

The Relationship between Fundamental Movement Skills and Physical Activity in Children and Adolescents: A Systematic Review

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Abstract

Introduction: This study was conducted to identify the current status of research on the relationship between basic motor skills and physical activity in children and adolescents, and to provide a reference for further research. A systematic evaluation method was used to find out the current status of research on the correlation between basic motor skills and physical activity in children and adolescents, based on two Chinese databases, CNKI and WANFANG DATA, and Web of Science, Scopus, Academic Search Premier (ASP), MEDLINE, Education Source, Education Resource Information Center (ERIC), and APA. Center (ERIC), APA PsycInfo, Psychology and Behavioral Sciences Collection, and other English databases, we collected studies on the relationship between fundamental movement skills and physical activity of children and adolescents published in China and abroad between 2016 and 2022. Results: A total of 17 studies were included, of which 13 studies were conducted on normal children and 4 studies were conducted on children with disabilities. **Conclusions:** (1) There is a positive relationship between basic motor skills and physical activity, and longitudinal studies are needed to further prove the relationship; (2) Basic motor skills have a facilitating effect on the physical activity of children and adolescents, especially those with disabilities, and can increase their physical activity time by improving their basic motor skills, and the relationship between the dimensions of basic motor skills and physical activity from (3) The relationship between basic motor skills and physical activity in children and adolescents are influenced by gender factors, and other factors have not been explored in current domestic and international studies.

Keywords: Fundamental movement skills, Physical activity, Children and adolescents, Systematic review.

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INTRODUCTION

Participation in physical activity by children and adolescents can improve muscle and cardiorespiratory fitness, improve bone and metabolic health, reduce the risk of hypertension, coronary heart disease, stroke, diabetes and depression, reduce the risk of falls and fractures, and help maintain a healthy weight [1]. Lack of physical activity increases people's risk of cardiovascular disease and makes them more prone to obesity and other health problems, based on this, international organizations and government agencies such as the World Health Organization, the United States, Australia, and China have recommended 60 minutes of moderate-to-vigorous physical activity per day for children and adolescents, yet only 21.2% of children and adolescents in China meet this standard, which shows that physical activity in children and adolescents has However, only 21.2% of children and adolescents in China meet this standard. The "peak

theory" of motor skill development suggests that basic motor skills are the cornerstone of active participation in organized and unorganized physical activity and have a positive impact on the development of physical activity habits, the maintenance of healthy weight, and the improvement of cardiovascular fitness and muscle strength endurance [3]. In the development of motor skills, if children do not acquire the correct basic movement patterns, their ability to perform different combinations of movements consisting of basic motor skills will be significantly reduced [4]. Basic motor skills are not naturally occurring basic learned motor patterns that underlie more complex physical and sporting activities [5], but also basic motor skills are fundamental skills used in everyday life, and therefore the acquisition of these skills by children and adolescents is an important factor in future participation in physical activity [6].

In the last decade, obesity and declining physical fitness among children and adolescents have become a global phenomenon [3], and the causes of this phenomenon are inextricably linked to the declining level of physical activity among children and adolescents. Low levels of physical activity not only affect the development of basic motor skills but may also lead to higher rates of obesity in children and adolescents [7], and participation in regular physical activity can have significant health benefits for adolescents, especially in the physical, social, cognitive, and psychological aspects of childhood [8]. How to promote active participation of children and adolescents in physical activity and what factors increase the level of physical activity in children and adolescents have been widely discussed by scholars in recent years, both nationally and internationally. Among them, exploring the relationship between basic motor skills and physical activity from the perspective of children and adolescents has become a hot topic. Based on this, the present study was based on studies on the relationship between basic motor skills and physical activity in children and adolescents published at home and abroad during 2016-2022, and studies that met the inclusion and exclusion criteria were included in the analysis in order to discover the current status of research on the correlation between basic motor skills and physical activity and to provide references for further research.

1. Basic Motor Skills and Physical Activity Concept Definition

1.1 Fundamental Movement Skills

Fundamental movement skill (FMS) is defined as the basic learned movement patterns that do not occur naturally, but are the basis for more complex physical and sporting activities. They can be divided into three different categories: displacement skills (including body movement, such as running, jumping, climbing and sliding), object control skills (including manipulation skills, such as grasping, throwing, kicking, catching, intercepting and striking) and stability skills (including balance, such as rotating, turning, bending and standing on one foot) [5].

