Preventive Medicine 189 (2024) 108149

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Secular trends of physical fitness in Austrian children attending sports schools: An analysis of repeated cross-sections from 2006 to 2023

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ARTICLE INFO

Keywords:
Physical fitness
Physical activity
School children
BMI
Trend

ABSTRACT

Background: Physical fitness (PF) offers numerous physical and mental health benefits, especially during childhood. Previous studies investigating trends in children's PF over the years reported contradictory findings.
Objective: To identify and analyse secular trends in PF among Austrian schoolchildren from 2006 to 2023.
Method: A repeated cross-sections design was used to examine the PF of children enrolling in sports schools between 2006 and 2023. During this period, a standardized eight-item motor performance testing battery was administered yearly to capture markers of strength, speed, endurance, agility and reaction time in Austrian schools.
Results: A total of $n = 3827$ children (996 girls) with a mean age of 9.9 ± 1.0 years were included. Linear mixed models indicated significant declines in sprint performance (5, 10, 20 m), tapping, jump (long jump and drop jump), throwing (medicine ball), and agility (snake run). No changes were observed in cardiorespiratory fitness (8 min run) or reaction time.
Conclusion: There has been a steady decline in PF among Austrian children attending sports schools. This finding underscores the need for enhanced PF monitoring and training in schools to improve public health outcomes.

1. Introduction

Physical fitness (PF), commonly promoted by means of regular exercise, is an important component of general health. According to a meta-analysis of 37 cohort studies with 2,258,029 participants, individuals with high cardiorespiratory capacity have a 45 % lower all-cause mortality risk than those with low cardiorespiratory capacity (Laukkanen et al., 2022). The available evidence also suggests that higher cardiorespiratory fitness is associated with lower odds of sustaining mental health disorders and that higher muscle strength reduces all-cause risk of death by 31 % (García-Hermoso et al., 2018).

PF seems to be particularly important in young age. Both, endurance and muscle strength are significant indicators of well-being in children and adolescents (García-Hermoso et al., 2019; Mintjens et al., 2018; Ortega et al., 2008; Tomkinson et al., 2018). An analysis of 58 studies revealed a positive, small-to moderate-magnitude association between PF and mental health in individuals aged 18 and younger (Cadenas-Sanchez et al., 2021). Of note, higher fitness levels during childhood and adolescence correlate with a lower risk of obesity, lower insulin resistance and lower triglyceride concentrations, but a higher bone density during adulthood (García-Hermoso et al., 2019).

In view of the high relevance of PF in early life, several studies have performed repeated motor performance assessments in schools to identify secular trends. The term secular, in this context, insinuates that trends are sustained over a long time and not influenced by short-term factors. Overall, most studies reported progressive declines in PF (Kasović et al., 2021; Li et al., 2023; Nevill et al., 2023; Shigaki et al., 2019; Leone et al., 2022; Radulović et al., 2022), especially with regard to cardiorespiratory fitness, endurance, and strength. However, no consistent trend could be observed for other fitness components such as sprint speed or coordination (Eberhardt et al., 2020a; Masanovic et al., 2020). Ambiguous evidence is also available for flexibility as boys seemed to experience decreases while girls showed increases in two studies (Li et al., 2023; Radulović et al., 2022). Fühner et al. (Fühner

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https://doi.org/10.1016/j.ypmed.2024.108149
Received 27 July 2024; Received in revised form 6 October 2024; Accepted 7 October 2024
Available online 9 October 2024

et al., 2021) investigated PF of children and adolescents from 1972 to 2015. Both muscle strength and speed increased slightly, but proxies of muscle power declined. Besides not yielding consistent findings, the vast majority of PF trend studies claim to have measured secular trends over decades, but in fact, did only compare few cross-sectional assessments (e.g., two measurements in 1970 and 2010, but not yearly measurements from 1970 to 2010) (Đurić et al., 2021; Kryst et al., 2023a; Matton et al., 2007).

The present study aimed to analyse possible changes in PF of children and adolescents in Austria, using a yearly administered test battery. We hypothesized that PF would have declined during the observation period from 2006 to 2023.

