Research in Physical Education, Sport and Health
2020, Vol. 9, No. 1, pp.41-46
ISSN(Print):1857-8152; ISSN(Online):1857-8160

APPLICATION OF THE TEST OF GROSS MOTOR DEVELOPMENT-2 FOR DETERMINING THE LEVEL OF FUNDAMENTAL MOVEMENT SKILLS OF CHILDREN INVOLVED IN DIFFERENT SPORTS ACTIVITIES

DOI: https://doi.org/10.46733/PESH2090041k
(Original scientific paper)

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Abstract

Approach:Fundamental movement skills are described as the most important aspect of human movement in early childhood, as well as the most important prerequisite for later involvement in sport. Purpose: The main purpose of this research was to determine the differences in fundamental movement skills among eight-year-old children participants of different sports activities. Methods: The sample consisted of 60 students: football (N = 20), gymnastics (N = 20) and universal sports school (N = 20). Children were tested using Test of Gross Motor Development – 2 (TGMD-2). Results: It is possible to conclude that all three sports activities that children are engaged in develop their fundamental movement skills on a high level. Based on the overall TGMD-2 test results, it is not possible to discuss which sport is developing overall skills on a higher level, because significant differences have not been found. However, analyzing locomotor and object control subtests obvious advantage of gymnasts in locomotor skills and footballers and participants of the universal sports school in manipulative skills is significantly visible. Conclusions: To gain even better insight about which sport or sports discipline best develops fundamental skills in children it would be important to analyze an even larger sample of subjects of different basic sports in future research.

Key words: *football; gymnastics; locomotor skill; motor skills; object control skill*

Introduction

Fundamental movement skills (FMS) are defined as standard motor activities that form the basis for more advanced and more specific motor activities, such as specialized movement skills (Wickstrom, 1983). FMS are described as building blocks for movement and form the basis for many specialized movement skills required for successful participation in sports and physical activity (Gallahue & Ozmun, 1998; Costa et al., 2018). Failure to develop basic motor movements during the key years of elementary school age often brings children to frustration and failure during adolescence and adulthood. For example, without developing basic patterns in throwing, catching, and other manipulative motor skills, children can hardly succeed in enjoying a recreational handball game. Also, if a child automates the wrong pattern of movement, say running, it's much harder to correct it than to learn it properly from the beginning. So, for example, today we can see a lot of footballers with improper running techniques, i.e. low knees, not using enough hip flexors. But if these same footballers mastered the correct pattern of movement in the crucial age, they would have had a much more developed speed, which is of great importance to that sport. Teachers and coaches should pay special attention to FMS development during childhood, i.e. in preschool education and youngest school age (Sanders, 1992; Gabbard, 2002) because the preschool environment is very important in encouraging and developing FMS (Dwyer, Baur & Hardy, 2009). Researchers report a wide range of FMS being important for children's cardiorespiratory fitness and physical activity (Bolger et al, 2019). Interventions designed to enhance the development of object control skills should be in place long before grade 4 when most physical education curricula transitions to games and sports (Angell et al., 2018). According to Burton and Miller (1998), FMS can be divided into two categories: locomotor skills and object control skills. The authors state that these skills can be considered as phylogenetic skills because of their universal appearance. Locomotor skills include walking, running, jumping, sliding, skimming, skipping, and object control skills include throwing, catching, hitting, bouncing and pushing.

Some tests for FMS assessment focus on the quantity and some on the quality of the performance. Quantitative approaches to FMS assessment include measuring the output of the performance. The result is mainly compared with normative group performances. This approach to the measurement of FMS mainly provides a high degree of reliability (Spray, 1987). Most tests can be done quickly and are suitable for testing larger groups. Since tests do not require a substantial understanding of the movement skill, this approach is suitable for all teachers who are not sufficiently educated about the quality of FMS (Hands & Larkin, 1998). On the other hand, the test results do not provide direct information on the level of performance (Branta, Haubenstricker & Seefeldt, 1984). More recently, the most commonly used tests for assessing FMS apply qualitative measures that focus on the form or technique of the movement, or how a skill is performed. Examples of such tests are "The Ohio State University Scale of Intra-Gross Motor Assessment" (Loovis & Ersing, 1979), "The Motor Skills Inventory" (Werder & Bruininks, 1988) and "Test of Gross Motor Development - 2" (Ulrich, 2000). Some authors also developed a short form of the later test (Valentini et al, 2018) to test a larger number of children. Also, Griffiths, Toovey, Morgan & Spittle (2018) reported TGMD-2 being one of the tests with the highest test-retest, inter-rater and intra-rater reliability.

