

Nature Preschool as a Promoter of Physical Activity in Young Children: An Exploratory Study of Nature Preschool in a Northern Climate

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ABSTRACT

Preschools and other early childhood education and care settings are influential in the promotion of physical activity (PA) for young children. This study utilized the Yamax Digiwalker pedometer within a quasi-experimental design to quantitatively explore the influence of nature preschools on the PA of 154 preschool-aged children. Results suggest that nature preschools support sufficient PA; furthermore, participants were able to achieve recommended PA during cold and wet months through unstructured nature play. These findings suggest that nature preschools support PA, even during winter months. The results also point to the important role unstructured nature play has in supporting children's physical activity and overall well-being. Implications for practice and further research are discussed.

Keywords: nature preschool, nature play, step-based physical activity

Physical activity is a critical component of the health and development of children (Pate et al., 2006). It promotes cardiovascular and musculoskeletal health (Janssen & Leblanc, 2010), and it has been associated with mental health, including a reduction in depression and anxiety, and with academic achievement (Strong et al., 2005). Additionally, physical activity is protective against obesity in the preschool years and has a strong protective effect on body fat accumulation through adolescence and adulthood (Tandon et al., 2012). A favorable combination of lower levels of sedentary behavior and higher levels of physical activity is positively associated with fitness and motor development (Kuzik et al., 2017). An analysis guided by the "Australian 24-hour Movement Guidelines" found that meeting physical activity, sleep, and screen time guidelines (Cliff et al., 2014) was positively associated with better social-cognitive development. Furthermore, physical activity levels and behaviors extend from early childhood to adolescence and beyond, thus underscoring the importance of establishing positive physical activity habits from a young age (Jones et al., 2013; Jones et al., 2019).

Guidance for Young Children's Physical Activity

Due to the importance of physical activity for children's growth and development, a variety of organizations have worked to establish guidelines or recommendations for children's physical activity. Guidelines from the United Kingdom (Department of Health and Social Care, 2019) and Canada (Canadian Society for Exercise Physiology, 2017)

call for a minimum of 180 minutes of physical activity per day, at least 60 minutes of which should be spent in energetic play. These guidelines further recommend children under the age of five years not be required to stay in a sedentary state for more than one hour, unless sleeping (Canadian Society for Exercise Physiology, 2017). The U.S. Institute of Medicine (McGuire, 2012) provides specific recommendations around sedentary behavior and physical activity for preschools and childcare centers, emphasizing that young children should be allowed to move freely, with periods of sitting or standing still limited to 30 minutes at a time. They further recommend that children participate in physical activity for at least 15 minutes per hour of care. Other guidelines in the U.S., from the Society of Health and Physical Educators (SHAPE, 2020), recommend that children participate in 2 hours of physical activity a day, with 60 minutes coming from structured physical activity and 60 minutes from unstructured or spontaneous active play. When taken in whole, the variety of guidelines underscore the importance of movement from an early age and seem to suggest that a sustainable increase in physical activity, especially when replacing sedentary behavior and/or screen time, may have positive benefits for young children.

While physical activity recommendations are often in the form of minutes per day, there have been efforts to convert these guidelines into step count targets to provide a mechanism for practitioners and researchers to monitor physical activity. Researchers have recognized that although evidence-based steps/day translations of national guidelines for specific age groups are useful and needed, accurately translating recommended minutes to recommended steps is a complex undertaking (Tudor-Locket et al., 2011). Adams et al. (2013) comment on the lack of a definitively identified, precise translation of the needed steps/day for youth, and encourage researchers to undertake further studies toward proposing reasonable “rule of thumb” values. Toward this end, research by Gabel et al. (2013) suggests a step count target of 6000 steps per day to determine if 3- to 5-year-old children are active for the recommended 180 minutes per day, per the U.K. and Canadian guidance. This recommendation of 6000 steps per day is commonly used in the research literature, as is another translation from Vale et al. (2015), which suggests preschool-aged children who accumulate less than 9000 steps per day may be considered insufficiently active.

Need for Increasing Physical Activity of Young Children

Despite the importance of physical activity for young children, it appears that many young children may not be sufficiently active. For example, in Tucker’s (2008) review of 39 studies from the United States, Scotland, Finland, Australia, Chile, Estonia, and Belgium only about half (54%) of preschool age children were meeting recommended physical activity guidelines. It is thought that increases in screen time, the fact that children have fewer siblings to play with than children of previous generations, and greater parental constraints in play places and safety concerns have resulted in dramatic increases in sedentary behavior (Boreham & Riddoch, 2001).

