Relation between Demographics and Physical Activity among Preschoolers Attending Head Start

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Abstract
Limited empirical evidence is available about preschoolers’ sedentary behavior (SB) and physical activity (PA) patterns in Head Start programs, we explored (a) preschoolers’ SB and PA patterns (ranging from SB to light-moderate-vigorous physical activity [LMVPA]) and (b) their relationships with sociodemographic factors, weight status, and motor development. Participants included 216 preschoolers (\(M_{\text{age}} = 4.32 \pm 0.63\); girls 56.5%) from six Head Start centers in an urban area in the southwestern region of the United States, assessing Actical® activity monitor-based PA, weight status, and motor development. The findings revealed preschoolers who were female, Hispanic/Latinx, with an at risk weight level, and/or in the below average motor development group tended to engage in less MVPA/LMVPA and also had higher SB patterns while participating in the Head Start program (% < 0.05–0.001, \(d\) ranged from 0.23 to 0.62). Head Start stakeholders (e.g., policymakers, leaders, curriculum coordinators, health professionals, and teachers) need to acknowledge the PA and health disparities, and intervene in underserved preschoolers’ health-promoting behaviors.

Keywords Head Start · Sedentary behavior · Physical activity · Motor development · Obesity

Highlights
- We explored SB and PA patterns using Actical® activity monitor for Head Start children.
- Higher SB and less engagements in MVPA/LMVPA were found among female, Hispanic/Latinx, at risk weight level group, and/or the below average motor development group.
- Head Start stakeholders need more attention in PA patterns during Head Start hours.

The primary health issues related to obesity have reached an epidemic level in the pediatric population (Fryar et al., 2020). The large data set from the National Health and Examination Survey (NHANES) showed a significant rise in childhood overweight (from 21.2 to 26%) and severe obesity (from 14.6 to 18.5%) among children 2–5 years old between 1999 and 2016 (Skinner et al., 2016). This is alarming, as childhood obesity increases the risk of adult obesity (Evensen et al., 2016). It is well documented that being physically inactive and having sedentary behaviors (SB) are associated with increasing childhood obesity (Carson et al., 2017; Katzmarzyk et al., 2015; Leblanc et al., 2015), which leads to major adverse health consequences (e.g., anxiety, cardiovascular disease, depression, and type-2 diabetes; Baker et al., 2017; Lavie et al., 2016; Lazarevich et al., 2016; Simmonds et al., 2016), as well as lower school readiness (e.g., working memories, motor development, and social and emotional development; Harrist et al., 2016; Morano et al., 2011; Wu et al., 2017).

The recommended preschoolers’ daily PA is 180 min of various intensities: light PA (LPA), moderate PA (MPA), and vigorous PA (VPA), as well as less than 60 min of SB (Institute of Medicine, 2011; United States Department of Health and Human Services, 2018). However, empirical evidence has indicated that preschoolers do not meet the recommended moderate-to-vigorous physical activity (MVPA) daily requirements (1.94–13%; Maltby et al.,

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2018; Ruiz et al., 2018; Tandon et al., 2016), during time at
the daycare center (2.63–6.03%; Gagné & Harnois 2013;
Leis et al., 2020), and reached high SB on a daily basis
(53–77.1%; Maltby et al., 2018; Ruiz et al., 2018; Tandon
et al., 2016), and while at the daycare center (60–62.6%;
Leis et al., 2020; Tandon et al., 2016). Notably, underserved
preschoolers, who are racial and ethnic minority children
from low-income families, tended to spend less time in PA
and more time in SB, which has been associated with
delayed motor development and increased overweight/
obesity compared to preschoolers from middle to high-
income families (Ansari et al., 2015; Brotman et al., 2011;
Hardy et al., 2012).

Poverty and deficient parental supervision can raise the
chances of children’s experiencing poor health during
important developmental times (Conroy et al., 2010). The
inequality of children’s PA has been related to low-income
families’ facing multiple barriers of safe accessibility to
physical environments (e.g., neighborhoods, playgrounds),
limited resources (e.g., equipment), and time/financial
constraints to afford age-appropriate extracurricular activ-
ities (Ling et al., 2016; Milteer et al., 2012). Offering safe
environments with accessible resources is essential for
underserved preschoolers to be physically active. Con-
sidering these facts, a school-based or childcare center-
based program can provide safe outdoor space and struc-
tured PA opportunities that will help establish young chil-
dren’s health-promoting behaviors (Lee et al., 2020a, b;
Lindsay et al., 2017).

