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Doctoral thesis

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Norwegian University of Science and Technology
Thesis for the Degree of
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Abstract

Early Childhood Education and Care (ECEC) institutions are essential for children's everyday experiences, health and development. The physical environment represents a crucial part of the learning environment in ECEC institutions, which is scarcely explored in research. This study explores how the physical environment in ECEC institutions influences children's well-being and physical activity, two fundamental health indicators in childhood.

The influence of the physical environment on children's well-being and physical activity was investigated by observing children's interactions with the physical environment during periods of free play in the indoor and outdoor environments of eight ECEC institutions in Norway. The total sample in this study consisted of 1808 video observations of 80 children at two data points. The observations were analysed with both qualitative and quantitative approaches. Measures of well-being, physical activity, the physical environment, play and the social context were included in the study.

The physical ECEC environment was found to be closely related to children's physical activity. In the outdoor environment, pathways and open areas were identified as places that were positively associated with physical activity. Mixed results were found for the association between fixed equipment for functional play and physical activity. Using materials in the outdoor environment was, for the most part, found to be negatively associated with children's physical activity. In the indoor environment, physical activity was positively associated with environments for physical activity, cubbies and open floor spaces and negatively associated with using tables. The results in this study suggest that children's physical activity is influenced by the physical environment through the affordances for movement and play in the environment.

Children's well-being was found to be more weakly associated with the physical ECEC environment compared to their physical activity. Natural environments and open spaces in the outdoor environment were positively associated with well-being. Indoor environments for physical activity were found to be positively related to well-being, whereas using tables was negatively associated with well-being. The findings in this study indicate that the physical environment influences children's well-being through

the experiences and feelings it provides, the play possibilities afforded, the opportunities to be physically active, and the mastery of physical challenges.

The findings in this study demonstrate that the physical environment of ECEC institutions is important for children's well-being and physical activity. Moreover, play was found to be strongly associated with both well-being and physical activity, and the physical environment influenced children's play behaviour. A physical ECEC environment of high quality provides children with meaningful and varied play opportunities that benefit children's everyday experiences and their health.

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List of papers

This thesis contains the following papers:

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II. Sando, O. J. (2019). The physical indoor environment in ECEC settings: children's well-being and physical activity. *European Early Childhood Education Research Journal, 27*(4), 506-519. https://doi.org/10.1080/1350293X.2019.1634238

III. Sando, O. J., & Mehus, I. (2019). Supportive indoor environments for functional play in ECEC institutions: a strategy for promoting well-being and physical activity? *Early Child Development and Care*, 1-12. https://doi.org/10.1080/03004430.2019.1651305

IV. Sando, O. J., & Sandseter, E. B. H. (2020). Affordances for physical activity and well-being in the ECEC outdoor environment. *Journal of Environmental Psychology, 69*, 101430. https://doi.org/10.1016/j.jenvp.2020.101430

Contents

List of figures and tables

1. Introduction

Next to the immediate family is the Early Childhood Education and Care (ECEC) institution where early development unfolds for many children (Phillips & Shonkoff, 2000). Here, children experience social relationships with children and adults, care and nurturing, friendship, happiness and belonging, but also challenges, lack of proximity to their primary care persons and feelings such as sadness and worry. How children experience their stay in ECEC institutions is crucial for not only their lives in the present but also their future lives. Research has demonstrated how high-quality ECEC is beneficial for children's development and health, especially with disadvantaged children (Oberklaid, Baird, Blair, Melhuish, & Hall, 2013). Therefore, providing children with high-quality ECEC institutions is essential from a health perspective.

In this study, well-being and physical activity are used as indicators for children's health. Well-being is a concept that has gained much attention in recent years, both in policies regulating ECEC institutions and in ECEC research. This concept is related to the common notion that children's well-being is an essential indicator for quality in ECEC institutions (Mashford-Scott, Church, & Tayler, 2012) and a key element in children's learning and development (Laevers, 2000). However, there is a shortage of studies that assess the ECEC institution's impact on children's well-being (Holte et al., 2014). Physical activity is also influential on children's health, and physical activity is found to be positively related to several health outcomes in childhood (Biddle & Asare, 2011; Boreham & Riddoch, 2001; Janssen & LeBlanc, 2010). Moreover, the ECEC institutions are found to be influential on children's physical activity levels (Finn, Johannsen, & Specker, 2002; Pate, Pfeiffer, Trost, Ziegler, & Dowda, 2004). Thus, promoting children's well-being and physical activity in ECEC institutions may benefit children's health.

Although well-being and physical activity are commonly used as independent health indicators, they are related concepts. In adults, compelling evidence demonstrates how physical activity has positive effects on well-being (Penedo & Dahn, 2005; Warburton, Nicol, & Bredin, 2006). Although the empirical support for a similar association in children is more limited than for adults, there are indications that physical

activity also has a positive effect on indicators related to well-being in children (Ahn & Fedewa, 2011; Biddle & Asare, 2011). Well-being and physical activity are applied in this study as health indicators in a holistic sense. This notion implies that both well-being and physical activity are expected to support the physical, emotional and social dimensions of children's health and that these aspects are related.

In addition to being linked to one another, well-being and physical activity are closely affiliated with play, an essential activity in childhood. Critical characteristics of play include having fun, being with friends, choosing freely, pretending, being intrinsically motivated and being free from outside rules (Sutton-Smith, 2009). Children describe play as something voluntary and self-controlled and as a fun, active, spontaneous, free, unlimited, natural, and self-initiated activity (Fein & Wiltz, 2006). Such fundamental aspects of play are also crucial elements for children's well-being, and play and well-being are considered closely linked in childhood (Ginsburg, 2007; Holte et al., 2014). Thus, there is a deeply embedded connection between play and well-being in children.

While the link between play and well-being can be related to the inherent value of play, the link between physical activity and play is often associated with the developmental benefits of play. Developmental perspectives on children's play suggest that children's play is positively related to cognitive development (Bergen, 2002), language development (Charman et al., 2000), social development (Fisher, 1992), and physical development (Pellegrini & Smith, 1998). Since children's play often involves movement and the exploration of one's physical capabilities, play often results in physical activity and thereby physical development. Such developmental benefits of play are connected to the increasing attention to the benefits of playful learning for various child outcomes in ECEC, where play and learning are considered intertwined concepts (Hirsh-Pasek, Golinkoff, Berk, & Singer, 2009). Thus, play relates to inherent, developmental and learning aspects in childhood and is essential to consider when studying the learning environment in ECEC and child outcomes.

The physical environment is an integral part of the learning environment in ECEC institutions. Characteristics of the physical environment are associated with children's development and health outcomes (Evans, 2006). The physical environment

can be defined as the objective and perceived characteristics of the physical context (Davison & Lawson, 2006). Physical elements of the ECEC environment such as the landscape, building, rooms, furniture, playground equipment, natural elements, toys, and objects may influence children's possibilities for play and exploration. Following this rationale, there is a growing interest in the influence of the physical ECEC environment on children's learning and development (Moser & Martinsen, 2010).

This study is conducted in Norway, where policies require that all children have access to affordable and high-quality childcare. ECEC institutions are governed by the Ministry of Education and Research and represent the first, non-compulsory component of Norway's educational system. As many as 92% of Norwegian children aged 1-5 years attend ECEC institutions (Statistics Norway, 2020). Most children have an arrangement where they can stay more than 41 hours per week, although most children spend 25-40 hours per week in the institution (Statistics Norway, 2017). The high participation rate and the long attendance hours make ECEC institutions the primary learning environment for young children in Norway.

A breakthrough in a genuinely universal child care system in Norway happened in the 2000s, with lowered fees and a heightened supply of places (Ellingsæter, Kitterød, & Lyngstad, 2017). In this period, substantial resources were used to increase the supply of childcare, and a high number of ECEC institutions were designed and built. There was a lack of research on the physical environment in ECEC institutions and a change towards more flexible institutions where children could follow their interests (Buvik et al., 2004). However, challenges with such flexible and large institutions have been highlighted (Seland, 2009; Vassenden, Thygesen, Bayer, Alvestad, & Abrahamsen, 2011). Knowledge about how the physical ECEC environments influence children in Norwegian institutions is therefore needed. The present study was conducted within the project Competence for Developing ECEC Institutions' Indoor and Outdoor Environments (EnCompetence) funded by the Research Council of Norway (DMMH, 2020), which addresses this knowledge gap.

Recently, an increasing focus on quality in Norwegian ECEC institutions has followed. The emphasis on quality in the ECEC sector is highlighted in White paper no. 19 (Ministry of Education and Research, 2016), where the government highlights its

ambitions for universal and high-quality childcare that is adapted to each child, where children's well-being, development and learning are secured. This document demonstrates the critical role of ECEC institutions in Norwegian governmental policy and the belief that the quality of the ECEC institution has an impact on children. The importance of the competence of the staff in creating a good and secure environment for care and learning is emphasised in this document. The physical environment is an essential part of the care and learning environment and is specifically believed to be influential on children's well-being, experiences, and learning (Ministry of Education and Research, 2016). These perspectives are implemented in the framework plan for Norwegian ECEC institutions (Ministry of Education and Research, 2017). Here, it is stated that the design of the physical environment is an essential factor for facilitating progression in learning and providing children with challenges that are suited to their experiences and interests (Ministry of Education and Research, 2017). The attention towards the physical environment in these policy documents demonstrates the relevance of knowledge about the role of the physical environment in ECEC institutions.

The Norwegian ECEC institutions are rooted in a Nordic early childhood culture. Wagner and Einarsdottir (2006) describe how childhood in this context commonly is viewed as important in its own right, as a period for freedom and free play, and with respect for children's rights. The centrality of play can be linked to another important concept in the Norwegian ECEC context, children's right to participate (Bae, 2009). The emphasis on children's right to participate and the importance of free play are closely linked to children's rights and the Convention on the Rights of the Child (United Nations, 2020). Consistent with this point, the Kindergarten Act (2005) in Norway states that children have the right to participate and shall have opportunities for play, self-expression, and meaningful experiences in ECEC institutions. Moreover, the framework plan (Ministry of Education and Research, 2017) emphasises children's need for play, the importance of play for children's development and learning, the inherent value of play, and that ECEC institutions shall promote play.

Another core value in the Norwegian ECEC field that is relevant for the present study is the significant contribution of the outdoor environment to the pedagogical content. Moser and Martinsen (2010) argue that the outdoor environment is essential to

children's social development and learning and find that Norwegian institutions have large outdoor areas that are used extensively. Outdoor play is also highlighted in the curricula, and nature is considered an essential place for play and learning by practitioners (Sandseter & Lysklett, 2018). Thus, both the outdoor and indoor environment serve essential purposes in the everyday pedagogical practice in Norwegian ECEC institutions.

The topic of this study is the influence of the physical ECEC environment on children's well-being and physical activity. Such knowledge is needed, given the lack of research-based knowledge about how the physical environment of ECEC institutions may promote or restrain children's well-being and physical activity. The overarching research question for the study is, *How does the physical environment in ECEC institutions influence children's well-being and physical activity?*

2. Theoretical framework and previous research

This chapter is a mix of overarching theoretical perspectives and previous research relevant to the topic of this study. The theory of affordances (Gibson, 2014) represents an essential framework for considering the link between the physical environment and children's behaviour in this study. Within the affordance chapter, previous studies investigating the link between the physical ECEC environment and children's behaviour are explored. Next, well-being and physical activity are addressed. At the end of these chapters, an overview of previous studies linking the particular concept to the physical environment in ECEC institutions is provided. This body of literature serves a critical reference point for the present study and identifies gaps in the literature that the current study addresses. Aims and specific research questions for the papers of this study are presented at the end of this chapter.

2.1 Theory of affordance

Affordances are defined by Gibson (2014) as what the environment offers the individual – what it provides or furnishes, either for good or ill. Affordances include both the environment and a perceiver, meaning that the affordances are unique for each individual. This notion follows the description of affordances as being equally a fact of

the environment and a fact of behaviour, including the complementarity of the individual and the environment (Gibson, 2014). Therefore, the possibilities of the environment and the behaviour of the child go together inseparably.

Among the types of affordances Gibson (2014) describes, objects and places are essential categories for considering the physical ECEC environment. Objects, and especially objects that are movable to the child, afford a wide range of affordances (Gibson, 2014). Pragmatically oriented, Gibson (2014) argues that children first perceive what an object affords rather than its qualities – substance, surface, colour, and form. Objects with many functions that can be used in many ways, such as sand and clay, are especially popular with children (Heft, 1989). Places refers to locations in the environment that offer sets of affordances, which can be within larger places and do not need to have sharp boundaries separating them from other places (Gibson, 2014). Thus, the ECEC institution comprises several subplaces with different physical structures and objects affording possibilities to the child.

Affordances are relational because they include both the environment and the child. Therefore, affordances do not fit into the dichotomy of objective and subjective entities. Affordances are objective in the sense that they are facts of the environment and subjective in the sense that they implicate a particular perceiver (Heft, 1989). Affordances thus emerge from the interaction between the child and the environment. According to Heft (2003), this interaction is immediate, as affordances are perceived directly in the activity. This idea means that children do not pause from the play they are engaged in to reflect on what an object may afford. Instead, the function of an object is perceived directly in a continuous flow of action. The importance of action is therefore deeply grounded in the theory of affordance, as perceiving is believed to be an active process that is supported by movement and action (Charles & Sommer, 2012).

Since affordances are perceived in a continuous flow of action, the intentions of the child are influential on what possibilities the child sees in the environment. The affordances perceived in the environment may therefore change as a function of intention (Heft, 1989). In a symbolic play episode, a child may perceive grains of sand as an ingredient in a meal, whereas later, the same grains of sand may be seen as building materials for a sandcastle in a constructive play episode. The physical

properties of the material have not changed, but the intentions of the child have. Heft (2003) emphasises that affordances are not a fixed functional property of a feature; instead, they are a dynamic entity in the ongoing process.

The theory of affordance was developed within the field of ecological psychology (Charles & Sommer, 2012) and addresses both humans' and animals' perception of the environment. In recent years, the theory has received increasing attention in a variety of fields, including studies of children's use of environments. Within this field, Heft's functional approach to children's environments (1988) and Kyttä's (2004) child-friendly environments have been particularly influential. These perspectives have demonstrated the relevance and practical applicability of the theory in studies of the child-environment relationship. The present study built on these perspectives when applying the theory of affordance to children's use of the ECEC environment.

2.1.1 A functional approach to children's environments

The theory of affordance can be used to describe the functions of the environmental features for an individual (Heft, 1988). As previously described, the concept of affordances is relational in how it involves a particular perceiver. Nevertheless, the physical structures in the environment and the physical characteristics of the child's body constrain the range of behaviours that can be carried out (Heft, 1989). Therefore, the more physically and developmental alike children are, the more likely it is that they share many of the same affordances in a given environment.

Based on the notion that children share many of the same characteristics and thereby also many of the same affordances, Heft (1988) has developed a functional taxonomy for children's use of the outdoor environment. This taxonomy includes ten classifications: 1: flat, relatively smooth surfaces; 2: relatively smooth slope, 3: graspable/detached object; 4: attached object; 5: non-rigid, attached object; 6: climbable feature; 7: aperture; 8: shelter; 9: mouldable material; and 10: water (Heft, 1988). Each of these categories includes subcategories, and all of the different classes afford children a wide range of functions. Such a functional description of the outdoor environment provides a meaningful psychological way to think about the environment (Heft, 1988).

This approach offers a framework to understand how children use elements in the physical environment of ECEC and what a child-friendly environment may include.

2.1.2 Child-friendly environments

Children benefit from having access to a diverse environment (Moore, 1986). A diverse ECEC environment holds many of the identified classes in Heft's (1988) taxonomy and thus affords children both flat and sloped terrain with different surfaces, climbable features, shelters, and an abundance of objects and water. However, to have a rich environment is not enough. Children must also be able to access and utilise the environment. While the diversity of the environment is given by the physical structures of the environment, children's access to the environment is dependent on the social context.

Kyttä (2004) has been influential on the understanding of the interplay between the social context and the physical environment, related to child-friendly environments. The variety of the environment in this framework is operationalised as the number of actualised affordances, which refers to the potential affordances the child utilises in a given environment (Kyttä, 2004). Children's access to the environment is operationalised by children's independent mobility. Kyttä (2004) describes independent mobility as related to the territorial range children are allowed to wander, children's license to move around and any mobility restrictions. Moore (1986) argues that access and diversity go hand-in-hand. The number of actualised affordances is therefore likely to be influenced by the mobility license of the child. A child-friendly environment involves a positive cyclical relationship between the child's mobility license and the actualisation of affordances, where higher mobility license leads to the actualisation of affordances, in turn motivating children to be mobile (Kyttä, 2004).

The mobility license of the children in ECEC institutions can be understood as the degree to which children are allowed to access different places in the indoor and outdoor environment. The staff in the institution is highly influential on children's' mobility within the ECEC environment. Moreover, staff may also influence children's actualisation of affordances in the environment they have access to through their response to children's behaviour. Kyttä (2004) categorises the potential affordances of

an environment into three subsets of affordances, the first being the field of promoted action, which refers to affordances encouraged by the social context. In contrast, the field of constrained actions refers to restricted behaviour, while the field of free action is affordances the child discovers without knowing how the social context will react to the actualisation (Kyttä, 2004). By distinguishing between what children "can" do and "ought" to do, the importance of sociocultural meaning for intentional human behaviour is included in the understanding of affordances (Heft, 2003). Thus, the social milieu in the ECEC institution is essential to the child-friendliness of the environment through children's mobility licence and what affordances are restricted and promoted.

2.1.3 The physical ECEC environment and children's behaviour

Based on the theory of affordance, a fundamental hypothesis for the present study is that the characteristics of the physical environment influence children's behaviour and that this behaviour may involve physical activity and influence their well-being. In this section, previous studies linking the physical ECEC environment to children's behaviour are presented. This body of literature is relevant to understanding how the physical environment may influence children's well-being and physical activity. With play being an essential behaviour in childhood, much of the previous research addressing the link between the physical ECEC environment and children's behaviour is related to this essential phenomenon. Previous findings explicitly addressing the key outcomes in this study, that is, well-being and physical activity, are presented within these chapters.

In the outdoor environment, the influence of the natural environment on children's behaviour in particular has been studied. Playing in a natural environment is found to support children's imaginary play and social relations (Dowdell, Gray, & Malone, 2011), encourage longer and complex play behaviours (Luchs & Fikus, 2013; Zamani & Moore, 2013), support risky play (Sandseter, 2009) and support various forms of play (Wight, Kloos, Maltbie, & Carr, 2016). From an affordance perspective, the numerous, diverse, and challenging play opportunities (Fjørtoft & Sageie, 2000) and the challenging terrain and abundance of loose objects (Lerstrup & Refshauge, 2016;

Lerstrup & van den Bosch, 2017) are characteristics of the natural environment that are believed to benefit children's play.

Studies conducted on traditionally build playgrounds also support the notion that an affordance-rich environment is beneficial for children's play. In an intervention study, introducing a wide range of loose parts to a school playground supported young children's creativity, cooperation and social interactions in play (Bundy et al., 2009). Similarly, Herrington and Brussoni (2015) found that increasing the number of affordances of the outdoor space in ECEC institutions by adding natural materials enriched children's play and promoted prosocial behaviour. Consistent with this finding, Larrea, Muela, Miranda, and Barandiaran (2019) found a lower availability of affordances to be associated with less group play and more parallel social play. These studies indicate that the affordances of the environment influence children's play behaviour and that this effect may influence children's psychosocial development.

Studies have also demonstrated how particular places and materials in an environment are associated with specific play behaviour. Fjørtoft and Sageie (2000) found the physical characteristics of the terrain and trees to influence to what degree children used a place for functional, constructive or symbolic play purposes in a natural landscape. Functional play commonly occurred in landscapes with mixed vegetation and varied topography affording running, tumbling and climbing, whereas symbolic and constructive play often involved using loose parts in scattered areas with mixed-bush vegetation (Fjørtoft, 2004). In a study of traditional build ECEC outdoor environments, Dyment and O'Connell (2013) found the frequencies of play types to vary across different places in the environment. Specifically, paths, manufactured equipment and paved expanses were found to be mostly associated with functional play, whereas sand features were mostly used for constructive play (Dyment & O'Connell, 2013). While these studies show how specific physical properties of the environment are associated with certain types of behaviour in many children, the wide range of factors influencing the child-environment relationship are also highlighted in these studies.

Studies targeting the ECEC indoor environment have also demonstrated that the characteristics of the physical environment influence children's behaviours. In an indoor intervention study increasing the availability of materials and defining zones for

different activities, children's play was found to last longer and to be more diverse (Acer, Gozen, Firat, Kefeli, & Aslan, 2016). In a long-term observational study, Torrens and Griffin (2013) found children's social interactions in the indoor environment to be clustered around resource-rich environments and that children used the physical environment to adjust their social behaviour. Interestingly, access to affordances was found to influence children's social interactions and whom they played with (Torrens & Griffin, 2013). Indoor environments rich in affordances thus seem to be beneficial for children's play.

However, open floor spaces, as a place with few environmental resources, have also been found to afford children valuable possibilities in the indoor ECEC environment. In a study of the youngest children, van Liempd, Oudgenoeg-Paz, Fukkink, and Leseman (2018) found the floor to be used in a multitude of ways and that this place offered a broad range of activities. Additionally, in a study of disabled and non-disabled children's use of an indoor space, children were found to use the floor for a variety of behaviours, including non-habitual ways to move (McLaren, Ruddick, Edwards, Zabjek, & McKeever, 2012). Thus, to have an indoor environment with both resource-rich environments and more loosely coded places that may serve different purposes seems beneficial.

Tables are an environmental feature of the indoor environment that have been linked to specific behaviour in children in ECEC. van Liempd et al. (2018) found tables to be mostly used for sitting or standing by while playing with small toys or with creative activities and to be associated with intense exploration for the youngest children. Tables were also identified as a hotspot for social interaction by Torrens and Griffin (2013), and most of the social interaction occurring at the tables involved staff. Consistent with this observation, Nordtømme (2016) discusses how the staff often are influential on children's activities at tables and argues that the arrangement of tables in ECEC institutions often signals to children that they are expected to be seated at the tables. These findings illustrate the dynamic relationship between the social context and the physical environment.

The presented literature on the association between the physical ECEC environment and children's behaviour supports the hypothesis that the characteristics of

the physical environment influence children's behaviour. Affordance-rich environments seem to benefit children's social interactions and play; in particular, the natural environment is demonstrated to promote a variety of beneficial play behaviours in children. Although the present study mainly addresses how the physical environment influences children's well-being and physical activity, the knowledge about the influence of the physical environment on children's behaviour is essential to understand the nature of the child-environment relationship for these outcomes. Following the prominent link between play and well-being in children in ECEC institutions (Giske et al., 2018; Howard & McInnes, 2013; Kennedy-Behr, Rodger, & Mickan, 2015), children's play represents a possible mediating factor in the relationship between the physical environment and children's well-being.

2.2 Well-being

The study of adults' well-being has a long history in fields such as philosophy and psychology. Here, well-being can be traced back to Aristotle, who linked happiness with virtue. From his perspective, happiness is something associated with growth and purpose and with the achievement of the best that is within us (Ryff & Singer, 2008). This understanding of well-being is related to eudemonic well-being, which refers to the subjective experiences of living life with high moral standards in pursuit of human excellence (Niemiec, 2014). Another perspective on well-being, commonly placed within the field of positive psychology, is the hedonic approach, where well-being is related to pleasure attainment and pain avoidance (Ryan & Deci, 2001). Both the hedonic and eudemonic perspectives are present in the commonly applied definitions of subjective well-being for adults, where all kinds of individual evaluations of different aspects of one's life are included (Diener, 2006).

2.2.1 Children's well-being

While the study of well-being in adulthood has a long tradition, the interest in children's well-being is more recent. In recent years, well-being has become a frequently used term in child research, but the definitions of the concept and the measures used to identify well-being vary (Pollard & Lee, 2003). The multidimensionality of the concept and the culturally situated nature of well-being may explain some of this diversity

(Mashford-Scott et al., 2012). Carlquist (2015) describes how the term well-being is used in a multitude of ways and that distinguishing among the words that are used to describe well-being, the actual phenomenon of well-being, and the conceptions that exist about well-being may be beneficial. Thus, it is challenging that words that are commonly associated with well-being (i.e., welfare, happiness, quality of life, and functioning) point to different phenomena and the cultural and contextual nature of such words. This point calls for cautious use of the concept of well-being and highlights the importance of clarifying how one understands well-being (Carlquist, 2015).

In a theoretical paper on children's well-being, Ben-Arieh and Frønes (2011) discuss different indicators used to measure well-being in childhood and how different indicators and measurements are rooted in different perspectives and understandings. Ben-Arieh and Frønes (2011) argue that the core of children's well-being is found in the complex balancing of children's well-being in the present and their predicted well-being in the future. The framework plan for kindergartens in Norway (Ministry of Education and Research, 2017) includes both perspectives. Moreover, it is emphasised that childhood has an intrinsic value, that ECEC institutions shall take a holistic approach to children's development and that they shall ensure that children can enjoy a good childhood with well-being (Ministry of Education and Research, 2017).

Although well-being has a prominent role in governmental guidelines and regulations and is referred to as an indicator of quality (Eide, Winger, Wolf, & Dahle, 2017; Laevers, 2000; Mashford-Scott et al., 2012), there is a lack of studies assessing the impact of ECEC intuitions on children's well-being (Holte et al., 2014). Koch (2012) describes how the institutions are expected to promote well-being; however, what well-being involves and how to construct the concept is not specified but is left to the practitioners. The participating pedagogues in Koch's (2012) study described well-being as something they can see, and their construction of well-being is grounded in a conception of the ideal child as a "happy child". This finding highlights the culturally situated nature of well-being, where one's understanding of what a good childhood entails influences the conception of well-being.

As emphasised by Ben-Arieh (2005), children themselves should be influential in constructing what well-being in childhood is. Before presenting studies addressing

children's perspectives on their well-being in ECEC institutions, two central studies of older children's views on well-being are mentioned. A study of school children's conceptualisation of their well-being indicates that vital elements in well-being for children are having a positive sense of self, the ability to have agency and influence, and feeling secure and safe (Fattore, Mason, & Watson, 2009). In another study of a concept related to well-being, happiness, children aged 6 to 12 years express that the true habitat of happiness is in human relationships and that happiness is experienced with others (Thoilliez, 2011). The findings in these studies point to well-being as a relational concept that is dependent on a wide range of factors.

Studies conducted in the ECEC context have also emphasised the importance of human relationships for children's well-being. Koch (2018) found the experience of friendship, engagement in free play, and the ability to balance one's relationship to the staff to be favourable approaches to well-being in ECEC institutions from children's perspectives. Similarly, Cooke, Brady, Alipio, and Cook (2019) found children's experiences of well-being in childcare to be influenced by parental relationships, their understanding of why they were in care and the degree of experienced autonomy. The importance of autonomy for children's well-being is supported by Sandseter and Seland (2016), who find that the opportunities to influence what to do, where to be, and whom to be with were essential to children's experiences of well-being in ECEC institutions. A related observational study on the youngest children found that well-being was expressed during social interactions and play and in situations where the child was seen, recognised and allowed to participate (Seland, Sandseter, & Bratterud, 2015). These findings demonstrate the importance of human relationships for children's well-being in ECEC institutions.

Play is a crucial element in the social relationships among children in ECEC institutions. Children's social competence, or successful functioning with peers, is related to children's play (Howes & Matheson, 1992). Thus, there is no surprise that well-being and play are found to be associated concepts in ECEC institutions (Giske et al., 2018; Howard & McInnes, 2013; Kennedy-Behr et al., 2015). In play, children can experience enjoyment and positive feelings, flow, and engagement, belonging, and meaning (Holte et al., 2014); the key elements in play are significant contributors to

children's well-being (Ginsburg, 2007). Play is an essential context for developing social relations and forming one's self. Children require both relations to others and to construct a separate self, and this process of socialisation and individualisation is important for children's well-being (Holte et al., 2014). Play can therefore be expected to promote children's well-being both hedonically through experiences of happiness and joy, and from a eudemonic perspective, through social belonging and meaning.

Children's possibilities for play and social interaction, the experience of being seen, challenged, and having autonomy, is dependent on the staff in the ECEC institution. How adults interact with children and how the adults provide children with developmentally stimulating opportunities are essential for child outcomes (Pianta, Barnett, Burchinal, & Thornburg, 2009). Also explicitly related to children's well-being, studies have demonstrated that how the caregiver interacts in different ways is essential (E. J. de Schipper, Riksen-Walraven, & Geurts, 2006; J. C. de Schipper, Van Ijzendoorn, & Tavecchio, 2004; Groeneveld, Vermeer, van Ijzendoorn, & Linting, 2016; Hannikainen, 2015). Although Koch (2018) found that adults rarely were mentioned by the children when explaining what makes them feel happy, she argues that adults' ordinary doings and pedagogical activities are essential for children's well-being in ECEC institutions.

This presentation of previous research on children's well-being in the ECEC field demonstrates the complexity and culturally situated nature of well-being and the diverse factors associated with children's well-being. The understanding of well-being applied in the present study builds on Laevers (2000) experimental approach. Here, children's well-being is believed to be manifested in behaviour and to be observable. Children's well-being is related to the degree to which children feel at ease and are vital, self-confident, and spontaneous (Laevers, 2000). According to Laevers (2000), such behaviour indicates that the child is doing fine and that the child's physical needs, the need for tenderness and affection, the need for safety and clarity, for social recognition, and to feel competent are satisfied. Following the understanding of well-being as something individual to the child that is expressed in a particular moment, the approach to well-being in this study is related to subjective well-being (Diener, 1984) and hedonic psychology (Kahneman, Diener, & Schwarz, 1999).

2.2.2 The physical ECEC environment and children's well-being

The physical environment in the ECEC institution can be expected to influence children's well-being in different ways. The development of place attachment and positive and negative feelings about their everyday surroundings (Jack, 2008) is one possible path. Another possible path is through the behaviours that the physical environment affords, as suggested in the affordance chapter. Architectural and technical attributes such as the sense of space, temperature, light, shade, air quality, and outlook may also influence children's well-being. However, few studies have investigated the relationship between the physical environment in ECEC institutions and children's well-being.

The studies that exist support the notion that the physical environment in ECEC institutions, in a general sense, is of significance for children's well-being. A study interviewing 4- to 6-year-old children about their well-being in ECEC institutions using questionnaires (Sandseter & Seland, 2016) found the physical environment and available materials to be important factors for children's well-being. Liking the indoor and outdoor environment was positively related to well-being in children (Sandseter & Seland, 2016). Similarly, Puroila, Estola, and Syrjala (2012) found inspiring and enabling environments and having opportunities for meaningful activities to be essential elements for children's experience of well-being in ECEC institutions. These findings indicate that the affordances provided by the physical environment may influence children's well-being.

Several studies have investigated the association between natural elements and children's well-being. In an intervention study, a decrease in depressed affect and antisocial behaviour and an increase in prosocial behaviour was found following an outdoor intervention that increased the number of affordances through increasing the availability of natural materials (Brussoni, Ishikawa, Brunelle, & Herrington, 2017). Contact with external green spaces has also been found to have a positive effect on children's levels of stress in an ECEC institution, suggesting that the natural environment has a positive effect on children's well-being (Carrus et al., 2012). Outdoor environments with trees, hilly terrain, and beneficial integration between vegetation, open areas, and play structures were also found to be positively associated with

indicators for well-being (Soderstrom et al., 2013). These studies suggest that natural elements in the outdoor space of ECEC institutions may facilitate well-being in children.

The social context is found to be influential on the relationship between the child and the physical environment related to children's well-being. Bjørgen (2017) demonstrated how the interaction of characteristics in the physical environment, social relationships, and the child's resources were related to children's well-being. From this perspective, the influence of the physical environment on children's well-being is a result of an interplay between the physical environment, the social context, and the child's different characteristics. The physical environment may afford the child challenges and varied experiences, a sense of autonomy, and support for social relationships facilitating well-being (Bjørgen, 2015). This finding suggests that the physical environment can influence children's well-being through mediating factors such as the play opportunities the environment affords, the experience of competence and autonomy, and as a place to develop social relationships. Thus, a complex and contextual relationship between the physical environment and children's well-being is expected.

The existing studies approaching the link between the physical environment in ECEC institutions and children's well-being indicate that the physical environment influences children's well-being (Bjørgen, 2017; Puroila et al., 2012; Sandseter & Seland, 2016). However, the degree to which the physical environment exerts an influence on well-being, the mechanisms driving this relationship, and what specific features of the physical environment support or restrain children's well-being in ECEC are less known. There are indications that the natural environment (Carrus et al., 2012; Soderstrom et al., 2013) and the availability of natural materials support children's well-being (Brussoni et al., 2017), but this knowledge base is limited and based on small-scale studies. There is a striking lack of studies addressing how features of the physical indoor ECEC environment influence children's well-being. The present study addresses these gaps in the literature by linking specific indoor and outdoor environmental features to children's well-being. The lack of an empirical framework for considering the association between the physical environment and children's well-being implies that

the present study has to take an explorative approach when considering how the physical environment may exert an influence on children's well-being. Furthermore, the considerations related to the relationship between the physical environments have to be interpreted within a broad framework to understand how well-being, an essential health indicator in childhood, may be influenced by the physical ECEC environment.

2.3 Physical activity

Physical activity is a behaviour that commonly is 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 physical activity on health for adults (Kesaniemi et al., 2001; Warburton et al., 2006). For children, the positive effect of physical activity is expected to be prominent since the positive effect of physical activity exists in both the short and long term. Physically active children are found to have healthier cardiovascular profiles, to be leaner, and to develop higher peak bone mass than are less active children, advantages that are believed to also result in better adulthood health (Boreham & Riddoch, 2001). The promotion of physical activity in childhood has therefore been given much effort from a public health standpoint.

The importance of physical activity for public health has resulted in guidelines recommending physical activity to the population. The national recommendations in Norway are that children should be physically active for at least 60 minutes each day in varied activities with moderate to high intensity and that physical activity beyond 60 minutes yields even more benefits for the child's health (The Norwegian Directorate of Health, 2020). Such governmental guidelines have been subject to some critique, as the evidence for the importance of a particular threshold value and the existence of a dose-response relationship is limited (Twisk, 2001). Further, the operationalisation of activity intensity and how to measure physical activity are actively debated (Welk, Corbin, & Dale, 2000). Nevertheless, governmental guidelines are often used as a benchmark to indicate the status of physical activity in a population. A recent study found that 90% of 6-year-old Norwegian children achieved the recommended 60 minutes of daily activity

(Steene-Johannessen et al., 2019). This finding indicates that most Norwegian 6-year-olds are sufficiently active according to the governmental guidelines.

2.3.1 Physical activity in ECEC institutions

The ECEC institutions are commonly believed to have a crucial role in explaining the variability in children's level of physical activity (Finn et al., 2002; Henderson, Grode, O'Connell, & Schwartz, 2015; Pate, McIver, Dowda, Brown, & Addy, 2008; Pate et al., 2004) and thus represent an essential arena for promoting public health by facilitating physical activity among children. This perspective is deeply grounded in Norwegian policy, where the framework plan for ECEC institutions (Ministry of Education and Research, 2017) emphasises that the institutions shall provide children with daily physical activity to support their health and development (Ministry of Education and Research, 2017). Thus, governmental regulations highlight the significant role of ECEC institutions in promoting children's health through physical activity, making physical activity an essential activity in ECEC institutions.

In addition to the health benefit of physical activity, how most children enjoy being physically active is an equally important argument for supporting children's physical activity in ECEC institutions. Rowland (1998) argues that there is a biological basis for physical activity and that children have a built-in need for physical activity. This need for activity often seems to result in a short burst of intense physical activity, with varying intervals of low- and high-intensity activity among children (Bailey et al., 1995). The extent to which ECEC institutions are sensitive to children's activity patterns and innate need for physical activity will influence to what degree children are physically active and perhaps also to what degree they experience autonomy and their right to participate. Thus, physical activity can also be considered an inherent value in childhood and thus associated with children's well-being.

