RELATIONSHIPS BETWEEN BIRTH WEIGHT, BREASTFEEDING AND DIGIT RATIO WITH PHYSICAL ACTIVITY AND PHYSICAL FITNESS IN SCHOOL ADOLESCENTS

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Abstract:

This study aimed to analyze the isolated and combined effects of non-modifiable factors on adolescents' physical fitness. This cross-sectional, descriptive study involved 1475 adolescents, aged 12 to 19 years, of whom 721 were girls, from four public schools in southern Spain. Physical activity, birth weight and breastfeeding time, and physical fitness were assessed. To calculate the 2D:4D ratio, three separate measurements of the length of the index finger (2D) and ring finger (4D) of both hands were taken. Results show no differences in the intake of breast milk nor its prediction power for physical fitness. Birth weight was related to horizontal jump and manual dynamometry results, while the 2D:4D ratio was not significant in the linear regression models. The non-modifiable factors studied in relation to physical activity practically ceased to be significant when variables such as sex, body mass index and physical activity practice were introduced into the models.

Key words: *physical fitness, adolescents, birth weight, breastfeeding*

Introduction

In recent years, the lifestyles of western populations have evolved significantly, motivated mainly by industrialization and the rise of new technologies (Hanafizadeh, Ghandchi, & Asgarimehr). This has led to a drastic decrease in predominantly physical activities and an increase in activities that require prolonged sitting, thus leading to a more sedentary lifestyle (Owen, Sparling, Healy, Dunstan, & Matthews, 2010). Since a low level of physical fitness, mainly in terms of aerobic capacity and strength level, is considered a key risk factor for several pathologies (Maestroni, et al., 2020; Morris, et al., 2013), and physical fitness level achieved in adulthood is closely related to physical fitness in childhood and adolescence (Huotari, Nupponen, Mikkelsson, Laakso, & Kujala, 2011), it would seem pertinent to analyze the factors that limit or enhance physical fitness levels among adolescents. In this regard, there is broad evidence that the level of physical activity has a positive impact on physical fitness (Eckerson, et al., 2013; Fang, et al., 2017; Twisk, Twisk, Kemper, & van Mechelen, 2002). However, the influence of non-modifiable factors (e.g., birth weight, breastfeeding and the 2D:4D digit ratio) requires further investigation.

Due to the beneficial effects of breastfeeding, some authors have argued that this nutrition strategy could have an impact on physical fitness in adolescents (Artero, et al., 2010). Regarding this, Corredor-Corredor, Castejon-Riber, Martínez-Amat, and Benítez-Sillero (2019) observed a trend indicating that Spanish boys (age: 14.74 ± 0.84 years) who were breastfed performed better in all the fitness tests, although only significant differences were reported in the abdominal strength test ($p<.019$). Additionally, these authors found that Spanish girls (age: 14.77 ± 0.84) who were breastfed obtained lower values in all the tests except the multi-stage fitness test, with significant differences only found in the flexibility test. Similarly, Vafa et al. (2016) and Zaqout et al. (2018) found a positive association between exclusive breastfeeding and physical fitness. On the other hand, inconclusive results about the effect of breastfeeding duration have been observed (Corredor-Corredor, et al., 2019; Labayen Goñi, et al., 2012; Vafa, et al., 2016), so future studies on this topic are needed.

The influence of birth weight on physical fitness levels among adolescents has not been studied in depth. Specifically, Corredor-Corredor et al. (2019) observed that those adolescents, both male and female, with higher birth weights presented a better performance in the handgrip test ($p<.01$). Additionally, these authors reported significant relationships between birth weight and performance in shuttle run ($p=.045$), long jump ($p=.008$) and abdominal strength ($p=.031$) tests in girls, while no significant relationships were observed in boys for these tests. Ortega et al. (2009) partially support these results since they also observed a positive relationship between birth weight and handgrip performance, mainly in girls ($p<.001$). However, these authors could not establish a relationship between birth weight and cardiovascular fitness ($p=.700$-$.810$). Despite the promising results obtained there are few studies on this topic, none of which is recent.

Since athletic performance is positively affected by circulating testosterone levels, prenatal testosterone may have a positive effect on physical fitness levels among adolescents (Hönekopp, 2012). In this sense, no significant relationship was observed between the 2D:4D digit ratio and several physical fitness tests in young scholars (Eghbali, 2016; Peeters, van Aken, & Claessens, 2013). Conversely, some authors found negative correlations between 2D:4D digit ratio and different fitness battery tests (Hönekopp, Manning, & Müller, 2006; Ranson, Stratton, & Taylor, 2015), showing the need to perform future studies to establish definitive conclusions on this topic.

