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Physical fitness levels and trends of kindergarteners in Hong Kong during the COVID-19 pandemic

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ABSTRACT

Background/objectives: The study aimed to examine the physical fitness and activity levels of kindergarteners in Hong Kong during the coronavirus disease 2019 pandemic.
Methods: A total of 2052 kindergarteners (48% girls; 32.9% Grade 1, 34% Grade 2, and 33.1% Grade 3) were recruited from July 2020 to November 2021. Participants completed the physical fitness tests, including body composition, flexibility, lower-limb muscle strength, upper-limb muscle strength, lower-limb muscle endurance, and agility. Children's physical activity and overall well-being were examined using parental proxy reports. Parents also reported their physical activity and parental support to children's physical activity engagement, as well as their perception of children's kindergarten physical activity environment. Fitness differences by age and gender were analyzed using one-way ANOVA and ANCOVA measuring effect size with partial eta-squared. Additionally, correlations assessed the relationship between children's fitness and parents' proxy reports.
Results: The results of the physical fitness tests were higher than those in previous studies conducted by the Physical Fitness Association of Hong Kong in 2015–2018. Gender-based differences were observed in most tests for children aged 4 years and older, with boys showing higher scores in the standing long jump, shot put, and balance tests, while girls had higher scores in the sit-and-reach test. Parents' proxy questionnaire answers indicated that children's continuous jump test performances were significantly related to their frequency of physical activity per week ($r = 0.19$, $p < 0.001$), and that children's health was significantly and positively correlated with their fitness level ($r = 0.179$, $p < 0.009$). Inadequate school physical activity was associated with poor upper-limb strength ($r = 0.078$, $p < 0.005$). Moreover, a high level of parental support for their children's participation in physical activity was correlated with a high level of parental participation in vigorous-intensity physical activities ($r = 0.167$, $p < 0.005$).
Conclusion: The physical fitness of children in Hong Kong was less affected by the epidemic. Parents' healthy behaviors and support were related to children's participation in PA. Efforts to improve children's physical fitness and motor development should include parent education and physical activity involvement.

1. Introduction

Physical fitness is a vital factor contributing to children's physical growth, well-being, and overall development. Many studies have suggested a close relationship between physical fitness in youth, which encompasses both physical health and skill-related components,[1] and cognitive skills in later life.[2,3] Physical fitness is expected to be developed through engagement in physical activity. Physical activity was defined as "any bodily movement produced by skeletal muscles that results in energy expenditure".[1] The bodily movement is being able to enhance the components defined in physical fitness, and they are muscle strength, muscle endurance, power, balance, cardiovascular system and flexibility.[4] Physical activity in early childhood is integral to desirable future health outcomes, such as increased indicators of bone health and reduced risk for excessive increases in weight and adiposity.[5]

The outbreak of the coronavirus disease 2019 (COVID-19) pandemic in December 2019 restricted physical activity for people of all ages in many countries. Moreover, online communication became part of

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everyday household activities. In 2020, some countries reported that children's behavioural health had deteriorated[6] due to pandemic restrictions, which might have prevented children from achieving the recommended levels of physical activity. The positive effects of physical activity on physical health are underpinned by such activity triggering a long-term adaptation process in the brain that enhances the brain's structure.[7] However, studies in Hong Kong have obtained inconsistent results before and after the COVID-19 pandemic. A longitudinal study found that the pandemic caused Hong Kong children's levels of moderate-to-vigorous physical activity to increase,[8] whereas a cross-sectional study found that there was a decrease in physical activity level.[9] Regardless of the COVID-19, a 2018 population survey in Hong Kong showed that over 90% of school-aged children and youth did not engage in sufficient amounts of physical activity based on the Health Assessment Questionnaire.[10] It could be interpreted that the influence of parenting practices on children's physical activity has become increasingly significant. This could be due to various factors such as socioeconomic status, social expectation from parents, access to digital technology, and the size of home environments. In addition, preschool' policies and practices and parents' education and attitudes toward physical activity influence children's levels of physical activity.[11,12] As a result, there are vast disparities in children's levels of physical activity. This highlights the importance of school-based research in enhancing schools' and parents' roles in enhancing and maintaining children's physical fitness and activity.

