

Comparative Study of Fundamental Movement Skills in Iranian Children and Selected Countries of the World: A Cross-Sectional Study

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Original Article

Abstract

Introduction: This study was performed to compare the fundamental motor skills (FMS) of children in Iran and selected countries.

Materials and Methods: In order to make a cross-cultural comparison regarding the motor development of children in the world, four studies from Iran, United States of America (USA), Portugal, and China were included, in which the test of gross motor development-second edition (TGMD-2) was used. After confirming the inclusion criteria and selecting the final studies, the average percentage of children in each region (country/state/island) who had mastered in FMS was extracted, compared, and analyzed. Descriptive statistics, chi-square test, Cramer's V statistics, and ratio were used to analyze the data.

Results: There was a relationship between the physical education curriculum guidelines in each country and the number of children who were master in FMS in that country. American children's average level of mastery was more than Chinese ($P = 0.009$), Portuguese ($P = 0.005$), and Iranian ($P = 0.001$) children. Besides, no relationship was found between the most popular sport in each country and mastery of FMS related to that sport in the studies ($Z < 1.645$).

Conclusion: Apparently, the mere existence of a popular sport in a country does not provide the basis for mastering the skills related to that sport; rather, present findings emphasized the need to appropriate, curriculum-based guidance and instructional components along with opportunities and incentives to develop and master basic motor skills.

Keywords: Fundamental motor skills; Test of gross motor development-2; Children; Motor development

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Introduction

Motor development refers to changes in an individual's motor behavior throughout their life, which result from the interaction between their biological characteristics, task requirements, and environmental conditions (1). Fundamental motor skills (FMS) are the main element of motor development and refer to movements that are present in all people who can perform voluntary activities, including walking, running, jumping,

trotting, rolling, sliding, jogging, and hopping, with a specific purpose (1, 2).

There are many factors that affect the speed of acquiring movement skills such as affordances, constraints, individual biology, and environment (4). Environmental conditions, such as training opportunities, encouragement, education, and ecology or context of the environment, play an essential role in the growth rate of FMS (3, 4). Environmental constraints in the long term can lead to changes in individual constraints and then the

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efficiency of motor skills. In environments where it is possible to do more physical activity, physical activity creates a more significant change in the structural characteristics of a person, leading to better performance of motor skills (5).

The acquisition of FMS is a development-dependent process that occurs during early childhood years (1, 3, 6). Children up to the age of 6-7 years have the necessary growth potential to reach the matured stage of FMS (1). For this reason, from birth to 7 years old is known as the fundamental movement period (7, 8). However, recent research suggests that children do not reach the same level of FMS mastery at age 7 or older across cultures and countries (6, 9). In some cultural settings, some children may have enough opportunities to experience a variety of movements and receive high-quality supplementary instruction in a variety of movements. Other children may have little opportunity to participate in such activities and, as a result, have a lower level of skill and mastery of FMS than their peers in other settings (2).

Although the importance of fundamental patterns of motor development (fundamental patterns period) has not been emphasized, FMS is considered the basis of advanced daily life movements and specialized movements (10, 11). The choice of skills to be practiced later in life depends on the improvements during the fundamental movement period. Whether children eventually decide to move on to exercise, sports, or even artistic pursuits such as playing music, painting, or sculpting depends on mastering skills during the fundamental movement period (2). Research shows a high correlation between acquiring basic movement patterns and children's participation in physical activities, promoting an active lifestyle, and avoiding acquired developmental disorders (12).

In their study, Haubenstricker and Seefeldt found that 60% of American children aged 6-7 had mastered 7 out of 8 basic motor skills (10). However, recent research has shown that children from other countries do not reach the same level of FMS mastery at age seven or older due to several factors including a lack of opportunity, encouragement, and guidance for physical activity (1, 13-15). Advice and guidance to perform physical exercises and physical education classes in average and exceptional schools are essential in

attracting students to physical activities (1, 8).

