day and assessed with the classroom assessment and scoring system to measure the quality of interactions. In conjunction with the real-time location system (RTLS) and accelerometers, these observations will measure the relationship between the quality of interactions and children's physical activity.

**Ethics and dissemination:** The results of this study will be disseminated through peer-reviewed publications and presentations. Ethical approval was obtained through the University of Wollongong Human Research Ethics Committee (HE14/330).

## Strengths and limitations of this study

- The combined use of a Real Time Location System and accelerometry is an innovative and novel approach to measuring the child, educator and physical environmental influences on children's physical activity in Early Childhood Education and Care settings.
- The use of the Classroom Assessment and Scoring System solely in outdoor environments of Early Childhood Education and Care settings is unique to this study.
- The design will collect data from a large sample size and from multiple sources, which will allow for a comprehensive analysis of social and physical environmental variables that influence children's physical activity in Early Childhood Education and Care settings.
- The study is in a specialized environment and each setting has an individual design, so consideration for establishing the best possible placement of the Real Time Location System anchor readers is essential in each setting.
- As the study relies on the synchronised use of accelerometers and location watches, it is crucial that each individual monitor is identified accurately for each participant to ensure information can be cross-checked.

## INTRODUCTION

The period of early childhood is critical for learning and development.<sup>1</sup> Children's health and well-being are paramount and contribute to their ability to concentrate, cooperate and learn.<sup>2</sup> More specifically, appropriate levels of physical health allow children to be physically active, which in turn is associated with improved blood pressure, cholesterol and bone density, as well as a number of social and emotional benefits

such as enhanced self-esteem and social interaction skills.<sup>3–5</sup> Research also shows that physical activity patterns in early childhood track into childhood, providing longer term health benefits.<sup>6</sup> Despite the known benefits of physical activity for young children, compliance with recommended physical activity guidelines within early childhood education and care (ECEC) settings (15 min per hour<sup>7</sup>) for children aged 3–5 years is low,<sup>8–9</sup> highlighting the need to identify the specific influences on children's physical activity in these settings.

ECEC settings provide opportunities for children's learning and development and have the potential to offer quality physical activity experiences.<sup>10–11</sup> Children's physical activity and sedentary behaviour in ECEC settings are influenced by a number of factors, including child characteristics and the physical environment of the ECEC setting.<sup>12–13</sup> Evidence shows that physical environmental factors such as the availability of an outdoor environment, natural ground coverings and the size of the playspace (larger spaces related to greater levels of physical activity) have a positive influence on children's physical activity in ECEC settings, as do the presence of natural features and portable equipment such as gardens and bikes.<sup>12–14</sup> Furthermore, evidence also shows that the presence of fixed equipment, such as a sandpit, has an adverse effect on levels of physical activity.<sup>12</sup> As the physical environment is a key indicator of children's physical activity in ECEC settings,<sup>12</sup> it is important that all potential influences from the physical environment are considered. Child and educator activity and movement around the physical environment may be influenced by social factors such as educator and peer presence and interaction, as well as physical factors, such as the amount and quality of the resources and equipment offered. To better understand these influences, it is important to identify social and physical 'hot spots' (locations that are predominant areas for the selected activity), intensity, type and duration of physical activity, as well as the movement of educators and children around the environment. Importantly, the location of children and educators' physical activity in relation to social and physical environmental contexts is an aspect that has not been studied in ECEC settings before.

The adult role is critical in providing quality opportunities for a child's learning.<sup>15</sup> Evidence shows that a quality relationship between children and educators enhances children's motivation, engagement and performance in the learning experience,<sup>16</sup> as well as their willingness to explore the environment.<sup>17–18</sup> The importance of significant educator relationships for children in ECEC settings is well documented.<sup>15–19</sup> For example, the positive outcomes of quality educator/child interactions for children at risk<sup>16</sup> and the significance of children's engagement with educators for the development of secure attachments.<sup>20</sup> However, few studies have investigated the relationship between educator's physical activity and children's physical activity, as well as the

influence of interactions on physical activity. Studies until now have been qualitative in nature with small sample sizes,<sup>21–22</sup> and no studies have used objective measures. Moreover, as very little is known about the physical activity of educators, it is yet to be determined whether and how the physical activity of an educator affects the physical activity of children. This study will address these gaps using objective measurements of physical activity levels alongside the identification of social and physical environmental location of physical activity. In addition to these, the use of an observation tool (classroom assessment scoring system, CLASS) will assess the quality of interactions between educators and children and also provide an opportunity to measure the relationship between the quality of interactions and levels of children's physical activity.