1.2 Physical Activity

Physical activity (PA) is any physical action produced by skeletal muscles that requires energy expenditure, which includes activities during work, play, housework, travel, and recreational activities [9]. PA is defined as follows in the article Physical Activity Guidelines for Children and Adolescents in China published by the Working Group for the Production of Physical Activity Guidelines for Children and Adolescents in China in 2007: physical activity is any bodily activity that involves energy expenditure above the basal metabolic level caused by skeletal muscle contraction. Physical activity includes: occupational work, household chores, leisure activities, sports, and physical exercise for fitness and health purposes. The intensity of physical activity is usually measured in

Metabolic equivalent (MET) as the basic unit. Physical activity can be classified by intensity as Light Physical activity (LPA), with an intensity of 1.5-2.9 MET, Moderate Physical activity (MPA), with an intensity of 3.0-5.9 MET, and Vigorous Physical Activity, (VPA) with an intensity of ≥ 6.0 MET [10].

2. RESEARCH METHODS

2.1 Literature Search Strategy

In China Knowledge Network, Wanfang database was used for "basic motor skills", "basic movement skills", "motor ability", "displacement skills", "object control skills"; "physical activity", "physical activity", "movement" and "children," "adolescents," and "students" were used as Chinese search terms for the literature search in Web of Science, Scopus, Academic Search Premier(ASP), MEDLINE, Education Source, Education Resource Information Center(ERIC), APA PsycInfo, Psychology and Behavioral Sciences Collection English databases as ("fundamental movement skill*" OR "fundamental motor skill*" OR "cross motor skill*") " OR "gross motor skill*" OR "motor skill*" OR "motor proficienc*" OR "locomotor skill" OR "basic athletic ability" OR "object control skill" OR "stability skill") AND ("physical activit*" OR " PA" OR "MVPA" OR "sports" OR "exercise*" OR "physical education") AND ("child*" OR "childhood" OR "adolescent*" OR "teenager*" OR "youth*" OR "student *") AND ("relationship*" OR "correlat*" OR "associat*" OR "effect*") as the English search formula for the literature search.

2.2 Literature Inclusion and Exclusion Criteria

(1) Inclusion Criteria

1. FMS was measured using process-oriented, outcome-oriented, or both measures;
2. PA levels or at least a specific intensity PA level were measured using subjective or objective instruments;
3. The relationship between FMS and PA was reported and statistically analyzed;
4. It was published in English in a peer-reviewed journal by November 20, 2021.

(2) Exclusion Criteria

- i. The age range of study subjects was not between 5 and 17 years;
- ii. The FMS assessment included only fine motor skills or only perceived FMS was investigated;
- iii. The study only reported PA type without measurement;
- iv. Editorials, conference proceedings, and abstracts should be excluded.

All articles were imported into EndNote for checking, duplicates were removed, and article eligibility was first determined by title and abstract according to the inclusion criteria, and reviewed by obtaining the full text when it could not be excluded by title.

