The outdoor environment and children’s health: a multilevel approach

Ole Johan Sando

Department for Physical Education, Queen Maud University College, Trondheim, Norway

ABSTRACT

Play in an outdoor environment may improve children’s health. Little is known about how characteristics of the outdoor environment in Early Childhood Education and Care (ECEC) settings influence children’s health. This study explored the relationship between the outdoor environment and children’s health by examining children’s well-being and physical activity in different outdoor environments. The sample consisted of 471 video observations of 80 children’s free play in the outdoor environments of eight ECEC institutions. Multilevel analysis indicated that playing is associated with health outcomes and that nature is positively associated with children’s well-being. Children’s physical activity was found to be positively associated with the use of pathways and open areas. The use of fixed functional equipment, wheeled toys and loose parts emerged as negative predictors of physical activity. The findings of this study contribute to a better understanding of how the outdoor environment in ECEC settings can influence children’s health.

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Introduction

More than 90% of Norwegian children are enrolled in Early Childhood Education and Care (ECEC) institutions, and most of these children spend full days in the institution (Statistics Norway, 2018). The learning environment in ECEC institutions is therefore an important learning environment for Norwegian children, and its quality is of great importance for children’s play, learning, development and health. The Norwegian Framework Plan for Kindergartens emphasizes that the design of the physical environment should give children the opportunity to participate in play and that institutions should promote physical and mental health (KD, 2017).

The aim of this article is to better understand how the physical outdoor environment in ECEC institutions can influence children’s health. Health is a complex concept that is defined by the World Health Organization (WHO, 2018) as a ‘state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.’ In this article, health is divided into physical and psychosocial health, where psychosocial health is operationalized by examining children’s well-being and physical health is

CONTACT
Ole Johan Sando ojs@dmmh.no Department for Physical Education, Queen Maud University College, Thond Nergaards veg 7, N-7044, Trondheim, Norway

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operationalized by examining physical activity (PA). The research question of this article is as follows: What characteristics in the ECEC physical outdoor environment influence children’s well-being and PA?

To understand the link between the physical environment and children’s health, the concept of play is important. Play involves activities that children perform because they enjoy doing the activity (Sutton-Smith, 2009). Hence, the motivation for play is intrinsic. The theory of affordance (Gibson, 2014) represents an important framework for this study. Building on the theory of affordance, the physical environment can be hypothesized to be important for children’s play because the physical environment affords children actions and behaviors that may influence health outcomes such as well-being and PA. Several studies have found differences in children’s play behavior in different physical outdoor environments (Czalczynska-Podolska, 2014; Dyment & O’Connell, 2013; Lerstrup & van den Bosch, 2017; Torrens & Griffin, 2013), indicating that the physical environment influences children’s play.

**Well-being in the outdoor environment**

Well-being is an ambiguous and multi-faceted concept that is often described as a subjective and internal feeling of being/feeling ‘well’ (Koch, 2018; Mashford-Scott, Church, & Tayler, 2012). Play and well-being are found to be strongly related concepts for children in ECEC institutions (Kennedy-Behr, Rodger, & Mickan, 2015), and children’s well-being is higher if children perceive an activity as play (Howard & McInnes, 2013). A previous project focusing on the perspectives of 4- to 6-year-olds regarding their well-being found that the physical environment, available materials, common activities, and the opportunity to influence their day were of crucial importance for children’s well-being in ECEC institutions (Sandseter & Seland, 2016).

Although children’s well-being in ECEC institutions has become a field of growing interest, previous research exploring the features or characteristics in the physical environment that influence well-being is scarce. Well-being in the outdoor environment was studied in a Canadian intervention study that found a significant decrease in depressed affect and antisocial behavior and an increase in prosocial behavior, play with natural elements and independent play following an outdoor intervention that increased children’s number of affordances and access to nature (Brussoni, Ishikawa, Brunelle, & Herrington, 2017).