The results of some studies suggest that external interventions aimed at improving FMS can enhance the mastery of these skills at a reasonable level (16-18). However, these interventions may not align with the content of general physical activity classes in a specific country or region. Typically, physical education classes follow strategies and guidelines designed by competent institutions such as the education and training of countries. For instance, while Portugal follows an organized and comprehensive educational program, it does not emphasize the explicit development of FMS. Conversely, physical education strategies and guidelines in the United States of America (USA), China, and Iran specifically target the development of FMS (20).

The American training program details the features required for each age group regarding FMS mastery. For example, at the end of preschool, children should master hopping, galloping, running, and sliding (21). Similarly, China's educational program has goals based on FMS development but also emphasizes learning sports, cultural games, and activities (19). The national educational program in Iran also pays attention to the acquisition and development of FMS, physical fitness, and preliminary skills of school sports such as football, volleyball, and table tennis in the primary period (22). Therefore, if there is a relationship between the designed curriculum and the actual content of physical education classes, does the curriculum design in each country affect the number of children mastering FMS or the speed at which these children acquire such skills? Does it work or not?

In addition to school programs, the most popular sport in a country may influence FMS development (19). Western countries offer more opportunities for kicking, throwing, and rolling sports due to cultural environments and available space (23). Soccer is popular in Portugal and Iran, and suitable spaces allow children to practice fundamental skills from an early age (19, 23, 24).

In addition to the educational programs of the school environment, the most popular activity or sport in a given country has been considered a potential influencing factor in the development of FMS (19). For example, the cultural environment in Western countries seems to provide more opportunities for children to practice the kicking,

throwing, and rolling skills that are the main popular sports in that part of the world, such as football, basketball, volleyball, and table tennis (23). This phenomenon happens mainly because children have more space to practice (that is, the most significant opportunity) and receive encouragement (especially from parents and friends) to do sports specific to their country (23). In Portugal and Iran, soccer is the most popular sport (19, 24). In this case, suitable space (soccer fields, indoor fields) allows children to practice. As an adaptation to encourage more, children in Portugal and Iran are expected to practice more in the fundamental skill of kicking, which is the basis of soccer. This causes many children to try and be encouraged for FMS from an early age, compared to children in other countries where football is not seriously practiced. Table tennis and basketball are popular in China, while American football and baseball are preferred in the USA (19, 25). Despite theories linking the most popular sport to differences in FMS mastery between children from different countries (23, 26), no empirical evidence supports this. This study investigates differences in the physical education program and environmental conditions in four regions (Hong Kong-China, ten states in the USA, Madeira Island in Portugal, and Tehran in Iran) and their effects on FMS mastery in the children aged 4-10.

Based on the USA, Iran, and China educational program guidelines, children in China, the USA, and Iran are expected to show higher FMS mastery than those in Madeira Island. The most popular sports skills mastered by children were investigated, and kicking (related to soccer) was likely fundamental in Madeira Island and Iran, over-the-shoulder throwing and hitting (about baseball and American football) in the USA, and dribbling on the spot (related to basketball) in Hong Kong.

Extensive research on FMS has been conducted (9, 18, 27-29). It is crucial to identify indicators aiding FMS acquisition, as it is the basis of movement skills in later courses. Empirical data on the impact of a country's popular sports activity on the growth and development of specific FMS are scarce (30). Therefore, the present study compares the FMS of children in Iran and selected countries worldwide, such as the USA, Portugal, and China, through cross-cultural analysis. These four countries were chosen based on their similar

methodologies and measurement and evaluation methods in the research search. In China, a study on FMS was selected from ten screened studies that met the necessary conditions. The study used the Test of Gross Motor Development (TGMD) to measure FMS with a sample size of at least 70 people, both boys and girls. The comparison is only valid when measurement conditions and components in the compared items are similar. The findings can assist movement educators, rehabilitation specialists, and teachers in recognizing and improving children's FMS.

Materials and Methods

In terms of method, this research was causal-comparative after the event, and in terms of purpose, it was applied, and due to its nature and comparative type, quantitative content analysis was also used.

The research included all studies targeting FMS performance in different countries. Sixty studies were retrieved for cross-cultural comparison and analysis. Criteria for extracted studies included a minimum sample of 70 people in each age group (ages 4-10), male and female participants, random sampling, and normal distribution of data. Selection keywords were "Test of Gross Motor Development-2 or TGMD-2", "Fundamental Movement Skills", "Fundamental Patterns of Movement", "Proficiency", and "Mastery". Four studies were purposefully selected from Portugal, China, the USA, and Iran.