All of these batteries of tests have proven validity and reliability and now it is up to coaches and Physical Education teachers to use them properly. With frequent measurements, determining the initial, transitory and final state, one can track the progress of children and based on test results, advice the parents of children for a certain sport selection. Recent studies that have dealt with normally developing population have shown a big lack of mastering object control skills in school children, especially girls (Eather et al., 2018). Studies have analyzed differences in FMS between children participating in sports and children doing only physical education classes at school (Ribeiro-Silva, Marinho, de Brito, da Costa & Benda, 2018), but no research was found on FMS proficiency between different sports. In this research, we decided to test children from three sports activities: football, artistic gymnastics and universal sports school. Football was chosen as a sport with the dominant use of object control skills; gymnastics as a sport where children mostly use locomotor skills; and the universal sports school that combines both skill areas of FMS. The importance of such research is that it could enlighten the best possible sports activity for children at early school age.

The main purpose of this research was to determine the differences in FMS among eight-year-old children participants of different sports activities.

Materials and Methods

Participants

The study included a sample of 60 respondents of both genders aged 7 to 8 years (20 football players, 20 gymnasts and 20 participants of the universal sports school). The study included children with no health problems and significant motor disorders. Previously, each respondent was verbally asked about the willingness to participate, and the parents also signed the official consent for the child to participate in the research.

Measures

The Test of Gross Motor Development-2 (Ulrich, 2000) was used to measure 12 fundamental movement skills. It consists of two areas that measure FMS that are developing early in life. The first is the area of locomotor skills (run, gallop, hop, leap, horizontal jump and slide) and the second area of object control skills (striking a stationary ball, stationary dribble, catch, kick, overhand throw, underhand roll). The measurement itself included videotaping the performance of the 12 skills. The materials were later assessed by a skilled coach according to set criteria of the test.

Statistical analysis

Statistica 13.3 software was used for statistical data processing and the level of significance was set at $p < 0.05$. Descriptive statistical parameters (mean, standard deviation, minimum and maximum score) were calculated preliminarily. Kolmogorov-Smirnov test (K-S) was used for the analysis of the distribution normality. To determine the difference between the respondents of different sports, both in the overall level of FMS and at the level of locomotor and object control skills separately, analysis of variance was applied with the post-hoc Tukey test.

Results

According to the results of the K-S test, all variables of total results do not deviate significantly from the normal distribution. Thus, the value for variables LOC-TOTAL, MAN-TOTAL and TGMD-TOTAL

varies from 0.12 to 0.23. So, the values do not exceed a limit value of 0.29 and can, therefore, be referred to as sensitive measurement instruments and subjected to further processing by parametric methods.

Table 1. Descriptive statistics of TGMD2 variables on a separate sample of gymnasts, football players and children in universal sport school (Mean – mean value, SD – standard deviation, MIN – minimal result, MAX – maximal result)

	GYMNASTICS				FOOTBALL				UNIVERSAL SPORT SCHOOL			
	Mean	**SD**	**MIN**	**MAX**	**Mean**	**SD**	**MIN**	**MAX**	**Mean**	**SD**	**MIN**	**MAX**
LOC1	7,35	0,93	6,00	8,00	7,80	0,62	6,00	8,00	7,80	0,52	6,00	8,00
LOC2	5,55	1,96	0,00	8,00	5,00	1,34	2,00	7,00	5,20	1,82	2,00	8,00
LOC3	8,80	1,79	3,00	10,00	7,35	2,74	2,00	10,00	7,20	2,02	4,00	10,00
LOC4	5,15	1,04	3,00	6,00	4,30	1,08	2,00	6,00	5,05	0,94	3,00	6,00
LOC5	6,80	1,61	3,00	8,00	5,55	2,28	2,00	8,00	6,30	2,05	2,00	8,00
LOC6	7,50	0,76	6,00	8,00	7,25	1,45	2,00	8,00	7,35	1,42	2,00	8,00
LOC-TOTAL	41,15	3,94	33,00	46,00	37,25	5,13	26,00	43,00	38,90	4,88	30,00	45,00
OC1	5,65	2,46	1,00	10,00	7,35	1,53	5,00	10,00	7,85	1,53	4,00	10,00
OC2	5,45	1,73	2,00	8,00	6,40	1,54	2,00	8,00	5,20	2,19	1,00	8,00
OC3	5,70	0,73	4,00	6,00	5,45	1,28	2,00	6,00	5,70	0,92	2,00	6,00
OC4	4,70	1,69	2,00	8,00	7,50	0,83	6,00	8,00	6,15	1,23	4,00	8,00
OC5	5,15	1,46	2,00	8,00	7,10	0,91	6,00	8,00	5,90	1,25	3,00	8,00
OC6	3,65	1,27	2,00	6,00	4,45	1,76	2,00	8,00	5,20	1,15	3,00	7,00
OC-TOTAL	30,30	3,15	25,00	34,00	38,25	3,31	34,00	44,00	36,00	3,97	27,00	42,00
TGMD-TOTAL	71,45	5,30	64,00	80,00	75,50	6,95	60,00	87,00	74,90	8,23	58,00	87,00