A comprehensive study was conducted in Hong Kong between 2015 and 2018 to evaluate the physical fitness of preschool children aged between 3 and 6 years using the 6-item physical fitness test protocol of the Keep-Fit Formula for Children Programme of the Physical Fitness Association of Hong Kong, China. The study provided a detailed physical fitness measurement protocol and analysis of the overall health landscape of pre-schoolers in Hong Kong.[13] However, the COVID-19 pandemic has had a significant impact on the physical activity and sedentary behaviour of children.[14] This has raised concerns about the effects of the pandemic on the physical fitness and activity levels of preschool children in Hong Kong. Therefore, it is essential to conduct a comprehensive study to understand the extent of the impact of the pandemic on the physical fitness levels of preschool children in Hong Kong.

2. Methodology

2.1. Study design

A repeated cross-sectional design was used to assess the physical fitness levels of Hong Kong kindergarteners. This study was an extension of the Keep-Fit Formula Project conducted by the Physical Fitness Association of Hong Kong in 2015–2018[13] and aimed to provide up-to-date information about the physical fitness levels of Hong Kong kindergarteners. The research team visited kindergartens from 2020 to 2021 to recruit pupils and assess their physical fitness through a range of tests. Additionally, questionnaire surveys were distributed to the kindergarteners' parents to assess their perceptions towards their children's levels of physical fitness, physical activity participation habits, and well-being.

2.2. Participants

An invitation letter was distributed to 150 cooperating Institutions' kindergartens in Hong Kong, and a total of 27 kindergartens (response rate: 18%) were recruited using convenience sampling with an average of 76 pupils from each kindergarten. To ensure the representativeness of the sample, kindergartens were selected from all metropolitan areas in Hong Kong, encompassing Hong Kong Island, Kowloon, and the New Territories. In this study, the kindergartens are distributed across these three districts and are located in 13 of Hong Kong's 18 districts. The number of pupils was provided by the recruited kindergartens depending on the total number of students in each class of the kindergartens. In addition, the sample was selected to ensure equal numbers for each gender and grade level. Regarding the parents' proxy report, 2039 parents completed the questionnaire about perceptions of their children's levels of physical fitness, physical activity participation habits, and well-being. The study was approved by the Institutional Review Board (REC/19-20/0324), and all participants gave their informed consent for inclusion before they participated in the study.

2.3. Instrument

2.3.1. Children's physical fitness

A 6-item physical fitness test was used based on the guidelines of the Keep-Fit Formula for Children Programme of the Physical Fitness Association of Hong Kong, China. There are six tests, such as Body Mass Index (BMI), sit and reach, standing long jump, shot put, continuous jump with both feet, and balance Beam. These tests were used to assess children's body composition, flexibility, lower-limb muscle strength, upper-limb muscle strength, lower-limb muscle endurance, and agility. All of the tests were conducted by trained physical fitness coaches provided by the Physical Fitness Association of Hong Kong, China.

2.3.2. Children's physical activity and overall well-being

Parents were asked to report their children's physical activity level by completing the Modified Physical Activity Questionnaire for Children (MPAQ-C). This parent-proxy questionnaire was previously well validated in children of different populations, and has a satisfactory test–retest reliability (>0.8), an adequate construct validity (comparative fit index [CFI] = 0.977; non-normed fit index [NNFI] = 0.962).[15] Additionally, the Parent-Proxy Health Questionnaire for Children and Adolescents of KIDSCREEN-10 was used to evaluate the overall well-being of the children. This questionnaire was previously found to have Cronbach's alpha of 0.82 (0.78), a satisfactory test–retest reliability of 0.70 for the self-(proxy-) report version,[16] and moderately correlated between self and parent proxy reports (r = 0.54).[16]

