Fundamental movement skills in preschoolers before and during the COVID-19 pandemic in Japan: a serial cross-sectional study

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Methods

The study was conducted in Unnan City (population 39,032; area 553.4 km²), a rural municipality in Shimane Prefecture, Japan. Data for this serial cross-sectional study were obtained from FMS surveys among preschoolers aged 3–5 years (grades 1–3) as part of the Unnan City Early Childhood Exercise Program, based on the Unnan City Basic Educational Plan, developed by the Board of Education and Child Policy Division (BECPD) at Unnan City Hall [12]. All 22 local preschools were invited to participate. In this study, the term preschool includes nursery schools, kindergartens, and authorized centers for early childhood education and care (ECECs). The principal of each preschool decided whether or not to participate. The BECPD issued letters explaining the study to the parents or guardians of all preschoolers. The surveys were subsequently conducted at each preschool from October to November in 2019 and 2020. According to the opt-out process, the parents/guardians were free to ask questions or refuse participation, as explained on the affiliated website. The BECPD approved the collected data for use in secondary research. Personal identifiers were stripped from the data analyzed in this study. The study protocol was approved by the Ethics Committee of Shimane University (#2856).

The Early Childhood Exercise Guidelines in Japan acted as the standardized assessment method according to which FMS were evaluated. These methods included the 25 m run (m/s), standing long jumps (cm) (locomotor skills), and softball throws (m) (object control skills) [13]. Two trials were conducted for each test item, and the best score was analyzed. Anthropometric measurements included objectively measured height (cm) and weight (kg) status without shoes and with light clothing, to the nearest 0.1 cm and 0.1 kg, respectively. The Kaup index [weight in kg/(height in m)²] data were divided into two categories employing the following cut-off scores: non-overweight: <18.0; overweight: ≥18.0 kg/m² [14].

The sample’s sex distribution and preschool types were compared before and during the pandemic. We presented continuous anthropometric parameters and FMS data as medians and interquartile ranges, with between-period comparisons by age group conducted via the Mann-Whitney U test. Independent-samples tests were conducted based on the null hypothesis that the participants’ FMS scores by age group are at the same level at the two-time points (see Additional file 1). The percentage of overweight participants in the two surveys was compared using a Chi-squared or Fisher’s exact test. To adjust for multiple comparisons (3 groups × 3 measures = 9 comparisons) in FMS, Bonferroni-adjusted p-values were calculated. Statistical significance was set at p < 0.05 for two-sided tests. All the data were analyzed with SPSS version 25.0 (IBM Corp., Armonk, NY, USA).

Results

Table 1 shows the participants’ characteristics. Of the 22 preschools, 21 (95.5%) and 17 (77.3%) participated in the 2019 and 2020 surveys, respectively. This study included 641 and 539 preschoolers in each survey. After excluding missing data, we analyzed 608 (94.9%) and 517 (95.1%) participants, respectively. The percentage of boys and girls before and during the pandemic was not significantly different in any grade (p > 0.055). Further, no significant difference was found before and during the pandemic in the percentage of preschool types (p = 0.746). Table 2 shows the comparison of FMS before and during the COVID-19 pandemic. The comparison of anthropometric parameters and FMS before and during the pandemic revealed the following: regarding height, participants aged 3 years were notably taller during the pandemic than before (p = 0.005), while those aged 4 and 5 years did not show significant differences (p ≥ 0.159). Regarding weight, children aged 3 years were notably heavier during the pandemic than before (p = 0.005), while those aged 4 and 5 years again did not indicate a significant difference (p ≥ 0.136). There was no significant difference before and during the pandemic for the Kaup index and overweight participants (p > 0.09).

For the 25 m runs, participants aged 5 years were faster before than during the pandemic (p = 0.018), while participants aged 3 and 4 years showed no significant differences. All participants aged 3–5 years showed no significant differences in the long jumps before and during the pandemic (p ≥ 0.072). For the softball throws, all grades scored higher before than during the pandemic (p < 0.001).

| Table 1 Participants’ characteristics | Before (2019) | During (2020) | P valueb |
|---------------------------------------|--------------|---------------|----------|
| Overall                               | n %          | n %           |          |
| Boys                                  | 318 52.3     | 251 48.5      | 0.231    |
| Girls                                 | 290 47.7     | 266 51.5      |          |
| Three years old                       |              |               |          |
| Boys                                  | 97 54.2      | 60 42.9       | 0.055    |
| Girls                                 | 82 45.8      | 80 57.1       |          |
| Four years old                        |              |               |          |
| Boys                                  | 84 49.7      | 89 52.0       | 0.745    |
| Girls                                 | 85 50.3      | 82 48.0       |          |
| Five years old                        |              |               |          |
| Boys                                  | 137 52.7     | 102 49.5      | 0.515    |
| Girls                                 | 123 47.3     | 104 50.5      |          |
| Type of preschool                     |              |               |          |
| Nursery school                        | 10 47.6      | 10 58.8       | 0.746    |
| Kindergarten                          | 4 19.0       | 2 11.8        |          |
| ECEC                                  | 7 33.3       | 5 29.4        |          |

ECEC: authorized center for early childhood education and care

*P for Chi-square test.
### Discussion

In this study, we compared FMS scores in preschoolers before and during the pandemic by age group. We found that all participants scored significantly worse on softball throws during the pandemic, while participants aged 5 had slower 25 m run times during the pandemic. To the best of our knowledge, this is the first study to investigate FMS in preschoolers in the COVID-19 context. However, although the FMS scores worsened during the pandemic, the effect size was small ($r < 0.28$). One of the reasons might be that the assessment period of this study was short-term (one year). Additionally, possibly because the preschoolers engaged in some physical activity with parents at home during the pandemic. Our findings supported the pandemic’s negative effect on the motor development of schoolchildren as demonstrated in two previous studies in Japan and Portugal [10, 11]. Considering these results, future studies should implement closer monitoring of FMS changes in school children.