Established in 1965, the Head Start program is the largest
government-funded early childhood education program in
the United States, serving more than 37 million underserved
children (birth to 5 years old) from low socioeconomic status
families (U.S. Department of Health and Human Services,
2020). Head Start is an important program that can facilitate
reducing and preventing childhood obesity. In fact, the
Head Start program has aimed to provide adequate time to
increase children’s PA during indoor and outdoor schedules
(Administration for Children and Families, 2016). Yet,
inconsistent evidence regarding children’s daily SB and PA
patterns have been found in this population. For example, in
the national survey of 1810 U.S. Head Start centers (Whit-
taker et al., 2009), over 70% of Head Start programs reported
that preschoolers are engaged in at least 30 min daily of
structured gross motor activities (adult-led or adult-guided)
and 30 min daily of unstructured gross motor activity (free
play/game). More than 95% of Head Start programs also
indicated less than 30 min of SB (excluding meals and naps).
Similarly, teachers’ reports from Head Start Family and
Child Experiences Survey (FACES) showed that Head Start
preschoolers played outdoors for at least 37 min per day
(Ansari et al., 2015). However, a previous study applying the
direct observation approach (System for Observing Fitness
Instruction Time for Preschoolers [SOFIT-P]) to assess
preschoolers’ PA behaviors during the Head Start time found
that children spent between 13 and 45% in MVPA indoors
and outdoors, respectively (Sharma et al., 2011). Another
objectively measured PA study also showed insufficient
MVPA levels (<10,000 steps/day) among Head Start pre-
schoolers (Bellows et al., 2013). These inconsistent find-
ings with young children’s PA patterns during the Head Start
programs continue.

Young children’s SB and PA patterns may be related to
sociodemographic factors, weight status, and motor
development. For instance, growing evidence in preschool-
aged cohorts showed positive/negative correlations or no
differences in preschoolers’ PA patterns across sex (boys’
MVPA > girls’ MVPA; Butte et al., 2014; Nilsen et al.,
2019; Pate et al., 2015), race/ethnicity (Black’s SB > other
race/ethnicity groups’ SB; Butte et al., 2014); no differ-
ences of MVPA between Blacks and Whites; Pate et al.,
2015), weight status (negative relationships between BMI
and MVPA; Butte et al., 2014; España-Romero et al.,
2013; Pfeiffer et al., 2009); no associations between BMI
and daily PA; Bellows et al., 2013; Cliff et al., 2009), and
motor development (positive correlations between motor
skills and MVPA; Schmutz et al., 2018). However, most
existing studies on the relationships between preschoolers’
PA patterns and those indicators did not include under-
served preschoolers; this lack of diversity creates a limited
understanding of the variabilities that are associated with
Head Start preschoolers’ SB and PA patterns. Although
few studies have investigated the relationships between
Head Start preschoolers’ PA and the potential indicators,
they did not examine the group differences of PA patterns
by race/ethnicity (mainly focused on Hispanic/Latinx;
Dawson-Hahn et al., 2015) or were not able to assess
Hispanic/Latinx versus non-Hispanic/Latinx preschool
groups (Pfeiffer et al., 2009; Stegelin et al., 2014; Tandon
et al., 2018) or to objectively measure SB and PA inten-
sities (Ansari et al., 2015; Marino et al., 2012; Sharma
et al., 2011; Whitaker et al., 2009). To our knowledge,
only one experimental study partially showed the rela-
tionship between motor development and PA among Head
Start preschoolers (Bellows et al., 2013), which used
pedometers to measure PA. However, the use of a ped-
ometer cannot precisely detect a young child’s LPA and
SB (Welk et al., 2000). Therefore, the current study
applied an Actical® activity monitor to identify pre-
schoolers’ SB and PA patterns.

Despite the need for supporting underserved pre-
schoolers’ healthy behaviors, limited empirical evidence
exists about objectively measured SB and PA among
Head Start preschoolers. Identifying underserved pre-
schoolers’ objectively measured SB and PA patterns in
this specific early childhood education environment
categorized by sociodemographic factors (e.g., sex, ethnicity), weight status, and motor development would be an important finding and contribution in the literature. This type of information can provide meaningful resources and insights for stakeholders in Head Start programs to address health disparities.

