

DIFFERENCES IN MOTOR SKILLS OF SELECTED AND NON-SELECTED GROUP OF CHILDREN IN ARTISTIC GYMNASTICS IN THE CONTEXT OF THEIR MOTOR DEVELOPMENT

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Original scientific paper

<https://doi.org/10.26582/k.51.1.16>

Abstract:

Main purpose of this paper was to find differences in motor skill level between the selected and non-selected group of children in artistic gymnastics. Artistic gymnastics is one of the sports that is frequently put into a negative context because of early specialization of children, while at the same time it is considered to be a basic, fundamental sport. Thirty-one children (age 5.59 ± 0.77 years) participated in this study. The data were collected using *Test of Gross Motor Development – Second Edition* (TGMD-2). One-way ANOVA and Bonferroni *post-hoc* test was used to determine the differences in motor skills of children. The results show differences in locomotor skills between the selected and the non-selected children gymnasts ($p < .05$). When comparing boys and girls, results show no gender differences in gross motor quotient, locomotor or manipulative skills, although significant differences exist in gross motor quotient and locomotor skills in the selected girls, compared to the non-selected girls ($p < .05$). These results suggest that female competition program in preschool age favors development of locomotor but not manipulative motor skills. Regardless of the sport in which preschool children participate, exercise program should be multilateral. For this reason, in artistic gymnastic we should encourage multilateral development and inclusion of tests and exercises for manipulative skills as well, which could have a positive effect on children's future overall (motor, social and psychological) development.

Key words: talent identification, sport selection, sport specialization, gender, boys, girls

Introduction

Overall development is of great importance in early childhood. Recently, more attention has been attributed to adequate levels of physical activity and development of fundamental motor skills since they are fundamentals of future healthy and active lifestyle (Stodden, et al., 2008). Appropriate motor stimulation through play during a preschool period provides a systematic sequence of fundamental motor skills development, but it also stimulates children's social, emotional and cognitive development. Fundamental motor skills consist of locomotor and manipulative skills commonly developed through the preschool and primary school age. Locomotor skills require displacement movements of the body in space like in walking, running or jumping, while manipulative skills are defined as expert use of an object like in throwing, catching or kicking a ball (Kirk & Rhodes, 2011).

The development of motor skills during early childhood, and even after seven years of age, provides the basis for sports skills, recreational or competitive alike, when children usually choose the

sport they will practise further (Busquets, Aranda-Garcia, Ferrer-Uris, Marina, & Angulo-Barroso, 2018; Clark, 2007). Also, research evidences have shown that the level of motor skills is positively related to physical activity of preschool children in a way that children with poorer motor skills tend to be less active than children with better motor skills (Williams, et al., 2008). Research on gender differences in fundamental motor skills indicates that boys are better than girls in running (speed), jumping (power), strength and coordination, but girls are better in flexibility, agility and balance (Božanić, Delaš Kalinski, & Žuvela, 2011; Hsieh, Lin, Chang, Huang, & Hung, 2017; Malina, Bouchard, & Bar-Or, 2004). However, not all research studies have demonstrated differences between boys and girls; most fundamental motor skills are similarly developed by the age of 5-6 years (Fisher, et al., 2005).

In sport, testing of children is necessary to determine trainees' progress and identify children talented for future high sport results. Talent identification plans are designed to select young athletes