The required research for FMS was collected through search engines and databases such as PubMed, Google Scholar, Web of Science, ResearchGate, and ScienceDirect. Two researchers, a full professor and an assistant professor, searched in English using specialized compounds and words related to FMS. Persian language sources were searched using the Scientific Information Database (SID) and specialized physical education publications, including "Motor Behavior, Sports and Motor Development and Learning, Sport Management, and Motor Behavior and Sport Psychology".

In all studies, the TGMD-2 test was used to evaluate 12 FMS. The FMS are divided into locomotion movements (running, galloping, hopping, leaping, horizontal jumping, and sliding) and object control movements (striking a stationary

ball, stationary dribble, catching, kicking, overhand throw, and rolling ball from under the shoulder). Each skill has performance criteria between 3 and 5. The child makes two attempts to execute the movement pattern for each skill, and if they display the desired criteria, they receive a score of 1. Otherwise, they receive a score of 0. The total performance criteria for each sub-test (small object transfer and control test) are 24, and the maximum raw score for each subtest is 48. The raw score for each subtest is converted into a gross motor score through predetermined normative tables. In the selected studies, children are considered proficient when they reach all the desired criteria in the tested attempts (19).

All selected study participants were trained and tested using TGMD-2 (32) standards for experimenter confidence coefficients in both locomotion and object control skills. Regular physical education classes were attended by all participants, with frequency ranging from two (hours) per week in China, USA, and Iran to three (hours) per week in Portugal. These courses lasted between 40 and 50 minutes. After collecting and analyzing the studies, the mastery of basic skills in Iran and other countries, including America, Portugal, and China, was investigated and compared. In order to analyze the percentage of children who had mastered FMS in different regions (cities, states, and islands), the researchers extracted data and entered them into SPSS software (version 18, SPSS Inc., Chicago, IL, USA) and MATLAB software version 2013 (MathWorks, R2013a, Natick, MA, USA). Descriptive statistics were used to calculate the mean, standard deviation (SD), and related graphs. The chi-square test was analyzed using Cramer's V statistic, which has a variable coefficient between zero and one. The decision criteria (Approx. Sig.) equals $P < 0.05$, and the odds ratio (OR) has values from zero to any positive number (34). The z-test was used with the criterion value for the difference equal to 1.645 and at the probability level of 95% (19).

Cramer's V statistic expresses the correlation between two nominal variables. It ranges from 0 to 1 and has no direction. A coefficient closer to 1 means a stronger relationship. A coefficient of 0.7 to 1 is vital, and 0 to 0.5 is low. To determine significance, look at the coefficient's significance level. If it is less than 0.05, the null hypothesis is rejected. This study compares the prevalence of FMS in children across different countries using

OR. The significance level was set at $P < 0.05$. It should be noted that the considerations and ethical code of Shahid Rajaei Teacher Training University, Tehran, Iran, carried out this research.

Results

Table 1 shows the characteristics of the selected studies. Four studies including Afonso et al. (26), Ulrich (32), Wong and Cheung (23), and Farokhi et al. (31) were reviewed. To examine the difference between the countries of America, Portugal, Iran, and China in terms of the prevalence of FMS mastery, chi-square test was used, the results of which are presented in table 2.

The chi-square test results indicate a significant relationship between FMS performance and the countries evaluated. Cramer's V statistic shows the difference in the percentage of children who have mastered FMS in each respective country. As age and time increased, the relationship values measured by Cramer's V statistic also increased. ORs were measured for each country, calculating the percentage of children's mastery of FMS compared to other countries. Table 3 presents the results of this analysis.

The OR analysis revealed that American children had the highest likelihood of demonstrating FMS proficiency at all ages compared to the other three countries. Children from China (Hong Kong) also showed a high chance of mastering FMS. In contrast, children from Portugal (Madeira Island) and Iranian children (Tehran) had a lower chance of mastering the FMS. Only the USA showed a percentage of children with FMS proficiency equal to or greater than the 60% predicted in the studies. This finding suggests that children from different countries do not reach the same and similar level of FMS mastery at seven years or older. Figure 1 shows the average percentage of children with talent at each age.