The link between physical activity and well-being is also related to how children may experience joy and mastery in physical activity. The framework plan for ECEC institutions in Norway (Ministry of Education and Research, 2017) states that the institutions shall promote children's joy of movement and that children shall be included in physical activity where they can experience motivation and achievement. To

support this plan, facilitating children's physically active play seems ideal. Play is an enjoyable and child-controlled activity, often having a vigorous physical component (Pellegrini & Smith, 1998). The experience of physical mastery within a joyful context may enhance feelings of self-worth and competence, elements highly relevant for well-being. Pellegrini and Smith (1998) argue that active physical play serves an immediate function for children's motor control, strength, endurance and for cognitive, social and emotional aspects. Therefore, to what degree physical activity happens within a playful context and how children experience physical activity in ECEC may be critical for children's well-being, their future activity habits, and their physical development. Thus, physical activity is significant for children's health in various ways, and the ECEC institution serves an essential function in society for promoting physical activity among children.

2.3.2 The physical ECEC environment and children's physical activity

The physical environment is commonly believed to have a substantial impact on children's physical activity in ECEC institutions (Brown et al., 2009; Sugiyama, Okely, Masters, & Moore, 2012). The evidence for this notion is mainly based on research on the outdoor environment, and previous systematic reviews have found attributes of the outdoor play area to be essential for children's physical activity (Broekhuizen, Scholten, & de Vries, 2014; Temple & Robinson, 2014; Tonge, Jones, & Okely, 2016; Trost, Ward, & Senso, 2010). Although one can expect a similar relationship to exist in the indoor environment, less is known about the influence of the indoor environment on children's physical activity.

The search for associations between characteristics of the physical ECEC environment and children's physical activity is often performed by investigating physical activity for groups of children attending a preschool with specific environmental characteristics and comparing them to children in other preschools with different environmental characteristics (Bower et al., 2008; Dowda et al., 2009; Henderson et al., 2015; Olesen, Kristensen, Korsholm, & Froberg, 2013; Peden, Jones, Costa, Ellis, & Okely, 2017). Other studies examine this association by looking at variation in physical activity for the same child at different sites within the same

preschool (Brown et al., 2009; Cosco, Moore, & Islam, 2010; Nicaise, Kahan, & Sallis, 2011). While the first group of studies usually uses objective instruments such as accelerometers to measure physical activity, the studies tracking children's physical activity within the same environment commonly use observation.

Studies examining the association between the indoor environment and children's physical activity are relatively few, and mixed results exist. Environments supportive of physical activity, such as having an indoor recreation room (Barbosa, Coledam, Stabelini Neto, Elias, & de Oliveira, 2016) and using the indoor space for motor activities (Sugiyama et al., 2012), are positively associated with physical activity. However, Olesen et al. (2013) did not find rooms for physical activity to predict children's physical activity levels significantly. In several studies, the Environment and Policy Assessment and Observation (EPAO) tool has been used to measure the physical environment and compare the scores on this scale to children's levels of physical activity. The association between the scales measuring the indoor environment in the EPAO tool and physical activity is mixed, and no distinct conclusions can be drawn (Bower et al., 2008; Gubbels et al., 2011; Gubbels, Van Kann, & Jansen, 2012; Peden et al., 2017; Tucker, Vanderloo, Burke, Irwin, & Johnson, 2015; Vanderloo, Tucker, Johnson, Burke, & Irwin, 2015). In one of these studies, Gubbels et al. (2011) found that the social environment interacts with the physical environment with regard to children's physical activity. This finding may explain some of the inconsistencies in the association among EPAO subscales and measured physical activity in the indoor environment and indicates that the social context is essential for physical activity in the indoor environment. The overall knowledge base on how the physical indoor ECEC environment may influence children's physical activity is scarce, and there is a gap in the literature related to the role of the indoor environment in children's physical activity.

More is known about the outdoor environment's influence on children's physical activity. Among the commonly considered positive attributes of the outdoor environment for physical activity is access to portable play equipment. The portable play equipment is positively associated with physical activity in several studies (Bower et al., 2008; Brown et al., 2009; Bundy et al., 2009; Dowda et al., 2009; Hannon & Brown, 2008; Nicaise et al., 2011). Other studies, using accelerometers to measure

physical activity, have not found the same positive association (Cardon, Labarque, Smits, & Bourdeaudhuij, 2009; Henderson et al., 2015; Olesen et al., 2013). One limitation of the accelerometer is that it may not register physical activity when children move heavy objects, as it only detects movement. This shortcoming of the instrument may explain some of the discrepancies.

How the preschool building was placed on the playground and the number of sides available for play is found to influence children's physical activity (Olesen et al., 2013). The positive effect of having more sides of the building available for play may be linked to the benefit of having pathways and circular tracks for physical activity (Cosco, Moore, & Smith, 2014; Nicaise, Kahan, Reuben, & Sallis, 2012; Nicaise et al., 2011). Pathways and tracks may afford children with possibilities for running and biking, and a complex network of pathways may be positive. Having more sides of the building available for play also provides children with hiding places and possibilities for risky play by avoiding supervision from adults (Olesen et al., 2013).

Another essential element in the outdoor environment for physical activity is open spaces. Open spaces that enable children to play freely is found to be positively associated with physical activity (Berg, 2015; Brown et al., 2009a; Cosco et al., 2010; Nicaise et al., 2011). Open spaces provide opportunities for running, chasing, and games with rules. Open spaces in ECEC institutions often include large flat areas with a hard surface such as asphalt or concrete that may be suitable for ball games. Studies have investigated the influence of playground markings of such areas, following the rationale that such markings would provide children with physically active play opportunities. However, playground markings are generally rejected as a successful intervention strategy for enhancing children's physical activity levels (Broekhuizen et al., 2014; Escalante, García-Hermoso, Backx, & Saavedra, 2014; Temple & Robinson, 2014; Tonge et al., 2016).

Fixed playground equipment is an asset in the outdoor environment that does not seem to have a clear association with physical activity. Studies are finding both positive (Brown et al., 2009; Larson, Normand, Morley, & Hustyi, 2014; Sugiyama et al., 2012), neutral (Henderson et al., 2015; Olesen et al., 2013) and negative (Bower et al., 2008; Dowda et al., 2009) associations between fixed playground equipment and physical

activity. Concerning the mixed findings on portable playground equipment, different measures for physical activity and variations in the conceptualisation of playground equipment may explain some of this inconsistency. How the surroundings, such as what other opportunities for physically active play exist and the placement of the equipment in relation to other equipment, influence physical activity patterns is also demonstrated (Smith et al., 2014). Contextual differences, both about the physical surroundings and the social context, may thus influence how a specific feature of the environment is related to physical activity.

Inconsistent findings also exist in studies investigating the association between natural elements in the outdoor space and physical activity. Both positive (Boldemann et al., 2011) and neutral (Storli & Hagen, 2010) associations between natural environments and physical activity are found. Further, the presence of vegetation on the playground is found to be negatively (Olesen et al., 2013) and neutrally (Cardon, Van Cauwenberghe, Labarque, Haerens, & De Bourdeaudhuij, 2008) associated with physical activity. Moreover, having mostly natural surfaces in the outdoor space is found to be negatively associated with physical activity (Sugiyama et al., 2012). The natural environment does, however, seem to foster motor competence in children (Fjørtoft, 2004). These findings indicate that the natural environment has qualities related to the quality of movement in children, although not to the quantity of movement.

The available literature indicates that the attributes of the outdoor physical ECEC environment influence children's physical activity to a high degree. Characteristics of the outdoor environment such as portable play equipment, pathways, and open areas seem to promote children's physical activity in ECEC institutions (Brown et al., 2009; Cosco et al., 2014; Dowda et al., 2009). The association with fixed playground equipment and nature is unclear (Henderson et al., 2015; Olesen et al., 2013). Less is known about what indoor environment characteristics influence children's physical activity, although spaces for physically active play seems to support physical activity (Sugiyama et al., 2012). Further, there are indications in the literature that the social environment influences the association between the physical environment and children's physical activity (Gubbels et al., 2011).

2.4 Aims and research questions

This study aims to develop knowledge about how the physical environment in ECEC institutions influences children's well-being and physical activity. A fundamental ambition is that the knowledge produced shall be practically applicable to different professions and stakeholders involved in planning, designing, and developing the physical environment of ECEC institutions. Furthermore, this study aims to expand the knowledge base in the field. Four sub-studies (papers) were conducted to reach these aims. Table 1 presents the overarching research question and the research questions for the four papers.

Table 1 Research questions of the study

Study	Research Question
Overarching	How does the physical environment in ECEC institutions influence children's well-being and physical activity?
Paper I	What characteristics in the ECEC's physical outdoor environment influence children's well-being and physical activity?
Paper II	What characteristics in the ECEC's physical indoor environment influence children's well-being and physical activity?
Paper III	How does the introduction of a tumbling space in ECEC institutions influence children's functional play, physical activity, and well-being?
Paper IV	How can affordances in the ECEC outdoor environment promote physical activity and well-being simultaneously?

Grounded in the theory of affordance (Gibson, 2014), this study has an underlying causal assumption, namely, that the physical environment influences children's behaviour. The behaviours that the physical environment affords may involve physical activity and influence children's well-being. Play is an essential component in this relationship, closely related to both well-being (Ginsburg, 2007; Holte et al., 2014) and physical activity (Pellegrini & Smith, 1998). In addition to the possible effect of the physical environment on well-being mediated through the behaviours afforded by the

physical environment, more direct effects such as the restorativeness of the environment (Carrus et al., 2012) may also exist. The research questions of the papers are contextualised in the following to demonstrate how they address gaps in the literature.

Although the theoretical framework of this study suggests that the physical environments in ECEC institutions influence children's well-being and physical activity, there are gaps in the literature related to what specific characteristics of the physical environment influence these outcomes. The link between specific physical elements in the outdoor environment and physical activity is explored in several earlier studies. Nevertheless, the literature shows a mixed picture related to how playground features such as natural elements and fixed and portable playground equipment influence children's physical activity. The link between the outdoor physical environment and children's well-being is only addressed in a few small-scale studies; there is a need for knowledge in this field. Paper I addresses these gaps in the literature guided by the following research question: *What characteristics in the ECEC's physical outdoor environment influence children's well-being and physical activity?*

Even less is known about how features of the physical indoor environment are linked to children's well-being and physical activity; there is a lack of studies addressing the link between the physical indoor environment and child outcomes (van Liempd, Oudgenoeg–Paz, & Leseman, 2020). Environments for physically active play seem to support physical activity indoors, but how other elements in the indoor environment are associated with physical activity is unknown. Children's well-being has not previously been linked to specific characteristics of the physical indoor environment of ECEC institutions. Paper II aims to develop knowledge about these relationships, using the following research question: *What characteristics in the ECEC's physical indoor environment influence children's well-being and physical activity?*

The underlying causal hypothesis of this study is best addressed by evaluating the effect of an intervention in the physical environment. Few previous studies have explored the effect of changing the physical environment on children's well-being and physical activity. Targeting the indoor environment, where this topic is especially underresearched, Paper III addresses this gap in the literature. Children's play

behaviours were included in this paper to understand more fully how the intervention influenced children. The following research question was used in Paper III: *How does the introduction of a tumbling space in ECEC institutions influence children's functional play, physical activity, and well-being?*

The theoretical framework of this study suggests that the child-environment relationship is context-dependent and influenced by a wide range of factors (Bjørgen, 2017; Heft, 2003; Kyttä, 2004; Smith et al., 2014). Essential elements may include the child's intentions, the social context and the interplay between different affordances in the environment. This complexity has rarely been incorporated in study designs in the ECEC context. Paper IV aims to address this gap in the literature within the context of the outdoor environment. The phenomenon investigated is physical activity with high well-being. Although children's experiences with physical activity in ECEC are likely to be significant for various health aspects, few studies have investigated children's experiences of well-being in physical activity. Paper IV addresses this crucial element for health promotion in ECEC guided by the following research question: *How can affordances in the ECEC outdoor environment promote physical activity and well-being simultaneously?*

3. Method

This part of the thesis presents the methodological approach and design, procedures, sample, measures, analysis and ethical considerations. The overarching aim of the study is to develop practically applicable knowledge about how the physical environment in ECEC institutions influence children's well-being and physical activity. Structured video observations of 80 children's free play in the indoor and outdoor environment of eight ECEC institutions were collected to reach the overall aim. Video observations of children in their everyday ECEC environment provided possibilities to analyse different aspects of children's behaviour and their use of the physical environment within a naturalistic context. Periods of children's free play were selected following the crucial role of play in the Norwegian ECEC context, where children can utilise the physical environment relatively freely based on their interests.

This study is conducted within a larger project, EnCompetence (DMMH, 2020), which was funded by the Research Council of Norway and approved by the Norwegian Social Science Data Services. The main objective of the project as a whole is to develop new knowledge that will result in a higher competence in planning, designing and developing ECEC institutions' physical environments. Although the overarching project has influenced methodological choices, the present study represents an independent yet fully integrated sub-study in the overarching study.

3.1 Methodological approach and design

The methodological approach applied in the present study is influenced by pragmatic philosophy (Morgan, 2014), is placed within educational design research (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003; Van den Akker, Gravemeijer, McKenney, & Nieveen, 2006) and uses mixed methods (Creswell, 2014). The following section introduces these three intertwined fields to clarify the methodological approach of the study. Pragmatism represents the most overarching and philosophical perspective and is presented first. Next, educational design research is addressed, before mixed methods as a methodological approach is explored.

3.1.1 Ontological and epistemological point of departure: Pragmatism

Epistemologically, this study is associated with an empiricist approach following the central place of experience in the acquisition and testing of knowledge (Benton & Craib, 2001). More specifically, the philosophical movement pragmatism affiliated with logical empiricism (Delanty & Strydom, 2003) has guided ontological and epistemological questions in the present study. Central figures in the foundation of pragmatism as a philosophical direction in the 19th century included William James, Charles Sanders Peirce and John Dewey. Their ontological perspectives and ideas of pragmatism vary somewhat, but they shared the notion that truth is related to something working satisfactorily and the significance of practical applicability. This perspective is seen in Peirce's (1905) description of objects as being utterly related to the practical bearings one conceives the objects to have. Rather than focussing on metaphysical discussions concerning what an object truly is, the practical consequences of objects are emphasised. Similar practical approaches are taken to ideas. For instance, Dewey (1908)

argues that one function of philosophy is to translate hypotheses into their meaning for behaviour and thus change the existing world. Correspondingly, James (1909) describes true ideas as those assimilated, validated, corroborated and verified, and emphasises that it is the practical difference that is the meaning of truth.

The human experience is vital from the pragmatic perspective and is inseparably influenced by both the facts of the world and the individual's perception of the world. Dewey emphasised that experiences involve interpretation and that this interpretation is influenced by contextual, emotional and social factors (Morgan, 2014). Furthermore, experience is closely linked to knowing, as experience concerns understanding the link between our actions and their consequences (Biesta, 2010). Dewey's concept of inquiry, one kind of experience, involves a form of self-conscious decision-making, where problematic situations are explored and solved through reflection and action (Morgan, 2014). The outcome of inquiry must be tested, and assertion may become warranted if it demonstrates applicability in action (Hall, 2013). Knowledge is, from this perspective, something we do; it is acquired through a combination of reflection and action (Biesta, 2010). Research is one form of inquiry, where systematic approaches to identifying problems, suggesting solutions and considering the effects of solutions are applied.

A vital issue in the philosophical area of the pragmatist's time was the dualism between realism and idealism. Dewey (1922) wanted to get past theoretical discussions and work with the identified problems based on their objective and temporal connection to events. This perspective is relevant for considering the dualism between post-positivistic and constructionist perspectives in the contemporary philosophy of science. According to Dewey, the nature of the outside world and our conceptions of it are two sides of the same coin, as both conceptions are important perspectives on human experience (Morgan, 2014). Drawing on Dewey's pragmatism, Biesta (2010) argues that subjective and objectivist conceptions of truth can coexist, since all experiences are equally real. From this perspective, knowledge is an active process of inquiry, where taking actions and experiencing their outcomes are central, with a dynamic relationship between beliefs and actions, where reflection is central (Morgan, 2014).

In a pragmatic approach to research, theories are viewed instrumentally and become true if they demonstrate workability, which is related to predictability and

applicability (Johnson & Onwuegbuzie, 2004). In this study, the theory of affordances (Gibson, 2014) is used as a theoretical framework. Noble (1981) argues that perspectives from pragmatic philosophy are compatible with the theory of affordances. The ontological properties of affordances are one reason for this compatibility, as affordances are neither objective nor subjective entities, since they are both objective facts of the environment and implicate a particular perceiver, which makes them subjective (Heft, 1989). The emphasis on the practical bearings of objects in pragmatism (Peirce, 1905) is recognisable in the notion in affordances where the perception of objects is mainly related to what an object can afford the individual (Gibson, 2014). Moreover, both pragmatism and affordances deal with the organism-environment relationship, where context and previous experiences are highlighted. The theory of affordance thus coincides on critical issues with a pragmatic approach, and applying the theory of affordance within a study inspired by pragmatic perspectives is therefore beneficial. Nevertheless, the practical applicability of the theory is the real test of the truth-value of the theory.

A pragmatic approach to social science, according to Morgan (2007), relies on abductive reasoning, has an intersubjective relationship to the research process and makes inferences based on transferability. The present study takes a back and forth relationship between theory and data that characterises abductive reasoning, as observations are converted to theories that are assessed through action. An intersubjective relationship between the researcher and the research process is applied since different frames of reference are applied in different parts of the study. In parts of the study, efforts are made to measure a concept as objectively as possible, whereas in other parts of the study, it is essential to understand reality from the child's perspective. The present study takes a transferability approach to inferences, implying that the developed knowledge is neither particular to the context of the present study nor universal. What others can use the knowledge for in other circumstances, and how the context in the present study must be considered when making inferences, are emphasised. This approach is consistent with an underlying assumption in pragmatism: theories can be both contextual and generalisable by evaluating the transferability to other situations (Shannon-Baker, 2016).

3.1.2 Educational design research

The overarching study, EnCompetence, is placed within the field of educational design research (McKenney & Reeves, 2013; Van den Akker et al., 2006), or what is also called design experiments in educational research (Cobb et al., 2003) or design-based research (Anderson & Shattuck, 2012). Since the present study is an integrated sub-study in this overarching study, the design of the overarching project influences key methodological elements in the present study. However, not all features of educational design research in the overarching study are fully integrated into the present sub-study. In the following, essential characteristics of this research tradition and how they are integrated into this study are addressed.

According to Cobb et al. (2003), key features of educational design research are the aim to develop knowledge about the learning process, the use of interventions, iterative design, being both prospective and reflective, and that the theories developed do real work in practice. To do real work in practice implies for the present study that the theories must provide detailed guidance on how to design an ideal physical ECEC environment to promote children's well-being and physical activity. If this point is not true, the theories should be adjusted or rejected. Educational design research seeks to develop theoretical knowledge and practical solutions simultaneously, in a naturalistic context, together with practice in the field through interventions (McKenney & Reeves, 2013). This approach makes the research methodology practice-oriented, where the gap between research and practice are bridged, with an aim to increase the impact and transfer of research into better practice (Anderson & Shattuck, 2012). This aim is highly relevant for the present study, conducted within a real-world context, with a high degree of user involvement, collaboration across professions, and the possibility of testing ideas quickly. These characteristics make the approach valuable in addressing complex problems where one has little prior research-based knowledge, as is true for the present study.

Plomp (2013) divides educational design research into development studies and validation studies. Development studies involve research-based solutions for complex problems, while validation studies are applied to develop or validate a theory (Plomp, 2013). The present study represents a development study, which aims to develop

research-based knowledge about how the physical environment in ECEC institutions influences children's well-being and physical activity. The focus on the learning process, identified by Cobb et al. (2003) as a crosscutting feature of educational design research, is thus not explicitly stated in the present study. Nevertheless, well-being and physical activity are relevant for children's health and development and thus fit within a broader understanding of the learning process in the early years.

Theories are critical in educational design research. The vital role of theories is related to their provision of a framework for the problem in focus, aiming to deepen the theoretical understanding of a phenomenon, and shaping the intervention that is designed to solve the problem in focus (McKenney & Reeves, 2013). In other words, theories should provide solid practical implications, a notion that is recognisable from pragmatic philosophy. Rather than testing theories, educational design research explores ways to build systems based on theory and evaluates the effectiveness of this exploration in practice (Walker, 2006). Thus, having a robust theoretical framework to guide the study is essential, both to develop successful interventions and to develop the findings into relevant knowledge that is applicable in other contexts.

The practice field is crucial in educational design research. Drawing on the competences of both the researcher and the teacher is a partnership developed to negotiate the problem identification, intervention design, intervention implementation, and theory building in the study (Anderson & Shattuck, 2012). Active involvement of the practitioners may increase the likelihood of the intervention being relevant and practically applicable and thereby successful (Plomp, 2013). Since educational design research uses an iterative design, where cycles of implementation and evaluation are carried out (Cobb et al., 2003), the participating teachers are involved in several different phases of the study and thus have a crucial role in the development of knowledge.

Interventions are central in educational design research as theory building, to develop and test knowledge, and to share knowledge about a phenomenon (McKenney & Reeves, 2013). An intervention may have an overarching objective that is experienced as a challenge in the sector, but the intervention also addresses problems and contextual factors of the specific institution (Anderson & Shattuck, 2012). Where

many educational design studies have several cycles of interventions (Gravemeijer & Cobb, 2006), the present study includes only one cycle of intervention. This choice implies that the possibility of adjusting the implemented interventions is lost, but conducting interventions in several institutions provides a broader understanding since different contexts are included.

The context-specific nature of educational design research is a challenge for the generalisation of results. Plomp (2013) emphasises the context-bound nature of educational design research, where statistical generalisation to a larger population is not possible. Kelly (2006) highlights that while the nature of the study is experimental, it is not an experiment, as generating and cultivating theories is emphasised. To transfer theoretical insights and practical interventions to other contexts is, however, an essential ambition in educational design research (McKenney & Reeves, 2013), where the aim is to translate findings into generalisable theories (Edelson, 2006). This aim can be achieved through analytical generalisation, which involves the abstraction of ideas from the findings, to apply the findings to other contexts and contribute to theory building (Yin, 2013). Such abstractions may often touch on causal questions. The present study takes a realistic process-oriented approach to inferences, where the significance of context and meaning is included in the interpretation and exploration of causal associations (Maxwell, 2004). This inclusion implies that human action is considered motivated, and the intentions and reasons for actions are looked for rather than universal laws that govern causality (Biesta, 2010). Such an approach to causation can be called "causal explanation," which includes both the mechanisms and conditions where the causal relationship holds (Gravemeijer & Cobb, 2006). Thus, the present study aims to adapt the findings to higher-order knowledge with support in the theoretical framework through analytical generalisation and a process-oriented conception of causal explanation.

The high degree of involvement by the researcher in the design, implementation, and evaluation of the intervention carries both advantages and disadvantages for the present study. On the positive side, the intervention in itself is a unique learning process for the researchers involved, as they deepen their understanding about the phenomenon while the experiment is in progress (Cobb et al., 2003). However, the intimate

involvement by the researcher may also lead to questions regarding the degree to which the researcher can make credible and trustworthy assertions (Barab & Squire, 2004) and raise questions regarding conflict of interest (Plomp, 2013). This issue may influence different aspects of the research process, including the bias related to evaluating the effect of the intervention, resulting in the risk of an evaluator effect (McKenney, Nieveen, & van den Akker, 2006).

3.1.3 Mixed Methods

A method can be described as a procedure for gathering or analysing data, and to use mixed methods is to intentionally combine different methods that are meant to gather different information (Greene & Caracelli, 1997). Information, or data, is often divided into quantities and qualities, where quantities are described using numbers, and qualities are usually described in text (Biesta, 2010). The combined strength of different methodological approaches is related to the acknowledgement that different methods are complementary ways to develop knowledge and that combining different approaches may provide more in-depth insight than single methods alone (Greene & Caracelli, 1997). With a pragmatic stance, research approaches should be mixed to offer ideal opportunities to answer important research questions (Johnson & Onwuegbuzie, 2004).

An essential perspective on approaching different ways of conducting mixed methods research is provided by Biesta (2010), who introduces seven levels of mixed methods research. These levels build upon each other and include data, methods, design, epistemology, ontology, the purposes of research and the practical roles of research (Biesta, 2010). The present study mixes at several of these suggested levels. Data are presented both as numbers and text in the present study, and both qualitative and quantitative methods are used. While the design of the study includes an intervention, parts of the analysis are also conducted on cross-sectional data, meaning that a sequential mix of designs is applied. Mixing perspectives at the epistemological level – for example, between objectivism and subjectivism – can result in claims about incompatibility (Biesta, 2010). As introduced in the section on pragmatism, the present study seeks support in Dewey's perspective on how such ideas can coexist. Regarding Biesta's (2010) distinctions of ontologies and purposes of research, the worldview in the

present study is associated with social ontology, and the purpose is both to explain and understand phenomena. Finally, the present study aims to have an impact on both practical roles of research suggested by Biesta (2010), as this study aims to provide practitioners with the means to support children's well-being and physical activity while at the same time providing practitioners with new perspectives on their everyday practice.

Creswell (2014) describes mixed methods research as an approach to research where both quantitative and qualitative data are gathered and integrated and where one uses both sets of data to make inferences. The mixing of methods may also be allocated at the analytical level (Biesta, 2010), which is true for the present study, where video observations are the only source of data. Videotapes are commonly described as qualitative data (Creswell, 1999). However, both qualitative and quantitative techniques are used to analyse the video observations, and the main emphasis has been on quantitizing the video observations. Sandelowski (2000) describes quantitizing as a process of using quantitative techniques to transform qualitative data into numbers by using items, constructs or variables that have the same meaning across different observations. The researcher intends to preserve the qualitative meaning in the development of such instruments (Fleury, 1993); however, as Sandelowski (2000) points out, one item can have only one meaning to ensure the psychometrical properties of the instrument. Thus, quantitizing results leads to less-complex and nuanced data material. In the present study, several instruments are used to transform the video observations into numbers that can be analysed using statistical techniques.

Mixed methods research can take many forms. Leech and Onwuegbuzie (2009) have developed a typology for mixed methods research design, where the level of mixing, time orientation, and emphasis of approaches are used as dimensions to group studies. A full level of mixing involves the use of both quantitative and qualitative approaches on one or more of the following components: research objectives, type of data and operations, type of analysis and type of inferences (Leech & Onwuegbuzie, 2009). The second dimension of the typology refers to the time dimension and separates between concurrent and sequential design. In concurrent design, the qualitative and quantitative phases are conducted closely in time, where they occur after each other in a

sequential design. Finally, studies are recognised by the weight of the included components when addressing the research question (Leech & Onwuegbuzie, 2009). The present study is placed within a "fully mixed concurrent dominant status design" in this typology, where the quantitative approach is weighted.

This study is associated with pragmatic philosophy, conducted within an educational design research framework, and is placed in mixed methods research. According to Cameron (2011), mixed methods research is distinguished from other research approaches because the either-or perspective is rejected in all parts of the research project; the emphasis is on cyclical and iterative approaches to research. Both characteristics are compatible with the pragmatic approach and the field of educational design research. According to Anderson and Shattuck (2012), educational design studies typically involve mixed methods and are associated with the pragmatic philosophy. The different roles of the researchers involved in this study and the integration of different methodological approaches at several levels in the research process may be a strength. However, that integration also brings with it an increasing degree of complexity and methodological challenge. Conducting mixed methods research requires care and reflexivity (Feilzer, 2010). The aim for the following method sections is to provide information about the methods and procedures used, thus highlighting the strengths and limitations of the study and the measures taken to reduce bias and strive for objectivity when appropriate.

3.2 Procedures

This study includes repeated data collections and interventions that were developed in close collaboration with the practice field, which resulted in knowledge building and practical implications. Figure 1 presents the key phases in this study. The first data collection (T1) was conducted between 9 October and 3 November 2017. The period for data collection lasted one week in each of the eight institutions. During this time, structured video observations of children's use of the physical environment were conducted. The data collections were placed as close together in time as possible to keep the seasonal variations to a minimum. Nevertheless, the substantial geographic

differences, with institutions both in the north and south of Norway, resulted in varying weather conditions. The researchers in the project analysed the video observations following the data collection, and Papers I and II in this thesis are based on cross-sectional analysis conducted in this first analytic phase.

The video observations were conducted during periods of free play and followed a predetermined scheme stating the time that each observation was to take place. A preschool teacher from each institution was recruited as a co-researcher and conducted the filming with assistance from a researcher. Four researchers were involved in the data collection, and the author of this thesis was responsible for the collection of data in four of the participating ECEC institutions. The other three researchers conducting the data collection were all highly experienced in the ECEC field and were researchers in the EnCompetence project. The researchers conducting the data collection developed the study protocol jointly with the project manager. In the protocol, a detailed description of the procedures for conducting the video observations was established to ensure consistent methods across all institutions.

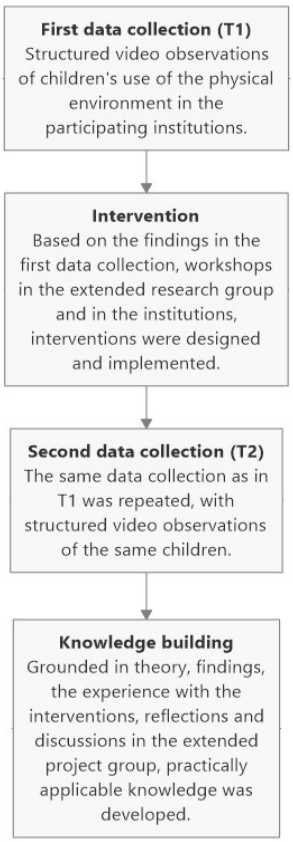

Figure 1 Study phases

Ten children were observed in each of the participating institutions (sampling procedures are described in the next section). For each child, six two-minute observations in both the indoor and outdoor environment were conducted at both data points. Two children were observed each day. 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 another six-minute break. This procedure was repeated until six observations of each child were conducted in the current environment. After lunch, the observational period in the remaining environment began, and the same procedure was repeated to conduct six more observations of each child. If children were in situations

where filming was not an option due to ethical considerations (e.g., toilet visits or the child refusing to be filmed), the observations were postponed. The co-researcher conducting the filming, who knew the children well, kept an ongoing dialogue with the children about the filming to ensure consent to participate. The procedures for the video observations were developed by the researchers of the project to give a broad and random sample of observations where children interacted with the indoor and outdoor environments during free play.

The researcher responsible for the data collection in the institution wrote field notes and ensured that the protocol was followed. A participant-as-observer role (Gold, 1957) was selected to serve this role. This role was distanced to reduce the impact on the children's and staff's behaviour. If approached by children or staff, the researcher interacted with them but was otherwise conscious of avoiding interacting with staff and children during the periods of observation. The preschool teacher conducted the actual filming with a GoPro Hero action camera. The benefit of having a person familiar with the children performing the filming was considered to outweigh the negative aspects of having eight different persons conducting the filming. The co-researcher was asked to do video observations regularly before the data collection so that the children were familiar with being filmed. Cameras were also used for pedagogical documentation before this study in the participating institutions. Regular use of cameras before the data collection and a familiar person filming with a small wide-angle camera were essential to be able to film children closely enough to be able to capture speech, body language, and facial expression without affecting the children noticeably.

The next phase of the study was the interventions, which were developed in close collaboration with the participating institutions and an extended project group. The extended project group included five researchers, eight co-researchers (one from each of the participating institutions), an architect and a landscape architect. To ground the findings in the practice field and to develop relevant knowledge, having the extended research group was vital. Here, the group's mutual previous experience and theoretical perspectives were used to interpret the findings from the first data collection. These discussions, in combination with existing knowledge and identified challenges in each of the participating institutions, formed the basis for the intervention. The

intervention was unique in each of the participating institutions and had to be low cost. The institutions themselves conducted the changes in the physical environment, with varying degrees of assistance from the researchers. The process of designing the intervention started in May 2018, and the changes in the environment were completed during August 2018 to allow children to become used to the changes before the second data collection.

The second data collection (T2) followed a year after the first and was carried out between 24 September and 25 October 2018. The same children as in T1 participated, and the procedure for conducting the video observations was identical to the first data collection. The same researchers and co-researchers conducted the data collection in their designated institutions, and the analysis of the video observations was conducted identically to the first. Analyses of changes from the first to the second data collection were conducted; Paper III represents one such analysis.

Following the analysis of the results from the second data collection, a new loop of workshops in the extended project group was carried out to generate practically applicable knowledge about the physical environment in ECEC institutions. This process resulted in increasing awareness of the context-dependent nature of the child-environment relationship. These perspectives contributed to the analytical design of Paper IV, which takes a more holistic and contextual perspective compared to Papers I-III. This thesis is also an outcome of this knowledge-building phase, in which findings from different phases of the study are integrated into practically applicable knowledge about the influence of the physical environment in ECEC institutions on children's well-being and physical activity.

3.3 Sample

The unit of analysis in this study is the collected video observations. These video observations were conducted in eight ECEC institutions on 80 children. In this section, the sample of ECEC institutions, the children, and the video observations are described. Finally, the question of the generalisability of the sample is addressed.

3.3.1 ECEC institutions

Following the project's aim and methodological approach, eight institutions were included in the study. This number was considered enough to provide a decent mix of different institutions while at the same time making it possible to ensure a high level of user involvement and gaining familiarisation with the physical environments in all the institutions. Two private ECEC owners and one public one participated as partners in the project. Three institutions were recruited from each of the private owners, whereas two institutions were recruited from the public owner. The ECEC owners provided a list of eligible institutions that were willing to participate, that had at least 20 children aged three to four years and had a preschool teacher who agreed to be a co-researcher in the project. The list of available institutions included descriptions of the size, location, age of the institution, physical environment, organisational form and number of children. Organisational form refers to how the institutions arrange the groups of children, ranging from traditional group-based organisation to flexible grouping (Vassenden et al., 2011).

The project group then conducted a purposeful sampling (Palinkas et al., 2015) of institutions. The sampling strategy was purposeful because all institutions were willing to participate and were interested in the research project. Moreover, complementary institutions were included in the sample (e.g., rural vs urban, large vs. small, new vs. old, and group-based vs. flexible grouping). Institutions that the researchers believed to be rich in information considering the child-environment interaction were selected based on the written descriptions about the physical environment provided by the ECEC owners. This selection implied that both institutions with a high degree of variability within the environments and institutions with scarce environments were selected. Table 2 presents basic information about the participating institutions.

Table 2 Participating institutions

Institution	N Children	Year built	Organisation	Location
A	109	2008	Group-based	Urban area in the north of Norway
B	117	2009	Flexible grouping	Rural area in the south of Norway
C	96	2016	Flexible grouping	Urban area in the south of Norway
D	79	2001	Group-based	Rural area in the middle of Norway
E	103	2005	Group-based	Rural area in the south of Norway
F	61	2014	Flexible grouping	Urban area in the south of Norway
G	80	2012	Flexible grouping	Urban area in the middle of Norway
H	56	1989	Group-based	Urban area in the middle of Norway

Institution A is located on a steep hill where the upper outdoor environment consists of a large forest area, sandboxes, and fixed playground equipment. The lower outdoor area is a small narrow asphalt place where children have access to tricycles. A sandbox is also available in the lower area. Gates separate the upper and lower outdoor environments, and children cannot freely move between the two outdoor environments. The four departments in the indoor environment consist of large rooms with tables and some smaller play zones. A spacious room for physical activity is located on the first floor, and all departments can use this room.