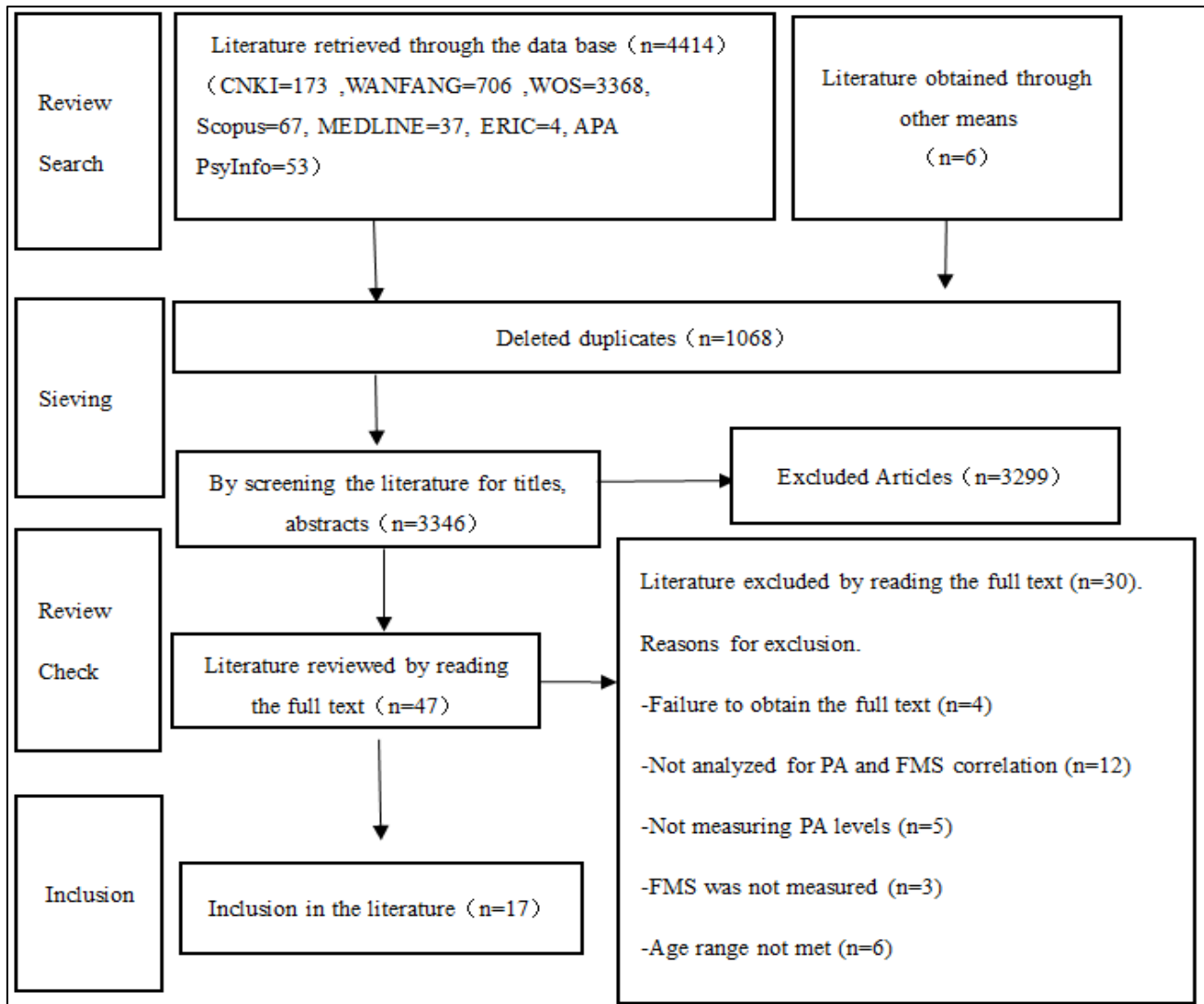


Figure 1: Flow chart of literature search

3. STUDY RESULTS AND ANALYSIS

3.1 Inclusion of Literature

A total of 17 studies were included by following the search strategy and screening the retrieved literature strictly according to the inclusion and exclusion criteria, among which 13 studies were conducted on normal children and 4 studies were conducted on children with disabilities. After summarizing the domestic and international studies on the relationship between FMS and PA from 2016-2021, it was found that among the 13 included domestic and international studies on the relationship between FMS and PA in normal children and adolescents, 11 studies used a cross-sectional study design, 1 study used a longitudinal study design, and 1 study used a combination of cross-sectional and longitudinal studies. Most of the included studies on basic motor skills

measurement used the Large Muscle Group Movement Development Measure (TGMD) to measure basic motor skills in children and adolescents, 38.5% of the included studies on physical activity measurement used questionnaires (e.g., the International Physical Activity Questionnaire) to subjectively investigate physical activity in children and adolescents, and 61.5% of the studies used objective All but one of the studies used pedometers to measure physical activity, and all but one of the studies used accelerometers to measure physical activity. Only four cross-sectional studies were retrieved to explore this issue in the population of children and adolescents with disabilities, and each of the four studies addressed four different types of disabilities: autism [11], cerebral palsy [12], CHARGE syndrome [13], and mild mental retardation [14].

