

# Development Characteristics of Fundamental Movement Skills of Children Aged 3-6 Years: A Systematic Review and Meta-Analysis

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## Abstract

**Objectives:** Using the method of meta-analysis to compare and analyze the development characteristics of children's FMS in countries with different development levels from the perspective of gender. **Methods:** We searched the PubMed, EBSCOhost, Embase and Web of Science databases for studies published up to April 5, 2021, empirical studies on the FMS of children aged 3-6 were included. Two researchers independently screened and extracted data according to inclusion and exclusion criteria. RevMan 5.4.1 software was used for meta-analysis to analyze the mastery level of global children's FMS. **Results:** Finally, 18 articles were included. Results of the meta-analysis showed that whether in developed or developing countries, there was no statistical significance in comparing the locomotor skill scores of boys and girls (all  $P > 0.05$ ); however, both in developed countries and developing countries, the scores of object control skills generally appear that boys are better than girls (Developed: 0.48 [95% CI 0.40, 0.56],  $Z=11.74$ ,  $P < 0.05$ ,  $I^2=0\%$ ; Developing: 0.53 [95% CI 0.30, 0.76],  $Z=4.53$ ,  $P < 0.05$ ,  $I^2=81\%$ ). **Conclusion:** From the perspective of gender, the developmental characteristics of FMS in children showed consistent patterns in countries with different development levels. There is no difference in the mastery of locomotor skills among children of different genders, but there is a significant difference in the mastery of object control skills, and boys are significantly better than girls.

**Keywords:** Children, fundamental movement skills, meta-analysis.

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## 1. INTRODUCTION

PA brings many health benefits to children. It is not only important to maintain physical health, such as heart and lung health and better weight status (Lubans et al., 2010), but also to support cognitive and social development in childhood. However, insufficient PA will have a negative impact on children in many aspects (Okely et al., 2001). The study found that preschool children should take PA for at least 3 hours a day (Wood et al., 2020), but the compliance rate is only 42% - 50% (Pate et al., 2015). Studies have shown that sports skills can promote PA, which lays a solid foundation for a person's lifelong sports activities (Stodden et al., 2008). FMS is the basic ability and skill for children to perform a series of organized basic movements (Wick et al., 2017), it is the basis of complex PA and more professional motor skill (Bardid et al., 2016), it includes locomotor skills (such as running and jumping) and object control skills (such as catching and kicking), it plays a vital role in using more

professional and complex skills in playing, games and sports (Wick et al., 2017). Studies have shown that overweight or obese children are often positively correlated with the ability of FMS (Logan et al., 2012). Children aged 3-6 are the key age group for the development of FMS (Gallahue & Donnelly, 2007). However, in recent years, the development of children's FMS shows a downward trend (Bryant et al., 2014), which needs extensive attention. However, FMS does not develop naturally. It takes time to learn and practice before it can be mastered (Stodden et al., 2008).

As for the description of influencing factors of children's FMS, previous studies have shown that there are obvious differences in children's mastery of FMS in different countries, but whether the development law of boys and girls in different countries is consistent has not been studied. Taking this as the starting point, this paper uses the meta-analysis tool to analyze the currently published studies on children's FMS, in order

to provide some references for the future research of FMS.

## 2. METHODS

### 2.1 Search Strategy

Three English databases including PubMed, EBSCOhost, EMBASE and web of science were searched on April 5, 2021. The key words used in the search were: child, children, preschoolers, fundamental movement skills, fundamental motor skills, gross motor, physical activity and TGMD.

Title, abstract and keyword search fields were searched using the following search strategy: child OR children\* OR preschoolers\* AND fundamental movement skills\* OR fundamental motor skills\* OR gross motor\* OR physical activity\* AND TGMD.

### 2.2 Inclusion Criteria

#### 2.2.1 Type of Study

The evaluation of children's mastery of FMS is based on on-site evaluation or video evaluation.

#### 2.2.2 Type of Participants

The participants were healthy children aged 3-6.

#### 2.2.3 Research Design

The study was divided into boys' group and girls' group.

#### 2.2.4 Measuring Tools

Children's mastery of FMS was evaluated by the TGMD-2 evaluation tool.

#### 2.2.5 Type of Outcome Measure

Includes the raw scores for locomotor skills and object control skills.

