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Motor competence of 10 years old children with different athletics practice years
Competencia motriz de niños de 10 años con diferentes años de práctica del atletismo

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Abstract. The present study aimed to verify whether, in children of 10 years of age practicing athletics, a greater number of years of practice of this modality would correspond to higher values of motor competence (MC), as determined by the Motor Quotient (MQ) in the Körperkoordinationstest Für Kinder (KTK). The cross-sectional and descriptive study was conducted in an athletics club in Portugal. Thirty-two children were evaluated, 15 female (10.4±0.25 years of age, 2.5±0.92 years of practice) and 17 male (10.4±0.22 years of age, 2.2±1.1 years of practice). Although no significant differences were found between children with one or two years of athletics practice and children with three or four, a moderate positive correlation was found between the time of practice (TP) and MC in girls (ρ=0.543, p=0.036). Mean MC results were considerably higher (both sexes) than the generality of studies often reveal. Finally, there were no significant differences on MC of boys and girls. The present results allow us to speculate that athletics may have helped to fill some gaps in motor coordination so often observed in girls, and the time of practice may have been especially beneficial for this group. It is suggested a longitudinal study to, more than confirm the detected association, verify what happens with boys' and girls' MC throughout the years of athletics practice.
Keywords: athletics; children; practice time; motor competence; KTK test.

Resumen. El presente estudio tuvo como objetivo verificar si, en niños de 10 años practicantes de atletismo, un mayor número de años de práctica de esta modalidad correspondería a valores más elevados de competencia motora (CM), determinados por el Cociente Motor (CM) en la prueba KTK (Körperkoordinationtest Für Kinder). Se llevó a cabo un estudio transversal y descriptivo en un club de atletismo en Portugal. Se evaluaron 32 niños, 15 de sexo femenino (10,4±0,25 años, 2,5±0,92 años de práctica) y 17 de sexo masculino (10,4±0,22 años, 2,2±1,1 años de práctica). Aunque no se encontraron diferencias significativas entre los niños con un o dos años de práctica de atletismo y los niños con tres o cuatro, se encontró una correlación positiva moderada entre el tiempo de práctica (TP) y el MC en las niñas (ρ= 0,543, p=0,036). Los resultados medios de MC fueron considerablemente más elevados (en ambos sexos) de lo que suelen revelar la generalidad de los estudios. Por último, no hubo diferencias significativas en el MC de niños y niñas. Los presentes resultados nos permiten especular que el atletismo puede haber contribuido a colmar algunas lagunas en la coordinación motora tan frecuentemente observadas en las niñas, y el tiempo de práctica puede haber sido especialmente beneficioso para este grupo. Se sugiere un estudio longitudinal para, más que confirmar la asociación detectada, verificar lo que ocurre con la CM de niños y niñas a lo largo de los años de práctica de atletismo.
Palabras clave: atletismo; niños; tiempo de práctica; competencia motriz; test KTK.

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Introduction

Physical Activity (PA) is a protective factor against major problems such as cardiovascular disease, type II diabetes, and obesity (Spessato et al., 2013). It contributes to improve bone, muscle, and psychological health in children and adolescents (Prieto-Báscon, 2010), and has an influence on motor competence (MC) (Spessato et al., 2013), which is related to performance in various sports (Buratti et al., 2020). Furthermore, motor competence (MC) also plays a significant role in physical activity adherence, creating a bi-directional relationship. In fact, the development of MC during childhood has been acknowledged as a crucial factor for engaging in regular physical activity throughout life (Ennis, 2011; Lubans et al., 2011; Stodden et al., 2008; Strong et al., 2005; Wrotniak et al., 2006). For instance, Wrotniak et al. (2006) emphasized that motor proficiency (the term used by the authors) is positively associated with physical activity and inversely associated with sedentary behaviors in children, making it an appropriate target for increasing physical activity in youth. MC is defined as an individual's ability to perform a variety of motor actions, whether fine or gross (Sá et al., 2021). Some studies (Marta et al., 2012; Sola et al., 2010) suggest that high levels of physical activity have an influence on Body Mass Index (BMI), which in turn has positive implications for overall motor proficiency performance. Motor experience allows the components of motricity to develop broadly, enabling the execution of simple and complex movements in a balanced and efficient manner (Marta et al., 2012). In a study conducted by Rodrigues et al. (2019), the authors reported that boys significantly outperformed girls in all MC tests (using the Motor Competence Assessment battery), with lower differences in the stability component. Logan et al. (2015) and Barnett et al. (2016) stress this same point, saying that, from the systematic revision they performed, it became evident that boys were more competent in object control skills and girls were more competent in locomotor skills. As a result, a stronger relationship between manipulative (object control) skills and physical activity was seen in boys, while a stronger relationship between locomotor skills and physical activity was clear in girls. These differences are likely not based on genetic dispositions but rather on varying exposure to specific stimuli, such as sports participation, among other factors. As stressed by several authors (Kauderer & Randler, 2013; Mota et al., 2008), boys tend