with the capacity for high sports performance and achievements, in other words, the talent selection makes it easier to perform the “right work with the right person” (Albuquerque & Farinatti, 2007; Di Cagno, et al., 2014). Throughout time, those considered as ‘talented’ will be modelled by an interaction between individual (chronological age, maturation status, training experience, psychological characteristics), task (speed, power, flexibility, strength, endurance, balance, aesthetics, coordination, perception, decision-making), and environmental (support, availability of facilities, coaching quality, cultural values, sport policy) causative factors (Baker, Coble, & Schorer, 2012). One of the sports that is often mentioned within a negative context due to its early specialization, even though it belongs to the three so-called basic sports, is artistic gymnastics. Sports specialization in most sports occurs after puberty (Bompa, 1995; Drabik, 1996; Rost & Schon, 1997), while gymnastics, diving, skating and swimming are characterized by early specialization (Malina, 2010). In artistic gymnastics the primary selection for sport is carried out with the boys and girls during their preschool age. A typical characteristic of sports training in artistic gymnastics is that it is focused on children’s technical development and, regarding the biomechanical characteristics of gymnastic elements, it is focused on the development of specific motor abilities (i.e., strength and coordination). Therefore, talent testing as well as gymnastic training is not always focused on overall, versatile motor development. It happens in other sports as well that, sometimes, sports training is carried out with specific programs of just one sport, which is not in accordance with scientific recommendations. Namely, children up to 10 years of age should engage in exercise that would stimulate their versatile motor development, i.e. they should experience as many different movement patterns as possible that will form the level of movement quality often called “physical literacy” (Šalaj, Krmpotić, & Stamenković, 2016). In other words, sports training programs are usually oriented to the development of only sport-specific performance-relevant domains, thus neglecting domains that are essential for children’s overall development. Also, for each motor skill there is the best time period for its development, the so-called sensitive phase. The optimal time for the adoption of basic movement skills is between the second and the seventh year of age, and the optimal time for organizing gymnastic program is between 5-7 years (Čuljak, Delaš Kalinski, Kezić, & Miletić, 2014; Čuljak, Miletić, Delaš Kalinski, Kezić, & Žuvela, 2014).

Basically, gymnastic skills fall into categories of discrete and closed motor skills, characterized by short-lasting and well-defined element-specific movement patterns and/or by rotation of the entire body around one or more axes (Čuljak, Miletić, et

al., 2014; Schmidt & Wrisberg, 2000). Previous research suggests positive effects of gymnastic programs on the children’s fundamental motor skills like galloping, hopping, leaping (Fallah, Nourbakhsh, & Bagherly, 2015), and motor abilities like strength, coordination and flexibility (Karachle, Dania, & Venetsanou, 2017; Sheerin, Williams, Hume, Whatman, & Gleave, 2012). Also, a positive transfer of fundamental movement skills to the level of specialized gymnastic skills was found (Čuljak, Miletić, et al., 2014). Garcia et al. (Garcia, Barela, Viana, & Barela, 2011) found significant improvements in balance and postural control in 5-7-year-old gymnasts compared to non-gymnasts. Nevertheless, the multilateral sport programs show some advantages over the gymnastic training programs in the development of children’s overall motor skills (Mostafavi, Ziaee, Akbari, & Haji-Hosseini, 2013).

In artistic gymnastics, each gymnastic school in leading countries has specific models of talent identification, like International Gymnastics Federation (FIG) Age Group Development Programme, USA Gymnastics TOPs programme, Gymnastics Functional Measurement Tool (GFMT), and World Identification Systems for Gymnastics Talent (WISGT) (Mkaouer, Hammoudi-Nassib, Amara, & Chaabène, 2018). Yet, there are some limitations of accompanying testing procedures in those models because they are related to specific gymnastic elements, which preschool children outside of gymnastic program are not familiarized with. Determining the profile of a child gymnast and his/her level of fundamental motor skills could assist coaches in talent identification, but also in his/her overall development through training of a child athlete. The aim of the study was to determine the differences in motor skills between the preschool children (boys and girls) selected for artistic gymnastics and those non-selected.

Methods

Participants

Thirty-one children participated in this study (age 5.59 ± 0.77 years), fifteen boys and sixteen girls. By the level of their gymnastic-relevant abilities, children were divided, at their first practice session, into two groups: selected group ($n=12$, 6 boys; 6 girls), or those participating in the “advanced artistic gymnastic program“, and non-selected group ($n=19$; 9 boys; 10 girls), or participants in the “gymnastic playground program“. A written informed consent was obtained from their parents prior to the measurements, and research was approved by the institutional ethical board.