### 2.3 Data Extraction

According to the research needs, two searchers independently extracted the relevant indicators included in the literature. The extracted contents mainly include: first author, publication period, sample size, research location, gender, age, outcome index and other relevant data.

### 2.4 Statistical Considerations

This paper uses Revman 5.4.1 software for meta-analysis, the outcome indicators of the included literatures were continuous variables, and the standard mean difference (SMD) and its 95% confidence interval (95% CI) were selected as the effect size indicators. At the same time,  $I^2$  value was used to test the heterogeneity among the studies. When  $I^2 < 50\%$ , there was no significant heterogeneity among the studies. Fixed effect model was used. On the contrary, random effect model is used. The subgroups were merged in the same way.

## 3. RESULTS

### 3.1 Search Results

We obtained 678 articles through three data retrieval, and obtained 3 articles from the pearling of reference list, 681 in total. It was imported into the document management software Note Express 3.2.0.7535, and 342 articles were included after removing the duplicate articles. After reading the title and abstract of the article, 34 articles were left. After further reading, 18 articles (19 studies) were included (Fig-1).

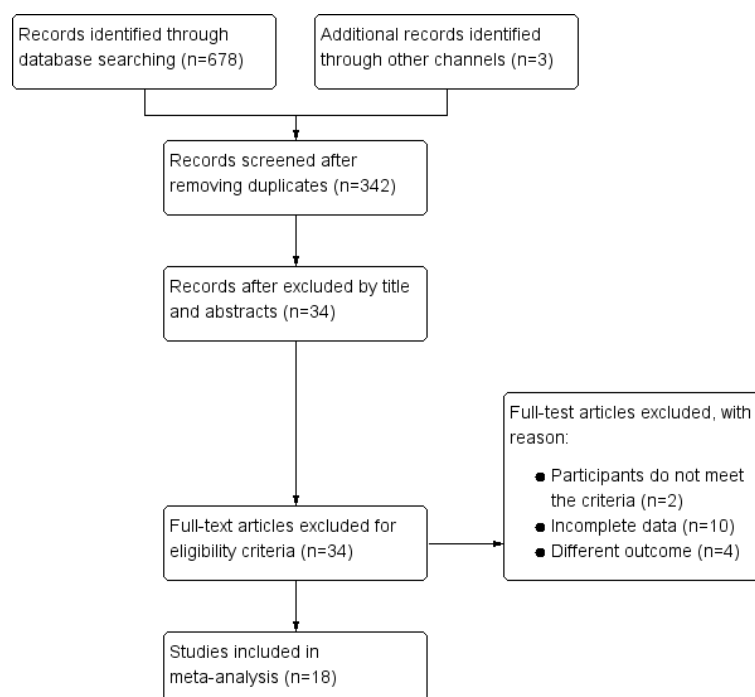


Fig-1: Flow diagram of the study selection process

### 3.2 Study Characteristics

A total of 19 studies were included, most of which were cross-sectional studies, of which 11 were from developed countries and 8 from developing countries. There were 2005 boys and 1938 girls in the

locomotor skill assessment, 2209 boys and 2153 girls in the object control skill assessment, and the age ranged from 3 to 6 years. There are 14 articles on TGMD-2 and 4 articles on TGMD-3 (Table-1).