Institution B is a large building with two floors. The youngest children are located on the ground floor, whereas the three- to five-year-olds are on the first floor. The indoor environment on the second floor holds three rooms for the groups of children with tables for eating. Further, the indoor environment consists of a large common room and specialised rooms for designated activities such as math, arts, language, and drama. A specialised room for physical activities is located on the ground floor. The outdoor part consists of a large open area with asphalt and grass surfaces. The outdoor environment also includes several fixed installations, a sandbox, a fenced area for the younger children, and a hilly natural environment.

Institution C is part of a housing unit. The ECEC institution is located on the ground and first floors of an apartment building. The groups of older children are located on the first floor. The indoor environment consists of a mix of large common areas for all groups, specialised rooms, play zones, and designated rooms for the

different groups. Tables for eating are located in a large bistro that is common for all groups of children. The outdoor area is mostly flat and open and holds different fixed playground equipment and a sandbox. The surface is mostly asphalt and rubber. Some grass and natural surface exist close to the fences, and the sand area is relatively large.

Institution D was initially built to house a primary school. Although the indoor environment has been renovated to suit the needs of an ECEC institution better, the original purpose of the building does influence the arrangement of rooms. The indoor environment contains many smaller rooms and corridors. Each department has a large common room and smaller play zones for different activities. A room for physical activity with soft mats and gymnastics equipment has been integrated into the department. The outdoor area is huge (13,000 m^2) and consists of large open areas with both flat and hilly terrain, forest areas, fixed playground equipment, playhouses, and a sandbox. The surfaces in this outdoor area are mostly gravel, grass, forest floor, and asphalt. In addition to portable playground equipment, the outdoor area possesses a wide range of natural materials.

Institution E is a two-floor building with five departments. Each of the departments has an indoor area with a common room with tables for eating, smaller rooms, and different play zones. A specialised room for physical activity is located on the first floor and is available for all departments. Although the outdoor area goes around all sides of the building, most of the outdoor area is located in the front of the building. Here, there is a network of asphalt circular pathways. Further, different kinds of fixed playground equipment, playhouses, and sandboxes are available in the outdoor environment.

Institution F, like institution C, is integrated into a housing unit. The ECEC institution is located on the ground floor, and the outdoor area is surrounded by four large apartment buildings; it is therefore an enclosed environment. The outdoor environment is placed above the parking facilities for the apartments and consists of asphalt, rubber surfaces, and artificial grass. In addition to an artificial hill, the outdoor area is completely flat. Fixed playground equipment, a sandbox, and playhouses are available in the outdoor environment. The indoor area consists of areas designated to the

departments, smaller rooms for specialised activities (math, arts, language and drama) and a large common room for physical activity.

Institution G is organised with one wing for the younger children and one wing for the older children. The older children are divided into three groups, but they share the same indoor environment, consisting of three large playrooms with different themes, two smaller rooms, and a large common room for eating and wardrobes. Furthermore, a spacious common room and a semi-tempered room are shared with the groups of smaller children. The outdoor area consists of pathways, a wide range of fixed playground equipment, a playhouse, sandboxes, equipment for water play, a self-made labyrinth, and a small natural environment with trees.

Institution H is organised into four smaller departments, where two departments include the older children. Both departments consist of a larger room with tables and different play zones in addition to smaller playrooms. The two departments share a large room for arts. The outdoor area goes around all sides of the building and consists of trees, playhouses, fixed playground equipment, pathways, sandbox, outdoor kitchen, and a grassy hill. The surface is mostly gravel and grass, and the outdoor area is relatively open.

3.3.2 Children

In each of the eight institutions, five boys and five girls were randomly selected from the three- and four-year-olds (at T1), with written consent for participation from their guardians. This age group was selected following methodological considerations. The five-year-olds would have started school at T2, and the youngest children (one- and two-year-olds) were not included to be able to interview the participating children. Interview data are not included in this study but are used in the overarching project. For ethical and methodological reasons, children with special needs were not included in the pool of children available for selection.

In institution H, only four girls were available for participation, so an extra boy was included in this institution. The participating children at T1 included 41 boys and 39 girls with a mean age of 3.8 years (SD=0.6). At T2, two girls and four boys no longer attended the institution. Additionally, one boy was excluded from the data

collection for ethical reasons. The seven children who were missing in the second data collection had a mean age of 4.1 years (SD=0.3) at T1. Three institutions had two children drop out, and one institution had one child drop out. In four of the institutions, all the participating children at T1 were also available at T2. The participating children at T2 included 36 boys and 37 girls, with a mean age of 4.7 years (SD=0.5).

3.3.3 Video observations

A complete sample of 24 video observations of 80 children would consist of 1920 video observations of two minutes or 64 hours of video recordings. The final sample in this study includes only 1808 observations, which represents 94% of the potential full sample. Of the 112 missing video observations, most are missing because of the dropout of children at the second data collection (N=84). Of the remaining missing video observations (N=28), ten occurred in the first data collection and 18 in the second data collection. The missing observations are related to human or technical error (N=4), children being picked up before all observations were conducted (N=3), or because of children being sick (N=5). The rest of the missing observations were excluded because the child was affected by the filming (N=7) or being hidden or far away from the camera (N=8). Finally, one observation was excluded because the child was hurt during the observation and the co-researcher intervened to comfort the child. The overall amount of missing observations is limited to 6% and is not considered a methodological challenge to the study. Table 3 presents descriptive statistics for the final sample of video observations across the two data collections and environments.

Table 3 Descriptive statistics for the sample

	Full sample	Indoor observations		Outdoor observations	
		T1	T2	T1	T2
N children	80	80	73	80	73
N boys	41	41	36	41	36
N observations	1808	479	429	471	429
Duration in seconds, mean (SD)	122 (5.5)	121 (7.4)	122 (4.3)	122 (5.6)	122 (3.4)
Age in years, mean (SD)	4.2 (0.7)	3.8 (0.6)	4.7 (0.6)	3.8 (0.6)	4.7 (0.6)

3.3.4 Generalisability

As described in the section on educational design research, statistical generalisation is not an aim in the present study. The small number of participating institutions and the purposeful sampling strategy (Palinkas et al., 2015) imply that the sample of institutions is not representative of the population of ECEC institutions in Norway. Despite the random selection of children, the degree to which the included children are representative of the population is not known. This uncertainty follows the selection strategy of institutions, the relatively low number of participating children, the random selection from children with consent to participate, and the lack of information about child characteristics other than age and sex (e.g., socioeconomic background, parents' educational level, and nationality). Thus, conclusions about the state of well-being or physical activity in Norwegian ECEC institutions cannot be drawn based on the findings in the present study. Instead, the sampling strategy is related to sampling for qualitative research, where an improved understanding of complex issues in a naturalistic context is emphasised (Marshall, 1996).

Drawing on analytical generalisation (Yin, 2013), findings on how the children in the present sample interact with the physical environment are transferable to other contexts. Heft (1988) argues that although the child-environment interaction is unique to the individual, children of a similar age and competence will perceive many of the same affordances in an environment. Following the methodological approach in the present study and the theoretical perspectives on how children perceive and utilise the environment provided by the theory of affordances, the present sample is therefore relevant for other ECEC environments, including those outside a Norwegian context. However, the significance of cultural context and the relational nature of the child-environment relationship must be considered when making inferences based on the present study.

3.4 Measures

The key measures in this study are well-being and physical activity and the characteristics of the physical environment. Additional measures of children's play and the social context are also included in this study.

3.4.1 Well-being

Children's well-being in the video observations is measured using the Leuven scale for emotional well-being (Laevers, 2005). These indicators (Appendix D) was initially developed as a self-assessment tool for improving the quality of ECEC institutions in Belgium (Laevers, 2005) and has in recent years also been used to measure children's well-being in research (Barnes, 2013; Bjørgen, 2015; Declercq et al., 2011; Klemm & Neuhaus, 2017; Laevers & Declercq, 2018). The scale is designed for observing children individually for two minutes and scores children's level of well-being on a scale from one to five (Laevers, 2005). Laevers and Declercq (2018) describe each of the five levels as follows:

1. Outspoken signs of distress
2. Signs of distress predominate
3. A mixed picture, no outspoken signs
4. Signs of enjoyment predominate
5. Outspoken signs of enjoyment

The measurement of well-being in the present study therefore aims to evaluate children's emotional well-being in each of the specific video observations and is placed within a hedonic research tradition (Kahneman et al., 1999). This approach follows the notion that children's "subjective" signals of discomfort and satisfaction in the moment are measured. With reference to the five structural theoretical axes of children's well-being identified by Amerijckx and Humblet (2014), the operationalisation of children's well-being in the present study is linked to both positive and negative manifestations of well-being, as signs of both distress and enjoyment are included in the measure. The measurement of well-being is also subjective, state- and individual-oriented because an interpretation of the specific child's subjective signals in the moment is the basis for the measurement. Material aspects are not emphasised; instead, the emphasis is on the subjective experience of well-being.

To heighten the quality of the measurement, the three researchers involved in the coding of well-being learned the scale together through the manual (Laevers, 2005) and training videos developed by the Leuven team. The English manual was used directly

without translation, as the researchers involved in the coding all use English as their academic language. Workshops to adjust, recalibrate and identify challenges were conducted when each of the three researchers had scored 24 observations. These clips were reviewed jointly and discussed to heighten the internal consistency in the coding. This procedure served as a form of piloting the measurement. These video observations remained in the sample but with adjusted scores following the discussions in the workshops. This procedure strengthened the belief in a reliable measure of children's well-being with satisfying internal consistency.

Two independent researchers scored the well-being of the children in each of the video observations. Disagreements of more than one point were reviewed and discussed until a mutual understanding was reached. Following this discussion, errors and misinterpretations were corrected. For differences of one point in well-being score, an average of the two scores was used. This choice implies that the score of well-being in the analysis is a nine-point scale, still ranging from one to five but also with intervening half scores (1.5, 2.5, 3.5, 4.5). In other words, measurement is treated as an interval scale, where the distance between scores is considered equal. To what degree it is reasonable to treat five-point scales as interval scales has been a subject of debate concerning the Likert scale (Boone & Boone, 2012), and a simulation study indicates that using more points will result in a closer approach to the underlying distribution (Wu & Leung, 2017). Thus, expanding the well-being scale to include half points may be beneficial from a statistical perspective, but the assumption that children in observations with a well-being score of four have twice as much well-being as children in observations with a score of two can be questioned. The methodological and statistical benefits of treating the scale as an interval scale were considered to outweigh this conceptual problem.

Inter-rater analyses were conducted to evaluate the reliability of the measurement of well-being. Given the numeric scale, with five possible outcomes in the initial scoring, weighted kappa (Cohen, 1968) was used. Ratings were weighted by 1.0 – 0.75 – 0.5 – 0.25 and 0.0. Weighted kappa differentiates between the size of the disagreements, something traditional kappa calculations do not (Viera & Garrett, 2005). For the complete sample of 1808 video observations, inter-rater agreement was 90% for

well-being with a kappa value of 0.45. These calculations are based on the scores of well-being after the second review of observations with disagreements of more than one point (N=29). Weighted kappa scores for the initial coding, before the adjustment, were 89% agreement, with a kappa value of 0.42. Kappa values in the range of the present study indicate moderate agreement (Viera & Garrett, 2005).

The use of a well-established measure for well-being, workshops, training videos and two independent researchers doing the coding has contributed to a trustworthy measure of children's well-being. The measurement of well-being was used as a key variable in all four papers in this thesis.

3.4.2 Physical activity

Observation was selected to measure physical activity in the present study since the primary source of data was video observations. Observational methods for measuring physical activity are found to be valid measures of children's physical activity (Loprinzi & Cardinal, 2011), and the Observational System for Recording Physical Activity in Children-Preschool (OSRAC-P) (Brown et al., 2006) was selected as the observational method in the present study (Appendix E). The physical activity level indicator in OSRAC-P was used to measure the children's level of physical activity. The classification of physical intensity in OSRAC-P is based on the Children's Activity Rating Scale (CARS) (Puhl, Greaves, Hoyt, & Baranowski, 1990), which has been psychometrically tested and found to demonstrate evidence of reliability (Loprinzi & Cardinal, 2011; Pate, O'neill, & Mitchell, 2010; Puhl et al., 1990).

The OSRAC-P uses a five-point scale to classify the intensity of the activity (Brown et al., 2006):

1. Stationary/motionless
2. Stationary with limb or trunk movements
3. Slow easy movements
4. Moderate movements
5. Fast movements

A score of one indicates that the child is motionless (e.g., sleeping or sitting passively in a stroller). A score of two implies no translocation, and such activities often include activities such as drawing, standing up, and being seated at a bike without pedalling. When a score of three is assigned, there is translocation, but at a slow and easy pace (e.g., easy walking and cycling, swinging without leg kicks). A score of four indicates translocation at a moderate pace and includes activities such as brisk walking or cycling, walking up a hill, tumbling, or swinging with legs kicking. Five indicates fast movement such as running, fast cycling, jumping and climbing.

The OSRAC-P tool was developed to be used during direct observations in naturalistic environments using five seconds of observational intervals every thirty seconds (Brown et al., 2006). The protocol used in the present study deviates from this formula, as two-minute video observations are used. The use of video allowed the coders to watch the observation several times to enhance accuracy. A combined score for the entire two minutes of observation was set to provide an overall measure of the physical activity in each of the observations, which serve as the unit of analysis in this study. Although two minutes is a relatively short period, children's physical activity intensity may vary significantly during two minutes, and discussions concerning how to score observations with varying intensity were held among the group of researchers doing the coding.

The scoring of physical activity followed an approach similar to that used for the measurement of well-being. The same three researchers that conducted the scorings of well-being assessed children's level of physical activity, and all researchers doing the coding have been educated in sport science and have previous research experience observing children's physical activity. Workshops to learn the OSRAC-P manual, meetings to calibrate the measurement after 24 observations, and two researchers independently coding each observation were similarly applied to the method for measuring well-being. Similarly, for physical activity, the English manual was used directly without translation. An average of the two scores was used when there was a one-point discrepancy between the two measurements, and discrepancies of more than one point were reviewed and discussed, implying that this scale is expanded to a nine-point scale with half points in the analysis and treated as an interval scale.

Weighted kappa calculations (Cohen, 1968) for the full sample (N=1808 observations) indicate an inter-rater agreement of 93% with a kappa value of 0.70. These numbers are based on the scores after reviewing ratings with two or more scores of disagreement (N=16). Kappa values of the initial coding, before this adjustment, are in 92% agreement, with a kappa value of 0.68. Agreements in this range indicate substantial agreement (Viera & Garrett, 2005) and signal good consistency in the measurement and reliable measurement of children's physical activity. The measurement of physical activity was used as a key variable in all four papers in this thesis.

3.4.3 Physical environment

This study aims to develop an understanding of the influence of the physical environment in ECEC institutions on children's well-being and physical activity. To measure the physical environment, two of the affordance categories suggested by Gibson (2014) – places and objects/materials – are used as overarching categories. Subcategories within places and materials were developed based on the theoretical framework, previous place and material classifying studies, adjusted to the Norwegian ECEC context and in dialogue with the data.

The measurements of places and materials were coded second-for-second using Noldus Observer XT 12.5 behavioural coding, analysis and management software for observational data (Zimmerman, Bolhuis, Willemsen, Meyer, & Noldus, 2009). To heighten the consistency in the coding of the physical environment across children, institutions and data collection, one researcher conducted the coding of places and materials for the entire sample. To ensure consistent coding and interpretation of the categories, a second researcher reviewed 10% of the video observations. Since this measure was coded second-for-second, inter-rater calculations were not conducted. Instead, the second researcher reviewed the coding critically. Only minor revisions to the initial coding were conducted following this process, and the overall consistency was satisfying.

Places were coded continuously using mutually exclusive categories for different locations in the indoor and outdoor environment. To be applicable in all eight

institutions, with their varying environments, the categories for places had to be broad. The place categories jointly had to encompass all the different places the children could be during observational periods. To develop the place categories in the outdoor environment, the categories used by Dyment and O'Connell (2013) to describe target areas were essential. Their categories for paths, paved expanse, sand, manufactured functional, and natural elements are represented in the present study as pathways, open areas, sandbox, fixed equipment for functional play and nature. The target area labelled manufactured constructive in Dyment and O'Connell (2013) was adapted into two categories describing fixed equipment for role play and other fixed equipment. Additionally, there was a category to describe indoor places included in the present study:

- Sandbox: all kinds of different areas containing sand – small and large, open and enclosed
- Pathways: defined narrow passages in the environment
- Nature: natural environments inside the fence of the institution, ranging from smaller groups of trees to larger forest areas with forest floor as surface
- Open area: large open areas and places between equipment. This definition includes both hilly and flat terrain, although large, open flat areas with a hard surface are most common
- Fixed equipment for functional play: functional playground equipment such as swings, climbing towers, slides, carousels, seesaws, etc.
- Fixed equipment for role play: structures for role play, such as playhouses, boats, huts, stores, outdoor kitchens, gas stations, etc.
- Other fixed equipment: fixed structures not specifically designed for play purposes, such as tables, storages, shelters, etc.
- Indoor environments: semi-tempered rooms, enclosed huts, cubbies, etc.

In Paper I and Paper IV, where the outdoor environment is studied, categories for nature, pathways, open area and fixed functional equipment were included. In Paper IV, the category for sandbox and a combined variable for the other places (fixed

equipment for role play + other fixed equipment + indoor environments) are additionally included.

To measure places in the indoor environment, the categorisation of different learning centres in the indoor environment of an ECEC classroom by Acer et al. (2016) served as a starting point. Their categories for gathering/play table, open space in the middle of classroom and different learning centres were adapted in the present study as categories for low/high tables, open floor space and play zones. Following the emphasis on physical activity in the present study, categories for room for physical activity and tumbling space were added. In dialogue with the data, variables for cubbies, windows and bathrooms were also included:

- Open floor space: spaces between other zones and furniture, places not specifically coded for any activity or purpose
- Low tables: child-height tables
- High tables: adult-height tables
- Cubbies: storage places for children's outdoor gear, rain clothes, boots, etc.
- Room for physical activity: spacious rooms designed specifically for physical activity outside the department
- Tumbling space: areas with soft surfaces, large construction materials, pillows and blankets for physical play integrated into the department
- Play zone: an area purposefully designed to afford play, offering materials such as building blocks, outfits, kitchen equipment, play animals, etc.
- Subspace: fixed smaller spaces such as cubes and dens
- Window: window posts
- Bathroom: changing rooms and toilets

All the indoor place categories were used in Paper II. The categories for window, bathroom and subspace together constituted a category for "other places" in Paper II and were not included in the statistical models. In Paper III, the place category for tumbling space was the only category used.

The materials the child was interacting with were also coded. Interaction implied that the child was holding, carrying, collecting, kicking, jumping off or into, sitting on,

or in other ways using the material. While the place categories were mutually exclusive, the categories for materials were not since children commonly utilise several materials simultaneously. To measure children's interactions with materials in the outdoor environment, the outdoor features suggested by Lerstrup and van den Bosch (2017) were a valuable inspiration. Their class of mouldable materials was adapted to sand and mud in the present study, whereas the class for water was used directly. The class of detached or loose objects (Lerstrup & van den Bosch, 2017) was divided into natural materials, toys, open-ended materials and wheeled toys. This decision was based on the data in the present study and the theoretical framework of the study suggesting that several of these categories are associated with children's well-being or physical activity. The categories that were used to measure children's use of materials in the outdoor environment included the following:

- Sand: commonly available in and around the sandbox
- Water: rain and lack of drainage lead to water puddles and flowing water
- Mud: moist natural material available in natural areas or by mixing water and sand
- Natural materials: natural materials other than sand, water and mud, such as sticks, flowers, logs, leaves, branches, grass, animals, cones, stones, snow, etc.
- Toys: defined toys such as cars, buckets and spades
- Open-ended materials: non-natural materials such as plastic pipes, wooden planks, plastic boxes, and other new or recycled materials initially designed for other purposes
- Wheeled toys: tricycles, bicycles and other wheeled toys that children could ride

In Paper 1, the variable for wheeled toys was used together with a combined variable for loose parts (toys + open-ended materials + natural materials). In Paper IV, all categories were used. Children's use of materials in the indoor environment was also measured. However, these variables were not included in any of the papers and are therefore not presented in this thesis.

The detailed second-for-second coding of places and materials in each of the video observations resulted in numeric information about the number of seconds the child had spent at different places in the environment and the number of seconds the child had interacted with materials during the observation. This information provided opportunities to use statistical approaches to investigate the association between use of different characteristics of the physical environment and children's well-being and physical activity.

3.4.4 Play

Following the theoretical framework of the study is play, an important concept when considering the child-environment relationship and child outcomes in early childhood. The five categories of play types used by Dyment and O'Connell (2013) were utilised to measure children's play. In addition, as suggested by Luchs and Fikus (2013), a category for mixed play was added:

- Functional play: play where children use their own body in physical play, such as running, riding bikes, sliding, tumbling, play fighting, climbing
- Constructive play: play with objects and materials, such as drawing, building sandcastles, creating huts and shelters, etc.
- Symbolic play: different types of creative and imaginative play, role play, dramatic play and social play
- Mixed play: combinations of different types of play where two or more of the above play types overlap, without one being dominant
- Looking on: no interaction with others or engagement in play, sitting, relaxing, walking around looking for something to do, empty staring, watching activities, etc.
- Talking: talking to other children or adults about something not related to play

The categories were mutually exclusive and were coded second-for-second using Noldus Observer XT (Zimmerman et al., 2009). In incidents where the selected play types overlapped, the dominating play type, as interpreted by the researcher, was coded. The mixed play category was used when a dominating play type could not be

determined. The categorisation of play resulted in numeric descriptions of the amount of the different play types in each observation.

One researcher coded play for the entire sample, and a second researcher ensured consistent coding by reviewing a random sample of 10% of the video observations. Like the second-for-second measurement of the physical environment, inter-rater calculations for play categories were not conducted. A second researcher reviewed the coding critically. This procedure resulted in discussions about how specific observations should be interpreted, the delineation between looking on and talking, if all translocation is functional play and when to use the mixed play category. These discussions resulted in a unified understanding of the content of each of the categories and minor revisions to the initial coding. Moreover, they revealed how measuring children's play is challenging and dependent on the researchers' interpretation. This lack of accuracy must be considered when interpreting the results related to playing. Nevertheless, including such a key metric as play in the analysis is a strength of the study and provides a more accurate description of the observations.

In Paper I and Paper II, a combined measure of the amount of play (functional play + constructive play + symbolic play + mixed play) was used. In Paper III, the category for functional play is used. In Paper IV, the categories for functional play, constructive play, symbolic play and mixed play are included.

3.4.5 Social context

Another important contextual element in this study is the social context, which may influence how the physical environment is associated with children´s well-being and physical activity. To measure the social context of the observations, these group-composition categories in OSRAC-P (Brown et al., 2006) were used (Appendix E):

- Solitary: children being alone
- 1-1 Adult: children interacting with one adult
- 1-1 Peer: children interacting with one peer
- Group-Adult: group of children with one or more adults being involved
- Group: group of children without any adults being involved

The same researcher who was coding children´s play analysed the social characteristics of the observations. Thus, the social context was also coded by one researcher for the entire sample. As for the other measures coded in Noldus Observer XT, a random sample of 10% of the video observations were reviewed by a second researcher to ensure consistent coding; thus, there was no inter-rater reliability calculated.

The evaluation of the measurement resulted in discussions on how the data collection procedures influenced how the categories should be used and on what consequences the methodological procedure carries for the interpretation of these categories. Since a co-researcher was filming, an adult was, in fact, always present. However, the co-researcher kept their distance and did not intervene or participate in the children´s activities. In addition, children were also supervised by staff in the institutions outside the observational period; thus, the children are in this sense never completely alone. The categories should therefore not be interpreted in absolute terms and instead reflect the degree of engagement with other people by the child being observed. The category for being solitary was used when children were sitting by themselves and were not socially engaged with others. If a staff person was talking to the child or engaged in the child´s play, 1-1 Adult or Group Adult was coded, depending on the presence of other children. 1-1 Peer reflects two children playing or talking together, whereas Group implies that more than two children were engaged in an activity, conversation or play without staff being involved.

The main emphasis in the present study was the physical environment. Because of this emphasis and because the procedures for data collection were not ideal for measuring the social characteristics of the observations, less nuanced categories of the social context were used in the analysis. Measures of the social context are included in Paper I, Paper II and Paper IV, and the included variables describe being with other children (1-1 Peer + Group-Adult + Group) and the presence of adults (1-1 Adult + Group-Adult). The measures of the social context are merely contextual variables. The findings related to the contextual variables in the present study should be interpreted with caution, following the methodological challenges of this measure.

3.5 Analysis

In this section, the analytical approaches applied in the four papers are presented. The video observations are the unit of analysis, and the data structure carries consequences for the analytical techniques being applied. The data structure in the present study is hierarchical, with observations (N=1808), nested in children (N=80), and children nested in ECEC institutions (N=8). Thus, the assumption of independence of units is breached, and multilevel techniques are applied in the four papers. All statistical analyses were conducted using the statistical software Stata MP 15.1 (StataCorp, College Station, TX, USA). Table 4 presents an overview of the analytical approaches, sample and environment of analysis.

Table 4 Analytical approaches and samples

	Data collection	Environment	N Institutions	N Observations	Analytical approach
Paper I	T1	Outdoor	8	471	Multilevel linear regression
Paper II	T1	Indoor	8	479	Multilevel linear regression
Paper III	T1+T2	Indoor	7	770	Multilevel linear regression including intervention analysis
Paper IV	T1+T2	Outdoor	8	858	Generalised linear multilevel model + qualitative analysis

3.5.1 Papers I and II

The analytical approaches are identical in Papers I and II and are therefore presented jointly. Multilevel regression analysis (Goldstein, 1986) – specifically random intercept models (Mehmetoglu & Jakobsen, 2017) – was used to investigate the association between measures of the physical environment and the two outcome variables, children's well-being and physical activity. Models for well-being and physical activity were fitted separately in both papers. Two-level models, with levels for the observations (Level 1) and children (Level 2), were used given the aim of the study, sample size at each level and calculations of the variance partition coefficient (VPC) (Mehmetoglu &

Jakobsen, 2017). Play was included in the models as a combined measure describing whether children were engaged in either functional, constructive, symbolic or mixed play. Play was included to control for whether children were actively involved in play in the observation. Similarly, variables describing whether children were with adults or other children were included in the model. In addition, variables for children's age and sex were included. The inclusion of variables in the model was based on the theoretical framework of the study, and a stepwise inclusion of variables starting at the lowest level in the model (Hox, 2010) was used, implying that variables describing observational characteristics were included before child characteristics.

3.5.2 Paper III

The analysis in Paper III approaches causal questions with the use of an experimental design with intervention and control groups and the analysis of change in outcome variables from the first to the second data collection. In this paper, the statistical analysis is conducted within a multilevel framework (Goldstein, 1986) utilising random intercept models (Mehmetoglu & Jakobsen, 2017). Two-level models selected following the same rationale were also in this paper, as in the previous papers. The physical environment in focus in this paper was the tumbling space. Functional play was used as an outcome variable, resembling a shift where the aim was to investigate the influence of environmental characteristics on children's play behaviours. Thus, three outcome variables were investigated in this paper; well-being, physical activity and functional play, and regression models were fitted separately for each of these variables.

Before approaching the analysis of the intervention effect, analysis of the association between the outcome variables and children's use and access to tumbling space was conducted. An intercept-only model was first conducted, followed by a model including a variable describing the use of the tumbling space. Next, a variable describing whether the child had access to a tumbling space was added to investigate whether having access to a tumbling space influenced children's physical activity or well-being when the child was not using the tumbling space. Finally, second-level variables describing the child's age and sex were included. Models with an interaction term for tumbling use/tumbling access and sex were conducted to investigate whether

there was any difference between boys and girls in how the tumbling space was associated with the outcome variables. The analysis of the intervention effect was carried out by running an intercept-only model first, followed by a model including age, sex and a variable for the intervention group. Next, a variable for T2 was added to explore change from the first to second data collection. Finally, an interaction term for the intervention group and T2 was included in the model to determine whether the change in outcome variables was different for the two groups.

3.5.3 Paper IV

Whereas the first three papers explore the research questions by using quantitative techniques, both qualitative and quantitative analytical approaches were used in Paper IV. This paper is focussed on the importance of experiencing physical activity positively and how high levels of both well-being and physical activity are beneficial from a health promotion standpoint. Further, the paper aims to develop knowledge on how the physical environment may influence such experiences.

Based on the scorings of well-being and physical activity, a dichotomous variable was generated to identify observations having a score of four or higher on both well-being and physical activity. The quantitative analysis uses this dichotomous variable as a dependent variable in the analysis. Since the outcome variable was dichotomous, generalised linear latent and mixed models (GLLAMM) (Rabe-Hesketh & Skrondal, 2008) were used to investigate the associations between the observations with high well-being and physical activity and age, sex, play, social context, places and materials. In this paper, each of the different play categories is analysed to investigate the association between high levels of well-being and physical activity and the different play types. Play was not added to the models investigating the association between the physical environment and well-being and physical activity, as was done in Paper I and II.

The qualitative analysis was conducted on the observations that were identified as having high levels of both well-being and physical activity. Gibson's (2014) types of affordances (places, materials/objects, and persons/animals) were used as a starting point in the analysis. Written descriptions of how these three categories of affordances

were utilised in the observations, and a general description of the observation, were first conducted. Next, these written descriptions were analysed to identify general trends in how each of the three groups of affordances was actualised by children in the observation. This analysis can be described as a deductive (Elo & Kyngäs, 2008) or directed (Hsieh & Shannon, 2005) content analysis, following the predetermined categories based on the theory of affordance. Finally, a second researcher investigated the analysis and provided comments and adjustments to the initial interpretation. To capture the essential characteristics of how the three categories of affordances were actualised, quotes from the transcribed observations were included in the presentation of results from the qualitative analysis.

3.6 Ethical considerations

Ethical issues have been previously mentioned in the description of the procedure and the sample. In this section, a more ample presentation of crucial ethical considerations in the present study is provided. Formally, this study has been approved by the Norwegian Centre for Research Data (NSD) (Appendix C). Such formalities are related to the procedural ethics dimension (Guillemin & Gillam, 2004); critical issues in the NSD approval are informational letters, consent to participate, confidentiality and data handling. A more overall perspective than this initial formal approval are the ethical issues that arise in conducting research, which can be described as ethics in practice (Guillemin & Gillam, 2004). The Norwegian National Research Ethics Committees (2020) highlight key principles such as respect, good consequences, fairness and integrity in their general guidelines for research ethics. These principles guided the present study and encompass the goals that research participants shall be treated with respect, researchers shall seek to ensure the good consequences of their activities, projects shall be designed and implemented fairly, and one shall comply with recognised norms and behave responsibly and honestly (The Norwegian National Research Ethics Committees, 2020).

To ensure confidentially, all data in this study were treated following the ethical guidelines of the NSD. Video observations were stored on password-protected hard drives, were available only to the research group and were deleted when the project

ended. The datasets and notes were anonymised using codes and were not traceable to individual children. In Papers I–III, statistics were presented that cannot be tied to individual children. In Paper IV, transcripts from the video observations were presented using fictive names for the children, and no information disclosing the institution in which the observation was being conducted was presented. Thus, the confidentiality of the participants was ensured.

Although ethics is an essential issue in all research, research where children participate should be the subject of special ethical considerations. For a young child to fully understand the abstract ideas and consequences of participation in research is challenging, and power relations between adults and children are important to consider (Hill, 2005). Therefore, child-friendly approaches to provide information about the study and being conscious of information about the voluntary nature of participation are vital. However, such special ethical considerations should not result in degrading children to being less competent actors whose perspectives are less important to include in the research. Prout and James (2015) highlight how children are worthy of being studied in their own right and how children should be active participants in constructing their own social lives and the society where they live. Children's right to participate in research (and to withdraw) as competent informants is linked to children's rights as human rights (Danby & Farrell, 2004). Thus, including children in research that concerns their lives is essential from an ethical perspective, but special attention to ethical issues must be given.

The principle of informed consent is a standard feature in social research and requires that subjects be informed about the nature and implications of the research and that participation is voluntary (Homan, 2001). The guardians of the children were informed about the study by the staff orally and in writing by the project manager (Appendix A). Thus, participants were reached through gatekeepers, which raises ethical concerns, as researchers may exploit their existing relationship to recruit participants to the study (Flewitt, 2005). To reduce the likelihood of such negative consequences, guardians were assured that there would be no negative consequences if their children did not participate. Both the staff in the institutions and the project manager were available to the guardians to answer questions about the study.

Following the information about the study, written consent to participate was collected from the guardians before the first data collection. Since the data collection involved video observation in the everyday environment of the ECEC institution, the video recordings were not limited to the participating children. Therefore, written voluntary consent to participate was also collected from the guardians of children not serving as observational children. The form for written consent included options for consent/dissent to participate, and parents could allow their child to be filmed if they were playing with children who were participating in the study, although their child was not included in the study.

Staff in the institution was also influenced by the data collection, as they were interacting with the participating children. The staff was informed about the study by the manager of the institution and in writing by the project manager (Appendix B). Written consent to participate forms were collected from staff in the institutions. Different measures were taken to avoid filming persons not having given consent to participate. In some institutions, there were persons without consent to being filmed in other environments during the observational period. In other institutions, the co-researcher stopped filming if a person who should not be filmed was in the proximity of the observational child. In a few incidents, observations were postponed following such considerations. Although these measures placed an extra burden on the staff, the overall impression from the data collection was that the procedures were manageable and did not interfere improperly.

The researcher and co-researcher talked to the children about the project to provide children with information about the present study and data collection. These conversations were conducted both with groups of children and individually. The co-researchers, as trained preschool teachers who knew the children well, were especially valuable in communicating the purpose and procedures of the study in a child-friendly way. Children were told that we were interested in how they utilised the physical environment for play and that we were going to film them while they were playing, if this was OK. This information being passed to the children was articulated within the broad framework of the study, and the consent to participate can be described as provisional rather than informed (Flewitt, 2005). In addition to the information at the

beginning of the data collection, the co-researchers kept up an ongoing dialogue with the children about the filming and were conscious to refrain if the child showed signs of not wanting to be filmed to ensure ongoing consent to participate. However, the co-researchers did not announce when each video recording started to limit the impact of the video recordings on the children's behaviour.

The presence of the researcher is also significant to consider from an ethical perspective. The role of the researcher was to write field notes and ensure that the protocol for video observations was followed. A participant-as-observer role (Gold, 1957) was selected. If children or staff showed signs of discomfort following the presence of the researcher, the researcher changed positions in the environment. Informal talks about the project and everyday activities were conducted outside observational periods to reduce any discomfort in staff following the presence of a researcher. It was also emphasised in the written information about the study and in the informal conversations that it was the physical environment that was the focus of the study.

Everyday life in ECEC institutions is many sided. Children are experiencing both positive and negative things during their stay in the institutions, and to what degree one shall intervene as a researcher when children experience distress is an ethical dilemma. The researcher had a relatively detached observational role during the data collection to reduce the impact of the data collection. Nevertheless, the researcher did intervene if children were in distress and staff were not available. Such considerations can be linked to the ethical principle of beneficence, which addresses the obligation of the researcher to act in ways that benefit others (Guillemin & Gillam, 2004). In some incidents, concern about specific children was expressed to the staff if the researcher felt that a child was not integrated into the group or needed help in some way. Such measures, clearly outside the intended role of the researcher, were taken to help children and to produce good consequences.

The overall research aim for this study is to develop knowledge that can result in physical environments in ECEC institutions that benefit children's well-being and physical activity. Another critical ethical perspective is to therefore ensure that the findings from the present study are disseminated in proper channels so that the

knowledge flows back to the practice field. A high priority has therefore been to present findings in the participating institutions, to the owners of the institutions, at national and international conferences, in research papers, and popular science publications. The emphasis has been placed on communicating the findings respectfully and fairly, with high quality, openness and integrity.

