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### Peer Effects on Aggressive Behavior in Norwegian Child Care Centers

With the majority of children in western societies now attending some form of Early Childhood Education and Care (ECEC) prior to school entry (OECD, 2014), concerns remain about negative behavioral consequences of early group care. Huston, Bobbitt, and Bentley (2015) claimed in a recent review that high quantities of group care increase levels of externalizing behavior problems, including, but not restricted to, aggression. The validity of this claim is, however, questioned by some researchers (e.g., Dearing & Zachrisson, 2017; Zachrisson, Dearing, Lekhal, & Toppelberg, 2013). Likewise, a meta-analysis (Burchinal, Kainz, & Cai, 2011) found only a small effect size (.08) linking observed staff child interactions to child social outcomes, while the influential National Institute of Child Health and Human Development Study of Early Child Care and Youth Development (e.g., NICHD ECCRN, 2006) found no such associations. Much less attention has been paid to the potential effects of having aggressive peers in the child group in ECEC, despite evidence that children spend a large proportion of their time in ECEC interacting with peers, often with limited adult supervision (Fabes, Hanish, & Martin, 2003). In contrast, peer effects on aggression in classrooms for school-age children have been addressed in multiple studies (e.g., Barth, Dunlap, Dane, Lochman, & Wells, 2004; Estell, Cairns, Farmer, & Cairns, 2002).

Peer influences form an essential part of children's social development, playing an important role in the development of social competence and adjustment (e.g., Fabes et al., 2003; Hanish, Martin, Fabes, Leonard, & Herzog, 2005). ECEC would, for many children, be the first encounter with large groups of same-aged peers and would provide the opportunity to acquire greater social and emotional skills, to learn to negotiate interests, and to communicate effectively (NICHD ECCRN, 2001). Since peers represent a crucial source of socialization in the ECEC context, it is important to investigate how peers influence children's aggressive behavior. Aggressive behavior patterns among school-aged children and adolescents start

early in childhood and tend to remain somewhat stable over time (e.g., Farver, 1996; Tremblay et al., 2004). Therefore, studying the effect of peer aggression in preschool children may have implications for understanding development of aggression over the years. This study aims to assess whether both levels of peer *physical aggression* (PA), and number of externalizing peers, predict physical aggressive behavior of preschool-aged children attending ECEC centers in Norway, where public ECEC is nearly universally attended.

### **Physical Aggression in Early Childhood**

Researchers in child development have distinguished between different subtypes of PA in young children (e.g., Hartup, 2005; Hay, 2016). For instance, proactive PA is exhibited in order to obtain resources like toys and can be described as an instrumental force (e.g., grabbing, snatching), whereas reactive PA comes as a response to anger or hostility. Reactive aggression is often seen as an end in itself and it is usually described as a personally directed force (e.g., hitting, kicking, biting) (e.g., Ostrov, Murray-Close, Goaleski, & Hart, 2013). Yet, interpretations of the function of physically aggressive behaviors may require an understanding of the young child's intentions, which cannot be easily observed. Thus, a more global definition of observed physical aggressive behaviors has been suggested (e.g., Nærde, Ogden, Janson, & Zachrisson, 2014; Tremblay & Nagin, 2005). In the current study, we follow this approach denoting PA as the use of physical force against others rated through observable behaviors, without making inferences about intentionality.

PA is seen by many researchers as an integral part of normative development, as a response to frustration, anger, or jealousy (e.g., Hay, 2016). It is common in most children throughout the first two years of life, followed by a normative decline after age 2 or 3 (e.g., Alink et al., 2006; Côté, Vaillancourt, LeBlanc, Nagin, & Tremblay, 2006; Nærde, et al., 2014). Gradually, the relatively high levels of aggressive behavior naturally used by the infant

to express negative feelings give way to more regulated ways of expression (Kochanska, Coy, & Murray, 2001; Tremblay & Nagin, 2005). The continued use of aggression to deal with frustration has been identified as a significant predictor of later outcomes, such as difficulties in social functioning and psychopathology (e.g., Keane & Calkins, 2004; Tremblay et al., 2004).

Yet, while both the increase and decrease of PA, as well as the timing of the peak around age 2 to 3 years, seem consistent for most children, levels of PA vary among children (e.g., Nærde et al., 2014). While genetic factors play an important role in the expression of aggression (e.g., Brendgen et al., 2008), PA is also dependent on environmental factors. In fact, home environment and associated variables such as maternal education and SES explain substantial amounts of variance in child aggression levels (e.g., Ha, Collins, & Martino, 2015; Kupersmidt, Griesler, DeRosier, Patterson, & Davis, 1995). Besides family related factors, there is some evidence that exposure to aggressive peers may contribute to negative behaviors (Hanish et al., 2005).

### **The Role of Peers in Aggression**

Peer behavior seems to play a crucial role both in the emergence and maintenance of aggression in childhood (e.g., Boivin, Vitaro, & Poulin, 2005; Chung-Hall & Chen, 2010). For example, in a sample of low-risk preschoolers, exposure to externalizing peers has been found to predict multiple problem behaviors, such as negative affect, hyperactivity and aggressive behavior (Hanish et al., 2005). Although frequencies of physically aggressive behaviors for most children follow a normative pattern of increase and decline, peers' PA seem to be one factor influencing this development. Because most children encounter a variety of peer groups during their toddler- and preschool years, groups that may vary

considerably in their levels of aggression, it is important to understand how these factors influence development of aggression above and beyond the normative developmental pattern.

Two recent theories have been proposed as explanations for the mechanisms through which children are influenced by their externalizing peers. According to the *homophily hypothesis*, children who exhibit more externalizing behavior are more likely to prefer to play with other externalizing children (e.g., Espelage, Holt, & Henkel, 2003; Estell et al., 2002). In a study conducted with 4-year-olds, it was observed that children developed social “cliques” according to similarities in terms of aggressive activity, social competence, and behavioral style (Farver, 1996). It is also possible that instead of actively seeking out externalizing peers, externalizing children may be disliked by non-aggressive peers and therefore be excluded from the mainstream groups and forced to join the other “discriminated” externalizing children (Hanish, Eisenberg, Fabes, Spinrad, Ryan & Schmidt, 2004).

Another theory posits that *peer contagion* is an important mechanism through which exposure to externalizing peers further increases externalizing behavior. Aspects such as modeling and social learning of behaviors and more general peer culture have been proposed as possible pathways (e.g., Hanish et al., 2005). Yet, studies of peer contagion in preschool age are rare. In a relatively recent review, Dishion and Tipsord (2011) have identified two longitudinal studies investigating this hypothesis in young children. Snyder, Horsch and Childs (1997) found that congregation with moderately to severely aggressive peers was associated with increases in observed and teacher-rated aggressive behavior over a period of three months. Hanish et al. (2005) found that preschool children who spent more time interacting with aggressive peers showed greater increases in aggression over the course of a semester. These findings support the contagion hypothesis suggesting that the impact of aggressive behavior on processes of peer socialization by close peers is already evident in the earliest peer relationships (Eivers, Brendgen, Vitaro, & Borge, 2012). The contagion hypothesis guides the present study,

where we test whether changes in aggression/externalizing behavior among peers are associated with changes in children's PA.