It has been suggested that the amount of time children spend in daycare is also associated with increasing sedentary behaviors among preschool children (Tucker, 2008). As over half of American children are enrolled in preschools or center-based care, spending from 4 to 10 hours per day on average in these settings, the preschool/childcare environment is influential on children’s physical activity levels (O’Neill et al., 2016). Studies confirm Tucker’s speculation, with data suggesting preschoolers in preschool/childcare environments are spending little time both in physical activity and in outdoor play (Trost et al., 2003). Similarly, another more recent study found that children spent 48.4% of time at childcare sitting (Ellis et al., 2017). This may be due to teachers assuming preschool-aged children are very active and engage in sufficient activity outside of childcare/preschool (Salbe et al., 1997), thereby deemphasizing the importance of encouraging physical activity within preschool or childcare settings (Tucker, 2008). More recent research further suggests that opportunities for physical activity are often lacking in preschool and childcare settings, with the majority of children’s activity being sedentary. This recent study of 10 Seattle childcare centers found preschoolers were offered only 48 minutes a day for active play, with 73% of their day in sedentary activities (Tandon et al., 2015).

Characteristics Associated with Young Children’s Physical Activity Levels

While childcare settings appear to contribute to this lack of physical activity, the strong correlation between characteristics of the childcare environment and children’s level of physical activity suggests a potential for using this setting toward increasing physical activity (Pate et al., 2008). Thus, while there is much need and opportunity

within the preschool and childcare setting to intervene toward increased physical activity, “the research on how to best organize childcare time to optimize physical activity and decrease sedentary behavior is in its nascence” (Tandon et al., 2018). Emergent characteristics associated with increased physical activity include overall preschool quality and teachers’ physical activity training (Dowda et al., 2009), as well as less fixed playground equipment, the amount of open space in the childcare/preschool setting and the amount of outdoor playtime included in the daily schedule (Bower et al., 2008). Tandon et al., (2018) found that preschool children were more active and less sedentary when they were outdoors, and that child-initiated activity (free play) resulted in more active play than teacher-led physical activity. In a similar vein, due to children’s increased levels of physical activity when playing outdoors, the American Academy of Pediatrics recommends children play outside as much as possible (Yogman et al., 2018). The Canadian 24-hour Movement Guidelines also state that replacing indoor time with outdoor time may provide greater health benefits (Canadian Society for Exercise Physiology, 2017).

Supporting Young Children’s Physical Activity through Nature Preschool

Although these findings suggest the positive impact of time spent outdoors on children’s PA, the research also suggests preschool-age children may not be getting much outdoor playtime while in childcare/preschool settings. Copeland et al., (2016) reported that only 3 in 10 children in the 30 childcare centers they studied participated in 60 minutes of outdoor play time. They also found that in many centers, outdoor play time actually occurred less frequently than scheduled, and that about a third of young children experienced no outdoor playtime whatsoever (Copeland et al., 2016).

In northern latitudes, the significant decline in childcare-related physical activity and outdoor playtime across seasonal changes represents another concerning trend (Schunta et al., 2016). Temperature, precipitation, and daylight hours can be barriers to physical activity and may explain seasonal variation in physical activity (Merrill et al., 2005; Berkey et al., 2003). Studies have suggested that total activity levels among youth are often highest in spring and summer. For example, Fisher et al. (2005) reported the highest activity level for preschool age children in the U.K. was in the summer months. Kolle et al. (2009) found Norwegian children were more likely to meet recommended levels of physical activity during spring than during winter. Research by Baranowski et al. (1993) suggests changes in the amount of outdoor time are associated with seasonal variations in physical activity levels among young children.

In contrast, nature preschools are an early childhood setting where unstructured, outdoor playtime occurs across all seasons and in all types of weather. Further, nature preschools combine two of the emerging characteristics that are associated with increased physical activity in young children: extended periods of free play and time outdoors. Nature preschools use the natural environment as the outdoor setting for this extended free play, which contrasts the more common fixed playground equipment where most outdoor play at childcare centers occurs. Play in the natural environment has been shown to have a positive effect on children’s motor development and level of physical activity (Fjortoft & Sageie, 2000; Fjortoft, 2004). This finding is consistent with a study of preschool age children in a climate of moderate temperatures (approximately 70 degrees Fahrenheit), which found increased physical activity after a playground was renovated to include more natural environments (Coe et al., 2014).