2.3.3. Parent-child physical activity and Home–School Bonding Survey

This survey incorporated various questionnaires. First, parents' self-reported sedentary behaviour and physical activity levels were measured using the Adult Sedentary Behaviour Questionnaire – Chinese Version (ASBQ-C[17,18]), and the International Physical Activity Questionnaire (IPAQ; Booth, 2000). It was found to be reliable, exhibited an ICC of approximately 0.7, and afforded results that were significantly correlated with accelerometer-based measurements.[17] The IPAQ is widely used, and its Chinese version was previously validated.[19]

Second, the level of parental support for their children's participation in physical activity was measured using the 5-item Parental Support Scale.[20] This scale is considered as reliable and has adequate internal consistency demonstrated by a Cronbach's alpha of 0.78. The sample questionnaire item is about the weekly frequency with which parents encouraged their child to do physical activities or play sports, etc.

Finally, the School Physical Activity Environment Questionnaire [21] was used to investigate whether parents thought their children's kindergarten provided a motivating physical-activity environment that enhanced their children's level of physical fitness. In general, this scale has sufficient internal consistency, as shown by a Cronbach's alpha of greater than 0.80. The questionnaire items reflect the equipment and facility quality and programming in school, such as "The indoor areas (e.g., gym) at my school are in good condition".

2.4. Data analysis

Statistical analyses were performed with SPSS Version 27. Data underwent normality checks and outlier removal, with outliers defined as ±3 standard deviations away from the mean. Stem-and-Leaf plots were also employed to visually assess the distribution of data points.

Descriptive statistics for kindergarteners' demographics and fitness tests include means and standard deviations. The comparison of physical fitness indicators across 4 years was also examined using an independent *t*-test. This involved comparing the baseline data from 2015/2016 with results derived from the same tests conducted by the Physical Fitness Association of Hong Kong from 2015 to 2018 years.[13] Fitness differences by age (≤3, 4, 5, ≥6 years) and gender were analyzed using one-way ANOVA and ANCOVA with sex as a covariate, measuring effect size with partial eta-squared. Additionally, Pearson correlations and linear regression assessed the relationship between children's fitness and parents' self-reported variables. These variables included parental physical activity, parent support for child activity, parents' reports on their children's activity levels, well-being, and perceived school activity environment. Independent samples T-tests were conducted to examine the differences in fitness test score between genders.

3. Results

3.1. Demographic information

From July 2020 to November 2021, 2052 kindergarteners (984 girls, 1063 boys, and 5 with missing data) were recruited from 27 kindergartens and completed the physical fitness test. These kindergartens were spread across 13 districts. The kindergarteners had a normal grade distribution: Grade 1 (<4 years) = 675 (32.9%), Grade 2 (4–5years) = 697 (34.0%), and Grade 3 ((≥5 years) = 680 (33.1%). Moreover, the Perceived Children's Physical Fitness Test and Parent-Proxy Children's Physical Activity Survey were completed by 949 parents and the Parent–Child Home–School Bonding Survey was completed by 1090 parents.

3.2. Fitness test results

Descriptive statistics indicated positive skewness in most indicators across age groups, with skewness for the Grade 1 long jump at 4.75 (SE = 0.10). Table 1 presents mean indicator values by age group. The physical fitness results of 2020/2021 were higher than in 2015/2018 (Table 2 and Table 3). Gender-based comparisons across age groups revealed significant differences in most tests for children older than 4 years; specifically, boys had higher fitness scores than girls in standing long jump, shot put, and balance but girls had significant higher score in and sit-and-reach test than boys. ANCOVA confirmed these differences with effect sizes ranging from 0.012 to 0.37, adjusting for gender. Table 4 detailed gender disparities within age groups.