2. Materials and methods

2.1. Study design and ethics

Our study adopted a repeated cross-sections (RCS) design. In 2006, a standardized eight-item motor performance testing battery was developed by the Olympic Training Centre Carinthia (Austria) and a local sports organization (ASKÖ). Its purposes were to a) serve as a regular monitoring of secular trends in children and adolescent fitness and b) represent the official admission tests of the secondary sports schools. Testing was performed yearly in March, between 2006 and 2023, capturing data from nine primary and secondary sports schools located in urban and rural areas. Sports schools in Austria are largely similar to regular schools, and anyone who passes the enrolment test can register. However, children attending sports schools have a higher weekly volume of physical education lessons and typically exhibit a stronger interest in sports compared to the general population. Due to some small changes to the testing protocols, data on reaction time, tapping and drop jump only pertain to the period from 2006 to 2021. For all other outcomes, the analysis refers to the full study period (2006 to 2023). Approval was granted by the education directorate of the state of Carinthia. The study followed the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines to ensure comprehensive and transparent reporting.

2.2. Sample

A total of 3852 children (9.9 ± 1 years, 1007 girls) underwent motor performance testing during the study period. However, after removal of incomplete or implausible data ($n = 25$), the final analytical sample consisted of 3827 participants (9.9 ± 1 years, 996 girls). Generally, all pupils were eligible for study inclusion (no random selection). They were screened for relevant health problems using parental reports and school's health records. Exclusion criteria comprised any contraindication for sporting activity, particularly chronic diseases or unhealed sports injuries. Participants were instructed to present rested and to refrain from vigorous physical activity on the two days preceding the testing procedures. Information sheets and consent forms were distributed to the parents or legal guardians, and written informed consent was obtained from both parents/guardians and the children.

2.3. Measurements

The 8-item motor performance testing battery was created using tests from published literature. For the selection of the items, we focussed on both previous validation and easy applicability in field settings. To ensure the reliability and consistency across the study period and the different schools, several standardization procedures were implemented. Test administrators underwent comprehensive initial training and participated in annual refresher courses to maintain uniform administration and measurement practices. Equipment consistency was ensured by using standardized devices and by performing regular calibration and maintenance checks. Testing environments were controlled for factors such as lighting and noise to reduce external influences on performance. Additionally, random audits and meticulous documentation were in place to monitor adherence to protocols and address any deviations, thereby enhancing the accuracy and comparability of the results. All investigators performing the measurements had a degree in sports science or physiotherapy.

2.3.1. 20 m sprint

Sprint time was measured on a 20-m distance on an indoor athletics track, using the high start position. The best from two attempts was considered for analysis. Besides the 20 m time, split times were measured at 5 m and 10 m using timing gates (Brower Timing System/USA). Sprint testing has been demonstrated to be highly reliable (ICC: 0.80–0.99) using the above distances and split times (Altmann et al., 2019).

2.3.2. Standing long jump

To measure explosive leg power, the standing long jump was applied. Children were instructed to adopt the starting position with a hip-width stance and the feet aligned parallel. The participants, standing on a hard surface, had to jump as far as possible in horizontal direction. Arm swing use was allowed. Two double-legged maximal jumps were performed, and the best was analysed. Jumping distance, quantified using tape measures, was determined as the distance between the take-off line and the heel strike of the rear foot during landing. Jump testing reliability has been shown to be high (ICC: 0.94) (Fernandez-Santos et al., 2015).

2.3.3. Reaction time

Four reaction plates (Fitro Reaction, Fitronic, Bratislava) were positioned on a table (10 cm distance) and on the floor in front of the table. A connected screen displayed signals corresponding to the arrangement of the sensors (right/left hand/ft) in random order and irregular intervals ($n = 15$). The participants stood in front of the table and were instructed to press the respective plate as quickly as possible after the signal had appeared. For analysis, the average response time [ms] as well as the number of correct responses were measured. Three reaction times measures (overall, hand, foot) were examined. Reaction tests show good reliability (ICC: 0.92) (Morral-Yepes et al., 2022).

2.3.4. Motor performance speed

A tapping plate (Werthner Sport Consulting KG, Linz) was used to capture motor performance speed. On the instruction to start, participants had to alternatingly lift the left/right foot from the ground, achieving as many foot taps as possible. Three trials were performed, and the best (contacts per time unit/Hz) was used for analysis. Tapping tests have demonstrated good reliability (ICC: $<$0.90) (Chaabouni et al., 2022; Lienhard et al., 2013).

