Motor Performance as Predictor of Physical Activity in Children: The CHAMPS Study-DK

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ABSTRACT

LARSEN, L. R., P. L. KRISTENSEN, T. JUNGE, C. T. REXEN, and N. WEDDERKOPP. Motor Performance as Predictor of Physical Activity in Children: The CHAMPS Study-DK. *Med. Sci. Sports Exerc.*, Vol. 47, No. 9, pp. 1849–1856, 2015. **Purpose**: Physical activity (PA) is associated with several health benefits in children, and PA habits developed in childhood tend to persist into adulthood. PA may be the foundation of a healthy lifestyle, and motor performance has been shown to be positively associated with PA in cross-sectional studies. The purpose of this study was to explore the longitudinal relation between motor performance and PA in a 3-yr follow-up study. **Methods**: Longitudinal analyses were performed using data from 673 participants (44% boys, 6–12 yr old) who had been included in the Childhood Health Activity and Motor Performance School study—DK. Baseline motor performance tests consisted of vertical jump, shuttle run, hand grip strength, backward balance, precision throw, and cardiovascular fitness. Composite *z*-scores were generated to express health-related fitness and performance-related fitness. PA was measured by accelerometer at baseline and at 3-yr follow-up and was expressed as a percentage of time in moderate-to-vigorous PA. **Results**: Cardiovascular fitness, vertical jump, health-related fitness, and performance-related fitness showed significant positive associations with 3-yr follow-up measures of PA in both sexes. Furthermore, shuttle run showed significant inverse associations with follow-up measures of PA for both sexes. **Conclusions**: Cardiorespiratory fitness, shuttle run, vertical jump, health-related fitness, and performance-related fitness were significantly associated with time spent in moderate-to-vigorous PA at 3-yr follow-up. The clinical relevance of the results indicates that cardiorespiratory fitness and shuttle run in childhood may be important determinants of PA in adolescence. **Key Words:** FITNESS, AGILITY, ACTIVITY, LONGITUDINAL ASSOCIATION, YOUTH

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Physical activity (PA) is associated with several health benefits in children and adolescents such as decrease in cardiometabolic risk factors, obesity, and depression in addition to improvements in bone density, and there seems to be a dose–response relation (19). Furthermore, PA habits have a tendency to track from childhood to adulthood (42) and the degree of tracking may be stronger than previously reported because of evidence from new, more reliable objective measures of PA (26). This highlights the importance of studying potential determinants of PA to encourage children to become, and stay, physically active.

Motor performance, covering both fundamental motor skills and fitness-related components, is important for physical, psychological, and social development in children and adolescents and may be the foundation of an active lifestyle (9,29). Sufficient motor performance is required to develop sports-specific skills (36,52) and to experience success in movement activities. Thus, the motivation to participate in leisure time sports and PA in general might be significantly influenced by the level of skill in motor performance.

Motor performance has been shown to be positively associated with PA in cross-sectional studies (21,29,51,52). The studies that examined the longitudinal relation between motor performance and PA have examined different components of motor performance such as motor skills (7,28,47), cardiorespiratory fitness (20,25), or physical fitness (28). In general, the motor skill component of motor performance has been reported as positively associated with PA (7,28,47). The same applies to cardiorespiratory fitness (20,25), whereas the associations with other fitness-related aspects of motor performance (FMP) items have been either small or not significant (20,28) possibly because of self-report methods for measuring PA. Self-report methods to assess PA in children tend to have low validity partly because of recall bias and difficulties in quantifying the intensity of PA (16,30).

There is a profound lack of longitudinal studies using objective measures to study the association between the FMP and PA from childhood to adolescence (10,29,39,52).

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Howley (18) suggested dividing FMP into health-related fitness that measures items associated with disease prevention and health promotion and performance-related fitness that reflects the performance aspect of physical fitness. This division makes it possible to examine whether the different components of FMP are associated differently with PA.

The objective of this study was to explore the longitudinal relation between FMP and PA in a 3-yr follow-up study. The hypothesis was that FMP in 6- to 12-yr-old children was predictive of PA.

