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Secular trend of 30 years of agility and speed of girls from Ilhabela

Tendencia secular de 30 años de agilidad y velocidad de las niñas de Ilhabela

Tendência secular de 30 anos de agilidade e velocidade das meninas de Ilhabela

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ABSTRACT

Objective: to describe the 30-year secular trend of the neuromotor variables agility and speed of girls from Ilhabela. **Methods:** the study is part of the Mixed Longitudinal Growth and Development Project of Ilhabela. The convenience sampling consisted of 511 girls - focused on data obtained in four periods: 1988 (n=132), 1998 (n=166), 2008 (n=147), and 2018 (n=66) - aged between 10 and 11 years old. The following variables were analyzed: Weight, Height, Agility, Shuttle Run Test, and 50-meter Sprint Speed Test. One-Way ANOVA was used, followed by Scheffé's post hoc test, with a significance level of p<0,05. **Results**: when analyzing the speed, we could observe a null secular trend in the comparison between the first and last decades. In terms of agility, there was a significant difference when comparing the years 1988/89 with 1998/99 and 2008/09, respectively. In addition, the comparison between 1998/99 and 2018/19 was significant, showing a positive secular trend in this variable. **Conclusion:** the results showed a positive secular trend only in the agility variable, showing that children became less agile over the years.

Descriptors: Physical Fitness; Physical Fitness Tests; Students; Child; Brazil.

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RESUMEN

***Objetivo**: describir la tendencia secular de 30 años de las variables neuromotoras agilidad y velocidad en niñas de Ilhabela. **Métodos**: el estudio forma parte del Proyecto de Crecimiento Mixto y Desarrollo Longitudinal de Ilhabela. El muestreo por conveniencia estuvo compuesto por 511 niñas - centrado en datos obtenidos en cuatro períodos: 1988 (n=132), 1998 (n=166), 2008 (n=147) y 2018 (n=66) - con edades comprendidas entre 10 y 11 años. viejo. Se analizaron las siguientes variables: Peso, Talla, Agilidad, Test de Shuttle Run y Test de Velocidad Sprint de 50 metros. Se utilizó ANOVA unidireccional, seguido de la prueba post hoc de Scheffé, con un nivel de significancia de p<0,05. **Resultados**: al analizar la velocidad, pudimos observar una tendencia secular nula al comparar la primera y la última década. En términos de agilidad, hubo una diferencia significativa cuando comparamos los años 1988/89 con 1998/99 y 2008/09, respectivamente. Además, la comparación entre 1998/99 y 2018/19 fue significativa, mostrando una tendencia secular positiva en esta variable. **Conclusión**: los resultados mostraron una tendencia secular positiva sólo en la variable agilidad, mostrando que los niños se volvieron menos ágiles con el paso de los años.*

***Descriptores**: Aptitud Física; Pruebas de Aptitud Física; Estudiantes; Ninõs; Brasil.*

RESUMO

***Objetivo**: descrever a tendência secular de 30 anos das variáveis neuromotoras agilidade e velocidade em meninas de Ilhabela. **Métodos**: o estudo faz parte do Projeto Misto de Crescimento e Desenvolvimento Longitudinal de Ilhabela. A amostragem por conveniência foi composta por 511 meninas - focada em dados obtidos em quatro períodos: 1988 (n=132), 1998 (n=166), 2008 (n=147) e 2018 (n=66) - com idades entre 10 e 11 anos. velho. Foram analisadas as seguintes variáveis: Peso, Altura, Agilidade, Shuttle Run Test e Sprint Speed Test de 50 metros. Foi utilizada ANOVA One-Way, seguida do teste post hoc de Scheffé, com nível de significância de p<0,05. **Resultados**: ao analisar a velocidade, pode observar uma tendência secular nula na comparação entre a primeira e a última década. Em termos de agilidade, houve diferença significativa ao comparar os anos 1988/89 com 1998/99 e 2008/09, respectivamente. Além disso, a comparação entre 1998/99 e 2018/19 foi significativa, mostrando uma tendência secular positiva nesta variável. **Conclusão**: os resultados mostraram tendência secular positiva apenas na variável agilidade, indicando que as crianças se tornaram menos ágeis com o passar dos anos.*

***Descritores**: Aptidão física; Testes de Aptidão Física; Estudantes; Criança; Brasil.*

INTRODUCTION

Health scholars have always been concerned with understanding human growth and development, following its characteristics and changes, both internal and external, enabling the establishment of parameters for the dimensional and functional changes that occur throughout the growth and development process[1]. Physical fitness has elements related to health and performance, and the interaction between fitness components related to health and physical activity are more focused on cardiorespiratory endurance capacities, strength, muscular

endurance, flexibility, and body composition[2].