4. Results

In this chapter, the main findings from the four papers are presented. A description of how the findings contribute to the existing literature in the field is provided. Papers I and IV address the outdoor environment, while Papers II and III focus on the indoor environment. Papers I and II utilise video observations from the first data collection, while Papers III and IV use video observations from both data collections.

4.1 Paper I

Paper I aimed to investigate how different characteristics of the ECEC institution's outdoor environment influenced children's well-being and physical activity. Multilevel regression analysis was used to analyse the association between children's well-being and physical activity and the variables describing places and materials in the outdoor environment. The sample consisted of 471 video observations of 80 children from the first data collection. The findings imply that the outdoor physical environment in ECEC institutions has a more significant influence on children's physical activity than on their well-being. Further, playing in the outdoor environment was positively associated with both well-being and physical activity. On the social characteristics of the observations, being with other children were found to be positively related to well-being, and adult presence was found to be negatively related to physical activity.

The results for well-being indicated that being in nature and open areas were positively associated with well-being and that using wheeled toys was negatively associated with well-being. Being on pathways or at fixed playground equipment for functional play were not significantly associated with well-being, and neither was the use of loose parts. Physical activity was positively associated with using pathways and open areas, while fixed playground equipment for functional play was negatively

associated with physical activity. Using loose parts and wheeled toys were negatively associated with physical activity. These findings have strengthened the evidence for the benefits of open areas and pathways for children's physical activity and the benefits of natural environments for children's well-being. New perspectives are added to the field related to the role of wheeled toys, loose parts and fixed playground equipment for health-related outcomes in ECEC.

4.2 Paper II

In Paper II, the aim was to explore the influence of characteristics of the ECEC institutions' indoor environment on children's well-being and physical activity. The sample was 479 observations of 80 children in the indoor environment from the first data collection. Multilevel analysis was used to investigate the association between where children were in the indoor environment and well-being and physical activity. As in Paper I, physical activity was more strongly associated with different places in the environment than was true for well-being. Playing was positively associated with well-being, while physical activity was not related to playing in the indoor environment. The presence of adults was negatively associated with physical activity.

Well-being was positively associated with rooms for physical activity, while high tables were negatively associated with well-being. Both associations were, however, relatively weak. The other places categories, open floor spaces, low tables, cubbies, tumbling spaces and play zones were not associated with well-being. Physical activity was positively associated with rooms for physical activity and tumbling zones. Moreover, cubbies and open floor space were positively related to physical activity, although these associations were not as strong concerning the categories describing rooms for physical activity and tumbling spaces. Tables, both low and high, were negatively associated with physical activity. No previous studies have investigated the association between different places in the indoor environment of ECEC institutions and children's well-being, and the results are thus a new contribution to the field. The findings related to physical activity in this study have contributed to a deeper understanding of how different places in the indoor environment of ECEC are

associated with children's physical activity levels, many of which have not been previously examined.

4.3 Paper III

Paper III aimed to explore how the introduction of a tumbling space in the indoor environment of ECEC institutions influenced children's functional play, physical activity and well-being. The sample consisted of 770 video observations of 65 children from both data collections. The video observations from the first data collection served as a baseline measurement, and the second data collection was used as a post-test to evaluate the effect of the intervention on the three variables of interest. Five of the participating institutions established a tumbling space in the intervention, and children were designated to intervention or control group based on their change in access to tumbling space from the first to second data collection.

Multilevel regression analysis demonstrated that using the tumbling space was positively related to functional play and physical activity. As in Paper II, no association between using the tumbling space and children's well-being was found. Having access to a tumbling space was positively associated with children's well-being, but the association was weak. The between-group analysis found that the control group and the intervention group had a similar increase in well-being and physical activity from the first to second data collection. The amount of functional play increased more in the intervention group following the intervention, indicating that the children utilised the possibilities afforded by the tumbling space for functional play. The similar increase in well-being and physical activity for the two groups does not support the hypothesis that establishing a tumbling space may increase children's well-being and physical activity, which was the basis for the intervention. The results indicate that establishing a tumbling space in the indoor environment may be beneficial from a health promotion standpoint, but to what the degree the social context also must be targeted to reap the benefits of the changes in the physical environment remains unknown.

Paper III represents a new contribution to the field in several ways. Although environmental interventions previously have been found to influence children's play behaviours, the focus on environments for functional play is a new perspective.

Similarly, studies have not previously evaluated the impact of an indoor physical environmental intervention on children's well-being or physical activity. Thus, the findings represent new perspectives on the child-environment interaction related to functional play, well-being and physical activity in the indoor environment of ECEC institutions.

4.4 Paper IV

Paper IV aimed to develop knowledge about observations where children experience high levels of well-being and physical activity simultaneously in the outdoor environment and how children utilise affordances in the environment in these observations. In total, 858 video observations from both data collections were analysed. Both qualitative and quantitative approaches were used. The importance of how children experience physical activity in childhood for establishing positive activity habits was the rationale for investigating observations with high levels of well-being and physical activity simultaneously. High levels of both well-being and physical activity were identified in 175 video observations.

The quantitative analysis used generalised linear latent and mixed model analysis. These analyses demonstrated that children experienced high levels of well-being and physical activity to a varying degree and that boys and older children experience more episodes with high well-being and physical activity simultaneously in the outdoor environment. Being with other children was also positively associated with high levels of well-being and physical activity simultaneously, as were the play categories functional play, symbolic play and mixed play. Key findings related to the physical environment included that the place categories describing the use of pathways and fixed equipment for functional play were positively associated with high levels of both well-being and physical activity. The use of sand, natural materials and toys were negatively associated with high well-being and physical activity observations. The other categories for places (sandbox, nature and open area) and objects (water, mud, open materials, and wheeled toys) were not significantly associated with the observations of high well-being and physical activity.

The qualitative analysis of the identified video observations with high levels of both well-being and physical activity was conducted by using as a starting point three categories for affordances: other persons and animals, places and objects. The analysis aimed to describe how these categories of affordances were utilised in the observations. The findings indicated that other children were essential to experience high levels of well-being and physical activity in the outdoor environment and that adults also have the potential to facilitate such behaviour. A variety of places afforded episodes with high well-being and physical activity. Although many of the investigated episodes did not involve objects, objects were essential in some of the observations, especially in symbolic play episodes. The findings illustrate the context-dependent nature of the child-environment relationship, where a wide range of affordances and their interplay influences children's play behaviour. The physical environment seems to be essential for promoting children's well-being in physically active play. Affording an outdoor environment with a wide range of possibilities through a variety of places and objects that can be utilised in a supportive social context with other children was found to be beneficial.

The phenomenon in focus in Paper IV, physical activity with high well-being, has not previously been investigated in an ECEC context. Following the emphasis on children's joy of movement, Paper IV is a valuable contribution to the field. These findings can contribute to increasing awareness concerning the role of the environment in children's positive experiences of physical activity in ECEC.

5. Discussion

This study aimed to explore how the physical environment in ECEC institutions influence children's well-being and physical activity. The results from the four papers identified characteristics of the physical environment that were associated with children's well-being and physical activity. In the following, these environmental characteristics are discussed in light of the theoretical framework and the previous research presented in chapter 2. This abductive process aims to develop practically applicable knowledge that can guide the planning, design and development of physical environments in ECEC institutions to promote children's well-being and physical

activity. Each of these chapters ends with suggestions for practical implications. Finally, strengths and weaknesses of the present study and suggestions for future research are addressed.

5.1 The outdoor environment

The outdoor environment has the potential to benefit children's well-being and physical activity through possibilities for active play in spacious, challenging and varied environments. In Papers I and IV, characteristics of the physical environment such as pathways, open areas, the natural environment, fixed equipment for functional play, and materials were identified as associated with children's well-being or physical activity. Each of these characteristics of the physical environment is discussed in the following.

5.1.1 Pathways

In this study, pathways are understood as narrow passages in the outdoor environment. Most of the pathways in this study were asphalt paths, but pathways with surfaces such as gravel, soil, and forest floor were also present in the sample. On average, pathways were used 5% of the observed outdoor time (Paper IV). From a theory of affordance perspective (Gibson, 2014), pathways are features in the physical environment that, depending on their surface and slope, provide children with possibilities for activities such as walking, running, chasing and cycling (Heft, 1988). In this study, pathways were identified as the place category in the outdoor environment that was most strongly related to physical activity (Paper I). Moreover, pathways were found to be associated with high levels of well-being and physical activity simultaneously (Paper IV). These findings indicate that the children in this study perceived and actualised pathways for movement, as the theory of affordance would suggest, and that pathways are positive attributes of outdoor environments.

The positive association between pathways and physical activity was also previously established. Nicaise et al. (2011) found that looping cycle paths were associated with moderate-to-vigorous physical activity (MVPA) and emphasised that the combination of wheeled toys and pathways may facilitate physical activity. Similarly, circular pathways were identified by Cosco et al. (2010) as accounting for a

large proportion of the physical activity in one centre, and they discussed how surrounding elements and the possibilities for circular motions influenced to what degree pathways were linked to physical activity. The establishment of a looping cycling path in an intervention study has also been found to increase children's physical activity levels (Nicaise et al., 2012). In another study, Smith et al. (2014) describe pathways as affordances of the environment that afford physical activity and discuss how seeing other children being physically active may trigger physical activity in a child. A well-developed network of pathways in the outdoor area can therefore be expected to boost physical activity both directly through the behaviours they afford and indirectly through the inspiration of seeing other children run and cycle.

Pathways may be used in different types of play. Running and cycling are functional play activities that children often carry out for the joy of this activity in itself. However, pathways were also found in this study to be used in symbolic play contexts (Paper IV), where the possibilities provided by the pathways are incorporated in an imaginary world. The use of pathways in such play episodes resonates in Heft's (2003) understanding of affordances as something perceived in an ongoing flow of activity through the course of action. Children engaged in family play may perceive the pathway as the road to the grocery store or the neighbour, depending on the child's intentions and the theme of the play. Thus, pathways represent more than an invitation for running or cycling; they are an attribute of the physical environment that may inspire and develop children's play.

Further, pathways may serve an essential role in the integration and connection of different elements in the outdoor environment of ECEC institutions. Herrington and Lesmeister (2006) describe the hierarchy of pathways as an element that can orchestrate movement, contribute to the connectedness of the environment, and help children to understand the space. Pathways can therefore guide children's movement, connect different elements in the environment and strengthen each element in the outdoor environment. This connecting potential of pathways can be linked to the findings by Smith et al. (2014) that the number of other play areas a place in the outdoor environment is connected to is positively associated with the physical activity levels in a

given place. Thus, pathways can increase the physical activity levels in the outdoor environment generally, even when children are not using the pathways.

Based on the results of this study and the theoretical considerations related to the role of pathways in the outdoor environment of ECEC institutions, the following practical implications are suggested to promote children's physical activity. Pathways should

- be a key feature of outdoor environments in ECEC institutions
- have a surface, shape and design that affords cycling and running
- be circular, looped and connected without dead ends
- connect elements and places in the outdoor space
- be visible from different places in the environment

5.1.2 Open areas

Children used open areas for more than half of the observed outdoor time in this study (Paper IV). Many of the outdoor environment were made up of different open spaces, including grassy fields, asphalt spaces, and gravel areas, and it is therefore not surprising that children spent much time in these spaces. However, the extensive use of the open area may also reflect that such areas have affordances that attract children. Open areas in this study were positively associated with both physical activity and well-being (Paper I).

The positive association between open areas and physical activity are related to the possibilities for running, cycling and chasing in the open areas (Heft, 1988). Previous studies have also found open areas to be positively associated with physical activity in ECEC institutions. Berg (2015) found an ample grassy open play space where children could move freely to facilitate physical activity. Open areas were also identified as an activity context related to physical activity in an observational study by Brown et al. (2009), and the authors suggest that having sufficient open space and appropriate outdoor materials is essential to facilitate physical activity.

Building on the theory of affordance (Gibson, 2014), one can expect that having materials and other children to play with in the open area is essential to take advantage of the possibilities for physical activity. This notion can be linked to the findings of Cosco et al. (2010), where open areas accounted for much more physical activity in one centre compared to another, and differences in possibilities for ball play and the involvement of staff in children's activities were discussed as possible explanations for this difference. In Paper IV, other children were present in observations with high well-being and physical activity in open areas, and tricycles were commonly used in groups of children in physically active play in these environments. These findings highlight how affordances of other persons and materials influence how the open areas may facilitate physical activity.

The surface of the environment is also important to consider from an affordance perspective (Gibson, 2014). Open areas with hard surfaces will afford cycling and running at high speed, while open areas with soft surfaces, such as grass, may afford rough and tumble play. From an affordance perspective, having a variety of open spaces with different surfaces to provide possibilities for different activities seems beneficial. What the surface of the open space is can therefore be expected to influence how children utilise the open space.

The positive association between open areas and well-being (Paper I) has not been previously established. The positive association between being physically active and well-being (Paper I) may explain some of this result, as the open area was positively related to physical activity. The association between open areas and well-being is, however, relatively weak. It must be emphasised that play is controlled for in the model. Following the importance of play for well-being (Giske et al., 2018; Howard & McInnes, 2013; Kennedy-Behr et al., 2015) and the significance of materials or other children to play within the open area (Cosco et al., 2010), no definite conclusions about the role of open areas for children's well-being can be established based on the findings in Paper I. This notion is supported in Paper IV by the lack of a statistically significant association between open areas and high levels of well-being and physical activity simultaneously, where play was not controlled for in the model. Thus, to what degree the open areas in ECEC are favourable for children's well-being remains uncertain.

Concerning the results in this study and the theoretical considerations related to the role of open areas in the outdoor environment of ECEC institutions, the following practical implications are suggested. Open areas should

- have a central place in ECEC outdoor environments
- be complemented with materials for physical activity (e.g., wheeled toys, balls, wooden planks, tyres, and plastic barrels)
- have different surfaces to afford different types of play

5.1.3 Natural environments

The natural environments in the present study range from large forest areas to smaller clusters of trees, with forest floor as surface. The availability of natural environments was different across the participating institutions, with some institutions having large natural environments and others having no natural environments. On average, natural environments were used 5% of the observed time (Paper IV). Being in natural environments was found to be positively associated with children's well-being (Paper I). No statistically significant associations were found between natural environments and physical activity (Paper I) or between high levels of well-being and physical activity simultaneously (Paper IV). However, the qualitative analysis in Paper IV indicated that the natural environment afforded forms of play where children experienced high well-being in physically active play. Furthermore, the challenging terrain and the changing affordances of the natural environment with different weather conditions and seasonal variances attracted children and inspired physical activity with high well-being (Paper IV).

The lack of a significant association between the natural environment and children's physical activity (Paper I) is consistent with previous mixed results in the field (Boldemann et al., 2011; Olesen et al., 2013; Storli & Hagen, 2010). The qualitative analysis (Paper IV) indicated that natural environments were places utilised by children for physically active play that was challenging for their motor skills. However, the many other play opportunities in natural environments for sedentary play probably contributed to the finding of a non-significant relationship between the natural

environment and children's physical activity. Nevertheless, it is essential to highlight that the natural environment has qualities that can promote children's motor competence (Fjørtoft, 2004), which may influence children's physical activity habits from a long-term perspective.

The beneficence of the natural environment for children's play found in this study (Paper IV) is consistent with the theory of affordance since they are affordance-rich environments. The natural environment has been previously found to afford children diverse and challenging play opportunities (Fjørtoft, 2004) and an abundance of loose objects that can be used in play (Lerstrup & van den Bosch, 2017). The play potential in the natural environments may influence children's well-being positively, since play and well-being are closely related in childhood (Ginsburg, 2007). The findings in an intervention study by Brussoni et al. (2017) support this hypothesis. The increased access to natural elements resulted in a positive effect on outcomes related to children's well-being (Brussoni et al., 2017). Thus, one possible path for the positive association between the natural environment and children's well-being is through the benefits of the natural environment for play.

In Paper I, the possible mediating role of play is partly controlled for in the established relationship between the natural environment and well-being. This approach is related to how the quantitative amount of play in the observation was included in the model. Previous studies have found the natural environment to afford complex and long-lasting play behaviours (Dowdell et al., 2011; Luchs & Fikus, 2013; Zamani & Moore, 2013). Such quality aspects of play are, on the other hand, not controlled for in the model in Paper I. To what degree the positive association between the natural environment and children's well-being is mediated through play and whether this potential mediation is related to the quality or quantity of play cannot be determined based on the present study.

Another possible explanation for the positive association between being in natural environments and children's well-being is related to the restorative benefits of nature for humans (S. Kaplan, 1995). Building such a theoretical framework, Carrus et al. (2012) found that contact with external green spaces was positive for children's levels of stress, and they emphasise the role of green environments for stress reduction

and the recovery of direct attention. This perspective raises a methodological question related to "when" the positive effect of being exposed to natural environments is to be expected. Carrus et al. (2012) found that children performed better on visual-spatial tasks after being in external green open spaces. Similarly, children's well-being may be higher after being exposed to natural environments, following the restorative hypothesis (S. Kaplan, 1995). In adults, having natural elements in the view is positively related to different aspects of well-being (R. Kaplan, 2001), representing yet another possible benefit of nature for children's well-being. The present study investigated the impact of the natural environment when children were in nature; however, the possible benefits of having been in natural environments or seeing natural elements were not included in the measure. Other methodological designs are necessary to tease out such possible effects of the natural environment on children's well-being.

The findings in the present study and the theoretical framework of the study suggest that the natural environment has benefits for children's health and that different paths for this association may exist. The following practical implications are suggested related to the natural environment:

- Natural materials and vegetation are essential elements in outdoor ECEC environments.
- When building ECEC institutions, natural elements in the outdoor space ought to be preserved and integrated into the play area.
- In urban environments, natural elements should be added to the outdoor environment.

5.1.4 Fixed equipment for functional play

Fixed equipment for functional play (hereafter called fixed equipment) encompasses fixed structures in the outdoor environment that were intentionally designed to afford functional play. In the present study, fixed equipment included elements such as swings, climbing towers, slides, carousels and seesaws. Fixed equipment had a central place in all of the eight institutions and was on average used 15% of the observed time (Paper IV). In Paper I, fixed equipment was found to be negatively associated with physical

activity, and no statistical association with well-being was found. However, in Paper IV, fixed equipment was found to be positively associated with high levels of physical activity and well-being simultaneously. The contradiction of these findings may be related to the different samples, statistical models and dependent variables.

Mixed findings are also found in the existing literature related to how fixed equipment is associated with physical activity. With a similar methodological approach to the present study, Brown et al. (2009) found MVPA more likely when children were at fixed equipment in a logistic regression model. However, most of the observations on fixed equipment were sedentary, and the amount of physical activity on fixed equipment was lower than for all outside observations combined (Brown et al., 2009). In the regression model, Brown et al. (2009) compared fixed equipment to using sociodramatic props, a sedentary activity context. If fixed equipment were compared with open space or play with balls and objects, fixed equipment would probably be negatively associated with physical activity, illustrating the significance of how the regression model is set up. In the present study, the selected strategy for the regression model (e.g., including play, materials and social characteristics in Paper I) also influenced the predicted effect of fixed equipment on physical activity.

Another approach to investigate the influence of fixed equipment on physical activity is to compare physical activity levels between institutions and link the availability of fixed equipment to children's physical activity in the institutions. Using such an approach, Sugiyama et al. (2012) estimated that MVPA per child per day increased by 2 minutes for every additional piece of fixed equipment available. The average number of fixed equipment items in the ten participating institutions was two installations, with a range from zero to four installations (Sugiyama et al., 2012). In addition to the wide range of confounding characteristics that may influence this finding, the low number of institutions and the range of equipment carry consequences for the trustworthiness of this estimate. This scepticism is supported by findings in other studies with larger samples, where the number of fixed equipment items in the institutions was found to be non-significant (Henderson et al., 2015; Olesen et al., 2013) and negatively (Bower et al., 2008) associated with physical activity. Thus, the existing

literature does not indicate that fixed equipment is positively associated with physical activity, and the findings in Paper I add to this body of evidence.

From an affordance perspective (Gibson, 2014), fixed equipment would be expected to facilitate physical activity. For instance, climbable features afford exercise and mastery (Heft, 1988). However, with most children attending the same institution for several years, designing equipment that remains interesting for several years is challenging. Hagen (2015) found the fixed equipment to be of limited importance for five-year-olds; it was used for other purposes than its intended use. The items were monofunctional and quickly explored and mastered (Hagen, 2015). Many of the observations of fixed equipment identified in Paper IV, with high levels of physical activity and well-being simultaneously, occurred within a symbolic play context where elements of the fixed equipment were given a new meaning in an imaginary world. Similarly, Herrington and Lesmeister (2006) found fixed equipment to be mostly used for purposes other than the intended use, and they argue that the usage does not correspond to the space occupied by the equipment or the financial cost of it.

A limitation of this study and of most of the existing literature on fixed equipment is related to how different types of fixed equipment are investigated jointly. The affordances of swings are different from those of climbing towers, and different climbing towers vary in their provided affordances. In the qualitative analysis in Paper IV, some structures were found to be used in several play episodes with high well-being and physical activity. This finding highlights how a more nuanced approach to the association between fixed equipment and children's physical activity is needed to understand the role of these structures in ECEC. Moreover, the surrounding features in the outdoor environment are found to influence an equipment item's association with children's physical activity (Smith et al., 2014) and play behaviours (Czalczynska-Podolska, 2014). This notion calls for in-depth studies where the contextual factors are weighted and specific equipment items are evaluated separately.

While the findings in Paper I and most of the existing literature support the notion that fixed equipment does not promote physical activity in ECEC institutions, the findings in Paper IV indicate that some types of equipment offering a wide range of

possibilities may facilitate active physical play with high well-being. The following practical implications are suggested:

- Fixed equipment is not necessary to promote physical activity.
- Fixed equipment affording a wide range of possibilities and varying challenges should be selected over monofunctional equipment.
- Beneficial placement of the fixed equipment relative to other physical elements is crucial.
- Materials that can expand the possibilities afforded by the equipment should be available close to the equipment.

5.1.5 Materials

The children participating in the present study used materials extensively in the outdoor environment. Toys were used for 32% of the time, and wheeled toys and natural materials were used 14% of the time (Paper IV). Sand (10%), water (8%) and open materials (7%) were also used frequently. Although the available materials were popular with the children, more use of materials in the present study was not related to higher well-being or physical activity. In Paper I, more use of loose parts (toys, open-ended materials and natural materials) was negatively associated with physical activity, and wheeled toys emerged as negative predictors of both physical activity and well-being. In Paper IV, more use of sand, natural materials and toys was negatively associated with observations of high well-being and physical activity simultaneously. However, the qualitative analysis in Paper IV indicated that wheeled toys and other materials were used in symbolic, constructive and functional play episodes resulting in high levels of well-being and physical activity. Thus, the results from the present study on the role of materials for children's well-being and physical activity are somewhat inconsistent and in contrast with much of the existing literature.

The quality and availability of portable playground equipment are commonly considered essential for promoting physical activity in ECEC institutions (Trost et al., 2010). Nevertheless, studies comparing physical activity levels between different institutions have found the availability of playground equipment to be both positively

related (Dowda et al., 2009) and unrelated (Henderson et al., 2015; Olesen et al., 2013) to physical activity levels. Several studies have explored the relationship between materials and physical activity using interventions. Bundy et al. (2009) found that increasing the availability of loose parts such as tyres, cardboard boxes, plastic barrels, water bottles, fabric, tubes, and wooden planks on the playground could increase children's physical activity levels. Similarly, Hannon and Brown (2008) found that providing children with playground equipment such as hurdles, hoops, tunnels, balance beams, targets, beanbags and balls could increase physical activity levels. However, in a much larger RCT, Cardon et al. (2009) found that providing children with portable playground equipment (balls, discs, rings, beanbags, hoops, and jumping bags) was not sufficient to increase physical activity levels. Thus, mixed results regarding the impact of the availability of materials in the outdoor environment exist, despite the common notion that materials facilitate physical activity.

The present study has a different methodological approach than do these studies, since the effect of interacting with the materials was studied rather than the effect of the availability of materials. Although this difference may explain some of the discrepancies with previous studies in the field, other studies using observation to compare children's physical activity levels within the same outdoor space have found physical activity levels to be positively associated with materials (Bower et al., 2008; Brown et al., 2009; Nicaise et al., 2011). As discussed in the section on fixed playground equipment, how the statistical models were built influences these findings.

Another explanation for the conflicting results relates to the different types of materials. From a theory of affordance perspective (Gibson, 2014), different materials afford different behaviours and may therefore influence children's physical activity levels differently. Outdoor toys (mostly buckets and spades), sand, water and natural materials were used a great deal in the present study, and the statistical analysis (Paper I and IV) indicates that these materials were mostly related to sedentary behaviour. Essential affordances of these materials are construction and building, activities that are mostly sedentary. Consistent with this point, Brussoni et al. (2017) found increasing the availability of natural materials in the outdoor space to reduce physical activity, even if the intervention benefited children's play. On the other hand, materials affording

functional play types and gross-motor movement such as balls (Brown et al., 2009), open-ended scrounge materials (Bundy et al., 2009), wheeled toys (Nicaise et al., 2011) and activity-friendly equipment (Hannon & Brown, 2008) are found to be positively associated with physical activity. Thus, different materials seem to have different associations with physical activity.

However, the lack of a positive effect of increasing the availability of portable equipment suitable for high-intensity play on children's physical activity in a large and controlled study by Cardon et al. (2009) and the negative association between wheeled toys and physical activity in the present study (Paper I) indicate that materials affording physical activity do not necessarily facilitate physical activity. The context-dependent nature of the child-environment relationship, where children's intentions (Heft, 1989) and the nature of the social context (Kyttä, 2004) influence the affordances the child perceives and actualises, may explain some of the inconsistency. The qualitative analysis in Paper IV found wheeled toys to facilitate high levels of physical activity when several children were playing together in symbolic play contexts, where the play theme involved movement. Cardon et al. (2009) point to the role of staff as essential to promote physical activity. How the staff promotes or constrains children's actualisation of affordances (Kyttä, 2004) may influence how the available materials are associated with physical activity.

Although few studies have explored the relationship between materials and well-being in ECEC, there is theoretical support for the hypothesis that the availability of materials is beneficial for children's well-being. Objects are an essential category in the theory of affordances, and objects that are movable for the individual afford an extensive range of possibilities (Gibson, 2014). This notion is applicable to children's interactions with materials, and Heft (2003) emphasises that materials that are mouldable and can be used in a variety of ways are especially popular with children. Similarly, Nicholson (1971) argues that children love to interact with materials and that materials are essential for children's play, experimentation, creativity, discovery and enjoyment. Thus, the lack of a positive relationship between using materials and well-being in the present study (Paper I) was surprising.

This finding is also in contrast with two previous studies. Brussoni et al. (2017) found increasing the availability of natural materials in the outdoor space to reduce depressed affect and antisocial behaviour and to increase prosocial behaviour, indicators related to well-being. Consistent with this point, interviews with the teachers in the open-ended materials intervention study by Bundy et al. (2009) indicated that children had become more social, resilient and creative in their play following the intervention. The positive link between affordance-rich environments and children's play have also been established in other research (Larrea et al., 2019; Lerstrup & Refshauge, 2016; Luchs & Fikus, 2013), and play may thus serve a mediating role in the possible positive relationship between materials and well-being, as discussed related to the natural environments. Therefore, controlling for the amount of play in Paper I may account for some of the discrepancies. The qualitative analysis in Paper IV also indicated that materials served an essential role in children's play, and contributed to play activities that were meaningful and fun, where several children interacted. Materials may therefore facilitate well-being in children through meaningful experiences with peers in play.

The findings in the present study and the theoretical framework of the study suggest that materials are essential in the outdoor environment in ECEC institutions. The following practical implications are suggested related to materials:

- Having an abundance of materials supports children's play.
- A variety of materials affording different types of play should be available in the outdoor space.
- Children must be able to access materials independently.

5.2 The indoor environment

The indoor environment is where children spend most of their time when in ECEC institutions, at least from an international perspective. The characteristics of the indoor environment are therefore essential for children's everyday experiences in the institution. While the outdoor environments in the Norwegian ECEC institutions are commonly vast (Moser & Martinsen, 2010), the norm for the size of the indoor

environment is 4 square metres net play area per child (Ministry of Education and Research, 2006). The limited area available in the indoor environment implies that children's play may be more restricted, that certain types of play may be prioritised over others, and that the design of the indoor environment is crucial to use the space efficiently. Paper II identified environments for physical activity, tables, cubbies, and open floor space as places in the indoor environment associated with children's well-being or physical activity. Paper III studied how the physical environment could be changed to promote physical activity, well-being and functional play by introducing a tumbling space in the indoor environment. In the following, these characteristics are discussed within the theoretical framework of the study and previous research.

5.2.1 Environments for physical activity

Environments for physical activity encompass the place categories for rooms for physical activity and tumbling spaces. Since these places share many of the same features, they are discussed jointly. The availability of these environments varied across the participating institutions and the two data collections. In the first data collection (Paper II), rooms for physical activity were used 2% of the observed time in the indoor environment, and tumbling zones were used 8% of the time. Five of the participating institutions established a tumbling zone in the intervention, and of the children gaining access to a tumbling zone, the tumbling zone was used 34% of the time in the second data collection (Paper III). The physical activity levels were found to be strongly positively associated with using rooms for physical activity (Paper II) and tumbling spaces (Paper II and III). Well-being was positively associated with using rooms for physical activity (Paper II) and weakly positively related to having access to a tumbling space (Paper III). Although children's well-being and physical activity increased following the intervention, the increase was similar in the children without a change in access to a tumbling space and those children who were gaining access to a tumbling space (Paper III). However, the amount of functional play increased significantly more in the intervention group (Paper III), indicating that the affordances provided by the tumbling space were actualised for functional play.

The positive association between using these places and children's physical activity and functional play are consistent with the theory of affordance (Gibson, 2014). Environments for physical activity included equipment such as crash mats, gymnastics equipment, balance beams, large construction materials and mats. Such elements afforded gross-motor behaviour such as balancing, jumping and tumbling. Similarly, Sugiyama et al. (2012) found that using the indoor space for motor activities was positively associated with physical activity. The extensive use of the tumbling space following the intervention (Paper III) indicated that the affordances of these environments were popular with the children. Providing children with possibilities for gross-motor activities in the indoor environment may therefore provide children with functional play opportunities supportive of their physical activity and motor development.

The two categories for environments for physical activity, rooms for physical activity and tumbling spaces differed in children's access to the space. The rooms for physical activity in the present study were shared with several other departments and often located far from the groups' area and unavailable for children without staff, thus rarely used. Children's lack of independent mobility (Kyttä, 2004) within the indoor space therefore influenced children's actualisation of these affordances in the environment. Limited access to the rooms for physical activity may explain why Olesen et al. (2013) found having such rooms to be unrelated to the physical activity levels. Thus, the impact of environments for physical activity on children's physical activity levels is dependent on their access to the space.

Since children could access the tumbling space freely and independently, these environments were used more (Paper II). Children having access to recreational spaces where children can play freely has been previously found to be positively associated with children's physical activity (Barbosa et al., 2016). While this independent access is favourable from a physical activity promotion standpoint, it may also be beneficial in supporting children's right to participate. If children are considered intentional actors who are capable of taking initiatives and making decisions about their daily life (Bae, 2009), one should seek to provide children with freely accessible environments for both rest and high-intensity activities. Having the power to regulate one's need for activity

independently may benefit not only children's activity habits but also their overall feeling of autonomy and competence.

Children's possibilities for utilising the indoor environment in ECEC for physical activity seems to be influenced by the social context. Children's physical activity indoors was negatively associated with adult presence (Paper II). Similarly, Gubbels et al. (2011) found that children's physical activity levels were lower when more staff were present in the indoor environment and that staff more often discouraged physical activity indoors than outdoors. This finding may indicate that staffs most often are involved in sedentary activities indoors and that the acceptance of physical activity is lower in the indoor environment compared to outdoors. Physically active behaviour may thus be within the field of constrained action (Kyttä, 2004). A critical bottleneck for children's physical activity while indoors in the ECEC may therefore be to what degree adults accept that children engage in physical activities such as running, jumping, tumbling and play fighting.

The similar increase in physical activity levels for the intervention and control groups in the tumbling intervention (Paper III) can be interpreted in light of the influence of the social context on children's physical activity indoors and Kyttä's (2004) perspective on restricted action. The importance of physical activity for children indoors was emphasised by the researchers in this project in the participating institutions during the data collections, in the extended research group and in the intervention process. This unspoken intervention targeting the staff may have increased the acceptance for physical activity in all institutions and moved such behaviour into the field of promoted action, overriding the physical environment intervention. To what degree this possibly heightened acceptance persisted after the data collection is not known. The nature of educational design research implies that interventions are not controlled (Kelly, 2006) and that many such questions remain unanswered. Future controlled studies with different conditions should investigate how both social and physical interventions may improve children's possibilities for physical activity in the indoor environment.

Following the popularity of the tumbling space, the positive association between functional play and well-being (Storli & Sandseter, 2019), children's innate need for physical activity (Rowland, 1998), and the social interactions in children's physically

active play (Lehto, Reunamo, & Ruismäki, 2012), using environments for physical activity was expected in the present study to be positively associated with well-being. The positive association between rooms for physical activity and well-being in the first data collection (Paper II) also indicated that being able to be physically active in the indoor environment may promote well-being. However, the limited amount of observations in this environment at T1 called for a cautious interpretation of this finding. The sample used in Paper III to evaluate the effect of establishing a tumbling space on children's well-being is much larger; thus, it is more appropriate to evaluate the association between environments for physical activity and well-being. In this study, there is no significant association between using the tumbling space and well-being. The increase following the intervention was no different for the children gaining access to a tumbling space compared to the control group. Although there is a weak positive association between having access to a tumbling space and well-being, the results from this study do not support the hypothesis posed – that environments for physical activity may promote well-being. However, the results of this study alone are not enough to reject this hypothesis.

The following practical implications are suggested based on the findings of the present study and the theoretical framework related to environments for physical activity indoors in ECEC:

- Environments for physical activity indoors in ECEC institutions are needed to support children's physical activity and functional play.
- Children should have access to supportive environments that they can use independently for physical activity within the indoor area.
- Designing a physical indoor environment where the staff is comfortable with children being physically active is essential.

5.2.2 Tables

Tables were categorised in this study as either low tables or high tables. This distinction was made following the increasing use of tables of child height in many Norwegian ECEC institutions. Since tables are designed for being seated, a sedentary behaviour,

the negative association between tables and physical activity (Paper II) was anticipated. However, sedentary activities are also valuable for children. Tables afford a place for art and craft activities, board games, constructive play and other essential activities in ECEC institutions. Therefore, it was surprising that children's well-being was weakly negatively associated with using high tables (Paper II). A similar association was found for low tables, but this association did not reach the significance level set. Because of the similar association with well-being and because few previous studies distinguished between high and low tables, tables are discussed jointly in the following discussion.

With no previous studies explicitly linking children's well-being to the use of tables, a broad range of studies is used to frame the finding of a negative association between tables and children's well-being. Nordtømme (2016) found that tables had a central place in the indoor environment and were a place where children were expected to be seated, materials were often unavailable without adult assistance, and activities led by adults dominated. Similarly, Acer et al. (2016) found tables to be placed in the centre of the room and that few materials were available for children. The framework plan (Ministry of Education and Research, 2017) for Norwegian ECEC institutions emphasises that toys and equipment should be accessible to children so that children are allowed to engage freely in activities. The accessibility of materials is an essential aspect for children's well-being, since children's opportunity to influence what to do (Sandseter & Seland, 2016) and the experience of exciting activities (Puroila et al., 2012) are positive aspects for children's well-being. Increasing the availability of materials is also found to benefit children's play (Acer et al., 2016), a key feature for children's well-being (Giske et al., 2018; Howard & McInnes, 2013). A possible lack of independent access to materials that can be used at the tables and lower experienced autonomy following adult-led activities can therefore be one possible explanation for the negative association between using tables and well-being in the present study.