**Table 1: Characteristics of studies included in meta-analysis**

Authors	Country	level	Sample				Design	Outcome
			Age	N	Boy	Girl		
Alessandro <i>et al.</i> , 2018	Brazil	developing	5-6	158	82	76	CS	TGMD-2
Aye <i>et al.</i> , 2017	Myanmar	developing	5	472	237	235	CS	TGMD-2
Aye <i>et al.</i> , 2018	Japan	developed	5	60	34	26	CS	TGMD-2
Behan <i>et al.</i> , 2019	Ireland	developed	5-6	367	LM:202	LM:200	CS	TGMD-3
					OC:158	OC:159		
Brian <i>et al.</i> , 2018	EXP: Belgium	developed	4-5	EXP:170	EXP:97	EXP:73	CS	TGMD-2
	CON: USA	developed		CON:156	CON:66	CON:90		
Crane <i>et al.</i> , 2017	Canada	developed	5-6	250	124	126	LD	TGMD-2
Cheung <i>et al.</i> , 2020	China	developing	4-6	295	162	133	CC	TGMD-2
Freitas <i>et al.</i> , 2018	Portugal	developed	3-6	314	155	159	CS	TGMD-2
Hall <i>et al.</i> , 2018	Britain	developed	3-5	177	91	75	CS	TGMD-2
Kim <i>et al.</i> , 2016	South Korea	developed	5-6	216	102	114	CS	TGMD-2
Kit <i>et al.</i> , 2017	USA	developed	3-5	339	LM:167	LM:163	CS	TGMD-2
					OC:170	OS:168		
Korbecki <i>et al.</i> , 2017	Poland	developed	6,7	64	29	35	CS	TGMD-2
Palmer <i>et al.</i> , 2020	USA	developed	3.5-5	54	27	27	OE	TGMD-2
Shi <i>et al.</i> , 2020	China	developing	5-6	43	22	21	RCT	TGMD-2
Tietjens <i>et al.</i> , 2018	Germany	developed	3-6	27	16	11	CS	TGMD-3
Tomaz <i>et al.</i> , 2019	South Africa	developing	3-6	259	130	129	CS	TGMD-2
Valentini <i>et al.</i> , 2017	Brazil	developing	3-6	281	135	146	CS	TGMD-3
Wang <i>et al.</i> , 2020	China	developing	3-6	268	126	142	LD	TGMD-3

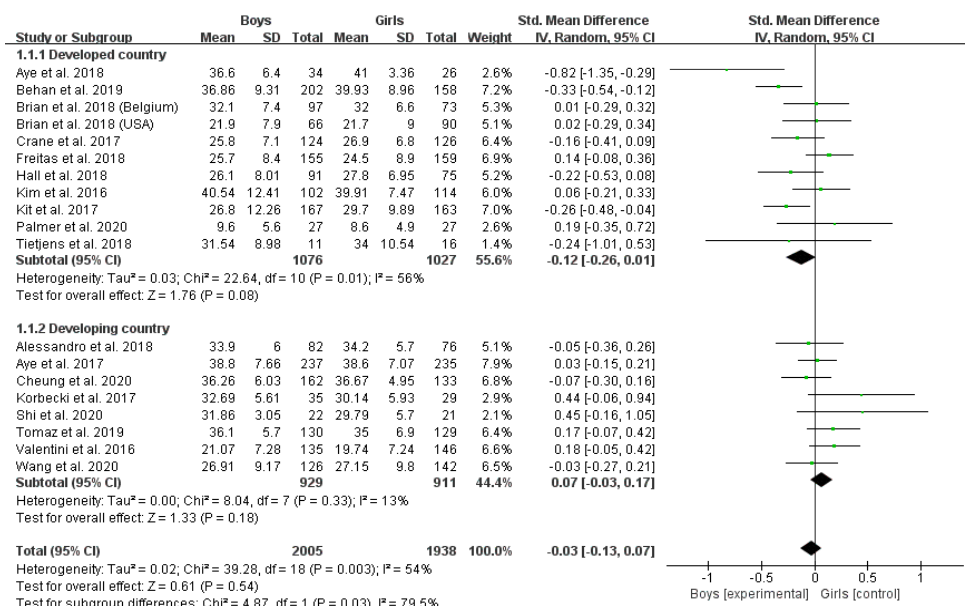
**Note:** EXP: experience group; CON: control group; LM: locomotor; OC: object control; CS: cross-sectional; LD: longitudinal direction; RCT: randomized control trial; OE: quasi-experimental; CC: case-control.

### 3.3 Meta-Analysis Results

#### 3.3.1 Gender differences in locomotor skills

Fig 2 shows the forest plot of comparison of the locomotor skills scores of boys and girls in developed and developing countries. Through the meta-analysis of 12 studies (1076 boys, 1027 girls) in

developed countries and 7 studies (929 boys, 911 girls) in developing countries, the results show that whether in developed or developing countries, there is no difference in the mastery of locomotor skills between boys and girls (All  $P > 0.05$ ).

