



A Convergent Mixed Methods Study to Explore Physical Activity Among Teachers and Children During the Preschool Day

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Accepted: 21 March 2023

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Abstract

Preschool teachers are uniquely positioned to impact children's physical activity levels, yet the relationship between teachers' and children's physical activity levels has not been widely investigated. The purpose of this study was to explore preschool teachers' physical activity levels, practices, and perceptions and how this relates to children's physical activity at preschool centers. This convergent mixed methods study included eight teachers and 20 children from four preschool classrooms. Accelerometers were used to measure their physical activity. Pearson correlations were used to explore the relationship between teachers' and children's physical activity levels. Direct observation was used to contextualize children's physical activity while at preschool. Teachers completed a semi-structured interview to explore their physical activity perceptions and practices. On average, teachers and children were physically active for $50.2 \pm 9.3\%$ and $29.5 \pm 7.0\%$ of their time at preschool, respectively. A significant positive correlation ($p=0.02$; $r=0.98$) was found between teachers' and children's percent of time at preschool per day in moderate-to-vigorous physical activity. Children mostly engaged in low-intensity activities (stationary play; light walking) during free play both indoors and outdoors and were mostly sedentary during teacher-initiated group times. All teachers stated they had a positive influence on children's physical activity. Teachers commonly reported pain or health conditions as a barrier to their physical activity. There was a positive relationship between teachers' and children's physical activity. More research is needed to confirm this relationship and to explore the impacts of high amounts of occupational physical activity on teachers' health.

Keywords Movement · Classroom · Outdoor · Play · Early Childhood

Introduction

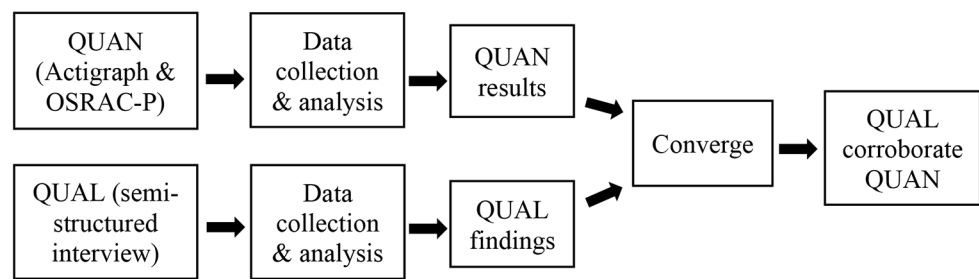
The preschool years (3–6 years of age) are recognized as an imperative stage in the physical and mental development of children (Dietz, 1998; Hodges, 2003). To achieve optimal development, the Physical Activity Guidelines for Americans recommends that preschool-aged children be physically active for at least three hours per day (Piercy et al., 2018). It is also recommended that caregivers, including teachers, serve as role models for physical activity and minimize the amount of time children are sedentary (Piercy et al., 2018). Teachers may play a considerable role in the

promotion of physical activity for preschool-aged children given that within the United States approximately 61% of children spend roughly 33 h in preschool and/or childcare per week (Laughlin, 2013). Previous research has found children achieve up to 50% of their total daily amount of physical activity while at preschool; therefore, making the preschool setting an important setting to target children's physical activity (Finn et al., 2002; O'Brien et al., 2018). However, several other studies have demonstrated children spend a majority of their time at preschool being inactive and/or sedentary (Fossdal et al., 2018; Henderson et al., 2015; Nilsen et al., 2019; O'Brien et al., 2018; Pate et al., 2008; Tandon et al., 2015). Spending a majority of time being inactive or sedentary during preschool may contribute to the likelihood of children developing obesity and hinder their development of fundamental movement skills that are necessary to perform physical activity throughout life (Jones et al., 2020).

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Fig. 1 Diagram of convergent mixed methods study design following the parallel-databases model



Several environmental factors exist within preschool centers that have been found to be influential on children's physical activity such as the size of indoor and outdoor spaces, weather, time, play equipment, and child enrollment numbers (Clevenger et al., 2022; Copeland et al., 2016; Culpepper & Killion, 2018; Dwyer et al., 2008; Henderson et al., 2015; Sisson et al., 2017). Additional factors that may influence children's physical activity are the behaviors of teachers (Culpepper & Killion, 2018; Frank et al., 2018; Gunter et al., 2012). For instance, studies have shown children's physical activity levels during outdoor play increased when teachers engaged in play with the children (Culpepper & Killion, 2018; Frank et al., 2018; Gunter et al., 2012). These findings suggest a positive relationship between teacher engagement and child physical activity; however, studies only focused on children's physical activity levels during times of outdoor free play and did not objectively measure teachers' physical activity through tools such as wearable devices (Culpepper & Killion, 2018; Frank et al., 2018; Gunter et al., 2012).