**Methods**

**Study Design and Participants**

A cross-sectional study was undertaken from December 2019 to February 2020, right before COVID-19 pandemic in the United States (March 2020). After approvals (protocol code #19648) were granted from the University Institutional Review Board (IRB) and Head Start centers administrated by Child Care Associates (CCA), six centers were selected from 24 Head Start centers in the U.S. southwestern region (urban areas) based on convenience sampling (e.g., closer location). The Head Start centers were requested to send recruitment information to children’s parents/guardians. The data collection measured preschoolers’ SB and PA, weight status, and motor development after obtaining parents/guardians’ consent forms. All of the participating Head Start centers have a similar classroom size, with around 15–20 preschoolers in each classroom, and provide outdoor learning/playtime (unstructured free play) for a total of 1 h, separated as 30 min each in the morning and afternoon schedule. The Head Start programs include 90 min of mealtimes (breakfast = 60 min; lunch = 30 min) and 45 min of napping.

A total of 223 preschoolers participated; preschoolers with disabilities that prohibited PA were excluded in the present study. In the final analysis, seven participants’ data were excluded because of incomplete SB and PA data. Thus, 216 participants’ data were included in the final data analysis. The sample size in this quantitative study was sufficiently powered to detect the hypothesized relationships (G*Power 3.1; Faul et al., 2009).

**Measures and Procedures**

**Sociodemographic variables**

Sociodemographic variables included chronological age (birth dates), sex, and race/ethnicity. The directors of each Head Start center provided their students’ age, sex, and race/ethnicity information with the participants’ parents’/guardians’ approval. Participants’ sex information was used for group comparison between boys and girls. Due to a high portion of Hispanic/Latinx preschoolers in our sample and limited evidence about any group differences between Hispanic/Latinx and non-Hispanic/Latinx, we compared these two ethnic groups.

**Weight status**

A Health-o-meter® 500KL digital physician height/weight scale (Pelstar, LLC, St. McCook, IL) was used to measure preschoolers’ height and weight (without shoes) to compute their body mass index (BMI; weight [kg] / height² [m²]). To gain more precise measurement results, the participants’ height and weight were measured twice, and the average of the two scores was used to calculate the BMI. This study applied the Centers for Disease Control and Prevention’s (CDC, 2019) BMI-for-age and -sex growth percentile (%) charts to classify participants’ BMI levels: underweight (≤5th percentile), normal weight (5th–85th percentile), overweight (≥85th percentile), and obese (≥95th percentile). The preschoolers’ weight status was classified into two groups in the present study: healthy weight (“normal weight”) and at risk weight (“underweight,” “overweight,” and “obese”; CDC, 2020).

**Motor development**

Preschoolers’ motor development was assessed with the Test of Gross Motor Development–3rd Edition (TGMD-3; Ulrich, 2019), which includes 13 fundamental motor skills (FMS) in two subtests: locomotor skills (i.e., run, gallop, hop, skip, horizontal jump, and slide) and ball skills (i.e., two-hand strike, one-hand forehand strike, dribble, catch, kick, overhand throw, and underhand throw). Each skill includes three to five performance criteria for each movement, scoring as either 1 (performs correctly) or 0 (does not perform correctly). Participants’ motor skills were evaluated by trained two examiners. The intra-class correlation coefficient (ICC) for the two ratings in our sample was sufficiently high in locomotor skills ($\alpha = 0.97$, 95% CI [0.96, 0.98]) and ball skills ($\alpha = 0.97$, 95% CI [0.96, 0.98]). The TGMD-3 showed high test-retest reliability for locomotor skills ($r = 0.97$) and ball skills ($r = 0.95$) among young children (age ranged from 3 to 10; Webster & Ulrich, 2017). The TGMD-3 scores can be transferred into age- and sex-norm gross motor index (GMI) scores to classify children’s motor development, ranging from “impaired or delayed” to “gifted or very advanced” (Ulrich, 2019). In this study, the participants were divided into two levels of motor development as suggested by previous research (Brian et al., 2018; Tomaz et al., 2019): (a) below average group (ranging from “impaired or delayed” to “below average” levels) and (b) average or above average group (ranging from “average” to “gifted or very advanced” levels). The cutoff points from the GMI scores were ≤89 (below average motor
development group) and ≥90 (average or above average motor development group; Ulrich, 2019).

