

KINESIOLOGY & COACHING

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Analysis of the level of motor coordination in children Brazilian jiu-jitsu practitioners

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Abstract

Background. Brazilian *jiu-jitsu* classes require a wide motor repertoire to carry out the activities since good motor coordination is needed to perform different techniques of the sport. However, little is known about the effects of Brazilian *jiu-jitsu* on the level of motor coordination of its practitioners.

Problem and aim. To compare motor coordination between beginner and experienced children Brazilian *jiu-jitsu* practitioners, as well as distinguish whether sex and age influence the results.

Methods. The study included 31 children (aged: 8 to 14 years, 19 male and 12 female) Brazilian *jiu-jitsu* practitioners. To assess motor coordination, the KTK (*Körperkoordinationstest für Kinder*) test battery was applied, consisting of four tasks (walking backwards, jumping sideways, hopping for height, and moving sideways). The normality of the data was verified by the Shapiro-Wilk test. For comparison between groups (practice time, sex, or age), the *t* test for independent measures was used.

Results: In the analysis by practice time, experienced practitioners presented better performance than beginner practitioners for the motor quotient score hopping for height ($p < 0.05$) and for total KTK motor quotient ($p < 0.05$). In the overall analysis (without distinction for sex, age, or practice time), 54.8% of the children were classified as having severe motor disorder. In total, 93.5% of the participants are below the classification considered normal, with only 6.5% reaching the normal coordination classification.

Conclusion. Brazilian *jiu-jitsu* may positively influence children's motor coordination. The practice of Brazilian *jiu-jitsu* alone was unable to avoid below normal levels of motor coordination. Future interventions in longitudinal studies with complementary tests are suggested.

Introduction

Motor coordination can be understood as the ability to integrate motor systems and sensory modalities in an efficient movement [Gallahue *et al.* 2013], which is essential to generate standardization of the movements of the body and limbs related to different events and objects [Magill 2000]. Interactions of motor tasks, individual

biology, and environmental conditions promote changes in motor behavior throughout the life cycle, occurring more sharply in childhood [Gallahue *et al.* 2013]. In this sense, physical activity, exercise, play, and sport are highly important in the motor development of children [Han *et al.* 2018; Opstoel *et al.* 2015].

However, high rates of physical inactivity have been shown in young people, with approximately 81% of stu-

dents aged 11-17 years not meeting the recommendations for physical activity [Guthold *et al.* 2020]. Moreover, different evidence suggests that physical inactivity increases the risk of being overweight, which negatively influences children's motor coordination levels [Henrique *et al.* 2018, Lopes *et al.* 2018, Luz *et al.* 2015]. As motor coordination is positively associated with physical activity and inversely associated with sedentary activity in children [Laukkanen *et al.* 2017; Wrotniak *et al.* 2006], it is extremely important to provide exercise strategies for the development of motor coordination in this age group.

Combat sports have shown effectiveness in the development of physical fitness and health of their practitioners [Brasil *et al.* 2020; Ciaccioni *et al.* 2019; Fukuda *et al.* 2011; Kambic *et al.* 2017; Lee, Kim 2015; Roh *et al.* 2020]. However, fewer studies have investigated the development of motor coordination in children [Alesi *et al.* 2014; Krstulovic *et al.* 2010; Sekulic *et al.* 2006]. Among combat sports, Brazilian jiu-jitsu has seen a wide increase in popularity in recent years, with great demand from new practitioners, including children [Gehre *et al.* 2010; Vidal-Andreato *et al.* 2011]. Brazilian jiu-jitsu classes require a wide motor repertoire to carry out activities, with different forms of displacements and movements [Branco *et al.* 2016; Del Vecchio *et al.* 2016]. Thus, good motor coordination is needed to perform different techniques of the sport (e.g. take-down, immobilizations, guard pass, sweep, choke, and joint locks). In addition, the sport includes calisthenic exercises and play for warm-up and conditioning. Therefore, this scenario seems to be conducive to the motor development of children. However, studies are lacking to verify this hypothesis.

Therefore, the current study aimed to compare motor coordination between beginner and experienced children Brazilian jiu-jitsu practitioners, as well as to distinguish whether sex and age influence the results.