The MPAQ-C and KIDSCREEN-10 parent-proxy questionnaires measured the mean score for Hong Kong kindergarteners' physical activity (M = 2.51, SD = 0.61) and well-being (M = 3.41, SD = 0.49), respectively. Children's jump test performance was significantly linked to their weekly physical activity ($r = 0.19$, $p < 0.001$), suggesting better performance with more exercise. The KIDSCREEN-10 also showed positive correlations between parental perceptions of children's fitness levels and health ($r = 0.179$, $p < 0.009$). However, these perceptions did not align with actual fitness levels.

School environment and physical activity findings indicated that inadequate school physical activity could lead to poor upper-limb strength, as seen in bean-bag shot put performance ($r = 0.078$, $p < 0.005$). Additionally, high parental support for children's physical activity was significantly related to parents' own activity levels, particularly for vigorous-intensity activities ($r = 0.167$, $p < 0.005$).

Table 1
Summary Table of the Indicators of the three age groups.

	Grade 1 (<4 years)		Grade 2 (4–5 years)		Grade 3 (≥5 years)	
	Mean	SD	Mean	SD	Mean	SD
Body Mass Index	15.4	2.00	15.3	2.07	15.6	2.68
Sit and Reach (cm)	6.2	4.50	7.0	4.98	7.3	5.67
Standing Long Jump (cm)	65.8	20.88	87.80	19.07	99.73	19.08
Shot Put (cm)	300.9	100.15	398.90	115.62	472.5	114.55
Continuous Jump with both Feet (s)	7.5	5.00	6.0	1.85	5.12	1.00
Balance Beam (s)	13.3	7.10	12.0	6.03	10.2	5.82

4. Discussion

Our findings show that despite the effects of the COVID-19 pandemic, there was a marked improvement in the physical fitness levels of Hong Kong kindergarteners compared with previous years.

Nevertheless, despite the fact that physical fitness is needed to support gross motor development in young children,[22] we found that parents' perceptions of the physical fitness levels of their children were not significantly correlated with their children's actual physical fitness levels. This indicated that parents lacked awareness of their children's motor development and ability. However, the survey revealed that compared with parents who participated in less vigorous-intensity exercises, those who participated in more vigorous-intensity exercises tended to show a higher level of support for their children's participation in physical activity; thus, expected to enhance children's physical fitness.

Apart from parents, school environments and resources are regarded as factors that affect the motor development of kindergarteners. Hong Kong's high population density means that most kindergartens are less spacious than those in other countries and may even be surrounded by dense public-housing estates. The survey results are consistent with this, as schools with environments that did not meet children's needs for physical activity negatively influenced children's upper-limb muscle strength, possibly because children are not allowed to throw objects indoors.

The results indicate that there were gender differences in most of the indicators, namely sit-and-reach distance (cm), standing long-jump distance (cm), bean-bag shot put distance (cm), and balance. The current large-scale study supports the gender differences indicated in previous pre-schoolers fundamental movement research[23]; while also addressed its limitation of not utilising a longitudinal trajectory approach. The current study supports the longitudinal approach of indicating the trend and change of gender differences within physical function of preschoolers, which is in line with previous studies.[24,25] Additionally, most studies have reported significant between-gender differences in physical fitness levels of children and adolescents aged 10–18, in terms of standing board jump, flexed arm hang, sit-up, hand grip, and shuttle run performances.[26–29] This also indicates that physical fitness test items with gender differences are aligned across age groups, ranging from pre-school children to adolescents. Flexibility is less likely to be affected by gender and age. Overall, these studies have demonstrated that girls exhibit different levels of physical fitness to boys across various age groups.