Testing procedures

Prior to testing, a standardized warm-up was conducted, consisting of a 5-minute running with

tasks and dynamic stretching exercises. The data were collected by a battery of tests for the motor skill assessment called Test of Gross Motor Development – Second Edition (TGMD-2) (Ulrich, 2000). Battery assesses 12 locomotor and manipulative skills. Tests were explained and demonstrated to children in advance. Each test was performed and measured twice. Movements were recorded using a video camera (Sony DCR-SX65E) for further analysis. Each movement was scored, and a total sum score was calculated, from which, using age and sex correction, the locomotor standardized score, the manipulative standardized score and the gross motor quotient were calculated. Previous research has shown good reliability of the TGMD2 test battery (Catenassi, et al., 2007; Mazzardo, 2008; Niemeijer, Smits-Engelsman, & Schoemaker, 2007; Simons, et al., 2008).

Training program characteristics

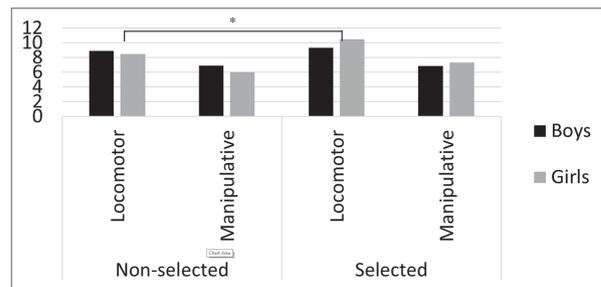
All children have been participating in general or specific gymnastic training for at least two years. The non-selected group of children gymnasts have been training for one hour two times per week, while the selected group of children have a greater duration and frequency of training: 1.5 hour three times per week. The non-selected group training program consisted of general exercises with focus on play, whereas the selected group training program was focused on learning the official artistic gymnastics' program with less time to play.

Data analysis

Results were analyzed using the Statistica 12.0 package (Statsoft, Inc., Tulsa, OK, USA). Analysis of variance (one-way ANOVA) and Bonferroni *post-hoc* test were conducted to determine main differences between the selected and the non-selected group of children gymnasts. Data were normally distributed: K-S test $d=0.15$, $p>.20$. The level of statistical significance was set to $p<.05$.

Results

The differences in locomotor skills between the selected and the non-selected children gymnasts were found ($F=4.21$; $p<0.05$, Table 1). There were numerical but not significant differences in manipulative skills and the gross motor quotient.



*different at $p<.05$

Figure 1. Differences in motor skills of male and female child gymnasts.

When comparing boys and girls, the results showed no sex difference in the gross motor quotient, locomotor, or manipulative skills, although there were significant differences in the gross motor quotient ($F=5.24$) and locomotor skills ($F=5.53$) between the selected and the non-selected girls ($p<.05$, Figure 1). The Bonferroni *post-hoc* test showed higher results in the selected girls (GMQ=93,5 vs. 83,5; LOC=10,5 vs. 8,5).

Discussion and conclusions

The significant difference in locomotor skills between the non-selected and the selected group of children gymnasts was found. Numerical difference was also visible in the overall motor development level, in favor of the selected group. The result of the overall motor quotient ranked the selected group on the twenty-seventh percentile, and the non-selected group between the sixteenth and twenty-first percentile (Ulrich, 2000). Both groups of gymnasts are at the average level of locomotor and manipulative skills compared to the Croatian preschool children, tested also by the TGMD2 test battery (Šalaj, et al., 2018), but at the below-average level of manipulative skills compared to the test manual normative data (Ulrich, 2000). These results suggest that the gymnastic training (or testing) is not based on the fundamental motor skills, but on the gymnastic-specific forms of preparation. The level of motor skills of the observed children gymnasts is generally comparable to the level of Croatian children that are not enrolled in sport programs (Šalaj, et al., 2018), but is lower than in children practicing multisport programs (Šalaj, et al., 2016). This could be attributed to the fact that artistic gymnastics is

