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Outdoor play areas in childcare settings and children's physical aggression: A longitudinal study of Norwegian kindergartens

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ABSTRACT

We investigated the role of physical characteristics of kindergartens' outdoor play areas in teacher-rated physical aggression (PAGg) among 423 children followed annually from ages two to four years. We used data from the Behaviour Outlook Norwegian Developmental Study which follows children from southeast Norway, a country where almost all two- to four-year-old children attend kindergartens. Nesting children in kindergartens, we found two significant associations after adjustment for family selection. First, children in kindergartens with more 'secret places' in their outdoor play areas (where they could play undisturbed) had more PAGg at baseline. Second, children in kindergartens with more adult supervision of their use of outdoor play material showed a less steep decrease in PAGg over time. If causal, these associations would suggest that children in kindergartens should not play completely unmonitored but also that teachers should not control children's outdoor play excessively.

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KEYWORDS Outdoor play areas; kindergartens; preschoolers; aggression

Introduction

There is much evidence to suggest that structural characteristics of childcare centres (including daycare centres, preschools, and kindergartens), such as child-adult ratio and group size, are associated with children's cognitive and socio-emotional development (Belsky et al., 2007; Curby et al., 2009; Keys et al., 2013; Peisner-Feinberg et al., 2001). However, physical characteristics, such as the outdoor play area, in these settings are also likely important. In this study, we

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investigated the association of outdoor play area characteristics with physical aggression (PAgg) in young children (aged 2–4 years) attending Norwegian kindergartens.

Researchers have long been interested in how the design of outdoor play areas and playgrounds may affect child development (Frost, 1978; Frost et al., 1990; Frost & Sutterby, 2017). Most have focused on type of play area (e.g., traditional, contemporary, adventure) and presence of features (e.g., swings, sand boxes, loose parts; Barbour, 1999), especially in relation to children's physical activity (Smith et al., 2016; Storli & Hagen, 2010) and play (Cloward Drown & Christensen, 2014; Maxwell et al., 2008). Play is essential for healthy child development, as it has cognitive, social, emotional, and sensorimotor benefits (Frost, 1997). *Outdoor* play is thought to be particularly beneficial because it promotes physical activity, but also contact with nature or natural elements, risky play, and social interactions (Bento & Dias, 2017; Brussoni et al., 2015; Little & Wyver, 2008; M.S. Tremblay et al., 2015). Its benefits therefore are seen as outweighing potential short-term disadvantages (e.g., minor injuries), assuming it takes place in safe but exciting play spaces (Frost & Henniger, 1979), with natural elements (Dankiw et al., 2020; Fjørtoft & Sageie, 2000), and with different types of equipment facilitating different forms of play (Phelps, 1984).

However, not much is known about the role of outdoor play area characteristics in child outcomes beyond physical activity and play. The evidence that does exist is about the role of outdoor education and time spent outdoors. For example, a study in Norwegian kindergartens established links between time spent outdoors and improved working memory and reduced hyperactivity and inattention (Ulset et al., 2017). The researchers followed 562 preschoolers (from age 4 years) near Oslo over four years, clustered in 28 kindergartens (and 13 elementary schools). Behaviour and cognitive performance were assessed every 12 months. Teachers rated children's behaviour with the Strengths and Difficulties Questionnaire, children completed the digit span test (a subtest of the Wechsler Intelligence Scale for Children, measuring working memory), and kindergarten managers reported the number of daily outdoor hours in both spring-summer and fall-winter seasons.

A more recent study of 160 children (aged 1–3 years) in Italian kindergartens showed positive associations of outdoor education with cognitive, emotional, social, and fine motor skills (Monti et al., 2019). In that study, two kindergartens followed a traditional education model (84

children), while another two offered a continuous outdoor education programme (76 children). Teachers assessed children's development at two time-points, in January and June, using Kuno Beller's developmental charts. There was greater improvement across domains for the 'outdoor education group'.

In another recent study, Larrea et al. (2019) investigated the association of affordance availability in Spanish preschool outdoor environments with social play behaviour. The researchers assessed the social play behaviour of 173 children (aged 3–6 years) in 18 childcare centres in the Basque Country by video-recording each child for six minutes during outdoor play, and rated the play areas' affordance availability. Lower affordance availability of a play area was associated with less group play and more parallel play.