Since the aforementioned non-modifiable factors seem to influence the physical fitness levels of adolescents, a multivariable analysis could shed light on this relationship and contribute to predictions and decisions that promote improved physical fitness levels among young people. In turn, this could help in the prevention of derived pathologies. Thus, the main aim of this study was to analyze the isolated and combined effects of non-modifiable factors (i.e., breastfeeding, birth weight, and 2D:4D digit ratio) on the physical fitness of adolescents. We hypothesized that physical fitness was influenced by non-modifiable factors, although this effect might seem to be sex-specific.

Methods

Participants

A convenience sample of 1,475 schoolchildren aged 12 to 19 years (mean = 14.87, standard deviation = 1.57), of whom 721 were girls (48.88%), voluntarily participated in this study. Participants belonged to four state schools in southern Spain (three in the province of Cordoba and one in Huelva). The participants were students of any of the first four years of secondary education (from 12 to 16 years of age) or the first year of baccalaureate (age 17), if they had not repeated a year. Subjects above that age were ruled out. The adolescents were informed of the main aim of the study and the anonymity, confidentiality, and voluntary nature of their participation. Written informed parental consent was obtained from each participant. This study protocol was in accordance with the latest version of the Declaration of Helsinki (2013), while the project was also approved by the Ethics Committee of the University of Cordoba.

Procedures

A descriptive and cross-sectional study design with non-probability-based sampling was used to determine the relationships between non-modifiable factors (i.e., breastfeeding, birth weight, and 2D:4D digit ratio) and the adolescents' physical fitness level. In four different sessions (during the school year), participants completed the EUROFIT battery and filled out the accompanying questionnaires.

Instruments

Physical activity

Two questions were asked to determine the level of physical activity, based on the modified version of the PAQ-A questionnaire (Martínez-Gómez, et al., 2009):

1. Physical activity in your free time: Have you done any activity in the last 7 days (last week)? If so, on how many days? The students answered by 0 to 7.
2. Do you regularly attend any kind of organized classes focused on physical activity, sports, etc.? Please specify the number of days per week. The days per week (0 – 7) were counted.

Based on these two questions, each student's level of total physical activity during free time and participation in organized physical activity was determined. Total physical activity included practical activities, both organized and independent, while organized activity referred to those regular activities repeated over time, dependent on a club or entity and directed by a person. In both cases, the compulsory hours corresponding to physical education at school were not counted.

Anthropometric characteristics

All measures were made with barefoot subjects wearing light clothing. On the first day, the focus was solely on anthropometric data collection. The body weight in kilograms (kg) was measured with a Tanita BF 350 scale (Tanita Corporation, Japan; precision 0.1 kg). A SECA stadiometer (Seca 213, Hamburg, Germany; precision 0.1 cm) was used for measuring body height. Based on these data, the body mass index [BMI = weight (kg)/height (m2)] was calculated.

Fitness tests

Before starting the assessment**,** a training session was held in order to guarantee the standardization, validation and reliability of the measurements. Five integrated tests were carried out within the EUROFIT battery (Committee of Experts on Sports Research EUROFIT, 1993). The scientific basis underlying the use of these tests in adolescents has appeared in previous publications (Evelein, et al., 2011) and has been used in the AVENA and HELENA international studies (Ortega, et al., 2009). All students had experience with these tests since they had been regularly used as a part of assessment tools throughout their education. The battery included the tests described below:

a) *30 seconds sit-up tests.* This is a trunk power test in which the subject tries to carry out as many sit-ups as possible during a period of 30 seconds. The subject lies on his/her back on a mat, and places his/her hands behind the back of their neck, with legs flexed at 90° and his/her feet on the ground. The subject should raise their trunk until he/she touches the knees with the elbows. The number of times the movement is performed correctly will be noted. A mat was given to each subject and a CasioHS-80TW chronometer was used.
b) *Sit-and-reach flexibility test.* This test measures the range of hip motion. Sitting on a mat with their legs stretched out and soles placed on a standardized box, the subjects must bend their trunk forward, trying to reach as far as possible with their hands outstretched, moving a ruler (in centimeters) placed on the surface of the box with their fingertips. According to protocol, the ruler is aligned with the edge of the box where the feet are placed, at the 15-centimeter mark.
c) *Horizontal jump.* It was used to assess lower body explosive muscular strength. The subject starts from a static position, located immediately before a line, with feet shoulder-width apart and parallel, having to make a jump as far as possible without losing balance on the landing. Two attempts were made on a hard, non-slip surface and the best of them was recorded. The result was recorded in centimeters, using a tape measure.
d) *Handgrip strength.* Manual grip strength in kilograms was assessed in both hands, using a TAKEY TKK 5110 dynamometer (interval 5-100 kg, precision 0.1 kg), with an adjustable handle. The subject holds the dynamometer keeping it slightly away from the body. He/she then presses gradually and continuously for two seconds. The optimal grip was calculated by the equation designed by Ruiz et al. (2006). Two attempts were made with each hand and the best result was recorded. For this study, the most common measure of the best performance with one hand was used (Committee of Experts on Sports Research EUROFIT, 1993).
e) *20 meters shuttle run test*. This is a maximal incremental field test that assesses the maximum aerobic capacity. The subject runs back and forth over 20 meters. The test begins at a slow pace. The subject should make the change of direction at the moment of the sound signal that occurs ever faster. The test ends when the subject is not able to follow the imposed rhythm. The time in minutes and seconds was determined to increase the precision of the measurements. The author's original software was used in an mp3 version (Léger, Mercier, Gadoury, & Lambert, 1988).

To avoid mutual impact between the tests, these were performed on different days in the following order: day two (sit-and-reach flexibility and sit-up tests), day three (20-m shuttle run), day four (handgrip and horizontal jump) (Corredor-Corredor, et al., 2019). The questionnaire was administered on the first day.

Birth weight and breastfeeding time

A shorter version of the questionnaire reported in the HELENA study (Jimenez Pavon, et al., 2010) was used, which was answered by the parents, who also filled out the consent form for their sons' and daughters' participation. The questionnaire provided us with data on birth weight and breastfeeding period. Birth weight was registered in kilograms, while breast milk intake time was coded as 0 (when the subject had not been breastfed), 1 (if breastfeeding lasted less than three months), 2 (if breastfeeding lasted from three to five months) and 3 (when breast milk intake lasted six months or more).

2D:4D ratio

To calculate the 2D:4D ratio, three separate measurements of the length of the index finger (2D) and ring finger (4D) of both hands were taken. The measurements were taken on the ventral side of the hand. Finger length was taken from the proximal crease at the base of the finger to the fingertip, as this measurement procedure has a high replication (Schneider, Pickel, & Stalla, 2006). A digital calliper with an accuracy of 0.1 mm, Tacklife DC01, was used. The 2D:4D ratio value for each hand was obtained by calculating the arithmetic mean of three measurements (Schneider, et al., 2006).

Statistical analysis

Descriptive data are presented as mean ± standard deviation (SD). The sample of data was first tested for distribution normality with the Shapiro-Wilk test. The subjects were compared by sex with the Student's *t*-test. Bivariate correlations were carried out with the Spearman test as some variables were non-parametric. Likewise, the breastfeeding variable was compared through ANOVA, and for a more complete analysis of breastfeeding, this variable was dichotomised between those who were and those who were not breastfed, using the Student *t*-test. To complete the analyses, a multiple regression analysis was carried out where the physical fitness variables were the dependent variables and age, sex, BMI, birth weight, breastfeeding, physical activity and 2D:4D ratio were the independent variables. The effect size was calculated according to Cohen (1988). Values above 0.8, between 0.8 and 0.5, between 0.5 and 0.2, and lower than 0.2 were considered as large, moderate, small, and trivial, respectively. The analyses were carried out using the IBM SPSS Statistics 25 statistical package.

Results

Table 1 presents descriptive data and differences between sex. Significant differences were found for all variables except BMI and the period of breast milk intake.

The relationships between study variables are shown in Table 2. Birth weight only correlated with the manual dynamometry test, while the 2D:4D ratio of the right hand correlated with all the physical fitness tests. The 2D:4D ratio of the left hand only correlated with the horizontal jump and shuttle-run tests. In the ANOVA analyses according to the period of breast milk intake, there were no significant relationships in any of the variables, nor in the *post-hoc* analysis, and therefore they are not shown in the tables. When comparisons were made between the two groups using the *t*-test, according to whether or not they were breastfed, the BMI variable was also not significant (M with breastfeeding: 22.30 [4.64]; M without breastfeeding: 21.52 [4.26]; p=.26).