SB and PA patterns

Preschoolers’ SB and PA were objectively measured by Actical® activity monitors (Philips Respironics, Bend, OR, USA) for five consecutive Head Start center days. The activity monitor has been validated to measure preschoolers’ SB and PA patterns (Adolph et al., 2012; Colley et al., 2013). SB and PA patterns during the Head Start time (8:30 am–3:30 pm; 7 h) was mainly focused on providing information for stakeholders in Head Start centers. The researchers visited each Head Start center, trained classroom teachers, and received assistance to help the participants place the activity monitors around their waist on an elastic belt at the hip/waist, which is more accurate measuring PA and SB than wearing the monitors on wrists for young children (Adolph et al., 2012; Kwon et al., 2019). The teachers also were asked to keep recording daily log sheets for the fidelity check about date and time when each participant wore and took off the device. The teachers’ recorded log sheets, which noted the dates/times that participants wore and removed activity monitors, were congruent with the collected activity data (above 95%; researcher coding of observational data). Each activity monitor was initialized with the participant’s information (name, age, sex, height, and weight). Epoch length was set at 15-second sampling intervals, which were suggested for preschool-age children, to precisely capture minute and intermittent burst of movements, including intensity, frequency, and volume (Pfeiffer et al., 2006). The accelerometer data were imported using ActiReader, and the Actical® Software 3.12 (Koninklijke Philips Electronics N.V., Amsterdam, Netherlands) was used to screen and clean the data, which were then downloaded into an Excel file. In the final analysis, we only included those participants who wore the monitors for more than 4 h per day and on at least 3 days (>50% of school days), which is consistent with the previously reliable and valid PA data acquisition methods used with preschoolers (Addy et al., 2014; Pate et al., 2016). SB and each PA intensity per day of the total wearing days were averaged for mean min/day. The amount of time spent in various SB and PA intensities (i.e., SB, LPA, MPA, VPA) were defined based on validated and published accelerometer cutoff points for preschoolers (Adolph et al., 2012): SB (AEE < 0.015 kcal·kg⁻¹·min⁻¹), LPA (0.015 ≤AEE < 0.054 kcal·kg⁻¹·min⁻¹), MPA (0.054 ≤AEE < 0.076 kcal·kg⁻¹·min⁻¹), and VPA (AEE ≥ 0.076 kcal·kg⁻¹·min⁻¹). MPA and VPA levels were combined into MVPA due to the low rates of VPA. Light–moderate-vigorous physical activity (LMVPA) was categorized as an indicator of a total PA.

Statistical Analysis

After screening the raw data for missing data, normality, and outliers, three steps were taken to analyze the study data using SPSS 27.0 for Windows (IBM Corp., Armonk, NY). Descriptive statistics were calculated for all study variables (sex, race/ethnicity, weight status, motor development) to provide the summarized data (frequency, percentage). Independent samples t-tests were performed to measure the group differences in sex (girls vs. boys), race/ethnicity (Hispanic/Latinx vs. non-Hispanic/Latinx), weight status (healthy weight vs. at risk weight), and motor development (average or above vs. below average) on preschoolers’ SB and PA patterns (i.e., SB, LPA, MVPA, LMVPA). Cohen’s d and 95% confidence interval (CI) were also used to estimate the effect size for group differences: ≥0.20 (small), ≥0.50 (medium), and ≥0.80 (large; Cohen 1988). The statistically significant level was set to p < 0.05 for all tests.

Results

Sociodemographic Factors

The characteristics of 216 children (Mage = 4.32 ± 0.63; girls 56.5%) were displayed in Table 1. More than half (54.6%) of them were Hispanic/Latinx, 25% were Black/African American, 11.6% were Middle Eastern/North African, 7.4% were White, 0.9% were mixed race/ethnicity, and 0.5% were Asian/Asian Indian.

Weight Status

A total of 59.3% were within a normal range (5th–85th percentile), but more than one-third of preschoolers (38.4%) were overweight/obese (≥85th percentile). Surprisingly, among the overweight/obese children, 19.9% of total preschoolers were obese. In addition, 2.3% of the preschoolers were underweight (<5th percentile). Thus, 59.3% of preschoolers were categorized as healthy weight, while 40.7% of them were at risk weight.

Motor Development

The preschoolers’ motor development showed that 47.2% of preschoolers were average, 24.5% were below average, 13.4% were borderline impaired or delayed, 6.5% were impaired or delayed, 6.5% were above average, and 1.9% were superior. No preschoolers demonstrated “gifted or very advanced motor skills” in this sample. The findings indicated that 55.6% of those showed average or above average motor development, and 44.4% of the preschoolers were in the below average motor development cohort.
Preschoolers wore the activity monitors for an average of 415.3 (SD = 11.2) min/day in the Head Start center. They spent 50.8% of the time in SB during the Head Start time. Although preschoolers engaged in LPA for 44.2% of the time, they only achieved MVPA for 4.2% while at the Head Start center. Overall, about half of the time (49.2%) the preschoolers spent in the center they were engaged in LMVPA.