METHODS

The data were derived from the longitudinal cohort study called "The Childhood Health Activity and Motor Performance School study—DK" (CHAMPS study-DK) (50). Participants were age 6–12 yr, and they were followed for three consecutive years. They attended 10 public schools, four of which offered the participants two physical education lessons per week and six of which offered the participants six physical education lessons per week. The selection of schools and sample size calculation have been described in detail previously (50). In 2008, the CHAMPS study-DK invited 1507 children to participate in the research program and 1218 children agreed to participate (50). In the current study, 1213 participants took part at baseline in 2009, of which 1146 participants had baseline data on both FMP and anthropometrics. Exclusion due to incomplete data resulted in 673 participants in the analyses on FMP as predictive of PA (Fig. 1).

Ethics approval was obtained as part of the CHAMPS study-DK (project ID S-20080047). This study conforms with the Declaration of Helsinki (49). The parents of all the participants gave their informed consent.

Motor Performance

A trained team conducted the tests on FMP in school sports halls. The clinicians conducting the tests were thoroughly instructed in all test procedures during two full days of practice that included standardized calibration of the equipment and measurement and instruction procedures. On the first day, the clinicians practiced on each other, and on the second day, the tests and procedures were tested on children of the same age as the participants in the CHAMPS study-DK. The tests of FMP consisted of the following:

- Backward balance. This is a balance test from the Körperkoordinations Test für Kinder (22,23). It consists of walking backwards on three different balance beams (6, 4.5, and 3 cm wide), with three trials on each beam and is counted as the number of successful footsteps with a maximum of eight points per trial. Possible scores ranged from 0 to 72 points.
- Precision throw from "Der Allgemeiner Sportmotorischer Test für Kinder von 6–11 Jahren" (11). Standing 3 m from a target plate, each participant had two sets of five throws, with 0–3 point per throw, making it possible to attain 30 points.

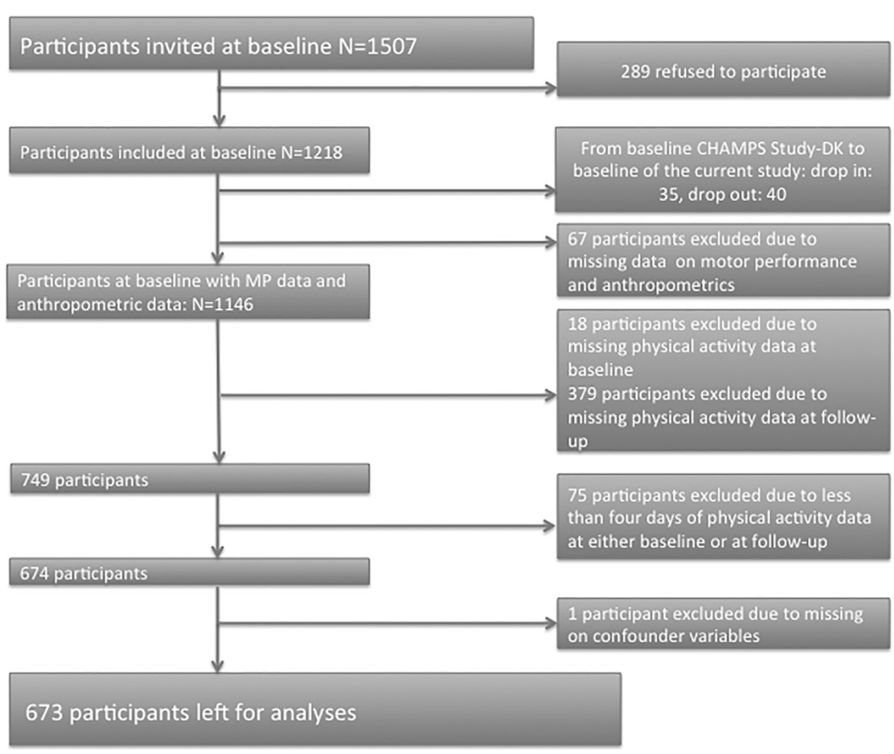

FIGURE 1—Flowchart of the participants.