In recent years, a number of commercial location identification systems (eg, Global Positioning Systems (GPS) and radio frequency tracking devices) have been developed and used in studying the location and movements of participants around an area.<sup>23–27</sup> Until now, however, only a handful of studies have combined location identification systems and objective measures of physical activity such as accelerometry. For example, GPS and accelerometers have been used together to measure location and physical activity levels of older children in neighbourhoods, parks and playgrounds.<sup>23–26</sup> Among adults, the 'Active Buildings' study<sup>27</sup> used a combination of a radio frequency tracking device (OpenBeacon TagPRO) and accelerometers to investigate associations between office layout and physical activity. These studies have demonstrated that social and physical environmental factors have a positive effect on the type and duration of physical activity. No studies have used a combination of such measures within ECEC settings. The innovative use of the tracking identification system in this study, in combination with the objective measure of physical activity, will allow specific identification of the social and physical environmental influences that promote or hinder physical activity levels for children and educators within ECEC settings.

### Study aim

The combination of a real-time location system (RTLS), accelerometry and direct observation will provide a study design that will address research questions that can only be resolved with the synchronised use of these measures. Thus, the aim of this study of children's and educator's physical activity in an ECEC outdoor environment is twofold: (1) to examine the engagement and interaction between educators and children and how the quality of these interactions may influence physical activity; (2) to determine whether there are physical activity 'hot spots' in the social and physical environmental outdoor environment within ECEC settings, and where they are.

This study will aim to address the following research questions:

- ▶ What are the levels of educator physical activity in ECEC settings and how does this influence the activity in children?
- ▶ How does the quality of the educator's interactions influence children's physical activity?
- ▶ How do ECEC setting characteristics influence the educator and children's physical activity?
- ▶ Are there social 'hot spots' in an ECEC outdoor environment where children and educators participate in physical activity levels, and where are they?
- ▶ Are there physical environmental 'hot spots' in an ECEC outdoor environment where children and educators participate in physical activity levels, and where are they?

## METHODS AND ANALYSIS

### Study design

This cross-sectional study will combine a number of data collection methods (figure 1). A cross-sectional design was chosen as it will enable the researchers to capture descriptive data on a number of variables in a short time frame (one time point only) in ECEC settings. It will use the most objective methods available to measure the physical activity and location of children and educators in ECEC outdoor environments.

### Setting and participants

During 2015/2016, ECEC services in the Illawarra region of New South Wales, Australia, within a 2 hour driving radius from the University of Wollongong will be recruited. Services invited to participate in the study will enrol children aged 2–5 years and have access to

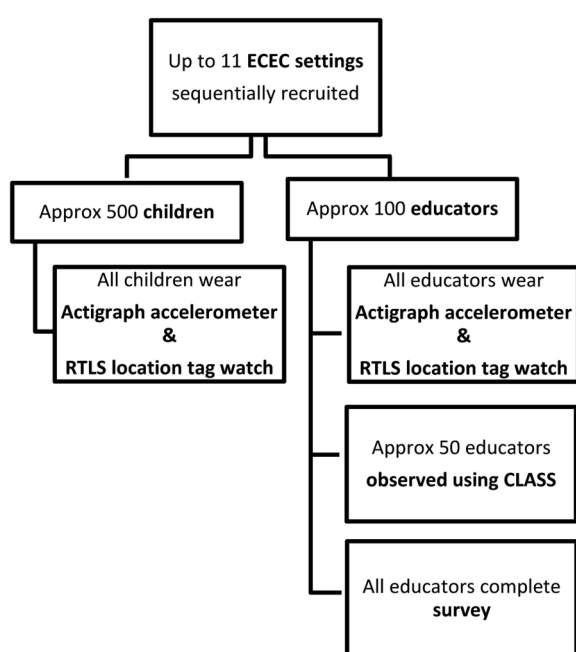
outdoor play spaces which will be separate from other play spaces for younger children. All children aged 2–5 years enrolled in the service and their educators will be invited to participate in the study. Data will be collected over five consecutive days in each service. Each morning, the project team members will fit the accelerometers and RTLS wrist tags on the children and educators, and they will be encouraged to wear them for the duration of the day. In the case of an unexpected event, and/or adverse weather that may lead to atypical practice or where children are not present in the outdoor environment, another data collection day will be scheduled.