The present study

We carried out this study to investigate the role of outdoor play area characteristics in child outcomes beyond physical activity or play, a gap in the literature. In particular, we explored the role of characteristics of kindergartens' outdoor play areas in trajectories of physical aggression (PAGg) across ages 2–4 years. Early and persistent PAGg affects not only physical and mental health but also behaviour and attainment later on, with persistent childhood PAGg being especially important (Broidy et al., 2003; R.E. R.E. Tremblay et al., 2004). At the same time, early PAGg is a normal part of children's development, usually peaking at around age 3 years before declining (Alink et al., 2006; Côté et al., 2006; Lorber et al., 2018; Nærde et al., 2014). Not all children, however, learn to regulate their use of PAGg. Risk factors include history of parental antisocial behaviour, teenage motherhood, family poverty, inter-parental conflict (R.E. R.E. Tremblay et al., 2004), and harsh and controlling parenting (Joussemet et al., 2008), among others (Lansford, 2018).

For our study, we used longitudinal data from Norway, a country in which almost all 2–4 year-olds attend kindergartens (<https://www.ssb.no/utdanning/statistikker/barnehager/aar-endelige>). We had detailed information of various characteristics of kindergartens' outdoor play areas, from availability of certain play equipment (e.g., swings) and presence of 'secret places' to level of adult supervision. To test for associations of outdoor play area characteristics with PAGg trajectories, we ran a two-level growth curve model (with children clustered in kindergartens),

accounting for relevant child- and kindergarten-level confounders. We expected that children in kindergartens with more outdoor play facilities, greater adult supervision and greater affordances in the outdoor environment would have lower levels of PAgg and steeper decreases in PAgg across time. We based our hypothesis on the existing evidence that such nature-based outdoor environments, coupled with appropriate supervision (Brussoni et al., 2015), would provide young children with more opportunities to practise perspective taking, communication, negotiation, and self-regulation skills, all fostering conflict managements skills (Pic & Han, 2021), in turn reducing aggression (Wheeler, 2004).

Methods

Sample and procedure

Our data came from the Behaviour Outlook Norwegian Developmental Study (BONDS), comprising 1,159 children from five municipalities in two counties in southeast Norway. For details, see, Nærde et al. (2014). We used data when the children were two (T1), three (T2), and four (T3) years old. Most of the BONDS children attended kindergarten at ages two, three, and four years (83%, 93%, and 98%, respectively). We started at age two years for practical reasons: the Norwegian parental leave policy provides 10 months of leave at full pay or 12 months of leave at 80% pay and so children seldom attend kindergartens before their first birthday; indeed, only 27% of the BONDS children attended kindergartens at 12 months. At each time-point, the kindergarten teacher who knew the child best was asked to complete a questionnaire that included items on child behaviour. The kindergarten headteacher/manager provided information about the physical characteristics and quality of the outdoor area, and the pedagogical leader of the department (unit) that the child attended provided information about the proportion of the day spent on outdoor play during both the summer and the winter semester.¹

At T1, 945 of the BONDS children had a valid kindergarten identifier and 751 of those had data on PAgg. These 751 children were more likely to come from non-immigrant and higher SES families. A total of 328 of

¹For most cases, information on our main variables was provided by three groups of practitioners: the headteachers/managers of the kindergartens who were the most appropriate to report on general operational matters; the pedagogical leaders of the units attended by the children, and the teachers in the units the children attended and who knew the children best. A teacher could be the pedagogical leader of the unit as well.

these 751 children changed kindergarten throughout the study period. We used data on the 423 children who remained in the same kindergarten at all three time-points as our study sample.