to spend more time in sport activities than girls. Despite the trend to reduction of sex (Wood & Eagly, 2012), it is still expected (or accepted) that girls engage into more quiet activities than boys. Additionally, parents tend to be more tolerant to their sons' participation in risky activities than to their daughters (Morrongiello & Dawber, 1999, 2000). Altogether, these realities may contribute to a sex motor competence gap. Several authors (Coppens et al., 2021; Fransen et al., 2014; Henrique et al., 2016; Vandorpe et al., 2012) found, with longitudinal studies, a positive association between sports participation and MC. Henrique et al. (2016) and Coppens et al. (2021) raised the question of if it would make any difference the type of sport children played on their MC. It is often assumed (Barnett et al., 2011; Stodden et al., 2014) that sports that rely mostly on object control, like football or basketball, provide more affordances for both object control and locomotor skills enhancement, in contrast with sports that are mainly locomotor-oriented, like running or swimming.

The present study aimed mainly to verify if 10-years-old children with more years of athletics practice would present better (higher values) of MC, as determined by Motor Quotient (MQ)in the KTK test. The rationale was that if athletics was to be a sport that could contribute to an overall MC enhancement, athletes with more practice years would present a higher MC. Kiphard and Schilling (1974) conducted a study with 1228 children aged five to 14 years, providing reference values for subsequent studies. They reported that 16% of the children had a motor quotient (MQ) below the normal classification, while another 16% had a MQ above the normal classification. MQ is the relative value derived from the gross values obtained in each KTK task, considering subjects' sex and age. Lopes et al. (Lopes et al., 2013), studying the motor competence of a sample of 596 Portuguese children aged 9-12-years-old with KTK, found that around 52% of them had a MQ below normal classification. Furthermore, none of the participants was classified as having a high MC. Mean MQ was 85.7 ± 14.4 (girls 81.7±14.5, boys 89.3±13.4, $p<0.001$). Vandorpe et al. (Vandorpe et al., 2011), with a sample of 2470 Flemish children aged six-12- years-old, presented the value of 21.1% of children with a MQ below normal classification and 8.7% above normal (8.3% good, 0.4% high). Mean MQ was 96.50±14.3 (girls 94.86±14.49, boys 98.03±14.10, $p<0.001$). Graf et al. (Graf et al., 2004), studying 668 German children aged six–nine years old, reported 31.3% having a MQ (using KTK) below normal and 8.3% above normal (7.9% good, 0.4% high). Furthermore, children with the greatest amount of physical activity reached significantly higher MQ results ($p<0.05$) than all the other participants, with a MQ mean result of 96.45±16.29 against the no sport practice (90.11±14.56). Boys presented significantly better MC results ($p<.001$) than girls.

The existing literature does not supply a definitive relationship between MC and athletics practice. However, considering that athletics involves key components such as balance, locomotion, and manipulation skills, which are promising for enhancing MC, this study aims to investigate whether a higher number of years of athletics practice in 10-year-old children would result in higher values of MC, as determined by the Motor Quotient (MQ) in the KTK test. Additionally, we will analyse potential differences in MC based on gender. The study hypotheses are as follows: a) More years of athletics practice will correspond to better results in MC for 10-year-old children involved in athletics; and b) Boys will show better results in MC compared to girls.