ECEC settings in Australia provide care and education for young children prior to school. Attendance is not compulsory, and the number and sequence of days, as well as the time of attendance each day, is not prescribed. A typical pattern of enrolment for children aged 2–5 years is 2 or 3 days per week, for 6–8 hours each day. Just as ECEC attendance may vary, so do the ECEC environments, routines and programmes within each setting. For example, some settings provide free-flowing play for children between indoor and outdoor environments, whereas other settings provide distinct times for inside and outside play. This study will include a mix of settings to ensure that the data are representative of the ECEC sector. The diversity of settings will be taken into consideration when data are collected, with the time and timing of the data collection period specific to each setting.

Information about the study will be presented to educators and families at staff and parent meetings and will also be available on the participant information sheets. Consent will be gathered by the researcher prior to data collection, and parents and carers will be asked to provide child consent. Ethical approval was obtained through the University of Wollongong Human Research Ethics Committee (HE14/330).

### Study size

As the aim of the study is to examine the physical activity and location of children as well as educators in an outdoor ECEC setting, it is important to recruit enough educators to investigate the relationships at a centre level. Much of the analysis will be descriptive; however, we would expect a moderate correlation of 0.3 between the physical activity levels of educators and children. For this correlation to be significant ( $\alpha=0.05$  and power=0.80), 85 educators are needed. To allow for clustering at the ECEC level and based on an intraclass correlation of 0.01 and an average cluster size of 10, ~100 educators will be targeted. To recruit 100 educators, up to 11 services will be approached, on the basis of each ECEC service employing between 6 and 15 educators. The number of children at each service ranges between 20 and 90, and so 11 services will provide ~500 children, which is a sufficient number of child participants for the study.



**Figure 1** Study design. CLASS, classroom assessment scoring system; ECEC, early childhood education and care; RTLS, real-time location system.

## Measurement instruments

To investigate the children and educator's location and movements around the ECEC setting, a location tracking identification system (RTLS) will be used. Actigraph accelerometers will measure the amount and intensity of physical activity of the children and educators. Each accelerometer will be paired with an RTLS wrist tag as a uniquely coded set. As a set, they will be stored in a coded bag and fitted and removed simultaneously to ensure that they are matched at all times. A master sheet will record the unique code for each participant. The quality of the interaction between the children and educators will be assessed using the CLASS observation tool. Information about organisational policies, procedures and professional development related to children's physical activity will be collected through surveys. These data methods will be combined to determine the social and physical environmental 'hot spots' for children and educators' physical activity, the quality of educator and child interactions and the influence on physical activity, levels of educator physical activity, the influence of ECEC setting characteristics on physical activity and the organisational processes that support educator practices and professional development in relation to children's physical activity.

### Real-time location system

Educators' and children's locations and movements within the ECEC outdoor environment will be measured using an RTLS (Convergence Systems Limited, Hong Kong), which collects data using radio frequency signals. Data are triangulated from the wristwatch tags (figure 2A) that are worn by each participant to the anchor readers (figure 2B) (which are distributed evenly around the perimeter of the outdoor ECEC environment). One of the anchor readers is the master anchor which consolidates all the collected data on an attached laptop computer. The wristwatch tags are lightweight (52 mm diameter×14 mm thick, 35 g), dust and water proof and have a frequency range of 902–928 MHz. Anchor readers (29 cm×21 cm×8 cm, 1.5 kg) will be positioned in all corners and recesses of the outdoor environment. To ensure that no anchor is more than 10 m apart, the anchor readers will also be placed along the perimeter of the environment to ensure even spacing throughout, particularly in large outdoor spaces. The position of the anchors will be ECEC-specific and

will be tailored to each ECEC setting's outdoor environment (figure 3). Anchor readers will be secured to a wall bracket, placed on a tripod or suspended from a secure location (2 m from the ground). Children's outdoor activities will not be hindered as a result of the positioning of the anchor readers.

All anchor readers will be set up prior to the children arriving at the ECEC setting. Each morning, children and educators will be fitted with a wristwatch and will be asked to wear it for the duration of their time at the ECEC setting for that day. Wearing of these wristwatches will be monitored throughout the day to ensure compliance, and all wristwatches will be collected at the end of the day.