To our knowledge, only two studies to date have objectively and simultaneously compared teachers' and children's physical activity levels within preschool settings (Chen et al., 2020; Fossdal et al., 2018). Findings from these studies demonstrated positive associations between teachers' and children's physical activity levels (Chen et al., 2020; Fossdal et al., 2018). However, both studies occurred within the Scandinavian region of Europe and given the probable differences in preschool pedagogy similar studies are needed within the United States. Additionally, these studies lack an investigation of additional teacher-specific factors that may impact children's movement including teachers' perceptions of physical activity, their initiation of physical activities and intensity level of that physical activity, and proximity to children during activities, which is most accurately measured by direct observation (Kippe et al., 2021). Mixed methods (e.g., direct observation; qualitative interviewing) are needed to assess these potential determinant factors more adequately, as previous studies have stated using solely a quantitative method was insufficient to confidently determine relationships between teachers' and children's physical activity (Fossdal et al., 2018; Kippe et al., 2021). Therefore, the purpose of this mixed methods study

Table 1 Percent of time in intensity of physical activity for teachers and children during the preschool day based on accelerometer data

| Classroom | Sedentary | LPA | MVPA | TPA |
|---------------------------------------|-----------|-------|-------|-------|
| Teachers | | | | |
| 1 | 50.6% | 36.0% | 13.4% | 49.2% |
| 2 | 41.0% | 36.0% | 23.0% | 59.0% |
| 3 | 48.5% | 27.1% | 24.3% | 51.4% |
| 4 | 59.1% | 27.9% | 13.0% | 41.0% |
| Children | | | | |
| 1 | 77.7% | 11.0% | 11.3% | 22.3% |
| 2 | 66.0% | 15.7% | 18.2% | 33.9% |
| 3 | 62.2% | 18.1% | 19.7% | 37.8% |
| 4 | 73.7% | 13.6% | 12.7% | 26.3% |
| Pearson Correlation (<i>r</i>) | | | | |
| | 0.55 | -0.51 | 0.98* | 0.54 |

Note. LPA: Light physical activity; MVPA: Moderate-to-vigorous physical activity; TPA: Total physical activity.

*Significance deemed at $p < 0.05$.

was to explore preschool teachers' physical activity levels, practices, and perceptions and how this relates to children's physical activity within preschool centers.

Methods

Study design. A convergent mixed methods study design was used following the parallel-databases variant triangulation model (Creswell, 2015). Quantitative (i.e., accelerometry; direct observation) and qualitative (semi-structured interviews) data collection and analysis occurred separately but within a concurrent timeframe. Quantitative results and qualitative findings were then converged, while holding equal weight for interpretation, meaning quantitative results were corroborated by qualitative findings. A diagram of the study design is provided in Fig. 1.

Study protocol. Institutional Review Board approval was obtained from the lead researchers' affiliated university prior to recruitment of participants (IRB protocol number: 0039-20-EP). Participants in this study consisted of preschool lead teachers and children from four preschool classrooms from three preschool centers, all of which were private, Christian-affiliated preschool centers located within the same Midwestern city. Each preschool operated on a

half-day schedule during morning hours (roughly 8 a.m. to 12 p.m.) and each classroom consisted of 8–12 children. Teachers were eligible to participate if they were a lead teacher of a preschool classroom for children aged three to six years. Each preschool classroom had two lead teachers participate, which included all eligible lead teachers from each preschool classroom. Children were eligible if enrolled in a participating preschool classroom and a parent consented to participation. Research personnel recruited participants by contacting preschool center directors via email and/or phone. Preschool directors then forwarded study information to preschool teachers to gauge interest. If teachers expressed interest, a consent meeting was set up with the director and teachers either in person at the preschool center or over a Zoom call. After the meeting, teachers signed the consent form to document their willingness to participate and were provided consent forms to hand out to parents to provide consent for child participation. Parents were given two weeks to review the consent forms and could contact the lead researcher with any questions. Parents had to provide written consent in order for their child to participate and return to the preschool center director. After the two weeks the research team picked up consent forms from the preschool center.