**Group Differences of Indicators in SB and PA Patterns**

Boys spent more time in MVPA during the Head Start hours than girls (19.98 vs. 15.61, $p < 0.01$, $d = -0.34$). No statistically significant differences between girls and boys were found in the time spent in SB, LPA, and LMVPA ($p > 0.05$; see Table 2). Hispanic/Latinx preschoolers engaged more time in SB (222.85 vs. 196.77, $p < 0.001$, $d = 0.51$), but less time in LPA (171.53 vs. 198.41, $p < 0.001$, $d = -0.62$) and LMVPA (192.74 vs. 218.16, $p < 0.001$, $d = -0.50$) compared to non-Hispanic/Latinx group of preschoolers. This race/ethnicity did not significantly differ in time spent in MVPA ($p > 0.05$). All preschoolers’ SB and PA patterns (SB, LPA, MVPA, and LMVPA) did not significantly differ by weight status ($p > 0.05$). However, given that effect size is the magnitude of the group differences (Sullivan and Feinn 2012), small effects in the group differences between healthy weight and at risk weight of preschoolers were found in SB (205.52 vs. 218.86), LPA (187.92 vs. 177.73), and LMVPA (209.39 vs. 196.97), indicating that preschoolers who were in healthy weight status were more physically active than those in at risk weight status ($d$ ranged between −0.23 and 0.24). Preschoolers’ motor development was related to their time spent in MVPA during Head Start hours. Preschoolers who demonstrated average or above motor development engaged in more MVPA (19.09 vs. 15.53, $p < 0.05$, $d = -0.28$) than the below average motor-developed preschoolers. There were no significant differences in SB, LPA, or LMVPA between the average or above and below average motor development groups ($p = 0.34$, 0.73, and 0.31, respectively).

**Discussion**

PA and health disparities in the underserved population are pervasive across the United States, but underserved pediatrics’ PA has received minimal attention (Dawson-Hahn et al., 2015; Stegelin et al., 2014). Especially, limited empirical evidence exists on objectively measured SB and PA patterns among underserved preschoolers. This has led to inconsistent findings regarding Head Start preschoolers’ SB and PA and their relation to potential indicators, such as sociodemographic factors, weight status, and motor development. We objectively measured preschoolers’ SB and PA patterns using Actical® activity monitors and examined the associations with those indicators to provide insights, which may suggest meaningful ways to promote

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**Table 1** Descriptive statistics for the preschoolers in Head Start

| Indicator | Value (M, SD) or Count (%) |
|-----------|-----------------------------|
| Number of preschoolers | 216 |
| Age (M, SD) | 4.32 (0.63) |
| Sex | |
| Girls (%) | 122 (56.5) |
| Boys (%) | 94 (43.5) |
| Race/ethnicity | |
| Hispanic/Latinx (%) | 118 (54.6) |
| Black/African American (%) | 54 (25) |
| Middle Eastern/North African (%) | 25 (11.6) |
| White (%) | 16 (7.4) |
| Mixed race/ethnicity (two or more, %) | 2 (0.9) |
| Asian/Asian Indian (%) | 1 (0.5) |
| Weight status | |
| Normal (5th–85th percentile, %) | 128 (59.3) |
| Overweight (≥85th percentile, %) | 40 (18.5) |
| Obese (≥95th percentile, %) | 43 (19.9) |
| Underweight (<5th percentile, %) | 5 (2.3) |
| Healthy weight (%): (normal) | 128 (59.3) |
| At risk weight (%): (underweight, overweight, obese) | 88 (40.7) |
| Motor development | |
| Impaired or delayed (%) | 14 (6.5) |
| Borderline impaired or delayed (%) | 29 (13.4) |
| Below average (%) | 53 (24.5) |
| Average (%) | 102 (47.2) |
| Above average (%) | 14 (6.5) |
| Superior (%) | 4 (1.9) |
| Gifted or very advanced (%) | 0 (0.0) |
| Average or above average motor development (%): (average–superior) | 120 (55.6) |
| Below average motor development (%): (impaired or delayed–below average) | 96 (44.4) |
| SB and PA patterns (min/Head Start hours) | |
| Wear time (M, SD) | 415.30 (11.2) |
| SB (M, %) | 211.01 (50.8) |
| LPA (M, %) | 183.72 (44.2) |
| MVPA (M, %) | 17.51 (4.2) |
| LMVPA (M, %) | 204.27 (49.2) |