2.3.5. Throwing distance

The starting position was a kneeling lunge (canoe stand) on a thick gym mat. Participants had to hold a medicine ball (weight: 1000 g) behind their head using both hands. They were then instructed to maximally throw it forwards without dodging sideways. The person taking the measurement moved along the measuring tape to precisely determine the bounce point. The best of three attempts was counted, using the distance [cm] from the drop line to the landing point of the medicine ball. Test of the medicine ball throw have shown high reproducibility (ICC: $<$0.90) (Fernandez-Santos et al., 2016; de Leite Maf et al., 2020).

2.3.6. Drop jump

The drop jump test was used to measure reactive strength and explosive force generation. The children stood on a 30 cm-block positioned directly behind a contact mat (Werthner Sport Consulting KG, Linz). With the hands fixed at the hip, the children dropped onto the mat, and immediately jumped straight up. They were instructed to keep the ground contact as short as possible. Three trials were performed and the best trials with the shortest contact time [ms] was used for analysis. Drop jump testing is highly reliable in children and adolescents (ICC: <0.90) (Celik et al., 2024; Dukarić et al., 2021).

2.3.7. Snake run

Three hurdles (height: 30 cm, width: 1.45 m) were set up in a row, with a 1-m distance in between. The hurdles adopted a 90° angle with regard to the start line, thus facing away from it. After running from the start line to the first hurdle (1.3 m), participants were instructed to turn and jump over the first hurdle. They then had to turn again, run through the space between the first and the second hurdle and repeat the procedure (turn, jump over hurdle, run through the space between hurdles). After having jumped over the third hurdle and completing 2.5 m to the turning point, the task was repeated on the way back. Two attempts were performed and the best (time in seconds measured with timing gates) was used for analysis. The snake run displays good reliability (ICC:>0.90) (Artero et al., 2011).

2.3.8. 8 min run

A 60 m track, marked with cones, was used for an 8-min run. Participants had to complete as many rounds as possible during the available. Distance covered in meters was documented. Moderate validity has been demonstrated for alike assessments ($r = 0.71$) (Batista et al., 2017).

2.4. Statistical analysis

The normal distribution of means and residuals (as appropriate) was tested by means of the Shapiro–Wilk test. A linear mixed model (LMM) was fitted with restricted maximum likelihood (REML) to examine changes in PF between the annual assessments. School was entered as a random effect to account for potential effects of clustered data, and time (2006–2023) was modelled as a fixed effect. As normality testing and QQ-Plots revealed a skewed distribution and kurtosis in some cases (drop jump, medicine ball, sprint 5 m, 10 m, 20 m, reaction time, snake run), bootstrapping (k = 500 bootstrap samples) was applied as needed to ensure that testing requirements were met. Both, unadjusted and adjusted analyses, correcting for sex, age, and BMI, were performed. The significance level was set to $\alpha = 0.05$. Data analyses were performed using JAMOVI, version 2.3 (https://www.jamovi.org).

3. Results

The sample comprised 3827 children, including 2831 boys and 996 girls, with a mean age of 9.9 ± 0.8 years for boys and 9.9 ± 0.9 years for girls. Regarding the developmental status, 85 % of the children were classified as normal, 14.8 % as accelerated, and 0.3 % as retarded (Table 1).

3.1. Anthropometric trends

Children showed significant increases in weight, height, and BMI ($p < 0.001$). According to the LMM analysis, weight increased by 0.20 kg/year, height by 0.17 cm/year, and BMI by 0.04 units/year (Table 2). These findings reflect a consistent upward trend in anthropometric measures across the study period.

3.2. Physical fitness trends

Physical fitness parameters mostly declined during the study period ($p < 0.05$, Fig. 1, Table 2). LMM demonstrated performance reductions regarding sprint times for 5 m (+0.01 s/year), 10 m (+0.01 s/year), and 20 m (+0.01 s/year), long jump distance (−0.44 cm/year), drop jump contact time (+1.71 ms/year), tapping speed (+0.02 Hz/year), throwing ability (−2.05 cm/year) and snake run time (+0.06 s/year). However, reaction time (+0.25 ms/year) and 8-min run performance (−0.76 m/ year) remained stable ($p > 0.05$). The results of the adjusted analysis were similar. Again, decreases in motor function were found for all parameters except for reaction time and the 8-min run. However, effect estimates tended to be slightly smaller (Table 3).