The RTLS data are collected and measured as a 'range' from at least three anchor readers. This can be viewed live or recorded as a 'Data Pack'. One or more tags can be viewed at a time and can be viewed as a movement track over a period of time around the designated 'cell' area (which is the total outdoor environment) or can be isolated to observe the actual location of tags at any time (figure 4). Once the 'data pack' is created, these options for replaying the data can be accessed.

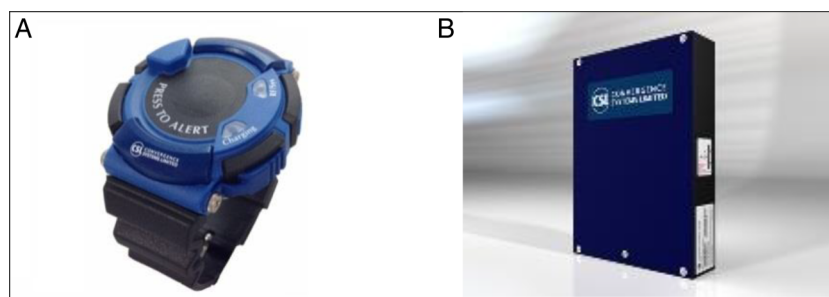
### Actigraph accelerometers

Children and educators will be asked to wear an Actigraph GT3X+ (Actigraph, Florida) accelerometer. These accelerometers (38×37×18 mm, 27 g) are lightweight, unobtrusive devices worn on the right hip on an elastic belt. They will be fitted at the same time as the wristwatch tags. Accelerometers measure triaxial g-forces from which the amount and intensity (sedentary, light, moderate, vigorous) of physical activity is determined. They are a water-resistant accelerometer that can collect very high-frequency raw data or wave-form triaxial accelerometer counts at 30 Hz epochs for >7 days. Previous versions have been the most widely used accelerometer in paediatric research to date, are a valid and reliable measurement tool and are the most widely used objective measure of physical activity for young children<sup>4</sup> and adult populations.<sup>28 29</sup>

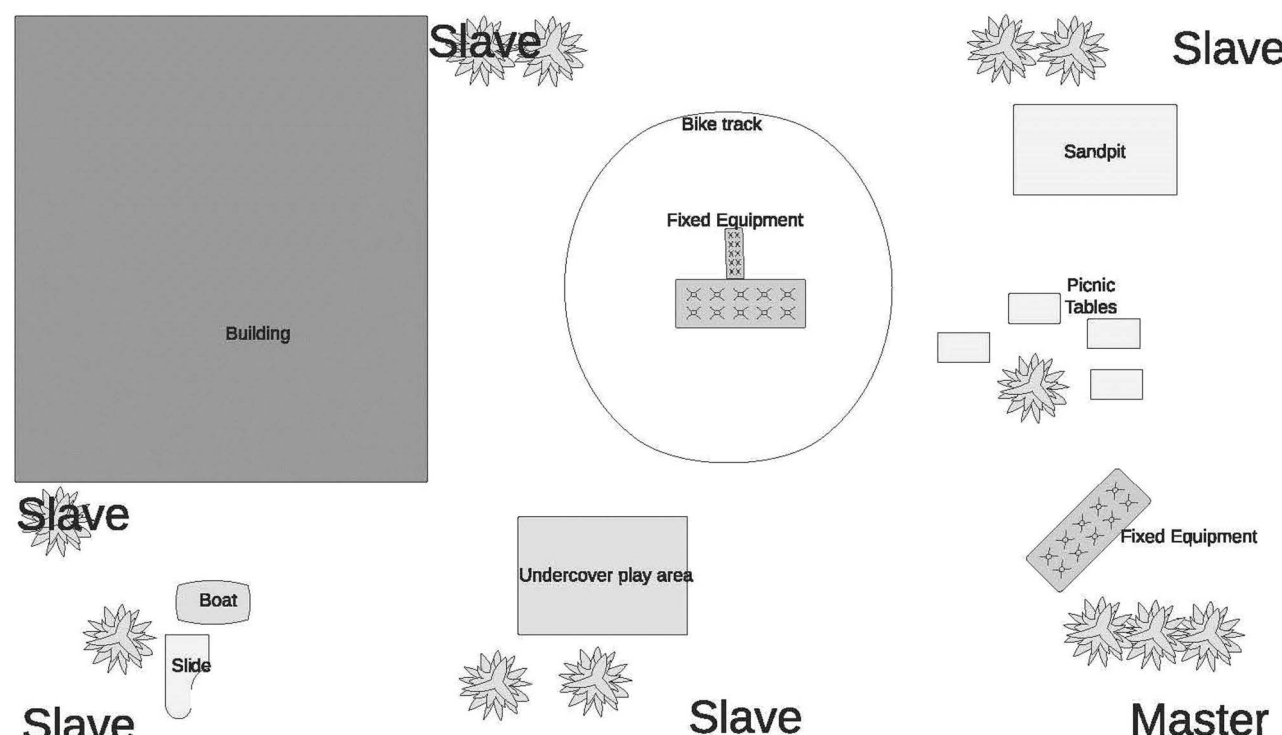
### Classroom assessment scoring system, Pre-K