Material and Methods

Participants

The current study included 31 children (11.2 ± 1.8 years old [yo], 8 to 14 years, 19 male and 12 female) Brazilian jiu-jitsu practitioners. The sample was subdivided into groups related to the practice time (*BEGINNERS*: $n=17$, 11.0 ± 1.8 yo, 10 boys and 7 girls, 6 months to 1 year of training; and *EXPERIENCED*: $n=14$, 11.5 ± 1.8 yo, 9 boys and 5 girls, > 1 year of training), sex: (*MALE*: $n=19$; 11.5 ± 1.8 yo; and *FEMALE*: $n=12$, 10.9 ± 1.8 yo) and age (*8 to 10 yo*: $n=17$ children, 9.8 ± 0.7 yo, 10 boys and 7 girls; and *11 to 14 yo*: $n=14$, 13.0 ± 1.1 yo; 9 boys and 5 girls). As an inclusion criterion, children should train Brazilian jiu-jitsu regularly for at least six months; and as an exclusion criterion was the presence of injuries, diagnosis of health problems, or regular participation in

classes of another sports modality. Parental or guardian informed consent was obtained for each subject in addition to written informed consent from the participants. The study was approved by the local ethics committee.

Brazilian jiu-jitsu classes

All children practiced Brazilian jiu-jitsu in the same sports club, in a city in southern Brazil. Classes were conducted 4 times a week, with each class lasting 1 hour, and most classes were divided into a warm-up (e.g. play, physical exercises) of 10 to 15 minutes, technical part (learning or repetition of some specific technique) of 10 to 20 minutes, combat (Brazilian jiu-jitsu simulates matches) of 15 to 20 minutes, and cool-down (stretching or concentration/relaxation activities) of 5 to 10 minutes. All classes were conducted by a coach who graduated from Physical Education and second-degree Brazilian jiu-jitsu black-belt.

Assessment of motor coordination

To assess motor coordination, the KTK (*Korperkoordinationstest für Kinder*) test battery was applied, consisting of four tasks (walking backwards, jumping sideways, hopping for height, and moving sideways). There was no standard warm-up before the KTK, but the participants performed familiarization trials before each task. An interval of five minutes was given between each task. The KTK is a highly valid and reliable test in healthy children, with a test-retest reliability of 0.97 [Kiphard, Schilling 1974].

Walking backwards: The participant is required to walk backwards, balancing on a bar (Figure 1), aiming at reaching the end of the bar. If the participant falls or touches the ground with one foot or any other part of the body, they have to return to the beginning of the bar and perform the test again. The participant was given one attempt at familiarization on each bar. However, during the test for data collection, three attempts, without interval, were executed for each of the three bars, and the best result between attempts was analyzed. The goal is to take as many steps on the bar without falling. For scoring, each step is worth one point (except for the first contact with the wood), and the maximum score is 8 points. If the participant is able to take more than eight steps or the route is completed in less than eight steps, the maximum score is awarded.

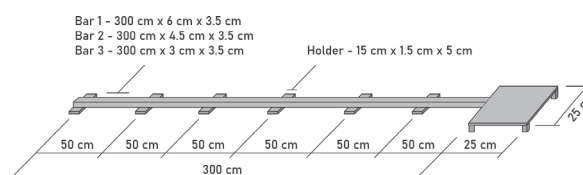


Figure 1. Dimensions of the balance bars.

Jumping sideways: The participant is required to jump, with both legs, on a wooden platform (Figure 2), from

side to side, as fast as possible for 15 seconds. The test consists of two 15-second attempts, with a one-minute interval between attempts. The participant was allowed to perform five jumps as familiarization. For scoring, the number of jumps performed in each attempt is counted (15 seconds), and the two attempts are added. Each jump is worth one point (going= +1; back=+1). Points are not considered when the participant: touches the wood; leaves the square in the jump; skips twice on the same side, or performs a one-leg jump.

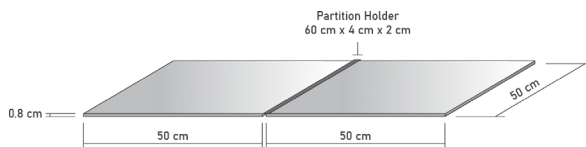


Figure 2. Dimensions of the wooden platform for jumping sideways.