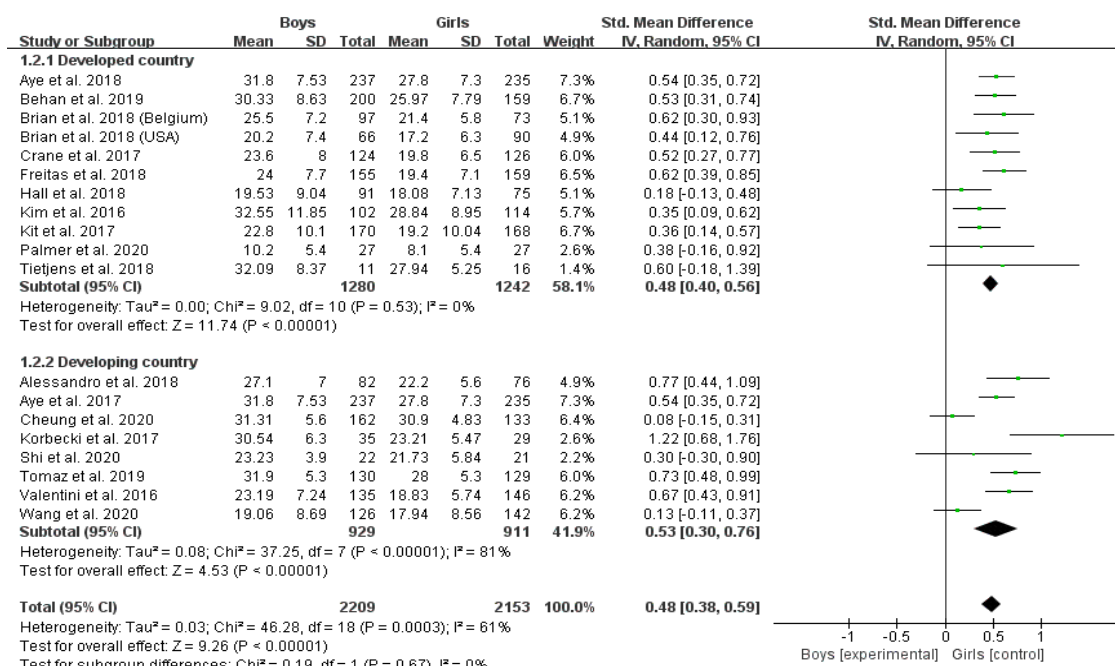


**Fig-2: Forest plot of locomotor skills scores**

### 3.3.2 Gender differences in object control skills

Fig 3 shows the forest plot of comparison of the object control skills scores of boys and girls in developed and developing countries. Through the meta-analysis of 12 studies (1280 boys, 1242 girls) in developed countries and 7 studies (929 boys, 911 girls) in developing countries, the results show that in both

developed and developing countries, boys have better mastery of object control skills than girls, and all of them were statistically significant (Developed: 0.48 [95% CI 0.40, 0.56], Z=11.74, P < 0.05, I<sup>2</sup>=0%; Developing: 0.53 [95% CI 0.30, 0.76], Z=4.53, P < 0.05, I<sup>2</sup>=81%).