Kindergarteners' physical fitness and physical activity levels and their parents' support and perceptions of their physical fitness levels figured prominently in the current study. These results are in line with the previous meta-analysis that parental support and modelling related to their children's PA, in specific, father's support have greater association with son than mother's.[30] Parental modelling is one of the factors that most affects early-childhood physical activity and active behaviours, which underscores the importance of parental support for and positive perceptions of their preschool children's physical activity and fitness.[31] Parents' willingness to support their children's healthy behaviours and engage in early-childhood parental education increase the number of opportunities that preschool children have to engage in active behaviours, thereby improving their social, motor, and cognitive skills.[32] Although reviews emphasise the importance of family influence on children's PA lifestyle, the family support in 49 countries (including

Table 2
Summary of physical fitness indicators of boys across 4 years (mean).

Boys	2015/2016 (n = 6040)		2016/2017 (n = 5729)			2017/2018 (n = 3382)			2020/2021 (n = 2052)		
	Mean	SD	Mean	SD	p-value	Mean	SD	p-value	Mean	SD	p-value
Body Mass Index											
3 years or younger	14.0	0.75	15.9	1.6	<0.001	15.9	1.2	<0.001	15.5	2.8	0.01
4 years	15.8	1.4	15.6	1.4	0.00	15.8	1.5	0.98	15.4	2.2	<0.001
5 years	15.8	1.3	15.5	1.6	0.01	15.5	1.4	0.03	15.4	1.9	0.00
6 years or older	15.7	1.8	15.6	2.1	0.01	15.5	1.8	0.00	15.6	2.4	0.36
Standing Long jump (cm)											
3 years or younger	52.6	22.0	46.6	22.3	<0.001	44.8	22	<0.001	54.0	24.2	0.02
4 years	69.4	23.0	71.7	21.7	<0.001	71.2	23.9	0.02	76.5	20.4	<0.001
5 years	86.1	23.6	89.5	22.4	<0.001	97.7	25.1	0.02	93.5	20.5	<0.001
6 years or older	94.6	26.9	100.6	21.8	<0.001	89.9	29.9	0.00	102.6	20.6	0.01
Shot Put (cm)											
3 years or younger	260	1.2	240	1.2	<0.001	250	1.5	0.00	278.7	102.9	0.02
4 years	320	1.3	340	1.4	<0.001	240	1.7	<0.001	369.5	113.9	0.05
5 years	400	1.4	410	1.5	0.00	420	1.7	0.00	454.0	121.6	<0.001
6 years or older	440	1.6	450	1.6	0.49	420	1.6	0.03	493.3	115.4	<0.001
Continuous Jump (s)											
3 years or younger	12.3	6.2	13	5.8	<0.001	13.5	6.7	<0.001	8.4	4.3	<0.001
4 years	10.2	5.2	9.2	4.2	<0.001	9.2	4.2	<0.001	6.7	3.6	<0.001
5 years	8	4.0	7.1	3.0	<0.001	6.9	2.6	<0.001	5.6	1.9	<0.001
6 years or older	7.3	4.0	6.7	2.9	<0.001	6.6	2.9	<0.001	5.1	1.5	<0.001
Balance Beam (s)											
3 years or younger	20.5	12.6	22.5	14.1	<0.001	20.7	12.0	0.70	12.3	6.3	<0.001
4 years	17.8	10.8	16.8	10.8	<0.001	17.5	9.9	0.39	12.0	6.2	<0.001
5 years	14.2	9.0	13.4	9.3	<0.001	14.2	8.8	0.86	10.8	6.1	<0.001
6 years or older	12.6	9.0	12	8.5	0.07	12.7	7.6	0.90	9.7	6.4	<0.001
Sit and Reach (cm)											
3 years or younger	5.9	4.8	5.2	4.6	<0.001	6	5.0	0.78	7.4	2.7	0.03
4 years	5.3	5.0	5	4.8	0.02	5.1	5.3	0.28	9.7	42.1	0.53
5 years	5.4	5.6	4.2	5.6	<0.001	4.4	6.3	<0.001	7.8	2.8	0.02
6 years or older	4.4	5.6	4.2	5.9	0.40	4.5	6.9	0.92	8.7	3.4	0.19

Notes: p-value is compared against the baseline year (2015/2016).