During data collection at each ECEC setting, observational data will be collected using the classroom assessment scoring system (CLASS), Pre-K.<sup>30</sup> Observations will

**Figure 2** RTLS instruments. (A) Wristwatch tag. (B) Slave anchor reader. RTLS, real-time location system.

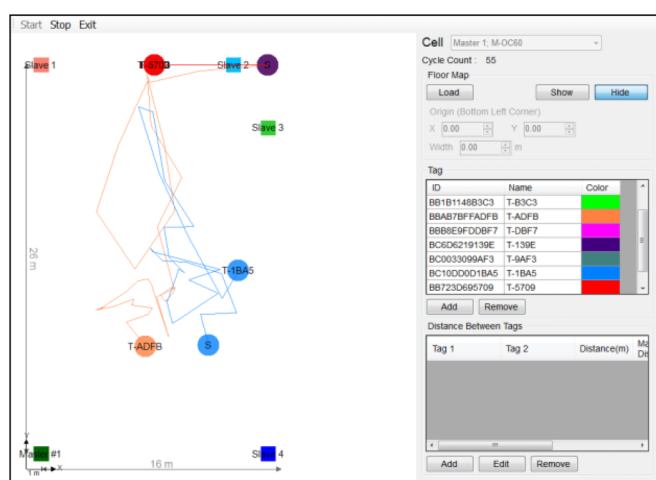




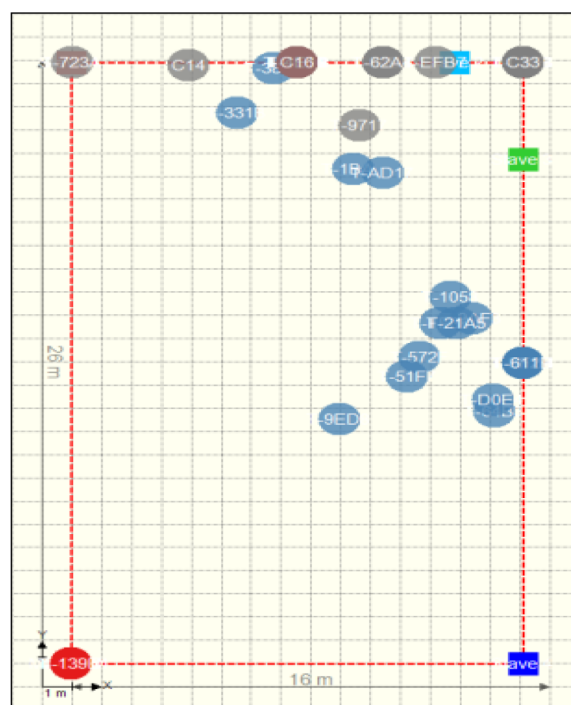


**Figure 3** Layout of RTLS anchor readers in ECEC setting. ECEC, early childhood education and care; RTLS, real-time location system.

A



B



**Figure 4** RTLS programme. (A) Tag tracking: the movement of one or more tags can be tracked and recorded as a line around the space. (B) Tag location: each tag can be individually coded and is represented as a circle that moves through the space. RTLS, real-time location system.

be between 10 and 25 min in length and will be videotaped and then later scored for quality of interactions. CLASS Pre-K is an observation system which assesses three domains of classroom quality—emotional support,

classroom organisation and instructional support. Each domain is divided into specific dimensions such as positive climate, productivity and quality of feedback<sup>30</sup> (figure 5). CLASS has widely been used to assess

**Figure 5** CLASS domains and dimensions. CLASS, classroom assessment scoring system.



classroom quality within the indoor environment,<sup>30</sup> yet the use of it in outdoor environments is limited. For this study, CLASS will provide an additional dimension to the data by measuring elements of interactions such as verbal communication and modelling, which, alongside the accelerometer and location data, will determine the relationship between the quality of interactions and children's physical activity. In total, up to 15 outdoor observational periods will be video recorded for each ECEC setting. During the observations, randomly chosen educators will also wear a small portable microphone attached on the upper body to enable conversations to be audio-recorded. To ensure reliability<sup>31</sup> of the observations and scoring, a second observer will observe and score 10% of the recorded observations.