Contact with external green open spaces has also been found to have a positive effect on children’s levels of stress in a child care center, suggesting that the natural environment is ‘restorative’ and positive for children’s well-being (Carrus et al., 2012). Soderstrom et al. (2013) found that high-quality outdoor environments were associated with several health aspects, including longer night sleep and better well-being. These findings indicate a positive link between nature and children’s well-being. This link was supported by a systematic review of the benefits of contact with nature for children that found that nature had a positive effect on children’s place attachment, ownership of the environment, dialogue with and effect on the environment, play, emotional adjustment and psychological restoration (Chawla, 2015). The presence of nature in an outdoor play environment for children seems to be a quality that supports children’s well-being.
**PA in the outdoor environment**

PA is often defined as any bodily movement produced by the skeletal muscles that results in energy expenditure (Caspersen, Powell, & Christenson, 1985). There is well-established evidence of the positive effect of PA on health (Warburton, Nicol, & Bredin, 2006). For children, the positive effect of PA is prominent because this effect can be expected to be both short term and long term. PA in ECEC institutions is therefore part of the Norwegian government’s systematic plan to promote public health in Norway (Helsedirektoratet, 2012). PA, like well-being, is associated with play; and especially outdoor play, is encouraged to increase PA (Herrington & Brussoni, 2015).

Portable play equipment has been found to be positively associated with PA in several studies (Bower et al., 2008; Brown et al., 2009a; Bundy et al., 2009; Dowda et al., 2009; Hannon & Brown, 2008; Nicaise, Kahan, & Sallis, 2011), although other studies have not found the same positive association (Cardon, Labarque, Smits, & Bourdeaudhuij, 2009; Henderson, Grode, O’Connell, & Schwartz, 2015; Olesen, Kristensen, Korsholm, & Froberg, 2013). The use of accelerometers to measure PA in these studies may explain some of this discrepancy because accelerometers may show little increased movement when children move heavy objects. The creation of pathways (i.e. asphalt cycle track, single or double loop pathways, circular tracks) is a promising strategy to increase PA (Cosco, Moore, & Smith, 2014; Nicaise et al., 2011; Nicaise, Kahan, Reuben, & Sallis, 2012), and open spaces that allow children to play freely also seem to be associated with more PA (Berg, 2015; Brown et al., 2009a; Cosco, Moore, & Islam, 2010; Nicaise et al., 2011).

Fixed playground equipment does not seem to have a clear association with PA, with studies finding positive (Brown et al., 2009a; Larson, Normand, Morley, & Hustyi, 2014; Sugiyama, Okely, Masters, & Moore, 2012), neutral (Henderson et al., 2015; Olesen et al., 2013) and negative (Bower et al., 2008; Dowda et al., 2009) associations with children’s PA. This is also the case for the effect of natural elements and vegetation in the outdoor space on children’s PA. Although some studies have found positive associations between natural elements and PA (Boldemann et al., 2011), others have found no difference in the natural environment compared to a traditional playground (Storli & Hagen, 2010).

**Method**

This study was conducted within the project ‘Competence for developing early childhood education and care (ECEC) institutions’ indoor and outdoor environments,’ funded by The Research Council of Norway and approved by the Norwegian Social Science Data Services. This was a three-year project with a mixed-method design (Creswell, 2013) conducted in close collaboration with three ECEC owners in Norway. The data collection involved systematic and randomized video observations of children in an outdoor environment during free play sessions. ‘Free play sessions’ imply that children can decide what they want to do, where they want to be and with whom they want to be.

**Procedure and sample**

The sample consisted of 471 video observations (mean duration of 122 s) of 80 children from eight ECEC institutions. The eight ECEC institutions were strategically selected...
among the partner ECEC institutions to have variation in size, age, location and physical environment. The institutions were located in the north (1), middle (3) and south (4) of Norway, had from 56 to 117 children ($M = 85$) and were built between 1989 and 2016 ($M = 2007$). Five girls and five boys in each institution were randomly selected among the 3- and 4-year-old children, and written consent to participate was received from parents. The participating children were informed about the video observations and were not filmed if they did not want to. Data collection was performed during one week in each ECEC institution in the fall of 2017 by four researchers and eight co-researchers. The researchers developed a strict protocol for the data collection that was followed in each of the ECEC institutions. A co-researcher was recruited from each participating ECEC institution. The researcher was a preschool teacher working in the ECEC institution. The researchers wrote field notes, and the co-researcher conducted the filming with small GoPro Hero 4 action cameras. The use of a person familiar to the children to perform the video recordings and the use of small neutral cameras with a wide-angle lens were intended to have as little impact as possible on the children’s behavior in the observed situations. The co-researcher attempted to get as close as possible to capture speech, body language and facial expressions without affecting the situation.