Material and methods

Study Design

The present study adopts a cross-sectional and descriptive design, aiming to analyse and compare subjects' MC in a single data collection.

Participants

The current study sample was taken by convenience. The study evaluated a total of thirty-two children, including 15 females (aged 10.4±0.25 years, with 2.5 ± 0.92 years of practice, and one athlete classified as overweight with a BMI% ≥85 and <95) and 17 males (aged 10.4±0.22 years, with 2.2±1.1 years of practice, one athlete classified as overweight with a BMI% ≥85 and <95, and one athlete classified as obese with a BMI% ≥95). To be eligible for participation, subjects had to meet certain criteria, which included being at least 10 years old, capable of performing the various tasks, and willing to take part after obtaining parental consent. All procedures adhered to the Helsinki Declaration (World Medical Association, 2013) and its subsequent revisions. Ethical approval was obtained by the Ethical Committee of Life Quality Research Centre (LQRC-CIEQV) before data collection (reference number: EA 06. 2022.CIEQV).

Instruments and procedures

The height was measured on a stadiometer, with children being barefoot and wearing only essential clothing and the weight measured on Tanita MC-780MAS Segmental scales. MC was determined by the MQ obtained through the application of KTK - Körperkoordinationstest Für Kinder, developed by Kiphard and Schilling in 1974 (Moreira et al., 2019). The test involves MC components such as: balance, pace, strength, laterality, speed, and agility and is composed of four tasks: (1) walking backwards along a balance beam with a decreasing width, from six cm to four-point five cm, to three cm. In each of these balance beams, subjects are to perform, after a first adaptation with a front walking, three consecutive essays, trying to reach the end of the beam or, otherwise, eight steps without touching the ground or any support of the beam. Each of these essays ends when one of these conditions occurs. Thus, the maximum number of steps subjects can perform is 72 (9x8); (2) jumping from two legs side to side for 15 s.

After an adaptation period with three to five jumps, subjects perform two essays. The final absolute result is the sum of these two essays; (3) move laterally over wooden boards for 20 s. As with JS, subjects may try the task for three or four lateral passages, trying to adapt to the task and to figure out the direction (left or right) that they prefer to perform it. Then, in each of the two essays, they try to make the highest number of lateral transpositions of the wooden platforms. Passing the platform, with both hands, to the other side of the body grants one point; stepping on it (i.e., passing from the actual platform where the subject is with their both feet to the moved platform) grants them another point. The final result of task comes from the sum of all points in the two essays; and (4) single-leg high jump over a foam obstacle with increasing height in consecutive steps of five cm (Gorla et al., 2003; Moreira et al., 2019). Depending on subjects age, researchers shall present them the task with a different number of initial foams, resulting in different initial heights to transpose. In the present case, as children were 10 years-old, the initial number of foams was five. In the present study, raw values (RV), the sum of all the absolute results in the four tasks) and relativized values (through the calculation of global Motor Quotient, deriving from the sum of the MQ of each task) were used. To calculate the MQ of the result of each task, raw results were converted using a predefined table which takes into consideration age and gender (on WB and MS, the table for all genders is the same).

The MQ is considered an index of motor performance, which can be grouped as: MQ 56–70, severe gross MC disorders (<5th percentile; MQS); MQ 71–85, moderate MC disorder (<15th percentile; MQMD); MQ 86–115, normal MC proficiency (16–84th percentile; MQN); MQ 116–130, good MC proficiency(>85th percentile; MQG); MQ 131–145, high MC proficiency ((>98th percentile; MQH).

Statistical analysis

Regarding the statistical analysis, as one of the variables – Time of practice (TP), the number of years of experience of athletics - did not follow a normal distribution, the non-parametric Rho correlation test (ρ) of *Spearman* was used to make the correlational analysis. To compare the MC of children, once the assumptions for the use of parametric tests were verified, the t-test for independent samples was used. In both cases, it was set up as value for interpretation of results $p \leq 0.05$. All analyses were performed using the IBM SPSS Statistics for Windows, version 28.