*SB* sedentary behavior, *LPA* light physical activity, *MVPA* moderate-to-vigorous physical activity, *LMVPA* light-moderate-vigorous physical activity
Table 2 Distributions and comparisons of sedentary behavior and PA patterns based on sociodemographic factors, weight status, and motor development (N = 216)

| Variables                      | SB (min/Head Start hours) | LPA (min/Head Start hours) | MVPA (min/Head Start hours) | LMVPA (min/Head Start hours) |
|--------------------------------|----------------------------|-----------------------------|-----------------------------|------------------------------|
|                                | M (SD)                    | n                           | d (95% CI)                  | M (SD)                      | n                           | d (95% CI)                  | M (SD)                      | n                           | d (95% CI)                  |
| Total                          | 216 (100)                 | 211.01 (54.74)              | 17.51 (13.04)               | 17.51 (13.04)               | 204.27 (52.01)              | -                            | -                            | -                            | -                            |
| Sex                            |                           |                             |                             |                             |                             |                             |                             |                             |                             |
| Girls                          | 122 (56.5)                | 212.25 (57.63)              | 0.37 (0.71)                 | 0.05 (-0.22, 0.32)          | 183.40 (46.79)              | -183.40 (46.79)             | -0.22, 0.32                 | 0.05 (-0.22, 0.32)          | 0.05 (-0.22, 0.32)          |
| Boys                           | 94 (43.5)                 | 209.42 (51.02)              | 1.48 (2.04)                 | 0.02 (-0.29, 0.25)          | 184.14 (43.53)              | 19.98 (13.37)               | -0.29, 0.25                 | 0.02 (-0.29, 0.25)          | 0.02 (-0.29, 0.25)          |
| Race/ethnicity                 |                           |                             |                             |                             |                             |                             |                             |                             |                             |
| Hispanic/Latinx                | 118 (54.6)                | 222.85 (53.99)              | 3.58 (0.001**)              | 0.51 (0.22, 0.76)           | 171.53 (42.82)              | -4.54 (0.001**)              | -0.62 (-0.89, -0.35)        | 17.63 (13.62)               | 0.23 (0.89)                 |
| Non-Hispanic/Latinx            | 98 (45.4)                 | 196.77 (52.49)              | 0.41 (0.86)                 | 0.02 (-0.25, 0.29)          | 198.41 (44.02)              | 17.38 (12.37)               | -0.25, 0.29                 | 0.02 (-0.25, 0.29)          | 0.02 (-0.25, 0.29)          |
| Weight status                  |                           |                             |                             |                             |                             |                             |                             |                             |                             |
| Healthy weight                 | 128 (59.3)                | 205.52 (56.02)              | -1.72 (0.07)                | 0.23 (-0.05, 0.51)          | 187.92 (47.89)              | 17.71 (13.31)               | 0.25 (0.88)                 | 0.23 (-0.05, 0.51)          | 0.23 (-0.05, 0.51)          |
| At risk weight                 | 88 (40.7)                 | 218.86 (52.18)              | 17.73 (40.83)               | 17.75 (12.71)               | 17.73 (40.83)               | 17.71 (13.31)               | 0.51 (0.14)                 | 17.71 (13.31)               | 0.51 (0.14)                 |
| Motor development              |                           |                             |                             |                             |                             |                             |                             |                             |                             |
| Average or above average       | 120 (55.6)                | 207.82 (55.27)              | 0.96 (0.34)                 | 0.13 (-0.14, 0.40)          | 184.68 (46.83)              | -0.35 (0.73)                | 0.05 (-0.32, 0.22)          | 19.09 (13.22)               | -2.01 (0.04)                |
| Below average motor development | 96 (44.4)                 | 215.01 (54.09)              | 182.51 (43.51)              | 15.53 (12.59)               | 200.14 (50.05)              | -                            | -                            | -                            | -                            |

SB = sedentary behavior, LPA = light physical activity, MVPA = moderate-to-vigorous physical activity, LMVPA = light-moderate-vigorous physical activity. d Cohen’s d, CI = confidence interval. ** p < 0.01, * p < 0.05.