To ensure random filmed situations, the filming of the children followed a predetermined scheme that stated the order and time that the observations were to be conducted. Each day, two children were filmed. The first child was filmed for two minutes followed by a six-minute break. Then, the second child was filmed for two minutes, followed by a break of another six minutes. This alternation between the first and the second child was repeated until six video observations of each child were recorded. If the child was in a situation where filming was not an option due to ethical considerations (such as the child refusing to be filmed, toilet visits or similar), the video observation was postponed. With six video observations of 80 children, a total of 480 video clips in the outdoor environment constituted a full sample. There was a total of 471 video clips in the final sample. Nine clips were missing: five video observations of one child were missing because of sickness, two were excluded because the child was occupied with the camera, and two observations were missing due to technical or human error. In one institution, only four girls were available for participation; therefore, an extra boy was randomly selected to replace the girl, so the final sample included 39 girls and 41 boys aged 2.8–4.8 years.

**Measures**

The key measurements in this study were children’s well-being, PA, place and materials. In addition, variables such as social characteristics, play, age and gender were included to control for the context of the observation.

**Well-being**

To measure well-being in the physical environment, the Leuven Well-Being Scale (Laevers, 2005) was used. The well-being scale is a method for measuring children’s subjective and emotional well-being in early years using focused and systemized observations on a scale from one to five. A score of 1 on the scale is given when children show clear signs of discomfort, such as whining, screaming, anger or sadness. A score of 5 is given when the child
shows signs of appearing happy, expressive, lively or relaxed. Level 3 indicates a neutral posture, and levels 2 and 4 indicate signs of either discomfort or happiness that are not consistently present. Training videos and workshops were conducted by the three researchers to promote consistency in the coding and interpretation of the scale. Each video observation was scored by two independent researchers, and one score was established for each two-minute video observation. Disagreements of more than one point were reviewed again and discussed in the research group until mutual understanding was reached. For disagreements of one point, an average of the two scorings was used. To determine inter-rater reliability, weighted kappa (Cohen, 1968) was used. Inter-rater agreement was 89% for well-being with a kappa value of 0.41. Cohen’s suggested interpretation of the kappa is below 0 as no agreement, 0.01–0.20 as non-agreement to slight agreement, 0.21–0.40 as fair agreement, 0.41–0.60 as moderate agreement, 0.61–0.80 as good agreement, and above 0.81 as very good agreement. Agreement above 80% and kappa values above 0.40 are often viewed as acceptable agreement (McHugh, 2012). Given the complex phenomena of well-being and the naturalistic data collection method of following children in their natural environment, inter-rater agreement in the lower acceptable range was anticipated and must be considered a limitation of the study.

**PA**

Children’s PA was measured using the Observational System for Recording PA in Children-Preschool (OSRAC-P) (Brown et al., 2009b), which codes PA from 1 (stationary) to 5 (fast movement). One score was established for each video observation. Scores were based on speed and characteristics of movement, such as assisted movement and moving heavy objects. The same procedure described for well-being using workshops, two independent researchers’ scoring, discussions, and average scores, were used for PA. For PA, inter-rater agreement was 92% with a kappa value of 0.67, indicating good agreement.

**Places and materials**

To measure the environment the children were in and what materials they were using, categories for places and materials in the outdoor environment were developed. This was done by adjusting categories used in previous research (Cosco et al., 2010; Dyment & O’Connell, 2013; Lerstrup & van den Bosch, 2017) to the Norwegian context. The categories for place included sandbox, pathways, nature, open area, fixed equipment functional play (swings, climbing towers, slides, etc.), fixed equipment role play (play houses, boats, huts, stores, etc.), fixed equipment other (tables, storage, etc.) and indoor. Places were coded continuously, and the categories were mutually exclusive. Given the theoretical framework presented in this study, the variables describing the use of nature, pathways, open area and fixed functional equipment were included in the analysis. Although the categories are relatively broad, not all categories are present in all ECEC institutions, and the content of the categories varies. Open area and fixed functional equipment were coded in all eight institutions, whereas pathways were coded in seven of the institutions. Nature was coded in four of the institutions and ranged from large forest areas (1500 m2) to smaller areas with trees and natural surfaces.