Participation in this study consisted of a brief demographic survey for teachers and children; measurement of height and weight for children; accelerometers to measure physical activity time and levels of teachers and children; direct observation to contextualize children's physical activity at preschool; and a semi-structured interview for teachers. All data collection occurred from August through October in 2021. Accelerometry and direct observation occurred over a consecutive three-day period for each preschool classroom during morning hours. No inclement weather (e.g., extreme hot or cold temperatures, severe storms) occurred during days of data collection with daily temperatures at noon that ranged from 52 to 85 degrees Fahrenheit.

Demographics. Teachers completed a short demographic survey for their age, race, gender, number of years working in childcare, and education level. Parents completed a short demographic survey for their child consisting of the child's birth date, race, and gender. Demographic surveys were completed via paper hardcopies after consent was completed. Children's height and weight were measured by research personnel in a private area at the preschool centers with a teacher present. Height was measured with a stadiometer and measured to the nearest tenth of an inch. Weight was measured with a SECA weight scale and measured to the nearest tenth of a pound. Measurements were taken twice for each child and then averaged to get one value for height and weight per child (Casadei & Kiel, 2019). Children's BMI percentile was calculated using the

CDC's BMI-for-age percentile for children (Kuczmarski et al., 2002).

Accelerometry. Actigraph GT9-X accelerometers were used to measure teachers' and children's physical activity and sedentary levels. Teachers and children wore an accelerometer for three consecutive days during the morning hours of preschool. Teachers wore the accelerometer on their wrist and children wore the accelerometer around their waist, positioned above their right hip. Location of wear was selected to enhance compliance to wear protocol (Montoye et al., 2020; Pate et al., 2006, 2010). Teachers were trained by research personnel on how to appropriately fit the accelerometer on the children. Accelerometers were placed on the children by teachers each morning they arrived at preschool and removed at the end of each preschool day. Teachers' accelerometer data were processed using wrist-based cut points by Montoye et al. (2020) and 60-second epochs. Children's accelerometer data were processed using cut points by Pate et al. (2006) and 15-second epochs.

Direct Observation. The Observational System for Recording Physical Activity in Children-Preschool version (OSRAC-P) was used to assess the context of activities (location, type, education/play context, group composition, initiator) performed by children (Brown et al., 2006). Research personnel completed observations for each preschool classroom during the morning hours of the three days accelerometers were worn which equated to approximately three hours per day on average. Due to COVID-19 restrictions, video recordings were used to observe inside of the classroom only. Two iPads were used for video recording and strategically placed to capture the entire indoor classroom area. The iPads were held by adjustable tripods, positioned within the classroom to avoid interfering with classroom activities. In-person observations were used to observe outdoors. One preschool did not have a playground area and therefore did not participate in any outdoor activity. Transitions within the preschool centers and to and from outdoor areas were not observed in adherence to social distancing protocols.

Observations followed the validated OSRAC-P protocol for momentary 30-second observation intervals (Brown et al., 2006). A summary of the OSRAC-P protocol is provided. See Brown et al., 2006 for a full description of the protocol. This entailed research personnel scanning the indoor or outdoor area of the preschool center following a focal child for five seconds and recording their observations for 25 s (Brown et al., 2006). Each participating child was randomly selected to serve as the momentary focal child for a ten-minute observation period. Between-child variation in physical activity is to be expected given differences in children's individual characteristics (e.g., gender, BMI, age) and play type preferences, thus the observation period was reduced

from 30 min to 10 min (Clevenger et al., 2022; Henderson et al., 2015). The standard of at least 60 observational samples per focal child per day was still met with the reduced time protocol (Brown et al., 2006). Lily Data Collector software (Version 2.0.5; Vanderbilt Kennedy Center) on PC tablet devices was used to record direct observation data. Three student researchers from the same research lab were trained to use the OSRAC-P and completed the observations. Interrater reliability using Cohen's Kappa was calculated as part of training procedures prior to data collection. Research personnel were found to have substantial agreement ($K=0.88$; average Cohen's Kappa among three researchers for indoor and outdoor intervals) on coding protocols.

Semi-structured interview. Following all other data collection, each participating preschool teacher completed a semi-structured interview with the lead author (male, Ph.D. level student) who was trained in qualitative interviewing through graduate-level coursework and prior qualitative research experience. Interview questions were based on the Theory of Planned Behavior to assess teachers' attitudes, perceived barrier control, and subjective norms about their personal physical activity behaviors and the physical activity of children (Ajzen, 1985). The interview guide can be found in Supplementary Table 1. Interviews occurred over Zoom or phone call in a private area at a time and place convenient for the teacher. Interviews lasted approximately 20 min. All interviews were audio recorded then transcribed verbatim into a Word document.