Results

Table 1 supplies an overview of the MQ classification. Approximately 60% (19/32) of the participants showed good or high gross motor coordination, with only two (about 6.3%) falling below the normal gross MC coordination level. Interestingly, the number of girls classified with high coordination (9/15 – 60%) was significantly higher than that of boys with the same classification (1/17 – 5.9%). Notably, there were no girls with severe or moderate gross MC disorders, while only two boys showed such conditions.

Table 1.
Descriptive analysis of the MQ Classification

MQ Classification QM	Frequency (%) of the total sample	Frequency (%) on boys	Frequency (%) on girls
Severe gross MC disorder	1 (3.1%)	1 (5.9%)	0 (0%)
Moderate gross MC disorder	1 (3.1%)	1 (5.9%)	0 (0%)
Normal gross MC proficiency	11 (34.4%)	8 (47.1%)	3 (20%)
Good gross MC proficiency	9 (28.1%)	6 (35.3%)	3 (20%)
High gross MC proficiency	10 (31.3%)	1 (5.9%)	9 (60%)
Total	32 (100%)	17 (100%)	15 (100%)

Among females, there is a moderate positive correlation with a value of 0.54 ($p = 0.036$). On the other hand, for males, the correlation is 0.38 ($p = 0.129$), which shows a weaker and non-significant association between MC and TP compared to females.

However, despite the moderate correlation seen in girls, as depicted in Table 2, no significant differences (Table 2) were found between children with one or two years of athletics practice and those with three or four years, for both girls and boys.

Table 2.
Comparison of the MC of children with less (1 or 2) and more (3 or 4) years of athletics practice

Sex	n	Years of practice	MQ	t	p
Female	8	1 or 2	111.38±10.309	-1.404	0.092

Notes: n = sample size; MQ = Motor Quotient; t = t-value; p = level of significance at $p < 0,05$

Moving on to Table Moving on to Table 3, the analysis reveals no significant differences in the MC of boys and girls in the KTK test, both in MQ and the absolute value (AV) resulting from the sum of various gross values (e.g., number of steps, number of jumps, etc.).e 4, the analysis reveals no significant differences in the MC of boys and girls in the KTK test, both in MQ and the absolute value (AV) resulting from the sum of various gross values (e.g., number of steps, number of jumps, etc.).

Table 3.
Comparison of the MC of boys and girls by MQ and RV

Sex	n	MQ	*t*	*p*	RV	*t*	*p*
Female	15	114.73±10.243	0.277	0.784	262.40	0.874	0.389
Male	17	113.53±13.830			255.12		

Notes: n = sample size; MQ = Motor Quotient; RV = Raw Values; t = t-value; p = level of significance at $p < 0,05$

Discussion

This study aimed to investigate whether a higher number of years of athletics practice in 10-year-old children would result in higher values of MC, as determined by the Motor Quotient (MQ) in the KTK test. Additionally, we analysed potential differences in MC based on gender. Primarily, the mean Motor Competence (MC) results of the present study appear to be quite impressive when compared to other results presented in the introduction, involving children of equal or similar ages. Specifically, the

Portuguese 10-year-old subjects in this study showed an MQ of 114.09±12.103 (girls 114.73±10.243, boys 113.53±13.830) on the KTK test. In contrast, previous studies by Lopes et al. (2013), focusing on Portuguese children aged 9-12 years using the same assessment instrument (KTK), reported an MQ of 85.7±14.4 (girls 81.7±14.5, boys 89.3±13.4). Similarly, Vandorpe et al. (2011), studying a sample of Flemish children aged 6-12 years, reported an MQ of 96.50±14.3 (girls 94.86±14.49, boys 98.03±14.10). Lastly, Graf et al. (2004), investigating German children aged six to nine years, reported an MQ of 93.49±15.01.