Bold values denote significant p values.
than 30 min of SB during Head Start hours. However, the findings from the present study using the objectively measured PA and SB showed that preschoolers spent approximately 18 min of MVPA and more than 3.5 h of SB daily in the Head Start center. Nevertheless, a lack of MVPA and high SB occurring in a daycare center is not an issue only for the Head Start program. For instance, a recent systematic review using objective evidence in SB and PA patterns of U.S. preschool samples showed high SB (67.4%) and low MVPA (13.41%) time on average spent within daycare centers (O’Brien et al., 2018). Although SB time in our sample was lower than the typical daycare centers’ preschoolers (50.8 < 67.4%), Head Start preschoolers were less engaged in MVPA than the average in O’Brien et al.’s (2018) study (4.2 < 13.41%). The differences in center-based activity time were prominent when compared to other high-income countries. For example, Danish preschoolers’ 10.9–21.8% of MVPA occurred at the daycare center, and 82% of preschoolers achieved the recommended MVPA (≥60 min; Møller et al., 2017). A high rate of MVPA obtained during the daycare center time was also observed among samples in Belgium (48.4%; De Craeemers et al., 2014). Yet, it is noted that worldwide preschoolers’ MVPA spent at a daycare center was too varied to determine the true SB and PA patterns (O’Brien et al., 2018). The variance might be associated with different preschool environments (e.g., policy, structured physical education [PE] classes, equipment, curricula, classroom teachers; Brian et al., 2018; Møller et al., 2017).

Similar to previous studies’ findings (Butte et al., 2016; Nilsen et al., 2019; Pate et al., 2014, 2015; Ruiz et al., 2018), boys spent more time than girls in MVPA during the Head Start hours, but the difference in SB was consistent in the present study with previous evidence (Nilsen et al., 2019). The sex differences in SB and PA patterns may be due to different playing styles (e.g., preferences of toys) or cultural norms between boys and girls (Todd et al., 2018). Although it has not been fully explained what distinct factors impact the sex differences in children’s PA, no sex differences in PA patterns were observed in the supportive physical environment provided by daycare centers (Møller et al., 2017; Pate et al., 2014). This suggests that when a school program targets increased MVPA for preschoolers during the center time, both sexes could be active, which would enhance health equity and reduce health disparities.

An important finding was that Hispanic/Latinx preschoolers were less physically active than non-Hispanic/Latinx cohorts (>SB, <LPA, and LMVPA) during Head Start center hours. Due to a lack of evidence about the group differences between these two race/ethnicity cohorts in SB and PA patterns, we found it difficult to provide a comparison with previous evidence (Dawson-Hahn et al., 2015; Pfeiffer et al., 2009; Steglin et al., 2014; Tandon et al., 2018), but Dawson-Hahn et al.’s (2015) study indicated Hispanic/Latinx preschoolers’ total PA was lower than what was seen in other groups, which included a high portion of non-Hispanic/Latinx Black children in a Head Start program. Similarly, Ruiz et al.’s (2018) research, which included 76% Hispanic preschoolers, showed a high rate of SB (53%) and a low rate of MVPA (13%) daily. As a longitudinal study’s evidence showed continually decreasing MVPA and increasing SB across time among Hispanic/Latinx children (Butte et al., 2014), it is possible that sociocultural factors may influence Hispanic/Latinx preschoolers’ SB and PA patterns. Lindsay et al. (2018) mentioned that parental style and home environment created by Hispanic/Latinx parents from low-income families might have a cultural influence on their children’s diet and daily PA habits, which possibly contribute to the risk of children becoming overweight/obese. Thus, it seems that targeting this cohort to enhance PA patterns and reduce SB through center-based and home-based interventions may be imperative.

Regarding weight status and SB and PA patterns, differences between healthy weight and at risk weight groups were not statistically significant, but a small effect size of the cohort differences was revealed (<SB, >LPA, LMVPA). These findings are in line with previous research evidence showing that healthy preschoolers were more physically active than their at risk weight counterparts, especially overweight or obese preschoolers (Butte et al., 2016; España-Romero et al., 2013; Pfeiffer et al., 2009). Still, it is noted that no relationships between weight status and PA patterns were reported from previous studies (Bellows et al., 2013; Cliff et al., 2009). Although inconsistent evidence about these relationships have been found in this preschool-aged group, longitudinal relationships with PA have been found in other studies about weight status (Spengler et al., 2014). Considering the prospective negative effects of early childhood obesity over time (Evensen et al., 2016), it is noteworthy to include at risk weight status preschoolers as a targeted cohort for intervention to increase PA patterns and reduce SB in Head Start programs.