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- Hand grip strength from the Eurofit test battery (1), measured in kilograms (JAMAR dynamometer, Scandidact, Cat.No.281128). Best of two trials was recorded.
- Shuttle run from the Eurofit test battery (1), a test of agility. It consists of five laps on a 5-m lane, measured in seconds.
- Vertical jump test, corresponding to the Abalakow vertical jump test (24). This test is a proxy for strength in the lower extremity, measured as jumping height in centimeters.
- The Andersen test. This is a test of cardiorespiratory fitness, measured as the number of meters run in an intermittent shuttle run test (2).

The Andersen test and hand grip test have been shown to be valid in child populations (2,4,12,40). Intraclass correlation coefficients (ICC) of test–retest reliability for the FMP tests ranged between 0.81 and 0.98 (40).

Baseline FMP scores were divided into health-related fitness and performance-related fitness according to previous studies (17,18). The hand grip test and the Andersen test were categorized as health-related measures. The vertical jump, shuttle run, backward balance, and precision throw were categorized as performance-related measures

Anthropometrics

- Weight was measured to the nearest 0.1 kg on an electronic scale (Tanita BWB-800S; Tanita Corporation, Tokyo, Japan) with the participant wearing light clothes.
- Height was measured to the nearest 0.5 cm using a portable stadiometer (SECA 214; Seca Corporation, Hanover, MD).
- Pubertal stage was assessed by the Tanner self-assessment questionnaire (14,31,32). Girls were asked to indicate both pubic hair and breast development from five pictures representing different pubertal stages. Boys were asked to indicate pubic hair development. The questionnaire was answered by the participant in a private space where there was sufficient time to answer the questions. For the analyses, pubertal stage was dichotomized (Tanner stage 1, prepubertal; Tanner stages 2–5, pubertal) because of few participants being at the pubertal stages of 3, 4, and 5.

Parental Education

Parental education level was derived from parental questionnaires and collapsed into one variable reflecting the highest level of education of the parents, either below Bachelor level or equal to or higher than Bachelor level.

PA

PA was measured by uniaxial accelerometry using the ActiGraph GT3X (Pensacola, FL). The ActiGraph detects acceleration in the vertical, horizontal, and frontal planes, corresponding to differences in levels of intensity and energy consumption (16) and has been found to be both a reliable and valid tool for measuring the level of PA in children (16). In the current study, we used acceleration along the vertical axis.

Participants were asked to wear the ActiGraph for seven consecutive days during waking hours and not to wear the device during water activities. The ActiGraph was worn in an elastic belt around the hips, placed on the right side.

To clean the data for nonphysiological values and to sort out inactivity periods due to nonwear of the device, data were screened in a customized software program (Propero version 1.0.18; University of Southern Denmark, Odense, Denmark). Periods with consecutive strings of "0" for 30 min or longer were classified as nonwear time. Participants with less than 10 $h \cdot d^{-1}$ of registration were excluded because this threshold is commonly accepted to represent "a normal day" (26,45). Only the participants with a minimum of four accepted days were included in the analysis (13,43).

PA was expressed as moderate to vigorous, generated by cut points according to Evenson et al. (16). Differences in total wear time of the ActiGraph were taken into account using the mean percentage of time in moderate-to-vigorous PA (mean MVPA) per day. To control for day type variation in PA, weekend activity was weighted by 2/7, and weekday activity, by 5/7.

Statistics

Descriptive statistics (means and SD) were calculated for all variables. The *T*-test or Wilcoxon rank sum test was used to compare descriptive data between sexes. To examine FMP tests as predictors of mean MVPA per day, multilevel mixed-effects linear regression models were applied because of the hierarchical structure of the data, with participants nested in school classes and school classes nested in schools. The mixed-effects model takes into consideration the interdependence between measurements. The ICC was calculated to examine whether a two-level model was better than a single-level model. The ICC for including school class was 0.075, and the ICC for including school level was 0.0003. Thus, school level did not improve the model fit, and therefore, only school class was included as a random-effect variable.