To evaluate the effect of FMS training programs in America, China, Portugal, and Iran, the average percentage of children aged 4-10 who had mastered FMS was examined and reported in table 4 and figure 1. American children had the highest average percentage among children with dominance at all ages, followed by Hong Kong (China), Madeira Island (Portugal), and Tehran (Iran) children, respectively. According to the results, the training program emphasizing the development of FMS affects the frequency of children who reach mastery.

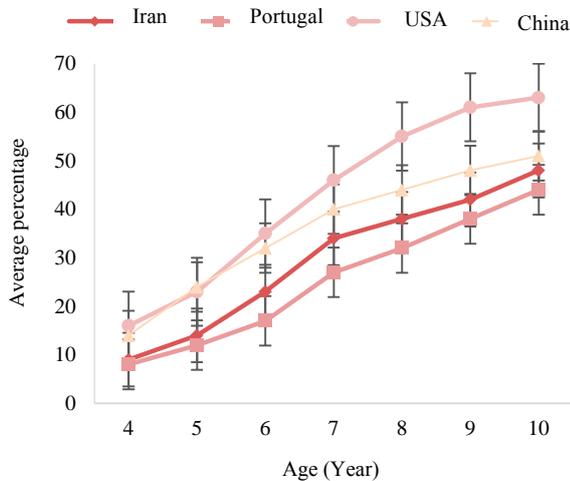


Figure 1. The average percentage of children mastering all fundamental motor skills (FMS) in each age group

*Significance at the P < 0.05 level

To investigate the difference between the children of the USA, Portugal, Iran, and China in terms of the level of mastery of FMS related to the most popular sports, that is, the test of the effect of the sports environment on children's mastery, the probability of each country (America, Portugal, Iran, China) to show a higher percentage of children mastering these popular and special skills (in China, dribbling due to the popularity of basketball, in America hitting with hand and throwing according to the popularity of baseball and American football, in Portugal and Iran kicking according to the popularity of soccer) was compared to other FMS for each age group (the particular skill means the same as the popular skill).

For example, the probability that Portugal and Iran showed a higher percentage of children mastering the kicking skill (given the effect of soccer) than all other FMS was compared for each

Table 2. Chi-square test results to examine the difference between the number of dominant people in each age in the evaluated areas

Age (year)	Chi-square value	P	Cramer's V
4	2.87	0.325	0.083
5	2.25	0.580	0.110
6	10.89	0.007*	0.163
7	11.48	0.009*	0.175
8	14.11	0.001*	0.189
9	15.05	0.003*	0.190
10	13.85	0.001*	0.178

*Significance at the P < 0.05 level

age. For this purpose, using the z-test related to the differences and the distribution of a domain, the percentage of specific FMS in each group was compared to other skills. The results of this comparison are presented in table 5.

At the 95% confidence level, no significant difference was found between the mastery of specific skills in the most popular sports and other FMS, as the calculated z was smaller than the critical z value of 1.645.

Discussion

The present study compared the FMS of children in Iran and selected countries, including America, Portugal, and China. Based on the theoretical foundations of motor behavior, it was assumed that the curriculum guidelines of different countries regarding the development of FMS affected the prevalence and the level of mastery of children who achieved mastery of these skills. The obtained results confirmed this hypothesis. The number of American children considered proficient in terms of FMS mastery indicators related to physical education curriculum guidelines was higher than Chinese, Portuguese, and Iranian

Table 1. Characteristics of the studies (samples) selected for the current research