### **Gender Differences**

Research has consistently found gender differences in rates of aggression. Boys tend to play in more active, rough and competitive ways (see for ex. Maccoby 1998). Similarly, when compared to girls, boys tend to engage in more PA (Crick, Ostrov, Burr, Cullerton-Sen, Jansen-Yeh, & Ralston, 2006; Romano, Tremblay, Boulerice, & Swisher, 2005). In this way, one could expect that exposure to externalizing behaviors would be more normative for boys than for girls (Hanish et al., 2005). In support of this idea, Hanish et al. (2005) tested the contagion hypothesis in preschool boys and girls and found that boys displayed higher levels of aggression but smaller increases in aggression resulting from exposure to aggressive peers. Exposure to externalizing peers predicted multiple problems in girls such as higher aggression, hyperactivity and anxiety, whereas, in boys, the effect was less pervasive. In contrast, studies of adolescents have found stronger negative peer effects for boys than girls (e.g., Dishion et al., 1996). These gender differences in responsiveness to externalizing peers may therefore depend on the developmental period in question, but may also be specific to the populations or samples studied, given the small number of studies. Nevertheless, gender has been identified already in preschool as an important moderator in the association between peer aggression and child aggression (Hanish et al., 2005).

### **Methodological Issues**

An important concern in peer research, as well as in child care research more generally, is selection bias (Duncan, Magnuson, & Ludwig, 2004; Foster, 2010). Consider for instance if parents in families with higher risk for aggression tend to select the same ECEC centers for their children, and that this is also the case for parents in families with lower risk

of aggression. This would lead to a clustering of children with higher risk for aggression in some centers, and with lower risk in other centers. If the selection factors driving this clustering are measured and included in the statistical models, such selection bias could be accounted for. Yet, there may be selection factors not measured, or inaccurately measured, which may bias the estimates. One approach to address this problem is to use within-child fixed-effects models (Allison, 2009), as has been used in other child care studies (e.g., McCartney, Burchinal, Clarke-Stewart, Bib, Owen, & Belsky, 2010; Morrissay, 2009; Zachrisson et al., 2013). Within-child fixed-effects models essentially isolate within child variation over time in the dependent and independent variables, and thus “fix” all between-child heterogeneity (Allison, 2009). This means that e.g., selection factors into ECEC that are stable over time are by design accounted for. In the study of peer effects of aggression, this allows us to study whether *changes* in peer aggression experienced by the child are associated with *changes* in individual levels of aggression. Given that both peer and individual aggression vary considerably over time, and that confounding variables that also change over time are accounted for, this analytical approach allows for an efficient and unbiased estimate of the association.

### **ECEC in Norway**

In Norway, there is universal access to subsidized child care for children aged 1 year and older. ECEC centers may be publicly or privately owned, but all centers receive public subsidies and are required to have the same quality standard. There is a recommended adult:child ratio of 3:10 for children under 3 and 3:19 for children over 3, while a minimum teacher:child ratio of 1:10 and 1:19 is required for children under and over 3, respectively. Teachers are required to have at least a 3-year degree in early childhood education. Although these standards are not yet met by all centers, there is a relatively homogenous quality standard across most centers (Winsvold & Gulbrandsen, 2009). Norwegian parents receive

one full year of paid parental leave, so children typically start in ECEC center around age 1. The proportion of children under 1 attending child-based care has remained under 5%. The percentage of children aged 1-2 years in ECEC was around 80% in 2010, whereas the percentage of 3- to 5-year-old children was nearly 97% (Statistics Norway, 2012). There are other important characteristics that make the Norwegian context distinct from other countries. Most peer studies conducted in the US include groups of same-age children who participate in a given program (e.g., pre-K). In Norway, children do not enter a class at the same time. Most children start in the fall of the year they turn 1 but year-round entries at any age also occur (see e.g., Lekhal 2012; Dearing, Zachrisson, & Nærde, 2015). One-year-olds typically enter mixed-age classes including children aged 1-3. They later move to preschool groups with 3- to 6-year-olds (usually in the fall of the year they turn 3).

### **The Present Study**

The aim of this study is to test peer exposure effects (contagion hypothesis) in a sample of children attending Norwegian ECEC centers across ages 2, 3, and 4 years. Specifically, we hypothesize that changes in levels of PA/externalizing behavior among a child's peers over time is associated with changes in the child's individual level of PA. We test this by estimating the association between within-child changes in observed PA (both teacher- and parent-rated) and changes in two complementary measures of aggression among peers in ECEC settings: average teacher-rated PA levels among a selected number of peers, for whom teacher ratings were available, and a global rating by the teacher of the number of children in the child group (none, one, or two or more) displaying high levels of externalizing behavior. The first of these approaches has the advantage of capitalizing on a precise teacher rating of peers' levels of PA, and has been previously used in research on peer effects (e.g., Henry & Rickman, 2007; Mashburn, Justice, Downer, & Pianta, 2009). This approach may, however, be biased because it relies on measures of a selected number of peers, and thus does



not reflect the level of PA in the class as a whole. We therefore supplement with a global rating of the *number of externalizing peers* in the entire class, although this provides less precise information. While this approach is insensitive to the level of aggression beyond the crude rating by the teacher, it informs about potential dosage effects, i.e., whether the estimated number of externalizing peers is of importance. Taken together, these two supplementary approaches may give a more robust and nuanced picture of the associations between peer aggression and the individual child's PA than a single analytical approach. In contrast with previous preschool studies, which have focused on short-term changes within a year (e.g., Hanish et al., 2005; Snyder et al., 1997), we analyze changes across a 3-year span. Moreover, we use a design robust to selection bias, as described above. Finally, we use data including more peers than has been common in previous peer research. This represents an advantage because by sampling a higher percentage of the total peers, one attains more valid estimates of peer effects. Separate sets of analyses will be done by using teachers' reports and parents' reports.

We hypothesize both changes in level of average peer PA and changes in number of externalizing peers to be associated with changes in individual PA across ages 2, 3 and 4 for both teachers' and parents' reports. In line with Hanish et al.'s study (2005), which refers to pre-school age findings, we hypothesize peer aggression to be more consequential for girls than for boys. In addition, we include a number of robustness checks. Specifically, we hypothesize the findings across the age span 2 to 4 years, including gender interactions, to replicate for the two narrower time spans 2 to 3 years and 3 to 4 years, as there is no indication in the previous literature that there should be age-specific peer effects within this time period. We also hypothesize the association between peer aggression and child PA to increase as a function of more hours in care and smaller ECEC group size, as more time spent in care, and smaller groups, potentially increase the exposure to aggressive peers.

## Method

### Participants

Our sample was composed of children from the *Behavior Outlook Norwegian Developmental Study* (BONDS), a longitudinal study of 1,157 children (559 girls) and their families recruited in Norway. The larger study uses a multi-method (interviews, questionnaires, observations), multi-informant (children, parents, and teachers) approach across a range of cognitive, social and behavioral developmental domains and follows up families from age 6 months onwards. At the initial stage, 1,931 families in 5 municipalities in southeast Norway were invited to be informed about the study upon routine check-up visits at child health clinics when the child was 5 months old. Inclusion criterion was fluency in Norwegian language. Of these, 1,465 (76%) agreed to be contacted, and 1,159 (79%, or 60% of eligible families) agreed to participate. Two families later withdrew their consent, leaving the final sample size to 1,157. From this overall sample, a unique ECEC identification was available for 956 children. BONDS is approved by the Norwegian Social Science Data Services and the Regional Committee for Medical and Health Research Ethics. Recruitment took place in 2006, 2007, and 2008 and participants belong therefore to three different cohorts. Participation rate at one-year follow-up was 98%, 92% at three years and 93% at four years.