This study provides evidence that preschoolers with better-developed motor skills have a higher MVPA pattern than others with poor motor development. This finding is consistent with a recent longitudinal study showing an association between motor development and children’s MVPA, aged 2–6 years old (Schmutz et al., 2018). As suggested by Stodden et al. (2008) theoretical model, there are bidirectional relationships between young children’s motor skill development and engagement in PA. These links become stronger across developmental periods, indicating the more motor skills a child develops, the more they prospectively engage/participate in PA. In fact, multiple school-based PA programs that target young children’s motor skill development to improve MVPA have been found to be effective (Kriemler et al., 2011; Lee et al., 2020a, b; Zhang et al., 2021). Head Start programs need to consider
integrating concepts of developing motor skills into their indoor and/or outdoor activity curricula. As if reflecting the need to develop motor skills among Head Start preschoolers, a recent study (Webster et al., 2020) implemented motor skill-related interventions during Head Start time (e.g., classroom PA breaks daily) through classroom teachers and demonstrated effective MVPA promotions for the preschoolers. Structured motor skill programs via classroom teachers may be useful and feasible to encourage Head Start preschoolers to engage in more daily activities during the school day (Carroll et al., 2021). Although Head Start has focused on motor skill development for children and provided movement curricula in Head Start centers (U.S. Department of Health and Human Services, 2020), Head Start teachers seemed to have difficulty understanding and implementing the programs based on the researchers’ observations. This might be due by the overburdened teachers’ role and unsupported working conditions in Head Start (Kwon et al., 2022). Considering the fact that classroom teachers’ motivation to deliver programs enhancing children’s motor skills is essential in increasing preschoolers’ PA (Gagné & Harnois, 2013), supporting teachers’ well-being should be considered when implementing activity plans via teachers in Head Start. As teachers play a crucial role in applying activities related to motor skills in terms of the school-based approach (Lee et al., 2019), providing teacher training and education (e.g., workshops, online learning modules) would be necessary to implement motor skill programs successfully in classroom. Further investigation is warranted about the development and effectiveness of Head Start teacher education modules on preschoolers’ motor skills and PA. Such efforts could support shaping preschoolers’ lifelong PA behaviors, which would in turn positively influence their health and well-being in the long term.

A salient strength of this study is the use of objective measures for SB and PA patterns, and weight status among Head Start preschoolers. We also applied the latest version of the gross motor development assessment (TGMD-3) to explore the underserved preschoolers’ motor development in Head Start programs. The data collection occurred right before COVID-19 pandemic in the United States (March 2020) so that the findings of the study may be useful guidance for comparison with post COVID-19. The limitation of this study is related to causal inference due to natural weakness from the use of the cross-sectional research design. The participating Head Start programs were all located in southwestern urban areas, so this may hinder the generalizability when considering results from different geographical locations (urban vs. suburban vs. rural; McGrath et al., 2015). The present study used participants’ height and weight to calculate BMI (age- and sex-specific percentile) and categorized their weight status, which has been widely used for screening BMI. Interpretative caution is warranted as BMI indices (height and weight) are imperfect assessments for adiposity among pediatric groups (Hall & Cole, 2006). Further studies should consider including anthropometry assessments of preschoolers’ body circumferences (waist, hip, limbs, and trunk) using more precise measurements (e.g., a skinfold caliper, BMI tape measure).

In conclusion, this study provided objective information about Head Start preschoolers’ SB and PA patterns while at the center and their relationship to potential indicators (e.g., sociodemographic factors, weight status, and motor development) of SB and PA patterns. The findings showed that preschoolers, who were female, Hispanic/Latinx, with at risk weight levels, and/or in the below average motor development group tended to engage in less MVPA/LMVPA and had higher SB patterns while at the center. Head Start stakeholders need to acknowledge the PA and health disparities, and intervene in underserved preschoolers’ health-promoting behaviors.

Data availability

The data, material, and code presented in this study are available on request from the corresponding author. The data are not publicly available.

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Author Contributions

Conceptualization: J.L. Methodology: J.L. and T.Z. Validation: J.L., J.K., and T.Z. Formal analysis: J.L. Resources: T.Z. Writing—original draft preparation: J.L. Writing—review and editing: J.L., J.K., and T.Z. Supervision: J.K. and T.Z. Project administration: T.Z. All authors have read and agreed to the final version of the manuscript.

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Compliance with Ethical Standards

Conflict of interest

The authors declare no competing interests.

Ethics Approval

Approvals (protocol code #19648) were granted by the University Institutional Review Board and Head Start centers administrated by Child Care Associates.

Informed Consent

Informed consent was obtained from all subjects involved in the study.

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