Measures

PAGg. At each of ages two, three, and four years, the child's kindergarten teacher was asked about the frequency of eight behaviours: 'hits other adults,' 'hits other children,' 'pushes others to get his/her way,' 'pulls hair,' 'pinches others,' 'throws things at others,' 'kicks others,' and 'bites others.' The responses were given on a seven-point frequency scale, from 1 (never/not in the past year) to 7 (three times per day or more). Item scores were averaged to create a scale score. Cronbach's alphas were .85, .87, and .89 at ages two, three, and four years, respectively, as reported elsewhere (Dearing et al., 2015; Ribeiro & Zachrisson, 2019). As expected, different teachers reported on child PAGg across time for most cases. For example, across the full BONDS sample, at age three years 18.1% of teachers confirmed that they had been asked about the child at age two years, 72.9% reported they had not, and 9% did not remember. The teachers reported on the frequency of these eight behaviours around the child's second, third, and fourth birthdays and thus at various times of the year for each child.

As previously described (Nærde et al., 2014), the PAGg items in BONDS were based on clinical assessment and previous research, in view of the lack of established instruments for low-level physically aggressive behaviour (e.g., pinches or pulls hair) that is particularly common among very young children. These items index PAGg as physical force against others in the form of observable behaviour irrespective of intent. Such a behavioural definition has high relevance and applicability for this age group and allows for accurate and easy measurement (Nærde et al., 2014). The psychometric properties of the PAGg questionnaire in BONDS are described in Nærde et al. (2014), where a discussion of the rationale for the measure and how it compares to other measures of PAGg can be found.

Individual-level variables, T1

We considered the following individual-level variables at T1 as covariates: gender (male/female), family size (number of non-adult siblings in the household), season born (winter as reference), ethnicity (both parents

Norwegian-born vs. at least one born abroad), municipality (five in total, with the most rural as reference), and SES. Region, family size, ethnicity and SES were likely confounders because they are associated with both child behavioural problems, including aggression, and selective sorting of families into areas (and therefore schools; in our case, kindergartens). SES was the average value over a composite of the following variables: 1) perceived quality of housing; 2) perceived economic strain; 3) mother's educational level; and 4) father's educational level. Season born was added to account for age differences in the peer group (related to aggression in young children) as classes were mixed-age.

Kindergarten-level variables, T1

There were two types of information about the kindergarten, as follows.

(i) Quality and physical characteristics of the outdoor area. Head teachers/managers indicated how strongly they agreed (on a five-point Likert scale) with the following items: 'the outdoor area is well-suited for children aged two and three years,' 'the outdoor area is well-suited for children aged three to six years,' 'the outdoor area provides possibilities for varied play for the youngest children (sand, asphalt, forest, grass, etc.),' 'the children can get hold of equipment/toys/materials for use in outdoor play by themselves,' 'the staff have to be involved when the equipment for outdoor play is to be used (bicycles, buckets, balls, etc.),' and 'the outdoor area has "secret places" where the children can play undisturbed.' These items were developed based on reviews of the relevant literature (Kampmann, 2006; Nordin-Hultman, 2004), as well as experiences from a kindergarten pilot study (Martinsen et al., 2009), conducted prior to BONDS, focussing, among other things, on the kindergarten's physical environment.

We examined these items individually as the Cronbach's alpha of their scale was only .25, and a principal components analysis showed they could not be reduced into factors. Headteachers/managers also indicated the specific type of outdoor materials, equipment and facilities available to children, including: 'teeter totter,' 'lean-to,' 'stationary/fixd car/boat,' 'playhouse,' 'climbing trees,' 'sledding hill,' 'slide,' 'sandpit,' 'rocking animals,' 'balance equipment (logs, tires, etc.),' 'obstacle course,' 'climbing wall,' 'forest area,' 'large playground equipment,' 'small playground equipment,' 'bird's nest swing,' 'swings,' 'tables and chairs,' 'swing rope,' 'amphitheater,' 'sand toys,' 'two-wheel bikes,' 'scooters,' 'tricycle,' 'bike

trailer,' 'water toys,' 'balls,' 'soccer goal,' 'stilts,' and 'toy cars'. For details, see, Moser & Martinsen (2010). They were also asked to report available material not included in this list. The sum of all available equipment, materials and facilities was for our analytic purposes the 'outdoor material index'.

(ii) Proportion of time playing outdoors. The pedagogical leaders of the units that the children attended provided an estimate of the proportion of the day spent on outdoor play for both the summer and the winter semester.