Data Analysis

Quantitative Data Analysis. Descriptive statistics including group means for teachers' and children's demographics and physical activity levels measured by accelerometry were calculated. Raw accelerometer data was processed using Actilife v6.11.4. Overall averages of teachers' and children's time in minutes and percent of time per preschool day were calculated for sedentary time, light physical activity (LPA), moderate-to-vigorous physical activity (MVPA), and total physical activity (TPA). Accelerometer data were then aggregated per preschool class for teachers and children to conduct Pearson correlations with 95% confidence intervals (CI) to investigate the relationship between teachers' and children's average percent of time being sedentary and in LPA, MVPA, and TPA at preschool. Average percent of time was used to standardize physical activity levels across the four classrooms due to varying durations of the preschool day. Pearson correlations were deemed statistically significance at $p<0.05$. All calculations were completed using IBM Statistical Package for the Social Sciences (SPSS) software (Version 26.0, IBM).

The Multi-Option Observation System for Experimental Studies software (MOOSESTTM; Version 5.0.8, VU e-Innovations) was used to process OSRAC-P data. Frequency counts and percentage of intervals observed per preschool classroom were calculated. Several indoor education/play context codes were merged together into broader categories due to the relatively small sample size and to simplify analysis. Since all video activities occurred during organized group times, the video code was merged with the group time code to create a "group time" category. Codes for art, books/preacademic, large blocks, manipulatives, music, and sociodramatic were merged into one "free play" category to more easily compare activity performed during free play and group time. Teacher-arranged (i.e., gross motor activities performed as a group activity) and gross motor (i.e., gross motor activities performed during free play) codes were merged into one "gross motor" category. Group composition codes were aggregated into two categories, (1) with an adult (e.g., group adult and one-on-one with an adult) and (2) without an adult (e.g., solitary, group, and one-on-one with peer).

Qualitative Data Analysis. Participants' transcripts were uploaded into QSR NVivo 13 (Version 16.2). A directed content analysis approach was used to analyze qualitative data (Assaroudi et al., 2018; Hsieh & Shannon, 2005). Transcripts were read through several times to develop a coding scheme within NVivo by the lead author. A deductive approach was used to develop the parent codes based on the Theory of Planned Behavior, whereas an inductive approach was used to develop subcodes under the parent codes. A codebook was then developed and used to provide definitions for each code and guide coding of participants' responses. Prior to coding, a second researcher (female, Ph.D. student with the same level of qualitative research training as lead author) reviewed and approved the coding scheme and codebook. The first researcher coded the data following the codebook. Once completed, the second researcher reviewed the coding and took note of any disagreements in the first researcher's coding. The two researchers then met to discuss any discrepancies through peer debriefing until consensus was reached (Creswell & Miller, 2000; Lub, 2015).

Results

Demographics. In total, eight preschool lead teachers (all female) and 20 preschool children ($n=11$ females) from the four preschool classrooms participated. Teachers' average age was 39.6 ± 14.2 years and the range of years having worked in childcare was 1 to 30 years. Among the teachers, 100% were white, 75% had at least a bachelor's degree, and

25% had an associate degree or high school diploma. The number of children who participated was roughly 50% of all children who were eligible to participate from across the four classrooms. Children's average age was 4.75 ± 0.6 years and their average BMI percentile was 42.2 ± 23.9 . Among the children, 85% were white, and 15% were either Black or Asian. No children identified as Hispanic or Latino.

Accelerometry. Teachers spent an average of 213.6 ± 43.7 min per day at preschool. On average, teachers accumulated 108.8 ± 36.7 min of sedentary time, 66.3 ± 9.2 min of LPA, and 40.4 ± 8.0 min of MVPA during

preschool each day. Teachers' average minutes of sedentary time per day accounted for $49.8 \pm 9.3\%$ of their time during preschool, LPA accounted for $31.8 \pm 5.1\%$, and MVPA accounted for $18.4 \pm 8.0\%$. Teachers spent on average $50.2 \pm 9.3\%$ of time during preschool per day being active (e.g., LPA and MVPA combined).