Consequently, while the mean MQ results in the referenced studies placed MC either in the transition from Moderate gross MC disorder to Normal gross MC proficiency or in the lower part of the Normal gross MC proficiency, the mean MQ results of the present study positioned MC in the transition from Normal gross MC proficiency to Good gross MC proficiency. Additionally, in the present study, only 6.3% of the athletics practitioners' MQ fell below the normal gross MC coordination level. This is in contrast to several other studies reporting higher percentage values of Moderate or severe gross MC disorder, such as the 16% reported by Kiphard and Schilling (1974), the 52% by Lopes et al. (2013), the 21.1% by Vandorpe et al. (2011), and the 31.3% by Graf et al. (2004). The present results appear to be notably better than those previously reported, although the type of (sports) practice was not reported in these studies. Besides this first finding, and focusing on the main aim of the study, although it was not possible to find significant differences between girls that practice for one or two years when compared with girls that had three or four years of athletics experience, results revealed that, in this sex, it was possible to find a (moderate) correlation (ρ=0.543, p=0.036) between TP and MC. Thus, it seems that the more years girls spend practicing athletics, the more they develop their MC. This result partially confirms hypothesis one. It appears that for boys, the relationship is not as linear as seen in girls, possibly due to differences in physical stimuli stemming from distinct lifestyles and varying durations of exercise and participation in sports and outdoor activities (Kauderer & Randler, 2013; Mota et al., 2008). As for hypothesis two, it was not confirmed since there were no significant differences between boys and girls in MC. This finding is noteworthy, considering that most previous studies (Graf et al., 2004; Logan et al., 2015; Lopes et al., 2013; Rodrigues et al., 2019; Vandorpe et al., 2011) concluded that boys typically outperform girls in MC results. Thus, the present results allow us to speculate that athletics may have helped to bridge some motor coordination gaps so often seen in girls, given that there were no significant differences in CM between them and boys, both via MQ and RV. Indeed, TP may have proved particularly beneficial for these girls. Several studies have reported a positive association between sports participation and Motor Competence (MC) (Coppens et al., 2021; Fransen et al., 2014; Henrique et al., 2016; Vandorpe et al., 2012). Additionally, Barnett et al. (2011) and Stodden et al. (2014) suggested that sports emphasizing object control may offer more opportunities for the development of general motor competence than sports primarily focused on locomotor skills. According to Stodden et al. (2008), the relationship between motor skill competence and physical activity strengthens over developmental time, and children's physical activity may drive their development of motor skill competence. Pombo et al. (2021) also confirmed in their study on the effect of COVID-19 lockdown on Portuguese children's MC that a prolonged period without practice negatively affects children's MC, supporting the notion that time or years of practice could correspond to better MC. Furthermore, Strong et al. (2005) added that other factors interact with the relationship between motor skill competence and physical activity as it strengthens over time.

Limitations and future research

The current study sample was relatively small and limited to a specific age group, which restricts the generalizability of the findings to other age groups. Additionally, the study's cross-sectional design prevents us from setting up cause-effect relationships. Without a longitudinal approach, it is challenging to find if the association between TP and MC would change in subjects with more years of athletics practice. Future research should consider including subjects from different age groups and employ longitudinal methods to explore changes in MC over time. Furthermore, the absence of other groups of children practicing different sports hindered the possibility of comparing MC between different sports. Future studies should consider including diverse sports groups to better understand the impact of various sports on MC. It would be beneficial to incorporate new batteries, such as the MCA (Rodrigues et al., 2019) and the KTK3+EHC by Platvoet et al. (2018), which assess manipulative components in addition to locomotor and stability skills. This broader evaluation could supply more comprehensive insights into the effects of athletics and other sports on MC. Only longitudinal studies can supply comprehensive insights into the developmental trajectory of MC in children throughout their years of practicing athletics and other organized sports. Additionally, implementing experimental studies with various intervention programs could help find key variables that contribute to enhancing MC. To prove clearer cause-effect relationships, it is crucial to control for several other variables, such as the participants' initial MC level upon starting athletics practice. This will help decide whether athletics developmentally affects MC or if individuals with higher initial MC are more likely to excel in athletics and continue practicing it. Furthermore, exploring the potential benefits of diverse sports practices or combinations of different sports would be interesting. Some studies (Côté et al., 2011; Fransen et al., 2012) suggest that engaging in a variety of sports at a youthful age positively affects gross motor function, including better motor coordination. Therefore, investigating the

comparative effects of different sports and multi-sport involvement on MC could yield valuable insights.