Motor development has a sequential order, similar in all children[3], related to the improvement of motor control from birth to adulthood[4]. The maturation process is used to describe the events that mark the beginning and end of human development[5]. The environment in which children live, their food, their space for games, their opportunity for socialization, and their formal education, among others, constitute a series of elements that influence the child's development[6]. The benefits of sports practice confirm the development of physical capacities such as cardiorespiratory endurance, strength, flexibility, and speed, in addition to stimulating agility[7].

Studies show that the practice of physical activity has an influence on physical fitness indicators and is considered a useful health marker starting in childhood through adolescence. Its improvement is even a major factor in health promotion[8,9]. In turn, speed is a performance-oriented physical fitness variable since it is a fundamental component of many sports[10]. In this sense, agility, which is dependent on speed, is characterized by rapid changes in direction and changes in the center of gravity[10].

In the epidemiological literature, it is possible to observe the use of secular trend analysis to verify the temporal variations of physical fitness variables, referring to the analysis of current values in relation to previous years, which may be positive, null, or negative[11]. A systematic review study of temporal trends containing a sample of 10,940,801 children and adolescents between 1960 and 2017 observed an increase in long jump in sample groups of boys and girls from Australia, Belgium, Bulgaria, Canada, China, Czech Republic, Estonia, Finland, France, Germany, Greece, Iceland, Israel, Italy, Japan, Lithuania, Mozambique, New Zealand, Poland, Republic of Korea, Singapore, Slovakia, Slovenia, Spain, Taiwan, Thailand, Turkey, United Kingdom and USA[12]. However, Masanovic et al[13] showed a decrease in neuromotor variables (strength and endurance) from 1969 to 2017. In addition, a recent systematic review pointed to a drop in cardiorespiratory resistance from 1977 to 2015[14].

A three-decade review[15] of the Mixed-Longitudinal Growth, Development and Physical Fitness Project of Ilhabela found that puberty

and growth of Ilhabela schoolchildren over the decades show little change in sexual maturation, but a significant increase in adiposity, especially among those overweight, and a positive secular trend at that time. Cardiorespiratory fitness decreased considerably, as indicated by a drop in VO2max values between 1978/80 and 2008/10, possibly due to increased sedentary behavior[16]. Furthermore, in a comparison of the physical fitness of schoolchildren from Ilhabela, a region of low socioeconomic status, with other richer regions, it was found that Brazilian girls had significantly lower anaerobic performance than French girls, due to less participation in regular physical activities[17]. Studies with the same students highlight that girls tend to be more sedentary than boys. Despite recommendations of at least 60 minutes of moderate to vigorous physical activity daily for children, many still do not reach this minimum. Public policies are essential to promote physical activity, such as the construction of cycle paths in Ilhabela, which significantly increased the population's level of physical activity, and programs such as Agita Ilhabela, derived from Agita São Paulo, encouraging active lifestyles.

We hypothesize that over time, females suffered from a decrease in neuromotor variables related to health and performance. Therefore, the aim of the study was to describe the 30-year secular trend of the neuromotor variables of agility and speed of girls from Ilhabela.

METHOD

In Brazil, one of the first initiatives to study physical growth and human motor performance over time was carried out within the scope of the Mixed Longitudinal Growth and Development Project of Ilhabela, coordinated by The Study Center of the Physical Fitness Laboratory of São Caetano do Sul (CELAFISCS)[18].