Table 3 shows the linear regression models. For all the physical fitness tests, the predictors age, sex, and BMI were significant, as well as the practice of organized physical activity for the abdominal strength, horizontal jump and cardiovascular endurance tests. Birth weight was only significant in the model for jumping strength and manual dynamometry tests. Neither the breastfeeding period nor the 2D:4D ratio of the right hand was significant. The models with the left hand in 2D:4D ratio and the independent physical activity practiced in free time were also studied, but their values were lower than those shown in the tables and are therefore not shown.

Discussion and conclusions

The aim of this study was to demonstrate the influence of non-modifiable factors on physical aptitudes and to verify if this effect was mediated by gender. Knowledge and control could be

Table 1. Descriptive analysis of the variables according to the sex of the participants

	n	Total M (SD) **n=876**	n	**Boys M (SD) n=754**	**Girls M (SD) n=721**	t	ES
Age	1475	14.87 (1.57)	B:754 G:721	14.91 (1.55)	14.83 (1.58)	0.88	0.05
Weight	1475	59.26 (13.98)	B:754 G:721	61.79 (15.14)	56.61 (12.11)	7.26***	0.43
Height	1475	164.62 (9.60)	B:754 G:721	168.51 (10.27)	160.53 (6.76)	17.74***	1.18
BMI	1475	21.77 (4.32)	B:754 G:721	21.63 (4.39)	21.92 (4.24)	-1.31	-0.07
Sit-up	1335	23.05 (6.15)	B:685 G:650	25.15 (6.29)	20.84 (5.14)	13.71***	0.84
Sit and reach	1492	17.20 (8.81)	B:771 G:721	14.51 (8.11)	20.08 (8.62)	-12.82***	-1.08
Hor. jump	1436	161.79 (36.33)	B:734 G:702	181.17 (34.19)	141.52 (25.99)	24.81***	1.53
Shuttle run	1454	4.93 (2.51)	B:749 G:705	6.07 (2.62)	3.72 (1.69)	20.47***	1.39
Handgrip	1475	26.35 (7.99)	B:754 G:721	29.95 (8.65)	22.59 (4.97)	20.13***	1.48
Birth weight	862	3.27 (0.56)	B:425 G:437	3.31 (0.60)	3.23 (0.52)	2.13*	0.15
Breastfeeding	872	1.65 (1.16)	B:430 G:442	1.66 (1.17)	1.63 (1.15)	0.37	0.02
D2/D4 (right)	934	1.01 (0.49)	B:487 G:447	1.00 (0.06)	1.02 (0.04)	-6.06***	-0.5
D2/D4 (left)	935	0.99 (0.04)	B:488 G:447	0.98 (0.04)	0.99 (0.04)	-4.43***	-0.25
PA total	1425	2.46 (1.98)	B:719 G:706	2.74 (1.98)	2.17 (1.93)	5.23***	0.29
PA organized	1429	1.63 (1.76)	B:720 G:709	1.97 (1.85)	1.30 (1.60)	6.98***	0.42

Note. M= mean; SD = standard deviation; ES = effect size; BMI= body mass index; Hor. = horizontal; PA = physical activity.

* Established level of significance; p<.05.

*** Established level of significance; p<.001.

Table 2. Bivariate correlations between the quantitative variables of the study

Variable	Age	Weight	Height	BMI	Sit-up	Sit and reach	Hor. jump	Shuttle run	Hand-grip	Birth weight	D2/D4 (right)	D2/D4 (left)	PA total
Age	-	-	-	-	-	-	-	-	-	-	-	-	-
Weight	0.370**	-	-	-	-	-	-	-	-	-	-	-	-
Height	0.457**	0.558**	-	-	-	-	-	-	-	-	-	-	-
BMI	0.167**	0.835**	0.059*	-	-	-	-	-	-	-	-	-	-
Sit-up	0.261**	0.070*	0.285**	-0.092**	-	-	-	-	-	-	-	-	-
Sit and reach	0.159**	0.041	-0.077**	0.099**	-0.018	-	-	-	-	-	-	-	-
Hor. jump	0.234**	0.030	0.450**	-0.253**	0.498**	-0.078**	-	-	-	-	-	-	-
Shuttle run	0.248**	-0.011	0.385**	-0.266**	0.554**	-0.022	0.665**	-	-	-	-	-	-
Handgrip	0.432**	0.540**	0.699**	0.219**	0.374**	0.021	0.543**	0.433**	-	-	-	-	-
Birth weight	0.019	0.172**	0.150**	0.111**	-0.020	0.005	0.062	0.023	0.129**	-	-	-	-
D2/D4 (right)	-0.124**	-0.020	-0.107**	0.059	-0.111**	0.078*	-0.199**	-0.218**	-0.134**	-0.038	-	-	-
D2/D4 (left)	0.004	0.101**	0.012	0.127**	-0.011	0.051	-0.109**	-0.129**	-0.035	-0.013	0.405**	-	-
PA total	-0.030	0.045	0.129**	-0.051	0.221**	0.062*	0.194**	0.280**	0.126**	-0.016	-0.062	-0.012	-
PA organized	-0.043	0.029	0.111**	-0.062*	0.301**	0.025	0.280**	0.377**	0.121**	0.013	-0.040	-0.027	0.557**