Children spent an average of 211.2 ± 38.4 min per day in preschool. On average, children accumulated 146.1 ± 32.3 min of sedentary time, 29.3 ± 10.2 min of LPA, and 32.1 ± 9.9 min of MVPA while at preschool. Children's average minutes of sedentary time accounted for $70.0 \pm 7.0\%$ of their time at preschool, LPA accounted for $14.4 \pm 3.1\%$, and MVPA accounted for $15.1 \pm 4.4\%$. Children spent on average $29.5 \pm 7.0\%$ of time during preschool per day being active.

A significant positive correlation ($p=0.02$; $r=0.98$, 95% CI: 0.38, 1.00) was found between children's and teachers' percent of time in MVPA. A breakdown of physical activity levels for teachers and children by classroom and Pearson correlation analysis results can be found in Table 1.

Direct Observation. The percentages of observed intervals based on each preschool classroom and totaled across all four classrooms according to OSRPAC-P categories and codes can be found in Table 2. The total number of observed intervals equaled 3,141 ($n=2,517$ indoor intervals; $n=656$ outdoor intervals) across the four preschool classrooms.

The most common types of activities within the classroom included sitting/squatting (60.4%) and standing (22.1%). Walking accounted for 10.1% of classroom activity, of which 59.7% occurred during moments of transitions (i.e., walking between play centers). The most commonly observed education/play context were group time activities (44.5%) and free play (41.5%). Among the gross motor activities observed (6.2% of all indoor activity), 77.4% was teacher arranged and 22.6% occurred during free play. Adult-initiated activity accounted for 57.0% of all indoor activity, of which 87.5% was of stationary activity which was primarily intended for academic purposes (e.g., literacy lessons, crafts, etc.). In comparison, among child-initiated activity 79.0% was considered stationary activity.

Among the outdoor intervals observed within the playground areas across three classrooms combined ($n=624$), the common types of activity included standing (30.1%), sitting/laying (25.5%), walking (19.7%), and running (11.1%). Most activity occurred within open space (44.1%) and on fixed equipment (34.8%) with a vast majority initiated by children (96.9%). As much as 57.6% of activity observed outdoors was considered stationary activity. Thirty-two additional outdoor intervals were observed during one organized activity led by teachers at one preschool classroom (e.g., nature walk; Classroom 2).

Table 2 Percent of direct observation intervals for physical activity of children by classroom and totaled across all classrooms

| Classroom | 1 | 2 | 3 | 4 | Total |
|-----------------------------------|------|------|------|------|-------|
| Indoors | % | % | % | % | % |
| PA Type | | | | | |
| Walk | 8.1 | 9.7 | 15.1 | 7.7 | 10.1 |
| Run | 0.5 | 1.6 | 0.3 | 0.2 | 0.7 |
| Jump/Skip | 0.1 | 1.0 | 2.1 | 0.5 | 0.9 |
| Sit/Lay | 76.1 | 56.7 | 54.2 | 60.1 | 62.7 |
| Stand | 12.7 | 29.6 | 23.4 | 25.0 | 22.1 |
| Dance | 0.3 | 2.7 | 0.3 | 3.4 | 1.6 |
| Crawl | 0.3 | 0.3 | 1.2 | 1.1 | 0.7 |
| Education/Play Context | | | | | |
| Group time | 54.5 | 69.4 | 22.9 | 22.1 | 44.5 |
| Free play | 25.9 | 26.3 | 58.0 | 62.6 | 41.5 |
| Gross motor | 11.8 | 0.0 | 5.6 | 9.2 | 6.2 |
| Transition | 3.2 | 4.1 | 6.3 | 4.8 | 4.5 |
| Group Composition | | | | | |
| With an adult | 82.2 | 80.9 | 48.8 | 61.8 | 69.0 |
| Without an adult | 17.4 | 19.1 | 39.0 | 38.2 | 30.3 |
| Initiator | | | | | |
| Adult | 73.6 | 77.6 | 38.0 | 30.4 | 57.0 |
| Child | 26.4 | 22.4 | 62.0 | 69.3 | 42.9 |
| Outdoors (playground only) | % | % | % | % | % |
| PA Type | | | | | |
| Walk | n/a | 17.6 | 21.2 | 13.3 | 19.7 |
| Run | n/a | 14.1 | 12.1 | 7.3 | 11.1 |
| Jump/Skip | n/a | 0.0 | 5.0 | 0.0 | 2.6 |
| Sit/Lay | n/a | 34.1 | 23.4 | 35.4 | 25.5 |
| Stand | n/a | 16.5 | 26.5 | 40.8 | 30.1 |
| Climb | n/a | 5.9 | 9.7 | 0.5 | 5.9 |
| Crawl | n/a | 9.4 | 1.2 | 1.4 | 2.6 |
| Education/Play Context | | | | | |
| Open space | n/a | 51.8 | 38.6 | 49.1 | 44.1 |
| Fixed equipment | n/a | 40.0 | 43.3 | 20.2 | 34.8 |
| Sandbox | n/a | 3.5 | 8.7 | 0.5 | 5.1 |
| Water play | n/a | 0.0 | 6.5 | 28.0 | 13.1 |
| Group Composition | | | | | |
| With an adult | n/a | 15.3 | 26.6 | 31.5 | 27.6 |
| Without an adult | n/a | 80.0 | 72.5 | 68.2 | 71.3 |
| Initiator | | | | | |
| Adult | n/a | 0.9 | 8.2 | 1.6 | 2.2 |
| Child | n/a | 97.7 | 90.6 | 98.1 | 96.9 |