Due to the lack of resources in Latin America, simple and low-cost techniques were adopted, applicable to large groups and scientifically valid, creating a "battery of tests" to evaluate general physical fitness. With the collaboration of interns and trained instructors, approximately 15,000 schoolchildren from the São Caetano do Sul public school system and 3,000 sportspeople were evaluated. Initially, the objective was to determine the “normal standards” of physical fitness,

but due to the high socioeconomic standard of São Caetano, more representative data from Brazil was sought. In 1977, a pilot project in São Sebastião showed no major differences in results, leading to the creation of the Mixed-Longitudinal Project of Ilhabela in 1978, focused on a community with more stable migratory characteristics. Methodological details, data collection, and additional information have been previously published[18]. The project was approved by the *Comitê de Ética da Universidade Federal de São Paulo* (UNIFESP) under protocol nº 0056/10.

Ilhabela is located on the north coast of São Paulo, Brazil, covering an area of 348 square kilometers. The city has an estimated population of 34,934 inhabitants with 5,331 students enrolled in elementary education[19].

Data collection began with authorization from the Ilhabela Municipal Education Department, followed by communication with the school board, teaching staff, students and family members. The project team informed about the objectives and procedures of the study, and authorizations were obtained through informed consent, signed by parents or legal guardians. Assessments took place twice a year, in April and October, on three consecutive days (Thursday, Friday and Saturday).

The children were recruited by convenience in three school units of Ilhabela, two municipal schools (one for early childhood education and one for elementary school II) and a state school (high school). These schools have been monitored over the last 46 years, located in the same neighborhood and location, which over time have undergone several architectural and environmental changes, such as paving, afforestation and signage. All schools have a standardized structure, including covered sports courts, classrooms equipped with fans and air conditioning, a teachers' room, and a nutritious diet.

Furthermore, for more than 10 years, these schools have had accessible infrastructure, with elevators and ramps. Although there are changes in physical education teachers due to municipal public education tender, all physical education professionals in the areas of education and sport are trained every six months by the center's team of teachers and researchers. Furthermore, there were no changes to the Political-Pedagogical Project (PPC) of the schools investigated.

The data collection team was made up of professionals from different

areas, including physical education teachers, nutritionists, physiotherapists and doctors. All team members were previously trained to ensure the uniformity and accuracy of the measurements collected. In addition to professionals, students from health-related areas and local volunteers (school directors and staff) also participated, offering logistical and operational support.

The study has a longitudinal design, with analysis of the secular trend. It is worth emphasizing that, throughout the project, the CELAFISCS standardization protocol has always been respected[20] regarding the process of data collection. One of the characteristics of this project is the use of unsophisticated and low-cost instruments that facilitate the application in large groups but with adequate degrees of validity, reproducibility, and objectivity. The reproducibility and objectivity values of each measurement performed between the years ranged from 0.96 to 0.99 for body weight, 0.97 to 0.99 for height, and 0.81 to 0.99 for skinfolds[21].

To compose the sample of this study, a pre-established database was used according to the following eligibility criteria (Figure 1). The final sample consisted of students who met the following inclusion criteria: (a) female; (b) aged between 10 and 11 years old; (c) have at least one assessment in the initial periods (1988/89), 10 years (1998/99), 20 years (2008/09) and 30 years (2018/19) including name, and date of birth; (d) data referring to anthropometric variables such as weight, height and neuromotor: speed and agility; and the following exclusion criteria: a) exercise restrictions; b) impaired physical mobility; c) diagnosed mental disorders and d) Absence of the Free and Informed Consent Form signed by the parents/ guardian.

The initial sample had 580 girls between 10 and 11 years old, and after the inclusion and exclusion criteria, the final sample was 511 girls (Figure 1). According to the demographic census, children enrolled in primary education, 5th year, in 2008 there were 533, in 2009 there were 591, 2018 was 540 and 2019 was 611[19].