Table 1: Basic information about the included literature

Author (Time)	Country (Region)	Study Design	FMS measurement tools	PA measurement tools	Sample size	Age of study subjects	Age group of study subjects (type of disability)
Jaakkola (2016)	Finland	L	Flamingo standing test, jump test, figure 8 dribbling	International Physical Activity Questionnaire Short Form (IPAQ)	333	12.41±0.27	Teenagers
Farmer (2017)	Ireland	C	TGMD-2	Physical Activity Questionnaire PAQ-C, PACE	160	8-12	Children and adolescents
Santos (2017)	Brazil	C	TGMD-2	Physical Activity Questionnaire	100	8-10	Children
Afthentopoulou (2018)	Greece	C	BOT-2	Pedometer	121	6-9	Children
Balaban (2018)	Czech Republic	C	TGMD-2	Accelerometer	201	8-11	Children and adolescents
Dubosed (2018)	United States	C	MABC-2	Accelerometer	96	3-10	Children
Mcgrane (2018)	Ireland	C	TGMD-2	Accelerometer	584	12.82-15.25	Children and adolescents
Jaakkola (2019)	Finland	L	Using the five-jump test and the throwing-catching combination test	Accelerometer	336	12.03±0.38	Children and adolescents
Miller (2019)	Australia	C	TGMO-3	Accelerometer	107	9-12	Children and adolescents
Schembri (2019)	Italy	C	TGMD	Physical Activity Questionnaire	112	6-11	Children and adolescents
Xin Fei (2019)	China (Macau)	C	TGMD-2	International Physical Activity Questionnaire Short Form (IPAQ-SF)	248	6-10	Children
Mucke (2021)	Germany & Switzerland	C	MOBAK-5	Accelerometer	91	10-14	Teenagers
Smith (2021)	Iran & United Kingdom	C	TGMD-2	Accelerometer	119 & 139	9-11	Children and adolescents
ByungMo (2020)	United States	C	Developmental Disability Coordination Questionnaire (DCDQ)	Physical Activity Questionnaire (MPAQ-C)	68	5-7	Children (Autism)
Gerber (2020)	Switzerland	C	GMFM-66	Accelerometer	25	8-17	Children and adolescents (cerebral palsy)
Perreault (2020)	United States	C	TGMD-2	Physical Activity Questionnaire (PAQ)	37	9.64±3.69	Children and adolescents (CHARGE syndrome)
Meng Jie (2020)	China	C	TGMD-2	Accelerometer	65	9-11	Children and adolescents (mental retardation)

3.2 Relationship between Basic Motor Skills and Physical Activity in Normal Child Adolescents

After summarizing the domestic and international studies on the relationship between FMS

and PA from 2016- 2021, it was found that among the 13 included domestic and international studies on the relationship between FMS and PA in normal child adolescents, 11 papers used a cross-sectional study

design, 1 paper used a longitudinal study design, and 1 paper used a combined cross-sectional and longitudinal study design. Most of the included studies on basic motor skills measurement used the Large Muscle Group Motor Development Measure (TGMD) to measure basic motor skills in children and adolescents, 38.5% of the included studies on physical activity measurement used questionnaires (e.g., the International Physical Activity Questionnaire) to subjectively investigate physical activity in children and adolescents, and 61.5% of the studies used objective All but one of the studies used pedometers to measure physical activity.

3.2.1 Interrelationships between Overall Basic Motor Skills and Physical Activity

Eight cross-sectional studies examined the interrelationship between overall basic motor skills and physical activity, and four studies with children measured a degree of correlation between overall basic motor skills and physical activity. Santos *et al.*, [15] showed a moderate positive correlation between habitual physical activity and basic motor skills, and Balaban [16] concluded that the relationship between VPA and steps per day had a very weak positive correlation with basic motor skills, Dubose *et al.*, [7] concluded that total basic motor skills scores were positively correlated with MPA and MVPA, and Xinfai *et al.*, [17] found some degree of correlation between mean MVPA and TPA time per day and basic motor skills scores. Four studies with children found a non-significant relationship between overall basic skills and physical activity when measured, Farmer *et al.*, [18] found no statistically significant difference in overall basic motor skill proficiency between the three PA groups after grouping participants by low, moderate, and high intensity physical activity levels, Afthentopoulou *et al.*, [19] found that physical activity and basic motor skills The correlation between was not significant in children aged 6-9 years, and Xinfai *et al.*, [17] concluded that there was no statistically significant correlation between mean daily LPA time and basic motor skill scores in any of the studies. Smith *et al.*, [20] found no single PA behavior was significantly associated with FMS scores after a study of Iranian and British children, except for MVPA in Iranian children. A study of adolescents concluded that there was no significant association between basic motor skills and MVPA in adolescents [21].