All analyses were controlled for the following possible confounders at baseline: mean MVPA per day, sex, age, body mass index (BMI), parental educational level, puberty (3,5,8,46), and type of school because the number of physical education lessons per week differed between schools in the CHAMPS study-DK (50).

Checking assumptions for the multilevel mixed-effects linear regression models included checking of the distribution of the residuals. Analyses were performed on single FMP tests and on composite *z*-scores. For each of the FMP variables, a *z*-score was computed as the number of SD units from the sample mean after normalization of the variables,

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i.e., $z = (\text{value} - \text{mean/SD})$. The z-scores were multiplied by −1 if better performance was expressed as lower values to introduce a higher degree of FMP with increasing value. Finally, the z-scores were summed to the composite z-score categories "health-related fitness" or "performance-related fitness" and divided by the number of included variables.

Stepwise model building was performed, and the Akaike information criterion was run on the final random-intercept model and on a corresponding random-slope model. The model with the lowest value of the Akaike information criterion was interpreted as the model with the best fit. Interaction between sex and FMP was tested and taken into account. There were significant interactions between sex and the agility run test, the Andersen test, and the z-score of health-related fitness; thus, in those analyses, we included an interaction term.

Some children had four weekdays but no weekend days of PA data registered, which excluded them from the weighted analyses. We compared analyses including these children with missing data on weekend days with the estimates of children with weighted PA data and found no influential difference in parameter estimates or significance levels. Thus, we chose to include participants with missing weekend days, if they had at least four weekdays of PA data registered, to gain more power. All calculations were performed in the statistical software program STATA 13 (StataCorp, College Station, TX). The level of significance was 0.05.

RESULTS

The descriptive characteristics of the participants are summarized in Table 1. Overall, boys had a significantly higher percentage of time in mean MVPA per day compared with that of girls both at baseline and at follow-up. In general, boys had significantly better FMP scores than girls except for balance score, in which the girls performed better (Table 1). In anthropometrics, only height was significantly different between sexes, boys being taller than girls (Table 1).

The multilevel mixed-effect linear regression showed significant positive associations between baseline and 3-yr follow-up measures in the analyses of the Andersen test and mean MVPA per day (boys, β = 0.008; girls, β = 0.003), vertical jump and mean MVPA per day (β = 0.04), hand grip (β = 0.06), the z-score of health-related fitness and mean MVPA per day for boys (β = 1.09), and the z-score of performance-related fitness and mean MVPA per day (β = 0.58) (Table 2). A significant inverse association was evident between shuttle run and mean MVPA per day for boys (β = −0.26), and for girls (β = −0.13) (Table 2).

In all analyses, the confounder variables of sex and baseline mean MVPA per day were positively and significantly related to follow-up mean MVPA per day. Age had a significant negative influence on follow-up mean MVPA per day in all analyses except for balance where it was nonsignificant. BMI had significant negative influence on follow-up mean MVPA per day in the analysis of hand grip, and high parental education had a significant positive influence on follow-up mean MVPA per day in the analysis of Andersen test.

Postestimations were performed on selected FMP measures using predictive margins to estimate the differences in outcome when the exposure variable changed by 1 SD from the mean value (standardized results are presented in Table 2). The largest effect on mean MVPA per day was found in changes in the Andersen test (Table 2). Thus, decreasing the Andersen test by 1 SD for a boy changed the

TABLE 1. Characteristics of the participants.