Materials were coded when a child was holding, using or interacting with a material. The categories were not mutually exclusive to capture the idea that children can use
several materials at once. The categories for materials were sand, water, mud, nature materials, toys, open-ended materials and wheeled toys. A theory-driven approach to the inclusion of variables in the analysis was used. Wheeled toys and a variable describing children’s use of loose materials (outdoor toys, nature materials and open-ended materials) were included in the analysis. Both wheeled toys and loose materials were coded in all eight institutions.

The variables for places and materials were coded as a percentage of time in different places and the use of different materials for each observation. The coding of places and materials was performed by one researcher, and a random sample of 10% of the video observations was reviewed by a second researcher to ensure consistent coding and interpretation.

Social characteristics and play
The context variables describing the social characteristics and play in the observation were coded continuously, and the categories were mutually exclusive. Group composition categories in the OSRAC-P (Brown et al., 2009b) were used to capture the social setting of the observation. The initial categories in the OSRAC-P (Solitary, 1-1 Adult, 1-1 Peer, Group Adult, Group) were reduced to two variables describing the percentage of time the child was with other children and the percentage of time an adult was present. Play was coded using categories for functional play, constructive play, symbolic play, mixed play, non-play and talking, adapted from previous studies categorizing play (Dyment & O’Connell, 2013; Fjørtoft, 2004; Luchs & Fikus, 2013). In this article, the categories were reduced to describe the percentage of time the child was playing (functional play, constructive play, symbolic play and mixed play). Both social characteristics and play were coded by one researcher for the entire sample, and a random sample of 10% of the video observations was reviewed by a second researcher.

Analysis
The scoring of well-being and PA was conducted in an Excel spreadsheet with a score for each of the observations. Place, materials, social characteristics and play were coded using Noldus Observer XT 12.5 behavioral coding, analysis and management software for observation data (Zimmerman, Bolhuis, Willemsen, Meyer, & Noldus, 2009). Data from Observer XT were paired with the spreadsheet of scores for well-being and PA and imported to the statistical software STATA (MP 15.1). Descriptive statistics and correlation analyses were conducted to give an overview of the data and the relationships between the variables. Given the hierarchal structure of the data with nested observations within children and in ECEC institutions, multilevel regression analysis (Goldstein, 1986) was conducted to investigate the association between the physical environment and children’s health.

Results
The average duration of the included 471 observations was 122 s. Descriptive statistics for the 471 observations are presented in Table 1. On average, well-being was scored 3.6 (SD = 0.6) and PA was scored 3.2 (SD = 0.9). Children were together with other children 76%
of the time, an adult was present 23% of the time, and children were playing 69% of the time. The most popular place in the outdoor environment was the open area, with more than half of the observations (57%) falling into this category.

The correlation analysis of well-being, PA and the context variables (Table 2) showed that the concepts of well-being, PA and play are associated. Well-being was positively correlated with PA \( (r = .40, p < .001) \), being with children \( (r = .19, p < .001) \) and play \( (r = .39, p < .001) \). PA was negatively correlated with adult presence \( (r = -.19, p < .001) \) and positively correlated with play \( (r = .27, p < .001) \). No association was found between PA and being with other children \( (r = .02, p > .05) \).

### Multilevel analysis

With six observations for every child in the sample within eight ECEC institutions, the data were nested within groups, and it was expected that observations within each child would highly correlate. A random intercept multilevel model was chosen to control for this nesting of data. The first step was to establish the empty model and find the amount of variance at different levels by calculating the variance partition coefficient (VPC) (Mehmetoglu & Jakobsen, 2017). Because children were nested within ECEC institutions, the proportion of variance at three levels was investigated: observation (level 1), child (level 2) and institution (level 3). For well-being, VPC was 0.25 at level 2 and 0 at level 3. Thus, 25% of the variance in well-being was at the child level, and 0% of the variance was found at the institution level. For PA, VPC was 0.12 at level 2 and 0 at level 3, indicating that 12% of the variance in PA was at the child level and none of the variance was explained at the institution level. Both well-being and PA had a substantial amount of