For the analyses involving “number of challenging peers”, we used the overall sample of 956 children (461 girls), nested in 175, 198, and 174 ECEC centers at ages 2, 3 and 4, respectively. These children were those for whom we had a valid ECEC identifier. For the main analyses involving peer average PA scores, we used a sub-sample of 323 children (157 girls) for whom we had both a valid ECEC identifier and data on peer PA for at least three of their peers at ages 2, 3 and 4. The 323 children were nested in 65, 69, and 64 “peer groups” (i.e., children attending the same ECEC center and born in the same year) at ages 2, 3, and 4

respectively. These peer groups were nested in 48, 51, and 49 ECEC centers at ages 2, 3 and 4 respectively (meaning that some centers had multiple peer groups, while others had only one). These were children from families initially recruited into the BONDS study, and whom, due to geographical proximity, self-selected into the same ECEC centers. The children were therefore not selected at random in the ECEC centers. Children included in our study subsample did not differ from the overall sample (with a valid ECEC identifier, but for whom we had data on less than three of their peers) in most demographic variables (see appendix).

The current study used demographic data from personal interviews with the parents at age 6 months and parent and ECEC-teacher reported data at 2, 3 and 4 years. In Norway, centers are organized in mixed-age groups and are usually divided in two sections. In each group, one finds children of varying ages (i.e., toddler group 1-3 years and preschool group 3-6 years). Each section has usually a separate play space indoors and children in the same section share meal times and other joint activities. Moreover, in some ECEC centers, several targeted activities and tasks (e.g., day trips; baking) are organized specifically for a certain age group. Same-age children often form spontaneous play groups and in some centers these groups are even organized under different names. In our analyses, we included as *peers* children who attended the same ECEC center and belonged to the same birth cohort (same age children). The average number of available same-age peers per child was 7 (SD = 3.70; range = 3-17) at age 2, 6 (SD = 2.98; range 3-15) at age 3, and also 6 (SD = 5.94; range 3-13) at age 4. At age 2 and 3, more than half of our sampled children had 7 same-age peers or more participating in the current study, which is more than 50% and 40% of the total number of peers respectively (even higher for same-age peers). At age 4, more than 40% of sampled children had 7 same-age peers in our study, which represents more than one third of the total number of peers in their group.

## Measures

**Aggression, teacher rated.** Teachers reported on the frequency of physically aggressive behavior in the ECEC context by rating eight items when the children were 2, 3, and 4 years old. The items were part of a questionnaire sent to the ECEC center around the child's (2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup>) birthday, asking the teacher who knew the child best to complete the questionnaire. The items were: a) hits other children; b) hits adults; c) pushes to get his/her way; d) pulls hair; e) pinches; f) throws things at others; g) kicks; h) bites. Teachers were asked how many times these behaviors had occurred in the past year. The response scale was as follows: 1 (never/not in the past year), 2 (once), 3 (1-3 times per month), 4 (once a week), 5 (2-3 times a week), 6 (1-2 times per day) and 7 (3 times daily or more). Internal consistency was high at 2, 3, and 4 years of age ( $\alpha$ s = .85, .87, and .89 respectively). Item scores were averaged to create the score for teacher-rated child PA. The items were developed specifically for the BONDS study, due to lack of standardized and valid questionnaires of these types of behaviors in Norway. Note that the items were designed to capture common types of physically aggressive behaviors, compared to e.g, the measure used by Tremblay et al. (1999), which captures more severe PA (Nærde et al., 2014). Although there is currently no clinical validation of the measure presented here, previous analyses suggest that, up to age 2 (Nærde et al., 2014), children estimated to be among the most physically aggressive were rated as exhibiting the listed behaviors from 2-3 times per week to 1-2 times per day. This measure was previously used by Dearing, Zachrisson, and Nærde (2015).

**Aggression, parent rated.** As part of the parent interviews at ages 2, 3, 4, parents completed a computerized version of the rating scale described above for teacher ratings, with the same response categories. In this version, the item "hits other children" was dropped and the item "hits adults" was replaced with "hits you". Alphas were as follows:  $\alpha$ s = .77, .78, and .79, at ages 2, 3, and 4, respectively. Item scores were averaged to create the score of

parent-rated child aggression. The psychometric properties of the parent version of the questionnaire were analyzed in Nærde et al. (2014), where an elaborate description of the rationale for the measure, as well as discussion of how it compared to other measures of PA, can be found.

**Number of “challenging” peers in ECEC groups, teacher rated.** Teachers were also asked to indicate, for each child at ages 2, 3, and 4, the number of “*other* children in the group exhibiting so much challenging behavior that it becomes a problem for other children”. Challenging behavior was exemplified as: difficult temperament, hitting, scratching, pushing other children, not following instructions, being disruptive, running away, teasing other children, taking things away from others, damaging things, cooperating badly, not playing well with other children, poor social skills for his/her age. Response categories were 0 (*No*), 1 (*Yes, one child in the group*), and 2 (*Yes, two or more children*). Responses were recoded into two dummy variables (0 was the reference group). This score supplements “average peer PA” by providing a rating for the entire group attended by each child. Thus, it is not restricted to the children in the group who coincidentally participated in the BONDS study. While being a cruder measure of externalizing behavior in the group, it can be seen as more ecologically valid, both because it includes all children in the group, and because it reflects the teachers’ perceptions of a level of externalizing behavior in the class that actually constitutes a *problem* for other children.

**Child care variables:** For ages 2, 3 and 4 we included as covariates the number of hours each child spent in child care per week, as reported by parents in the personal interviews at those three time points. We also included the number of children per class, and for how many months the teacher had known the child, as reported by teachers in the ECEC questionnaire.

**Family characteristics & maternal mental health:** At age 6 months, parents were interviewed and asked about the child's gender, date of birth, immigrant status (recoded into *western* and *non-western*, used as dummy variables with Norwegian as reference group). These are time invariant variables and were only included for descriptive purposes. Time-varying covariates in the estimated models (measured at ages 2, 3, and 4 years) include family composition (two-parent family [0], single-parent family [1]), maternal education (recoded into years of completed education), and maternal employment status (dummy-coded as 0 [mother employed], 1 [mother at home]). Mothers were also assessed on their symptoms of depression and anxiety by taking the mean score of the 13-item version of the Hopkins Symptom Check List (Strand, Dalgard, Tambs, & Rognerud, 2003). Note that the data collection at age 3 was primarily targeted at fathers, thus missing values were high on this variable at that time point. These variables were chosen because they are commonly found to predict PA, and thus enable us to rule out plausible alternative hypothesis (e.g., Nærde et al., 2014).

### **Analytic Strategy**

**Peer averages.** The specificity of our design implied that each child in a given peer group functioned both as a “target-child” and as a peer. Therefore, PA scores were used as both the dependent variable and as the score used to create an aggregated measure of peer PA. Inspired by the work of Mashburn and colleagues (Mashburn et al., 2009), we computed a series of peer average PA scores at age 2, 3 and 4 by calculating the average PA scores of a child's peers, excluding the target-child. For example, if we had data on 7 children, in order to calculate the peer average PA score of child  $i$ , we calculated the average score of the 6 remaining peers (excluding target-child). This approach yielded a child-level peer variable, which means each child had a unique peer average score based on ratings of the other children in the group. As emphasized by Mashburn and colleagues, the alternative approach, i.e.,

including the target-child in the calculation of peer average scores (and treating peer average as a Level 2, classroom variable), has a number of disadvantages. One of these is that a child's score is entered twice, as a peer group-level measure of PA and as a child-level dependent variable.