Note. PA: Physical activity.

Semi-structured interview. An overview of qualitative findings is presented in Table 3. Teachers reported various benefits of physical activity for children. In general, the majority of teachers referenced physical activity as having a large impact on children's health; however, the behavioral and emotional benefits of physical activity for children was the most commonly reported benefit. This was more commonly reported than physical or cognitive benefits. For example, one teacher stated, "I think it is essential. The more movement you have, I think it actually increases time on tasks and increases their ability to pay attention."

All teachers believed they had a positive influence on children's physical activity behaviors and four teachers believed that they had more of an influence than children's parents. Teachers stated they influenced children's physical activity through a variety of ways such as by verbal encouragement, role modeling, having a positive attitude, and incorporating physical activity into the preschool curriculum or within free play. One teacher mentioned, "By modeling it (physical activity), and building it into the curriculum, you show them (children) that it's important." Teachers mentioned several barriers that interfered with implementing physical activity at preschool. These barriers included a lack of space or small classroom size, lack of time in the half-day preschool

schedule, and COVID-19 restrictions. No teacher reported that their center had a formal written policy for the amount of physical activity children should attain.

Regarding their own physical activity, teachers were asked about their general feelings on physical activity. Most teachers were considered to have a positive outlook on performing physical activity. For example, one teacher stated, "I would prefer to be physically active. I just, I feel better," whereas another teacher mentioned, "Dread, sometimes, just right now dread because I don't feel like doing it." Regarding barriers they experienced outside of work for physical activity, teachers most commonly (five teachers) stated having a personal health issue (e.g., arthritis; mental health issue) and/or physical pain (e.g., back; leg). One teacher stated, "Standing on that hard ground all day, like I get home and I'm just, I'm in pain... my back hurts." Other commonly reported barriers included feelings of low motivation, tiredness, and lack of time. As for their thoughts on how being a teacher influenced their daily physical activity levels, all but one teacher mentioned it had a positive influence on their physical activity levels. More specifically, most teachers mentioned that physical activity was a natural demand of their job and therefore increased their daily physical activity levels. Lastly, all teachers reported that preschool children had a positive influence on their physical activity due to children making them feel obligated or motivated to participate in physical activity with them particularly during moments of free play. For instance, one teacher stated, "I think we help one another. I see them so energized and out there running, and I was like, yeah, see if they can do it, I can too." Another teacher stated, "I definitely feel like they have made me become more active, because they want me to play, and I don't want them to feel rejected."

Table 3 Qualitative findings from semi-structured interviews with teachers

| Findings for children's PA | Findings for teachers' PA |
|---|--|
| 1. PA benefits for children | 1. Personal feelings on PA |
| Emotional/Behavioral | Positive |
| Physical | Negative |
| Cognitive | 2. Personal barriers for PA |
| 2. Teacher impact on children's PA | Health condition or pain |
| Positive | Low motivation |
| 3. Greatest impact on children's PA | Tiredness |
| Teachers | Lack of time |
| Parents | Weather |
| Child | 3. Occupational influence on PA |
| 4. Teachers' impact on children's PA | Positive |
| Role model or positive attitude | Negative |
| Incorporate PA in preschool schedule | 4. Reasons for occupational influence on PA |
| Make PA enjoyable for children | Natural demands of job |
| Verbal encouragement | Role modeling PA to children |
| Minimize screen time | 5. Children's influence on their PA |
| 5. Barriers to implement PA in preschool | Obligation to be active with children |
| Lack of space or small classroom size | Children motivate them to be active |
| Lack of time | |
| COVID restrictions | |
| Lack of child interest | |
| Nap time | |
| 6. Physical activity policy | |
| No | |

Note. PA: Physical activity.