4. Discussion

The objective of the present study was to identify secular trends in the PF of Austrian children attending sports schools. Previous research had yielded mixed results, reporting declines (Nevill et al., 2023; Đurić et al., 2021; Kryst et al., 2023a; Dos Santos et al., 2015), no declines (Huotari et al., 2010; Knaier et al., 2023; Potočnik et al., 2020), or contradictory findings (Eberhardt et al., 2020a; Führer et al., 2021; Nebiker et al., 2023; Roth et al., 2010; Schlag et al., 2021). Our study represents one of the first and largest serial assessments using yearly cross-sections over a period of almost 20 years. Of note, we identified

Table 1
Descriptive statistics of participant characteristics among Austrian schoolchildren, stratified by benchmark years (2006, 2014, 2020) and averaged over the study period from 2006 to 2023.*

Measure	Year	Boys (n)	Mean (SD)	Girls (n)	Mean (SD)	Total (n)	Mean (SD)
Age (years)	2006	219	9.79(0.6)	40	9.94(1.03)	259	9.81 (0.71)
	2014	147	9.96(0.8)	52	9.75(0.7)	199	9.9(0.8)
	2020	136	10.1(1.0)	65	10.4(1.2)	201	10.2(1.3)
	Overall (2006–2023)	2831	9.93(0.8)	996	9.94(0.9)	3827	9.93(0.8)
Weight (kg)	2006	211	35.9(6.6)	37	33.9(6.7)	248	35.6(6.7)
	2014	135	35.6(6.8)	50	35(7.8)	185	35.4(7.0)
	2020	128	39.7(5.7)	61	38.1(11.0)	189	38(9.9)
	Overall (2006–2023)	2094	37(7.9)	758	36.1(8.21)	2852	36.8(8)
Height (cm)	2006	211	143(6.4)	38	143(6.8)	249	143(6.5)
	2014	136	144(7.5)	51	142(6.3)	187	144(7.2)
	2020	128	146(9.1)	61	146(9.5)	189	146(9.2)
	Overall (2006–2023)	2289	144(7.2)	831	144(7.7)	3120	144(7.4)
BMI	2006	210	17.5(2.5)	36	16.4(1.9)	246	17.4(2.5)
	2014	133	17.1(2.1)	50	17.2(3.2)	183	17.1(2.4)
	2020	126	18.3(3.0)	60	17.7(3.0)	186	18.1(3)
	Overall (2006–2023)	2063	17.7(2.7)	744	17.4(2.8)	2807	17.6 (2.8)
Developmental categories	2021–2023						
Normal		364		148		512	
Accelerated		76		11		87	
Retarded		1		1		2	

kg = kilogram, cm = centimetres, BMI = Body Mass Index, SD = standard deviation.
* From 2021 to 2023.

Table 2
Unadjusted trends of anthropometric measures and motor performance among schoolchildren in Austria from 2006 to 2023, analysed using linear mixed models.

	Mixed models omnibus test			Fixed effect (year) parameter estimate		
	F	R^2 marginal	R^2 conditional	Estimate	95 % CI	p
Anthropometrics						
Weight	40.2	0.01	0.05	0.20	0.13 to 0.26	<0.001
Height	32.6	0.01	0.03	0.17	0.09 to 0.19	<0.001
BMI	17	0.00	0.04	0.04	0.02 to 0.06	<0.001
Motor function						
5 m sprint	297	0.07	0.18	0.01	0.00 to 0.00	<0.001
10 m sprint	147	0.04	0.09	0.01	0.00 to 0.00	<0.001
20 m sprint	105	0.03	0.04	0.01	0.00 to 0.01	<0.001
Long jump	52.2	0.01	0.01	−0.44	0.56 to 0.32	<0.001
Drop jump*	112	0.03	0.04	1.71	1.39 to 2.02	<0.001
Reaction overall*	0.04	1.57	0.00	0.25	−1.97 to 2.48	0.82
Reaction foot*	3.18	0.98	0.00	2.25	−0.23 to 4.72	0.08
Reaction hand*	0.00	2.2	0.00	0.09	−2.10 to 2.29	0.93
Tapping*	13.4	0.00	0.00	0.02	0.01 to 0.04	<0.001
Medicine ball	55	0.01	0.02	−2.05	−2.6 to −1.51	<0.001
Snake run	252	0.06	0.09	0.06	0.05 to 0.07	<0.001
8 min run	2.25	5.79	0.06	−0.76	−1.79 to 0.24	0.13

* Data from 2006 to 2020, BMI = body mass index, *p*-values were calculated using Wald tests for fixed effects in mixed models.

decreases in most tested fitness parameters and our adjusted analysis shows that these decreases were robust with regard to factors such as age, sex, and BMI.