Table 3
Summary of physical fitness indicators of girls across 4 years (mean).

Girls	2015/2016 (n = 6040)		2016/2017 (n = 5729)			2017/2018 (n = 3382)			2020/2021 (n = 2052)		
	Mean	SD	Mean	SD	p-value	Mean	SD	p-value	Mean	SD	p-value
Body Mass Index											
3 years or younger	14.9	1.8	15.5	1.3	<0.001	15.7	1.1	0.11	15.5	2.3	<0.001
4 years	15.5	1.3	15.4	1.4	0.18	15.5	1.3	0.53	14.9	2.2	0.00
5 years	15.4	1.5	15.2	1.4	<0.001	15.3	1.4	0.00	15.3	2.5	<0.001
6 years or older	15.4	1.72	15.3	2.0	0.04	15.1	1.6	<0.001	15.5	2.7	0.48
Standing Long jump (cm)											
3 years or younger	52.3	20.2	44.4	19.7	<0.001	43.5	19.8	<0.001	51.0	21.7	0.43
4 years	65.6	20.2	68	18.3	<0.001	67.9	21.7	0.00	71.2	18.1	<0.001
5 years	79.5	21.3	83.9	20.3	<0.001	83.5	23.2	<0.001	88.7	17.1	<0.001
6 years or older	87.2	24.5	93.8	18.8	<0.001	86.2	27.3	0.56	97.1	16.9	0.00
Shot Put (cm)											
3 years or younger	250	1.0	230	1.0	<0.001	220	1.4	<0.001	250.5	91.1	0.39
4 years	290	1.1	300	1.1	0.02	320	1.5	0.54	321.0	95.0	0.03
5 years	360	1.3	370	1.3	0.06	390	1.5	<0.001	403.7	104.0	<0.001
6 years or older	400	1.5	420	1.4	0.02	410	1.4	0.54	460.1	105.7	<0.001
Continuous Jump (s)											
3 years or younger	12.1	5.8	13.2	5.7	<0.001	13.1	6.3	<0.001	8.2	3.6	<0.001
4 years	10.1	4.8	9.2	4.0	<0.001	8.8	3.8	0.00	6.7	2.6	<0.001
5 years	8.2	4.2	7.1	3.2	<0.001	7.1	2.9	<0.001	5.7	1.5	<0.001
6 years or older	7.4	4.2	6.6	2.7	<0.001	6.3	2.1	0.56	5.2	1.0	0.05
Balance Beam (s)											
3 years or younger	19.3	11.3	21.9	11.3	<0.001	20.7	11.6	<0.001	12.1	7.3	<0.001
4 years	17.9	10.6	17.3	10.8	0.02	18.1	10.1	0.05	12.6	6.5	<0.001
5 years	15.1	9.5	13.8	9.2	<0.001	15.3	9.0	0.34	11.3	6.2	<0.001
6 years or older	13.1	8.9	11.8	7.5	<0.001	12.2	7.2	0.07	11.3	6.4	<0.001
Sit and Reach (cm)											
3 years or younger	7.1	4.4	6.3	4.5	<0.001	6.7	4.8	0.04	7.3	2.6	0.98
4 years	7	4.7	6.5	5.1	<0.001	6.9	4.7	0.48	8.2	3.0	0.47
5 years	6.8	5.2	6.4	5.2	<0.001	6.4	6.2	0.03	8.9	3.3	0.74
6 years or older	6.6	5.6	6.6	6.1	0.97	5.8	5.5	0.01	9.0	3.5	0.66

Notes: p-value is compared against the baseline year (2015/2016).

Table 4
Summary table of the independent samples T-tests (gender differences) for the year 2020/2021.