A rapidly growing movement within the U.S., nature preschools are defined as preschools that use the natural world to support both child development and the development of conservation values or an environmental ethic (North American Association of Environmental Education [NAAEE], 2017). Nature is the central organizing concept of the program - the integrating thread that intentionally ties together the preschool’s philosophy, methodologies, classroom design, outdoor spaces, and public identity (The Natural Start Alliance, 2019). Despite an expanding body of literature regarding the benefits, the emphasis on early academic preparation in the U.S. education system continues to limit this movement from reaching its full potential. Tandon et al. (2018) suggest, “Although the relationship between physical activity and learning is gaining considerable support through research in school-aged children, it is not yet as well established in preschoolers” (p. 1429). Research on the impact of nature preschools on children’s physical activity, coupled with existing research on the benefits of nature preschools on cognitive functions and social-emotional outcomes (such as that by Ulset et al. (2017) which found a positive relationship between the

time spent outdoors in preschool and children's working memory and an inverse relationship with inattention-hyperactivity symptoms), can help counter the idea that active play and learning are mutually exclusive.

METHODOLOGY

Research Purpose

This purpose of this study was to explore the potential for nature preschools, with their emphasis on nature play, to promote young children's physical activity in preschool/childcare settings, particularly in northern climates. Given the gap between recommendations for physical activity and actual practices in childcare settings, and in light of little research regarding how to arrange childcare time and settings to optimize physical activity, the study aimed to contribute to this developing body of literature. Notably, growth within this area of research may help to promote early learning practices and policies that are supportive of active play outdoors and oriented toward supporting the development of children across all domains. Further, documenting physical activity at nature preschools, particularly in late fall and winter months, would advance an understanding of the potential of nature preschools to counter the seasonal decline of outdoor physical activity. Specifically, the following research questions were addressed in this study:

1. Do nature preschools in northern climates promote seasonal physical activity toward meeting recommended physical activity guidelines?
2. When controlling for age, gender, and prior physical activity levels, are nature preschoolers more active while at preschool than their peers in non-nature programs?

Research Design

Our study utilized a pretest posttest non-equivalent control group design. This quasi-experimental design, commonly employed in education research settings, was necessitated due to the inability to randomly assign children to preschool settings. To control for potential pre-existing differences among the children, data was collected on children's age and gender. Due to a lack of variability in terms of racial and ethnic diversity within the geographic region of the study, race and ethnicity of participants were not collected. To control for pre-existing differences in activity level prior to preschool participation, parents of participating children were asked to complete a brief questionnaire, the Early Years Physical Activity Questionnaire (EY-PAQ) (Bingham et al., 2016), which contains items that gather data about the activity level of their children. This questionnaire has been validated for use in assessing young children's baseline physical activity in situations when objective, direct assessments are not feasible (Bingham et al., 2016).

Participants in the treatment group were children attending one of the five participating nature preschools, located in northern Minnesota, U.S. Participants in the non-equivalent control group attended one of three non-nature preschools, also located in northern Minnesota. Of the five nature preschools and three non-nature preschools, one of the preschools in each grouping was a Head Start preschool program; the rest of the programs were private preschools, with the exception of one that was affiliated with a public university. Participating sites were asked to complete a brief form, specifying the average length of their preschool day and the average amount of time daily spent in free play indoors, free play outdoors, teacher-led physical activity indoors, and teacher-led physical activity outdoors. Teachers were also asked to specify the location of their outdoor free play, and also if any of these responses varied monthly or seasonal, and if so, to indicate which months and the amount of time across the aforementioned activities (these daily averages are reported in Table 1).

Nature and non-nature preschools differ in philosophy as well as in instructional methods and time allocation of the school day. The five nature preschools applied a nature-focused, child-directed play philosophy. Regardless of weather, the majority of the day was spent outdoors in nature play (defined for this study as child-initiated play that take place in and with nature). For children in the full day program, this schedule allowed for approximately four to five hours of daily nature play. Outdoor play occurred in a variety of nature settings including "wild" (unmaintained)

natural space, minimally managed space, and natural playscapes designed specifically for nature play. The natural playscapes included “structures” such as stepping stones or stumps, digging areas, and a collection of loose natural parts for building and creating. Indoor spaces were used minimally for approximately thirty to ninety minutes. Indoor time was devoted primarily to free play; although, teachers typically led loosely structured, playful learning experiences for approximately 15-30 minutes each day. These five nature preschools had a combined total of 98 participants, with 48% of them female.

For this study design, three non-nature preschools served as a comparison or baseline group, rather than a true control group, due to fewer participants and the lack of random assignment. The comparison schools were selected based on willingness to participate as well as a similar geographic location, tuition structure, and demographic makeup in relation to the treatment schools. All three programs shared the aim of supporting children’s cognitive, social, emotional, and physical development. The majority of play at these programs occurred indoors, with varying amounts of the preschool day devoted to unstructured or loosely guided play (one to four hours). In addition to indoor playtime, these three programs provided opportunities for outdoor play, varying in length from 30 minutes to 2 hours and 30 minutes. Outdoor play was primarily in a maintained outdoor space with typical, fixed playground equipment. Children also experienced teacher-guided learning, with the amount of time varying by site (from 15 minutes to 2 hours). The comparison group was comprised of a total of 56 participants, with 48% of the participant female.