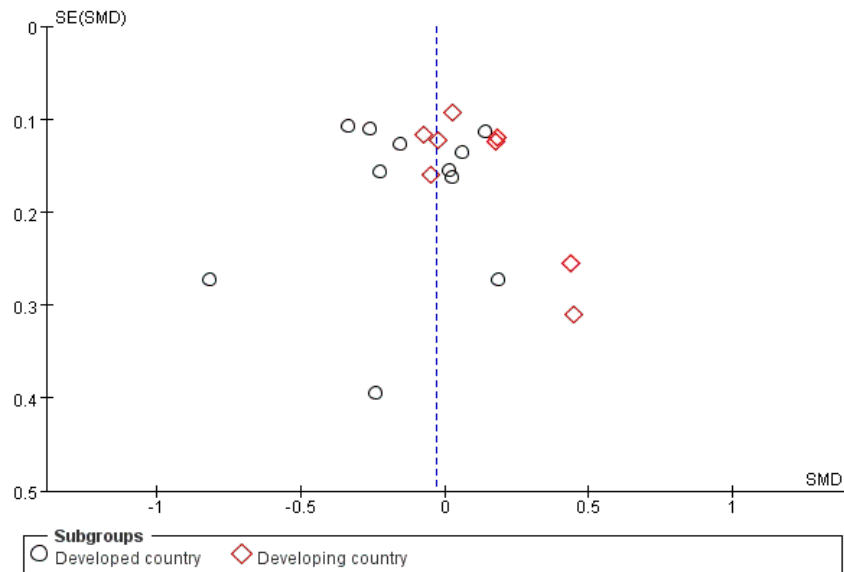


**Fig-3: Forest plot of object control skills scores**

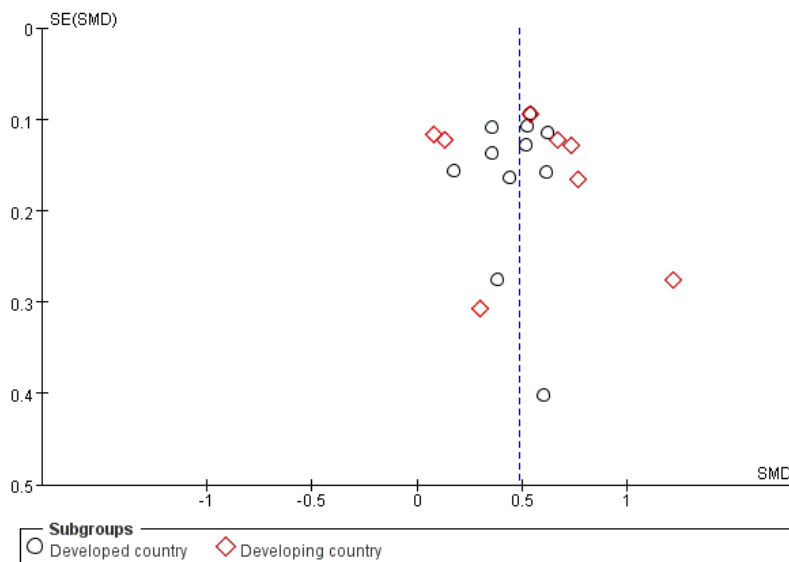
### 3.4 Sensitivity analysis and risk assessment

Sensitivity analysis was performed on 19 included studies, and the results were relatively stable after each study was eliminated in turn.

Funnel plot analysis of the included studies shows that the symmetry of the two dimensions of locomotor skills (Fig 4) and object control skills (Fig 5) is good, suggesting that the risk of bias may be small.



**Fig-4: Funnel plot based on locomotor skills scores**



**Fig-5: Funnel plot based on object coniect control skills scores**

**4. DISCUSSION**

A large number of studies have shown that there are gender differences in children’s FMS, but whether the results are consistent in countries with different levels of development has not been discussed. This meta-analysis included 18 articles, including 19 studies, the results show that there is no gender difference in the mastery of locomotor skills, but there is gender difference in the mastery of object control skill, and boys are better than girls. This shows that there is no regional difference in gender difference in FMS.

This result may be due to the physiological differences between boys and girls, which has been suggested by Butterfield *et al.*(Butterfield *et al.*, 2012), it may also be influenced by family environment,

teachers, society and so on(Garcia, 1994; Thomas & French, 1985). It is generally encouraged boys should take part in more control sports and girls should develop dance sports(Payne & Isaacs, 2017; Fagot & Leinbach, 1989; Hardy *et al.*, 2012). Other studies have shown that children’s FMS can be improved through intervention(Barnett *et al.*, 2010), which can show that gender differences can be reduced through intervention.

This paper compares the children in developed and developing countries, but it is difficult to rule out the heterogeneity of family income. The heterogeneity of object control skills development of children in developing countries is relatively high, which needs further discussion.



## 5. CONCLUSION

From the perspective of gender, the developmental characteristics of FMS in children showed consistent patterns in countries with different development levels. There is no difference in the mastery of locomotor skills among children of different genders, but there is a significant difference in the mastery of object control skills, and boys are significantly better than girls.