Reductions were particularly consistent in strength and power capacities. The performance decrements seen in the drop and long jump are in line with the available literature (Fraser et al., 2019; Hardy et al., 2018; Müllerová et al., 2015; Sandercock et al., 2015). Interestingly, Kocić et al. (Kocić et al., 2019) pointed out that an increase in height (which we observed) should normally have a positive influence on long jump distance. Possibly, resulting improvements were masked by the parallel increase in the BMI which may not have been related to a higher lean but rather a higher fat mass. Like the development of lower body strength, also the reduction in upper limb strength is in accordance with the available evidence (Cohen et al., 2011; Sandercock and Cohen, 2019). While Cohen et al. (Cohen et al., 2011) reported annual declines of 1.3 % for boys and 2.3 % for girls, Sandercock et al. (Sandercock and Cohen, 2019) found a reduction in bent-arm-hang of 48 % in boys and 31.4 % in girls from 1998 to 2014.

Although our results are largely consistent with previous studies on strength measures, we demonstrate a notable contrast in cardiorespiratory fitness, which has been the most studied component of PF in children and adolescents (Ortega et al., 2008; Falk et al., 2018; Marques et al., 2021). A bulk of literature reported declines of CF in children and adolescents (Shigaki et al., 2019; Leone et al., 2022; Dos Santos et al., 2015; Sandercock et al., 2015; de Moraes Ferrari et al., 2013; Eberhardt et al., 2020b) and these have been attributed to sedentary behaviour, a low total exercise time of children, and altered body composition (Mintjens et al., 2018; de Moraes Ferrari et al., 2013). Our study, however, did not reveal indications of a CF reduction as performance in the 8 min run seemed fairly constant during the study period. Interestingly, Tomkinson et al. (Tomkinson et al., 2019) demonstrated that the global decrease of CF has slowed and Nebiker et al. (Nebiker et al., 2023) showed negligible changes in CF over the past eight years, which would fit with our data.

In contrast to strength and endurance, changes in speed, coordination, and agility have been investigated far less. This may also be related to a lack of standardized or recurring test formats (Knaier et al., 2023). Previous studies on speed yielded inconsistent findings including both increases (Moliner-Urdiales et al., 2010; Spengler et al., n.d.) and decreases (Dos Santos et al., 2015; Müllerová et al., 2015). Our result of worse performance in the sprint and tapping tests speak to the latter. Recent literature has also been inconsistent for agility, as increases (Huotari et al., 2010; Moliner-Urdiales et al., 2010) and decreases (Dos Santos et al., 2015) were found. While our data, based on results of the snake run, support the assumption of a performance reduction, both assessment and interpretation of agility remain a challenge (Knaier et al., 2023; Eberhardt et al., 2020b).

Except for endurance, the only other outcome without a decline was reaction time. A plethora of studies reported a correlation between PA and cognitive function (Bidzan-Bluma and Lipowska, 2018) and it is assumed that the general decline in PA seen over the past decades (Guthold et al., 2020; van Sluijs et al., 2021) would go alongside worse cognitive performance. However, the opposite is the case, as cognitive function has improved over the years (Westfall et al., 2018; Woods et al., 2015). This particularly applies to reaction time (Knaier et al., 2023; Castel et al., 2005). It has been argued that the use of digital technologies, i.e., video games on computers, tablets, or smartphones, promotes faster reaction times in response to visual stimuli (Knaier et al., 2023; Castel et al., 2005). Yet, with regard to our sample, it remains speculative if video-gaming has counteracted the negative consequences of PA reductions because neither the usage of digital technology nor the amount of accumulated PA were assessed. Notwithstanding, both variables may be considered in future studies.