	Total (n = 673), Mean (SD)	Girls (n = 375), Mean (SD)	Boys (n = 298), Mean (SD)
Height (cm)*	136.9 (9.5)	136.1 (9.7)	138.0 (9.3)
Weight (kg)	31.9 (7.3)	31.8 (7.7)	32.1 (6.6)
BMI (kg·m^{-2})	16.8 (2.2)	16.9 (2.4)	16.7 (1.9)
Age (yr)	9.2 (1.4)	9.1 (1.4)	9.3 (1.4)
Mean wear time 2009 (d)	6.3 (0.9)	6.2 (1.0)	6.1 (1.0)
Mean wear time 2009 (min·d^{-1})	805.8 (50.4)	801.2 (50.4)	806.9 (52.6)
Mean wear time 2012 (d)	6.3 (1.1)	6.2 (1.2)	6.0 (1.2)
Mean wear time 2012 (min·d^{-1})	829.6 (50.9)	828.4 (49.9)	828.1 (52.4)
Mean % MVPA 2009 (%)**	8.0 (2.5)	7.3 (2.3)	8.8 (2.4)
Mean % MVPA 2009 (unweighted estimates)**	8.1 (2.4)	7.4 (2.3)	9.0 (2.4)
Mean % MVPA 2012 (%)**	6.8 (2.6)	6.1 (2.2)	7.7 (2.9)
Mean % MVPA 2012 (unweighted estimates)	6.9 (2.7)	6.1 (2.2)	7.9 (3.0)
Shuttle run 2009 (s)**	23.7 (2.6)	24.1 (2.6)	23.4 (2.6)
Shuttle run 2012 (s)**	21.8 (2.2)	22.2 (2.2)	21.2 (2.1)
Balance (points)***	47.0 (12.9)	48.6 (12.7)	45.0 (13.0)
Precision throw (points)**	13.2 (4.9)	11.7 (4.8)	14.8 (4.5)
Hand grip (kg)**	17.0 (4.4)	16.1 (4.1)	18.1 (4.6)
Vertical jump 2009 (cm)**	28.6 (6.0)	27.9 (5.4)	29.4 (6.4)
Vertical jump 2012 (cm)**	33.6 (6.5)	32.6 (5.9)	34.9 (6.9)
Andersen test 2009 (m)**	946.7 (103.3)	925.4 (97.0)	968.3 (102.2)
Andersen test 2012 (m)**	1016.8 (114.0)	980.8 (99.5)	1057.5 (115.8)
Maximum parental education (% level 2)****	50.5	49.7	51.3

Data in the table are presented as means and SD.
*Values for boys are significantly higher than those for girls.
**Boys performed significantly better than girls.
***Girls performed significantly better than boys.
****Levels 1 and 2. Level 1 indicates below bachelor level. Level 2 indicates bachelor level and above.
Mean % MVPA, mean percentage of time spent in MVPA.

TABLE 2. Associations between FMP tests from 2009 and mean percentage of time spent in MVPA in 2012.

	n	Coefficient (95% CI)	Standardized Coefficient (95% CI)	*P* Value
Balance (point)	672	0.01 (−0.006 to 0.026)	0.13 (−0.07 to 0.33)	0.206
Precision throw (point)	673	0.04 (−0.006 to 0.09)	0.20 (−0.03 to 0.43)	0.088
Hand grip (kg)	673	0.06 (0.002 to 0.113)	0.27 (0.01 to 0.53)	0.042
Shuttle run* (s)	667			
Boys		−0.26 (−0.42 to −0.11)	0.70 (0.30 to 1.11)	0.001
Girls		−0.13 (−0.22 to −0.04)	0.35 (0.11 to 0.59)	0.004
Vertical jump (cm)	673	0.04 (0.002 to 0.07)	0.23 (0.013 to 0.44)	0.038
Andersen test* (m)	642			
Boys		0.008 (0.005 to 0.012)	0.87 (0.48 to 1.26)	0.000
Girls		0.003 (0.0001 to 0.005)	0.27 (0.01 to 0.54)	0.042
Health-related MP* (*z*-score)	642			
Boys		1.09 (0.52 to 1.66)		0.000
Girls		0.34 (−0.03 to 0.71)		0.068
Performance-related MP (*z*-score)	667	0.58 (0.24 to 0.93)		0.001

All analyses were adjusted for sex, baseline PA, puberty stage, age, BMI, school type, and parental educational level.
For the *P* value, the level of significance was 0.05.
*Significant interaction by sex.
Health-related MP (*z*-score), *z*-score of the items Andersen test and hand grip; performance-related MP (*z*-score), *z*-score of the items balance, shuttle run, vertical jump, and precision throw.

mean MVPA per day, with 0.87 percentage point equivalent to a decrease in mean MVPA per day from 61.7 to 54.0 min.