Hopping for height: The participant is required to jump with one leg over a 5 cm high foam block (Figure 3). After jumping over the block, the participant is required to jump twice on the same leg, so that the jump is considered valid. In sequence, the participant performs the same activity with the other leg. If the task is carried out successfully, a new block is added, and the procedure is repeated up to a maximum of 12 blocks. The participant is allowed two attempts as familiarization. If the participant is able to perform the task on the first familiarization attempt, it is not necessary to perform the second. The test consists of three attempts for each foot, at each height, without interval between attempts. As a score, each height is jumped with the left leg and then immediately with the right leg, but evaluated separately. When the participant performs the jump successfully on the first attempt, they receive 3 points, on the second attempt, 2 points, and on the third attempt, 1 point. In the case of three wrong attempts at a given height, the participant can only go to the next height when the sum of the points from the two previous heights adds up to 5 points.

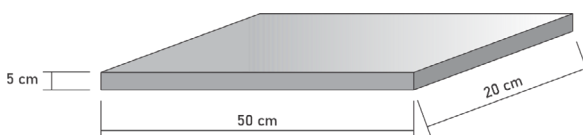


Figure 3. Dimensions of the foam block.

Moving sideways: The participant is required to move laterally the greatest number of times in 20 seconds, by changing platforms (Figure 4). The participant begins with both feet on platform 1, they then pick up platform 2 with both hands and place it on the other side of the body and then move to this platform. Next, they pick up platform 1 with both hands, place it on the other side of the body and continue the movement, repetitively. During the test the participant is required to move in

a straight path, and not put their feet on the floor. The participant performs the test twice, with each test taking 20 seconds. Between the tests a pause of at least 10 seconds is allowed. Prior to performing the test, a familiarization attempt with three transpositions was allowed. For scoring, one point is awarded when the participant takes the board from one side and places it on the other and when they change platforms. The values of the two attempts, of 20 seconds each, are noted and added up, and the total score is recorded.

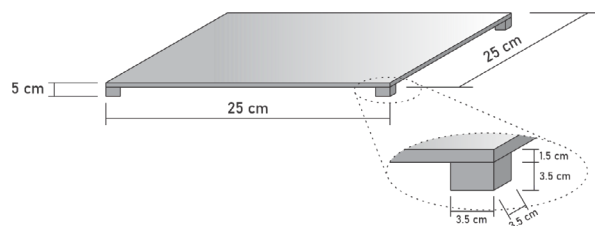


Figure 4. Dimensions of the wooden platform for moving sideways.

The test scores for these four tasks were transformed into motor quotient (MQ) scores, according to the test's sex-specific norms, and interpreted as follows: severe motor disorder (MQ score 56–70, percentile 0–2), moderate motor disorder (MQ score 71–85, percentile 3–16), normal (MQ score 86–115, percentile 17–84), good (MQ score 116–130, percentile 85–98), and high (MQ 131–145, percentile 99/100) [Kiphard, Schilling 1974; Walhain *et al.* 2016].

Statistical analysis

The data are presented as mean and standard deviation, or frequency and percentage. The Shapiro-Wilk test was used to verify the normality of the data. For comparison between groups (practice time, sex, or age), the *t* test for independent measures was used. To evaluate the magnitude of the difference, the Cohen's *d* was calculated [Cohen 1988], with the following threshold values: trivial= < 0.2; small= 0.2 and < 0.6; moderate= 0.6 and < 1.2; large= 1.2 and < 2.0; very large= 2.0 and < 4.0; nearly perfect= ≥ 4.0 [Hopkins 2006]. The significance level was set at 5%. The data were analyzed using the *Statistic Package for the Social Sciences* (SPSS) software, version 15.0.

Results

Table 1 presents the results of gross motor coordination of the children Brazilian jiu-jitsu practitioners.

In the overall analysis (without distinction for sex, age, or practice time), 54.8% of children presented the classification as severe motor disorder. In total, 93.5% of practitioners were below the classification considered normal, with only 6.5% reaching the classification of nor-

mal motor coordination. In the analysis by practice time, experienced (85.7%) and beginner (100%) practitioners presented a low level of motor coordination, with only 14.3% of experienced practitioners classified within the normal range. In the analysis by sex, male (89.5%) and female (100%) practitioners had low levels of motor coordination, with only 10.5% of boys classified within the normal range. In age analysis, 8-10 years (88.2%) and 11-14 years (100%) practitioners presented low levels of motor coordination, with only 11.8% of 8-10 years children classified within the normal range.

Table 1. Classification of the gross motor coordination of the children Brazilian jiu-jitsu practitioners, evaluated by the KTK test.