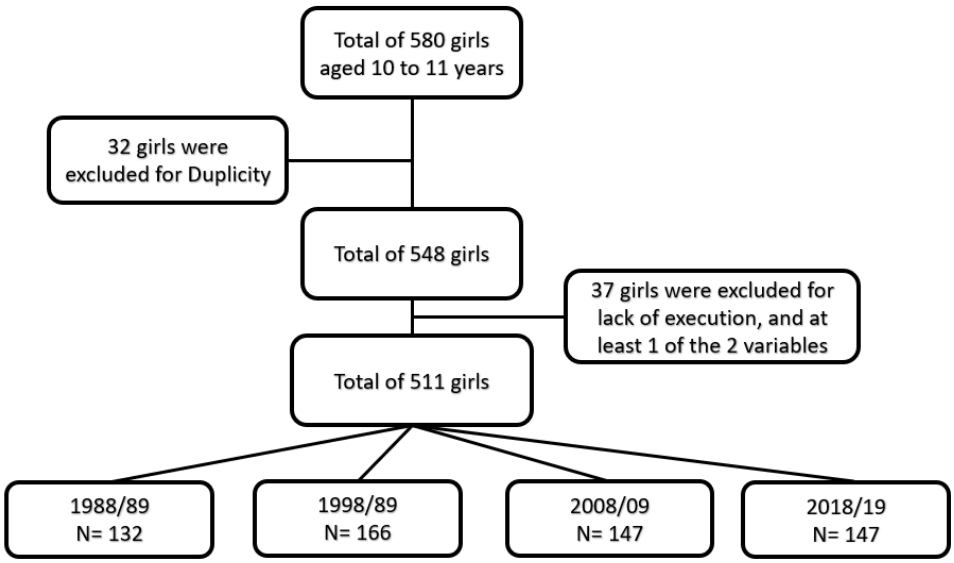


Figure 1 - Flowchart for the selection of students from Ilhabela.

During the four periods investigated, there were changes in half of the evaluation team. However, all new evaluators, made up of health professionals such as physical educators, doctors and nutritionists, underwent rigorous training on tests and measurements, following all stipulated protocols. The research protocol was maintained consistently throughout the project.

The tests were carried out on the premises of the participating schools, specifically on the courts and open spaces. Eligibility criteria included the absence of medical conditions that could be aggravated by exercise. In case of any complications, the children were immediately removed from the tests and evaluated by a health professional. School teachers were involved to help organize and supervise children during activities, ensuring a controlled and safe environment. The tests took place in the morning and afternoon, generally between 8 am and 5 pm, without restrictions or specific guidelines regarding food and hydration, allowing students to follow their normal routine during the school period. Each data collection session lasted approximately 30 minutes per child, ensuring a detailed and systematic assessment.

All children aged between 10 and 11 years old were recruited to carry out measurements and tests. Although all students were evaluated, the study excluded, for research purposes, children with exercise restrictions, impaired physical mobility or diagnosed

mental disorders. These exclusions aimed to maintain the homogeneity of the sample, as well as guarantee the safety and validity of the results.

The school team informed the guidelines on clothing and footwear the day before the assessment. On the day of the tests, participants received detailed instructions on how to carry out the activities. They wore clothing suitable for physical activities, such as t-shirts, shorts and sports shoes, although none of the items were standardized.

The tests were carried out individually. The team, made up of 10 researchers, followed strict schedules to standardize time, ensuring that each child had the same time to prepare and perform the tests. To analyze the anthropometric variables, we decided to use a digital scale (Filizola®, Personal Life model) for body weight (kg) and a stable stadiometer with a mobile cursor for height (cm). For the neuromotor variables, the speed and agility tests were applied.

The location where the tests were carried out were the same during the 4 data collection periods. The Shuttle Run test, to check agility, was carried out in the school yard close to the sports court, with the floor being the same during the 4 periods, and the speed test was carried out on the cobblestone street next to the school. In the 50-meter sprint (sec) the subjects were instructed to perform the test at their maximum speed during the course because it is a maximum performance test, and two attempts were made to get the best result. And the Shuttle Run (sec) test is executed at the highest speed with the subject leaving the starting point toward the blocks, picking one of them up, and returning to the starting point. Without interrupting the run, he repeats the same task, totaling a distance of 36.56 m with changes and alterations of the center of gravity when picking up the cues on the ground. Two attempts were made, and the shortest execution time was the best time to be recorded for this variable.