Based on these defining characteristics, participants across the preschools shared similar geographic locations and experienced developmentally appropriate programs led by caring and responsive teachers. The proportion of daily preschool time spent in free (unstructured) play and the location of the unstructured play time served as the main differentiation between the nature and non-nature preschools. See Table 1 for a description of participating nature sites.

Research Instrument and Procedures

The Yamax Digiwalker Pedometer is an electronic pedometer that measures vertical oscillations and provides a total count of accumulated movements. It has been shown to have functional utility in assessing physical activity in school children and has been validated for measuring physical activity in young children (Cardon & Bourdeaudhuij, 2007). Schunta et al. (2016) suggest a consecutive five-day period yields sufficiently reliable physical activity data in young children. Thus, data was collected during a five-day period during the end of October and again during a five-day period at the end of February. These months were selected as they are often less conducive to outdoor play. Temperature in both months is often in the 20-degree Fahrenheit range, with generally little snow on the ground in October, changing to significant snow on the ground in February; the region averages 70 inches of snow annually. In order to control for potential weather variations week to week that could affect activity levels, the same five-day period in February and October was used for data collection at each of the sites.

Procedures used in Vale et al. (2015) guided the protocol regarding use of the pedometers for data collection. Following approval from the University’s Institutional Review Board, researchers met with each lead teacher at the participating preschools to ensure proper use/wear of the devices and to clarify data collection protocol. This protocol involved obtaining consent from parents and asking parents that granted consent to complete the EY-PAQ, which served as the proxy measure of pre-existing physical activity level (the baseline measure for the survey). Parents were asked to complete the questionnaire for the time period of August, which was the month that preceded preschool participation; this was done so that the baseline was measured prior to the start of the treatment. While the strategy of asking parents to have their children wear pedometers and record data prior to the start of the academic year was considered, this approach for obtaining baseline PA data didn’t seem feasible (due to not having access to participants to administer the consent process and provide them with pedometers, prior to the start of the school year, and due concerns that the time and effort involved on the part of parents would result in a decrease in participation rates).

For the five-day data collection periods, the lead teacher was responsible for fastening children’s pedometers on the waistbands of their left hip, in alignment with the midpoint of their knee, upon their arrival. They were also

responsible for removing it at the end of the preschool day during the two specified five-day periods. The preschool teacher recorded the time of arrival and departure during data collection days, so that variations in length of preschool day for each child were controlled for in the analysis. Additionally, teachers recorded the number of minutes of napping/resting time per day, to account for variations across sites and so that these minutes were not considered within physical activity assessments. To reduce the influence of inter-device variability on physical activity measurements, children wore the same device for each of the data collection days and across both data collection time periods. The devices were “taped” so that the display screens were covered; this was to prevent the devices from being distractions to the children and to avoid encouraging interaction with the device.

RESULTS

Descriptive statistics were used to analyze the data toward addressing the first research question regarding nature preschools and if they promoted physical activity toward meeting recommended physical activity guidelines. As noted in the literature review, achieving 6000-9000 steps per day was used as the indicator of meeting recommended daily physical activity for preschool-age children, per Gabel et al. (2013) and Vale et al. (2015). For participating sites, average step counts per minute for late October and late February are reported in Table 1. Table 1 also reports the average steps achieved during the preschool day, which were calculated by multiplying average steps per minute by average length of preschool day in minutes. Based on data yielded in the two data collection periods in this study, and using this analysis approach, all three full-day nature preschools are generally supporting sufficient physical activity among their preschool participants. Late October average daily step counts ranged from 6821 to 8100 steps. For the late February data collection window, steps were lower (5765 to 7390 steps), but still generally within (close to) the targeted range of step-based physical activity. While the guidelines for recommended daily steps are more difficult to apply to half-day preschool programs, due to the shorter length of time children spend at preschool, preschoolers attending the half-day nature preschools averaged 4033 to 4595 daily steps (see Table 1).

To address the second research question regarding if young children in nature preschool programs had significantly more steps per minute than children in the non-nature preschools, general linear modelling (between-subjects multivariate testing) was used. In this analysis, the between-factor (independent variable) was program type, with three levels (half-day nature, full-day nature, and non-nature). The dependent variables were average steps/minute in late October and average steps/minute in late February. The covariates in the analysis were age, gender, and baseline physical activity.