**Disclosure statement:** The authors declare that no conflicts of interest.

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## 6. REFERENCES

- Aye, T., Kuramoto-Ahuja, T., Sato, T., Sadakiyo, K., Watanabe, M., & Maruyama, H. (2018). Gross motor skill development of kindergarten children in Japan. *Journal of physical therapy science*, 30(5), 711-715.
- Aye, T., Oo, K. S., Khin, M. T., Kuramoto-Ahuja, T., & Maruyama, H. (2017). Gross motor skill development of 5-year-old Kindergarten children in Myanmar. *Journal of physical therapy science*, 29(10), 1772-1778.
- Bardid, F., Huyben, F., Lenoir, M., Seghers, J., De Martelaer, K., Goodway, J. D., & Deconinck, F. J. (2016). Assessing fundamental motor skills in Belgian children aged 3 - 8 years highlights differences to US reference sample. *ACTA PAEDIATRICA*, 105(6), e281-e290.
- Barnett, L. M., van Beurden, E., Morgan, P. J., Brooks, L. O., & Beard, J. R. (2010). Gender differences in motor skill proficiency from childhood to adolescence: A longitudinal study. *RESEARCH QUARTERLY FOR EXERCISE AND SPORT*, 81(2), 162-170.
- Behan, S., Belton, S., Peers, C., O Connor, N. E., & Issartel, J. (2019). Moving Well-Being Well: Investigating the maturation of fundamental movement skill proficiency across sex in Irish children aged five to twelve. *JOURNAL OF SPORTS SCIENCES*, 37(22), 2604-2612.
- Brian, A., Bardid, F., Barnett, L. M., Deconinck, F. J., Lenoir, M., & Goodway, J. D. (2018). Actual and perceived motor competence levels of Belgian and United States preschool children. *Journal of Motor Learning and Development*, 6(s2), S320-S336.
- Bryant, E. S., Duncan, M. J., & Birch, S. L. (2014). Fundamental movement skills and weight status in British primary school children. *European Journal of Sport Science*, 14(7), 730-736.
- Butterfield, S. A., Angell, R. M., & Mason, C. A. (2012). Age and sex differences in object control skills by children ages 5 to 14. *PERCEPTUAL AND MOTOR SKILLS*, 114(1), 261-274.
- Cheung, P., & Zhang, L. (2020). Environment for Preschool Children to Learn Fundamental Motor Skills: The Role of Teaching Venue and Class Size. *Sustainability*, 12(22), 9774.
- Crane, J. R., Foley, J. T., Naylor, P., & Temple, V. A. (2017). Longitudinal change in the relationship between fundamental motor skills and perceived competence: kindergarten to grade 2. *Sports*, 5(3), 59.
- Fagot, B. I., & Leinbach, M. D. (1989). The young child's gender schema: Environmental input, internal organization. *CHILD DEVELOPMENT*, 663-672.
- Freitas, D. L., Lausen, B., Maia, J. A., Gouveia, É., Antunes, A. M., Thomis, M., Lefevre, J., & Malina, R. M. (2018). Skeletal maturation, fundamental motor skills, and motor performance in preschool children. *SCANDINAVIAN JOURNAL OF MEDICINE & SCIENCE IN SPORTS*, 28(11), 2358-2368.
- Gallahue, D. L., & Donnelly, F. C. (2007). Developmental physical education for all children. *Human Kinetics*.
- Garcia, C. (1994). Gender differences in young children's interactions when learning fundamental motor skills. *RESEARCH QUARTERLY FOR EXERCISE AND SPORT*, 65(3), 213-225.
- Hall, C. J., Eyre, E. L., Oxford, S. W., & Duncan, M. J. (2018). Relationships between motor competence, physical activity, and obesity in British preschool aged children. *Journal of Functional Morphology and Kinesiology*, 3(4), 57.
- Hardy, L. L., Reinten-Reynolds, T., Espinel, P., Zask, A., & Okely, A. D. (2012). Prevalence and correlates of low fundamental movement skill competency in children. *PEDIATRICS*, 130(2), e390-e398.
- Kim, C., & Lee, K. (2016). The relationship between fundamental movement skills and body mass index in Korean preschool children. *European Early Childhood Education Research Journal*, 24(6), 928-935.
- Kit, B. K., Akinbami, L. J., Isfahani, N. S., & Ulrich, D. A. (2017). Gross motor development in children aged 3 - 5 years, United States 2012. *MATERNAL AND CHILD HEALTH JOURNAL*, 21(7), 1573-1580.
- Korbecki, M., Wawrzyniak, S., & Rokita, A. (2017). Fundamental movement skills of six-to seven-year-old children in the first grade of elementary school: A pilot study. *Baltic Journal of Health and Physical Activity. The Journal of Gdansk University of Physical Education and Sport*, 9(4), 22-31.
- Logan, S. W., Robinson, L. E., Wilson, A. E., & Lucas, W. A. (2012). Getting the fundamentals of