**Fixed-effects analyses.** We used fixed-effects models (in Stata 13, StataCorpLP, 2014) to test our hypothesis that changes in peer PA/externalizing behavior were associated with individual changes in child PA across three time points (2, 3, and 4 years of age), analyzing average peer PA and number of challenging peers in separate models. The fixed-effects equation can be written as  $y_{it} - \bar{y}_i = \beta_x(x_{it} - \bar{x}_i)$ . In our models (ignoring covariates and error terms),  $y_{it}$  is the PA score for child  $i$  at time  $t$ , and  $\bar{y}_i$  is the average PA score across the three time points. Likewise  $x_{it}$  and  $\bar{x}_i$  are peer PA for child  $i$  at time  $t$  and averaged across all time points. As such,  $\beta_x$  is interpreted as the average within-child association between peer PA and individual child PA. We adjusted standard errors for nesting in ECEC centers (using ECEC identifier at age 4). The fixed-effects model was then expanded to include time-varying covariates to account for time-varying confounding. Although fixed-effects estimates, by design, control for all possible time-invariant sources of bias, unmeasured time-varying factors may still bias estimates, and a correctly specified model is contingent on the inclusion of all probable time-varying confounders. Efficient fixed-effects estimates require also considerable within-child variability in both the dependent and independent variables over time (Allison, 2009). Moreover, it is important to take into account that our within-child fixed-effects models estimate associations between changes in the dependent and the independent variables over time. Consequently, they cannot be used to study patterns of normative change in PA, which is beyond the purpose of this article. Rather, they provide an estimate for the extent to which within-child changes in PA (presumably following a normative developmental pattern) are associated with changes in exposure to peer

PA. In other words, fixed-effects analyses enable estimation of the associations between changes in peer aggression and changes in child aggression over and above the effect of normative changes.

To test our hypothesis that peer effects were stronger for girls than for boys, we added the interaction term of gender and peer PA/number of externalizing peers (the product of gender and the peer variables). To ease interpretation, we also tested the main-effect models separately for boys and girls. In our robustness checks hypothesizing stronger effects for children in smaller groups and for those who spend more hours per week in ECEC, we also analyzed interaction effects by including the product of peer variables with our hypothesized moderators. Thus, we tested interactions with both time invariant (gender) and time varying (group size and hours in ECEC) moderators (Allison, 2009).

For analyses including average peer PA scores, we calculated effect sizes (ES) in standard deviation units, by multiplying the unstandardized coefficient from the fixed-effects regression with the quotient of the within-child SDs of the *x* and *y* variables (the SDs reflect children's normative changes),  $ES = coeff \left( \frac{SD_x}{SD_y} \right)$ . For analyses including the ratings of challenging peers, which has an intuitive metric, we simply divided the unstandardized regression coefficient by the within-child SD of the *y* variable.

We included weights in our fixed-effect analyses reflecting the varied number of peers available in each group. We used the *iweight* option in Stata 13. Peer groups containing a higher proportion of the total children attending the ECEC were given higher weights. We calculated this proportion by dividing the number of children in each peer group by the average total number of children in the respective ECEC classes. To obtain weights, we then took this percentage, subtracted from it its mean value, and added 1. Generating this type of weights by setting the median child (whose percentage of peers available is on percentile 50) to 1, translated into giving these “children in the median” a weight of 1. More weight was



given to children from whom we had higher coverage of peers and less weight was given to children for whom we had a lower coverage of peers (total range .66-1.52).

### **Missing Data**

The overall percentage of missing data in demographic and family variables collected by parent reports was less than 11% across all items in both the overall and the subsample (with the exception of reports of maternal depression at age 3 for which over 70% of the scores were missing). For teachers' reports and ECEC variables, the percentage of missing data was higher because not all ECEC units agreed to participate. We used multiple imputation (20 datasets) to account for missing data with all variables included in our analyses, using the multiple imputation by chained equations program in Stata. We included the complete BONDS sample (N=1,157) in the imputation models, then selected children for the analytical subsamples based on pre-imputation criteria: (i) valid ECEC center identifier (for analyses involving "number of challenging peers") and ii) both valid ECEC and valid data on at least three peers for analyses involving peer averages. Results were substantively identical when we used listwise deletion for missing values; we therefore report results from the MI analyses only.

## **Results**

### **Descriptives**

Descriptive data for our analytical sample is displayed in Table 1. Teachers rated children's PA on average to be less frequent than parents did. Moreover, the developmental trends of aggressive behavior were rated slightly different; while teachers rated average PA to peak at age 3, parents rated, on average, a decrease in PA from age 2 through 4. Notably, the within-child variability in teacher rated PA over time for the overall sample (SD= 0.59) was about the same as the between child variability (across time and children; SD= 0.58), and

71% of the overall, combined within- and between- variability (SD= .83). The same was true for parent reported PA (within SD= .55; between SD= .60; overall SD= .82). Thus, the prerequisite of considerable variability within-child over time for the ratings of PA was met.

The aggregated teacher rating of peer PA followed the same pattern as the individual rating, peaking at age 3. Also for this variable, within-child variability over time (SD = .30) was identical to the between-child over time variability (SD = .30), and 71% of the overall variability (SD= .42). Teacher ratings of numbers of challenging peers increased over time, e.g., from 27.41% of teachers reporting two or more challenging peers in the group at age 2, to 37.93% at age 4. This increase is likely because group sizes tend to be larger for older children, increasing from an average of around 14 children at age 2 to around 21 children at age 4. Also for this variable, within-variability over time was similar to the between-variability, and about  $\frac{3}{4}$  of the overall variability. The proportion of children at age 2 attending a group with no challenging peers, but being in a group with one challenging peer at age 4 was 22%, and with two or more challenging peers was 28%. The proportion of children attending a group with two or more challenging peers at both ages (2 and 4) was 23%. In sum, within-child variability over time of both the dependent and focal independent variables is sufficient to assume efficient fixed-effects estimates.

### **Teacher-Rated Child Physical Aggression Predicted by Peer PA/Externalizing Behavior**

**Main effects and interactions with gender.** In our first set of models, we estimated the association between changes in average peer PA ratings and changes in teacher rated individual PA scores. Recall that the average peer PA scores are aggregates of all the peer PA ratings, excluding the individual child's rating. As can be seen in Table 2 (Model 1) there was a significant association between changes in average peer PA and changes in child PA across

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ages 2, 3 and 4. A one within-child SD increase in peer PA was associated with a 22% of a within-child SD increase in child PA (i.e., a standardized effect size of .22).

Next, we estimated the same model separate for boys and for girls. As can be seen in Table 3 (Model 1), the association between changes in average peer PA and changes in individual PA rating was significant for both boys and girls. It was, however, stronger for boys, with a standardized effect size of .27, compared to .16 for girls. Notably, for girls only, it seemed that the longer the teacher had known a girl, the higher ratings of PA the teacher was likely to report, which might indicate that girls first begin to show aggressive behavior after they have spent some time in a given ECEC environment. Yet, the interaction with gender was only approaching statistical significance ( $p=.08$ , see Table 2, Model 1 with gender interaction). Thus, changes in peer PA were not significantly more associated with individual changes in PA for boys than for girls.

In our second set of models (Model 2), the dependent variable was changes in the dummies representing the number of challenging peers in the child's group, while the models were otherwise identical to those presented above. As can be seen in Table 2 (Model 2) changes to having one "challenging peer" (as opposed to having none), were not associated with changes in teacher ratings of PA when boys and girls were included in the same analysis, with the effect size being essentially zero. However, the presence of two or more "challenging" peers in the group (as opposed to none) was associated with increased ratings of child PA. Changes from zero to two or more challenging peers were associated with 38% of a within SD increase in teacher rated PA.

Again, we estimated the same models for boys and girls separately, as can be seen in Table 3 (Model 2). Changes to one challenging peer were not associated with significant changes in PA for either boys or girls. However, changes from none to two challenging peers

were associated with as much as 55% of a SD increase in PA for boys, and a 13% of a SD increase for girls. We then tested the interaction of number of challenging peers and gender, by including the product of each of the dummy variables multiplied by gender in the fixed-effects equation. As can be seen in Table 2 (Model 2 with gender interaction), the increase in PA was significantly stronger for boys, when number of challenging peers changed from none to two or more. Specifically, boys' PA increased with 47% of a SD more than girls when experiencing changes from none to two or more challenging peers ( $p < .05$ ), adjusting for all time varying covariates listed in Table 2. When boys experienced changes from none to one challenging peer, boy's PA increased on average with 32% of a SD more than girls but this was not significant ( $p = .08$ ). These differences were calculated by doing a follow-up analyses of differences between boys' and girls' estimates for changes from none to one/two or more challenging peers and dividing it by the within SD of Y (see plotted interaction in Figure 1).