The results suggest a significant difference in steps/minute by program type for both late October data and late February data, $F(2) = 11.48, p < .001$ and $F(2) = 13.85, p < .001$ respectively (see Table 2). Estimated marginal means by program type are reported in Table 3. Pairwise comparisons of estimated marginal means for data from late October suggest children in the half-day and full-day nature preschools were significantly more active than children in the non-nature programs in late October (MD = 6.25, SE = 1.34, $p < .001$; MD = 4.35, SE = 1.19, $p < .001$, respectively). For the late February data, one of the non-nature preschool sites did not collect data. February data from the sites who did collect data indicates children in the half-day nature preschools were significantly more active than children in both the full-day non-nature preschool and nature preschools (MD = 6.36, SE = 1.29, $p < .001$; MD = 4.68, SE = 1.11, $p < .001$, respectively). There was not a significant difference between children in the full-day nature and non-nature programs, which will be discussed below in light of the change in number of participating sites. See Table 4 for statistical data for these pairwise comparisons.

DISCUSSION

Physical activity behavior trends in preschool tend to extend into childhood (5-8 years old), thus highlighting the importance of developing strong PA levels from an early age (Jones et al., 2013; Jones et al., 2019). Because children may spend from 4 to 10 hours per day in childcare (O’Neill et al., 2016), understanding practices that support PA are of utmost importance. Nature preschools offer promising opportunity as they combine two characteristics that have been positively associated with increased PA: free play and outdoor play. Therefore, this study sought to offer empirical evidence regarding the effect nature preschools have on physical activity.

Table 1
 Description of Study Sites and Summary of Participants Physical Activity Levels

| Site | Number of Participating children | Nature (Nat) or Non-Nature (Non) | Full or Half Day Program | Average Length of Preschool Day, in Minutes ^a | Average play or PA minutes/daytime minutes (percentage of daytime minutes) ^b | | | | M (SD) pre-Physical Activity Level ^c | M (SD) Steps/Min Last week of October | M (SD) Steps/Min Last week of February | Total Average Steps Achieved During Preschool Day for Oct/Feb ^d |
|------|----------------------------------|----------------------------------|--------------------------|--|---|-------------------------------------|-------------------------------------|------------------------|---|---------------------------------------|--|--|
| | | | | | Free play indoors | Free play outdoors | Teacher-led indoor PA | Teacher-led outdoor PA | | | | |
| 1 | 16 | Nat | Full | 410 | 60 min (14%) | 300 min (73%) | - | - | 37.43 (22.25) | 17.75 (5.58) | 14.06 (5.35) | 7100/5765 |
| 2 | 17 | Nat | Full | 390 | 90 min (23%) | 270 (70%) | - | - | 47.35 (21.25) | 20.77 (4.42) | 18.95 (5.23) | 8100/7390 |
| 3 | 27 | Nat | Full | 345 | 30 min (9%) | 225 min (65%) | - | - | 57.32 (37.99) | 19.77 (3.83) | 17.95 (3.96) | 6821/6193 |
| 4 | 23 | Nat | Half | 195 | 40 min (20%) | 100 min (50%) | 20 min (10%) | 20 min (10%) | 42.73 (23.86) | 20.68 (4.81) | 21.99 (5.56) | 4033/4288 |
| 5 | 9 | Nat | Half | 180 | 90 min (50%) | 60 min (33%) | 5 min (3%) | - | 29.63 (19.37) | 25.53 (4.66) | 25.41 (7.01) | 4595/4574 |
| 6 | 21 | Non | Full | 345 | 60 min (17%) | 60 min (17%) *30 min (8%) in Feb | 30 min (8%) *50 min (14%) in Feb | - | 38.61 (11.28) | 12.25 (3.88) | 14.48 (4.34) | 4226/4996 |
| 7 | 9 | Non | Full | 430 | 250 min (58%) | 150 min (35%) | - | - | 30.81 (21.82) | 22.49 (4.28) | 17.09 (3.44) | 9675/7353 |
| 8 | 14 | Non | Full | 320 | 90 min (28%) | 30 min (10%) | 20 min (6%) | - | 51.40 (47.62) | 17.61 (5.15) | -- | 5632 |

Notes:

- ^a Length of day in minutes excluding nap/rest time (daytime minutes); to account for variability across children within sites for drop-off and pick up times, length of day was average length of day for participants (calculated by average number of minutes pedometers worn minus napping minutes)
- ^b Day is defined as daytime or non-napping minutes; percentage of daytime (non-napping) minutes during preschool day; same for October and February, unless noted
- ^c Calculated from average total minutes of moderate to vigorous physical activity, as reported by parents on EY-PAQ for their children's physical activity levels the month prior to preschool participation, divided by 840 daytime (awake) min/day multiplied by 100 to yield proportion of waking day in moderate to vigorous physical activity; number reported in column is site average across participants
- ^d Calculated by average steps/min multiplied by average length of minutes in preschool day