However, tables have also been found to be beneficial for factors positively affiliated with children's well-being in other studies. In a long-term observational study investigating the association between the physical environment and children's social interactions, Torrens and Griffin (2013) found tables to be a hotspot for social interaction. Human relations have in several studies been found to be essential for

children's well-being (Fattore et al., 2009; Koch, 2018; Seland et al., 2015; Thoilliez, 2011), and if tables facilitate social interactions, tables may support children's well-being. The social interaction occurring at the tables in the study by Torrens and Griffin (2013) was, however, mostly staff interaction, and there was minimal peer interaction at the tables. This characteristic of the social interactions at the tables may influence how tables are associated with well-being, since peer relationships seem to be more critical for children's well-being in ECEC institutions than are staff relationships (Koch, 2018).

Tables afford a place for activities such as drawing, painting, building Legos, and other activities that require concentration. In a study of the youngest children, van Liempd et al. (2018) found tables to be mostly used for in-depth playing with small toys or focussed creative activity. Tables were also found to offer a limited set of affordances, positively associated with the intensity of exploration, and negatively associated with a variety of explorations (van Liempd et al., 2018). These findings indicate that tables were used for a narrow range of activities and that the explorations occurring at the tables were intense. Such in-depth activities are closely linked with the concept of involvement, which Laevers (2000) ties closely to children's well-being. Thus, tables may facilitate children's well-being through continuous, intense activities, provided that children have access to inspiring materials.

The following practical implications are suggested related to tables in the indoor environment in the ECEC:

- Materials for use at the tables should be accessible to children.
- Tables should be placed in a part of the environment suitable for concentration.
- The design of the tables and chairs should allow all children to access and leave the tables easily.

5.2.3 Cubbies

The category for cubbies included environments where children's clothes and outdoor gear were stored. While cubbies are not explicitly designed for play, cubbies can be included in the calculated indoor play area according to the Norwegian regulations for

indoor space per child (Ministry of Education and Research, 2006). Cubbies were also frequently used for play in the present study, with 7% of the observed indoor time occurring in cubbies (Paper II). The results in Paper II indicated that using cubbies was positively associated with physical activity and not related to children's well-being. No studies have previously investigated such relationships, and the following discussion takes a broad approach to exploring the role of the cubbies in children's well-being and physical activity.

The positive association between cubbies and physical activity makes sense from an affordance perspective (Gibson, 2014). Cubbies often have open spaces and narrow halls, which affords walking, running and chasing. Benches and racks for clothes in the cubbies are climbable features, elements that afford opportunities for exercise and mastery (Heft, 1988). The degree to which the social context encourages or restricts the actualisation of these affordances (Kyttä, 2004) influences how the cubbies are associated with children's physical activity. The results in Paper II indicated that children in this study were allowed to utilise the cubbies for physically active play, following the increased physical activity level in cubbies. Thus, the use of cubbies for play can be positive from a physical activity promotion standpoint.

The cubbies may serve an essential role for children's rough play indoors in institutions without environments for physical activity. Cubbies are commonly a durable environment that is separated from other play areas. These characteristics of the space can lead to the acceptance of rougher and louder forms of play in the cubbies than elsewhere in the indoor environment. Storli (2013) describes the benefits of rough and tumble play for children's bodily, social and perceptual experiences, the importance of social and physical affordances for such play, and how soft gymnastics mats afforded tumbling. Equipping the cubbies with soft mats that can be taken out when needed may support different forms of functional play and thus strengthen the affordances of the cubbies for physical activity.

In addition to affording possibilities for functional play activities, cubbies afford hiding places behind outdoor clothes, inside cabinets or in smaller drying rooms. Gibson (2014) describes places affording concealment as an essential kind of place and suggests that hiding involves placing oneself in a position where the body is concealed

from as many points of observation as possible. Play involving hiding is a popular activity with many children. Bratterud, Sandseter, and Seland (2012) describe how some of the younger children in their study seemed to experience well-being and excitement when hiding in dimmed cubbies between outdoor clothes and strollers. These observations indicate that the cubbies may facilitate well-being through the play experiences the environment affords, although the results in Paper II do not indicate that using cubbies promotes children's well-being significantly more than using other places in the indoor environment.

The cubbies may also be a place to escape the adult gaze. Koch (2018) observed several children engaging in joyful and rough play in the cubbies before they were confronted and stopped by an educator. Such rough and tumble play is often restricted in the indoor environment (Storli & Sandseter, 2015), and cubbies are often an adult-free zone where such forbidden play may happen. Koch (2018) argues that an essential take on children's well-being in ECEC institutions is related to how children together oppose adult rules and norms while at the same time maintaining a positive relationship with the staff. Cubbies may represent a free haven from adult rules, where children can challenge the adult rules and thereby engage in peer culture and experience well-being jointly. The data collection in the present study, with a preschool teacher filming the children, was not ideal for capturing such events. Other methodological approaches are needed to understand how places such as cubbies can be essential places in the peer culture of ECEC institutions related to children's well-being.

Based on the findings of the present study and the theoretical framework, the following practical implications are suggested related to cubbies in ECEC institutions:

- Children should be allowed to play in the cubbies.
- Having equipment for functional play available in the cubbies may expand the possibilities for physical activity in the cubbies.

5.2.4 Open floor space

Open floor spaces represented the indoor place category in the present study that was used the most, with 37% of the observed time occurring in such spaces (Paper II). Like the category for open areas in the outdoor environment, this category included a variety

of places that were not purposefully designed for specific activities. Using open floor space was found in Paper II to be positively associated with children's physical activity. No association with well-being was established, indicating that the well-being of children was similar to that in most of the other places in the indoor environment. Like many of the previously discussed indoor places, such relationships have previously not been addressed in research, and a broad theoretical framework is applied to discuss these findings and to suggest practical implications related to open floor space in ECEC institutions.

The finding of a positive relationship between open floor space and physical activity suggests that this space is associated with movement. This notion is consistent with the theory of affordance (Gibson, 2014), where flat, relatively smooth surfaces afford walking and running (Heft, 1988). Coinciding with this notion, van Liempd et al. (2018) found the floor to be used frequently by the youngest children and mostly for movement. Similarly, McLaren et al. (2012) found both disabled and non-disabled children to use flat, open spaces with smooth surfaces for movement, and they argue that open non-prescribed areas offer children the freedom to move. Thus, open floor space affords movement and physical activity in the indoor environment.

The intensity of the children's movement in the open floor space is likely to be influenced by social acceptance by the staff of physical activity in the indoor environment. The results in Paper II indicate that the physical activity occurring in the open floor space is mostly of moderate intensity. The open floor space does, however, also afford higher intensity activities such as running and tumbling. Such high-intensity activity may not be accepted in the indoor environment, and the utilisation of such affordances may be within the field of constrained action (Kyttä, 2004). Such constraints on children's use of the open floor space for higher intensity activities were found in the McLaren et al. (2012) study, where rapid movements were discouraged and forbidden by the staff. The open floor space thus represents a space that potentially may also foster higher intensity physical activity, if children are allowed such activity by the staff.

Although the open floor space in itself affords a relatively narrow set of affordances, affordances provided by materials or other children can expand the

possibilities in the space drastically. McLaren et al. (2012) found children's use of the open space to involve movement in a variety of non-habitual ways and that children mimicked each other and were triggered by other children's movement. This finding illustrates the significance of social affordances for children's exploration of their physical possibilities and how the child-environment interaction is influenced by the social context. The floor was also found to have a multifunctional character by van Liempd et al. (2018), with a variety of affordances explored by the children, including toy play and expressive activities. Thus, the open floor space can be considered a flexible space for different kinds of play, where children's interests can determine the use. The availability of materials in the proximity of the open floor space and the social affordances provided by other children are influential on how the open floor space may serve a variety of functions in the indoor environment.

The open floor space can also contribute to the use and success of other zones in the indoor space. As discussed related to the outdoor environment, Herrington and Lesmeister (2006) argue that pathways have a critical role in connecting the different elements in the outdoor space and in guiding children's movement. Similarly, the open floor space in the indoor environment connects play zones and direct movement in ways that can inspire play and protect activities from disturbance. However, the design of the open floor space may also steer the movement in ways that restrain the use of other play zones through disturbance or because they become unavailable. Therefore, it is necessary to take a holistic perspective on how the indoor environment provides children with calmer areas for deep concentration and more active areas for physical play. The open floor spaces may be an essential buffer between such zones, affording children possibilities to expand their play and to make transitions between different forms of activities. Therefore, open floor spaces are more than "dead space" in ECEC institutions. They are flexible places for movement and a variety of activities and are an essential connecting feature of the indoor environment.

This discussion related to the open floor space in ECEC institutions has demonstrated that these spaces may serve different vital purposes in the environment. Based on the results of the present study and the theoretical framework used in this

discussion, the following practical implications are suggested related to open floor space in the indoor environment of ECEC institutions:

- Children should be allowed to use the open floor space for a variety of purposes, including functional play with peers.
- Such space should be complemented with materials to facilitate play.
- Carefully connecting the indoor environment with open floor space can orchestrate movement and strengthen the play zones.

5.3 Strengths and weaknesses

The present study has both strengths and weaknesses, many of which are addressed in the method chapter. In the methods, strengths and limitations related to the mixing of methods, quantitizing of video observations, the use of interventions, the context-specific nature of the research, the measures used, and the multifaceted role of the researchers in educational design studies were presented. Moreover, limitations related to generalisability were described. All of these aspects are relevant to consider when making inferences based on this naturalistic study and when the overall validity and reliability of the study are evaluated.

Another limitation is related to the lack of a comprehensive pilot study. The procedure for data collection was not piloted before the first data collection, and its effectiveness could have been improved through a pilot study. Furthermore, a pilot study where the measures used were tested and evaluated in the context of the present study could have strengthened the validity of the study. Such a pilot study was, however, not possible within the time and financial frame of the study. The overall limitation related to the lack of piloting was considered modest, as the measures were adapted from a similar cultural context, and manuals were used in their original language. The procedure for data collection functioned well, and the use of video observations enabled the researchers to make adjustments and revisions to the initial coding when needed and is a strength of the study.

The measures in the study aimed to evaluate complex phenomena through video observations, and weaknesses in the validity and reliability of these measures exist. In

the measurement of well-being, children's perspectives on how they perceive their well-being are missing, and the measurement of well-being relies on the researcher's interpretation of children's expressions of well-being (Mashford-Scott et al., 2012). Therefore, essential elements in the concept of children's well-being, such as self-assessment, internal feelings and conceptions, and feelings of meaning and belonging are missing in the measurement of well-being in the present study. Although the inter-rater agreement is acceptable, it does indicate that the researchers doing the scoring of well-being have interpreted children's signals of well-being somewhat differently and represents a limitation of the study.

For physical activity, the inter-rater agreement was higher. The tool used to measure physical activity was designed to be used in short periods, but the present study deviates from this design by evaluating the physical activity level for two minutes. The rapidly changing nature of children's physical activity, with short bursts of activity (Bailey et al., 1995) and the dependence on reliable observers to capture varying intensities for two minutes, represents a challenge. The reliability measures indicate that the researchers involved in the coding met this challenge.

While the measures of well-being and physical activity were scored by two independent researchers and in a way piloted through the review of the first 24 observations each of the researchers coded, the same procedure was not followed for the measures coded second-for-second. These measures (places, materials, play, and social context) were scored by one researcher and reviewed by a second for a random 10% sample of the observations. The lack of two researchers independently evaluating these measures and the lack of inter-rater scores imply that these measures are more of a concern in terms of uncertainty than are the measures for well-being and physical activity.

The analytical approach used to measure places and materials relies on the assumption that more time in a place or interacting with a material may influence child outcomes. It is a strength of the study that children's well-being and physical activity were matched with what places and materials they interacted with within the actual observation, and not to general characteristics of the physical environment as in many previous studies. However, relationships other than the one examined in the present

study may also exist, such as having an outlook on nature may influence well-being, running to gather materials may result in physical activity before the child interacts with the material, and having the opportunity to be physically active in the morning may influence the well-being of the child in the afternoon. Another limitation on the measurement of the physical environment is related to how vital qualities of the physical environment (e.g., noise, daylight, shading, heating, quality of materials, terrain, and integration between different elements) are not included in the measurement. Thus, possibly essential aspects of the physical environment of ECEC institutions were left unexplored in this study.

Measuring children's play is challenging due to the ambiguity of play (Sutton-Smith, 2009), where what goes on inside the child's head is an essential but unknown entity. Therefore, a truly objective and valid measure of play does not exist. Including children's perspectives on their play behaviour would have strengthened the quality of the measure. However, collecting such data on such an extensive number of observations was not possible in the present study. The measure of play therefore solely relies on the researchers' interpretation of children's activities in the observation and the categories used, representing a weakness in the study. Nevertheless, the inclusion of play in this study is a strength of the study that has contributed to a more comprehensive understanding of the child-environment interaction related to children's well-being and physical activity.

A limitation of the measurement of the social context is the effect of the camera. Whereas most children seemed to be unaffected by the co-researcher filming them, the staff was more conscious of the filming and were more influenced by the camera. The potential for higher participant reactivity is a limitation commonly associated with video observations in behavioural studies (Haidet, Tate, Divirgilio-Thomas, Kolanowski, & Happ, 2009). Some of the staff did not want to be filmed, although they had agreed to participate, and avoided interacting with children being filmed; thus, their behaviour was influenced by the data collection. It is also possible that staff and children changed behaviour because of the filming. Thus, the use of video observation has influenced the social characteristics of the observations – perhaps especially the adult-child interactions – and is a limitation of the study.

The theory of affordance (Gibson, 2014) has represented an essential framework for considering children's interactions with the physical ECEC environment in the present study. This theory guided various parts of the study and has strengthened the inferences made in this study. However, the theory of affordance proved better suited to understanding the child-environment relationship related to children's physical activity than to their well-being. This notion relates to how physical activity is a form of behaviour, while well-being is an internal feeling or a state. Still, the theory of affordance has been crucial to understanding the possible mediating role of children's behaviour in the relationship between the physical environment and children's well-being. Nevertheless, a weakness of the study is related to the lack of a more general theory suitable to grasping a multitude of aspects of how the physical environment influences children's well-being.

The range of limitations presented relates to the complexity, naturalistic context and high ambitions of the present study. The child-environment relationship is many sided, and several concepts that are challenging to measure are included in this study to approach this relationship. The extensive data material and the inclusion of essential measures that were carefully implemented is a strength of the study. Nevertheless, considering the limitations of the study and their possible consequences for the interpretation of results is critical when transferring the findings to other circumstances.

5.4 Future research

This study has demonstrated the impact of the physical environment on well-being and physical activity in young children and the need for more studies to address the child-environment relationship in the ECEC context. While the link between the outdoor physical environment and children's physical activity is explored in several studies, the influence of the indoor environment on physical activity is only addressed in a few studies. For well-being, the influence of both the indoor and outdoor physical environment is limitedly explored. Future research should test the practical implications suggested in the present study in more controlled studies.

Following the unexplored nature of the child-environment relationship in the ECEC context, the present study had to take an explorative approach where particular

environmental characteristics were weighted and others were overlooked. Characteristics of the physical indoor environment such as light, noise, openness, outlook, temperature, the size of rooms, available play space per child, and other architectural attributes were not explored. Similarly, characteristics of the outdoor physical environment such as shading, terrain variations, surfaces and the size of the environment were not studied. Future studies may seek to incorporate such vital characteristics of the physical environment in the analysis of the link between the physical environment and child outcomes.

Although the measurement of the physical environment in places and materials in the present study has been fruitful, important contextual or relational aspects of the physical environments are lost in such analytic processes. How places are connected to other zones, how materials may be decisive for a place to be popular with children, and how the overall physical environment promotes a variety of play opportunities for children are such essential questions that need to be addressed in research. Since the child-environment relationship is complicated, sophisticated methods are needed to develop knowledge about how to design an ideal environment for children. The methods applied in the present study represent a development in this regard, and they can be further refined in future studies. How to study different physical elements holistically is one important topic to address.

Theories serve an essential role in understanding multifaceted processes such as the child-environment relationship. Although the theory of affordance proved valuable in the present study, future studies should explore other theoretical perspectives. The complexity of children's well-being with several possible paths for an influence of the physical environment calls for a more comprehensive theoretical perspective to supplement what the theory of affordance provides. Self-determination theory (Deci & Ryan, 2012) is one possible theory that may complement what the theory of affordance lacks; its effectiveness in understanding how physical ECEC environments influence children's well-being should be explored.

The present study has indicated that play serves a mediating role in the relationship between the physical environment and health indicators such as well-being and physical activity. However, research-based knowledge about how the physical

environment influence children's play is lacking. Such knowledge is essential to understand how the physical environment influences child outcomes in ECEC and how physical environments can be designed to benefit children. Future studies should address both the link between the physical environment and children's play and the possible mediating role of play in the relationship between the physical environment and child outcomes.

The social context is another crucial element for how children use the physical ECEC environment that needs to be addressed in research. Other children are essential for play and to share experiences with while exploring the possibilities of the physical environment. Staff may also serve this role, and they are crucial for what behaviours are promoted and restricted. Thus, other children and staff serve critical roles in how the child interacts with the physical environment and how the physical environment influences children's well-being and physical activity. Especially in the indoor environment, the social context seems to be decisive for children's possibilities to be physically active. The social acceptance for physical activity is therefore essential to target when aiming to increase children's physical activity levels in ECEC institutions. Research-based knowledge on how to increase awareness and acceptance for active forms of play in the staff is needed.

Children's voices are another essential element to incorporate in studies related to the physical ECEC environment. Although the present study has aimed to consider children's perspectives, their own perspectives are not included in the analysis. Future studies should seek to incorporate children's voices in the study of physical ECEC environments. Children's perspectives are highly relevant for knowledge about how to design child-friendly ECEC environments.

Overall, there is a need for high-quality research with different methodological approaches addressing how the physical environment in ECEC influences children. Future studies may build on the methodological approach and findings of the present study to develop such knowledge. Research-based knowledge is needed to reap the benefits of a well-designed physical environment for children's everyday experiences in ECEC institutions and for their future outcomes.

6. Conclusions

The overarching research question of this study asked how the physical environment in ECEC institutions influences children's well-being and physical activity. The identified characteristics of the physical environment influencing these essential health indicators were addressed in the discussion. General perspectives on how the physical environment influences well-being and physical activity and the overarching implications of this study are provided in this conclusion.

The physical environment may influence children's well-being through the feelings, sensations and place attachment children experience in a given place (Jack, 2008). The finding in this study of a positive impact of the natural environment on children's well-being is partly attributed to this hypothesis. Environments where children feel secure and that are restorative (Carrus et al., 2012; S. Kaplan, 1995) may promote children's well-being in ECEC institutions. Thus, designing environments where children's senses are stimulated, where there are natural restorative elements, and where children can feel belonging and attachment may promote children's well-being.

Moreover, this study has demonstrated how play is closely related to children's well-being and how the physical environment influences children's play behaviours. In all of the papers in this study, children's well-being was found to be positively associated with play, and a physical environmental intervention in Paper III was found to influence children's play behaviours. Furthermore, the qualitative analysis in Paper IV found that children experience well-being in a variety of physically active play contexts and that the physical environment served an essential role in these play episodes. Although a mediating analysis has not been conducted in the present study, these findings suggest that play serves a mediating role in the relationship between the physical environment and children's well-being. A varied environment with different play opportunities may benefit children's well-being through the play behaviours the environment offers. Moreover, access to affordance-rich environments supports social interactions among children (Larrea et al., 2019), another critical element for well-being. Thus, providing children with a diverse environment benefits children (Moore, 1986).

Physical activity is another behaviour that, like play, may serve a mediating role in the relationship between the physical environment and children's well-being. The positive association between well-being and open areas in Paper I and rooms for physical activity in Paper II may be attributed to this hypothesis. The weak positive association between having access to tumbling zones and children's well-being may also indicate a relationship between having the opportunity to be physically active and well-being in children. How the children experience mastery in physically active play (Pellegrini & Smith, 1998), identified in Paper IV, represents another possible link between children's engagement in physical activity and their well-being. Therefore, physical environments that are supportive of children's physical activity and provide children with physical challenges that are appropriate for their capabilities may facilitate well-being.

The physical environment in this study was found to influence children's physical activity through the behaviours the physical environments offered for physical activity and children's actualisation of these affordances. An example of this relationship was the participating children's use of pathways. Pathways were identified in Papers I and IV as places associated with physical activity following children's use of the pathways for movement in various forms. In the indoor environment, using environments for physical activity was positively related to physical activity. These findings indicate that physical indoor and outdoor environments that afford movement promote children's physical activity, a notion consistent with the theory of affordance (Gibson, 2014; Heft, 1988).

An essential path for the influence of the physical environment on children's physical activity through the behaviours the environments afford is related to play. In Paper IV, various play behaviours, including symbolic and constructive play episodes, were found to involve physical activity. The physical environment was essential to these play behaviours. This finding implies that the influence of the physical environment on children's physical activity is not solely related to affording behaviours such as running on pathways or jumping off gymnastics equipment. Constructive play where children are physically active to collect materials or symbolic play involving several children moving through the environment is also an important path for how the physical ECEC

environment influences children's physical activity. Affordances for such play may be crucial for the children who do not enjoy functional play. Providing children with an ECEC environment supportive of movement and various play behaviours through access to different materials and places is essential. Additionally, a supportive social context where children are allowed to explore and actualise affordances (Kyttä, 2004) seems beneficial to facilitate physical activity in ECEC institutions.

The findings in this study propose different paths for the influence of the physical ECEC environment on children's well-being and physical activity. Children's well-being is suggested to be influenced by the physical environment through the experiences and feelings it provides, the play possibilities afforded, the opportunities to be physically active, and through the mastery of physical challenges. Children's physical activity is suggested to be influenced by the physical environment through the affordances for movement and play. Furthermore, the findings in this study indicate that the social context is essential for how children utilise the physical environment. This notion implies that the social context may moderate the effect of the physical environment on children's well-being and physical activity.

This study has expanded the knowledge base in the field related to how specific features of the physical ECEC environment are associated with children's well-being and physical activity. These findings have addressed gaps in the literature (Holte et al., 2014; van Liempd et al., 2020). Moreover, the complex nature of the child-environment relationship and how play and the social context are essential concepts to include when studying the link between the physical environment and child outcomes have been demonstrated. Possible paths for how the physical environment exerts an influence on children's well-being and physical activity have been suggested, contributing to the theoretical understanding about the role of the physical environment for young children.

The methods applied in this study, where complex phenomena have been measured in a large sample using video observations, represent a methodological development that future studies may build on. The success of the methodological approach was dependent on a close and mutual collaboration with the practice field. The participating ECEC teachers were essential in key methodological processes such as the data collection, the interpretation of the findings and in the development of the

interventions. The methodological approaches and the mutual partnership with the practice field have been crucial to the success of the present study in providing high-quality knowledge that is practically applicable.

For the practice field, the critical implications of this study were presented in the discussion. In addition to the specific recommendations for physical properties of the physical environment, the results in this study support the understanding of play as an essential activity for children (Ginsburg, 2007; Holte et al., 2014) and highlight the necessity of facilitating and safeguarding children's possibility to engage in free play. Furthermore, the findings in this study support the notion of a significant role of the social context in children's interactions with the physical environment (Kyttä, 2004). Thus, the present study has implications for the practice field related to the social milieu, play and the design of ECEC institutions.

A well-designed physical ECEC environment lays the foundations for a high-quality ECEC institution and supports the practitioners in their everyday efforts to provide children with optimal education and care. ECEC institutions represent an important arena for early development (Phillips & Shonkoff, 2000), and institutions of high quality are found to support children's health and development (Oberklaid et al., 2013). This study suggests that the benefits that can be realised from a well-designed physical ECEC environment are many. While interacting with the physical environment, children learn about their bodies and the world, establish friendships, and experience joy, belonging and meaning. A high-quality physical ECEC environment provides young children with meaningful activities that benefit their everyday experiences and health.

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

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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

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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 co-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%

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	–

*$p < .05$: **$p < .01$: ***$p < .001$.

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

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 childreńs 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)		Children's Health	
		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	471	471
	Residual Variance Empty Model	.678	.296
	Residual Variance Full Model	.520	.243
Child level	Sample Size	80	80
	Residual Variance Empty Model	.090	.097
	Residual Variance Full Model	.072	.067
Variance at child level (%)		12%	25%
Goodness of fit -2LL (empty – full model)		124***	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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The physical indoor environment in ECEC settings: children's well-being and physical activity

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ABSTRACT

The physical environment in Early Childhood and Care (ECEC) settings is believed to be important for children's play and development. In this study, the influence of the physical indoor environment in ECEC settings on children's well-being and physical activity was explored. The data were obtained from video observations of the free play of 80 children in eight ECEC institutions. Multilevel regression analysis indicated that children's well-being was positively associated with the use of rooms for physical activity and negatively associated with the use of high tables. Children's physical activity was strongly positively associated with the use of rooms for physical activity and tumbling zones. Furthermore, open floor space and cubbies were positively associated with physical activity, whereas tables were negatively associated with children's physical activity. These results indicate that physical environments supportive of physical active play are beneficial and that dominating the indoor space with tables should be avoided.

KEYWORDS

Physical environment; indoor; play; well-being; physical activity

Introduction

During the last decade, substantial resources have been used to facilitate full Early Childhood Education and Care (ECEC) coverage in Norway, and many ECEC institutions have been designed and built. Today, more than 90% of Norwegian 1- to 5-year-old children are enrolled in ECECs (Statistics Norway 2018). ECEC settings therefore represent an important learning environment for children and are of great importance for the short- and long-term development of children (Phillips and Shonkoff 2000). The Norwegian Framework Plan for Kindergartens emphasizes that the design of the physical environment should give children the opportunity to play and that institutions should promote physical and mental health (Norwegian Directorate for Education and Training 2017). The aim of this article was to explore how the indoor environment in ECEC institutions can influence children's well-being and physical activity (PA). In this study, well-being is defined as a subjective and internal feeling of being/feeling 'well' (Koch 2018; Mashford-Scott, Church, and Tayler 2012), whereas PA is defined as any bodily movement produced by the skeletal muscles

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that results in energy expenditure (Caspersen, Powell, and Christenson 1985). Well-being and PA are both key elements in children's health (Boreham and Riddoch 2001; Mashford-Scott, Church, and Tayler 2012).

The theory of affordance (Gibson 2014) represents an important theoretical framework in this study. In this theory, the physical environment is believed to afford the child possibilities and actions. The characteristics and features of the indoor environment can therefore be hypothesized to influence children's play and activities, which in turn may influence well-being and PA. Play involves activities that children perform for the sake of enjoyment (Sutton-Smith 2009). Play and well-being are strongly related for children in ECEC institutions (Kennedy-Behr, Rodger, and Mickan 2015; Giske et al. 2018; Howard and McInnes 2013), and the key elements in play are important contributors to children's well-being (Ginsburg 2007). Given the relationship between play and well-being and the fact that children's play seems to be influenced by the physical environment (Shim, Herwig, and Shelley 2001; Torrens and Griffin 2013), it is also likely that children's well-being is influenced by characteristics of the physical environment.

Although ECEC settings have become a field of growing interest in research on child outcomes, there is a lack of studies assessing the impact of ECEC institutions on children's well-being (Holte et al. 2014). The literature is even more limited in regard to how the physical indoor environment influences well-being. In a study of the perspectives of 4- to 6-year-olds on their well-being, the physical environment, available materials, common activities, and the opportunity to influence their day were of crucial importance in ECEC institutions (Sandseter and Seland 2016). This result is in line with the findings of a previous Norwegian study, indicating that the materials and the arrangement of the physical indoor environment influence children's play experiences (Nordtømme 2016).

A previous systematic review aimed to evaluate the associations between the Early Childhood Environment Rating Scale (ECERS)/ECERS-Revised and children's well-being. A vast difference in methodological approaches and some minor positive associations between the overall quality of the institution and well-being were found (Brunsek et al. 2017). Since well-being is a complex and multifaceted concept, it may be difficult to isolate the effect of overall quality or the physical environment on children's well-being. The theoretical framework of this study implies that the physical indoor environment in ECEC institutions is important for children's well-being, but the extent and mechanism remain unknown.

More is known about the importance of the physical environment for children's PA. The physical environment is commonly believed to have a strong impact on children's PA in ECEC institutions (Brown et al. 2009; Sugiyama et al. 2010). However, this evidence is mainly based on studies on the outdoor environment and specific knowledge of the indoor environmental characteristics that influence PA is lacking.

Previous studies have found that the size of the play area (Gubbels et al. 2012; Olesen et al. 2013), having an indoor recreation room (Barbosa et al. 2016) and using indoor space for motor activities (Sugiyama et al. 2010) are positively associated with PA. The association between indoor subscales of the Environment and Policy Assessment and Observation (EPAO) tool and PA is unclear (Gubbels et al. 2011; Bower et al. 2008; Peden et al. 2017; Tucker et al. 2015; Vanderloo et al. 2015). In one study, Gubbels et al. (2011) found that the social environment interacts with the physical environment with regard to children's PA. This finding may explain some of the inconsistencies in the

associations among EPAO subscales and measured PA. Even the most appealing room for PA will not promote PA if children are prohibited from running indoors.

Little is known about the influence of the indoor physical environment on children's well-being and PA. The lack of previous research in the field implies that this study has to be explorative in the search for associations between the physical indoor environment and children's well-being and PA. The research question for this article is as follows: What characteristics in the ECEC physical indoor environment influence children's well-being and PA?

Materials and methods

This study was conducted within the project 'Competence for developing ECEC institutions' indoor- and outdoor environments', which was funded by The Research Council of Norway and approved by the Norwegian Social Science Data Services. This project is a three-year study with a mixed-method design (Creswell 2013) conducted in close collaboration with three ECEC owners in Norway. The data collection involves systematic and randomized video observations of children in the indoor environment during free play sessions. 'Free play sessions' implies that children can decide what they want to do, where they want to be and who they want to be with in the available indoor space. Adults are present and may interact with and invite the children to participate in different activities, but the children are free to engage in other activities as they wish.

Procedure and sample

The sample consists of 479 video observations of 80 children from eight ECEC institutions with a mean duration of 121 s. The eight ECEC institutions were strategically selected among the partner ECEC institutions to vary in size, age, location and physical environment. 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 obtained from parents. The children were informed about the video observations and were not filmed if they did not want to be filmed. Data collection was performed over one week in each ECEC institution during the fall of 2017 by four researchers and eight co-researchers. The researchers developed a strict data collection protocol that was followed in each of the ECEC institutions. A preschool teacher from each ECEC institution was recruited as a co-researcher and conducted the filming with a small GoPro Hero action camera. The researcher wrote field notes and ensured that the protocol was followed. The co-researcher was asked to regularly perform video observations prior to the data collection to allow the co-researcher and children to become accustomed to filming. Cameras were also used regularly for other pedagogical purposes at all participating institutions. A person familiar to the children performed the video recordings using small neutral cameras with wide-angle lenses to reduce any impact on the children's behaviour under 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. However, the presence of the co-researcher filming may still have influenced the children's behaviour and is a limitation of the design.

To ensure that random situations were filmed, the filming of the children followed a predetermined schedule that stated in what order and at what time 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, child two 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 (12 min) of each child were recorded in the indoor environment. If the children were in situations in which filming was not an option due to ethical considerations (such as toilet visits, the child refusing to be filmed or similar), the video observation was postponed. The co-researcher, who knew the children well, was very conscious to refrain from filming in sensitive situations and kept an ongoing dialogue with the children about the filming to ensure assent to participation. With six video observations of 80 children, a total of 480 video clips in the indoor environment constituted a full sample. With a total of 479 video clips in the final sample, one clip was missing. This clip was excluded because the child was inside a tent and was hidden for the entire period. In one institution, only four girls were available to participate; therefore, an extra boy was randomly selected to replace the unavailable girl, and 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 and environment. In addition, variables such as social characteristics, play, age and gender were included to control for the context of the observation. The Leuven Well-Being Scale (Laevers 2005) was used to measure the *well-being* of the children on a scale from one to five. The Leuven Well-Being Scale was developed as a tool to improve the quality of ECEC institutions through self-assessment (Laevers 2005) but has also been previously used in research in the ECEC context (Declercq et al. 2011; Bjørgen 2015). 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. To promote consistency in the coding and interpretation of the scale, training videos and workshops were conducted by the three researchers performing the coding. The training videos included 40 clips of children recorded in early settings in Flanders with justifications of each of clip rating. During the workshops, video observations was reviewed, scored and discussed by the researchers. Each video observation was scored by two independent researchers, and one score was established for each two minute video observation. Differences greater than one point were reviewed again and discussed in the research group until a mutual understanding was reached. For differences of one point, an average of the two scores was used.

To determine the inter-rater reliability, weighted kappa values (Cohen 1968) were used. The inter-rater agreement was 89% for well-being with a kappa value of 0.42. A kappa value of 0.42 indicates a moderate agreement, and agreements above 80% and kappa values above 0.40 are often viewed as acceptable agreements (McHugh 2012). Given the complex phenomena of well-being and the naturalistic data collection method of observing children in their everyday environment, an inter-rater agreement in the lower range of what is acceptable was anticipated and must be considered a limitation of the study.

Children's PA was measured using the Observational System for Recording PA in Children-Preschool (OSRAC-P) (Brown et al. 2006), which codes PA from one (stationary) to

five (fast movement). One score was established for each video observation. Scores were based on speed and characteristics of the movement, such as assisted movement and moving heavy objects. To evaluate PA, the same procedures described for well-being were used, except for the training videos, as follows: workshops, scoring by two independent researchers, discussions, and average scores. For PA, the inter-rater agreement was 93% with a kappa value of 0.65, indicating good agreement. OSRAC-P has been previously used in several studies in the ECEC context and in studies specifically linking PA to the physical environment (Gubbels et al. 2011; Gubbels et al. 2012; Hannon and Brown 2008; Nicaise, Kahan, and Sallis 2011).

To measure which places the children used, place categories were developed, which were based on categories used in previous research (Acer et al. 2016) and discussions within the project group and constant dialogue with the data. The categories had to be quite broad in order to be used in all eight institutions with substantially different indoor environments. After some adjustments, the final categories included the following:

- Open Floor Space: spaces between other zones and furniture, places not specifically coded for any activity or purpose.
- Low Tables: child-height tables.
- High Tables: adult-height tables.
- Cubby: cubbies for children's outdoor gear, rain clothes, boots, etc.
- Room for PA: spacious rooms (approx. 50 m2) designed specifically for PA.
- Tumbling Zone: areas with soft surfaces, large construction materials, pillows and blankets for physical play.
- Play Zone: a zone offering materials such as building blocks, outfits, kitchen equipment, play animals, etc.
- Subspace: fixed smaller subspaces such as cubes and dens.
- Window: window posts.
- Bathroom: changing rooms, toilets or bathrooms.

Places were coded continuously, and the categories were mutually exclusive. The variables for places were coded as the percentage of time spent in different places during each video recording. The coding was conducted 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. Given the theoretical framework, purpose of the study and the limited use of the window, bathroom and subspace categories, these spaces were excluded from the analysis and together constituted the 'other' category shown in Table 1. Not all place categories were present in all institutions, as presented in Table 1.

The contextual 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. 2006), were used to capture the social setting of the observation. In this study, the initial group variables 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, which were adapted from previous play-categorizing studies (Dyment and O'Connell 2013; Fjørtoft 2004; Luchs and Fikus 2013). In this article, the categories were combined 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, similar to the procedure for the categories describing places.