Source	Country/city	Number of samples in each age group (y/o)							Girls/ boys	Summation
		4	5	6	7	8	9	10		
Wong and Cheung (23)	China, Hong Kong	245	270	167	127	89	108	107	675/675	1228
Ulrich (32)	America, 10 states	114	103	146	165	207	179	179	604/604	1208
Afonso et al. (26)	Portugal, Madeira	95	107	113	103	102	104	167	426/427	853
Farokhi et al. (31)	Iran, Tehran	178	190	190	184	177	187	173	640/639	1279

y/o: Years old

Table 3. Odds ratio (OR) for total fundamental motor skills (FMS) at each age

Country/city	OR for total FMS in each age group						
	4 y/o	5 y/o	6 y/o	7 y/o	8 y/o	9 y/o	10 y/o
China, Hong Kong	1.08	1.52	1.35	1.18	0.90	0.97	1.01
America, 10 states	1.49	1.23	1.74*	1.69*	1.93*	2.10*	1.96*
Portugal, Madeira	0.52	0.50	0.45	0.51	0.55	0.48	0.58
Iran, Tehran	0.78	0.54	0.83	0.62	0.49	0.68	0.76

*Significance level at $P < 0.05$

OR: Odds ratio; FMS: Fundamental motor skills; y/o: Years old

countries regarding the development of FMS affected the prevalence and the level of mastery of children who achieved mastery of these skills. The obtained results confirmed this hypothesis. The number of American children considered proficient in terms of FMS mastery indicators related to physical education curriculum guidelines was higher than Chinese, Portuguese, and Iranian children. Injustifying this finding, it should be said that attention to basic skills is the basis of physical education in all countries. Over time, this attention is not removed in any educational system because, according to developmental experts, there is a kind of mastery barrier between the implementation of essential skills and other advanced skills. That is, a lack of basic skills prevents the performance of more advanced skills. For example, someone who has difficulty with the essential skill of walking cannot perform the advanced skill of climbing or shoveling well. Therefore, the basic skills training program in childhood is considered an integral part of physical education in most countries. It was also true in the countries under review, and this issue is still considered. Based on this, the time interval between the conducted studies and their time interval with the current research does not create a problem in interpreting the findings.

According to existing theories, popular sports in each country were expected to lead to mastery of

specific skills related to that sport. However, the results showed no higher degree of mastery in FMS related to popular sports (19, 23, 25). For example, compared to the other three countries, children from Madeira were less likely to master kicking at all ages. Although the statistical analysis showed that children in China, America, and Iran had higher mastery levels in skills related to their popular sports than children in Portugal, the results indicated no significant relationship between popular sports and mastery of FMS in any country. Therefore, the most popular sport in each country does not lead to dominance of FMS associated with that sport in children exposed to that popular sport.

It was believed that the popularity of certain sports would lead to the mastery of related skills, but this was not the case. The factors were isolated and not enough to promote FMS mastery. Comprehensive physical education curriculum and promotion of FMS have a more significant effect on children's mastery. The current research results were in line with previous studies (35, 36) and confirmed their findings. These studies compared children who played freely in a structured environment to support the practice of various skills with children who received guidance from a physical education specialist. The results showed that only those who received advice significantly improved their FMS performance.

Table 3. Odds ratio (OR) for total fundamental motor skills (FMS) at each age

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America, 10 states	1.49	1.23	1.74*	1.69*	1.93*	2.10*	1.96*
Portugal, Madeira	0.52	0.50	0.45	0.51	0.55	0.48	0.58
Iran, Tehran	0.78	0.54	0.83	0.62	0.49	0.68	0.76

*Significance level at $P < 0.05$

OR: Odds ratio; FMS: Fundamental motor skills; y/o: Years old

Table 4. The average percentage of children with mastery in all fundamental motor skills (FMS)

Country/city	Percentage of children proficient in all FMS in each age group (y/o)							Mean percentage
	4	5	6	7	8	9	10	
China, Hong Kong	14	24	32	40	44	48	51	36.14
America, 10 states	16	23	35	46	55	61	63	42.71
Portugal, Madeira	8	12	17	27	32	38	44	25.42
Iran, Tehran	9	14	23	34	38	42	48	29.71

FMS: Fundamental motor skills; y/o: Years old

Therefore, adding appropriate training and guidance along with opportunities and incentives is necessary for the growth of FMS (35, 36). However, it should be noted that the assumption that girls are less encouraged to participate in sports primarily reserved for men, like soccer in Iran and Portugal and American football in America, may not apply to the participants in the studies reviewed in this project since the gender ratio was the same.