Conclusion

In conclusion, our study revealed a direct moderate association between time of practice and MC, specifically seen in girls. Notably, the mean MC results for both sexes surpassed the typical findings reported in most studies. Surprisingly, no significant differences were found between girls and boys on MC, as assessed using KTK. Our findings suggest that athletics may have played a crucial role in the development of MC in children, with a seemingly greater impact on girls than on boys. However, it is essential to further investigate the specific features of athletics training sessions that contribute to this enhancement of MC in girls. Considering the results, it becomes clear that exploring the underlying factors and mechanisms involved in athletics' influence on MC can supply valuable insights and possibly lead to tailored interventions to promote motor competence in children, irrespective of gender. Further research in this area could contribute to the optimization of physical activity programs and foster healthier and more active lifestyles among children.

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References

Barnett, L. M., Lai, S. K., Veldman, S. L. C., Hardy, L. L., Cliff, D. P., Morgan, P. J., Zask, A., Lubans, D. R., Shultz, S. P., Ridgers, N. D., Rush, E., Brown, H. L., & Okely, A. D. (2016). Correlates of Gross Motor Competence in Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports Medicine (Auckland, N.Z.)*, *46*(11), Article 11. https://doi.org/10.1007/s40279-016-0495-z

Barnett, L. M., Morgan, P. J., Van Beurden, E., Ball, K., & Lubans, D. R. (2011). A reverse pathway? Actual and perceived skill proficiency and physical activity. *Medicine and Science in Sports and Exercise*, *43*(5), 898–904. https://doi.org/10.1249/MSS.0b013e3181fdfadd

Buratti, J., Souza, N., & Gorla, J. (2020). *Coordenação motora: Instrumentos de Medidas e Avaliação*. FEF/UNICAMP.

Coppens, E., Rommers, N., Bardid, F., Deconinck, F. J. A., De Martelaer, K., D'Hondt, E., & Lenoir, M. (2021). Long-term effectiveness of a fundamental motor skill intervention in Belgian children: A 6-year follow-up. *Scandinavian Journal of Medicine & Science in Sports*, *31 Suppl 1*, 23–34. https://doi.org/10.1111/sms.13898

Côté, J., Lidor, R., & Hackfort, D. (2011). ISSP position stand: To sample or to specialize? Seven postulates about youth sport activities that lead to continued participation and elite performance. *International Journal of Sport and Exercise Psychology*, 7. https://doi.org/10.1080/1612197X.2009.9671889Ennis, C. D. (2011). Physical education curriculum priorities: Evidence for education and skillfulness. Quest, 63(1), 5-18. doi:10.1080/00336297.2011.10483659

Fransen, J., Deprez, D., Pion, J., Tallir, I. B., D'Hondt, E., Vaeyens, R., Lenoir, M., & Philippaerts, R. M. (2014). Changes in physical fitness and sports participation among children with different levels of motor competence: A 2-year longitudinal study. *Pediatric Exercise Science*, *26*(1), 11–21. https://doi.org/10.1123/pes.2013-0005

Fransen, J., Pion, J., Vandendriessche, J., Vandorpe, B., Vaeyens, R., Lenoir, M., & Philippaerts, R. M. (2012). Differences in physical fitness and gross motor coordination in boys aged 6-12 years specializing in one versus sampling more than one sport. *Journal of Sports Sciences*, *30*(4), 379–386. https://doi.org/10.1080/02640414.2011.642808

Gorla, J. I., Araújo, P. F., Rodrigues, J. L., & Pereira, V. R. (2003). O teste KTK em estudos da coordenação motora. *Conexões*, *1*(1), Article 1. https://doi.org/10.20396/conex.v1i1.8640804

Graf, C., Koch, B., Kretschmann-Kandel, E., Falkowski, G., Christ, H., Coburger, S., Lehmacher, W., Bjarnason-Wehrens, B., Platen, P., Tokarski, W., Predel, H. G., & Dordel, S. (2004). Correlation between BMI, leisure habits and motor abilities in childhood (CHILT-project). *International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity*, *28*(1), 22–26. https://doi.org/10.1038/sj.ijo.0802428