Noncompliance analysis showed that participants not included in the analysis because of missing data on either baseline PA or follow-up PA differed significantly from included participants on baseline anthropometrics, as included participants were characterized by lower height, lower weight, and lower BMI, were younger, and had a lower pubertal stage. There were no differences in results regarding FMP, except for hand grip, where the excluded participants performed better.

DISCUSSION

This study explored the longitudinal relation between objectively assessed FMP and mean MVPA per day in 6- to 12-yr-old children. A clear positive and significant association was evident between baseline FMP and mean MVPA per day at 3-yr follow-up for the Andersen test, vertical jump, shuttle run, hand grip, the *z*-score of health-related fitness, and the *z*-score of performance-related fitness in both boys and girls. Interaction by sex was observed for several FMP components. There was a tendency toward stronger associations between FMP components and PA for boys than those for girls, and the differences between boys and girls were statistically significant (Table 2).

The clinical importance of the findings primarily depends on the estimated effect sizes—a significant result is not by definition an important result. To assist the interpretation of effect sizes, the change in mean MVPA per day resulting from a change of 1 SD in selected FMP measures was calculated. For boys, an increase in the Andersen test from a mean value of 968 m to a 1 SD better result (1070 m) increased the mean MVPA per day with 0.87 percentage point, equivalent to an increase of 6.9 min spent in MVPA per day (from 61.7 to 69.4 min) or an increase of 54 min of MVPA per week. Correspondingly, girls improved their mean MVPA by 0.27 percentage point, equivalent to 16 $min \cdot wk^{-1}$, because of a significant interaction by sex.

For the shuttle run, a decrease of 1 SD (2.6 s) in running time for boys was related to an increase of 6.0 $min \cdot d^{-1}$ or 42 $min \cdot wk^{-1}$ in mean MVPA per day. These changes in MVPA seem modest considering the relatively large assumed change of 1 SD in FMP; however, some degree of random measurement error should be expected in this type of study, causing us to underestimate the true strength of the association studied. Compared with other potential predictors of PA examined in earlier longitudinal studies, such as self-perception of sports competency, having active parents, and influence by behavioral factors (20), the results of the current study indicate that FMP, and particularly running abilities, could be considered among the predictors, which have shown strongest associations with PA at this point.

The clinical implication also depends on the potential to improve performance of the exposure variables. Intervention studies have shown that children respond to training by improving their performance between 6% and 16% (15,33,34,44). Thus, an increase in the Andersen test from 968 to 1070 m is possible because it is equivalent to an increase of 10%.

Many different definitions of motor performance exist, as do methods for assessing motor performance. Some studies used fundamental movement skills or motor skills, evaluated by tests of coordination, balance, and speed of a sequence of motor tasks (7,28,47). Other studies examined motor performance as physical fitness, measured by power, strength, agility, and cardiovascular fitness (20,25,28). Moreover, the vast majority of earlier studies on the association between FMP and PA have relied on self-report measures of PA, which further limits the comparability between studies. However, despite different tests, the findings are in line with previous studies suggesting that motor performance in general is predictive of PA in longitudinal studies (7,20,28) and associated with PA in cross-sectional studies (21,29,51,52). We did not identify studies quantifying the clinical implications of their findings. Consequently, it was not possible to compare the clinical implications of the current study with those of earlier studies.

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Two summary scores were generated according to the definition of health-related and performance-related fitness put forward by Howley (18) to examine the separate associations with PA for the two concepts. We planned to compare the two components, but because of interactions in the analysis of health-related fitness between sex and the variables included in the health-related *z*-scores (Table 2), the two *z*-scores were not comparable. Because both associations were positive, the estimates from analyses between the single FMP measures and PA were confirmed.

Comparison of the coefficients of the two analyses indicated differences in movement behavior between boys and girls. This is supported by previous studies reporting motor skills to be particularly important in boys in relation to PA (27,35). The reason for this difference between boys and girls is not clear but could be explained by a tendency for girls to focus more on the social aspects of sports whereas boys tend to focus on the competitive element in sports (9,48).