3 years or younger	t	df	p	Direction
Body Mass Index	−0.72	608	0.47	
Sit and Reach (cm)	1.05	635	0.29	
Standing Long Jump (cm)	−1.65	627	0.10	
Shot Put (cm)	−3.66	635	<0.001	Boy>Girl
Continuous Jump with Both Feet (s)	−0.69	627	0.49	
Balance Beam (s)	−0.20	631	0.84	
4 years				
Body Mass Index	−3.78	947	<0.001	Boy>Girl
Sit and Reach (cm)	2.24	997	0.025	Girl > Boy
Standing Long Jump (cm)	−4.38	992	<0.001	Boy>Girl
Shot Put (cm)	−7.23	994	<0.001	Boy>Girl
Continuous Jump with Both Feet (s)	−0.079	993	0.937	
Balance Beam (s)	1.36	997	0.175	
5 Years				
Body Mass Index	−1.80	953	0.072	
Sit and Reach (cm)	4.80	1020	<0.001	Girl > Boy
Standing Long Jump (cm)	−3.99	1018	<0.001	Boy>Girl
Shot Put (cm)	−7.98	1013	<0.001	Boy>Girl
Continuous Jump with Both Feet (s)	−0.50	1020	0.615	
Balance Beam (s)	0.48	1022	0.139	
6 years or older				
Body Mass Index	−1.19	360	0.236	
Sit and Reach (cm)	2.43	364	0.015	Girl > Boy
Standing Long Jump (cm)	−2.73	365	0.007	Boy > Girl
Shot Put (cm)	−2.81	359	0.005	Boy > Girl
Continuous Jump with Both Feet (s)	0.76	366	0.439	
Balance Beam (s)	2.38	366	0.018	Girl > Boy

Note: >means greater.

Hong Kong) are low, which is warrant more public health action.[33,34] For example, educating parents and raising their awareness of their children's actual level of physical fitness. This will enable parents to provide suitable and adequate support to enhance their children's levels of physical activity and fitness, which will in turn benefit children's motor development.

However, the study has certain limitations. First, while the sample size in this study exceeds the required number of participants based on an effect size (f) of 0.11 for children, a correlation coefficient (r) of 0.19 for parents, an alpha level of 0.05, and a power of 0.95, which suggests the presence of 124 children and 295 parents to achieve robust statistical analysis, it is important to acknowledge that having a sample size significantly larger than the calculated requirements could magnify biases resulting from other study design problems.[35] In addition, using parent-proxy questionnaires to assess the kindergarteners' physical activity levels due to their low levels of literacy. This might have led to recall bias and thus inaccurate assessments of children's physical activity levels. Moreover, other factors that may contribute to physical fitness levels, such as nutrition and sleep patterns, were not accounted for.

5. Conclusion

This study examined and summarised the physical fitness levels of various age groups and genders of Hong Kong kindergarteners and thereby contributes information on current trends and norms in this population's physical fitness levels in the post COVID-19 Era. This study highlights the positive effects of adequate levels of physical activity, a supportive school environment, and positive parental support and perceptions on the physical fitness of Hong Kong kindergarteners. It emphasizes the importance of home-school bonding in enhancing children's physical activity, which ultimately leads to improved physical fitness. Future research could examine how kindergarteners' physical fitness levels are affected by various factors, such as nutrition and sleep habits.

Authors' contributions

PKC conceptualized the study; developed the study protocol; MYCW conducted all data collection; helped to analyse the data; presented the data; and drafted the manuscript; KLO conducted all data collection; helped to analyse the data; presented the data; drafted the manuscript; and edited the manuscript; WSW advised on the study protocol; SSH advised on study protocol.

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Ethics approval and consent to participate

All participants gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the study was approved by the Institutional Review Board at [Hong Kong Baptist University] (approval reference number [REC/19-20/0324]). Measures were taken to ensure the confidentiality and privacy of study participants, and the study protocol was modified as necessary with the approval of the ethics committee.

Consent for publication

Not applicable.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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