3.2.2 A Single Relationship between Overall Basic Motor Skills and Physical Activity

Overall basic motor skill competence positively contributes to physical activity [16, 22]. Schembri *et al.*, [23] concluded that children who exhibit higher motor skills participate in more sports and physical activities compared to children with lower levels of basic motor skills, Santos *et al.*, [15] found that compared to children with low and average levels of basic motor skills, children with Children with high levels of skills were more likely to develop higher

levels of physical activity, Balaban [16] identified the promotion of FMS in boys and girls as an important factor in increasing children's PA levels, Jaalloia *et al.*, [24] showed through a longitudinal study that basic motor skills had a significant explanatory effect on LPA, MPA and VPA scores, Jaakkola *et al.*, [22] also used a longitudinal study design to find that PA participation is influenced by basic motor skill ability, and that higher levels of motor skill ability typically provide greater likelihood of participation in a variety of physical activities, sports, and games in late childhood and adolescence. Increased levels of physical activity promote the development of overall basic motor skills [15, 23]. Santos *et al.*, [15] concluded that participation in organized physical activity enhanced children's basic motor skill levels, Schembri *et al.*, [23] found that less than two hours of physical activity per week decreased the probability of developing gross motor skills at the highest level, and Dubose *et al.*, [7] concluded that the more time children spent on MPA and MVPA (but not VPA) the higher the total basic motor skill scores.

3.2.3 Relationship between Different Dimensions of Basic Motor Skills and Physical Activity

There was a positive relationship between the dimensions of basic motor skills and a certain level of physical activity. There was a significant positive correlation between object control skills and children's MVPA time [7, 25, 26], and Balaban [16] concluded that there was a weak positive correlation between displacement skills, object control skills and VPA, and a very weak positive correlation between object control skills and number of steps per day. Xinfai *et al.*, [17] found that displacement skills and object control skills were more correlated with mean daily MVPA and TPA time compared to each other. The balance subscale was positively correlated with MPA, suggesting that children with more MPA had better balance scores than children who spent less time on MPA [7].

3.2.4 Effect of Gender on the Relationship between Basic Motor Skills and Physical Activity

There were significant gender differences in the relationship between basic motor skills and physical activity [17], Jaakkola *et al.*, [22] found that only girls' MVPA in grade 6 was positively correlated with jumping skills in grade 7 after a longitudinal study, Mcgrane *et al.*, [21] concluded that girls' actual displacement skills were related to MVPA and boys' stability skills were related to MVPA, and boys accumulated daily MVPA significantly more than girls is due to girls' lower mastery in FMS than males, which may lead to lower levels of PA in girls. Xinfai *et al.*, [17] found that boys' average daily MVPA and TPA time were positively correlated with displacement skills and total basic motor skills scores, respectively, and girls' average daily MVPA time was positively correlated with displacement, object control skills, and total basic motor skills scores, respectively, and

displacement skills were more highly correlated than object control skills, and average daily TPA time and displacement skills scores. There was a positive correlation between TPA time and displacement skill scores.

The correlations between basic motor skills and physical activity in the included studies were not accurately concluded by each empirical study, probably because cross-sectional surveys may not easily verify the two-way relationships, and two-way associations need to be verified by research designs such as long follow-up studies or experiments [27]. The unidirectional relationships between basic motor skills and physical activity were all concluded to have positive facilitative effects in the included studies. The relationship between the dimensions of basic motor skills and physical activity and the effect of gender differences on the relationship between the two are less well documented and need further validation in future studies.