Analytic strategy

Analyses were run in Mplus. First, we estimated a single-level growth curve model to describe the average trajectory of PAgg across ages two, three and four years. Then, we estimated two-level growth curve models, nesting children in kindergartens. This allowed us to disentangle the variance into two components, accounting for the heterogeneity of children (within-level variance) and for differences between kindergartens (between-level variance). We followed a stepwise procedure by constructing models of increasing complexity, ending up with a conditional two-level solution whereby we modelled growth factors for PAgg at both the individual- and the kindergarten-level while adjusting for covariates. Two latent growth factors (intercept and slope) were defined by the three repeated measures of PAgg as indicators. Factor loadings for the intercept were fixed to 1, while those for the slope were set to 0, 1, and 2. We also checked for a solution with a quadratic slope, but this did not fit the data. Residual variances of the outcome variables were fixed to 0 for the between-part of the model. Individual- and kindergarten-level covariates were entered as predictors at the within- and between-levels of the model, respectively. Goodness of fit was assessed by using the well-accepted criteria of CFI > .95, RMSEA < .05, and SRMR < .06 for a well-fitting model (West et al., 2012). We used full information maximum likelihood to account for missingness.

Results

Our 423 study children were clustered in 109 kindergartens (with an average cluster size of 3.8 children per kindergarten). Means, standard deviations, and bivariate correlations of all the study variables are

reported in [Table 1](#) (within-level) and [Table 2](#) (between-level). As can be seen in [Table 2](#), average levels of PAgg decreased across time. The intraclass correlations (ICCs) for PAgg were .028, .104, and .128 at the three time-points, respectively, indicating an increase in the amount of variance accounted for at the between-level.

Unconditional single-level growth curve model

A single-level model fitted the data very well, $\chi^2(1) = .24$, $p = .622$, RMSEA = .000, 90% CI [.000, .101], CFI = 1.000, TLI = 1.014. This solution gave a significant mean (1.968, $p < .001$) for the PAgg intercept, indicating the average initial status of PAgg at age two years, and a significant negative mean for the slope ($-.015$, $p < .001$), revealing a reduction of PAgg from two to four years. The value of the intercept variance was significant, but that for the slope variance was not (i.e., there was no individual variation in rate of change). There was no significant covariance between intercept and slope ($-.002$, $p = .452$). This model thereby indicated individual variations around initial status.

Unconditional two-level growth curve model

The unconditional two-level model fitted the data well, $\chi^2(4) = 7.057$, $p = .133$, RMSEA = .042, CFI = .986, TLI = .979. There was significant within-level variance, but not between-level variance, around the intercept, indicating that children differed in their baseline levels of PAgg but that there were no differences at the kindergarten-level. There was also significant between-level (but not within-level) variance around the slope, suggesting that kindergartens, but not individual children, differed in their change of PAgg across time, in accordance with the increasing ICCs across time discussed above.

Conditional two-level growth curve model

The final model ([Tables 3–4](#), [Figure 1](#)) fitted the data very well, $\chi^2(34) = 45.479$, $p = .090$, RMSEA = .028, CFI = .971, TLI = .913. (Intercept = 2.480, slope = $-.013$.) As can be seen, several of the associations at the individual-level reached significance. For example, girls had lower initial levels of PAgg, as did children from higher SES. At the between-level, [Figure 1](#) shows that having secret ('hidden') outdoor

Table 1. Within-level correlations, means, and standard deviations (n = 423).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Physical aggression T1	.397													
2. Physical aggression T2	.401	.523												
3. Physical aggression T3	-.168	-.237	-.203											
4. Female	-.006	.015	-.088	.034										
5. Family size	-.012	.104	.031	-.019	.067									
6. ≥1 parent foreign-born	-.078	.016	-.031	.003	.044	.007								
7. Spring-born	.011	-.043	-.028	.076	.068	.028	-.410							
8. Summer-born	.094	.020	.097	-.100	-.079	-.046	-.346	-.358						
9. Autumn-born	-.045	-.135	-.064	.021	-.044	-.111	.017	-.053	.037					
10. SES	-.016	-.055	.013	-.037	.020	-.076	.039	-.021	.033	-.123				
11. Municipality 1	.022	-.019	.033	.008	-.152	.081	-.056	-.017	-.004	.084	-.293			
12. Municipality 2	-.001	.098	.096	.056	.024	-.096	-.055	.072	-.001	.079	-.204	-.468		
13. Municipality 3	-.004	-.016	-.140	.015	.129	.014	.007	-.021	.047	.149	-.117	-.269	-.187	
14. Municipality 4				1.48	.85	.32	.28	.30	.23	3.10	.11	.40	.25	.10
Mean				.500	.813	.523	.450	.457	.422	.621	.318	.490	.430	.938
SD														