- movement: a meta - analysis of the effectiveness of motor skill interventions in children. *Child: care, health and development*, 38(3), 305-315.
- Lubans, D. R., Morgan, P. J., Cliff, D. P., Barnett, L. M., & Okely, A. D. (2010). Review of the benefits associated with fundamental movement skill competency in youth. *SPORTS MEDICINE*, 40(12), 1019-1035.
  - Okely, A. D., Booth, M. L., & Patterson, J. W. (2001). Relationship of physical activity to fundamental movement skills among adolescents. *MEDICINE AND SCIENCE IN SPORTS AND EXERCISE*, 33(11), 1899-1904.
  - Palmer, K. K., Harkavy, D., Rock, S. M., & Robinson, L. E. (2020). Boys and Girls Have Similar Gains in Fundamental Motor Skills Across a Preschool Motor Skill Intervention. *Journal of Motor Learning and Development*, 8(3), 569-579.
  - Pate, R. R., O'Neill, J. R., Brown, W. H., Pfeiffer, K. A., Dowda, M., & Addy, C. L. (2015). Prevalence of compliance with a new physical activity guideline for preschool-age children. *Childhood Obesity*, 11(4), 415-420.
  - Payne, V. G., & Isaacs, L. D. (2017). *Human motor development: A lifespan approach*. Routledge.
  - Ré, A. H. N., Logan, S. W., Cattuzzo, M. T., Henrique, R. S., Tudela, M. C., & Stodden, D. F. (2018). Comparison of motor competence levels on two assessments across childhood. *JOURNAL OF SPORTS SCIENCES*, 36(1), 1-6. <http://doi.org/10.1080/02640414.2016.1276294>
  - Shi, K., Sun, X., Wang, Y., & Zha, P. (2020). Effects of gymnastics intervention on gross motor development in children aged 5 to 6 years: a randomized, controlled trial. *MEDICINA DELLO SPORT*, 73(2), 327-336.
  - Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Robertson, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. *QUEST*, 60(2), 290-306.
  - Thomas, J. R., & French, K. E. (1985). Gender differences across age in motor performance: A meta-analysis. *PSYCHOLOGICAL BULLETIN*, 98(2), 260.
  - Tietjens, M., Dreiskaemper, D., Utesch, T., Schott, N., Barnett, L. M., & Hinkley, T. (2018). Pictorial scale of physical self-concept for younger children (P-PSC-C): a feasibility study. *Journal of Motor Learning and Development*, 6(s2), S391-S402.
  - Tomaz, S. A., Jones, R. A., Hinkley, T., Bernstein, S. L., Twine, R., Kahn, K., Norris, S. A., & Draper, C. E. (2019). Gross motor skills of South African preschool-aged children across different income settings. *JOURNAL OF SCIENCE AND MEDICINE IN SPORT*, 22(6), 689-694.
  - Valentini, N. C., Zanell, L. W., & Webster, E. K. (2017). Test of Gross Motor Development - Third Edition: Establishing Content and Construct Validity for Brazilian Children. *Journal of Motor Learning and Development*, 5(1), 1-22.
  - Wang, H., Chen, Y., Liu, J., Sun, H., Gao, W., & Gao, Z. (2020). A Follow-Up Study of Motor Skill Development and Its Determinants in Preschool Children from Middle-Income Family. *Biomed Research International*, 2020, 6639341. <http://doi.org/10.1155/2020/6639341>
  - Wick, K., Leeger-Aschmann, C. S., Monn, N. D., Radtke, T., Ott, L. V., Rebholz, C. E., Cruz, S., Gerber, N., Schmutz, E. A., & Puder, J. J. (2017). Interventions to promote fundamental movement skills in childcare and kindergarten: a systematic review and meta-analysis. *SPORTS MEDICINE*, 47(10), 2045-2068.
  - Wood, A. P., Imai, S., McMillan, A. G., Swift, D., & DuBose, K. D. (2020). Physical activity types and motor skills in 3-5-year old children: National Youth Fitness Survey. *JOURNAL OF SCIENCE AND MEDICINE IN SPORT*, 23(4), 390-395.