**Robustness checks.** We then carried out a number of robustness checks to further probe the accuracy of our findings for teacher-rated PA. First, to test for age-specificity, we re-estimated our fixed-effects models including only two time points, from ages 2 to 3, and 3 to 4 years, respectively. As can be seen in Table S1 (in the appendix), results for the first time-span, from age 2 to 3 years, were very similar to those reported above including three time points, for both average peer PA and for number of challenging peers in the group. In Table S2 (in the appendix), we show results for the same set of analyses across ages 3 to 4 years. The estimates were lower when compared to those resulting from changes occurring between ages 2 and 3. For girls, the association with changes in peer average aggression was no longer statistically significant.

Teacher-rated levels of PA decreased from age 3 to 4 (as can be seen in Table 1). To probe whether the associations reported specifically for this age span are uniquely due to a decrease in the overall level of PA, we tested whether the associations were specific to

increases versus decreases in peer aggression. We created a dummy variable with values 0 (child PA stays the same or decreases from 3 to 4) and 1 (PA increases from 3 to 4), and tested the interaction between this variable and peer average aggression. The interaction was non-significant, meaning that the effect of peer average aggression is not dependent upon child PA levels decreasing from 3 to 4 years. This was true for both boys and girls and supports the robustness of peer contagion effects over and above normative changes in child PA.

We tested also interactions with two time-varying covariates which we expected would provide stronger evidence for a causal relation between changes in peer PA and individual changes in PA. The first of these was weekly hours spent in ECEC. Consistent with the contagion hypothesis, we expected children who spend more hours in a group, with either higher average peer PA or more challenging peers, to be rated by their teachers as exhibiting more PA. However, none of these models showed statistically significant results, and the effect size of the interaction terms were trivial. Likewise, we expected that children who attended groups with challenging peers would be rated by their teachers as more aggressive if the group size was smaller, i.e., if the proportion of challenging peers was higher. Again, there were no significant interaction effects.

Subsequently, we tested reversed lagged models, in which we hypothesized that changes in individual PA occurring between ages 2 and 3 would be associated with changes in peer level PA between ages 3 and 4 (i.e, reversed causality). Notably, lagged effects in fixed-effects analyses induce a correlation between the lagged outcome and the error-term, which we avoided by modelling the lagged analyses in SEM where this correlation can be modeled (Allison, 2009). However, none of these models yielded statistically significant results, rendering no evidence for reversed lagged associations.

### **Parent-Rated Child Physical Aggression Predicted by Peer PA/Externalizing Behavior**

In a second set of analyses, we re-estimated all models described above, while using changes in parent-rated as opposed to teacher-rated child PA. Note that the average parent and teacher ratings of PA were correlated .20, despite being reported on the same scale. In short, none of the main-effects models, for either average peer PA or “number of challenging peers” (teacher rated), were significant. However, we found an interaction between peer average PA and group size (see Table S3 in appendix). Figure 2 shows this interaction by plotting estimates of changes in children’s PA across ages 2, 3, and 4. Comparing point estimates for children in low peer average PA groups (-1 SD) in smaller vs. larger peer groups (+/- 1 SD), shows a 51% of a standard deviation difference in PA changes (difference between point estimates divided by the within SD of Y). In contrast, among individuals in high peer average PA groups (+1 SD), a 3% of a standard deviation difference was found between children in smaller vs. larger groups (+/- 1 SD). We found no other significant interactions.

### **Discussion**

In this study, we added to the limited literature on effects of peer aggression in preschool age by assessing whether changes in peer aggression predicted changes in individual level PA of preschool-aged children attending Norwegian ECEC centers. Our main purpose was to investigate whether changes in peer PA /externalizing behavior across ages 2, 3 and 4 were associated with changes in child PA over and above normative changes naturally occurring throughout this period. Our main finding was that peer PA /externalizing behavior predicted child level PA, more robustly so for boys.

In our subsample (n =323), for which we had teachers’ ratings of peer average PA (three or more peers), we found that changes in peer PA across ages 2, 3 and 4 were associated with changes in child PA (as reported by teachers). Moreover, based on teacher

reports available for all the children attending ECEC ( $n= 956$ ), we found that changes in the number of peers exhibiting challenging behavior (teacher reported) were also associated with teacher-reported child PA if two or more “challenging” peers attended the child’s group. This effect was significant for boys only. No main effects were significant for parent reported outcomes.

Taken as whole, our findings support the contagion hypothesis, suggesting that the impact of aggressive behavior on peer processes is already present in the preschool years. These findings are in line with previous studies reporting an association between exposure to peer PA and child PA (e.g., DeRosier, Cillessen, Coie, & Dodge, 1994; Hanish et al., 2005). To our knowledge, only two studies so far have tested the contagion hypothesis of aggressive behavior in preschool ages (Hanish et al., 2005; Snyder et al., 1997, c.f., Dishion & Tipsord, 2011). These studies, especially Hanish et al.’s, include a detailed data collection procedure and direct observations of peer interactions, something that was not done in our study. However, our study has the advantage of including a much larger and demographically diverse sample and to control for selection biases. Our use of fixed-effects models is consistent with current recommendations in the field for addressing the problem of selection effects (Foster, 2010; Miller, Henry, & Votruba-Drzal, 2016). In sum, the consistency of findings from these three studies, with their different methodological strengths in rather different populations, speak to the likelihood of the contagion hypothesis reflecting actual peer processes in ECEC settings.

Regarding the effect of average peer PA, we found no significant differences between genders (albeit a trend for larger effects in boys). The main effect of “number of challenging peers” on child PA was only significant upon exposure to more than one challenging peer and that effect was only significant for boys. It thus seems that the contagion hypothesis receives stronger support for boys in our study. In Hanish et al’s (2005) study, they found the opposite:

girls were more prone to contagion effects. However, they explain their findings as discordant with previous studies (notably of adolescents) and suggest that this effect might have been caused by the fact that those girls who were more likely to be exposed to externalizing peers exhibited relatively higher levels of externalizing behaviour at the start. In fact, their study showed also a stronger confirmation of the *homophily* hypothesis for girls. Although we were not in a position to test the *homophily* hypothesis in our study, we can speculate that we might have attained the opposite effect, with aggressive boys more likely to choose to play with other aggressive boys. In fact, Hanish et al. acknowledge that being attracted to externalizing behaviors is less normative for girls (Hanish et al., 2005).