Table 1. Motor skills in selected and non-selected gymnasts

	LOC score	MAN score	LOC stan score	MAN stan score	GMQ
Non-selected	29.95±4.94	19.37±6.48	8.68±1.53	6.42±2.06	85.32±9.48
Selected	35.75±3.44*	24.67±5.55	9.92±1.78*	7.08±1.88	91±8.58

* different from the non-selected gymnasts $p<.05$

Legend: LOC score – sum of locomotor test results; MAN score – sum of manipulative test results; LOC stan score – standardized locomotor score; MAN stan score – standardized manipulative score; GMQ – gross motor quotient.

sport with no special manipulative requirements. For good performance in artistic gymnastics a high level of coordination is required of the child's whole body and its parts. Coordination and precision could be long-term predictors of a gymnast's potential for achieving future success in competition and, consequently, a more sensitive measure of their talent for sport at an early age (Vaeyens, et al., 2006). A motor coordination test might be valuable in the early talent identification of gymnasts, as its discriminating and predictive qualities might be sufficiently powerful for the child to adolescent athlete selection (Ahnert, Shneider, & Bos, 2009; Vandorpe, et al., 2012). This is important in artistic gymnastics because elements on all apparatuses (men's and women's all-around) are divided from easy to hard, which means they are consequently connected. Most of them require coordination of the whole body in space. Recent findings have shown a moderate to high long-term stability in coordination skills and sport-specific skills from childhood to adolescence (Ahnert, et al., 2009). Motor learning capacity may be considered a requirement for the stabilization of gymnastic-specific skills and is especially important in the pre-adolescent period, identified as a "sensitive phase" in which the talent selection is carried out (Hirtz & Starosta, 2002). Anthropometric and physical performance tests are less sensitive, but a non-sport-specific motor coordination test could be an important identifier of potential gymnastic talents (Vandorpe, et al., 2012). Maturation plays the main role in child's development, especially in terms of reaction time and coordination, but sport practice contributes to the development of motor capabilities and influences individual differences in children's scores (Busquets, et al., 2018). Di Cagno et al. (2014) investigated the predictive value of coordination and precision in skill acquisition during motor learning, and results showed that gymnasts with the best results in the coordination and motor learning tests continued to achieve better competition results in a three-year term. In the field of practice, it could be useful for coaches to include motor skill tests in selection procedures, as objective criteria that could discriminate between prospective elite and sub-elite pre-adolescent gymnasts (Di Cagno, et al., 2014). This could be a reason to implement test TGMD2, since the locomotor skill seems to differ the selected from the non-selected children. The difference in this variable is attributed to the selection and orientation procedures of training programs for the child gymnast development, and is possibly related to higher specific gymnastic skills. The results of this study also support the claim that motor stimulation in different areas is needed for the overall development of children. Multisport programs proved to be advantageous in the development of fundamental motor skills compared to the gymnastic and