Table 2

Statistical Results of Multivariate Between-Subjects Test for Effect of Preschool Program Type on Physical Activity

| Source | Dependent Variable | df | F | Significance |
|---|---------------------|----|-------|--------------|
| Pre-physical activity level | Late Oct. steps/min | 1 | 1.37 | .24 |
| | Late Feb. steps/min | 1 | .31 | .58 |
| Age | Late Oct. steps/min | 1 | 1.20 | .28 |
| | Late Feb. steps/min | 1 | .27 | .60 |
| Gender | Late Oct. steps/min | 1 | 3.91 | .05 |
| | Late Feb. steps/min | 1 | 9.20 | .003 |
| Program Type (Nature full, Nature half, Non-Nature Full) | Late Oct. steps/min | 2 | 11.48 | <.001 |
| | Late Feb. steps/min | 2 | 13.84 | <.001 |

Table 3

Estimated Means and Standard Errors of Physical Activity Levels by Program Type

| Program Type | Dependent Variable | Mean | Std. Error |
|---------------------|---------------------|-------|------------|
| Full-day Nature | Late Oct. steps/min | 19.65 | .67 |
| | Late Feb. steps/min | 17.33 | .65 |
| Half-day Nature | Late Oct. steps/min | 21.56 | .94 |
| | Late Feb. steps/min | 22.00 | .90 |
| Full-day Non-Nature | Late Oct. steps/min | 15.31 | .96 |
| | Late Feb. steps/min | 15.64 | .93 |

Note: Covariates in the model evaluated at the following values: Pre-physical activity level = 43.98; Age = 4.33

Table 4
Pairwise Comparisons of Physical Activity Levels by Program Type

| Dependent Variable | Program Comparison | Mean Difference | Std. Error | Significance |
|----------------------------|---|-----------------|------------|--------------|
| Late October Steps/Minute | Full-day Nature and Half-day Nature | -1.91 | 1.16 | .10 |
| | Full-day Nature and Full-day Non-Nature | 4.35 | 1.19 | <.001* |
| | Half-day Nature and Full-day Non-Nature | 6.25 | 1.34 | <.001* |
| Late February Steps/Minute | Full-day Nature and Half-day Nature | -4.68 | 1.11 | <.001* |
| | Full-day Nature and Full-day Non-Nature | 1.69 | 1.15 | .14 |
| | Half-day Nature and Full-day Non-Nature | 6.36 | 1.29 | <.001* |

The results of this study suggest the potential for nature preschools to positively impact children's seasonal PA. Children in the full-day nature programs were meeting recommended levels of physical activity while at preschool, which is meaningful toward countering the likely lower physical activity opportunities during the after-care hours (in light of less daylight, evening routines, etc.). Children in the half-day nature programs had high levels of physical activity, achieving about 4000-5000 of the recommended 6000-9000 steps in a relatively small proportion of their waking day (about three to four hours of a 12- to 14-hour waking day). While steps decreased slightly during the second collection window (late February), children were still close to the targeted range of PA. It is worth noting, too, that depth of snow in February may have reduced the total number of steps taken or the total number of steps detected by the pedometers, as these devices were not validated for movement in snow environments. Little is known about the connection between movement through snow and impacts on health. However, it is possible that while movement in snow may yield fewer steps, it could also be associated with higher levels of physical exertion and thus other positive impacts on physical health.

Children in the nature preschools achieved the recommended physical activity primarily through unstructured nature play, rather than through structured activity (see Table 1). Some guidelines suggest that part of young children's PA should come in the form of teacher-led exercises (SHAPE, 2020). Yet many caregivers do not feel trained or confident in leading such exercise (Jones et al., 2019), which may create a barrier to children engaging in such forms of PA. However, in the current study, even in the absence of structured teacher-led exercises, preschoolers were able to achieve the recommended number of steps. Children innately know how to play and engage in the natural world, thus allowing them to meet PA guidelines through their own volition. Not only did nature preschoolers generally meet the recommended PA levels, but they also experienced a limited amount of sedentary time, spending much of their day in unstructured play. These activity levels align with the SHAPE guidelines which recommend children participate in unstructured physical activity for a minimum of 60 minutes, but for up to several hours, per day (2020). Thus, these findings support the notion that children can get enough steps through play.