Unlike previous studies of effects of peer aggression in ECEC, we also included parents' reports on individual child PA. Analyses of these outcomes yielded no statistically significant main effects, despite some trends in the same direction as found for teachers' reports. The lack of cross-informant consistency in our findings could be suggestive of reporter bias, since teachers report both on peer PA and on child PA, whereas parents report on child PA only. We do not find this likely. Correlations between teachers' ratings of peer PA and child PA were low (.20). Also, when calculating the proportion of within- versus between-classroom variation in child PA, we found that within-variation was systematically larger than between-variation at ages 2, 3 and 4. This means there is more variation within a class than between classes, which speaks against the reporter-bias hypothesis that teachers tend to rate all children in their class in a similar way (which would have inflated associations between child PA and peer PA). We found a significant interaction predicting parent-rated PA. Peer effects on parent-reported PA appeared to have the greatest bearing for children in smaller groups, with those exposed to more aggressive peers displaying higher levels of PA than those exposed to less aggressive peers. For larger groups, child PA levels were higher and independent of average peer PA. Moreover, it could also be that teachers' reports are



more valid descriptions of the child's behavior due to teachers' experience with a vast number of children and ability to compare them with typical behavior of peers. In the current study, parents rated child aggression levels higher than teachers did (e.g., 2.37 vs. 1.79 at age 2). It could be that parents' judgments are potentially contaminated by their emotional bond to the child, which might lead them to over-rate aggressive behavior. An alternative explanation, which we cannot rule out, is that teachers might overlook certain aggressive behaviors due to the fact that they are busy attending to a large group of children. Yet, it seems likely that differences in parents' and teachers' ratings are more plausibly linked to the fact that peer effects might be context specific and do not necessarily generalize to the home context.

As mentioned, our use of fixed-effects models remove all time-invariant observed and non-observed confounding by design, and thus provide stronger basis for making causal interpretations than previous studies. Yet, the validity of such causal interpretations is still contingent on correct model-specification of time-varying covariates. Rather than making a strong inference of causal effect of peer PA on individual PA, we interpret our findings as being consistent with a causal hypothesis of effects of exposure to peer PA. Another type of miss-specification which could invalidate our findings is that of reversed causality. Although this may seem counter-intuitive for the average child, this could well be the case for highly disruptive and aggressive children. In other words, the disruptive behaviour of just one highly aggressive child could have a greater influence in the group than the reverse. Two parts of our analyses do, however, speak against reversed causality. First, our reversed lagged analyses (in the robustness checks) showed no evidence that changes in individual level PA (from age 2 to 3) were associated with changes in average peer PA (from 3 to 4). A second set of analyses strengthens our confidence that there is no reversed causality. By using the teacher ratings of number of "challenging peers", we investigated a dose-response relationship between changes in number of aggressive or otherwise externalizing children, and changes in individual level

PA. The measure is undoubtedly crude but, still, these analyses suggest that just one child displaying externalizing behaviour in the group does not seem to have negative consequences (on average) for the other children. This supports the direction of influence from peer group to child, as hypothesised in this study.

While our main hypotheses were supported, our robustness checks yielded some unexpected findings. We found that peer effects were weaker for boys and disappeared for girls when changes from 3 to 4 years only were considered separately. This is, notably, an age period of normative decreases in levels of child PA for most children (e.g., Côté et al., 2006), as was also evident in our data (with lower mean levels at age 4). Although there are no indications in the previous literature that sensitivity to peer aggression decreases when average levels of aggression decrease, our robustness check is consistent with this interpretation. We did nevertheless show in our robustness checks that normative decreases in child PA from ages 3 to 4 are not single-handedly driving our findings. Even when child PA atypically increased from ages 3 to 4, increases in peer average aggression were still associated with increases in child PA for boys.

Group size and number of hours in care did not, as we hypothesized, robustly moderate the association between peer PA/externalizing behavior and child PA. Although previous studies in Norway have failed to find consistent associations between these predictors and externalizing behavior in ECEC (e.g., Solheim, Wichstrøm, Belsky, & Berg-Nielsen, 2013; Zachrisson et al., 2013), we assumed children who spent more time in care, and spent time in smaller groups (thus with potentially higher concentration of aggressive peers or fewer non-aggressive peers to interact with), would be more influenced by peer aggression. Since this was not the case in our data, it may speak to a wrong assumption on our part. There may be low thresholds for group size or hours in care (i.e., just a few hours with highly aggressive peers may have enough impact), above which exposure to peer aggression

is unaffected by more hours in care and smaller group sizes. Alternatively, these results may point to a lack of robustness of our findings when it comes to these specific moderators.

Taken together, our findings have implications for practice in ECEC settings, in line with increased attention paid to prevention of externalizing problems in early educational settings (Schindler et al., 2015). Fewer children with high levels of such behaviors in each playgroup or classroom would potentially prevent escalation of aggressive behaviors among other children in the group. There are, of course, practical limitations to this. It is probably most applicable to ECEC contexts children attend for multiple years. In such contexts, the staff know the children and their typical behavior, and can make allocations to new classes based on this knowledge to avoid the congregation of children displaying high PA levels. However, since our estimates are of associations between changes, not levels, in PA, we are not in a position to determine whether there are certain thresholds of PA which should guide such decisions, beyond the teachers' response to the "challenging peers" question based on a list of externalizing behaviors described as a nuisance to other children.

Our study has some notable strengths. Being one of the few studies on associations between peer PA /externalizing behavior and individual PA during preschool age, we have a large sample followed longitudinally through toddlerhood and preschool age. Beyond the strengths of our statistical approach, discussed above, we also take two different approaches to conceptualizing peer PA: our subsample analyses based on average peer PA enabled us to ascertain the effect of the precise teacher ratings assessed as a continuous variable and therefore referring also to less extreme levels of PA. This was complemented with using "number of challenging peers" in the class as a whole, which reflects a less precise estimate but informs about potential dosage effects of more extreme and varied aggressive/externalizing behaviors; this measure is cruder but more ecologically valid and easier to directly translate into implementation strategies (i.e., avoiding the congregation of

two or more peers in the same class). Moreover, we consider the use of fixed-effects models an advantage given they estimate whether exposure to physically aggressive peers, over time, predict variation around the normative aggression levels by focusing on within-child variation. As mentioned above, our aim was to study changes in peer PA as a predictor of *individual* variation in changes in child PA, over and above normative changes.

Our study has also limitations that must be considered. Our outcome measure includes PA only, and results cannot be directly generalized to other types of aggression such as relational aggression (Burr et al., 2005). More specifically, our findings of stronger effects for boys than for girls might reflect the subtype of aggression measured. Likewise, we cannot make any inferences with respect to the intentions behind aggressive behaviors (e.g., whether the child proactively wanted to protect her/his toys). Moreover, we included only same-age peers when calculating peer average PA. Given the structure of mixed-age classrooms in Norway, at the initial level of assessment (age 2), children had same-age peers but also peers who were one year younger (1-year-olds) and one year older (3-year-olds). However, shared activities with younger and older children are fewer and the period of overlap in the same section is shorter. For example, when children are 2 years old, their older peers are already 3 or almost 3 and likely to be soon transferred to the preschool section of the center (3-6 years). So the period of overlap in the same section with older peers is much shorter. Younger peers are just 1 year of age at the initial assessment (we did not have teacher ratings for PA at this age). Hence, we chose to focus on same-age peers who share the same environment and are likely to interact for longer periods across the assessment waves. Importantly, this limitation applies to the analyses of the subsample with ratings of peer averages only. In our analyses of “challenging peers”, there were no age restrictions, and thus these analyses apply to the entire child group. Another potential limitation is that, for the analyses of average peer PA, children were included on the basis of their participation in the BONDS study, and on the coincidence

of children attending the same ECEC centers. Children were not selected at random or as a function of whom they usually interact with in their groups. However, the recruitment of peer groups composed of a high percentage of the total peers (e.g. at age 2 and 3, more than half of our sampled children had more than 40% of their total number of peers participating in the study) gives us confidence in our estimates. Moreover, random selection may not be the best way of decreasing measurement biases. Children do not choose their closest peers randomly but based on play skills and social skills. As we have mentioned above, several studies have lent support to the *homophily* hypothesis, according to which children choose playmates among those who are more similar to themselves, namely in terms of PA levels (e.g., Espelage et al., 2003; Snyder et al., 1997). A recent study has shown that, already in preschool, children might be sensitive to behavioral cues, which allow them to select peers based on similarity (see DeLay, Hanish, Martin, & Fabes, 2015). In line with this, it is important that future research addresses issues of selective play, considering that aspects such as similar aggressive behavior or gender may be better ways of studying peer composition (see e.g., Fabes, Hanish & Martin, 2003).