### Table 1. Descriptive statistics.

|               | Mean | SD  | Min | Max |
|---------------|------|-----|-----|-----|
| Well-being    | 3.6  | 0.6 | 1   | 5   |
| PA            | 3.2  | 0.9 | 1   | 5   |
| Age           | 3.8  | 0.5 | 2.8 | 4.8 |
| Play          | 69   | 37  | 0   | 100 |
| With Children | 76   | 38  | 0   | 100 |
| Adult Present | 23   | 38  | 0   | 100 |
| Nature        | 4    | 18  | 0   | 100 |
| Pathway       | 5    | 18  | 0   | 100 |
| Open Area     | 57   | 43  | 0   | 100 |
| Fixed Functional Equipment | 15 | 33  | 0   | 100 |
| Wheeled Toys  | 20   | 38  | 0   | 100 |
| Loose Parts   | 48   | 54  | 0   | 257 |

\( N = 471 \) observations.

### Table 2. Correlation matrix for well-being PA and the context variables \( (N = 471 \) observations).

|       | 1.   | 2.   | 3.   | 4.   | 5.   | 6.   | 7.   |
|-------|------|------|------|------|------|------|------|
| 1.    | Age  | –    | –    | –    | –    | –    | –    |
| 2.    | Gender (0 = girl) | .11* | –    | –    | –    | –    | –    |
| 3.    | Well-being | .18*** | .05 | –    | –    | –    | –    |
| 4.    | PA    | .20*** | .09 | .40*** | –    | –    | –    |
| 5.    | With Children | .22*** | .18*** | .19*** | .02 | –    | –    |
| 6.    | Adult Present | .00 | –.01 | .06 | –.19*** | .03 | –    | –    |
| 7.    | Play  | .12** | .03 | .39*** | .27*** | .15*** | –.06 | –    |

* \( p < .05 \); ** \( p < .01 \); *** \( p < .001 \).
variance at the child level and none at the institution level. A two-level model with level 1 presenting each observation and level 2 presenting each individual child was therefore selected for further analysis.

The next step was to develop the model with explanatory variables. Variables describing places and materials were all allocated at level 1 together with observational context variables. Background variables included children’s age and gender and were included at level 2 in the model. The most common way of building a multilevel analysis model is to conduct a stepwise inclusion of variables starting at the lowest level in the model (Hox, 2010). Context variables (step 1) describing play, being with children and the presence of an adult were first added to the model. Next, the variables describing place and materials were added (step 2), and the second-level variables describing age and gender were added (step 3). A likelihood-ratio test was performed between each step to determine whether the more complex model was an improvement. For well-being, step 1 ($p < .001$) and step 2 ($p < .05$) were significant. The inclusion of gender and age did not contribute significantly to the model. For PA, all steps contributed significantly ($p < .01$). The regression coefficients in Table 3 are for the full models for well-being and PA and show the predicted effect of a one-unit increase in the independent variables on well-being and PA controlling for the effect of the other independent variables in the model.

The background variables of age and gender were not significant predictors of children’s well-being in the outdoor environment. The contextual variable of play was the strongest positive predictor of children’s well-being in the model. Well-being was predicted to increase by 0.006 on the 1–5 Leuven scale if the child went from not playing to playing 1% of the time. Playing for the entire observation (100%) was estimated to increase well-being by 0.6. Being with other children the entire observation was estimated to increase well-being by 0.2, whereas there was no significant association between the

### Table 3. Multilevel model of well-being and PA in the outdoor environment.

| Predictors (fixed effects) | Physical activity | Well-being |
|---------------------------|-------------------|------------|
| Constant                  | 1.8               | 2.6        |
| Background                |                   |            |
| Age                       | .240**            | .092       |
| Boy                       | .153              | .022       |
| Context                   |                   |            |
| Play                      | .008***           | .006***    |
| With Children             | −.001             | .002**     |
| Adult Present             | −.004***          | .001       |
| Place                     |                   |            |
| Nature                    | .004              | .004*      |
| Pathway                   | .010***           | .003       |
| Open Area                 | .004***           | .002*      |
| Fixed Functional Equipment| −.003*            | −.001      |
| Materials                 |                   |            |
| Wheeled toys              | −.006***          | −.002**    |
| Loose Parts               | −.004***          | −.001      |

Model statistics (including random effects)

| Observation level | Sample Size | Residual Variance Empty Model | Residual Variance Full Model |
|-------------------|-------------|-------------------------------|------------------------------|
| Child level       |             |                               |                              |
| Sample Size       | 80          | .090                          | .072                         |
| Residual Variance Empty Model | .072 | .097                         |
| Residual Variance Full Model     | .072           | .067                         |