The data was entered and organized using Excel. This software allowed direct entry of collected data through computers. The data was added after the evaluation and entered into Excel by research assistants. The data was organized in tables and databases, categorized by collection period, age group and type of test performed. The researchers responsible for statistical analysis were responsible for verifying the accuracy of the data. These researchers reviewed the entered data

to identify and correct possible errors or inconsistencies.

In the statistical analysis, both the mean and standard deviation were used to describe the variables. The Kolmogorov-Smirnov test was used to analyze the normality of the data. The Kruskal Wallis one-way ANOVA test was used to verify possible differences between the periods and expressed as delta percentages. A significance level of $p<0.05$ was adopted, and the statistical package SPSS version 25.0 was used.

RESULTS

When verifying the significant differences in the period of the 30 years analyzed, we highlight a positive secular trend of the anthropometric variables of weight, height, and BMI, as well as the neuromotor variable, agility, translated into a lower performance (Table 1).

Table 1 - Sample characteristics according to anthropometric and neuromotor variables.

	1988/89		1998/99		2008/09		2018/19		p
	Mean	DP	Mean	DP	Mean	DP	Mean	DP	
Age (years)	10,54	0,50	10,42	0,50	10,42	0,50	10,74[a,b,c]	0,46	<0,001
Weight (kg)	37,16	8,98	36,12	8,02	36,76	7,87	45,28[a,b,c]	13,92	<0,001
Height (cm)	142,87	8,77	143,68	8,03	145,42	8,34	146,35[a,b]	20,50	<0,001
BMI (kg/m^2)	25,80	4,98	25,03	4,89	25,13	4,37	31,11[a,b,c]	8,38	<0,001
Agility (sec)	13,75	1,19	12,97[a,c,d]	0,89	13,39	1,07	13,73	1,41	<0,001
Speed (sec)	10,42	0,87	10,52	0,88	10,41	0,91	10,85	1,35	0,06

Kruskal Wallis one-way ANOVA test with a significance of $p<0.05$. the significant difference with 1988/89; b significant difference with 1998/99; c significant difference with 2008/09; d significant difference with 2018/19; SD = standard deviation.

The result of the secular trend analysis of agility was positive, as demonstrated by the difference in the percentages between the decades analyzed, from the 10-year period (1998/99) when compared with the previous decade (1988/89). We emphasize that this phenomenon is highly negative since the analyzed variable is expressed in seconds, this being the only period of improvement in the performance of the agility variable, which continued to show a decrease in this variable in the periods of 20 and 30 years (2008/09 and 2018/19 respectively) with a positive trend (Figure 2).

The velocity in the same analyzed period verifies a null secular trend. There was no significant difference in any of the comparisons (Figure 3).

Figure 2 - Agility boxplot of schoolgirls according to the periods analyzed.