Analysis

The scoring of well-being and PA was performed in an Excel spreadsheet with a score for each of the observations. Places, materials, social characteristics and play were coded using Noldus Observer XT 12.5 behavioural coding, analysis and management software for observation data (Zimmerman et al. 2009). The Observer XT data were paired with the spreadsheet of the well-being and PA scores and imported to Stata (MP 15.1), which was used for the statistical analysis. Descriptive statistics and correlation analyses were conducted to provide an overview of the data and the relationships among the variables. Given the hierarchical structure of the data with nested observations of children within ECEC institutions, a multilevel regression analysis (Goldstein 1986) was conducted to investigate the association among the indoor environment and children's well-being and PA. Multilevel analysis enables the control of contextual factors and increases the accuracy of the predictions (Gelman 2006).

Results

The mean duration of the 479 video observations was 121 s. The descriptive statistics for these 479 video observations are presented in Table 1. The average scores were 3.6 (SD = 0.6) for well-being and 2.6 (SD = 0.8) for PA. The children played for an average of 73% of the time, they were with other children 80% of the time, and adults were involved in the activity 30% of the time. The most frequently used place among all the institutions was the open floor space, with 37% of the time spent in this category, followed by play zones with 20% of the time spent in this category. High and low tables were both used for 10% of the time, whereas children used the tumbling zones for 8% of the time. Cubbies were used for 7% of the time, and rooms for PA were used for 2% of the time. The remaining time was

Table 1. Descriptive statistics ($N = 479$ observations).

	Overall Mean	Overall SD	Overall Min	Overall Max	Coded in N Institutions	Mean in N Institutions
Well-being	3.6	0.6	2	5	8	–
PA	2.6	0.8	1	5	8	–
Age	3.8	0.5	2.8	4.8	8	–
Play	73	36	0	100	8	–
With Children	80	36	0	100	8	–
Adult Present	30	42	0	100	8	–
Open Floor Space	37	42	0	100	8	–
Low Tables	10	28	0	100	6	13
High Tables	10	28	0	100	5	16
Cubbies	7	23	0	100	7	8
Rooms for PA	2	14	0	100	3	6
Tumbling Zone	8	27	0	100	2	33
Play Zone	20	37	0	100	8	–
Other	6	23	0	100	6	8

Table 2. Correlation matrix ($N = 479$ observations).

	1	2	3	4	5	6	7
1. Age	—						
2. Boy (0 = girl)	.10*	—					
3. Well-being	−.06	.04	—				
4. PA	.03	.08	.28***	—			
5. With Children	.05	.03	.09*	.05	—		
6. Adult Present	−.01	−.06	−.11*	−.17***	.13**	—	
7. Playing	−.06	.12*	.42***	.05	.07	−.18***	—

*$p < .05$.
**$p < .01$.
***$p < .001$.

spent in the other category, which is composed of bathrooms, windows and subspaces. Since not all categories were present in all eight institutions, the mean use of each category within the institutions with said category is also of interest. In the six institutions with low tables, these tables were used for 13% of the time, whereas in the five institutions with high tables, these tables were used for 16% of the time. Cubbies were used for 8% of the time in the seven institutions in which this category was available; rooms for PA were used for 6% of the time in 3 institutions. Only two of the institutions had a tumbling zone, which was used for 33% of the time in these institutions.

The correlation matrix presented in Table 2 shows that well-being was positively correlated with PA ($r = .28$, $p < .001$), being with other children ($r = .09$, $p < .05$) and playing ($r = .42$, $p < .001$). Well-being and PA were negatively correlated with the presence of adults ($r = -.11$, $p < .05$; $r = -.17$, $p < .001$, respectively).

Multilevel analysis

With six observations of 80 children nested within eight ECEC institutions, the data have a hierarchical structure in which the assumption of the independence of units was breached. A random intercept model was chosen to account for the nesting of the data. First, an intercept-only model was run to calculate the variance at the three levels: institutional (level 3), child (level 2) and observational (level 1). The variance partition coefficient (VPC) with a limit of 5% variance was used to determine the number of levels in the model (Mehmetoglu and Jakobsen 2017). For well-being, the VPC resulted in an estimate that 3% of the variance was at the institutional level and 27% was at the child level. This estimate indicates that there were some structural differences in child-level well-being among the eight institutions, although the differences were not above the selected threshold. However, there is a substantial amount of variance at the child level that needs to be controlled for. For the PA VPC estimates, there was 2.5% variance at the institution level and 15% variance at the child level. A two-level model was selected for both well-being and PA.

A stepwise inclusion of variables starting at the lowest level in the model (Hox 2010) was performed. Contextual variables (step 1) describing the play, being with children and the presence of an adult were added to the model first. Next, the variables describing the places were added (step 2), and the second-level variables describing age and gender were added last (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=<.01) were significant improvements. For PA, step 1 ($p < .01$) and step 2 ($p = <.001$) improved the model. The inclusion of gender and age did not contribute significantly to the model for either well-being or PA, indicating that these background variables are not associated with well-being or PA in the present data. The regression coefficients in Table 3 reflect 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 multilevel regression analysis showed that there is an association between children's well-being and playing. The model estimates that for each 1% increase in time children played during the observation, an increase in 0.007 on the Leuven Well-Being Scale would result. If the child played during the whole observation, a 0.7 increase in well-being was expected. Neither background variables, such as age or gender, nor whether children were with other children or adults emerged as significant predictors of well-being in the indoor environment. Two variables describing different places in the indoor environment stood out as significant predictors of well-being. Being at high tables for the whole observation was estimated to reduce the level of well-being by 0.3, and being in a room for PA was expected to increase well-being by 0.4.

The PA model indicated that age, gender, playing and being with other children were not significantly associated with PA in the indoor environment. There was a small significant negative effect of adults being present, with an estimated decrease in PA of 0.2 on the OSRAC-P scale if the child was with adults for the entire observation. The open floor space, cubbies, rooms for PA and tumbling zone categories were all significantly positively associated with PA. The use of open floor space during the entire observation was estimated to increase PA by 0.4, whereas being in the cubby during the whole observation

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

Predictors (fixed effects)		Physical activity	Well-being
Constant		2.3	3.4
Background	Age	.008	−.048
	Boy	.034	−.023
Context	Playing	.000	.007***
	With Children	.001	.001
	Adult Present	−.002**	−.001
Place	Open Floor Space	.004**	−.001
	Low Tables	−.003*	−.002
	High Tables	−.004*	−.003*
	Cubbies	.005**	.001
	Rooms for PA	.017***	.004*
	Tumbling Zone	.013***	.001
	Play Zone	.002	−.002
Model statistics (including random effects)			
Observation level	Sample Size	479	479
	Residual Variance Empty Model	.493	.294
	Residual Variance Full Model	.318	.240
Child level	Sample Size	80	80
	Residual Variance Empty Model	.086	.109
	Residual Variance Full Model	.044	.077
Variance at the child level (%)		15%	27%
Goodness of fit -2LL (empty – full model)		220***	105***

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

was associated with a 0.5 increase in PA. The two strongest predictors of PA in the model were being in rooms for PA or tumbling zone. Using rooms for PA during the entire observation was estimated to increase PA by 1.7, and the use of a tumbling zone was estimated to increase PA by 1.3. Using tables was expected to reduce PA, with an impact of 0.3 for the use of low tables during the entire observation and 0.4 for the use of high tables during the entire observation.

Discussion

The findings in this study imply that the physical indoor environment influences children's well-being and PA. The magnitude of the impact of the place variables and the model statistics indicates that the physical environment has a stronger impact on PA than on well-being. The clear association between the characteristics of the physical environment and PA is in line with previous research in the field (Brown et al. 2009; Sugiyama et al. 2010). The few moderate associations between the physical environment and well-being may be in line with previous research that has struggled to find clear associations between environmental quality and children's well-being in ECEC institutions (Brunsek et al. 2017). The amount of variance at the child level in the multilevel analysis shows that well-being is more stable and internalized than PA. Well-being may therefore be less prone to influences by external factors such as the physical environment, and other external factors such as the quality of the caregiver interactions (de Schipper, Riksen-Walraven, and Geurts 2006) may be more important for children's well-being.

The only contextual factor that was found to be related to children's well-being in this study was playing. The positive association between playing and well-being adds to the existing evidence (Kennedy-Behr, Rodger, and Mickan 2015; Howard and McInnes 2013), suggesting that playing and well-being are strongly related in ECEC institutions. Strategies to support, guard and facilitate playing in ECEC institutions are highly important.

The only physical environmental variable in this study that was significantly positively associated with well-being was rooms for PA. This place variable was also strongly positively associated with PA, which is in line with previous studies (Barbosa et al. 2016; Sugiyama et al. 2010). The correlation analysis indicated that children's well-being and PA are related in the indoor environment, and the positive association between rooms for PA and well-being can be interpreted in this regard. The possibilities for physically active play and the freedom to be active in these rooms may also promote well-being. Having an indoor room for PA in ECEC institutions may therefore be considered important for both children's well-being and PA, depending on the children using the room. The limited use of this room in this study may imply that the overall impact of such a room on children's well-being and PA is limited. However, the data in this study is too limited to draw such a conclusion. The limited number of observations in this category also calls for caution when interpreting the association of the rooms for PA with children's well-being and PA.

The use of high tables in this study was found to be negatively associated with children's well-being. The role of tables in ECEC institutions was discussed in a previous Norwegian study about playing, space and materiality (Nordtømme 2016). In this study, tables were found to have a very central place in the institutions, taking up much of the available floor space and facilitating sedentary behaviour. Furthermore, the arrangement of tables and the other furniture signalled to children that they were expected to be seated at the tables and

that physical and active play would not be tolerated. Nordtømme (2016) suggested that this normative arrangement of the room and the available materials may limit children's possibilities for participation and choice. The negative association between well-being and the use of high tables identified in the present study may support this idea. The results of this study indicate that dominating the indoor play space with high tables should be avoided.

The presence of adults was significantly negatively associated with PA, but the effect was small. None of the other contextual or background variables were significantly related to PA in this study. The negative association between the adult presence and PA is in line with a previous study in which children were found to be less active when there were more adults present indoors (Gubbels et al. 2011). This finding may indicate that for the most part, adults encourage sedentary behaviour and play activities that do not foster PA.

Many institutions may have a shortage of rooms that support PA, and allowing running and chasing in the existing environment may be challenging. The positive association between the use of the cubbies and children's PA may indicate that this room can function as a room for PA. The cubbies are often in open spaces or halls and have benches or other furniture that allows children to climb or jump, and outdoor clothing provides hiding places. With the theory of affordance in mind, it is no surprise that children utilize such environments for PA. Affordance involves what the environment affords the child and the complementarity of the child and the environment (Gibson 2014). Children often have an urge for play involving PA, and the cubbies may afford running, climbing and hiding. Seeing and designing cubbies as a place for physically active play may heighten the quality of the indoor environment and support children's possibilities for PA. Furthermore, open floor spaces were positively associated with PA, and tables were negatively associated with PA. These relations also makes sense from an affordance perspective, as open floor space affords activities such as running, chasing and gross motor movements, while the tables facilitate sedentary behaviour, often including fine motor activities.

Tumbling zones were found to be a strong positive predictor of PA, which is in line with a previous study that found the use of indoor spaces for motor activities to be positively associated with PA (Sugiyama et al. 2010). While rooms for PA were often unavailable for most of the day, the tumbling zones in this study were an integrated part of the indoor space that children could access freely. The tumbling zones were therefore used very frequently and were very popular in the two institutions offering them in this study. The positive association with PA and the frequent use of these areas indicate that including tumbling zones in the indoor space may be a promising strategy to promote children's PA in ECEC institutions. The practical implications for planning, designing and developing ECEC setting indoor environments based on the main findings in this study are as follows:

- emphasizing the provision of supportive environments for play
- highlighting the importance of indoor environments affording physical active play
- avoiding dominating the indoor space with high tables

Limitations

As a cross-sectional study conducted within the children's everyday environment, there are several limitations to this study. No causal inferences can be established based on

the results of this study; only associations between the physical environment and children's well-being and PA could be determined. The inter-rater reliability test indicated that there was some uncertainty related to the measurement of children's well-being, and the contextual variable describing whether children were playing may also be questioned in terms of how accurately one can determine whether children are playing.

With little previous research on how the physical indoor environment influences children in ECEC settings, this study had to develop new categories for the physical indoor environment. Hence, there is little previous research available for comparison, and more studies are needed to confirm the findings in this study. Other variables describing the physical environment, such as noise, daylight, overall quality of the building, etc. that were not included in this analysis may also influence children's well-being and PA. An influence is also seen for the social context in the institution, including caregiver quality, ratio, sensitivity and knowledge of children's well-being and PA.

Nevertheless, analysing a vast number of video observations from several institutions and analysing these video observations from different perspectives has provided new knowledge of the role of the physical indoor environment in ECEC institutions in children's well-being and PA. Future research may build on these findings and put the results of this study to test in more rigorous and controlled experiments to build much needed knowledge of how the physical environment in ECEC institutions influences children's well-being and PA.

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Paper III

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Supportive indoor environments for functional play in ECEC institutions: a strategy for promoting well-being and physical activity?

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ABSTRACT

The physical environment in Early Childhood Education and Care (ECEC) institutions provide children with possibilities for play. This study describes a physical environmental intervention aiming to increase the possibilities for functional play in the indoor environment, and its influence on children's well-being and physical activity. The intervention involved the establishment of a tumbling space with soft surfaces, mats and big construction materials. The sample consists of video observations of 65 children's free play in seven ECEC institutions at two data points. Multilevel regression analysis indicates that children's physical activity and functional play is strongly related to the use of a tumbling space, and that the intervention group had a higher increase in functional play following the intervention compared to the control group. The impact of the tumbling space on well-being is limited. The results indicate that targeting children's possibilities for functional play may be beneficial form a health promotion standpoint.

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Tumbling space; indoor environment; well-being; physical activity; functional play

Introduction

Most children aged 3–5 years in the Western world attend early childhood education and care (ECEC) institutions (OECD, 2018), making ECEC intuitions an important arena for public health promotion. Well-being is often considered to be a central component in programme quality, but a common understanding on how ECEC institutions can promote well-being is lacking (Mashford-Scott, Church, & Tayler, 2012). More is known about the impact of the ECEC institution on children's physical activity. What type of ECEC institution children attend is found to be a strong predictor for children's physical activity and to account for about 40% of the variance in physical activity while in child care (Finn, Johannsen, & Specker, 2002; Pate, Pfeiffer, Trost, Ziegler, & Dowda, 2004). Structural differences between institutions in outdoor time and how much time children are able to engage in free play are possible explanations for the significant impact of the institution on children's physical activity (Pate et al., 2004). The association between time to engage in free play and physical activity may be explained by the fact that much of children's play behaviours involve physical activity, and that the achievement of fine and gross motor mastery in early years facilitates active play types (Johnson, 2006). Play where children engage in gross-motor activities and basic skill development and movement such as climbing, jumping, running and chasing are often defined as functional

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play (Fjørtoft & Sageie, 2000). Children's possibilities for free play may also be linked to well-being as children can experience enjoyment and positive feelings, flow and engagement, belonging and meaning in play (Holte et al., 2014). Hence, promoting children's possibilities for free play may enhance both well-being and physical activity in ECEC institutions.

Physically active children have healthier cardiovascular profiles, are leaner and develop higher peak bone mass (Boreham & Riddoch, 2001). Characteristics of the physical environment, as well as child characteristics such as gender and age are found to be correlated to physical activity in ECEC institutions (Tonge, Jones, & Okely, 2016). Mapping physical activity levels with objective measures in ECEC institutions have shown relatively high levels of sedentary behaviour (Reilly, 2010). Similar results are found in an observational study by Pate, McIver, Dowda, Brown, and Addy (2008) were children engaged in moderate or higher levels of physical activity in less than 3% of the observations and that children were sedentary for more than 80% of the time. New knowledge about how the ECEC institution may promote well-being and physical activity is highly needed, as children's experiences in ECEC institutions may influence their health status both in the present and in the future.

Well-being and physical activity are important elements in the framework plan for ECEC institutions in Norway, where this study was conducted. It is emphasized that the institutions shall promote psychical and mental health, provide children with daily physical activity and contribute to children's well-being (Norwegian Directorate for Education and Training, 2017). Physical activity and indicators for well-being are found to be associated in children and adolescents (Biddle & Asare, 2011). Findings of an association between well-being and functional play in an ECEC study (Storli & Sandseter, 2019) indicate that this also may be true for the context in this study. This possible association may be attributed to explanations like the biological effects of having physical activity (Silverman & Deuster, 2014), children's innate need for physical activity (Rowland, 1998), social interaction in physical activity (Lehto, Reunamo, & Ruismäki, 2012) and the association between play, well-being and physical activity (Sando, 2019). Allowing children to choose functional play activities that involve physical activity in ECEC institutions will most likely promote physical activity, and perhaps also well-being. Furthermore, mastering motor activities in functional play can enhance children's self-esteem and perceived competence.

Enhancing children's possibilities for physical activity in the indoor environment may impact children's daily physical activity to a high degree, as the indoor environment is commonly associated with sedentary behaviour (Andersen et al., 2017; Klesges, Eck, Hanson, Haddock, & Klesges, 1990). Previous studies indicate that having an indoor recreation room that is supportive of motor activities is associated with less sedentary behaviour (Barbosa, Coledam, Stabelini Neto, Elias, & de Oliveira, 2016) and that using the indoor space for motor activities is positively associated with physical activity (Sugiyama, Okely, Masters, & Moore, 2012).

The possibilities for using the indoor environment for children's motor activities are highly dependent on the adults in the institution. Adult interaction with children and how the adults provide children with developmentally stimulating opportunities are important for child outcomes (Pianta, Barnett, Burchinal, & Thornburg, 2009). For well-being, caregiver interactions (de Schipper, Riksen-Walraven, & Geurts, 2006), caregiver stability (de Schipper, van Ijzendoorn, & Tavecchio, 2004), and caregiver sensitivity (Groeneveld, Vermeer, van Ijzendoorn, & Linting, 2010) have been found to be important aspects. Considering physical activity, staff members' training in physical activity is found to be positively associated with children's physical activity (Sugiyama et al., 2012). Studies have also demonstrated specifically that the social environment influences how the physical environment is associated with children's physical activity (Gubbels et al., 2011). Hence, the adults in the institution are an important contextual factor influencing how children can utilize the physical environment.

The scope for this study is to explore how the physical indoor environment can be changed to promote functional play, physical activity and well-being. Designing an indoor space that supports functional play may promote children's physical activity and possibly also their well-being as these concepts have been found to be related. This study is a design experiment in education (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003) and uses an iterative design to develop and test

interventions in a real-life context. The intervention developed and tested in this study is the establishment of a tumbling space in ECEC institutions. A tumbling space is a place for bodily play with a soft surface, mats, pillows and large construction materials. The research question that is explored in this study is How does the introduction of a tumbling space in ECEC institutions influence children's functional play, physical activity and well-being?

Methods

This study was conducted within the project 'Competence for developing ECEC institutions' indoor and outdoor environments', which was funded by the Research Council of Norway and approved by the Norwegian Social Science Data Services. The project is a three-year study using mixed methods (Creswell, 2013) conducted in close collaboration with three ECEC owners in Norway. The project design included two data collections and an intervention. The data collection involved systematic and randomized video observations of two minutes during children's free play sessions. Results from the first data collection are described in previously published studies (Sando, 2019; Storli & Sandseter, 2019).

Procedure and sample

The participating ECEC institutions were strategically selected among the partner institutions to have a variation in size, age, location and physical environment. The sample in this study includes seven ECEC institutions. One preschool teacher from each of the participating institutions was recruited to be a co-researcher in the project and was included in the extended project group. The extended project group included five researchers, eight preschool teachers, an architect and a landscape architect.

The first data collection (T1) was conducted in the fall 2017 when 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 be. 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. Six video observations of two minutes of each child were recorded in the indoor environment at each data collection. With six video observations of 70 children, a total of 420 video clips in the indoor environment constituted a full sample at the first data collection. Actually, the final sample was made up of 419 video clips, with one clip excluded because the child was inside a tent and was hidden for the entire observation. Based on the results from the first data collection, discussions in the extended project group and in each of the participating institutions an intervention was conducted in the spring 2018.

The second data collection (T2) was conducted in the fall 2018, one year after the first data collection among the same children as in T1. Five children were excluded from the sample, four of the 70 previously participating children no longer attended the participating institution at T2, and one of the children was not included because of ethical considerations. A complete sample at T2 with six observations of each of the 65 remaining children in the indoor environment would consist of 390 video observations. However, the final sample at T2 includes only 381 video observations. Nine video clips were excluded. Four because the child was hidden, three because the child was occupied with the camera and two due to technical or human error.

Thus, the final sample included 770 video observations of 65 children from T1 ($N = 389$) and T2 ($N = 381$) of 33 girls and 32 boys. The children's mean age was 3.8 years (SE = 0.6) at T1 and 4.7 years (SE = 0.6) at T2.

Intervention

All participating institutions carried out an intervention in the spring 2018. The intervention was based on preliminary criteria for good physical environments established in workshops with the

extended research group following the first data collection. These criteria were inspired by the 7Cs (Herrington, Lesmeister, Nicholls, & Stefiuk, 2007), and included for the indoor environment characteristics like an inviting atmosphere, richness, clarity, accessibility, connectivity, transformability, and variety. Although the interventions were built on the same knowledge base, the intervention was unique in each of the participating institutions. The intervention had to be low-cost and each institution had 1000 euros that could be spent on the intervention. The overarching aim for the intervention was to promote play, and specifically to increase children's possibilities for symbolic play in the outdoor environment and for functional play in the indoor environment, as environments supporting these play types seemed to be lacking in the first data collection (Storli & Sandseter, 2019). This article focuses on the promotion of functional play in the indoor environment.

One of the participating ECEC institutions had a tumbling space at T1. This was a place for different types of physical play with soft surfaces, pillows and gymnastics equipment. This space showed promising possibilities for promoting functional play, well-being and physical activity in the indoor environment. An important asset with this tumbling space was that it was integrated into the department and therefore accessible to children throughout the day. This was in contrast to the specialized rooms for physical activity in some of the other institutions that were placed outside the department, had to be booked in advance and were shared with other departments. Hence, the tumbling space was used much more frequently than the specialized rooms for physical activity and could therefore be expected to have a greater impact on children.

Based on the findings in the first data collection, five of the participating institutions established a tumbling space in the intervention. Children getting access to a tumbling space at T2 were placed in the intervention group, while children who did not have a change in access to a tumbling space were placed in the control group. An overview of the participating institutions and the interventions are presented in Table 1.

The tumbling spaces in the participating institutions are quite different since the institutions have different buildings, room plans, grouping of children and materials for bodily play. All tumbling spaces did, however, include soft surfaces, mats and some larger materials that children could use for functional play. It is important to emphasize that other considerable changes were made in the participating institutions from T1 to T2. Many of the institutions established new play zones and increased the availability and quality of play materials. Specialized rooms for physical activity varied in availability from group to group of children and data collections. Structural changes from T1 to T2 were also conducted, and some of the participating children were moved to another department within the institution they attended. Changes in the staff were also made, and the staff's

Table 1. Participating institutions.

Institution	N children (Observations)	Tumbling intervention	Group
A	8 (48)	A tumbling space was established in both participating departments.	Intervention group
B	9 (54)	A tumbling space was established in a common room outside the department.	One child had access to the tumbling space during the observational period. This child was placed in the intervention group. The other children were in the control group.
C	10 (59)	A tumbling space was established in the department.	Intervention group
D	8 (48)	This institution had a tumbling space at both T1 and T2.	Control group
E	10 (60)	No tumbling intervention.	Control group
F	10 (60)	Tumbling space established in the intervention. The room was locked and unavailable for two days.	The children with access to the tumbling space were in the intervention group. The other children were in the control group.
G	10 (60)	Tumbling space was established in one of the two participating departments.	The children with access to the tumbling space were in the intervention group. The other children were in the control group.

competence regarding the physical environment and its importance for children's play most likely increased because of their participation in this project. This illustrates the complexity and context-dependent nature of naturalistic research in education, and this lack of control over important contextual factors must be considered when drawing conclusions from the findings in this study.

Measures

The Leuven Well-Being Scale (Laevers, 2005) was used to measure the *well-being* of the children. The Observational System for Recording Physical Activity in Children–Preschool (OSRAC-P) (Brown et al., 2006) was used to measure physical activity. Both instruments use a scale from one to five. Each video observation was scored by two independent researchers. Disagreements greater than one point were reviewed again and discussed in the research group until a mutual understanding was reached. For differences of one point, an average of the two scores was used. Using weighted kappa (Cohen, 1968), inter-rater agreement was 89% for well-being with a kappa value of 0.44. This indicates moderate agreement and agreements above 80% and with kappa values above 0.40 are often viewed as acceptable agreements (McHugh, 2012). For physical activity, the inter-rater agreement was 94% with a kappa value of 0.70, indicating good agreement.

Children's play was coded using categories for functional play, constructive play, symbolic play, mixed play, non-play and talking, which were adapted from previous play-categorizing studies (Dyment & O'Connell, 2013; Fjørtoft & Sageie, 2000; Luchs & Fikus, 2013). In this article, a variable describing the percentage of time the child was engaged in functional play were used. Play was coded by one researcher for the entire sample, and a random sample of 10% of the video observations was reviewed by a second researcher to ensure consistent coding. To measure the use of the tumbling room, a variable describing the percentage of time in the tumbling room was generated. Further variables describe children's age and gender, if the child had access to a tumbling space and if the child was in the intervention or control group used in the analysis.

Analysis

The scoring of well-being and physical activity was performed on an Excel spreadsheet. The use of tumbling spaces was coded using the Observer XT 12.5 behaviour coding (Noldus), analysis and management software for observation data (Zimmerman, Bolhuis, Willemsen, Meyer, & Noldus, 2009). The Observer XT data were paired with the spreadsheet of scores for well-being and physical activity and imported to Stata MP 15.1 (StataCorp, College Station, TX, U.S.A.), which was used for the statistical analysis. Given the hierarchical structure of the data with nested observations of children within ECEC institutions, multilevel regression analysis (Goldstein, 1986) was used to investigate the associations of tumbling rooms and children's well-being, physical activity and functional play. Multilevel analysis makes it possible to control for contextual factors and increases the accuracy of the predictions (Gelman, 2006).

Results

The mean duration of the 770 video observations in the full sample was 122 s (SE = 6). The average scores were 3.7 (SE = 0.7) for well-being and 2.7 (SE = 0.8) for PA. Tumbling spaces were used for 12% (SE = 32) of the observed time and accessible to children in 35% (SE = 48) of the observations. Children engaged in functional play for 11% (SE = 29) of the time. To examine the effect of establishing a tumbling space on well-being, physical activity and functional play, the participating children were placed in a control group or an intervention group based on the information given in Table 1. Descriptive statistics for the full sample and for the two groups at the two data points are presented in Table 2.

The use of the tumbling spaces varied across the institutions and the two data points. At T1, the tumbling space was in use for 46% of the time in institution D. The other institutions did not have a

Table 2. Descriptive statistics.

		Control group		Intervention group	
	Full sample	T1	T2	T1	T2
N children	65	36	36	29	29
N boys	32	15	15	17	17
N observations	770	216	208	173	173
Age, mean (s.e.)	4.2 (0.7)	3.8 (0.5)	4.8 (0.5)	3.7 (0.6)	4.6 (0.6)
Functional play, mean % (s.e.)	12 (29)	10 (27)	15 (33)	5 (19)	19 (34)
Well-being, mean (s.e.)	3.7 (0.7)	3.5 (0.6)	3.8 (0.7)	3.7 (0.6)	3.9 (0.6)
Physical activity, mean (s.e.)	2.7 (0.8)	2.5 (0.7)	2.8 (0.8)	2.6 (0.6)	2.9 (0.8)
Tumbling use, mean % (s.e.)	12 (32)	10 (30)	7 (24)	0 (0)	34 (46)
Tumbling access, mean (s.e.)	0.35 (0.5)	0.22 (0.4)	0.22 (0.4)	0 (0)	1 (0)

tumbling space at T1. At T2, the tumbling space was used 14% of the time in institution A, 7% of the time in institution B, 28% of the time in institution C, 30% of the time in institution D, 28% of the time in institution F and 17% of the time in institution G. Institution E did not have a tumbling space at either of the data collections.

The correlation matrix presented in Table 3 shows that well-being is positively correlated with physical activity ($r = .29$, $p < .001$), use of tumbling space ($r = .12$, $p < .01$), having access to a tumbling space ($r = .20$, $p < .001$) and functional play ($r = .25$, $p < .001$). Physical activity is positively correlated to age ($r = .13$, $p < .001$), use of tumbling space ($r = .39$, $p < .001$), having access to a tumbling space ($r = .22$, $p < .001$) and functional play ($r = .57$, $p < .001$). Functional play is positively correlated to use of tumbling space ($r = .42$, $p < .001$) and having access to a tumbling space ($r = .24$, $p < .001$).

Use of and access to the tumbling space

To analyse the association between the outcome variables well-being, physical activity and functional play, and the variables describing the use of and access to the tumbling space, multilevel regression analysis was applied. This was done to control for the nested data structure and the children's age and gender. Random intercept models were used in all multilevel analysis. The data are nested at three levels: observation level (level 1) ($N = 770$), child level (level 2) ($N = 65$) and institutional level (level 3) ($N = 7$). The variance partition coefficient (VPC), with a limit of 5% variance, was used to determine the number of levels in the model (Mehmetoglu & Jakobsen, 2017). VPC calculations for well-being indicate that there is 4% variance at the institutional level and 16% variance at the child level. For physical activity, there is 2% variance at the institution level and 6% variance at the child level. Similar variances are found in the functional play, with 4% variance at the institution level and 5% variance at the child level. A two-level model is selected for further analysis.

Well-being, physical activity and functional play were used as dependent variables in the analysis to investigate the association with use of and access to a tumbling space. A stepwise inclusion of variables starting at the lowest level in the model (Hox, 2010) was performed. An intercept-only

Table 3. Correlation matrix ($N = 866$ observations).

	1.	2.	3.	4.	5.	6.	7.
1. Age	–						
2. Boy (0 = girl)	.13***	–					
3. Functional play	.09*	.01	–				
4. Well-being	.08*	.03	.25***	–			
5. Physical activity	.12***	.03	.57***	.29***	–		
6. Tumbling use	.11**	.04	.42***	.12**	.39***	–	
7. Tumbling access	.22***	.03	.24***	.20***	.22***	.53***	–

*$p < .05$.
**$p < .01$.
***$p < .001$.

Table 4. Models for well-being, physical activity and functional play: use of and access to a tumbling space.

Model	M0: Functional play	M3: Functional play	M0: Well-being	M3: Well-being	M0: Physical activity	M3: Physical activity
Fixed part	Coeff.(s.e.)	Coeff.(s.e.)	Coeff.(s.e.)	Coeff.(s.e.)	Coeff.(s.e.)	Coeff.(s.e.)
Intercept	12.4 (1.3)	−.59 (6.1)	3.72 (.04)	3.23 (.17)	2.68 (.04)	2.11 (.17)
TumblingUse		.372(.04)***		.000 (.001)		.009 (.001)***
TumblingAccess		.47 (2.5)		.17 (.07)*		−.04 (.07)
Age		2.04 (1.5)		.10 (.04)*		.11 (.04)**
Boy		−.78 (2.2)		.02 (.08)		−.00 (.06)
Random part						
Level 1 Variance	820 (44)	694 (37)	.36 (.02)	.35 (.02)	.55 (.02)	.47 (.03)
Level 2 Variance	44 (20)	19 (14)	.06 (.02)	.06 (.02)	.04 (.02)	.03 (.01)
Deviance	7384	7241	1464	1441	1764	1632
AIC	7390	7255	1470	1455	1770	1646
BIC	7404	7288	1484	1487	1784	1678

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

model was run first (M0), followed by a model including a variable describing use of the tumbling space (M1). Next, a variable describing if the child had access to a tumbling space was added (M2), and lastly the second-level variables describing age and gender were added (M3). Deviance, Akaike's Information Criterion (AIC) and Schwarz's Bayesian Information Criterion (BIC) are presented to indicate how well the model fits the data and to compare the final model to the intercept-only model (Hox, 2010). Table 4 presents M0 and M3 for well-being, physical activity and functional play.

The final model for functional play indicates that there is a positive association between the use of a tumbling space and functional play. The amount of functional play is estimated to increase by 37% when children are in a tumbling space for the entire observation (100%). There is no significant association between age, gender or having access to a tumbling space and functional play, when it is controlled for the use of the tumbling space. The first model (M1) for functional play is a significant improvement compared to the intercept-only model using likelihood-ratio test ($p < .001$). M2 and M3 do not contribute significantly to explaining the variance in functional play compared to M1.

The final model for well-being (M3) indicates that there is no association between use of the tumbling space and children's well-being. There is, however, a small positive association between having access to a tumbling space and well-being. Children's well-being is estimated to be 0.17 higher on the Leuven Well-being Scale when children have access to a tumbling space. There is also a positive association between age and well-being, and being one year older is estimated to increase well-being by 0.1. There is no significant association between gender and well-being. For well-being, only M2 is a significantly improved model compared to the previous ($p < .001$) using a likelihood-ratio test. M1 and M3 do not significantly improve the explanatory value, and the overall explanatory impact of the independent variables on the variance in well-being is limited.

Physical activity is positively associated with the use of a tumbling space. If the child uses a tumbling space for the entire observation, children's physical activity is estimated to be 0.9 higher on the OSRAC-P scale. There is a positive association between age and physical activity, and being one year older is estimated to increase physical activity by 0.1. There is no significant association between gender or having access to a tumbling space and physical activity. The first model (M1) for physical activity is a significant improvement compared to the intercept-only model using the likelihood-ratio test ($p < .001$). M2 does not contribute significantly to explaining the variance in physical activity compared to M1, whereas M3 is a significant improvement ($p < .05$) over M2.

To test if there is any difference between boys and girls in how use of and access to the tumbling space influence well-being, physical activity and functional play, models with an interaction term for tumbling use/tumbling access and gender were conducted for each of the outcome variables controlling for age. No differences between the boys and girls were found in how use of or access to

the tumbling space influences well-being, physical activity and functional play. Nor is there any difference between boys and girls in how much the tumbling space is used.

Between-group analysis

Mean levels of well-being, physical activity and functional play increased from T1 to T2 for both groups (Table 1). A random-intercept model controlling for age and gender was used to examine if the intervention effect was statistically significant and if the intervention effect was different between the groups. An intercept-only model was run first (M0), followed by a model including age, gender and a variable for the intervention group (M1). Next, a variable for T2 was added (M2), and lastly, an interaction term for the intervention group and T2 was included in the model (M3).

Well-being was estimated to increase by 0.3 from T1 to T2 ($p < .001$), controlling for age and gender. Physical activity also increased by 0.2 from T1 to T2 ($p < .01$), controlling for age and gender. For well-being and physical activity there was no intervention effect, indicating that the increase is similar for the intervention group and the control group. Functional play shows an estimated increase of 10% following the intervention ($p < .01$), controlling for age and gender. Notably there was an intervention effect present in the case of functional play, estimating the intervention group to have an 8% higher increase ($p < .05$) in functional play compared to the control group from T1 to T2.

Discussion

Well-being and physical activity have been previously found to be related concepts in the outdoor environment of ECEC institutions (Sando, 2019), and the initial correlation analysis showing a moderate correlation ($r = .29$, $p < .001$) indicated that this also may apply to the indoor environment. The relatively weak association between physical activity and well-being was in line with previous studies of different mental health indicators associated to physical activity (Biddle & Asare, 2011). Functional play was positively correlated to well-being ($r = .25$, $p < .001$) and physical activity ($r = .57$, $p < .001$), indicating that the engagement in functional play may be beneficial from a health promotion perspective.