Henrique, R. S., Ré, A. H. N., Stodden, D. F., Fransen, J., Campos, C. M. C., Queiroz, D. R., & Cattuzzo, M. T. (2016). Association between sports participation, motor competence and weight status: A longitudinal study. *Journal of Science and Medicine in Sport*, *19*(10), 825–829. https://doi.org/10.1016/j.jsams.2015.12.512

Kauderer, S., & Randler, C. (2013). Differences in time use among chronotypes in adolescents. *Biological Rhythm Research*, *44*(4), 601–608. https://doi.org/10.1080/09291016.2012.721687

Kiphard, E., & Schiling, F. (1974). *Körperkoordination Test für Kinder*. KTK. Beltz Test Gmbh.

Logan, S. W., Webster, E. K., Getchell, N., Pfeiffer, K. A., & Robinson, L. E. (2015). Relationship Between Fundamental Motor Skill Competence and Physical Activity During Childhood and Adolescence: A Systematic Review. *Kinesiology Review*, *4*(4), 416–426. https://doi.org/10.1123/kr.2013-0012

Lopes, L., Santos, R., Pereira, B., & Lopes, V. P. (2013). Associations between gross Motor Coordination and Academic Achievement in elementary school children. *Human Movement Science*, *32*(1), 9–20. https://doi.org/10.1016/j.humov.2012.05.005

Lubans, D. R., Morgan, P. J., Cliff, D. P., Barnett, L. M., & Okely, A. D. (2010). Fundamental movement skills in children and adolescents: review of associated health

benefits. Sports medicine (Auckland, N.Z.), 40(12), 1019–1035. https://doi.org/10.2165/11536850-000000000-00000.

Marta, C. C., Marinho, D. A., Barbosa, T. M., Izquierdo, M., & Marques, M. C. (2012). Physical Fitness Differences Between Prepubescent Boys and Girls. *The Journal of Strength & Conditioning Research*, *26*(7), 1756. https://doi.org/10.1519/JSC.0b013e31825bb4aa

Moreira, J. P. A., Lopes, M. C., Miranda-Júnior, M. V., Valentini, N. C., Lage, G. M., & Albuquerque, M. R. (2019). Körperkoordinationstest Für Kinder (KTK) for Brazilian Children and Adolescents: Factor Analysis, Invariance and Factor Score. *Frontiers in Psychology*, *10*. https://www.frontiersin.org/articles/10.3389/fpsyg.2019.02524

Morrongiello, B. A., & Dawber, T. (1999). Parental Influences on Toddlers' Injury-Risk Behaviors: Are Sons and Daughters Socialized Differently? *Journal of Applied Developmental Psychology*, *20*(2), 227–251. https://doi.org/10.1016/S0193-3973(99)00015-5

Morrongiello, B. A., & Dawber, T. (2000). Mothers' Responses to Sons and Daughters Engaging in Injury-Risk Behaviors on a Playground: Implications for Sex Differences in Injury Rates. *Journal of Experimental Child Psychology*, *76*(2), 89–103. https://doi.org/10.1006/jecp.2000.2572

Mota, J., Santos, M. P., & Ribeiro, J. C. (2008). Differences in Leisure-Time Activities According to Level of Physical Activity in Adolescents. *Journal of Physical Activity and Health*, *5*(2), 286–293. https://doi.org/10.1123/jpah.5.2.286

Platvoet, S., Faber, I. R., de Niet, M., Kannekens, R., Pion, J., Elferink-Gemser, M. T., & Visscher, C. (2018). Development of a Tool to Assess Fundamental Movement Skills in Applied Settings. *Frontiers in Education*, *3*. https://www.frontiersin.org/articles/10.3389/feduc.2018.00075

Pombo, A.; Luz, C.; de Sá, C.; Rodrigues, L.P.; Cordovil, R. Effects of the COVID-19 Lockdown on Portuguese Children's Motor Competence. Children 2021, 8, 199. https://doi.org/10.3390/ children8030199

Prieto-Báscon, M. (2010). *Habilidades motrices básicas*. Csifrevistad.