regular physical education class activities in kindergartens, as demonstrated by the TGMD-2 test. The gymnastic program had a positive effect on locomotor skills, but the multisport program was more effective in those skills' development (Mostafavi, et al., 2013). This is another example of how the artistic gymnastics' exercise program with preschool children is focused on the development of only certain (locomotor) skills, which is a reason why deficits occur in the development of other (manipulative) skills. Regardless of a quality level of an exercise program realized in a sports club, a child will always be lacking in certain motor skills that have not been frequently used in the current sport training and competition. For example, gymnasts will be impeded in skills like ball bouncing, kicking, or overhand striking, or other manipulative skills frequent in some sport games. The best proportion of versatile motor stimuli, improving various movement skills, can possibly be found in preschool multisport programs, which improve overall motor skills to a greater extent than other sport-specific programs (Mostafavi, et al., 2013). Šalaj et al. (2016) determined a similar motor skill level in preschool children that were not practicing sport at all and in children enrolled in some early specialization sport, while children enrolled in multisport programs had the highest level of fundamental motor skills (Šalaj, et al., 2016). An intervention program of pre-level gymnastic exercises in preschool girls (5-6 years of age) showed a significant development of balance and locomotor skills, specifically, galloping, hopping and leaping (Fallah, et al., 2015). This is expected because the basic program of artistic gymnastics consists of exercises that indirectly develop balance (e.g., balance beam elements) and some gross motor skills (e.g., different jumps on the floor and trampoline). Long-term effects of artistic gymnastic training could be visible in a great balance ability and a high level of locomotor skills, as in our study. Besides balance, gymnastic program in early childhood can be effective for the motor proficiency enhancement (Karachle, et al., 2017). Gymnasts (6-10 years of age) demonstrated significantly better performance in postural control tasks (stability skills – the log roll, rock and back support) than children not enrolled in a gymnastic training (Rudd, et al., 2015). Čuljak, Miletić, et al., (2014) conducted an 18-week basic gymnastic skill program with seven-year-old children and determined its positive influence on the fundamental motor skills with a conclusion that both might be developed at the same time because there is a positive effect between the fundamental motor skills and basic gymnastic skills. Children who participated in the gymnastic program made significant gains in motor abilities (dynamic balance, agility, flexibility, power and muscular endurance), and social skills, while a small improvement was observed in body

mass index (Al-Awamleh, 2010). Motor abilities, especially strength and power, are crucial in artistic gymnastic, which means that gymnasts with high motor abilities will be able to perform the hardest elements. Motor skills and abilities are interrelated, so performance of jumping or leaping is related to the skill level, but some skills cannot be performed without a high level of leg strength and power.

The second important result of our study is a gender difference in fundamental motor skills of children gymnasts. A comparison between boys and girls within the non-selected group showed no significant difference in the gross motor quotient, although numerically, boys achieved somewhat better results (83.50 vs. 87.34). A comparison of the results of boys and girls within the selected group of gymnasts showed a significantly better gross motor quotient in girls than in boys (93.50 vs. 88.50). Because of changes related to biological maturation, training of boys and girls is not the same in artistic gymnastics; coaches are trying to teach female gymnasts as many skills as possible before they reach maturity (Delaš Kalinski, Jelaska, & Atiković, 2018). Girls start with maturation and hormone changes much earlier than boys. Male gymnasts do not train so hard like female gymnasts before the age of 14 or 15 because they should wait for the period of increased testosterone level (they need extreme level of strength, especially of the upper body) (Delaš Kalinski, et al., 2018). Competition eligibility age, especially for the Olympic Games, is not equal for men and women. Before 80-ies, the minimal eligible age was 14 years for women, whereas nowadays it is 16 years for women and 18 years for men.

Gymnastic practitioners have experienced gender in boys and girls' ability to maintain concentration; boys appear to be more playfull. Concentration and attention to the training follows the principle of undulation. Throughout the time, as children are getting older, concentration increases, but girls are focused more on the tasks and training than boys. This high concentration of girls, compared to boys of same chronological age, can also be attributed to the earlier biological development. Because of this, girls' work for the same time interval is of higher efficiency, so more time can be spent on developing sport-specific skills and abilities. Al-Awamleh (2010) investigated the influence of gymnastic program on preschool children and found small gender differences in motor capabilities of dynamic balance and explosive power. They concluded that the difference was due to the biological and environmental influence. A study of a 10-week gymnastic intervention program with preschool children showed initial gender differences in the fundamental movement skills assessment, where girls outperformed boys in five out of eight variables, while the final testing showed the