Finally, there is an alternative explanation for our findings we cannot empirically rule out, namely that the changes we observe in peer aggression and child PA are due to changes in teacher classroom management style. If changes in management style affected all children in the group, our estimates of changes in peer PA and individual child PA would be biased. The plausibility of this explanation must, however, be viewed in the context of the child-centered approach of Norway's ECEC pedagogy. There is a generalized belief in the value of allowing children to play freely without much interference from the teachers (Wenche, Grindheim & Waters, 2009; OECD, 2015). Therefore, it could be that the impact of teacher class management style is less determinant in the Norwegian context. Yet, this is certainly a venue for further investigations.

## **Conclusions**

Our study lends further support to the contagion hypothesis in peer research. We found that average peer PA predicted changes in child PA across ages 2, 3 and 4, and that having two or more externalizing peers in the class predicts increases in child PA, particularly for boys. Peer effects seem to predict changes in child PA over and above normative changes, and most strongly those occurring from ages 2 to 3. For changes between ages 3 and 4, peer effects are only significant for boys. Aggressive behavior in early childhood has been identified as a significant predictor of later unfavorable outcomes such as poor social competence with peers and difficulties in social functioning (e.g., Keane & Calkins, 2004). Using PA to resolve conflicts may set the child on a vicious circle, since aggressive behavior leads to rejection by peers and consequently prevents children from developing close mutual relationships where opportunities to develop more competent responses arise (e.g., Farver, 1996). On the other hand, aggressive behavior patterns in the preschool tend to remain somewhat stable over time and carry on to grade school and adolescence (e.g., Tremblay et al., 2004). This has implications for researchers and policy makers and emphasizes the need for early intervention and implementation strategies to prevent the congregation of highly aggressive children, especially boys, in the same ECEC class.

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Table 1: Summary of child, family, and ECEC characteristics for the overall sample (n = 956) and for the subsample used in analyses with peer average PA scores (n = 323).

	Overall sample			Subsample		
	% Missing	M/%(range)	SD	% Missing	M/% (range)	SD
<i>Child &amp; Family characteristics</i>						
Boy	.00	51.78	-	.00	51.39	-
At least 1 sibling*	.03	57.86	-	.93	65.50	-
Maternal education (years)*	.04	14.50(9-18)	2.51	.31	14.40 (9-18)	2.35
Maternal age*	.01	30.92(19-42)	4.76	.00	31.20(20-42)	4.57
<i>Maternal characteristics (time variant)</i>						
Single mother (age 2)	5.96	9.39	-	4.95	7.43	-
Single mother (age 3)	8.16	11.82	-	7.12	9.01	-
Single mother (age 4)	7.11	9.69	-	4.64	7.12	-
Mother employed (age 2)	5.54	69.74	-	5.57	73.41	-
Mother employed (age 3)	10.36	63.39	-	9.29	67.36	-
Mother employed (age 4)	6.07	77.53	-	2.48	80.34	-
Maternal Dep/Anx (age 2)	6.69	1.35(1.0-3.5)	.43	5.88	1.34(1.0-3.5)	.42
Maternal Dep/Anx (age 3)	72.59	1.36(1.0-3.9)	.48	72.14	1.43(1.0-3.9)	.53
Maternal Dep/Anx (age 4)	9.83	1.33(1.0-3.5)	.39	4.33	1.34(1.0-3.5)	.41
<i>Teachers reports</i>						
Child aggression (age 2)	23.22	1.78(1.0-4.5)	.79	13.93	1.79(1.0-4.5)	.79
Child aggression (age 3)	21.44	1.91(1.0-5.8)	.89	10.22	1.86(1.0-5.8)	.89
Child aggression (age 4)	35.67	1.60(1.0-6.0)	.75	16.41	1.56(1.0-5.3)	.72
Peer aggression (age 2)	-	-	-	-	1.81(1.0-3.2)	.41
Peer aggression (age 3)	-	-	-	-	1.88(1.0-4.1)	.48
Peer aggression (age 4)	-	-	-	-	1.55(1.0-3.4)	.36
1 challenging peer (age 2)	24.06	27.49	-	-	-	-
2 or > challeng. peers (age 2)	24.06	29.73	-	-	-	-
1 challenging peer (age 3)	22.49	29.15	-	-	-	-
2 or > challeng. peers (age 3)	22.49	33.61	-	-	-	-
1 challenging peer (age 4)	36.30	31.13	-	-	-	-
2 or > challeng. peers (age 4)	36.30	38.54	-	-	-	-
<i>ECEC variables</i>						
Hours spent weekly (age 2)	5.33	33.25(6-50)	8.67	5.88	34.15(7-50)	7.62
Hours spent weekly (age 3)	7.32	34.39(5-48)	7.34	6.19	34.83(15-45)	6.84
Hours spent weekly (age 4)	7.01	34.74(6-47)	6.41	3.41	35.04(8-45)	6.51
# children per class (age 2)	23.54	14.00(3-30)	3.95	13.93	13.82(3-28)	3.71
# children per class (age 3)	21.65	17.30(3-30)	4.68	10.22	17.55(5-30)	4.30
# children per class (age 4)	35.67	20.70(6-43)	5.00	16.41	20.43(6-43)	4.44
# months knowns child (age 2)	23.74	9.07(0-24)	4.85	14.24	9.07(1-24)	5.01
# months knowns child (age 3)	22.07	11.18(0-46)	8.47	10.22	10.79(0-40)	8.82
# months knowns child (age 4)	36.19	14.42(1-83)	10.23	17.65	14.29(1-83)	10.12
<i>Parents reports</i>						
Child aggression (age 2)	4.60	2.37(1.0-5.7)	.88	4.02	2.43(1.0-5.7)	.93
Child aggression (age 3)	9.52	2.15(1.0-5.4)	.76	6.81	2.13(1.0-4.43)	.72
Child aggression (age 4)	7.22	1.92(1.0-5.2)	.73	1.55	1.93(1.0-4.5)	.71

\*time invariant (measured when the child was 6 months old); not in the models.

Peer effects on aggressive behavior

Table 2: Fixed effects models predicting teacher-rated child PA from teachers' ratings of peer average PA (Model 1, n = 323) and number of challenging peers in the group (Model 2, n= 956) across ages 2, 3 and 4.

	Model 1 (peer average PA)		Model 1 with gender interaction		Model 2 (# challenging peers)		Model 2 with gender interaction	
	Coeff (SE)	ES	Coeff (SE)	ES	Coeff (SE)	ES	Coeff (SE)	ES
Peer average PA	.403**(.086)	.22	.043(.170)	.02	-	-	-	-
1 challenging peer	-	-	-	-	.036(.052)	.06	-.053(.063)	.09
2 or more	-	-	-	-	.222**(.062)	.38	.080(.073)	.14
Group size	-.008(.009)	.004	-.002(.012)	.001	-.009(.007)	.02	-.008(.007)	.01
How long known child	.006(.003)	.003	.0005(.005)	.0003	.002(.002)	.003	.002(.002)	.003
Hours in care	.004(.005)	.002	.010(.007)	.005	.003 (.004)	.005	.003(.004)	.005
Single mother	-.113(.214)	.06	.177(.200)	.10	.151(.117)	.26	.158(.118)	.27
Maternal employment	-.010(.074)	.005	-.145(.089)	.08	.038(.049)	.07	.042(.049)	.07
Maternal depression	.048(.12)	.03	-.071(.178)	.04	-.040(.086)	.07	-.028(.086)	.05
Peer average PA x gender	-	-	.394(.233)	.21	-	-	-	-
1 challenging peer x gender	-	-	-	-	-	-	.169(.097)	.29
2 or more x gender	-	-	-	-	-	-	.265* (.107)	.45