3.3 Relationship between Basic Motor Skills and Physical Activity in Children and Adolescents with Disabilities

Compared to typically developing children and adolescents, children and adolescents with disabilities have less time for moderate-to-vigorous physical activity and spend most of their time in a sedentary state [28], and their performance in basic motor skills is significantly lower than that of typically developing children and adolescents [29- 31]. Since both physical activity levels and basic motor skills levels are lower in children and adolescents with disabilities than in children and adolescents with normal development, it is necessary to further explore the relationship between the two in children and adolescents with disabilities. Only four cross-sectional studies exploring this issue were retrieved between 2016-2021 and each of the four studies addressed four different disability types: autism [11], cerebral palsy [12], CHARGE syndrome [13], and mild intellectual disability [14].

3.3.1 Interrelationships between Overall Basic Motor Skills and Physical Activity

There is an interrelationship between overall basic motor skills and physical activity in children and adolescents with disabilities. ByungMo [11] showed that there is an association between basic motor skills and physical activity behaviors in children with ASD and that it is a bidirectional relationship, that physical activity is a significant predictor of basic motor skills, that children with ASD may develop basic motor skills through participation in physical activity, that high intensity Physical activity is important for the development of basic motor skills in children. Meng J *et al.*, [14] found that the average daily LPA, MVPA and TPA time of children with mild intellectual disability were positively correlated with overall basic motor skills.

3.3.2 Relationship between Basic Motor Skills and Physical Activity in Different Dimensions

Basic motor skills are a positive facilitator of physical activity. Meng *et al.*, [14] found that displacement skill was the only variable explaining daily MVPA time in children with mild intellectual disability, and both displacement skill and object control skill significantly explained TPA time, but displacement skill explained more than object control skill. The results of Perrealt *et al.*, [13] showed that only the test item of running in displacement skill was moderately positively related to physical activity. Gerber *et al.*, [12] suggested that a certain level of displacement skill is a prerequisite for a longer duration of PA.

3.3.3 Effect of Gender on the Relationship between Basic Motor Skills and Physical Activity

There were gender differences in the correlation between basic motor skills and time per day MVPA and TPA [14]. Meng *et al.*, [14] found no statistically significant correlation between LPA time and basic motor skill scores in boys, and positive correlations between MVPA and TPA time and both displacement skill scores and total FMS scores, and no correlation with object control skill scores. LPA time per day was positively correlated with displacement skill scores for girls, and MVPA and TPA time per day were positively correlated with object control skill scores and total FMS scores, but not with displacement skill scores.

Fewer studies have been conducted on the relationship between basic motor skills and physical activity in children with disabilities, as evidenced by the only few papers available. (1) there is a positive relationship between basic motor skills and physical activity; (2) basic motor skills have a facilitating effect on physical activity of adolescents with disabilities and can increase their physical activity time, especially displacement skills, by improving their basic motor skills; and (3) the relationship between basic skills and physical activity of children with disabilities is also influenced by gender. Future studies on children and adolescents with disabilities should further explore these three aspects to provide more accurate data to clarify the relationship between the two in the population of children and adolescents with disabilities.

4. STUDY CONCLUSIONS

The interrelationships between basic motor skills and physical activity in healthy children and adolescents in the included studies could not be accurately concluded through various empirical studies, probably because cross-sectional surveys may not easily validate bidirectional relationships, and bidirectional associations need to be validated by research designs such as long follow-up studies or experiments [27]. The unidirectional relationships between basic motor skills

and physical activity were all concluded to have positive facilitative effects in the included studies. The relationship between the dimensions of basic motor skills and physical activity and the effect of gender differences on the relationship are less well documented and need further validation in future studies. The few studies on the relationship between basic motor skills and physical activity in children with disabilities show that there is a positive relationship between basic motor skills and physical activity; basic motor skills have a facilitating effect on the physical activity of adolescents with disabilities and can increase their physical activity time, especially displacement skills, by improving their basic motor skills; the relationship between basic skills and physical activity in children with disabilities is also affected by gender. The relationship between basic skills and physical activity of children with disabilities is also influenced by gender. Future research on children and adolescents with disabilities should further explore these three areas to provide more accurate data to clarify the relationship between the two in the population of children and adolescents with disabilities.

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