Beyond meeting general PA recommendations through play, children in the nature preschool setting got enough steps in their day without having to go indoors during the winter months. The geographical area in which the preschools studied are located sees significant precipitation and cold temperatures throughout many months of the year, with February temperatures typically ranging from -7 degrees to 31 degrees Fahrenheit. These findings challenge the commonly held response to changes in weather and seasons. A 2007 review identified that 73% of studies on the topic found changes in weather had significant effect on participants' PA levels (Tucker & Gilliland). Typical solutions for this decline advise providing kids with more indoor opportunities during the winter months (Silva et al., 2011; Tucker & Gilliland, 2007). In contrast, the current findings suggest that heading indoors is not the only way to stay active during wet and cold weather. Based on the many studies highlighting the importance of PA in young children, adding yet another solution (nature play) to the mix of viable options for increasing winter activity offers valuable insight. Additionally, while sending children indoors may offer one avenue for maintaining activity levels, it could limit other benefits of outdoor play and learning, such as the positive impacts nature play has upon children's cognitive development (Dankiw et al., 2020).

Taken collectively, the data shows that while physical recommendations suggest indoor activities in the winter months (Silva, et al., 2015) and structured PA (SHAPE, 2020) are necessary for young children, a focus on play may provide another important strategy for increasing PA in children, as children in the nature preschools studied achieved PA without indoor, structured PA. As the literature review shows, increasing movement in young children brings a host of positive benefits. Regardless of this evidence, young children generally still experience a lack of PA and the associated negative impacts. Many factors may coalesce to impact low levels of PA (Burdette & Whitaker, 2005; O'Neill et al., 2016; Jones et al., 2019), may coalesce to impact low levels of PA. Burdette and Whitaker suggest that the campaign to increase PA in children may be more successful if the language and outcomes shift to promoting play and its myriad of total health benefits (2005). Rather than focusing on just physical health, researchers and practitioners should perhaps shift to focus on the overall well-being indicators of attention (cognitive), affiliation (social), and affect (emotional) health. When the results of this study are viewed in the context of the other research-based positive outcomes associated with nature play, then perhaps sending kids outside to play in all weather is good for both body and mind.

In addition to the results of this study demonstrating that nature preschools can be conducive to supporting physical activity, also of interest was the level of physical activity at the nature preschools relative to the level of physical activity at the non-nature preschools. Results from the first data collection (late October) suggest that children in the half-day and full-day nature preschools were significantly more active than children in the non-nature programs. The second data collection (late February) showed that children in the half-day nature preschools were significantly more active than children in both the full-day nature and non-nature programs, while children in nature and non-nature full-day programs had similar levels of physical activity. As noted in the results, one of the three full-day non-nature preschools did not collect their February data, resulting in an imbalance of sites (three nature preschool programs in the treatment group and two non-nature preschools in the comparison). Thus, it is hard to know if the physical activity levels on average were truly similar. For example, the snow cover may have potentially slowed down or reduced the children's actual activity level, or influenced the pedometer's detection of step, or influenced both. Or perhaps the variation was compounded by the small sample number of sites in each group, making interpretations of the data challenging. In general, high standard deviations and standard errors in the data suggest variability in physical activity levels within and across preschool settings, which makes comparisons challenging and points to the need for further research with more sites within each comparison group, thus providing the opportunity for multi-level modelling to accommodate the "nesting" of the data (children within preschool sites within comparison groups).

Based on the current data set, the half-day nature preschool was the most conducive setting for encouraging PA. Children in this setting had significantly higher average PA levels during preschool hours than children at both the full-day nature and non-nature preschools, in both October and February. These results suggest the potential influence of the proportion of program activity (ex: play time versus sedentary time) on physical activity rather than just the location of play (indoors v. outdoors). For example, during the half-day nature preschool, much of the day was spent in play with less time focused on sedentary activities like lunch and learning circles. Past research has theorized that genetic factors may play a large role in shaping children's activity (Rowland, 1998). However, O'Neill et al. (2016) found that while this genetic influence may exist, the effects of social and physical environmental factors play a far greater role in influencing children's physical activity. Their findings, coupled with those of this study, further underscore the importance of additional research that leads to a greater understanding of the specific factors within the preschool day that help support and encourage children's physical activity.

The results of this study also speak to the important influence all preschools have on PA levels of young children. Given the percentage of time children spend at preschool, their experience there can drastically support or limit PA. One study found that preschools range from 0% to 83% of children meeting PA guidelines (O'Neill et al., 2016). Factors such as classroom management style, teaching philosophy, and amount of time spent in teacher-led lessons may all have an effect on the overall amount of PA. Within this present exploratory study at hand, children at one of the non-nature preschools also had high levels of PA, which demonstrates the potential for both nature and non-nature preschools to positively influence or constrain PA levels. There are likely a variety of characteristics such as the teacher, the setting, and schedule/routine/activity, as well as multiple combinations that are conducive to PA, with unstructured nature play outdoors being one of them. However, from the perspective of impacting children's overall well-being, a building body of research suggests nature play may offer social, emotional, and cognitive benefits as well as the physical benefits accompanying increased PA (Dankiw, et al., 2020).