#### Surveys and additional data collection

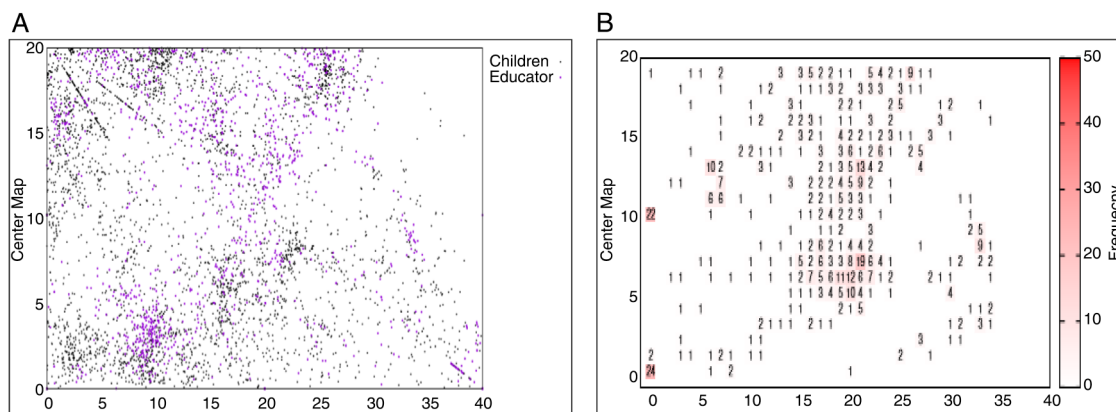
Child and educator descriptive data, information about the experiences of educators and specific ECEC setting characteristics will be collected through surveys, observations and interviews. Child descriptive data, such as age, sex and days of enrolment, will be provided by the parent/carer on the child's consent form. Educator descriptive information such as year of birth, sex, qualifications, days of work and position in the ECEC setting will be provided on their consent form. Each educator will be asked to complete a survey pertaining to organisational policies, procedures and professional development for each ECEC setting. For example, questions such as 'Have you undertaken formal education or

training in providing physical activity experiences to children?', and 'In what ways does your centre promote children to be physically active?' will be asked. Additional environmental data will also be collected including daily floor plans of the outdoor environment, weather conditions at regular intervals during the day, a record of programmed and spontaneous activities and portable equipment present in the environment. Photos and videos will be taken of significant activities such as spontaneous group physical activity experiences and environment and equipment changes as they occur. General data such as the size of the physical environments, number of children enrolled and the organisational structure of the ECEC setting will be collected through observation and informal interviews.

#### Analysis

##### Real-time location system

RTLS data are recorded in real time, in intervals of 1 s. The recorded information consists of a data pack and log file for location data. There are a number of illustrations that can be produced from these files. The location of all children and educators during a particular period of time or across the whole day can be determined (figure 6A), as well as the frequency, measured in 10 s bouts, of when a child or educator stays at particular locations during the given period of time (figure 6B). Additionally, the RTLS data can determine when children and educators are inside or outside through the measurement of their location.



**Figure 6** RTLS graphs. (A) RTLS location—represents a 1 hour time frame and the location of all tags within the space in 10 s intervals. This measures 'hot spots' of location. (B) RTLS frequency—represents a single participant's presence in particular locations in the space, indicated as a proportion of the time. RTLS, real-time location system.

The initial analysis of the location data is completed with the RTLS site manager software package in which commands are created and entered to produce graphs such as in figure 6A and B. The software also allows an export of log files containing all real-time location data. The software is run under a Linux/Fedora operation system. The code used is the C programming language and the Linux shell. The extracted information is stored in text file (.txt) while the raw data files are in .csv extension. Gnuplot is used to create the illustrations for visual support analysis.