Discussion

The purpose of this mixed methods study was to explore preschool teachers' physical activity levels, practices, and perceptions and how this relates to children's physical activity within preschool centers. We found a significant and positive correlation between the MVPA levels of teachers and children during the morning hours of preschool, which is similar to findings from a much larger Finnish study (Fossdal et al., 2018). One possible explanation for this is that the teachers interviewed in our study stated they felt obligated to play when asked by the children, particularly when outdoors where children were able to achieve more MVPA. However, results from the direct observation revealed that the vast majority of focal children's physical activity while outdoors did not occur within close proximity of a teacher. Given the OSRAC-P protocol uses a momentary sampling

of one focal child it is likely that if teachers happened to play with children, they may not have necessarily been engaged in play with the focal child being observed at the time. Additional findings from our study revealed no significant correlation between preschool teachers' and children's levels of being sedentary, LPA, or TPA during the morning hours of preschool. However, a study conducted in Sweden, found a significant and positive association for LPA levels between teachers and children but no association for MVPA levels (Chen et al., 2020). No studies have found an association for sedentary time between children and teachers (Chen et al., 2020; Fossdal et al., 2018).

It has often been suggested that the more teachers promote and demonstrate physical activity the more likely children are to be physically active (Bruijns et al., 2022a; Fossdal et al., 2018; Froehlich Chow & Humbert, 2014; Kippe et al., 2021). Most teachers in our study believed they helped children to be more physically active during preschool and stated they even had more of an impact on children's daily physical activity levels than the children's parents, which is similar to findings from other studies (Derscheid et al., 2010; Dinkel et al., 2022; Kippe et al., 2021). Although teachers identified themselves as key role models to children's physical activity, children still spent up to 60% of their outdoor play time being inactive; engaged in activities such as sitting on fixed equipment, despite outdoor play time being intended for children to achieve MVPA. Furthermore, a large percentage of children's indoor activity was considered sedentary due to a majority of this activity being adult-initiated for academic purposes including for children's cognitive, language, and literacy outcomes. Teachers rarely integrated organized gross motor activities within their pedagogy. Therefore, teachers may have felt they were competent to role model physical activity to children during outdoor free play but lacked knowledge on how to effectively promote physically active play types and how to integrate movement into organized learning.

Similarly, there is an abundance of existing literature that supports moving while learning within the classroom for improved cognitive and behavioral outcomes among preschool children (Becker et al., 2014; Kirk & Kirk, 2016; Kirk et al., 2014; Tandon et al., 2016). Interestingly, teachers most often associated physical activity as a benefit to children's behavioral and emotional outcomes, more so than cognitive or physical outcomes, and stated using physical activity as a behavior management tool. Teachers perceiving more of a benefit for children's behavioral outcomes presumably provided a benefit to teachers due to expending less effort on redirecting children's off-task behaviors (McGowan et al., 2021). Interestingly, even when activities were child-initiated, teachers were believed to have considerable control over children's activity levels due to

classroom rules and their behavior management strategies that were necessary because of limited space and small classroom size (Copeland et al., 2012). Therefore, the use of certain behavior management strategies may be a significant predictor of children's physical activity levels, especially when indoors, but the impacts of pedagogy on children's physical activity has not been widely investigated.