Mplus does not give the means for the outcomes in the within-part of the model.

Table 3. Conditional two-level growth curve model of PAgg (within-level results; $n = 423$).

Predictors	Intercept				Slope			
	b	SE	t	β	b	SE	t	β
Female	-.292**	.060	-4.836	-.593				
Family size	-.010	.036	-.283	-.021				
Spring-born	.032	.071	.454	.065				
Summer-born	.026	.082	.313	.052				
Autumn-born	.119	.088	1.355	.242				
≥ 1 parent foreign-born	.066	.045	1.464	.135				
SES	-.094*	.047	-1.986	-.191				
Municipality 1	.071	.120	.592	.145				
Municipality 2	.152*	.077	1.991	.310				
Municipality 3	.248*	.107	2.327	.504				
Municipality 4	.235*	.110	2.126	.477	-.015**	.005	-3.043	-.459

Note. As shown, only one predictor had an effect on the slope at the individual-level and was therefore kept in the model. ** $p < .01$, * $p < .05$.

Table 4. Conditional two-level growth curve model of PAgg (between-level results; $n = 423$).

Predictors	Intercept				Slope			
	b	SE	t	β	b	SE	t	β
Outdoor area suits 2-3-year-olds	.077	.056	1.357	.356	.001	.003	.270	.051
Outdoor area suits 3-6-year-olds	-.019	.037	-.513	-.118	.002	.002	1.011	.183
Outdoor area varieties for youngest	-.026	.087	-.296	-.123	-.001	.004	-.168	-.040
Can find outdoor material alone	-.020	.049	-.421	-.088	.003	.003	1.124	.154
Adult supervision of outdoor material	-.029	.038	-.753	-.220	.006a	.002	2.596	.548
'Secret' ('hidden') outdoor spaces	.103*	.046	2.220	.639	-.003	.002	-1.234	-.230
Outdoor time (percent) summer	.000	.004	.044	.010	.000	.000	-1.266	-.239
Outdoor time (percent) winter	.000	.005	.014	.004	.000	.000	.079	.014
Outdoor material (index)	-.300	.561	-.535	-.208	.016	.023	.705	.145

$ap < .01$, * $p < .05$.

places in the kindergarten was associated with higher baseline levels of child PAgg. Furthermore, adult supervision of outdoor play material had a positive effect on the slope. Table 4 shows that, as expected, the effects at the between-level were small.

Discussion

To the best of our knowledge, this is the first study to investigate the link between physical characteristics of kindergartens' outdoor play environments and the trajectory of teacher-reported physical aggression (PAgg) from age two to age four years. Importantly, this study used data from a large longitudinal project in Norway, a country where almost all two- to four-year-olds are enrolled in kindergartens.