	LEVEL OF MOTOR COORDINATION		
	Normal	Moderate disorder	Severe disorder
Overall			
All children (n= 31)	2 (6.5%)	12 (38.7%)	17 (54.8%)
Practice time			
Beginners (n= 17)	0 (0%)	5 (29.4%)	12 (70.6%)
Experienced (n= 14)	2 (14.3%)	7 (50.0%)	5 (35.7%)
Sex			
Male (n= 19)	2 (10.5%)	10 (52.6%)	7 (36.8%)
Female (n= 12)	0 (0%)	2 (16.7)	10 (83.3%)
Age			
8-10 yo (n= 17)	2 (11.8%)	8 (47.1%)	7 (41.2%)
11-14 yo (n= 14)	0 (0%)	4 (28.6%)	10 (71.4%)

Data are presented as frequency and percentage. KTK: *Körperkoordinationstest für Kinder*; yo: years old.

Table 2 shows the results of each component of the KTK test, applied to Brazilian jiu-jitsu practitioners, divided by categories (practice time, sex, and age).

In the analysis by practice time, experienced practitioners presented better performance than beginner practitioners in the MQ score of the hopping for height test ($p<0.05$; $d= 1.3$; *large*) and for total KTK performance ($p<0.05$; $d= 1.1$; *moderate*). In the other components, no significant differences between the groups were found. In

the analysis by sex, boys performed better than girls in the MQ score of the jumping sideways test ($p<0.05$; $d= 2.0$; *very large*). In the other components, no significant differences between the sexes were found. In the analysis by age, 8-10 yo performed better than 11-14yo in the MQ score of the moving sideways test ($p<0.05$; $d= 1.7$; *large*). In the other components, no significant differences between the two groups were found.

Discussion

The current study aimed to compare motor coordination between beginner and experienced children Brazilian jiu-jitsu practitioners, as well as to distinguish whether sex and age influence the results. The main results showed that the majority of children have a severe motor disorder classification, regardless of age, sex, or practice time. When comparing the subgroups, there was an effect of practice time, since the experienced group presented a higher MQ score on the hopping for height test and total MQ score of the KTK test than the beginner group.

In the overall analysis (without distinction for sex, age, or practice time), the vast majority of the sample presented a classification index below normal (moderate motor disorder or severe motor disorder). These results are similar to those previously observed in Brazilian schoolchildren (931 children of 7 to 10 years of age), where 70.1% of the participants presented coordination below the classification considered normal (42.4% with moderate motor disorder and 27.7% with severe motor disorder), regardless of age and sex [Carminato 2010]. This poor motor performance may be associated with the contemporary lifestyle, since high levels of physical inactivity are observed among children and adolescents worldwide [Guthold *et al.* 2020; Hallal *et al.* 2012], a fact that causes impairments in motor coordination [Laukkanen *et al.* 2017; Wrotniak *et al.* 2006].

In this sense, it is necessary to consider that motor disorders occur due to a delay in motor coordination in relation to motor development throughout life, in

Table 2. Gross motor coordination of children Brazilian jiu-jitsu practitioners, considering each component of the KTK test.

	Walking backwards	Hopping for height	Jumping sideways	Moving sideways	TOTAL MQ
Practice time					
Beginners (n= 17)	81.6 ± 17.2	72.7 ± 18.6	77.5 ± 18.5	44.0 ± 5.0	276.0 ± 44.4
Experienced (n= 14)	92.7 ± 17.5	92.6 ± 9.9*	88.5 ± 15.2	47.7 ± 5.2	321.7 ± 35.5*
Sex					
Male (n= 19)	86.8 ± 18.5	83.8 ± 19.3	92.3 ± 13.6	46.0 ± 5.7	308.9 ± 45.4
Female (n= 12)	86.4 ± 17.8	78.5 ± 16.4	67.0 ± 11.3 [‡]	45.2 ± 4.9	277.1 ± 42.0
Age					
8-10 yo (n= 17)	89.8 ± 15.9	83.6 ± 14.2	85.7 ± 21.6	48.9 ± 4.3	308.1 ± 44.7
11-14 yo (n= 14)	82.8 ± 20.1	79.4 ± 22.3	78.5 ± 11.1	41.9 ± 4.0 [¥]	282.7 ± 45.6

Data are presented as mean ± standard deviation. KTK: *Körperkoordinationstest für Kinder*, MQ: motor quotient, yo: years old. * $p<0.05$ compared to beginners, [‡] $p<0.05$ compared to male, [¥] $p<0.05$ compared to 8-10 yo.