The study found that the mastery of FMS was strongly correlated with the specificity of physical education curriculum goals (37-39). Children in Portugal and Iran whose curriculum had general purposes had less chance of achieving mastery in FMS than Chinese children with more specific goals. The USA had the highest odds of mastery across FMS skills due to their particular targets for growth. Research has shown that targeted approaches to FMS growth can lead to significant performance improvements. Two Australian plans, "Move, Master Plan" and "Master, Activate Plan", are presented as examples (17-19). These projects aimed to increase the number of children fluent in FMS. The results showed a significant increase in children fully implementing FMS after the project began. In other words, having specific goals and focusing on achieving them provides more opportunities for practice and appropriate guidance, leading to better FMS implementation.

The present study examined articles that used the TGMD-2 test, and the analysis results showed that many American children were fluent in FMS. In addition to the particular FMS development plan in the USA, another important aspect that should be considered in connection with the superior results of North American children was the cultural bias of the test. Considering that TGMD-2 is a North American test, the skills evaluated by this

test were based on the skills suggested by the National Association of Sports and Physical Education (32). Therefore, it can be said that the growth and development of such skills may be part of the cultural context of the USA, which has caused many American children to demonstrate mastery of FMS.

The present research showed that having a plan, planning, program, and special strategies is 100% necessary for the growth and development of FMS. Without effective external factors such as appropriate guidance, encouragement, and opportunities, children have difficulty mastering FMS (19). This issue is very important, because there is a significant dependence between the stages of motor development. Low performance in FMS can create a barrier for the following stages of development (1) and can lead to a harmful decrease in the performance of physically active children (17). In the current research, the mentioned factors were investigated indirectly, but the findings somehow support this relationship.

Limitations

It should be noted that the research studies on children's FMS from the USA and China were conducted about nine years prior to the study in Madeira Island and 14 years before the study in Iran. As a result, numerous geographic and socio-economic changes may have influenced the development of children's FMS over time and across successive years.

Recommendations

It is suggested that the current research be conducted using national and continental forms, covering different regions of Iran and the Asia continent. Various tools like the Denver Developmental Screening Test-II (DDST-II) should also be utilized.

Table 5. The average percentage of children with mastery in all fundamental motor skills (FMS)

Country/city	Z score difference of special sports skill and 11 other movement skills in each age group						
	4 y/o	5 y/o	6 y/o	7 y/o	8 y/o	9 y/o	10 y/o
China (dribbling)	1.08	1.52	1.35	1.18	0.90	0.97	1.01
America (hitting)	0.78	0.83	0.52	1.34	1.25	1.16	1.25
America (throwing)	0.69	0.50	0.45	0.71	0.87	1.11	1.18
Portugal (kicking)	0.78	0.54	0.83	0.96	1.13	1.23	1.14
Iran (kicking)	0.78	0.54	0.83	0.62	1.49	0.68	1.23

The critical value of the difference was 1.645; y/o: Years old

Conclusion

According to the study, the most popular sport is not the determinant of FMS mastery level. Direct goals in national curricula are associated with higher mastery. Special programs are necessary for FMS development, including media, parental, and friend encouragement. These programs should have specific goals in line with FMS development, especially in elementary school.

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Authors' Contribution

Study design and ideation: Majid Kashef
 Getting financial resources for the study: Sayed Kavos Salehi, Majid Kashef
 Scientific and executive support of the study: Sayed Kavos Salehi, Majid Kashef
 Data collection: Sayed Kavos Salehi, Majid Kashef
 Analysis and interpretation of the results: Sayed Kavos Salehi, Majid Kashef
 Specialized statistics services: Sayed Kavos Salehi
 Manuscript preparation: Sayed Kavos Salehi, Majid Kashef
 Specialized scientific evaluation of the manuscript: Majid Kashef

Confirming the final manuscript to be submitted to the journal website: Sayed Kavos Salehi, Majid Kashef

Maintaining the integrity of the study process from the beginning to the publication, and responding to the referees' comments: Sayed Kavos Salehi, Majid Kashef

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Conflict of Interest

There is no conflict of interest. Dr. Sayed Kavos Salehi and Dr. Majid Kashef attracted the budget for the study related to this article from Shahid Rajaei Teacher Training University and are working as faculty members in this university.

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