The intensity of PA has been called a predictor of cardiovascular fitness in children (37). The interrelation between PA and the cardiorespiratory component of motor performance generates the question as to whether motor performance is a predictor of PA or whether PA is a predictor of motor performance. *Post hoc* analyses with mean MVPA per day as a predictor of FMP were performed for three FMP tests (shuttle run, vertical jump, and the Andersen test) to examine the reverse pathway, including 768 participants. These analyses showed significant associations between mean MVPA per day and the Andersen test ($\beta = 3.90$; 95% confidence interval (CI), 0.91–6.82) and mean MVPA and the shuttle run ($\beta = -0.08$; 95% CI, -0.13 to -0.02) at 3-yr follow-up. This result was not in line with a study by Baquet et al. (5) who investigated PA as a predictor of FMP (5) using similar methods for assessing FMP as in the current study and assessed PA by self-report. Their study reported PA to be not significantly related to FMP, which may be because of the use of self-report measures of PA instead of objective measures of PA. One SD change in mean MVPA per day corresponded to a 0.2-s change in the shuttle run and an 8-m longer run in the Andersen test, which do not seem clinically relevant. Thus, the relation between FMP and PA seemed to differ according to choice of predictor. It could seem that the clinical importance of FMP as a predictor of PA is greater than the importance of PA as a predictor of FMP. However, the random measurement error might be higher for PA compared with that for FMP, and this could affect the slope coefficient, thus making the mentioned finding less certain (38). Furthermore, previous studies mentioned a possible positive feedback loop between FMP and PA, meaning that interventions with PA will result in higher levels of FMP and *vice versa* (6,41). Thus, the causal relation between FMP and PA is still undetermined.

Strengths and Limitations

The current study is one of the few studies to analyze associations between FMP and PA longitudinally with quantitative and objective measures of both PA and FMP. The chosen tests are all maximal performance tests with satisfactory reproducibility and validity in child populations (2,40). Furthermore, the study had a large sample size.

There are risks of residual confounding because of lack of information on other variables shown to be relevant when examining factors associated with PA, such as behavior and psychosocial factors as friends' behavior, parents' behavior, support, and heredity (9).

Loss to follow-up is known to introduce bias in longitudinal studies if the participants lost to follow-up differ from those who remained. This study was an open study including new participants as new children entered the participating schools, and we actually had close to the same number of children carrying the accelerometer at follow-up as that at baseline (1171 vs 1134). However, even though approximately the same number of children carried the accelerometers at baseline and at follow-up, we experienced a high number of children missing some of the data, resulting in 673 children or 58.7% having all data needed for analyses. In addition, sensitivity analysis on anthropometrics showed significant differences between the included participants and the participants with missing PA measures. The participants with missing PA measures were older, and this way, they were also taller and heavier, had higher mean BMI, and had significantly higher levels of pubertal development. FMP between the included participants and those excluded because of missing PA measures did not differ, except for hand grip where the excluded participants performed better. This might be a limitation of this study because we do not know whether the association between FMP and PA differed between the included and the excluded participants.

The tests for FMP were analyzed as single items and as composite *z*-scores. The ideal tests would be a test battery to measure the motor skill component and another battery to measure the FMP component. It is for future research to determine, describe, and standardize the specific components of motor performance to reach scientific consensus on how to test motor performance in children in a field setting.

Because the CHAMPS study-DK is conducted as a natural experiment, the selection of participating schools was not random. The schools volunteered to participate. This could potentially limit the generalizability of the results.

The analyses were adjusted for age and sex, but they were not standardized for age and sex. Regarding age, this means that it was not taking into account that a 7- and a 12-yr-old child scoring the same on an FMP test would not be at the same level of motor performance relative to their age. Not standardizing for age could have an effect on the apparent associations with PA, and possibly, the same goes for sex.

CONCLUSIONS

Cardiorespiratory fitness, shuttle run, vertical jump, health-related fitness, and performance-related fitness were longitudinally associated with PA in children. The clinical relevance of the results indicates that cardiorespiratory fitness and shuttle run are important skills to perceive in childhood because they affect MVPA in adolescence and perhaps most importantly in boys.

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