Rodrigues, L. P., Luz, C., Cordovil, R., Bezerra, P., Silva, B., Camões, M., & Lima, R. (2019). Normative values of the motor competence assessment (MCA) from 3 to 23 years of age. *Journal of Science and Medicine in Sport*, *22*(9), 1038–1043. https://doi.org/10.1016/j.jsams.2019.05.009

Sá, C. dos S. C. de, Luz, C., Rodrigues, L. P., & Cordovil, R. (2021). Motor Competence Assessment—Adaptação cultural para o Brasil (MCA-BR). *Fisioterapia e Pesquisa*, *28*, 49–59. https://doi.org/10.1590/1809-2950/20017628012021

Sola, K., Brekke, N., & Brekke, M. (2010). An activity-based intervention for obese and physically inactive children organized in primary care: Feasibility and impact on fitness and BMI. *Scandinavian Journal of Primary Health Care*, *28*(4), 199–204. https://doi.org/10.3109/02813432.2010.514136

Spessato, B. C., Gabbard, C., & Valentini, N. C. (2013). The Role of Motor Competence and Body Mass Index in Children's Activity Levels in Physical Education Classes. *Journal of Teaching in Physical Education*, *32*(2), 118–130. https://doi.org/10.1123/jtpe.32.2.118Stodden D, Langendorfer S, Roberton MA. The association between motor skill competence and physical fitness in young adults. Res Q Exerc Sport 2009; 80 (2): 223-9Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Roberton, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A Developmental Perspective on the Role of Motor Skill Competence in Physical Activity: An Emergent Relationship. Quest, 60(2), 290–306. https://doi.org/10.1080/00336297.2008.10483582

Stodden, D. F., Gao, Z., Goodway, J. D., & Langendorfer, S. J. (2014). Dynamic Relationships Between Motor Skill Competence and Health-Related Fitness in Youth. *Pediatric Exercise Science*, *26*(3), 231–241. https://doi.org/10.1123/pes.2013-0027Strong, W. B., Malina, R. M., Blimkie, C. J., Daniels, S. R., Dishman, R. K., Gutin, B., Hergenroeder, A. C., Must, A., Nixon, P. A., Pivarnik, J. M., Rowland, T., Trost, S., & Trudeau, F. (2005). Evidence based physical activity for school-age youth. The Journal of pediatrics, 146(6), 732–737. https://doi.org/10.1016/j.jpeds.2005.01.055.

Vandorpe, B., Vandendriessche, J., Lefevre, J., Pion, J., Vaeyens, R., Matthys, S., Philippaerts, R., & Lenoir, M. (2011). The KörperkoordinationsTest für Kinder: Reference values and suitability for 6–12-year-old children in Flanders. *Scandinavian Journal of Medicine & Science in Sports*, *21*(3), 378–388. https://doi.org/10.1111/j.1600-0838.2009.01067.x

Vandorpe, B., Vandendriessche, J., Vaeyens, R., Pion, J., Matthys, S., Lefevre, J., Philippaerts, R., & Lenoir, M. (2012). Relationship between sports participation and the level of motor coordination in childhood: A longitudinal approach. *Journal of Science and Medicine in Sport*, *15*(3), 220–225. https://doi.org/10.1016/j.jsams.2011.09.006

Wood, W., & Eagly, A. H. (2012). Chapter two—Biosocial Construction of Sex Differences and Similarities in Behavior. In J. M. Olson & M. P. Zanna (Eds.), *Advances in Experimental Social Psychology* (Vol. 46, pp. 55–123). Academic Press. https://doi.org/10.1016/B978-0-12-394281-4.00002-7

World Medical Association. (2013). World medical association declaration of Helsinki. *JAMA*.Wrotniak, B. H., Epstein, L. H., Dorn, J. M., Jones, K. E., & Kondilis, V. A. (2006). The relationship between motor proficiency and physical activity in children. Pediatrics, 118(6), e1758–e1765. https://doi.org/10.1542/peds.2006-0742.