differences only in the balance, running speed and agility tests in favor of girls (Božanić, et al., 2011). Exercises for boys and girls are different; also, girls have four apparatuses and boys six, and each of them have specific requirements. Balance beam is typically a women's apparatus, which requires exceptional dynamic balance, and typically men's apparatus is rings, where strength of the whole body is most important. Butterfield, Lehnhard, and Coladarci (2002) examined the contribution of age, sex, and body mass index to performance of the fundamental locomotor skills (run, gallop, hop, leap, jump, skip, and slide) in 6-year-old children and results showed that running, leaping, and skipping improved with age, but no differences were found between boys and girls in any of the seven skills; however, some gender differences occurred in motor abilities. Generally, gymnastics requires boys to be more powerful than girls, which consequently reduces flexibility that is not so important in men's all-around. Possible consequences of a too early specialization can be complications in growth and maturation due to a high intensity training, although it is difficult to scientifically establish that early specialization and intensive training are factors that impede growth and maturation (Malina, 2010). The reason why specialization in gymnastics occurs in preschool age is that artistic gymnastics includes a wide range of motor activities that require performance of different gymnastic skills which depend on specific capacities and, for that reason, it is important to perform a previous talent selection so that the work can be differently focused for children who intend to reach elite performance level and the ones who will practice it as leisure (Albuquerque & Farinatti, 2007). Gymnastic program can be adjusted for the kids who are not for the elite level of gymnastics with a lower work intensity, structurally similar to multisport exercise programs containing gymnastic elements. Participation in gymnastics is considered to promote postural control of younger children (Rudd, et al., 2015). Nine weeks of gymnastic training had a beneficial effect on abdominal strength, flexibility, coordination and lower body strength in children aged 4-9 years, as found by Sheerin et al. (2012). Therefore, participation in gymnastics must be recommended as a positive foundational physical activity for school-aged children, from early childhood to adulthood. Additionally, research findings can provide useful information on how to optimize training loads for pupils involved in gymnastic training throughout physical education classes (Trajković, Madić, Sporiš, Aleksić-Veljković, & Živčić Marković, 2012). Gymnastics has also a beneficial influence on memory in children. Influence of an 8-week gymnastic program (gross motor skills) on spatial working memory in children aged 7 to 10 years resulted in positive relations of those

variables (Hsieh, et al., 2017). Artistic gymnastic training at low intensity (3 hr/wk) may be associated with up to 66 % musculoskeletal benefits to the upper limbs; however, the greatest musculoskeletal changes were observed following more than one gymnastic class per week (10.5 hr/wk) (Burt, Ducher, Naughton, Courteix, & Greene, 2013). Gymnastic practice improves postural control in 8-11-year-old children (Busquets, et al., 2018).

For preschool children it is extremely important to develop fundamental motor skills that would provide favorable conditions for future sports and physical activities. These activities directly affect health and psychological well-being of the individual who performs them. The process of learning and developing fundamental motor skills requires time and effort invested. The level of motor skills of children gymnasts in this research shows that both gymnastics groups have very well-developed locomotor skills, but manipulative skills are far behind and need to be trained to achieve a complete

development of the child. There is also a difference between the two groups due to the selected girls who stood out markedly in locomotor tests. Apparently, locomotor skills are a variable that differs selected from non-selected gymnasts and could be incorporated in testing procedures for determining talented prospective gymnasts at early age. However, this study does not show true origin of differences; talent identification and selection criteria or amount of practice vary across Croatian gymnastics clubs and specific gymnastics programs.

Due to certain disbalance in domains of motor development detected in this study, we can suggest that preschool children should not be limited only to practice one sport, for example, artistic gymnastics. Regardless of the sport which children are practicing at preschool age, a training program must be multilateral. For this reason, multisport programs can be recommended to fully encourage motor, social and psychological development during childhood.

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Submitted: April 9, 2019

Accepted: May 31, 2019

Published Online First: June 13, 2019

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Acknowledgment

Paper presents a work from a research project "Motor skills of preschool children" [UIP - 2014-09-5428], funded by the Croatian Science Foundation.