Lastly, teachers on average accumulated a high amount of physical activity during the morning hours of preschool. Findings from the semi-structured interviews revealed that teachers believed children motivated them to be more physically active, especially during periods of outdoor play, and teachers felt obligated to engage in play especially when asked by children. Although not captured through the OSRAC-P protocol within this study, a general observation made by the research team was that teachers were often walking around to individual children and bending over to meet individual children at eye level when children were engaged in sedentary learning activities (e.g., sitting at a table doing crafts; Randall et al., 2022). As found in other research, teachers often accumulated physical activity through short bouts of movement but the direct causes of this movement and resulting health outcomes have not been extensively explored (Fossdal et al., 2018; Randall et al., 2022). It is possible that during particular times of the preschool day children influence teachers' physical activity more than teachers influence the children's physical activity. However, there is little to no research on the degree to which children influence teachers' physical activity. Further investigation of how children influence teachers' physical activity is especially needed as teachers commonly reported experiencing back and leg pain and general tiredness in the semi-structured interview, which is similar to findings from other research (Randall et al., 2022). It is possible that high amounts of occupational physical activity as the result of educating and caring for children may potentially result in undesirable health outcomes such as musculoskeletal pain and low levels of leisure-time physical activity resulting in low cardiorespiratory fitness (Grant et al., 2019; Randall et al., 2022; Whitaker et al., 2013). Future research should utilize a validated direct observation tool to measure teachers' physical activity behaviors within preschool to further investigate ergonomic and physical activity outcomes and relation to children's physical activity. Furthermore, teachers may have to consider ways in which they can be physically active with children while also being cognizant of how to best sustain their energy and wellness to provide a high quality of education and care (Culpepper & Killion, 2018; Hibbs-Shipp et al., 2015; Lessard et al., 2020). Efforts may be needed to help preschool teachers take part in more restorative physical activity practices (e.g., stretching) that could help reduce pain.

Limitations

The primary limitation of this study is the small sample size compiled from within one Midwestern city. The small sample size limited the ability to investigate mediating and moderating factors, as well as confounders, for teachers' and children's physical activity levels such as children's and teacher's demographic factors. Our direct observation was also limited due to social distancing requirements. This prevented us from observing transitions between classrooms within the preschool center and between indoor and outdoor areas, which resulted in a loss of assessing children's physical activity. Additionally, teachers may have been subject to the Hawthorne effect in that they may have prioritized physical activity more than what is typical due to the presence of researchers.

Several limitations arose from the use of accelerometers. First, participants were instructed to remove the accelerometers for any water-based play, therefore data from two classrooms' periods of outdoor water-based play were not measured. Second, teachers were instructed to wear the accelerometer on their wrist to increase wear protocol compliance; however, an accelerometer worn on the wrist may overestimate physical activity levels due to detecting sedentary arm movements as ambulatory activity (Montoye et al., 2016). Third, data collection occurred over a period of only three days. Although this is the recommended minimal amount of time to provide a valid amount of direct observation and accelerometer data, an increase in the number of days would provide more data points for a more accurate estimation of physical activity behavior within the preschool setting (Pate et al., 2010). However, increased number of days may come with increased participant burden and decreased adherence to accelerometer wear protocol. Additionally, time segmenting of the teachers' preschool day is needed to know when MVPA was most often performed and if MVPA was sustained during certain periods of the preschool day to better understand health outcomes of job demands. Furthermore, this study lacks a validated assessment of teachers' self-efficacy, knowledge, or competency in implementing physical activity in pedagogy (Bruijns et al., 2022b). Any of these aforementioned individual factors of teachers may be highly influential in their physical activity promotion and participation with children but were not considered in this study.

Conclusion

This study adds to existing literature by providing an objective assessment of teachers' physical activity that coincides with children's physical activity, while also exploring

teachers' perceptions of physical activity through a qualitative approach and contextualizing children's physical activity by direct observation. Findings from this study demonstrated the likely impacts of preschool teachers' physical activity levels and perceptions on the physical activity behaviors of children while in preschool. More research, however, is needed to confirm this relationship among a larger sample of preschool classrooms from within the United States to appropriately consider moderating factors and confounders. Consideration of teachers' knowledge and self-efficacy to incorporate physical activity into pedagogy and free play is also warranted. Lastly, given the high amounts of physical activity found among preschool teachers, more research is needed to explore the potential health impacts and the implications this has on the quality-of-care teachers provide.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10643-023-01486-8>.

Authors' Contributions Study conception and design was performed by John Rech, Michaela Schenkelberg, and Danae Dinkel. Material preparation, data collection, and analysis were performed by John Rech, Priyanka Chaudhary, and Danae Dinkel. The first draft of the manuscript was written by John Rech and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript. Funding acquisition was completed by John Rech. Supervision of this research was provided by Danae Dinkel.

Declarations

Ethics approval and consent to participate This study was funded by a Graduate Research and Creative Activity Grant from the University of Nebraska – Omaha, awarded to the lead author. The authors have no relevant financial or non-financial interests to disclose. This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Institutional Review Board at the University of Nebraska Medical Center and University of Nebraska - Omaha (IRB protocol number: 0039-20-EP). All participants provided their written informed consent prior to participation. Written informed consent was obtained from parents. Availability of data upon request will be provided by the lead author. We would like to thank the preschool centers for participating in this study.

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