Note. BMI= body mass index; Hor. = horizontal; PA = physical activity.
* Established level of significance; p<.05
** Established level of significance; p<.01

Table 3. Linear regression with age, sex (female), BMI, birth weight, breastfeeding, organized physical activity and D2/D4 index of the right hand as the predictors of the different physical fitness tests

	Sit-up		Sit and reach		Horizontal jump		Shuttle run		Handgrip	
	β	t	β	t	β	t	β	t	β	t
Age	0.257***	7.348	0.137***	3.611	0.316***	11.266	0.290***	9.809	0.382***	12.304
Sex (female)	-0.351***	-9.880	0.308***	8.053	-0.518***	-18.205	-0.418***	-13.941	-0.424***	-13.457
BMI	-0.143***	-4.062	0.118**	3.101	-0.342***	-12.077	-0.302***	-10.140	0.130***	4.149
Birth weight	-0.018	-0.517	0.041	1.083	0.054*	1.940	-0.009	-0.313	0.075*	2.434
Breastfeeding	0.005	0.139	0.026	0.696	0.044	1.611	-0.001	-0.028	0.007	0.216
Org. PA	0.200***	5.724	0.068	1.801	0.147***	5.233	0.283***	9.574	0.060	1.928
D2/D4 (Right)	0.049	1.395	0.009	0.249	-0.005	-0.189	-.050	-1.688	-0.025	-0.791
	$F_{(7)} = 32.89$ p<.001 $R^2 = .27$		$F_{(7)} = 13.41$ p<.001 $R^2 = .13$		$F_{(7)} = 99.24$ p<.001 $R^2 = .53$		$F_{(7)} = 81.98$ p<.001 $R^2 = .48$		$F_{(7)} = 62.63$ p<.001 $R^2 = .41$	

Note. * p<.05; ** p<.01; *** p<.001. Organized physical activity (Org. PA) was considered in all models except in the flexibility model where total physical activity was considered. The D2:D4 ratio of the right hand was considered as it showed the best results in the model compared to when the index finger was considered in the left hand.

an excellent way to estimate the main factors that can affect—both negatively and positively—performance in certain physical skills, and its possible consequences (Ruedl, et al., 2019).

Exclusive breastfeeding is defined as a feeding pattern based only on breast milk without any complementary foods (Zaqout, et al., 2018) and is considered to be a key factor in improving the survival, health, and development of children (Victora, et al., 2016). The results of our study show that there are no differences between genders in terms of the breastfeeding period. However, there is no scientific consensus on this fact since there are studies that have determined the period of breastfeeding is greater in boys (Hafeez & Quintana-Domeque, 2018), and others that have found the opposite result, stating that the lactation period for males begins later and lasts less time (Sen, Mallick, & Bari, 2020; Shafer & Hawkins, 2017). It seems that external factors such as culture or geographic location may play a relevant role since the results differ depending on the population analyzed. There seems to be an agreement that breastfeeding has a positive effect on both physical abilities and cardiorespiratory ability, and that it improves when breastfeeding lasts longer (Berlanga-Macías, et al., 2020).

However, Corredor-Corredor et al. (2019) found that while birthweight did have a positive correlation with different physical tests, the same did not occur with breastfeeding. In this sense, breastfeeding time can play a fundamental role, since there are considerable differences among those adolescents who are breastfed for a longer time in some tests such as dynamometry (Greven, Richards, & Buitelaar, 2018; Heshmati, et al., 2018).