Our study has implications for clinical practice, particularly when contextualized internationally. The observed decline in most components of PF seemingly reflects a broader global trend: research from various countries found similar decrease in PF among children (Dos Santos et al., 2015; Müllerová et al., 2015; Eberhardt et al., 2020b; Kryst et al., 2023b). In view of the strong associations between PF and physical/mental health (García-Hermoso et al., 2019; Ortega et al., 2008; Cadenas-Sanchez et al., 2021), the protective effect of PF against diverse major non-communicable diseases (García-Hermoso et al., 2018; García-Hermoso et al., 2019; Mintjens et al., 2018) and the high relevance of early-life PA for lifetime PA (Fernandez-Jimenez et al., 2018), efforts need to be made to stop the ongoing reductions in fitness. The identification of children with low levels of PF has been demonstrated to be an economically efficient strategy to counteract future lifestyle-related diseases and effective in filtering out developmental deficits (Lopes et al., 2020; McIntosh et al., 2000). This is particularly relevant because school has worldwide been shown to be an excellent setting for PA promotion and related interventions such as active breaks, active transport, extracurricular PA programs, and the design of an activity-friendly school environment have been proven effective (Carson et al., 2014; Kriemler et al., 2011; Webster, 2022). Of note, there is not only strong evidence for the positive effects of school-based interventions (Kriemler et al., 2011; Erwin et al., 2013; Messing et al., 2019; Yuksel et al., 2020), but it has also been shown that these reach children and adolescents regardless of their socioeconomic background (Lopes et al.,