Limitations and Recommendations for Further Research

It is important to acknowledge that the findings of this pilot study are based on data taken from a relatively small and locally specific sample. Accordingly, as noted previously, further research should aim to reduce these limitations by utilizing a larger sample size, as well as a more equivalent control group in order to more fully assert nature preschools' influence on young children's physical activity. Furthermore, extending this research to a large population with greater ethnic, racial, and socioeconomic variability would lend further insight into the possible wide scale influence of nature preschools on physical activity. Cold weather does create some barriers in terms of knowledge of and access to the correct clothing to stay warm and safe. Thus, as researchers and practitioners examine ways to expand opportunities and methods to promote physical activity, this socioeconomic and cultural barrier must be included in the bigger picture. Future studies might explore young children's PA levels in snowy

environments (particularly deep snow conditions) to better understand the relationship across changes in step-based PA levels and intensity of PA, as well as the ability for step-based activity tracking devices to collect valid step counts.

Another important direction for further research includes working towards deeper understanding of what aspects of the nature preschool experience are most influential in supporting physical activity. As noted in the literature, overall preschool quality and teachers' physical activity training (Dowda et al., 2009), less fixed playground equipment, amount of open space and amount of outdoor playtime (Bower et al., 2008), and child-initiated free play (Tandon et al., 2018) have all been positively associated with increased physical activity in prior research. This study at hand supports the positive role nature preschools can play in supporting physical activity. However, there is still much to examine in terms of how and why nature preschools are conducive to physical activity. Potential questions to consider include, "How influential is the location of play (indoors versus outdoors) relative to the influence of the amount of time spent in free play?" and "What is the role of loose parts versus fixed equipment?" Both types of play materials can be used in an outdoor and indoor setting and thus may add another layer of variability when investigating physical activity. For example, gym play with loose parts like balls and jump ropes might generate more steps than exploring fixed equipment outside in the winter. Further analysis of the physical elements of the space and the ways in which children interact with these elements is an important next step in the research (Dankiw et al., 2020). A deeper understanding of these nuances would allow practitioners greater insight and strategy in terms of how to arrange both the time and setting of the preschool day in order to optimize physical activity.

Recent reviews have called for creative and unique PA interventions (Jones et al., 2019). Reframing PA as play, and looking at the myriad of connected benefits may just be one answer. While isolating variables is important in these early stages of research, it will also be important to approach this research with a holistic lens. While physical activity is a key aspect of child development and wellbeing, so too are many other characteristics that may be positively influenced by nature preschools and outdoor free play. For example, SHAPE recommends that preschoolers should not be sedentary for lengths of time greater than 60 minutes, except when they are sleeping. While the exact schedule of daily activities is outside the scope of this research study, it is worth noting that, excluding nap/rest time, 4 out of 5 of the nature preschools did not have 60 minutes left in their day once all play time was accounted for. Perhaps, because nature play allows children to meet academic and developmental outcomes while playing, there is more time left in the day for physical activity. Considering these outcomes through the lens of play may promote a more holistic picture of all of the needs of a developing young mind and body.

CONCLUSION

The significance of this study lies in the critical importance of physical activity in the healthy development of young children. Globally, there are more than 42 million preschool children classified as overweight or obese, and early intervention is needed to "increase daily physical activity levels and promote positive lifestyle behaviors that will track into adulthood" (Sharp et al., 2017, p. 1). This has become a public health priority, as physical inactivity contributes to the many non-communicable, chronic diseases (Sharp et al., 2017). Although children spend a significant amount of time in childcare, they are often not sufficiently active in these settings (Reilly, 2010). Given that preschools are influential toward countering other barriers to physical activity such as time, daylight, and afterschool schedules, additional successful interventions for increasing physical activity within the preschool/childcare setting are needed. In this study, physical activity recommendations were generally achieved through play and specifically outdoor play, which comes with many other development benefits including social emotional learning skills (Lithoxidou et al., 2017), cognitive skills (Ulset et al., 2017; Dankiw et al., 2020), and emotional well-being (Brussoni et al., 2017; Groves & McNish, 2011).

However, as previously noted, the small sample size and homogenous makeup of the study participants make it necessary to use caution when speculating about correlations, impacts, and influence. Even with these limitations and a need for further research in mind, the results of this exploratory study suggest nature preschools are conducive to supporting physical activity, and potentially more conducive than non-nature preschools. Further research should work to identify if variation across nature preschools influences children's physical activity and if so, what characteristics seems to be associated with this variation. This research should aim towards a deeper understanding

of the how and why of influencing factors such as program length and schedule, teacher mindset, and children's specific behaviors and interactions with the play space.

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