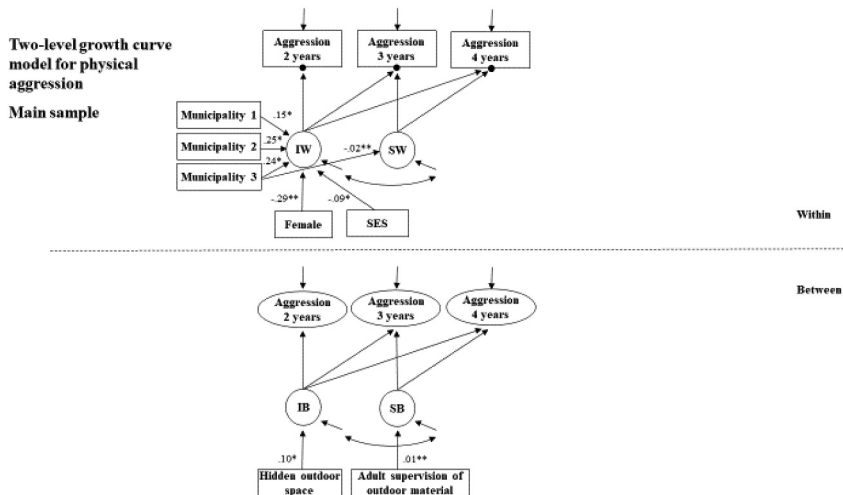


Figure 1. IW = ‘intercept-within’, baseline PAgg at the individual-level. SW = ‘slope-within’, change in PAgg across time at the individual-level. IB = ‘intercept-between’, baseline PAgg across kindergartens. SB = ‘slope-between’, change in PAgg across time at the kindergarten-level.

We found that, even after controlling for families’ selection into areas (and therefore kindergartens), boys and lower SES children showed higher initial levels of PAgg and levels of PAgg decreased with age, in line with previous studies (Alink et al., 2006; Baillargeon et al., 2007; Romano et al., 2005; R. E. R.E. Tremblay et al., 2004). With respect to our main research question, we can report two key findings. First, there was a positive effect of ‘secret places’ on the intercept, which suggests that children in kindergartens with more ‘secret places’ showed more initial PAgg. Second, there was an effect of adult supervision (i.e., involvement of staff when children use outdoor play equipment) on the slope of PAgg, such that children in kindergartens with more supervision of their play with outdoor material showed a less steep decrease in PAgg over time.

With respect to the first finding, we can probably assume a causal relationship, i.e., that more ‘secret places’ in outdoor play areas ‘led’ to more PAgg. The children did not choose their kindergartens themselves and it is unlikely that parents considered ‘secret places’ in their choice of kindergarten. Therefore, reverse causality should not be an issue here. Moreover, we cannot think of an obvious confounding variable, currently missing in our models, that would explain this relationship. Nonetheless, it is important to note that we could not test causality formally, so our results must be interpreted with caution.

It is unclear why 'secret places' would encourage (or fail to discourage) children's use of PAgg. In fact, one could think that secret places may encourage social play behaviour, a 'positive' outcome. For example, in an observational study, Maxwell et al. (2008) found that enclosed spaces encourage dramatic or fantasy play in preschoolers. However, the enclosed spaces in that study were part of a playground and had visibility to other areas (i.e., were not hidden). In our study, 'secret places' were areas where children could play undisturbed but also 'unseen'. It is plausible that such hidden places would facilitate behaviour, including physically aggressive behaviour, that is generally discouraged by both teachers and parents. Unfortunately, because teachers reported on children's PAgg in the kindergarten only, we do not know whether 'secret places' in the kindergarten's outdoor play area were also associated with children's PAgg outside the kindergarten. It is also plausible, however, that kindergartens with hidden places would generally facilitate 'rough and tumble play', a specific type of risky play, often mistaken for aggression but generally considered to be normative and serve an evolutionary purpose (DiCarlo et al., 2015).

The second finding was that although PAgg generally declined with age in our sample, as expected, more adult supervision seemed to reduce it less. An explanation may be that more supervision by teachers would result in less exploratory and risky play in children, either due to the mere presence of teachers, or due to teachers' active control (or minimization) of children's risky play. Research suggests that risk-taking and risky play are essential for young children because they give them the opportunity to explore their environments, challenge themselves, learn new skills, and experience their limits (Brussoni et al., 2015; Little & Wyver, 2008). Thus, minimizing risky play may limit the quality and benefits of physical outdoor play for this age group (Little & Wyver, 2008). In this study, it is possible that adult supervision of use of outdoor material prevented children from playing freely with it.