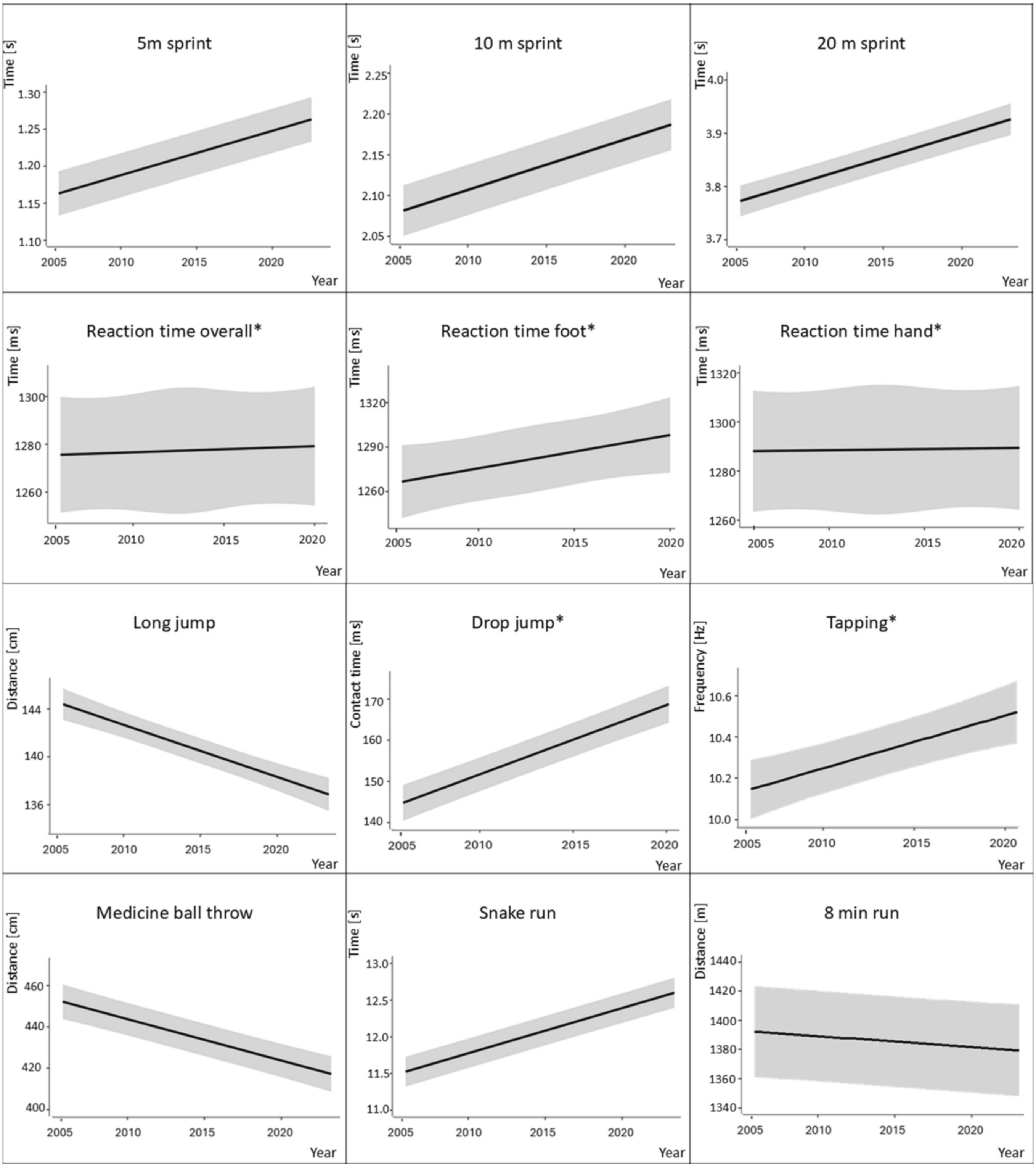

Fig. 1. Trends in the development of physical fitness among schoolchildren in Austria from 2006 to 2023, analysed using linear mixed models with 95 % confidence intervals.
*Data from 2006 to 2020.

2020; Lai et al., 2014; McGrane et al., n.d.; Morgan et al., 2013).

Finally, it needs to be considered that our study sample comprised children from sports schools. Given that this cohort can be expected to have a particular interest in physical activity, exercise, and fitness, the observed trend of progressively declining fitness seems even more alarming. Consequently, it is plausible that schoolchildren attending regular schools, who may not share the same level of engagement in these activities, could exhibit even more pronounced declines in fitness.

Some methodological issues merit consideration. It is a particular strength of our study that we – contrarily to earlier works – present data from a large sample collected over almost 20 years. Yet, despite the intriguing results, it would have been of value to examine further

Table 3
Adjusted trends of anthropometric measures and motor performance among schoolchildren in Austria from 2006 to 2023, analysed using linear mixed models.

		Mixed models omnibus test			Fixed effect parameter estimates		
		F	R^2 marginal	R^2 conditional	Estimate	95 % CI	p
Motor function	Fixed effects						
5 m sprint	Year	99.22	0.04	0.17	0.01	0.00 to 0.00	<0.001
	Sex	11.04			0.01	0.00 to 0.0	<0.001
	BMI	25.36			0.00	0.00 to 0.00	<0.001
	Age	8.01			−0.00	−0.01 to −0.00	0.005
10 m sprint	Year	49.63	0.03	0.09	0.01	0.00 to 0.00	<0.001
	Sex	12.71			0.02	0.01 to 0.03	<0.001
	BMI	31.57			0.00	0.00 to 0.00	<0.001
	Age	7.79			-0.01	-0.01 to −0.00	0.005
20 m sprint	Year	38.70	0.04	0.05	0.01	0.00 to 0.00	<0.001
	Sex	26.30			0.06	0.03 to 0.83	<0.001
	BMI	42.70			0.01	0.00 to 0.01	<0.001
	Age	18.30			−0.02	-0.03 to −0.01	<0.001
Long jump	Year	15.40	0.03	0.03	−0.30	-0.45 to −0.15	<0.001
	Sex	42.20			−5.53	-7.19 to −3.86	<0.001
	BMI	40.20			−0.86	-1.13 to −0.59	<0.001
	Age	11.50			1.44	0.61 to 2.28	<0.001
Drop jump*	Year	100.64	0.05	0.08	1.72	1.39 to 2.06	<0.001
	Sex	8.76			4.98	1.68 to 8.28	0.003
	BMI	34.29			1.59	1.06 to 2.12	<0.001
	Age	1.36			−0.99	-2.65 to 0.67	0.243
Reaction overall*	Year	0.02	8.81	0.00	0.16	−2.25 to 2.58	0.893
	Sex	0.00			−0.66	−24.65 to 23.32	0.957
	BMI	0.47			−1.35	−5.24 to 2.53	0.493
	Age	1.57			−7.65	−19.63 to 4.31	0.21
Reaction foot*	Year	2.35	0.00	0.00	2.12	-0.59 to 4.83	0.125
	Sex	0.06			3.44	-23.53 to 30.42	0.803
	BMI	1.20			−2.44	-6.80 to 1.93	0.274
	Age	0.95			−6.68	-20.14 to 6.77	0.33
Reaction hand*	Year	0.01	8.96	0.00	−0.10	−2.51 to 2.29	0.93
	Sex	0.01			−1.07	−24.85 to 22.69	0.929
	BMI	0.16			−0.78	−4.63 to 3.07	0.691
	Age	1.93			−8.43	−20.32 to 3.46	0.165
Tapping*	Year	441.39	0.10	0.20	−0.24	−0-27 to −0.22	<0.001
	Sex	0.20			−0.05	−0.30 to 0.19	0.653
	BMI	1.32			−0.02	−0.06 to 0.01	0.251
	Age	3.08			0.11	-0.01 to 0.26	0.079
Medicine ball	Year	28.90	0.05	0.05	−1.84	−2.51 to −1.17	<0.001
	Sex	22.70			−17.97	−25.36 to −10.59	<0.001
	BMI	50.00			4.28	3.09 to 5.46	<0.001
	Age	38.80			11.70	8.02 to 15.39	<0.001
Snake run	Year	102.30	0.07	0.08	0.04	0.03 to 0.05	<0.001
	Sex	46.74			0.36	0.25 to 0.46	<0.001
	BMI	42.32			0.05	0.03 to 0.07	<0.001
	Age	4.83			−0.05	-0.11 to −0.00	0.028
8 min run	Year	0.04	0.03	0.06	0.00	−0.01 to 0.13	0.84
	Sex	24.96			−0.34	−0.47 to −0.20	<0.001
	BMI	69.10			−0.09	-0.11 to −0.06	<0.001
	Age	1.03			−0.03	-0.10 to 0.03	0.309