Legend: LOC1 – run, LOC2 – gallop, LOC3 – hop, LOC4 – leap, LOC5 – horizontal jump, LOC6 – slide, LOC-total – sum of locomotor skills, OC1 – striking a stationary ball, OC2 – stationary dribble, OC3 – catch, OC4 – kick, OC5 – overhand throw, OC6 – underhand roll, OC-TOTAL – sum of object control skills, TGMD-TOTAL – total TGMD result.

According to the mean results of gymnasts (Table 1), we can notice a much higher locomotor skills result (41,15) than the result in object control skills (30,30). This was not the case in football players who equally well scored in both areas (37,25; 38,25). The children who participated in universal sports school also had a similar result in the two areas of the TGMD-2 (38,90; 36,00). The gymnasts had the best results in the hooping test, and the footballers and children from universal sports school scored best in running test. Surprisingly, the children from the universal sports schools had extremely good results in the striking a stationary ball test.

Table 2. *Analysis of variance (ANOVA) with a post-hoc Tukey test between different groups of athletes*

	GYMNASTICS	FOOTBALL	UNIVERSAL SPORT SCHOOL
LOC	41,15	37,25*	38,90
OC	30,30	38,25	36,00**
TOTAL	71,45	75,50	74,90

Legend: LOC – sum of locomotor skills, OC – sum of object control skills, TOTAL – total TGMD-2 result, * - significant difference between gymnasts and football players (p=0,00), ** - significant difference between all three groups (p<0,05).

Table 2 shows the results of ANOVA between different groups of participants (football, gymnastics and universal sports school) in the variables of total test results. Thus, a separate analysis was carried out to determine the differences in the locomotor, object control and total FMS skills. To distinguish between which group a significant difference occurred, a post-hoc Tukey test was applied. Looking at the overall score of the FMS (TOTAL), which is generally the sum of the locomotor and manipulative areas, significant differences were not found between the groups of respondents. As for the locomotor area, a statistically

significant difference appeared only between the gymnasts and footballers (p = 0.00) in favour of the gymnasts who achieved a significantly better result. In the field of object control skills, there were significant differences between all groups of respondents. Thus, footballers and participants of the universal sports school were significantly better than the gymnasts (p = 0.00), and the footballers showed a far better result than the participants of the universal sports school, with a slightly smaller but still significant level of significance (p = 0.04).

Discussion

Equality between genders is often advocated in Physical Education classes and sports in general. Despite this, boys and girls differ as individuals in their skills and competencies and those differences are often the focus of motor skills researchers. Although scientists report gender differences in manual skills (Flatters, Hill, Williams, Barber & Mon-Williams, 2014) and different developmental curves in visual-motor integration (Bavčević, T., Bavčević, D. & Bavčević, I., 2019), boys and girls of early school age rarely differ in their gross motor skills, especially locomotor ones. Since this paper is dealing only with gross motor skills, there was scientifically no justified cause to separate the sample by gender.

The TGMD-2 is a test in which a raw test score could be converted into a standard score for each subtest and gender and then used to estimate a Gross Motor Quotient. This quotient is another type of standard score and is derived by adding the subtest standard scores and converting the sum to a quotient (Ulrich, 2000). However, this quotient was not used in this research since there would be a lack of detailed analysis about the level of proficiency separately for locomotor and object control skills, like in some researches (Sgro, Quinto, Messana, Pignato & Lipoma, 2017). Also, all participants were very close in age difference (±5 months) and there was no need for standardization according to age. Using only raw scores we could compare children from different sports separately for different subtests.