The amount of variance in well-being at the institutional level (4%) indicates that there are some structural differences between the participating institutions when it comes to children's well-being. With only seven institutions in the sample and without explanatory variables at the institutional level, this study is not suited to explain institutional influences on children's well-being, leaving the topic for investigation in future research. For physical activity there was limited variance at the institutional level (2%), a finding in contrast to previous studies indicating more than 40% variance at the institutional level (Finn et al., 2002; Pate et al., 2004). These studies, however, measured physical activity through the whole day in different environments, whereas the present study measured physical activity specifically during free play in the indoor environment. The structural differences discussed by Pate et al. (2004) as possible explanations to the large variances at the institutional level were controlled for in the present study. Findings were, therefore, interpreted in support of outdoor time and time for free play being crucial for children's physical activity levels in ECEC institutions.

The amount of variance at the child level in well-being demonstrates that this is a more internalized concept that varies less across different observations than is the case for physical activity and functional play. The child's home situation, self-esteem and feeling of self-worth are quite stable entities that may influence children's expressions of well-being. It has been previously demonstrated that caregivers in different ways influence children's well-being (de Schipper et al., 2004; de Schipper et al., 2006; Groeneveld et al., 2010), and perhaps the social environment in the institution is more important for children's well-being than the physical environment. Although children's physical activity is influenced by their preferences for physical activity and the extent to which the child has an innate

need for physical activity (Rowland, 1998), environmental and contextual factors may impact children's physical activity and functional play to a higher degree. The fact that physical activity and functional play varied more across each observation compared to well-being indicated that the potential for explaining variance in physical activity and functional play at the observational level is higher than for well-being. Thus, the impact of the child's experiences in the ECEC institution on well-being may be more long-term than is the case for physical activity and functional play. Other methods for examining well-being than direct observation may be needed to tease out such long-term effects.

Child characteristics measured in this study – age and gender – show a limited association with well-being, physical activity and functional play. Well-being and physical activity are positively associated with age with an estimated increase of 0.1 in both measures if the child is one year older. Functional play is not associated with age. Nor are well-being, physical activity or functional play related to gender, and no differences were found between the genders when it comes to the impact of the tumbling space on the outcome variables. Previous studies have found boys to be more physically active than girls (Tonge et al., 2016). In light of this finding, one could hypothesize that boys would utilize the tumbling space for physical activity and functional play to a larger degree than girls, but this was not the case in the present sample. These results show that there are no differences between boys and girls in how much the tumbling space is used or how this space influences their well-being, physical activity and functional play. These rooms provided possibilities with open-ended materials that are not coded for special purposes or gendered roles and thus may be used in a multitude of ways by children with different interests. The fact that the tumbling space offers equal opportunities for functional play and physical activity for boys and girls is interpreted as a positive finding, and adds to the positive benefits of having access to a tumbling space.

Results also showed that access and use of the tumbling space explained little of the variance in well-being. There was a small positive association between having access to a tumbling space and children's well-being, but no associations between the use of the tumbling space and well-being. This may indicate that having access to a tumbling space allowing children to engage in bodily play has a positive influence on children's well-being through the day, a notion also supported by the correlation between physical activity and well-being. However, to what degree an estimated increase in well-being of 0.17 on the Leuven scale translates to an actual improvement in well-being in real-life is uncertain. The limited impact, the complexity of the concept and the challenges with the measurement of well-being (Mashford-Scott et al., 2012) illustrated with an inter-rater agreement in the lower acceptable spectrum, calls for a cautious interpretation of this finding.

Physical activity and functional play was, however, strongly associated with how much time the children spent in the tumbling space. The results in this study indicated that physical activity could be expected to be 0.9 higher on the OSRAC-P scale and the amount of functional play to be 37% higher when children are in the tumbling space for the entire observation. This adds to previous evidence suggesting that the possibility to use rooms in the indoor environment for motor activities is positively associated with children's activity levels (Barbosa et al., 2016; Sugiyama et al., 2012). Targeting the possibilities for functional play in the indoor environment may, therefore, be a successful intervention strategy in order to promote physical activity in ECEC institutions.

The implementation of tumbling spaces in five of the participating institutions was done in order to test the hypothesis that such an environment could promote functional play, well-being and physical activity. Functional play increased significantly more in the intervention group following the intervention, indicating that the introduction of a tumbling space provided opportunities for functional play that children actualized. Although there is a significant increase in well-being and physical activity from the first to the second data collection, the increase is equal for the intervention group and the control group. Children in the intervention group utilized the tumbling space for almost one-third of the observed time, showing that this space was very popular. However, the between-group analysis does not support the hypothesis that the establishment of this environment leads to higher well-being and physical activity. Still, the increase in functional play in the intervention

group may have possible positive benefits in itself for children's social and motor development even if well-being and physical activity are stable.

The increase in well-being and physical activity following the intervention may be explained by other changes in the physical environment, by rater bias as the researchers doing the scoring of well-being and physical activity have been involved in the interventions, or by other aspects. It is also possible that the increase in physical activity in the intervention group was primarily related to the introduction of the tumbling space, and by other factors in the control group. The clear association between use of the tumbling space and physical activity and the popularity of the room in the intervention group may support this notion. The lack of control over potentially important contextual factors such as the staff, what department children attend and access to other supportive environments for physical activity such as a specialized room for physical activity may also explain the lack of difference between the intervention and the control group.

Although the intervention in this study focused on the physical environment, another more unspoken 'intervention' has targeted the social environment. The importance of physical activity for children in the indoor environment has been highlighted in the discussions in the extended project group and in formal and unformal meetings in each of the participating institutions. This has most likely influenced the staff's attitude towards physical activity in the indoor environment, and possibly also to the degree to which functional play is promoted in the indoor environment. This effect may be illustrated by the increase in functional play in the control group from T1 to T2, while children's use of the tumbling space decreased. This may indicate that the social acceptance for functional play increased in both groups following the intervention. The social environment has been found to be important for how children can utilize the physical environment for physical activity (Gubbels et al., 2011), and the degree to which the adults in the institutions have integrated this attitude may influence children's possibilities for functional play in the indoor environment. The lack of difference between the control group and the intervention group in physical activity may indicate that the social environment can override the physical environmental intervention. Perhaps the social environment represents the most important limiting factor for children's physical activity in the indoor environment and, if allowed, most children will engage in physical activity. A more rigorous study design examining combinations of interventions targeting both the physical environment and the social environment in a larger sample may be needed to develop knowledge on how to most effectively to promote physical activity in the indoor environment.

Conclusion

The variability in access to tumbling spaces across the two data points allowed for a quasi-experimental analysis studying the effect of establishing a tumbling space on children's well-being, physical activity and functional play. The main finding in this study is that the introduction of tumbling space in ECEC institutions increases the amount of functional play in the indoor environment for boys and girls alike. The lack of randomization and the changes in other environmental and contextual factors from T1 to T2 in all institutions, call for caution when interpreting the results from the between-group analysis. It is important to highlight that the aim for design research in education is to generate and develop hypotheses, not testing them (Kelly, 2006). Hopefully, the results from this study can be adapted to more general knowledge claims and theory building that can be tested in more rigorous studies later. Still, the positive associations between the use of the tumbling space and the children's physical activity and functional play are promising from a health promotion standpoint and shows that an environment supportive of functional play is associated with physical activity.

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Paper IV

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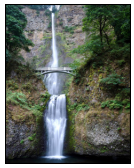

Affordances for physical activity and well-being in the ECEC outdoor environment

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ABSTRACT

Children's everyday experiences with physical activity in Early Childhood Education and Care (ECEC) institutions are important from a health promotion standpoint. Experiencing well-being in physically active play is important, and the affordances of the environment may support such behaviour. The aim of this study is to develop knowledge about how the affordances of the ECEC outdoor environment may facilitate physical activity and well-being simultaneously. The sample in this study consists of 858 video observations of 2 min from eight ECEC institutions. The video observations are analysed both quantitatively and qualitatively. The findings highlight the importance of the physical environment for promoting children's well-being in physical activity and show how different affordances of the environment are important to enhance well-being and physically active play for all children in the outdoor environment of ECEC institutions.

1. Introduction

Early Childhood Education and Care (ECEC) institutions represent an important learning environment for children's development (Phillips & Shonkoff, 2000). The everyday activities in ECEC institutions have a crucial role in a child's life and from a health perspective. Health is an ambiguous concept, holding a wide range of elements. In this study, well-being and physical activity are selected as indicators for children's health. Well-being is understood as a subjective and internal experience of feeling "well" (Koch, 2018; Mashford-Scott, Church, & Tayler, 2012). Physical activity is defined as any bodily movement produced by the skeletal muscles that results in energy expenditure (Caspersen, Powell, & Christenson, 1985). Following the growing concern about children's health linked to sedentary behaviour and the prevalence of overweight (Pate, Mitchell, Byun, & Dowda, 2011), the positive benefits of the outdoors have been highlighted in recent years (Waller, Sandseter, Wyver, Ärlemalm-Hagsér, & Maynard, 2010). The outdoor environment is found to be beneficial for children's development, well-being and physical activity (Cooper, 2015; Pate, Pfeiffer, Trost, Ziegler, & Dowda, 2004; Ulset, Vitaro, Brendgen, Bekkhus, & Borge, 2017). Hence, the way in which the outdoor environment in ECEC can promote children's well-being and physical activity is the focus of this study.

1.1. The physical environment in ECEC

The theory of affordances (Gibson, 2014) offers a framework for considering the child-environment interaction since this theory concerns the individual's perception of the environment. Affordance is defined as what the environment offers the individual and what it provides or furnishes, either good or ill (Gibson, 2014). Affordance includes both the environment and the child, meaning the affordance is unique and relative for each individual. An affordance emerges from the interaction between the child and the environment, an interaction that is immediate, as affordances are perceived directly in a natural flow of activity (Heft, 1989, 2003). The perception of affordance is influenced by the child's intentions, previous experiences and the context. Because of the dynamic and contextual considerations for affordance, Heft (2003) emphasises that affordances are not a fixed functional property of a feature, rather they are a dynamic entity in the ongoing person and environment process. Affordance may therefore be suitable for studying the interaction between the child and the environment in a dynamic and context-dependent reality.

Affordance has previously been applied to research on how children utilise the outdoor ECEC environment. Such study has demonstrated how both physical and social affordances influence children's physical activity levels (Bjørgen, 2016), how different places afford different activities (Cosco, Moore, & Islam, 2010; Smith et al., 2014), the importance of available affordances in the outdoor environment for

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children's social play (Larrea, Muela, Miranda, & Barandiaran, 2019), how the environment affords risky, thrilling, and intense play opportunities for children (Sandseter, 2009), and the benefits of having access to both natural and built environments (Norðdahl & Einarsdóttir, 2015; Zamani & Moore, 2013).

1.2. Children's play

Play is a key concept when studying children in ECEC institutions. From the children's perspective, play is voluntary and self-controlled, it is a fun, active, spontaneous, free, unlimited, natural and self-initiated activity (Fein & Wiltz, 2006). These characteristics of play highlight the inherent value of play and that children play because they enjoy the activity itself. The intrinsic value of play and the positive impact on children's development in general imply that children's play should not be reduced to a means for promoting health (Alexander, Frohlich, & Fusco, 2014; Herrington & Brussoni, 2015). Therefore, a holistic approach to how play can be facilitated in ECEC institutions is favourable.

Building on the theory of affordances (Gibson, 2014), the features of the physical environment can be hypothesised to influence children's play behaviours. Previous research has demonstrated how different places and elements in the environment are significant for children's play (Dyment & O'Connell, 2013; Shim, Herwig, & Shelley, 2001; Torrens & Griffin, 2013). Playing is also found to be related to both physical activity and well-being in the outdoor environment of ECEC institutions (Author). If the aim is to promote children's health, then promoting children's play through a supportive environment might be a fruitful approach.

1.3. Physical activity

The emphasis on physical activity in early years is often rooted in a belief that physical activity habits are established in childhood. However, longitudinal studies have found tracking of physical activity from childhood to adulthood to be non-significant or very low (Telama, 2009). As highlighted by Malina (1996), many contextual factors influence how physical activity tracks across life. One possible important factor is to what degree children perceive physical activity in childhood as something positive. If children are physically active in a playful setting where they enjoy the activity, positive activity habits may grow. Hence, a shift from how much time children are physically active, to how children perceive and experience physical activity may be beneficial.

A growing body of research shows how the physical environment has an influence on children's physical activity. Pathways and open spaces have been found to be positively associated with physical activity (Cosco et al., 2010; Nicaise, Kahan, & Sallis, 2011; Sando, 2019). Studies examining associations between physical activity and nature (Olesen, Kristensen, Korsholm, & Froberg, 2013; Storli & Hagen, 2010), fixed functional equipment (Bower et al., 2008; Dowda et al., 2009; Olesen et al., 2013; Sugiyama, Okely, Masters, & Moore, 2012), and loose parts (Brussoni, Ishikawa, Brunelle, & Herrington, 2017; Bundy et al., 2009; Hannon & Brown, 2008; Sando, 2019) show divergent results, and no clear conclusion about these elements' association with physical activity can be established. This illustrates the complexity of the child-environment relationship.

1.4. Well-being

Well-being is in this study defined as to what degree children feel at ease, are vital, self-confident and spontaneous (Laevers, 2000). Since children who attend ECEC institutions often spend a lot of time in the institutions, and their experiences and activities in a given day are highly dependent on the institution, it is appropriate to believe that the ECEC institution is important for children's well-being. Well-being is also a key component in programme quality, but understandings of what well-being is and how ECEC institutions can promote well-being are varied and unclear (Mashford-Scott et al., 2012).

Little is known about the influence of the outdoor environment on well-being. Previous research suggests that natural elements may be beneficial for different indicators of children's wellness (Brussoni et al., 2017; Carrus et al., 2012; Sando, 2019; Söderström et al., 2013). In a study of the perspectives of four-to six-year-olds on their well-being, the physical environment and available materials were among factors highlighted as being of crucial importance in ECEC institutions (Sandseter & Seland, 2016). Still, the overall knowledge base of how the outdoor environment may influence children's well-being is limited and needs to be expanded.

1.5. Aim of study

The main objective of this study is to develop knowledge about play episodes where children experience high well-being and physical activity simultaneously in the outdoor environment, and how children utilise affordances in these situations. The following research question will be addressed: *How can affordances in the ECEC outdoor environment promote physical activity and well-being simultaneously?* This can contribute to a better understanding of how the outdoor environment in ECEC institutions may promote physical active behaviour that children perceive positively.

2. Materials and methods

This study was conducted within the project EnCompetence, funded by The Norwegian Research Council, and approved by the Norwegian Social Science Data Services. The project is a three-year study using mixed methods (Creswell, 2013) conducted in close collaboration with three ECEC owners in Norway. Data collection involved systematic and randomised video observations of children in outdoor environments at two data points. The observations were conducted during free play, meaning children could decide what they wanted to do, where they wanted to be and with whom they wanted to interact. Adults was available in the environment, and the adult-child ratio was about 1:6.

2.1. Procedure and sample

Eight ECEC institutions were strategically selected among the partner institutions to allow variation in size, age, location and physical environment. The eight outdoor environments range from small urban environments with mainly asphalt and rubber surface to large (13 000 square meters) natural environments. Five girls and five boys in each institution were randomly selected among the three- and four-year-old children, and written consent to participate was obtained from parents. Data collection was performed over 1 week at two data points in each ECEC institution during the fall of 2017 and 2018 by four researchers and eight co-researchers. The researchers developed a strict data collection protocol that was followed in each of the ECEC institutions. A preschool teacher from each ECEC institution was recruited as a co-researcher and conducted the filming. The researcher wrote field notes and ensured that the protocol was followed. A person familiar to the children performed the video recordings using small neutral cameras with wide-angle lenses, GoPro Hero action cameras, to reduce any impact on the children's behaviour during the observed episodes. The co-researcher attempted to get as close as possible to capture speech, body language and facial expressions without affecting the situation. To ensure that random episodes were filmed, the filming of the children followed a predetermined schedule that stated the order and time that observations were to be conducted. Two children were filmed each day. The first child was filmed for 2 min, followed by a 6-min break. Then, child two was filmed for 2 min, followed by another 6-min break. This alternation between the first and the second child was repeated until six video observations of each child were recorded in the outdoor

environment. If the children were in situations in which 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. The co-researcher was very conscious to refrain from filming in sensitive situations and kept an ongoing dialogue with the children about the filming to ensure assent to participation.

The first data collection (T1) included 80 children. The second data collection (T2) was carried out a year after T1. Six of the 80 participating children no longer attended the institution. Additionally, one child was not included at T2 for ethical reasons. The sample in this article therefore includes 73 children, 36 boys and 37 girls, with a mean age of 4.2 years (SE = 0.7). A complete sample of six observations at two data points for 73 children would include 876 2-min video observations. The final sample only included 858 observations (429 observations at each data point, with an average of 11.8 observations per child). Hence, 18 observations are missing. Missing observations occurred because children were sick or picked up early, or they were excluded because the child was hidden from view, was preoccupied with the camera, or a technical or human error occurred.

2.2. Measures

The Leuven Well-Being Scale (Laevers, 2005) was used to measure the well-being of the children on a scale from 1 (extremely low) to 5 (extremely high). 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. A score of 3 indicates a neutral posture with moderate well-being. Score 2 (low) and 4 (high) indicate obvious signs of either discomfort or happiness that are not consistently present. The Observational System for Recording Physical Activity in Children–Preschool (OSRAC-P) (Brown et al., 2006) was used to measure physical activity, which codes PA from 1 (stationary) to 5 (fast movement). A score of 4 indicates moderate movement, and are commonly used as the cut-off point for moderate to vigorous physical activity (MVPA). Training videos and workshops were conducted by the three researchers performing the coding to promote consistency in the coding and interpretation of both scales.

Two independent researchers scored each video observation. Disagreements greater than one point were reviewed again and discussed in the research group until a mutual understanding was reached. For differences of one point, an average of the two scores was used. Using weighted kappa (Cohen, 1968), inter-rater agreement was 90% for well-being, with a kappa value of 0.48. This indicates moderate agreement, and agreements above 80% and with kappa values above 0.40 are often viewed as acceptable agreements (McHugh, 2012). For physical activity, the inter-rater agreement was 92%, with a kappa value of 0.65 indicating good agreement. Based on the scores of well-being and physical activity, a dichotomous variable identifying observations with both well-being and physical activity scores of four or higher was created. These cut off points were chosen since four or above on the physical activity scale represents MVPA, and four on the well-being scale indicates high well-being.

Children's play and the observation's social characteristics were coded continuously, and the categories were mutually exclusive. Children's play was coded using categories for functional play (e.g. running, riding bikes, tumbling, climbing), constructive play (e.g. building sand castles, creating huts and shelters), symbolic play (e.g. role play, dramatic play, social play), mixed play (when children combine several types of play without one being dominant), non-play and talking. These categories were adapted from previous play-categorising studies (Dyment & O'Connell, 2013; Fjørtoft & Sageie, 2000; Luchs & Fikus, 2013). The variables used for play in this article describe the percentage of time for each of the play categories for each observation. Group composition categories in the OSRAC-P (Brown et al., 2006) were used to capture the observation's social characteristics. 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 and social characteristics 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 to ensure consistent coding.

Categories for places and objects were developed to measure the components of the physical environment. 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 context and theoretical framework for this study. The categories for place included sandbox, pathways, nature, open area, fixed functional play equipment (swings, climbing towers, slides, etc.), fixed role-play equipment (playhouses, boats, huts, stores, etc.), fixed equipment other (tables, storage, etc.) and indoor (cubbies, huts and semi-heated outdoor rooms). Places were coded continuously, and the categories were mutually exclusive. Variables describing the use of sandbox, pathways, nature, open area and fixed functional equipment were included in the analysis in this study. Sandbox, open area and fixed functional equipment were present in all of the eight environments, while the presence of nature and pathways varied.

The use of objects was coded when a child was holding, using or interacting with an object. To capture the possibility that children may use several objects at once, the categories of objects were not mutually exclusive. Categories for objects included sand, water, mud, nature materials, toys, open-ended materials and wheeled toys. Sand, toys, and wheeled toys were available in all eight institutions, whereas the availability of water, mud, nature materials and open-ended materials varied across the institutions. The variables for places and objects describe the percentage of time the child is at a place or in which the object was used during each observation. The coding of place and objects was performed by one researcher, and a random sample of 10% of the video observations was reviewed by a second researcher.

2.3. Analysis

The scoring of well-being and physical activity was performed on an Excel spreadsheet. Play, social characteristics, places and objects were coded using Observer XT 12.5 behaviour coding (Noldus), analysis and management software for observation data (Zimmerman, Bolhuis, Willemsen, Meyer, & Noldus, 2009). The Observer XT data were paired with the spreadsheet of scores for well-being and physical activity and imported to Stata MP 15.1 (StataCorp, College Station, TX, USA), which was used for the statistical analysis. Given the hierarchical structure of the data, with several observations of each child and the dichotomous outcome variable, generalized linear latent and mixed models (GLLAMM) (Rabe-Hesketh & Skrondal, 2008) was used to investigate the associations between the observations with high well-being and physical activity and age, gender, play, social context, places and objects.

Following the statistical analysis, the video observations with high well-being and physical activity were identified and analysed qualitatively to search for the affordances children actualised in these observations. This analysis used three of Gibson (2014) categories for affordances as a starting point: *other persons and animals*, *places* and *objects*. The first phase in this analysis was conducted by writing descriptions of how these three groups of affordances were actualised in the observation. Additionally, a general description of the observation was written to describe the context of the observation. This first phase of the analysis was not a detailed description of every affordance the child actualised in the observation. The aim was rather to get a broad overview of how these three categories of affordances were utilised and to identify general trends in how children used the affordances in the environment. In the second phase of the analysis, each written description from the first phase was read, and general comments

regarding how the children utilised the three groups of affordances were written. This analysis was conducted by one researcher, and a second researcher reviewed the analysis and provided comments and adjustments to the initial coding and interpretation. Quotes from the transcribed observations representing ideal types of how different types of affordances commonly utilised are included in the results to provide examples from the material. The quotes are marked with a fictive name of the child, and the age is indicated with numbers; e.g. 4.11 meaning four years and 11 months.

3. Results

The results from the quantitative analysis are presented first, followed by the qualitative analysis. In the discussion, the findings from the two approaches will be combined in an overarching discussion drawing on both analyses.

3.1. Quantitative analysis

The mean duration of the 858 video observations was 122 s (SD = 5). There is an average of 11.8 observations per child, and 49% of the observations were of boys. Descriptive statistics are presented in Table 1.

To examine significant associations between observations with high well-being and physical activity and age, gender, play, social context, places and objects, GLLAMM (Rabe-Hesketh & Skrondal, 2008) was used. Models were fitted separately for background variables, play, social context, places and objects. Age and gender were added to all models to control for these characteristics. Written descriptions of the main findings in these models are provided in the following results. Full models are available from the corresponding author.

Table 1
Descriptive statistics for the full sample, the high well-being and physical activity observations and the remaining sample.

	Full sample	High Well-being and Physical activity	Remaining sample
	N = 858	N = 175	N = 683
	Mean (SD)	Mean (SD)	Mean (SD)
Age	4.2 (0.7)	4.5 (0.7)	4.1 (0.7)
Well-being	3.7 (0.7)	4.4 (0.4)	3.6 (0.6)
Physical activity	3.2 (0.9)	4.4 (0.4)	3.0 (0.7)
Play			
Functional play %	35 (40)	61 (40)	28 (37)
Constructive play %	23 (38)	9 (26)	26 (40)
Symbolic play %	7 (22)	8 (24)	6 (22)
Mixed play %	6 (22)	11 (30)	5 (19)
Social context			
With other children %	77 (37)	86 (29)	75 (38)
With adult %	21 (36)	17 (35)	22 (37)
Places			
Sandbox %	9 (27)	3 (15)	11 (29)
Pathways %	5 (15)	7 (15)	4 (15)
Nature %	5 (21)	7 (24)	5 (20)
Open area %	53 (42)	51 (38)	53 (43)
Fixed functional %	15 (33)	21 (37)	14 (32)
Other places %	13 (28)	11 (22)	13 (30)
Objects			
Sand %	10 (27)	2 (8)	12 (30)
Water %	8 (23)	6 (20)	9 (24)
Mud %	1 (9)	1 (8)	1 (9)
Nature materials %	14 (31)	10 (26)	15 (32)
Toys %	32 (44)	20 (37)	35 (45)
Open materials %	7 (23)	7 (20)	7 (23)
Wheeled toys %	14 (33)	12 (31)	14 (33)

3.1.1. Child characteristics, age, gender and play types

Children experience high well-being and physical activity to a varying degree. Intraclass correlation analysis estimates that 12% of the variance is at the child level, indicating that there are substantial differences among children. The observations with high well-being and physical activity are distributed among 61 children, with an observation range from one to eight among these children. Thirteen children, four boys and nine girls, had no such observations. There is a positive association between observations with high well-being and physical activity and being a boy (b = 0.45, p = .04, 95% CI = 0.02-0.88). Boys represent 59% of the observations. Higher age is also positively associated with high well-being and physical activity observations (b = 0.67, p = .000, 95% CI = 0.40–95). The amount of the play types functional play (b = 0.035, p = .000, 95% CI = 0.027-0.043), symbolic play (b = 0.019, p = .000, 95% CI = 0.009-0.030) and mixed play (b = 0.033, p = .000, 95% CI = 0.023-0.043) are all higher in the observations with high well-being and physical activity. Constructive play is not significantly different in these observations.

3.1.2. Other persons and animals, places and objects

Observations with high well-being and physical activity are positively associated with being with other children (b = 0.009, p = .003, 95% CI = 0.003-0.015). The presence of adults is not significantly different in these observations.

Observations with high well-being and physical activity are positively associated with the use of pathways (b = 0.018, p = .005, 95% CI = 0.005-0.030) and fixed functional equipment (b = 0.011, p = .007, 95% CI = 0.003-0.019). The other place categories, sandbox, nature and open area are not significantly different.

Objects are used less in observations with high well-being and physical activity compared to the other observations. More use of sand (b = −0.027, p = .001, 95% CI = −0.043–0.011), nature materials (b = −0.008, p = .028, 95% CI = −0.015–0.001) and toys (b = −0.007, p = .022, 95% CI = −0.012–0.001) is negatively associated with observations with high well-being and physical activity. Variables describing the use of water, mud, open materials and wheeled toys are not significantly different.

3.2. Qualitative analysis

The results from the qualitative analysis are grouped in the three categories of affordances used in the analysis: other persons and animals, places and objects.

3.2.1. Other persons and animals

Other children are highly present in almost all of the observations with high well-being and physical activity. There is often a large group of children playing together in a symbolic context.

> Tom 4.11: *A large group of children plays a catch game. The play is based on a TV series called The Labyrinth. The play starts close to a labyrinth built by pallets in one corner of the outdoor area. A boy pretends to be a robot that hunts the other children. The boy we are following runs from the dangerous robot together with several other children. Close to the entrance, a large cable reel functions as a free haven. They express joy and fear of the robot and run back to the labyrinth, where they collapse in the grass.*

Different types of rough-and-tumble play, such as hunting, catching and play fighting are commonly occurring.

> Hans 4.10: *Three children stand by the climbing structure. A boy and a girl walk off, and the boy we are following waits for a couple of seconds before he roars loudly and runs after them. They run between small hills and onto a circular pathway, where the girl is captured. The boy comes running to help the girl. Two other children join the fight and free the girl. The chase continues on the pathway and into an open grass field. The girl*

is captured once again and dragged down in the grass. Two children join the pile of children trying to free the girl. They succeed and run off again. Next, one of the boys is chased and captured. The two boys are harsher in their play fighting. They hit and kick each other within a playful context. The children are happy, physically active and deeply involved in the play.

Other children are a necessity to carry out such functional/risky play, as they afford someone to hunt and fight with and have fun with. In other episodes, we also see that other children may heighten the physical challenge by increasing the speed or difficulty or by acting as an obstacle. Although many of the observations involve different types of functional play, such as climbing, cycling, swinging, running or jumping, the functional play episodes commonly also involve a story or fantasy context in which the movements are carried out. This context is commonly constructed with other children. As such, other children are important affordances in the environment for physical activity episodes with high well-being in a multitude of ways.

Adults are, for the most part, not directly involved in the observations with high well-being and physical activity. Adults commonly observe the activity from a distance. There are, however, some observations where adults are playing with children.

Peter 4.5: *One adult and several children are building an obstacle course in an area with gravel. The adult initiated the activity and digs in the gravel to place stumps, logs and cable reels in a circular course. The boy in focus collects a large stump in another part of the outdoor space and carries it to where they are building. The stump is heavy. He is clearly proud that he managed to carry the stump and the adult praises him for his strength. He runs off in joy to find more stumps with another boy.*

The adult has initiated a constructive play activity that resulted in physical activity and joy through the mastering of different skills. Having the time to fully engage in such activities seems to be a shortage, and sometimes they are distracted when engaged in play.

David 4.1: *One adult and several children are playing in the sandbox. The sand represents the sea where the boy we are observing is a shark. The other children and the adult are humans the shark tries to eat. When eaten, they too become sharks. The humans are balancing on the edge around the sandbox and jump onto a wooden podium in the middle of the sandbox. Suddenly, another adult contacts the participating adult to sort out some practicalities. The play continues, but the intensity and involvement in the play drop for many of the children.*

The adults' participation helped give different environmental characteristics meaning and supported physically active play and well-being for the group of children. Such observations of adults indicate that adults have a potential to facilitate positive experiences with physical activity for children, but this potential is rarely utilised in the observations in this study. Animals are also included in this category of affordances. There are only a few clips where animals are a focus of the child's attention in the investigated observations. All of these observations involve worms. The high well-being in these episodes is connected to the children's joyful and thrilling encounter with a living creature, and the physical activity is connected to movement in their search for more worms or to show the captured worms to other children or adults.

3.2.2. Places

A variety of places are used in the observations. Some places afford thrills, excitement and physical challenges, other places are resource-rich environments that inspire complex forms of symbolic play, whereas other observations occur in open areas with limited affordances provided by the place. Fixed playground equipment, such as climbing structures and swings, are places that afford functional play types and mastering of motor skills.

Monica 5.2: The girl hangs by her arms from the climbing handles half a meter above the rubber surface. By swinging her body and letting one arm go, she moves forward. She passes with ease a piece of cloth that hangs from one handle. With full control, she lets go and lands on the ground before she starts over with a different part of the equipment.

Here, the physical environment affords the child possibilities for movements that drive and inspire the play. In other observations, the physical environment is a surrounding where the child's play, imagination and interaction with peers and adults play out. Fixed, functional play equipment may also serve this role.

Noah 4.0: He stands in the middle of the climbing structure. He participates in a catch game with an adult and a large group of children. The adult plays a pirate known from a TV series. The children try to escape. The playground equipment is a frame for the play, and different subspaces within the structure are given functions, such as a pot where children are placed to be boiled when captured.

The same equipment that provided the girl with challenging climbing opportunities is here a scene for symbolic play. Different parts of the equipment are given a symbolic meaning in an interaction between the equipment, the participating children and the adult. Places with many and diverse natural elements are also commonly used in the observations with high well-being and physical activity. Also, natural elements afford possibilities for symbolic play.

William 4.8: He plays with a girl below a large old tree with branches hanging over them. They jump across a small gap in the terrain filled with needles from the overhanging tree. They jump across several times, holding a rake in each hand. The gap contains lava, and they collect more needles (lava) to fill the gap. He wants a nearby adult to participate in the play and makes armour and lava shoes for the adult with the rakes at a stump so she can join the play.

Natural elements afford changing affordances in different weather conditions and seasons. Affordances that suddenly appear in the environment due to seasonal variations and weather conditions seem to attract children.

Maria 3.1: Heavy rain and a lack of drainage have resulted in a large pool of water. Several tables have been placed over these pools to prevent children from going into the water. Together with several other children, the girl jumps from the tables into the water. The water splashes, and the children enjoy the activity. They seem to adjust the challenge in their play in accordance with their skills. The girl in the observation jumps off the bench meant for seating, whereas other children jump off the top of the table. Two boys even cover their eyes before jumping off the table to increase the challenge even more.

Places with challenging and varied terrain, such as nature, facilitate physical activity with high well-being, although the main activity is not functional play. To move sand or water from one place to another, children playing in a natural environment have to move through rough terrain, demanding motor skills and physical activity. Similarly, pathways are places in the outdoor environment that facilitate physical activity in many different play episodes. Pathways are used in a continuous flow of activity and are often incorporated into a symbolic play context or used for transportation in different activities. Many of the observations with high well-being and physical activity are also played out in open areas. Here, the affordances provided by other children commonly drive the play, and the open area simply affords a place where they play and interact and have fun with each other.

3.2.3. Objects

Objects provide a wide range of affordances for children in the outdoor environment and are used in many different ways. However, there are also many observations with high well-being and physical activity where objects are not used. In episodes where children engage in running, climbing and rough-and-tumble play, objects are, for the most part, not used. In other play types, such as symbolic play, objects often have a key role.

Patrick 5.3: A group of boys is pretending to drive taxis. Each of the boys has a tricycle that he pretends to be a car. They cycle in a row on pathways and through open areas at high speed. Different places in the outdoor area have different functions. Money is collected at one side of the building, and the airport is on the other side of the building. One of the children holds a board that represents a phone.

Here, tricycles and the board were important elements representing cars and a phone in this symbolic and functional play context (mixed play). Objects may also serve purposes other than representing imaginary items, like affording possibilities for children to create their own places.

Lucas 5.5: Several boys are playing family. Below a slide, they have created a small space using different boxes. Twelve boxes are used to fill openings so there is an intimate subspace below the slide. The boy we are following walks over to a boy who pretends to be a baby. They walk to a box that lies upside down and use the box as a trampoline. The plastic at the bottom of this box is flexible and affords jumping. He climbs back into the subspace below the slide, a place that seems to function as their home.

Although objects are commonly used in symbolic play episodes, objects are also involved in episodes where children engage in challenging functional play. A small piece of wood was used for balancing, resembling a skateboard, in one observation. Thrilling and risky play is also a play where children commonly challenge their physical and motor abilities, and objects are often used to achieve high speed. Objects such as cycles, tricycles, spades and baby buggies are used in play with great speed. Also, equipment from the sandbox is used in play with high speed.

Oliver 4.10: He plays with another boy by the sandbox. They each collect a truck from the sandbox. There is a steep hill and pathway below a large tree close to the sandbox. They carry the trucks up this hill. At the top of the hill, they sit down on top of the trucks and ride down the hill at high speed.

In this observation, equipment from the sandbox was used for purposes other than their intended use and provided these boys with possibilities for exciting high-speed play. This may serve as an example of the overarching finding in the qualitative analysis, namely the complex and relational nature of different sets of affordances in observations with high well-being and physical activity. Other children and adults, places and objects all provide valuable affordances for children in the outdoor environment. These categories of affordances are not isolated entities, but rather elements that interact and strengthen each other.

4. Discussion

The objective of this study was to develop knowledge about episodes where children express high well-being during physical activity and what affordances children utilise in such situations. The results from the quantitative analysis indicate that children experience well-being in physical activity to a varying degree and add to previous evidence suggesting that activity patterns differ between children (Andersen et al., 2017). Boys and older children had more observations with high well-being and physical activity, and as many as 13 children in our sample did not experience high levels of well-being and physical activity simultaneously during the observational period. This highlights the importance of teachers being conscious of how children experience free play in the outdoor environment and systematically observing all children in the outdoor environment to ensure that all children participate in play.