* Data from 2006 to 2020, BMI = body mass index, p-values were calculated using Wald tests for fixed effects in mixed models.

potential confounders like socioeconomic status, parental fitness levels, dietary habits, or environmental factors which all have been shown to be associated with fitness and/or physical activity (Juneau et al., 2015; Ombrellaro et al., 2018). Future analyses looking into trends over time should therefore consider adjusting for these factors. In addition, although we assessed reaction time, which is as part of the basic cognitive functions, it would also have been interesting to include measures of executive functions as these are closely related to motor capacity (Bidzan-Bluma and Lipowska, 2018).

5. Conclusion

Over the past decades, Austrian schoolchildren have shown a consistent decline in PF, with notable reductions in strength, power, and speed, though endurance and reaction time remained relatively unaffected. These findings underscore two critical points: first, the necessity of early and ongoing monitoring of PF in young populations, and second, the imperative to implement and promote regular exercise interventions designed to enhance overall fitness. Addressing these issues proactively is essential for reversing the trend and ensuring the long-term health and performance of future generations.

Credit authorship contribution statement

Alexandra Unger: Methodology, Formal analysis, Writing – original draft. **Walter Reichel:** Conceptualization, Investigation, Resources, Data curation, Writing – review & editing. **Katrin Röttig:** Conceptualization, Investigation, Resources, Data curation, Writing – review & editing. **Jan Wilke:** Methodology, Formal analysis, Writing – review & editing, Supervision, Visualization.

Declaration of competing interest

The authors declare no conflict of interest.

No financial disclosures were reported by the authors of this paper.

This research did not receive any specific grant from funding

agencies in the public, commercial, or not-for-profit sectors.

Data availability

Data will be made available on request.

Acknowledgements

The authors thank Gregor Kastner for providing support in data analysis. The authors further thank the involved persons organizing and carrying out the PF assessments: Sven Gratzer, Renate Macher–Meyenburg, Hannes Wolf, Michale Eder Michael. The Authors would like to thank the schools, children and their guardians/ teachers that gave their time to our study.

Appendix A. STROBE statement — Checklist of items that should be included in reports of *cross-sectional studies*

	Item no	Recommendation	Page no
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	p.1/2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	p.2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p.4
Objectives	3	State specific objectives, including any prespecified hypotheses	p.4
Methods			
Study design	4	Present key elements of study design early in the paper	p.4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p.4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	p.5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p.5,6,11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	p.6,7,8
Bias	9	Describe any efforts to address potential sources of bias	n/a
Study size	10	Explain how the study size was arrived at	p.5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p.8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	p.8
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	n/a
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	n/a
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—Eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	n/a
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	p.5
		(b) Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	15*	Report numbers of outcome events or summary measures	p.8–9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95 % confidence interval). Make clear which confounders were adjusted for and why they were included	p.8
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) if relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—Eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	p.9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p.11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p.9,10,11
Generalisability	21	Discuss the generalisability (external validity) of the study results	p.11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p.13

* Give information separately for exposed and unexposed groups.

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