### Actigraph accelerometers

For this study, the time spent in different intensities of physical activity for children will be measured according to the cut points: sedentary behaviour  $\leq 37$  counts/15 s; light physical activity 37–420 counts/15 s; moderate/vigorous physical activity  $\geq 420$  counts/15 s,<sup>32</sup> which are well established and the best understood measurement for classifying physical activity intensity and sedentary behaviour among children aged 3–5 years. For educators, the cut points: sedentary behaviour  $\leq 25$  counts/15 s; light physical activity 2–504 counts/15 s; moderate/vigorous physical activity  $\geq 505$  counts/15 s<sup>29</sup> will be used for physical activity and sedentary behaviour measurement. For this study, non-wear time will be calculated at 20 min, with a minimum wear time of 180 min per day and at least 1 day of accelerometer data collected per participant for data to be valid. Accelerometer data will be analysed using ActiLife software.

### Classroom assessment scoring system, Pre-K

The video observations collected will be assessed using CLASS Pre-K. Standardised procedures and scoring sheets as detailed in the CLASS Pre-K manual<sup>30</sup> will be followed. For each service, the six longest video recordings, each no less than 10 min in length, will be scored. Given the unique outdoor environment, all observations will be assessed retrospectively, which will increase the accuracy of the scoring. Additionally, 10% of videos will be scored by a second observer for inter-reliability. For each observation, a rating from 1 to 7 (low to high range) is given for each dimension. The scores from the dimensions (within each domain) are added and then averaged to provide a domain score for each observation. Each ECEC setting will receive an average score (calculated from the six videos) for each of the domains.

### Surveys and additional data collected

All information from the consent forms, surveys and additional data collected will be entered into an excel spreadsheet.

## CONCLUSIONS

The study is the first of its kind internationally. The design incorporates novel methods of objectively measuring the social and physical environmental influences on

children's physical activity in ECEC services, and the multilevel data collection supports a depth of analysis that is unique. Previous research addresses levels of children's physical activity, yet the activity levels of educators, the specific locations of physical activity in an ECEC setting, organisational characteristics of ECEC settings that influence physical activity and the relationship between children's and educator's physical activity have not been investigated. The experiences and relationships that occur for children at this age are significant and include establishing foundations for health and well-being, learning and social experiences that will have positive long-term effects.<sup>33</sup> Importantly, quality relationships and environments have the potential to promote children's confidence and competence in being physically active which will establish behaviours that promote health and well-being conducive to learning and development.

Given the study's specialised environment (ie, the outside environment in ECEC settings) and the use of multiple instruments, additional methodological consideration will need to be considered. For example, the position of the RTLS anchors will be unique to each ECEC outdoor environment due to the individual design of the settings, and their placement will need to consider safety and security aspects for the children in each centre. The RTLS watches are designed for adults, and so consideration of comfort and their secure fastening on children's wrists will need to be managed. Children will wear additional wristbands to ensure that the wristwatch tags are secure. As the study relies on the synchronised use of accelerometers and location watches, it is crucial that each individual monitor is identified accurately for each participant to ensure that information can be cross-checked. Additionally, as the study is carried out in an outdoor environment, at times the presence of the children and educators in the environment will be weather dependent. Weather conditions will also influence the preparation of the RTLS equipment as it is not suitable in wet or adverse conditions.

This project has several benefits for the research community, making an important contribution to the field's understanding of the correlates of children's physical activity in ECEC services. The focus on social environments, as well as the physical environmental aspects of ECEC settings on children's physical activity, is innovative, as is the measurement of educator physical activity and location. The outcomes of this study have the potential to inform and add to current knowledge, resulting in positive influences on policy and practice in ECEC settings that will provide quality experiences and opportunities to support children's physical activity, resulting in improved health and well-being.

## DISSEMINATION

Written informed consent will be sought from all educators. All educators will receive detailed participant information and be informed that they have the right to withdraw from the study at any point.



Additionally, an information sheet will be provided to the parents of the children. Parents will provide written consent for their children to participate in the study, and children will provide assent. Parents and children will be informed that participation is not compulsory. The researchers will be present at all times in the case that a child chooses not to wear or to remove the monitors.

The results of the study will be disseminated to academic audiences through presentations and through peer-reviewed publications in relevant journals. Results will be disseminated to participants, the public, policy-makers and the early childhood profession through seminars and press releases.

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**Contributors** KLT, RAJ and ADO designed the study and contributed to the study protocol. KLT drafted the manuscript and RAJ, MH, TVN and ADO assisted in drafting. All authors read and approved the final manuscript.

**Competing interests** None declared.

**Patient consent** Obtained.

**Provenance and peer review** Not commissioned; externally peer reviewed.

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