which the lack of motor experiences can generate low motor coordination related to age [Quintas *et al.* 2000]. Thus, the results of the present study suggest that not even a systematized activity such as Brazilian jiu-jitsu is able to supply the entire motor apparatus that comprises the human body. The development of specialized movement skills depends on the opportunities for practice, stimulus, quality of practice, and ecological context of the environment [Gallahue *et al.* 2013]. Therefore, in addition to the practice of Brazilian jiu-jitsu, children should experience various motor stimuli (e.g. sports, games, and recreational activities, among other activities), which contribute to motor development. These approaches should be adopted in different situations, such as the occupation of free time (through the promotion of deliberate practices that involve maximum experimentation and diversification of movements), school (during breaks/lunch break and in sports schools), and daily activities of the child (facilitated through the family and environmental context). Finally, it is also necessary to consider the characteristics of the test used in this study to evaluate the motor coordination. Many movements explored in Brazilian jiu-jitsu are performed on the ground, thus showing little similarity with the tasks of the KTK test. Therefore, the transfer of motor experiences from the practice of Brazilian jiu-jitsu may require more time to be observed in a non-specific test.

Regarding practice time, although the majority of participants in both groups (beginners and experienced) were classified below the normality indices, the results showed that the experienced group presented better performance in the MQ score of the hopping for height test and performance in the total KTK MQ score, in relation to the beginners group. In addition, when analyzing qualitatively, there was a lower occurrence of experienced practitioners classified with severe motor disorder (35.7% vs 70.6%), whereas there was a higher occurrence of experienced practitioners receiving the normal coordination classification (14.3% vs 0.0%). In this sense, although the study of the influence of Brazilian jiu-jitsu on motor coordination has not been much explored in the current literature, it is possible that this better performance of the experienced group is due to the Brazilian jiu-jitsu classes involving a variety of motor experiences (e.g. groundwork, standing work, takedown, immobilizations, play), thus working children's psychomotricity, in addition to developing some physical abilities and skills that are essential for the practitioner to achieve combat efficiency.

Regarding sex, there was no difference between boys and girls for the total MQ scores, with both sexes classified mostly below normality indices. However, when analyzing qualitatively, there was a higher occurrence of girls classified with severe motor disorder (83.3% vs 36.8%) and a higher occurrence of boys who received the classification of normal coordination (10.5% vs 0.0%). Thus, in a way, these results are similar to those previ-

ously observed in Brazilian schoolchildren (108 children and adolescents aged 10 to 12 years) [Soares *et al.* 2014]. In this sense, this difference could have a cultural influence regarding; the type of activities chosen, with girls tending to spend less time on active games; parents, who culturally tending to be more permissive towards boys, allowing greater opportunity for active moments in daily life [Valdivia *et al.* 2008]; and body composition, with girls at puberty tending to have higher body fat, which negatively influences motor coordination [Henrique *et al.* 2018; Valdivia *et al.* 2008].

Regarding age, the results showed that there was no difference between 8-10 yo and 11-14 yo for the total MQ scores, with both age groups being classified mostly below normality indices. However, when analyzing qualitatively, there was a higher occurrence of 11-14yo classified with severe motor disorder (71.4% vs 41.2%) and a higher occurrence of 8-10 yo receiving the classification of normal coordination (11.8% vs 0.0%). In this sense, there seems to be no consensus in the literature regarding age and motor coordination, with studies reporting divergent results [Laukkanen *et al.* 2017; Soares *et al.* 2014]. In a previous meta-analysis, strong evidence was reported for age as a positive factor for some skills (object control, locomotor skills, and stability), but inconsistent evidence for age as a correlate of motor coordination and composite skills [Barnett *et al.* 2016]. Prepubescents, for example, may suffer less from changes in a spatial sense, since pubescents develop quickly at the extremities of the body, with a significant change in the center of mass of the limbs and body, requiring constant readjustment of brain processing [Gallahue *et al.* 2013]. In addition, it should be considered that older children (pubescent) tend to have a gradual participatory decrease in adherence to sports practices (many due to higher levels of school/study demand and/or discoveries regarding relationships in adolescence), which can lead to decreases in motor contribution, and may even negatively affect the subject in relation to coordination and/or skill difficulties in adult life.

Due to the biological changes that children and adolescents undergo, knowing the level of development of motor coordination of these individuals is an important reference to enable adjustment of motor activities in programs aimed at them. Thus, motor coordination assessment could be an important tool in programs aimed at children, since the results allow the coach to understand how the child combines the possibilities of the numerous degrees of freedom of the motor system in the execution of tasks [De Rose Jr 2009].