Variance at child level (%)

- Well-being: 12%
- Physical activity: 25%

Goodness of fit -2LL (empty – full model)

- Well-being: 124***
- Physical activity: 101***

*p < 0.05, **p < 0.01, ***p < 0.001.
presence of adults and children’s well-being. For the variables describing the physical environment, being in nature was estimated to increase well-being by 0.4, and being in an open area had an estimated increase in well-being of 0.2. Being on fixed equipment for functional play and pathways were not significant predictors of children’s well-being. The variables describing the use of materials indicated a small reduction in well-being with the use of wheeled toys (0.2) and no significant association with the use of loose parts.

With regard to PA, age appeared to have a small positive impact, with an increase of 0.2 on the OSRAC-P scale for each year of a child’s age. However, there was no predicted significant effect of gender on PA. Playing during the entire observation was estimated to increase PA by 0.8. Being with other children was not significantly associated with PA, and the presence of an adult was predicted to reduce PA by 0.4. Among the variables describing the physical environment, being on pathways was a strong positive indicator of PA, with an estimated increase in PA of 1.0. An open area was also a positive predictor of PA with a 0.4 estimated increase, whereas being on fixed equipment for functional play was negatively associated with PA with an estimated reduction of 0.3 in PA. Nature was not a statistically significant predictor of PA. The use of wheeled toys emerged as a significant negative predictor of PA with a predicted reduction in PA of 0.6. Additionally, the use of loose parts was predicted to reduce PA, with an estimated reduction in PA of 0.4 with the use of loose parts in the entire observation.

Discussion

The results of this study support the idea established in previous research (Howard & McInnes, 2013; Kennedy-Behr et al., 2015) that well-being and play are related in ECEC institutions and that PA and play are related (Herrington & Brussoni, 2015). A different methodological approach is needed to examine the direction of the association and any possible causal explanations. This is not the aim of this article; however, play seems to be related to health outcomes such as well-being and PA for children in ECEC institutions and that supporting children’s play may promote children’s health.

The variables describing physical environment have a larger predicted effect on PA than on well-being, indicating that the physical environment is more important for PA than for well-being. The positive influence of nature on children’s well-being has been found in several previous studies (Brussoni et al., 2017; Carrus et al., 2012; Chawla, 2015; Soderstrom et al., 2013), and the findings in this study add to this evidence. In the present study, being in nature was not significantly related to PA. These findings support the lack of a clear association between nature and PA (Olesen et al., 2013; Storli & Hagen, 2010).

The positive association between pathways and PA in this study is consistent with previous research (Cosco et al., 2014; Nicaise et al., 2011; Nicaise et al., 2012), and this environmental characteristic seems to afford running, chasing, and cycling foster PA. The presence of open spaces is suggested to be a positive attribute of an outdoor area with regard to promoting PA (Berg, 2015; Brown et al., 2009a; Cosco et al., 2010; Nicaise et al., 2011), a notion supported by the findings in this study. However, the open area may need materials, active adults or other children to play with to support children’s PA.

Fixed functional playground equipment shows a negative association with PA and no association with well-being. Fixed functional playground equipment has been found to be
both positive (Brown et al., 2009a; Larson et al., 2014; Sugiyama et al., 2012), neutral (Henderson et al., 2015; Olesen et al., 2013) and negative (Bower et al., 2008; Dowda et al., 2009) in relation to PA. This study is in the latter category and should be interpreted in light of the fact that children utilize fixed functional playground equipment sparingly and that such installations are relatively expensive, require considerable space and are heavily regulated by safety demands.

More surprisingly, wheeled toys emerge as significant negative predictors of PA. Wheeled toys were previously found to be a positive predictor of PA (Brown et al., 2009a; Nicaise et al., 2011). These studies have comparable study designs and use OSRAC-P to measure PA, as in this study. Contextual differences, such as the fact that the Norwegian outdoor spaces in our study may be larger with more opportunities for physically active play in different areas, may explain this discrepancy. Many of the tricycles in our study had room for one or two passengers, which allowed for more social play but also allowed children to be transported while sedentary. These passengers were coded within the category for wheeled toys and contribute to the negative association with PA. It may also be that wheeled toys are an activity that can be performed by children not engaged in play rather than the wheeled toys causing low PA. The small negative association between wheeled toys and well-being may be attributed to this possible explanation.