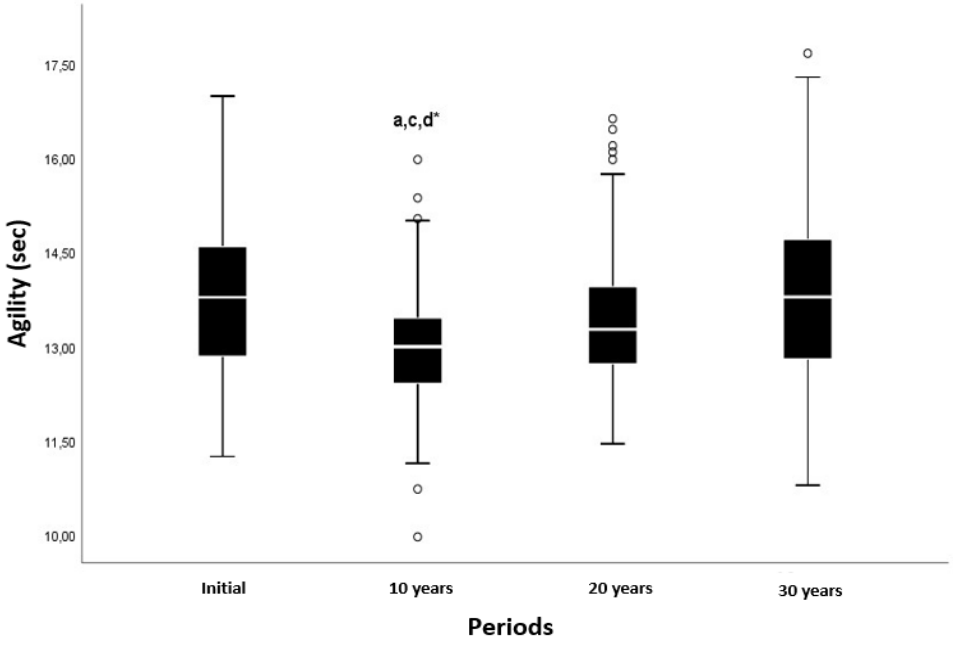
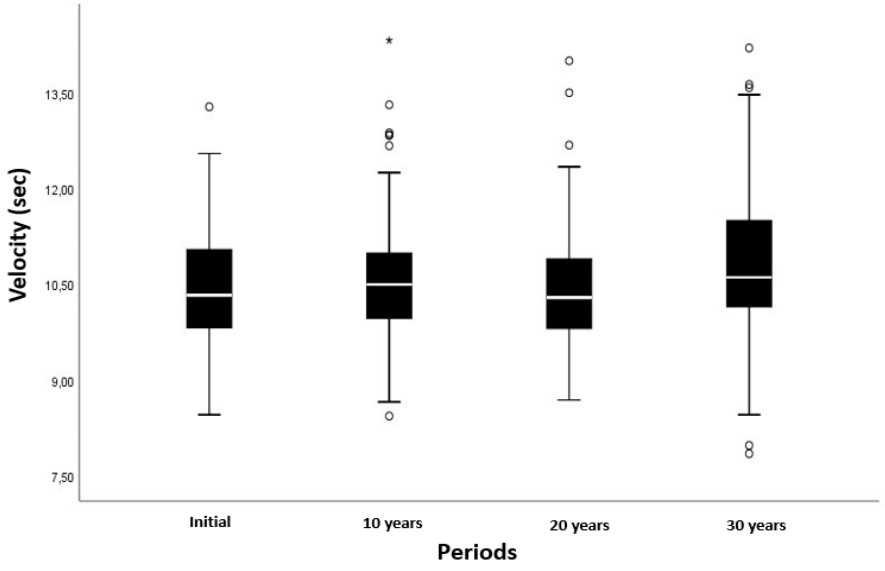


Figure 3 - Speed boxplot of schoolgirls according to the periods analyzed.



For an adequate elucidation of the secular trend phenomenon in the period of 30 years of the analyzed neuromotor variables, we highlight the percentage changes of the agility and speed variables by decade (Table 2). In the 30 years analyzed, there was a more accentuated percentage decrease (-5.67%) in agility in the first period with the second, followed by a percentage increase in the other periods.

Table 2 – Percentage difference in agility and speed between decades.

	AGILITY			SPEED		
	1988/89	**1998/99**	**2008/09**	**1988/89**	**1998/99**	**2008/09**
1998/99	-5,67%			0,95%		
2008/09	-2,61%	3,23%		-0,10%	-1,04%	
2018/19	-0,14%	5,85%	2,53%	4,12%	3,13%	4,22%

DISCUSSION

The result of the study allows us to observe that over these 30 years, there was a worsening in the performance of the agility variable, showing that the children became less agile. In addition, there was a significant increase in the body weight of these girls, with an increase of approximately 10 kg on average over the last decade, which may explain these results.

These findings corroborate other articles written with the same population that show a positive secular trend for obesity due to the increase in fat (skinfolds) over 20 years[21], and also that there was a positive secular trend in the increase in resting heart rate, which can be justified by the change in the behavior of these young people, thus reducing their physical fitness[22].

Since the early 1960s, there has been a decrease in performance in anaerobic capacity, as verified by the speed test in Australian children and adolescents, with an accelerated decline until about 1990, at an average rate of reduction of -0.24% per year (range of 95% confidence -0.22 to -0.26% per year)[23]. After this period, the decline is similar to the worldwide decline of this variable. This reduction observed in the last three decades in our findings was around -0.14%[23]. This decline is mechanically explained by the increase in body fat that impairs running performance since fat constitutes an overload on the musculoskeletal structure, interfering with the biomechanics of running. Physiological changes demonstrate cardiorespiratory capacity[23].