The results from both the quantitative and qualitative analyses highlight the importance of play for simultaneously promoting physical activity and well-being. Observations with high well-being and physical activity included more functional, symbolic and mixed play compared to the other observations. This finding should be interpreted within a holistic take on children's play, where health is conceptualised broadly, and a diversity of play types should be promoted (Alexander et al., 2014; Herrington & Brussoni, 2015). It is important to underline that play is a voluntary, self-initiated and spontaneous activity that runs out of the child's interests (Fein & Wiltz, 2006), and not something that adults can force children into. Providing children with a physical environment that affords a multitude of play opportunities may be a beneficial strategy, where the fundamental self-initiated nature of play is ensured. The importance of promoting a wide range of play activities is demonstrated by the finding that many episodes happened within a symbolic (e.g. Noah 4.0, William 4.8, Patrick 5.3) and risky play context (e.g. Monica 5.2, Maria 3.1, Oliver 4.10). Sandseter and Kennair (2011) discussed how risky play may be beneficial for children's development, and this study's findings indicate that allowing children to take risks also may be important in facilitating positive experiences with physical activity. Therefore, aiming to facilitate a wide range of play opportunities in the outdoor environment of ECEC institutions is significant from a health perspective.

4.1. Sharing experiences with other children and adults

A supportive environment for play is one that has the social child in focus. The importance of other children was a predominant finding in both analytic approaches. Other children afford someone to play with and someone to share experiences with. Other persons offer the richest and most elaborate affordance as they move around and interact with each other and the individual (Gibson, 2014). They may also inspire movement and increase the challenge and complexity in the activity. Although the presence of adults was not related to observations with high well-being and physical activity in the quantitative analysis, the results from the qualitative analysis indicate that adults in the environment may also serve an important role. However, this potential is not commonly utilised in the present data. Bjørgen (2016) showed the importance of social affordances for physically active play, and how sharing social knowledge and observing others' behaviour may motivate and facilitate physical activity. The episodes of play fighting in the present study show the joy, activity and intense experiences that can flourish in a social and bodily play context. As such, ECEC institutions should seek to facilitate environments that strengthen friendships and children's relationships.

4.2. Having access to various and diverse places

Places are locations in the environment that offer sets of affordances (Gibson, 2014), and different places have been found to afford different activities (Cosco et al., 2010; Smith et al., 2014). The quantitative analysis identified fixed functional equipment and pathways as places that were positively associated with high well-being and physical activity. Children's use of pathways illustrates the dynamic and spontaneous child-environment relationship (Heft, 2003), where affordances in the environment are perceived directly in a flow of activity. The pathways could function as a running track, road for cars or a cycling track, depending on the play context and the child's intentions. Similarly, fixed playground equipment could, although designed for functional play purposes, serve as a scene for symbolic play. The ideal fixed playground equipment perhaps meets both ends, providing physical challenges and having different subspaces that can be used in a variety of play contexts. The overall impression from the qualitative analysis is that episodes of high well-being and physical activity happen in a variety of places. Having access to different places, smaller and bigger, closed and open, natural and built environments seems to be beneficial, a notion in line with previous research (Norodahl & Johannesson, 2016; Zamani & Moore, 2013).

4.3. Interacting with a multitude of objects

In the quantitative analysis, the limited use of objects in the observations with high well-being and physical activity revealed that objects are not a necessity for children to experience well-being in physically active play. Previous analysis of well-being and physical activity independently (Sando, 2019), indicate that more use of objects are mostly negatively linked to physical activity. However, objects were in the present study found to be important elements in episodes where children engaged in symbolic play in the qualitative analysis, a finding in line with a previous study (Larrea et al., 2019). Further, the amount and type of objects available in the outdoor environments in the present study may have influenced the degree to which children utilised objects in physical active play. Having access to an abundance of open-ended objects like wooden planks, tyres, plastic barrels and water containers that afford physical active play, as demonstrated by Bundy et al. (2009), could have influenced the results.

The role of objects should also be considered in relation to what places the outdoor environment holds and the children's interests, so the objects strengthen the affordances of the places and build on the child's interests. Although the results from the quantitative analysis indicate that wheeled toys are not related to observations with high well-being and physical activity, the qualitative analysis showed how tricycles within a social and symbolic play context, where they have access to circular pathways, may facilitate both high levels of well-being and physical activity. This illustrates how different affordances in the environment interact and can collectively support children's play and how social affordances influence the relationship between the physical environment and the child. This highlights the context-dependent nature of the interactions between the child and the environment and the infinite number of factors that influence how a child utilises the environment in a given situation.

4.4. Limitations and conclusion

Although the mixed-methods approach used in this study provided new and valuable knowledge about how the environment can support children's joy of movement, there are some limitations to this study. The qualitative analysis was intended to offer a different perspective than the quantitative analysis. Still, the fact that the results from the quantitative analysis were known when the qualitative analysis were conducted may have influenced the interpretation. Also, the selection of video observations was based on the scorings of well-being and physical activity, making the analysis far from independent. The two analytical approaches are therefore intertwined, as common in mixed-methods research.

Further, may the presence of the co-researcher conducting the filming have influenced children's behaviour, although the person was familiar to the children to minimize the impact. Measuring an ambiguous concept such as well-being is challenging. Although we have tried to interpret children's expressions of well-being through systematic observation, it is a weakness that the children's own voices are not heard. This should be incorporated in future studies. Also, the categorisation of children's play can be questioned, and the qualitative analysis indicates that the boundaries between different play types are quite blurry, and perhaps even non-existent in some observations.

The eight outdoor environments included in the present study are very different and range from small urban environments to extremely large natural environments. The availability of objects is also different across the institutions. The context dependent nature of the child-environment relationship indicate that different associations between the environment and the child may exist in each of the eight institutions. Although the categories and analytical approaches used have aimed to compensate for the range in different environments, this also represents a limitation to the study.

The findings in this study highlight the importance of the physical environment for promoting children's well-being in physical activity and emphasise how other children and adults, places and objects are important to enhance well-being and physically active play for all children in the outdoor environment of ECEC institutions.

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CRediT authorship contribution statement

Ole Johan Sando: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft. **Ellen Beate H. Sandseter:** Conceptualization, Methodology, Formal analysis, Writing - original draft, Project administration.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2020.101430.

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Appendix

The following documents are attached to the thesis:

A. Information letter to guardians

B. Information letter to staff

C. Confirmation letter NSD

D. Indicators used from Leuven Well-being Scale (Laevers, 2005).

E. Indicators used from Observational System for Recording Physical Activity in Children-Preschool (OSRAC-P) (Brown, Almeida, Pfeiffer, & McIver, 2012).

Ellen Beate Hansen Sandseter
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Thrond Nergaards veg 7
7044 Trondheim

Trondheim 01/08 2017

Foreldre/Foresatte til ……..

Forespørsel om deltakelse i forskningsprosjektet

"Kompetanse for utvikling av barnehagers inne- og utemiljøer"

Bakgrunn og formål

Målet med dette prosjektet er å utvikle ny kunnskap og å teste ut nye forskningsverktøy som kan bidra til høyere kompetanse i planlegging og utvikling and barnehagers fysiske miljø. Prosjektet vil undersøke hvordan barn interagerer med og bruker miljøet rundt seg i lek og aktivitet, og hvordan miljøet bidrar til å fremme lek, læring, psykososial- og fysisk helse. Målet er å bygge kompetanse blant viktige aktører i barnehagefeltet, og å utvikle verktøy for hvordan man kan forbedre det fysiske miljøet i barnehagen.

Kunnskapen fra dette prosjektet vil bli utviklet i nært og gjensidig samarbeid med barnehagene, og barnehagelærere vil være medforskere. Prosjektet er interdisiplinært ved at forskere og fagfolk fra ulike fagområder jobber sammen; utdanning, pedagogikk, helse, arkitektur og landskapsarkitektur. Kunnskapen/verktøyene vil være relevante og nyttige for barnehagesektoren og andre faggrupper som planlegger, utvikler og rehabiliterer barnehager, samt relevante utdanninger (barnehagelærer, arkitekt, landskapsarkitekt).

Studien er finansiert av Norges Forskningsråd og gjennomføres av Dronning Mauds Minne Høgskole for barnehagelærerutdanning (DMMH) i samarbeid med Høgskolen i Oslo og Akershus (HiOA), Private Barnehagers Landsforbund (PBL), Trondheim kommune, Espira og Læringsverkstedet.

De åtte barnehagene som deltar i prosjektet er valgt strategisk blant samarbeidspartnerne i prosjektet. I disse barnehagene blir det tilfeldig trukket ut 10 barn blant 3- og 4 åringene (5 gutter og 5 jenter). Du/dere får denne forespørselen fordi deres barn går på den aktuelle avdelinga/gruppa.

Hva innebærer deltakelse i studien?

Prosjektet består av 4 faser som bygger på hverandre. I fase 1 vil barns bruk av de eksisterende miljøene i 8 barnehager observeres og analyseres. I fase 2 vil denne kunnskapen bli brukt i utviklingen av kriterier for optimale inne-/utemiljø i barnehagen, og en intervensjon med endring av miljøene i henhold til kriteriene vil bli gjennomført i barnehagene. I fase 3 vil vi igjen observere barnas bruk av miljøene (etter intervensjonen), og barn og barnehagelærere vil bli intervjuet om endringene. I fase 4 vil vi til slutt bruke kunnskapen fra fase 1 til 3 for å videreutvikle kriteriene for optimale miljø, og utvikle et internettbasert verktøy for utvikling av fysiske miljø i barnehagen.

For ditt barn vil deltagelse i prosjektet innebære at det vil bli gjennomført observasjoner av den frie leken inne og ute i barnehagen. Observasjonene vil bli registrert i form av notater og videoopptak. Dette vil bli gjennomført i løpet av en uke høsten 2017 (fase 1) og en uke høsten 2018 (fase 3). I fase 3 vil det også gjennomføres intervju med barna som trekkes ut til å delta i prosjektet. Spørsmålene i intervjuet vil omhandle hvordan inne- og utemiljøet i barnehagen oppleves for barnet. Ta kontakt om du ønsker å se intervjuguiden før gjennomføring av intervjuet med ditt barn.

Hva skjer med informasjonen om ditt barn?

Alle personopplysninger vil bli behandlet konfidensielt. Kun prosjektleder og den forskeren som deltar i datainnsamlingen i deres barnehage vil ha tilgang til navneliste og koblingsnøkkel mellom navn og

kode. Det vil ikke bli samlet inn personopplysninger om barna, og alle observasjonsnotater, videoopptak og lydopptak vil merkes med koder som ikke kan tilbakeføres til det enkelte barn. Intervjuet vil bli tatt opp på bånd, anonymisert og transkribert. Etter transkribering vil lydopptaket slettes.

I skriftlig publisering av resultatene fra undersøkelsen vil data bli behandlet som gruppedata, og det vil ikke være mulig å gjenkjenne deltagerne i undersøkelsen. I formidling av funn på konferanser og i undervisning kan det bli aktuelt å bruke noen videopptak fra undersøkelsen. Siden videoopptakene vil kunne identifisere barna ved utseende, etterspør vi samtykke til å kunne bruke opptakene i formidling av resultater fra prosjektet ved for eksempel foredrag og lignende (se samtykkeerklæring). Dette er ingen forutsetning for å bli med i undersøkelsen, og vi forsikrer at videoopptak av barn hvor vi ikke har dette samtykket ikke vil bli sett av andre enn forskerne i forbindelse med analyse av datamaterialet.

Prosjektet skal etter planen avsluttes 31.12.2020. Datamaterialet vil anonymiseres ved prosjektslutt. Observasjoner, videopptak og intervjudata vil brukes til videre forskning på betydningen av det fysiske miljøet i barnehagen av prosjektgruppa også etter prosjektslutt. Data vil lagres på en sikker server hvor kun prosjektgruppa har tilgang.

Frivillig deltakelse
Det er frivillig å delta i studien, og du kan når som helst trekke ditt samtykke uten å oppgi noen grunn. Dersom du trekker deg, vil alle opplysninger om ditt barn bli anonymisert. Om du ikke ønsker at barnet ditt deltar, vil det ikke få noen innvirkning på deres forhold til barnehagen eller pedagogisk tilbud.

Dersom du har spørsmål til studien, ta kontakt med prosjektleder Ellen Beate Hansen Sandseter på telefon 73 80 52 59 eller epost ebs@dmmh.no.

Studien er meldt til Personvernombudet for forskning, NSD - Norsk senter for forskningsdata AS.

Samtykke til deltakelse i studien

Samtykkeerklæring fra foreldre/foresatte for (navn)……

- ☐ Jeg har mottatt informasjon om prosjektet «Kompetanse for utvikling av barnehagers inne- og utemiljøer» og samtykker til at mitt barn kan delta i prosjektet.
- ☐ Jeg samtykker til at videoopptak av mitt barn kan brukes i formidling av resultatene ved foredrag, undervisning og lignende.
- ☐ Jeg ønsker ikke at mitt barn skal delta i prosjektet, men det er greit at mitt barn blir filmet hvis det leker med barn som deltar i prosjektet.
- ☐ Jeg ønsker ikke at mitt barn skal delta i prosjektet. Jeg ønsker heller ikke at mitt barn skal bli filmet i hvis det leker med barn som deltar i prosjektet.

(Signatur foreldre/foresatte, dato)

Ellen Beate Hansen Sandseter
Dronning Mauds Minne Høgskole
Thrond Nergaards veg 7
7044 Trondheim

Trondheim 01/08 2017

Forespørsel om deltakelse i forskningsprosjektet

"Kompetanse for utvikling av barnehagers inne- og utemiljøer"

Bakgrunn og formål
Målet med dette prosjektet er å utvikle ny kunnskap og å teste ut nye forskningsverktøy som kan bidra til høyere kompetanse i planlegging og utvikling and barnehagers fysiske miljø. Prosjektet vil undersøke hvordan barn interagerer med og bruker miljøet rundt seg i lek og aktivitet, og hvordan miljøet bidrar til å fremme lek, læring, psykososial- og fysisk helse. Målet er å bygge kompetanse blant viktige aktører i barnehagefeltet, og å utvikle verktøy for hvordan man kan forbedre det fysiske miljøet i barnehagen.

Kunnskapen fra dette prosjektet vil bli utviklet i nært og gjensidig samarbeid med barnehagene, og barnehagelærere vil være medforskere. Prosjektet er interdisiplinært ved at forskere og fagfolk fra ulike fagområder jobber sammen; utdanning, pedagogikk, helse, arkitektur og landskapsarkitektur. Kunnskapen/verktøyene vil være relevante og nyttige for barnehagesektoren og andre faggrupper som planlegger, utvikler og rehabiliterer barnehager, samt relevante utdanninger (barnehagelærer, arkitekt, landskapsarkitekt).

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De åtte barnehagene som deltar i prosjektet er valgt strategisk blant samarbeidspartnerne i prosjektet. I disse barnehagene blir det tilfeldig trukket ut 10 barn blant 3- og 4 åringene (5 gutter og 5 jenter). Du/dere får denne forespørselen fordi du jobber på den aktuelle avdelinga/gruppa.

Hva innebærer deltakelse i studien?
Prosjektet består av 4 faser som bygger på hverandre. I fase 1 vil barns bruk av de eksisterende miljøene i 8 barnehager observeres og analyseres. I fase 2 vil denne kunnskapen bli brukt i utviklingen av kriterier for optimale inne-/utemiljø i barnehagen, og en intervensjon med endring av miljøene i henhold til kriteriene vil bli gjennomført i barnehagene. I fase 3 vil vi igjen observere barnas bruk av miljøene (etter intervensjonen), og barn og barnehagelærere vil bli intervjuet om endringene. I fase 4 vil vi til slutt bruke kunnskapen fra fase 1 til 3 for å videreutvikle kriteriene for optimale miljø, og utvikle et internettbasert verktøy for utvikling av fysiske miljø i barnehagen.

Undersøkelsen fokuserer på hvordan barna bruker det fysiske miljøet i barnehagen. Av barna vil det bli gjennomført observasjoner av den frie leken inne og ute. Observasjonene vil bli registrert i form av notater og videoopptak. For deg innebærer deltagelse i prosjektet at du kan bli filmet hvis du er i nærheten av barn som observeres. Dette vil bli gjennomført i løpet av en uke høsten 2017 (fase 1) og en uke høsten 2018 (fase 3). I fase 3 vil det også gjennomføres intervju med ansatte på avdelinga. Spørsmålene i intervjuet vil omhandle hvordan inne- og utemiljøet i barnehagen brukes av barna.

Hva skjer med informasjonen om deg?
Alle personopplysninger vil bli behandlet konfidensielt. Kun prosjektleder og den forskeren som deltar i datainnsamlingen i deres barnehage vil ha tilgang til navneliste og koblingsnøkkel mellom navn og kode. Det vil ikke bli samlet inn personopplysninger i intervjuet, og lydopptak vil merkes med koder

som ikke kan tilbakeføres til deg. Intervjuet vil bli tatt opp på bånd, anonymisert og transkribert. Etter transkribering vil lydopptaket slettes.

I skriftlig publisering av resultatene fra undersøkelsen vil data bli behandlet som gruppedata, og det ikke være mulig å gjenkjenne deltagerne i undersøkelsen. I formidling av funn på konferanser og i undervisning kan det bli aktuelt å bruke noen videopptak fra undersøkelsen. Siden videoopptakene vil kunne identifisere deltagerne ved utseende, etterspør vi samtykke til å kunne bruke opptakene i formidling av resultater fra prosjektet ved for eksempel foredrag og lignende (se samtykkeerklæring). Dette er ingen forutsetning for å bli med i undersøkelsen, og vi forsikrer at videoopptak av deltagere hvor vi ikke har dette samtykket ikke vil bli sett av andre enn forskerne i forbindelse med analyse av datamaterialet.

Prosjektet skal etter planen avsluttes 31.12.2020. Datamaterialet vil anonymiseres ved prosjektslutt. Observasjoner, videopptak og intervjudata vil brukes til videre forskning på betydningen av det fysiske miljøet i barnehagen av prosjektgruppa også etter prosjektslutt. Data vil lagres på en sikker server hvor kun prosjektgruppa har tilgang.

Frivillig deltakelse
Det er frivillig å delta i studien, og du kan når som helst trekke ditt samtykke uten å oppgi noen grunn. Dersom du trekker deg, vil alle opplysninger om deg bli anonymisert.

Dersom du har spørsmål til studien, ta kontakt med prosjektleder Ellen Beate Hansen Sandseter på telefon 73 80 52 59 eller epost ebs@dmmh.no.

Studien er meldt til Personvernombudet for forskning, NSD - Norsk senter for forskningsdata AS.

Samtykke til deltakelse i studien

Samtykkeerklæring for (navn)……

Jeg samtykker til at jeg kan bli filmet hvis jeg er i nærheten av barn som deltar i prosjektet
☐ Ja ☐ Nei

Jeg samtykker til at videoopptak hvor jeg er med kan brukes i formidling av resultatene ved foredrag, undervisning og lignende.
☐ Ja ☐ Nei

Jeg samtykker til å delta i intervju om hvordan barna tar i bruk det fysiske miljøet i barnehagen
☐ Ja ☐ Nei

(Signatur, dato)

Ellen Beate Hansen Sandseter
Thonning Owesensgt. 18
7044 TRONDHEIM

Vår dato: 21.08.2017 Vår ref: 54846 / 3 / AH Deres dato: Deres ref:

Tilbakemelding på melding om behandling av personopplysninger

Vi viser til melding om behandling av personopplysninger, mottatt 22.06.2017.
Meldingen gjelder prosjektet:

54846	*Kompetanse for utvikling av barnehagers inne- og utemiljøer*
Behandlingsansvarlig	*Dronning Mauds Minne Høgskole, ved institusjonens øverste leder*
Daglig ansvarlig	*Ellen Beate Hansen Sandseter*

Personvernombudet har vurdert prosjektet og finner at behandlingen av personopplysninger er meldepliktig i henhold til personopplysningsloven § 31. Behandlingen tilfredsstiller kravene i personopplysningsloven.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, ombudets kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database.

Personvernombudet vil ved prosjektets avslutning, 31.12.2020, rette en henvendelse angående status for behandlingen av personopplysninger.

Dersom noe er uklart ta gjerne kontakt over telefon.

Vennlig hilsen

Marianne Høgetveit Myhren

Dokumentet er elektronisk produsert og godkjent ved NSDs rutiner for elektronisk godkjenning.

Appendix D: Indicators used from Leuven Well-being Scale.

Laevers, F. (2005). Well-being and Involvement in care settings. A process-oriented Self-evaluation Instrument (SIC's). Retrieved from https://www.kindengezin.be/img/sics-ziko-manual.pdf

THE SCALE FOR WELL-BEING		
Level	**Well-being**	**SIGNALS**
1	**Extremely low**	The child clearly shows signals of discomfort: • whines, sobs, cries, screams; • looks dejected, sad or frightened, is in panic; • is angry or furious; • shows signs feet, wriggles, throws objects, hurts others; • sucks its tomb, rubs its eyes; • doesn't respond to the environment, avoids contact, withdraws; • hurts him/herself: bangs its head, throws him/herself on the floor..
2	**Low**	The posture, facial expression and actions indicate that the child does not feel at ease. However, the signals are less explicit than under level 1 or the sense of discomfort is not expressed the whole time.
3	**Moderate**	The child has a neutral posture. Facial expression and posture show little or no emotion. There are no signals indicating sadness or pleasure, comfort or discomfort.
4	**High**	The child shows obvious signs of satisfaction (as listed under level 5). However, these signals are not constantly present with the same intensity.
5	**Extremely high**	During the observation episode, the child enjoys, in fact it feels great: • it looks happy and cheerful, smiles, beams, cries out of fun; • is spontaneous, expressive and is really him/herself; • talks to itself, plays with sounds, hums sings; • is relaxed, does not show any signs of stress or tension; • is open and accessible to the environment; • is lively, full of energy, radiates; • expresses self-confidence and self-assurance.

Appendix E: Indicators used from OSRAC- P

Brown, W. H., Almeida, M. J., Pfeiffer, K. A., & McIver, K. L. (2012). Observational system for recording physical activity in children-preschool (OSRAC-P). Training Manual for Observers. Retrieved from https://docplayer.net/7856504-Observational-system-for-recording-physical-activity-in-children-preschool-osrac-p-osrac-p-training-manual-for-observers.html

NOTE TO OBSERVERS: After recording the highest level of physical activity within a five-second observational interval, all subsequent codes for the other seven categories in that interval are coded based on the highest level of physical activity level observed and recorded (i.e., any code selected should correspond to the focal child's highest physical activity level for the observational interval). For example, if you see a child run, walk, and sit during a five-second observational interval, then the activity type (e.g., run, walk, sit) should be coded based on the highest level of physical activity level observed. In this example, run should be coded for Physical Activity Type.

A. PHYSICAL ACTIVITY LEVEL CATEGORY AND CODES

The Physical Activity Level Codes represent five different levels of the intensity for the focal child's physical activity. **The intensity level of physical activity is based on several considerations. Intensity may depend on (a) the speed or vigorousness of child movement ranging from slow easy to moderate to fast movements, (b) whether the movement is assisted by others, (c) whether the child movement is repeated within the observational interval, and (d) if there is any weight being moved, held, or translocated.** If there are multiple body parts involved in the movement, the intensity is usually higher. Stationary activities represent a resting state or involve extremely limited or confined movement. Limb physical activity involves non-vigorous arm, leg, and trunk movements but no actual translocation from one place to another (i.e., remember "two-step rule" where both feet have to move to another spot for walking to be coded). Any activity normally classified as limbs, slow easy, or moderate can be "upgraded" to the next intensity code, if it is performed more vigorously or if the activity requires more effort (carrying a heavy object, pushing a swing). Can't tell is coded ***only*** if you cannot see the focal child or you really cannot determine a particular code within a category. Remember, the physical activity level is defined by what the focal child is doing during the five-second-observation interval.

Code	Code Names	Definition
1-Stationary	**Stationary/motionless (Level 1)**	***Stationary/motionless (resting state/motionless with head, finger, hand, or foot, or writing and drawing movement only and no major limb movement or two major joint movements)*** • Sleeping, lying, standing, sitting, squatting, or kneeling • Riding passively in a wagon

Appendix E: Indicators used from OSRAC- P

Brown, W. H., Almeida, M. J., Pfeiffer, K. A., & McIver, K. L. (2012). Observational system for recording physical activity in children-preschool (OSRAC-P). Training Manual for Observers. Retrieved from https://docplayer.net/7856504-Observational-system-for-recording-physical-activity-in-children-preschool-osrac-p-osrac-p-training-manual-for-observers.html

Code	Code Names	Definition
2-Limbs	**Stationary with movement of limbs or trunk (Level 2)**	***Stationary with easy movement of limb(s) or trunk (arm, trunk, or leg movements without moving the entire body from one place to another)*** • Standing up, sitting down, bending and squatting, or kneeling down with limb or trunk movement • Holding an moderately heavy object while unsupported • Hanging or partially hanging off of something, leaning on a pole, fence, or wall (includes a partial climb - one leg up and arms holding on) • Swinging passively (being pushed by another), bending, digging in the sand, twisting • Throwing ball or object without translocating • Leaning back on arms while sitting down • Resting head on arms on a tabletop • Sliding down a slide (without pushing self) ***Add-on rule example:*** ***Standing motionless while holding object (1) + moderately heavy object (1) = 2***

3-Slow-Easy	**Slow/easy movement (Level 3)**	***Translocation (moving body from one location to another at a slow and easy pace)***
		
		• Walking
		  • Walking at a slow or easy pace and focal **child MUST translocate with BOTH feet** (3 continuous steps)
		  • Slow and easy marching (in place or translocating), crawling, skipping, hopping, jumping, rolling
		• Riding
		  • Slow and easy cycling, skateboarding, roller skating, scooter
		• Slow and easy crawling on a flat surface
		• Swinging without assistance from others or leg kicks
		• Slow and easy tumbling/wrestling
		
		Add-on rule example:
		Going down a slide (2) + pushing self (1) = 3
		Throwing a ball (2) + heavy ball (1) = 3

Appendix E: Indicators used from OSRAC- P

Brown, W. H., Almeida, M. J., Pfeiffer, K. A., & McIver, K. L. (2012). Observational system for recording physical activity in children-preschool (OSRAC-P). Training Manual for Observers. Retrieved from https://docplayer.net/7856504-Observational-system-for-recording-physical-activity-in-children-preschool-osrac-p-osrac-p-training-manual-for-observers.html

4-Moderate
 	
Code
	Moderate movement (Level 4)
	Code Names
		Translocation (moving body from one location to another at a moderate pace)
		Definition
		• Walking
		  • Walking at a brisk or rapid pace
		  • Walking up at least 2 stairs or a hill
		  • Two repetitions of skipping, hopping, jumping, leaping, kicking, or galloping
		• Riding
		  • Two repetitions of cycling at a moderate pace
		• Climbing
		  • Climbing on monkey bars, jungle gym, fence
		  • Climbing backwards up a slide or an incline (or stairs) with arm usage
		  • Hanging from bar with legs swinging
		• Tumbling
		  • Two repetitions of a forward or backward roll
		  • Fighting or wrestling at a moderate pace
		• Swinging with legs kicking

5-Fast	**Fast movement (Level 5)**	***Translocation (moving body from one location to another at a fast or very fast pace)***
		
		• Running
		• Walking up 3 or more stairs or an incline fast or with vigorous arm movement
		• Three repetitions or more of skipping, hopping, jumping, leaping, kicking, or galloping
		• Riding
		  • Three repetitions or more of fast cycling, skateboarding, roller skating, scooter
		• Three repetitions or more jumping jacks or jumping rope
		• Three repetitions or more of tumbling
		• Vigorous fighting or wrestling
		• Climbing
		  • Translocating across bars with hands while hanging
		
		Add-on rule:
		Walking (3) + carrying very heavy object like another person (2) = 5

Can't Tell	Cannot Tell	• Cannot Tell

Appendix E: Indicators used from OSRAC- P

Brown, W. H., Almeida, M. J., Pfeiffer, K. A., & McIver, K. L. (2012). Observational system for recording physical activity in children-preschool (OSRAC-P). Training Manual for Observers. Retrieved from https://docplayer.net/7856504-Observational-system-for-recording-physical-activity-in-children-preschool-osrac-p-osrac-p-training-manual-for-observers.html

Coding Rules

- Many motor activities such as riding and jumping other than running can be classified as slow-easy, moderate, or fast; it depends on the intensity of child movements ranging from slow/easy to moderate to fast/vigorous and how often the movement is repeated.
    - Example: One single jump is considered slow-easy movement. Two jumps in a row are considered moderate movement. Three or more jumps in a row are considered fast movement.
- If the focal child is swinging on a swing on his/her stomach, the activity level is coded as 3-Slow-Easy, unless he/she is running in circles or performing a higher activity level of some sort.
- If the focal child takes one or two steps and does not translocate, it is considered category 2-Limbs.
- For a movement to be considered 2-Limbs, the focal child needs to visibly bend a major joint or limb or perform a movement involving 2 joints (NOT including wrist, ankle, fingers, and toes) or the child clearly reaches for and perhaps grasp an object. For example, foot tapping does not count as limb movement, but bringing a cup up to the mouth for a drink is considered limb movement.
- The 90° angle rule: The joint must be at or above 90 for it to be considered limb movement, i.e. scratching one's nose while the elbow is at sides, would be considered a 1-Stationary. Scratching one's nose with the elbow up and parallel to the ground constitutes a 2-Limbs coding.
- If the focal child is being supported by another object (wall, table) or limb (leaning on arms), 2-Limbs should be coded. 2-Limbs should be coded if the child would fall if the object were to be removed.
- Smaller movement at the elbow or knee should also be coded as 2-Limbs, when the movement is repetitive (occurs more than twice). If the child is stabilizing him/herself while squatting (feet flat, knees bent), 2-Limbs should be coded due to the shifting of the center of gravity.
- Activity levels for coding throw should be similar to coding activity levels for jump. Where intensity level 1 = 1 jump and level 2 = two jumps, multiple consecutive throwing actions during an interval should also be coded in an increasing level. For example, if the focal child throws, catches, and kicks a ball during the observation interval, activity level = 5 and activity type = throw because three throwing actions were performed consecutively.

Appendix E: Indicators used from OSRAC- P

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G. GROUP COMPOSITION CATEGORY AND CODES

Group is defined by the number of children and adults who are in the same activity area as the focal child or who are engaged in activity with the focal child or are in proximity of the focal child. Group composition is defined first by interaction with another child, group of children or adult, and secondly by proximity (within 5 feet) of another child, group of children or an adult. Remember that Group Composition is not depended on explicit social interaction or engagement with the same materials.

Examples of children who are in the same group include: children doing an art project; children having snack; children playing with the same outdoor equipment (e.g., monkey bars, riding and pushing a wagon); children playing with pretend toys in the kitchen area; children in a group singing a song during circle time; and children who are involved in clean-up. The following six group arrangement options may be coded.

1. Solitary – Solitary arrangement, sometimes known as solitary/alone is coded when the focal child is not interacting with or in proximity of adults or peers. Usually, the focal child will be involved in an activity by himself or herself. Examples include: the focal child is in an art activity area when other children are not in proximity or not involved in an art activity; the focal child is moving to a new activity without passing through another group or by another child or adult (i.e., when there is not a group transition); and the focal child is in time-out.

2. One-to-One Adult – One-to-one adult is coded when the focal child is in an activity area by himself or herself with at least one adult or interacting with an adult. Examples include: the focal child is alone with the teacher at the sink; the focal child goes to physical therapy room or the other side of the room with the physical therapist and the teacher; and the teacher is putting the focal child in time out, the teacher is talking to the child from across the room. This code should be used when there is one or more adults interacting with the child or within 5 feet of the focal child in the absence of a group.

3. One-to-One Peer – One to one peer is coded when the focal child is engaged in an activity or is in proximity (within 5 feet) of 1 peer. Examples include: the focal child is painting at the easels with 1 other child; the focal child is in a pre-academic activity with another child and the teacher is not present; and the focal child is putting together a puzzle with 1 other child, the child passes by another child in the 5-second observation interval.

4. Group Adult – Group adult is coded when the focal child is engaged in an activity with or is in proximity to 1 or more peers and an adult. The adult is considered WITH the group if he or she is sitting at the table with the focal child, is passing out materials to the group, or is in a designated activity area (e.g., sitting in the block area). If the adult moves away from the activity area, but maintains verbal contact during the five-second observation interval, the adult is still considered WITH the group. If the adult moves away, but does not maintain verbal contact during the five-second-observation interval (i.e., by talking to a child or the group), the adult is not considered with the group. Examples include: the focal child (along with 2 other children) are read a story by an adult; the focal child and one other child are working on a pre-academic activity with the teacher present; and the focal child and the teacher are playing catch with 2 other children on the playground. This can also include more than one adult in the group.

5. Group Child – Group child is coded when the focal child is engaged in an activity with 2 or more peers and no adult. Examples include: the focal child and 2 children are playing in the

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sensory bin; the focal child and 3 children are riding tricycles in proximity to one another and following one another; the focal child and 1 other child are walking in a line to the bathroom; the focal child runs past a group of 2 or more children on the playground.

6. Can't Tell – Can't Tell is coded when you cannot see the size of the group cannot be determined.

Code	Code Names	Definition
Solitary	**Solitary/alone**	• ***Engaging in an activity alone and not in proximity to children or adults*** • ***Being in an activity area alone, clearly without peers or adults***
1-1 Adult	**One-to-one with adult**	• ***Engaging in an activity with or in proximity to only an adult*** • ***Being in an activity area with only an adult***
1-1 Peer	**One-to-one with peer**	• ***Engaging in an activity with or in proximity to only a single peer*** • ***Being in an activity area with only a single peer***
Group Adult	**Group with adult**	• ***Engaging in an activity with or in proximity to one or more peers and an adult*** • ***Being in an activity area with one or more peers and an adult***
Group Child	**Group without adult**	• ***Engaging in an activity with or in proximity to two or more peers, without an adult in the group*** • ***Being in an activity area with two or more peers, without an adult in the group***
Can't Tell	**Cannot tell**	• ***Cannot tell***

- ***Group composition should be coded first by interaction, then by proximity.*** "Looking" by either the focal child or by someone towards the focal child does not constitute interaction. When inside, proximity is based on defined areas when applicable. For example, if the focal child is alone in the large block area, and other children/adults are in the sociodramatic area, code = solitary if there is not interaction with the focal child. In non-clearly defined areas inside or when outside, proximity is based on a 5-foot parameter measure. Anyone outside of 5 feet of the focal child should not be considered in group composition. Proximity can also be determined by parallel play (someone slightly outside of the 5-foot parameter, but engaged in activities matching that of the focal child).

- ***Remember that group composition is based upon the focal child's interaction/proximity to other children or to 1 adult.*** If the focal child is interacting or in proximity to no other children, but to multiple adults, code = 1-1 adult. Also note that while teacher and parents

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contribute towards group composition, observers do not unless they are specifically interacting with a child for a necessary non-routine, non-observational purpose.

- ***"Passing through" a group or by another adult or child is considered being part of that group if it occurs during the 5-second observation window.*** If the focal child is interacting with another child(ren) or adult(s) or in proximity to others at all during the observation period, group should be coded as the appropriate option other than solitary. This includes a walk-by during nap (code = 1-1 adult), running by another child while outside (code = 1-1 peer).

- **Solitary** should be coded when the focal child is alone for the full 5 seconds and does not interact with, or come in proximity of another child, group of children or an adult.

- **Group adult** should be coded when the focal child is engaged with an adult who is part of a group of children, i.e. the focal child asks the teacher a question while playing in the sociodramatic area and the teacher is reading a story to a group of 3 children in the book area, code = group adult.

- **1-1 adult** should be coded when the focal child is engaged with an adult who is in proximity to, but not interacting with a group of children, i.e. the focal child is talking to a teacher who is cleaning the table and is in proximity to children playing in the large block area, code = 1-1 adult.

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