The question that remains, of course, is why this would be associated with children's PAgg. An explanation may be that children who are not allowed to engage in risky play may use their surplus energy for other, potentially riskier behaviours, such as PAgg towards other children. Another explanation may be that children in such situations may feel controlled by their teachers. Overcontrol is associated with poor self-regulation (Karreman et al., 2006), related to PAgg, and has in fact been linked directly to high and stable PAgg in elementary school children

(Joussemet et al., 2008). Given this, intrusive supervision of children's outdoor play by teachers may feel as excessive control and could thus promote PAgg. However, without more information on the type and amount of supervision in our study such a conclusion remains speculative. We must also note, of course, that the item 'staff have to be involved when the equipment for outdoor play is to be used (bicycles, buckets, balls, etc.)' may simply reflect that staff are available to offer help when children use play equipment. That is, they may not control children or even monitor or 'supervise' them. (Monitoring is usually taken to mean a general awareness of the child's activities, as compared to supervision which typically involves more active watching and listening.)

Our statistically significant findings notwithstanding we must acknowledge our several null findings. Four of the six characteristics considered in this study (i.e., 'the outdoor area is well-suited for children aged two and three years,' 'the outdoor area is well-suited for children aged three to six years,' 'the outdoor area provides possibilities for varied play for the youngest children,' and 'the children can get hold of equipment/toys/materials for use in outdoor play by themselves') were not associated with either intercept or slope of PAgg. A reason may be that those items are too generic. For example, that the outdoor area is well-suited for a particular age group does not tell us anything about its specific characteristics. Another explanation may be that characteristics, as reported by headteachers/managers, are heavily reliant on subjective perceptions of quality and risk. We urge future research to develop psychometrically robust tools to measure what we think is a vital outdoor context for young children across most parts of the world.

Our study has several limitations. First, child PAgg was teacher-reported. Because teachers could only assess children's use of PAgg in the kindergarten, we do not know whether that assessment was a good approximation of children's PAgg in other environments, such as the home. It would be interesting to see whether characteristics of outdoor childcare centre areas are related to PAgg across contexts. Second, PAgg was not always rated by the same teacher. This may have biased results because different teachers may have very different perceptions of a child's PAgg. Nevertheless, we can assume that the use of eight different domains of PAgg has kept this bias to a minimum. In addition, PAgg encompasses overt behaviours, which makes it relatively easy to measure. Third, the outdoor play area was rated by headteachers on a relatively small set of items, some of which may also have been too generic.

Responses may have been biased, especially when items referred to 'quality' and 'suitability'. More objective data on features of outdoor play areas, such as those provided by independent raters, may have resulted in more accurate descriptions. Furthermore, it would have been useful to observe children's behaviour in different parts of outdoor play areas, using behavioural mapping, to directly associate specific features with specific behaviours. Fourth, we did not have data on rules imposed by teachers or teachers' risk perceptions. Finally, our findings may be limited to kindergarteners in Norway, a country where outdoor play is very common and where kindergartens are expected to help children appreciate and connect with nature (Borge et al., 2003; Prince et al., 2013). Future studies should look at the association between the outdoor childcare centre environment and children's PAgg across settings and, indeed, countries. They should also extend the range of both outdoor play area features and child outcomes beyond PAgg. This would allow for more specificity in the link between physical characteristics of outdoor play areas and children's socio-emotional development.

In summary, our results suggest that both lack and excess of supervision of outdoor play in the kindergarten are associated with children's physical aggression (PAgg) as reported by their kindergarten teachers. In our study, more secret places in the outdoor play area were associated with more PAgg in children. At the same time, more supervision of children's use of play material in the outdoor area was associated with a less steep decrease of children's PAgg with age. Our findings could have implications for the design of outdoor play areas and outdoor play sessions in the context of childcare centres. If our assumption about the role of supervision is correct (and we would urge future studies to measure appropriately both quality and quantity of supervision), then our findings suggest that young children should not play unmonitored (i.e., in fully hidden places), but also that teachers should not supervise and control young children's outdoor play excessively. To make concrete suggestions about the design of outdoor play areas, however, future studies are needed to confirm our findings and, crucially, test for causality.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The data that support the findings of this study are available from the (<https://www.nubu.no/>)Behaviour Outlook Norwegian Developmental Study (BONDS). Restrictions apply to the availability of these data, which were used under license for this study. Data are only available from BONDS by direct application.

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