Time trends were estimated from 965,264 children and adolescents from 19 countries over the three-decade period between 1981 and 2014, using data from 137 studies[24]. Collectively, there was a moderate decline in cardiorespiratory fitness (ACR) of 3.3 mL/kg/min (95% CI -3.5 to -3.1), equivalent to a 7.3% decline (95% CI -7.8% to -6.7%)[24]. The decline was greater for boys than girls and was similar for children and adolescents. There was a strong negative association between

country-specific trends in income inequality as well as in developing countries[24]. Both phenomena were also found in previous studies with the same population of the study of schoolchildren from Ilhabela, which shows a decrease in cardiorespiratory fitness and an increase in adiposity over three decades[25].

A meta-analysis study compared the results of 55 performance reports of children and adolescents aged 6 to 19 years who used the 20m running test (20m SRT)[26]. All data were collected from 1981-2000 in 11 (mostly developed) countries, representing a total of 129,882 children and adolescents[26]. There was a significant 0.43% decline in the average per year, even when weighted by sex and age[26]. And the decline was proportionally greater with advancing age[26]. Our findings with a specifically female sample, 580 schoolgirls, showed that there was a 5.8% increase in agility time already at an early ///age at an average age of 10 years.

A study[27] that evaluated health-related physical fitness (AFRS) in children aged between seven to ten years with 1,136 subjects in three time periods (2002, 2005, 2010-11) found a negative secular trend for AFRS also verified by the decline of speed, and the individuals that studied in 2010 showed lower results compared to their peers (2002-2005) in both sexes. These results are worrisome since the literature demonstrates an inverse association between the components of AFRS and health risk factors[27].

It is believed that the positive secular trend for agility observed in this study is, to some extent, justified by the reduction in physical activities and sports among children and adolescents in recent decades. In contrast, the hours spent in sedentary activities, such as watching television, have increased considerably. This similar justification can also be found in previous studies[25], as seen by the association between watching TV in the bedroom and obesity and between sports practice and the intake of fruits and vegetables in 10-year-old children (same population).

In addition, there is a relationship between 20m running performance and health indicators among children and young people. Previously verified in a systematic review showing that the performance of 20mSRT was favorably associated with adiposity indicators and some indicators of cardiometabolic, cognitive, and psychosocial health in boys and girls[26]. These findings corroborate our findings

in previous studies that have already determined the influence of cardiorespiratory fitness on physical fitness and are still related to school performance[27].

The school environment plays an important role in the bio-psycho-social development of children and adolescents. One of its great roles is the promotion of healthy lifestyle habits for schoolchildren, as well as their families, among which the practice of physical activity stands out[28]. Furthermore, it is important to highlight that healthy habits in childhood and adolescence can have a positive impact on adulthood, and even reduce the chances of illnesses and illnesses caused by stressful sources[29,30].

Despite the depth of this 30-year longitudinal study, which analyzed data from a sample in a developing country, the authors acknowledge several limitations. First, the sample selection bias is a concern, as children were chosen based on convenience criteria, resulting in a non-representative sample. Additionally, the study focused on a specific age group, excluding younger and older students who may exhibit early or late sexual maturation. Furthermore, the study lacked data on race, socioeconomic status, and family size. Another limitation is the failure to control for adiposity, despite its known changes among schoolchildren participating in the Mixed Longitudinal Project for Growth, Development, and Physical Fitness of Ilhabela over years.

CONCLUSION

The results indicated a positive secular trend exclusively in the agility variable, revealing an increase in test execution time over the decades, which suggests that children have become less agile. This finding underscores the impact of lifestyle changes —particularly in physical activity levels, screen time, and diet— on physical fitness, specifically neuromotor variables.

To mitigate the observed decline and achieve more favorable outcomes in biological variables that support adequate growth and development, it is recommended to review these lifestyle factors. Future studies should also examine other social, demographic, and psychosocial variables to provide a more comprehensive understanding.

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