Another point to be highlighted is that for a deeper understanding of the effect of Brazilian jiu-jitsu on the motor coordination level of children, future investigations should overcome some of the limitations present in the current study. The design of the present study was transversal, whereas a longitudinal intervention design

could provide stronger evidence of how BJJ influences motor coordination in children. Longitudinal studies may contribute to understanding of the cause-effect of the practice, given the limitation of the transversal model for this purpose. It is relevant to include tests that address different aspects of motor development, double-task, or more complex tests. Moreover, in order to reduce the risk of bias in the analysis, a control group is highly recommended, either with a traditional model of a group of children not involved in BJJ during the intervention or with multiple baseline tests with the experimental group before the intervention. Finally, this study did not strictly control factors that may influence the variables assessed. Therefore, future studies should monitor confounding factors such as past and current practices in other sports, as well as physical activity levels in general.

Finally, it is expected that the results of this study could guide coaches to include different motor activities, which are not only directed to the development of specific skills of Brazilian jiu-jitsu, but which assist in the child's general motor development. In addition, these results can guide parents, who in addition to providing systematic sports practice, should offer other motor experiences to their children, in order to be able to cover the motor multiplicities of the human body. Furthermore, the development of public policies is relevant to support opportunities for the practice of sports activities that contribute to the motor development of Brazilian children, providing more pleasurable physical activities and, thus, making individuals less sedentary and more active.

Conclusions

Based on the present findings, it is suggested that Brazilian jiu-jitsu positively influences children's motor coordination, although the practice alone is not enough to prevent children from presenting motor coordination below the normal level. In addition, although there were no differences in the total MQ scores, qualitatively, boys obtained better ratings than girls, and 8-10 yo children obtained better ratings than 11-14 yo children.

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Analiza poziomu koordynacji ruchowej u dzieci praktykujących brazylijskie jiu-jitsu

Słowa kluczowe: sporty walki, sztuki walki, kontrola motoryczna, rozwój motoryczny

Streszczenie

Tło. Zajęcia brazylijskiego jiu-jitsu wymagają szerokiego repertuaru motorycznego, ponieważ potrzebna jest dobra koordynacja ruchowa do wykonywania różnych technik tego sportu. Niewiele jednak wiadomo o wpływie brazylijskiego jiu-jitsu na poziom koordynacji ruchowej jego praktykujących. Problem i cel. Porównanie koordynacji ruchowej między dziećmi praktykującymi brazylijskie jiu-jitsu na poziomie początkującym i zaawansowanym, a także rozróżnienie, czy płeć i wiek wpływają na wyniki.

Metody. W badaniu wzięło udział 31 dzieci i młodzieży (w wieku: od 8 do 14 lat, 19 mężczyzn i 12 kobiet) brazylijskich praktykujących jiu-jitsu. Do oceny koordynacji ruchowej zastosowano baterię testową KTK (*Korperkoordinationstestfur Kinder*), składającą się z czterech zadań (chodzenie do tyłu, skakanie na boki, skakanie wzwyż i poruszanie się na boki). Prawidłowość danych zweryfikowano testem Shapiro-Wilka. Do porównania między grupami (czas praktyki, płeć lub wiek) zastosowano test t dla pomiarów niezależnych.

Wyniki. W analizie według czasu praktyki doświadczeni zawodnicy prezentowali lepsze wyniki niż początkujący zawodnicy

w zakresie przeskakiwania wskaźnika motorycznego dla wzrostu ($p < 0,05$) oraz dla całkowitego wskaźnika motorycznego KTK ($p < 0,05$). W ogólnej analizie (bez rozróżnienia na płeć, wiek lub czas praktyki) 54,8% dzieci zostało sklasyfikowanych jako mających ciężkie zaburzenia motoryczne. W sumie 93,5% uczestników znajduje się poniżej klasyfikacji uznanej za normalną, a tylko 6,5% osiąga normalną klasyfikację koordynacyjną.

Wniosek. Brazylijskie jiu-jitsu może pozytywnie wpływać na koordynację ruchową dzieci. Sama praktyka brazylijskiego jiu-jitsu nie była w stanie poprawić poziomu koordynacji ruchowej, która została poniżej poziomu normalnego. Sugerowane są przyszłe interwencje w badaniach podłużnych z testami uzupełniającymi.