Our results indicated participants’ poor performance on the 25 m run and softball throw during the pandemic. Recent reviews support the associations between physical activity level and FMS [3, 15]. Although we did not assess physical activity levels, fewer opportunities for vigorous physical activity during the pandemic may have hindered the development of FMS. Under the emergency conditions, all kindergartens were temporarily closed (from April 18 to May 17, 2020). During this time, the BECPD requested that nursery schools and ECECs students refrain from visiting the childcare facility. However, we were unable to identify whether specific students in these nursery schools and ECECs were absent. During the one-month self-restraint period, home play and preschool activities may not have entailed vigorous physical activity; that is, there were limited opportunities to develop FMS.

Moreover, the participants’ object control skills were poorer than their locomotor skills during the pandemic. Locomotor skills are viewed as phylogenetic because they develop “naturally” and require minimal formal instruction and feedback [16]. By contrast, object control skills are considered ontogenetic because they are more culturally determined and require formal practice and feedback to reach a competent level [16]. Although locomotor skills require adequate practice and instruction to reach proficient performance, the throwing motion may be more affected by personal inexperience rather than running and jumping motions. For example, ball sports typically require specialized conditions (e.g., specialized equipment or a team of participants). The coronavirus may be transmitted by coming into physical contact with objects previously touched by infected individuals [17]. Therefore, preschools may have restricted ball-related activities. However, parents, caregivers, and teachers could incorporate physical activity including movement skill-related components into children’s daily routine while adhering to infection prevention regulations [17–19].

### Table 2: Comparison of fundamental movement skills before and during the COVID-19 pandemic

| Anthropometric parameter | Before (2019) | During (2020) | Effect size | P value |
|--------------------------|--------------|---------------|-------------|---------|
| Height (cm)              | 97.8 (95.1–100.4) | 99.3 (95.3–107.8) | 0.08 | 0.159 |
| Weight (kg)              | 14.6 (13.3–15.8) | 15.2 (14.0–16.4) | 0.16 | 0.005 |
| Kaup index (kg/m²)       | 15.2 (14.6–15.9) | 15.4 (14.9–16.0) | 0.08 | 0.129 |
| Overweight (%)           | 0.6 (0.0–3.1) | 0.6 (1.2–3.1) | 0.11 | 0.000 |
| Softball throw (m)       | 7.7 (6.6–8.8) | 7.5 (6.0–9.0) | 0.01 | 1.000 |
| Overweight (%)           | 0.6 (0.0–3.1) | 0.6 (1.2–3.1) | 0.11 | 0.000 |
| Softball throw (m)       | 7.7 (6.6–8.8) | 7.5 (6.0–9.0) | 0.01 | 1.000 |
| Overweight (%)           | 0.6 (0.0–3.1) | 0.6 (1.2–3.1) | 0.11 | 0.000 |

*P values for Mann–Whitney U test for continuous data and a Chi-squared or Fisher exact test for categorical data. To adjust for multiple comparisons (3 groups), Bonferroni-adjusted p-values were calculated.*
demonstrates the importance of vigorous physical activities in increasing FMS development among preschoolers during the pandemic [20]. Several limitations of this study should be noted. Our findings cannot be generalized because the study was performed in a single rural city. Next, there might have been a selection bias because of 5 non-participating preschools in the 2020 survey. Our results might have underestimated the negative impact of the pandemic on FMS, if these preschools were reluctant to allow children to participate in physical activity during the pandemic. Finally, we did not investigate the potential effects of frequency or type of physical activity in the preschool/home. Our research design also precludes causal inferences.

Conclusions

Lower performance was exhibited in the 25 m runs and softball throws in preschoolers aged 3–5 years during the pandemic compared to the pre-pandemic statistics. This indicates that FMS growth may have been impeded due to the pandemic restrictions. This highlights the need for interventions aimed at developing FMS in preschoolers during and after the pandemic.

Abbreviations

COVID-19: coronavirus disease 2019.

Supplementary information

The online version contains supplementary material available at https://doi.org/10.1265/s10438-022-02049-6.

| Additional file 1: The study methodology. |

Declarations

Ethics approval and consent to participate

The Board of Education and Child Policy Division (BECPD) at Unnan City Hall approved the collected data for use in secondary research. All 22 local preschools were invited to participate, the principal of each preschool decided whether to participate or not. The BECPD issued letters explaining the study to the parents or guardians of all preschoolers. The surveys were subsequently approved the collected data for use in secondary research. All 22 local preschools were invited to participate, the principal of each preschool decided whether to participate or not. The BECPD issued letters explaining the study to the parents or guardians of all preschoolers. The surveys were subsequently conducted and collected at each preschool from October to November in 2019 and 2020. According to the opt-out process, parents/guardians were free to ask questions or refuse participation, as explained on the affiliated website. The personal identifiers were stripped from the data analyzed in this study and the study protocol was approved by the Ethics Committee of Shimane University (K2956).

Consent for publication

Not applicable.

Availability of data and material

Data cannot be shared for ethical reasons.

Competing interests

The authors declare no conflicts of interest.

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Author contributions

T.A. and N.F. planned and conducted this study. J.K. collected the data, while T.A., J.K., and N.F. performed statistical analyses, interpreted the results, and organized the paper. J.K., M.K., and S.O. made substantial contributions to data analysis and draft revisions. K.U., C.T., and Y.M. critically appraised the paper and made final suggestions. Y.M. helped supervise the project. All authors reviewed and revised the manuscript and agreed to its submission.

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