ES = effect size



Peer effects on aggressive behavior

Table 3: Fixed effects models predicting teacher-rated child PA from teachers' ratings of peer average PA and number of challenging peers in the group across ages 2, 3 and 4 (for boys and girls separately)

	Model 1 (peer average PA)		Model 2 (# challenging peers)	
	Coeff (SE)	ES	Coeff (SE)	ES
<b>Boys only</b>				
Peer average PA	.526**(.139)	.27	-	-
1 challenging peer	-	-	.112(.078)	.18
2 or more	-	-	.347**(.088)	.55
Group size	-.014 (.013)	.007	-.010(.010)	.02
How long known child	.001 (.005)	.0005	.004(.003)	.006
Hours in care	-.0009 (.007)	.0004	.004 (.006)	.006
Single mother	.072 (.357)	.04	.295 (.150)	.47
Maternal employment	-.055 (.121)	.03	.003 (.075)	.005
Maternal depression	-.054 (.007)	.03	-.028 (.111)	.04
<b>Girls only</b>				
Peer average PA	.280* (.116)	.16	-	-
1 challenging peer	-	-	-.056 (.063)	.01
2 or more	-	-	.075 (.073)	.13
Group size	.001 (.013)	.0006	-.004 (.007)	.007
How long known the child	.011* (.005)	.006	.0004 (.003)	.0007
Hours in care	.008 (.008)	.005	.002 (.005)	.004
Single mother	-.253 (.264)	.15	-.018 (.189)	.03
Maternal employment	.051 (.081)	.03	.087 (.059)	.16
Maternal depression	.164 (.163)	.10	-.027(.112)	.05

ES = effect size

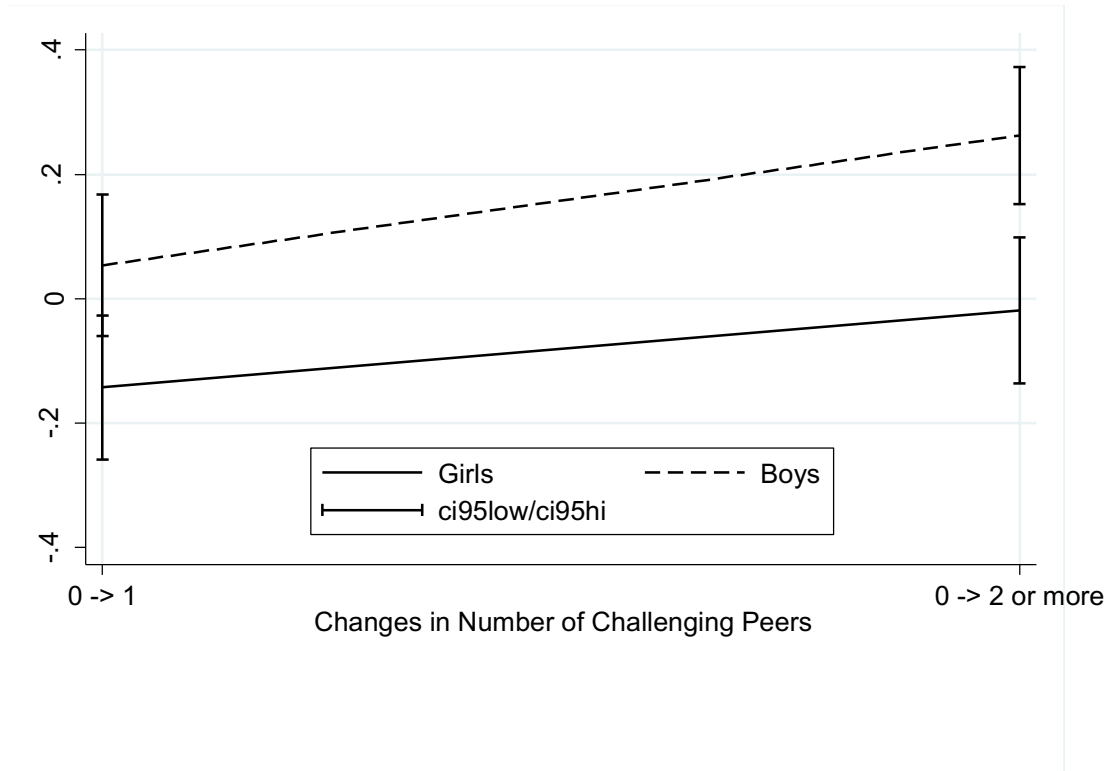


Figure 1: Interaction between changes in number of “challenging” peers and gender in predicting changes in child PA levels (teacher-rated)

# Peer effects on aggressive behavior

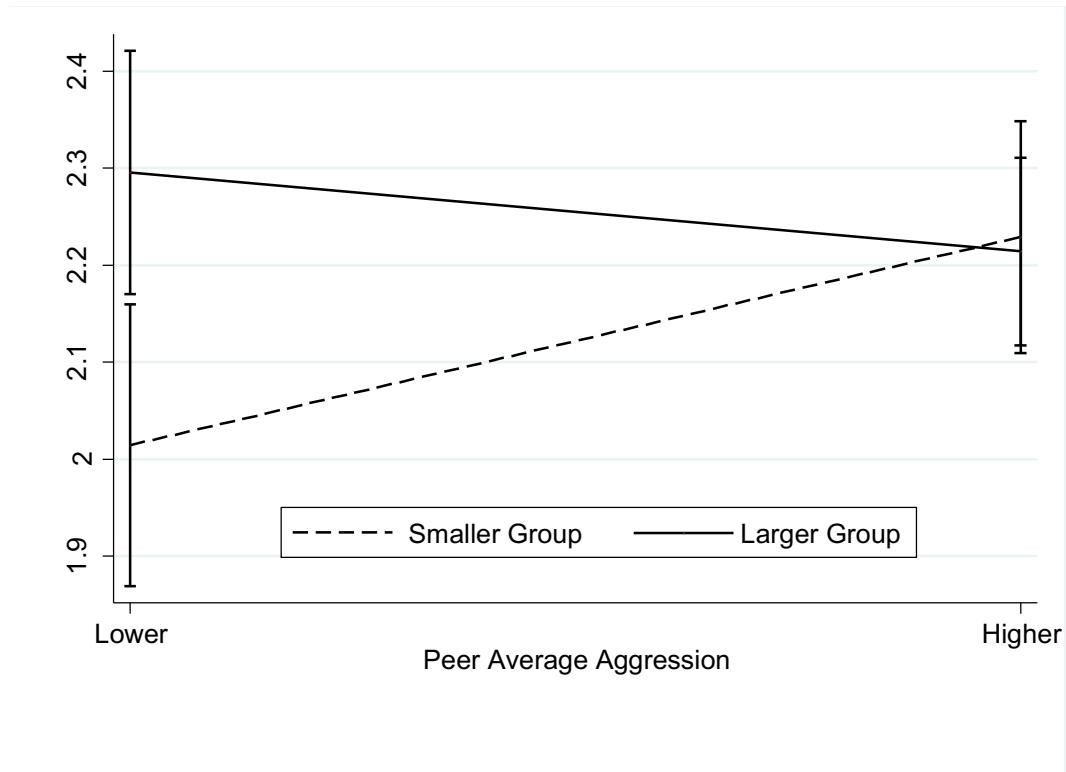


Figure 2: Interaction between peer average PA and group size in predicting changes in child PA levels (parent-rated)