More use of loose parts in this study was found not to be significantly associated with well-being. A previous intervention study indicated a positive effect on children’s well-being following an intervention in which more loose parts were added to the outdoor space (Brussoni et al., 2017). The present study takes a different approach that measures time interacting with loose parts. Loose parts are commonly believed to be of great importance for children’s play (Bundy et al., 2009). The regression model in the present study controlled for the effect of play on well-being, and it may be the case that higher availability of materials promotes children’s play, which in turn may foster children’s well-being. More complex analysis is needed to explore this possible relationship.

Loose materials have been associated with PA in several previous studies (Bower et al., 2008; Bundy et al., 2009; Dowda et al., 2009; Hannon & Brown, 2008; Nicaise et al., 2011). Other studies have not established the same positive association (Brussoni et al., 2017; Cardon et al., 2009; Henderson et al., 2015; Olesen et al., 2013), and in the present study, greater use of loose parts emerged as a negative predictor of PA. The variable describing the use of loose parts in this study involved the use of outdoor toys, loose parts from nature and open-ended materials. These materials are often used in constructive play, an activity that is often sedentary. A more nuanced categorization in which different types of loose parts are divided is needed to understand the impact of loose parts on PA. Further studies should consider how the availability and location of the loose parts, nearby play zones and play equipment influence the impact of loose parts on children’s play (Czalczynska-Podolska, 2014), as well as adults’ attitudes toward different types of loose parts.

Limitations and future directions

This study presents cross-sectional research that aimed to measure children’s outcomes in their natural ECEC institution environment. Thus, there are several limitations to this
study. The design and analysis approach is not suitable for causal inferences, and only associations between the physical outdoor environment and children’s well-being and PA are established. The concept of health in children, operationalized here in well-being and PA, is challenging to measure. The degree to which well-being and PA are related to children’s health can be questioned, although they are commonly believed to be key elements in children’s health. However, health also consists of several other parameters not measured in this study.

In the multilevel model, play is treated as a contextual variable that is controlled for when the association of the environmental variables and health outcomes is estimated. Based on previous research (Dyment & O’Connell, 2013; Lerstrup & van den Bosch, 2017; Torrens & Griffin, 2013), we can assume that the attributes of the physical environment influence children’s play. Because play is important for well-being and PA, play may serve as a mediating variable in the relationship between the physical environment and health outcomes, such as well-being and PA, an effect that is not captured in the model presented in this article. More complex models that can consider such possible mediating effects are needed to more accurately estimate the associations among play, the physical environment and children’s health.

The kappa test of interrater reliability indicates that there is more uncertainty attached to the measurement of well-being than there is for PA. Measuring a complex phenomenon such as well-being by interpreting speech, facial expression and other body language is challenging. A well-established manual and two independent researchers were employed to minimize these problems. Although used only as a contextual variable, many of the same conceptual questions can be raised in defining when children are playing.

A definition of categories for different places and materials in the outdoor environment that is suitable for all eight institutions had to be balanced between general overarching categories and detailed categories. A general approach was used to include several institutions, but not all outdoor environments had places with nature, the availability of loose materials varied, and the fixed playground equipment differed across the eight outdoor spaces. A more qualitative approach to the way children interact with an outdoor environment in one institution would provide new and valuable insight into the complex and multifaceted way the physical environment may influence children’s health.

Nevertheless, the attempt in this study to investigate how the physical environment may influence children’s health with the inclusion of important factors such as play and social context across different outdoor environments adds important new knowledge to the field. The main contribution of this study is the acknowledgement of the importance of play for children’s health. Nature, open areas and pathways may promote health outcomes, and wheeled toys and fixed functional playground equipment may contribute negatively to children’s health outcomes. This knowledge can be put to the test in more rigorous and controlled intervention studies in the search for causal inferences about the effect of physical environments on children’s health.

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Notes on contributors

Ole Johan Sando is a PhD-student at Queen Maud University College, Norway. The topic for his PhD is the physical environment in ECEC institutions and children’s health. His previous publications include injuries in ECEC institutions and how safety affects children’s play in ECEC institutions.

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