As for the gymnasts and their greater results in the locomotor field of FMS, the result is not surprising given that it is a sport that generally develops locomotor skills, and object control skills are almost not developed at all. It is also visible that the highest results are achieved in the variables of skip and slide skills which are specific for the sport. The individual results in the field of object control skills are visibly modest, reflecting the overall result in the object control field of FMS. As for the overall results of FMS, it is slightly higher than the average for this age and the results of other studies (Žuvela, 2009).

Analyzing the results of football players, it is clear that they have achieved equally good results in both areas - both locomotor and object control. The highest scores were achieved in the run skill (7.80), even more than the gymnasts (7.35), while they dominated the kick skill in the object control field, which is quite a logical result. Given the above, their high overall result is not a surprise.

The third group was the attendees of the universal sports school, who also develop locomotor and object control skills in their training program, that is, they deal with a wide range of sports and sports disciplines. According to the indicators of descriptive statistics, they achieved equal running results as football players (7.80) and have a very similar result in the overall locomotor field of FMS. Surprisingly, these respondents had extremely good results in the striking a stationary ball test (7.85). Given that this test is very similar to the baseball kick and is quite specific in its structure, as well as the fact that baseball game has not yet taken its swing in our environment, it remains questionable how these respondents have achieved such good test results. It is likely that the attendees of the universal sports school have adopted a large number of different movements in their various training, and thus mastered certain skills, which they can easily adapt to any new motor task and perform it with greater ease than the participants of gymnastics or football. The ability to adapt to a variety of new situations is the competence which belongs to the area of coordination, and it is quite certain that these respondents have developed such coordination with their diverse training.

Looking at the overall score of the FMS, which is generally a sum of the locomotor and object control areas, statistically significant differences were not found between the groups of respondents. So, although they numerically differ in several points, this difference did not prove to be significant. By comparing these results with the results of Žuvela (2009) on a sample of children of the same age who do not deal with sports (59.65), respondents from this research reached a much higher overall value. This leads us to the conclusion that all three activities (sports) develop the FMS of children equally well. Likewise, respondents from this research have much greater values than those who deal with athletics or dance (Benić, 2016). However, it should be noted that the sample in the latter study was comprised of a large number of younger subjects, even 3-year-olds, so no concrete conclusions could be drawn. Finally, just by looking at the

separate areas of the TGMD2 test we can conclude on the partial influence of a particular sport on different skills.

As for the locomotor area, a statistically significant difference appeared only between the gymnasts and the footballer's sample in favour of the gymnasts who achieved a significantly better result. This outcome is completely expected concerning the contents of gymnastics as a sport. These contents mainly focus on the development of the exclusively locomotor performance of children, which should be brought to perfection in this sport. Again, looking at the survey by Žuvela (2009) on a similar sample of unskilled children (31.20), we also noted higher scores in all groups of respondents.

In the field of object control skills, there were significant differences between all groups of respondents. Thus, footballers and participants of the universal sports school were significantly better than the gymnasts, while the footballers scored much better than the participants of the universal sports school, with a slightly smaller but still significant level of significance. The greatest contribution to these differences was given by the participants of the gymnastics with their significantly inferior results of object control skills, which is not surprising because in their training they do not have such content. A similar result (31.1) was also given by Žuvela (2009) on a sample of unskilled children. What might have been expected was the absence of significant differences between football players and participants of the universal sports school since both of them have object control skills development in their training processes. However, it is obvious that a football school develops object control skills at a higher level.

Conclusions

Based on the results obtained it is possible to conclude that all three sports activities, that children are engaged for at least one year, develop their FMS very well. Based on the total TGMD-2 test results, it is not possible to discuss which sport is developing such skills on a higher level because significant differences have not been found. However, it is possible to perceive some differences by the insight into separate areas of FMS. So, we can militate about a higher level of locomotor skills in gymnasts and a higher level of object control skills in footballers and participants of the universal sports school. What is additionally rewarding to the students of the universal sports school is the ability to perform well in new situations, which is a good sign of motor intelligence, but this is certainly to be checked by further research. To gain even better insight and make more concrete conclusions about which sport or sports discipline best develops FMS in children, it would be important to analyze an even larger sample of subjects of different basic sports in future research, using multiple measurement points.

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