Another factor which has attracted much attention in the literature over recent years is the 2D:4D digit ratio, defined as the length of the second finger divided by the length of the fourth finger (Eghbali, 2016). This ratio appears to be a marker of prenatal testosterone levels, in which a lower 2D:4D digit ratio indicates higher prenatal testosterone (Eghbali, 2016). It has been shown that the differences between the right 2D:4D ratio and the left 2D:4D ratio is greater in girls, although the differences may vary depending on ethnicity (Manning, Stewart, Bundred, & Trivers, 2004; Manning & Fink, 2020). However, with respect to the right 2D:4D ratio and age, our results contradict those of certain studies (Trivers, Manning, & Jacobson, 2006). Nevertheless, they do coincide with physical condition tests, in which the relation is negative in all tests (Hönekopp, et al., 2006), with the exception of flexibility; while in our study the relationship with flexibility was positive, most studies do not find such a connection (Peeters, et al., 2013). Birth weight is considered to be a relevant index of the intrauterine condition which has a known programming effect on later body size and body composition (Labayen, et al., 2006). Regarding birth weight, there is a positive relationship with manual dynamometry (Corredor-Corredor, et al., 2019; Moura-Dos-Santos, et al., 2013), especially in women (Ortega, et al., 2009), but also with lower body strength, since in both our study and that by Moura-Dos-Santos et al. (2013), jumping strength was positively correlated with running speed.

The vast majority of studies conclude that men perform more physical activity than women and have a higher adherence rate (Barja-Fernández, Juste, Pino, & Leis, 2020; Pino-Juste, 2019). In addition, we can state that the adolescents who carry out non-regulated physical activity perform equally well in regulated physical activity (Rodríguez-Cabrero, et al., 2015). Free physical activity is related to an improvement in a high number of physical parameters (Eather, Morgan, & Lubans, 2013). Likewise, those adolescents who do not meet the minimum guidelines for physical activity are less likely to achieve healthy levels of physical fitness, aerobic capacity and they have a worse BMI (Morrow, et al., 2013). The association with BMI is especially strong since it has a high negative correlation with moderate and vigorous physical activity (Joensuu, et al., 2018). It is therefore clear that both organized and unorganized physical exercise improves physical fitness (Chen, Hammond-Bennett, Hypnar, & Mason, 2018; Mora-Gonzalez, et al., 2020). Moreover, it is worth highlighting the importance of unregulated physical activity in girls, since there are considerable differences, especially between those who participate in unregulated physical activity and those who do not, compared to boys (Chen, et al., 2018). These results may be due to the fact that, in general, boys perform more physical activity than girls. Finally, it should be noted that age, sex and BMI are significant predictors with respect to physical fitness tests. Regarding age, it has been proven it has an effect on physical aptitudes linked to developmental stages (Smith, Weir, Till, Romann, & Cobley, 2018). When it comes to gender, men will have greater physical abilities than women (Dawes, et al., 2017). In terms of body mass index, those with obesity have poorer abilities and skills, both in terms of physical skills (Korsten-Reck, et al., 2007) as well as emotional and social skills (Utesch, Dreiskämper, Naul, & Geukes, 2018) than those with normal BMI or who are overweight (Kukic, Cvorovic, Dawes, Orr, & Dopsaj, 2018). In fact, BMI can be used as a useful, non-invasive and fast predictor of physical performance (Kukic, et al., 2018).

This study is not without limitations, the main one being the need to point out the impossibility of establishing causal relationships between the variables under study, given the type of cross-sectional descriptive study used here. Furthermore, we cannot state that these data hold up over time given their cross-sectional nature. In spite of the aforementioned limitations, though, the study offers insight into the influence of non-modifiable factors on adolescents' physical condition and points us towards measures that favor the improvement of their physical condition in order to prevent derived pathologies. Consequently, it would be worthwhile for future research to study causal relationships through a correlational study to ascertain the influence of different variables on each other. Another limitation is that participants were considered peers according to their biological age, without considering their degree of sexual development, which could be interesting to do in future studies.

Differences regarding sex in the non-modifiable factors that influence physical fitness were observed, with boys performing better in all the tests compared to the girls, except for the sit-and-reach test. However, there are no differences based on the period of breast milk intake, nor is it a predictor of physical fitness between the sexes. On the other hand, physical activity seems to be positively related to abdominal strength, flexibility, jumping, cardio-respiratory fitness and manual dynamometry, while age, sex, and body mass index were significant predictors with respect to the physical fitness tests. In addition, the practice of organized physical activity was a significant predictor in the abdominal strength, jumping and cardiovascular endurance tests. Birth weight is a significant predictor with respect to horizontal jumping and manual dynamometry. Finally, we can conclude that the non-modifiable factors studied in relation to physical activity practically ceased to be significant when variables such as sex, BMI and physical activity practice were introduced into the models.

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