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Original Article

Effects of Diversified Sports Activity Module on Physical Fitness and Mental Health of 4–5-Year-Old Preschoolers

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Abstract

Background: Chinese children are poorer in sports activity as compared to foreign children and their prospects as to physical fitness are not optimistic. This study aimed to discuss the effects of diversified sports activity modules on physical fitness and mental health of preschoolers ages 4–5 years.

Methods: Sixty preschoolers aged 4–5-yr-old from two kindergartens in Jiaxing of China were selected randomly during Mar-Oct 2019. These respondents were divided into the experimental group (n=30) and the control group (n=30). The experimental group implemented the diversified sports activity module for 16 wk successively, 5 d per week, and 30-45 min per day. The control group adopted conventional sports activity. The body shape, physical fitness, and mental health of the two groups were measured and compared.

Results: For body shape, the height of the experimental group increased is significantly higher than that of the control group. The experimental and control groups show no significant differences in body weight. For physical fitness, the experimental group is significantly superior to the control group in testing results of standing long jump, double-feet continuous jump, balancing on one foot, tennis shot, sit-and-reach, and 10 m repeated run. For mental health, the testing results of action development, language development, and social development of the experimental group are significantly better than those of the control group.

Conclusion: The diversified sports activity module is not only conducive to strengthening the physical fitness of 4–5-year-old preschoolers but also improves their mental health.

Keywords: Sports activity; Diversified intelligence theory; Preschoolers; Physical fitness; Mental health

Introduction

In June 2018, WHO issued the Action Plan of Global Physical Exercises (2018–2030), which calls on the public, especially teenagers and children, to participate in physical exercises actively and improve the physical fitness of the whole nation through diversified sports activities. National documents concerning operations of kindergarten, such as the Guidelines on Study and Development of 3–6-year-old Children and Guidance Outline for Kindergarten Education (Trial), also emphasize the importance of improving the physical fitness of children. Therefore, China has focused considerable attention on the physical fitness of preschoolers. Nevertheless, the recent national physical test results indicated that the speed, strength, endurance, explosive force,

and flexibility of Chinese children are not optimistic, showing a downward trend in overall physical fitness (1,2). Chinese children have relatively poorer physical fitness (e.g. physical weakness and poor endurance) compared to children in European and American countries. The physical fitness of Chinese children is not optimistic, thereby raising the urgency of developing children's physical fitness.

Preschoolers are developing physical fitness and mental health, which is an important stage for children to perceive the world and train behaviors through physical activities. The psychological theory believes the intelligence of children can be attributed to actions (3). Sports activity is the basic way for active development and is a major means to strengthen the physical fitness of children, which is an important component of preschool education (4). Scientific and effective sports activities at the preschool age are conducive to improving various physical indices (strength, speed, flexibility, and endurance) of children, thereby facilitating the development of children's physical fitness. The long-term exercise intervention was not only beneficial for the gross motor and fine motor development of children but could also promote bone growth of children (5). Thirty children ages 5–6 yr were divided into the control and the experimental groups. The experimental group was given a four-week exercise intervention (6). The scores of side jump, ball catching, and ball shot of the experimental group were found to have increased significantly compared to those of the control group. Sports activity had positive effects on the physical fitness, cognition, and psychology of children (7). Toussaint et al. (8) chose children in with ages 2.5–4 yr as the research objects of the PLAYTOD (PLAYgrounds for TODdlers) program, which could strengthen motor skills and improve the physical fitness of children.

Sports activity has positive effects on the improvement of physical fitness and mental health of children. However, few intervention methods and limited effects have been observed. Sports activity methods for children have yet to be optimized continuously.

Howard Gardner, an educator, pointed out that the intelligence of individuals was composed of language, logic mathematics, space, body movement, interpersonal communication, music, introspection, and nature. On this basis, he proposed the diversified intelligence theory (9). Sports courses based on the diversified intelligence theory are beneficial to improving children's motor ability (10). Moreover, intervention practices based on the diversified intelligence theory can promote the mental health of children and improve their sensation, interpersonal communication, movement, and language skills (11). Because of the current single exercise intervention schemes for children, the intervention effect is not outstanding and involves high consumption of time and finance. Guided by the diversified intelligence theory, this study constructed a diversified sports activity module and applied it to the physical fitness intervention of children. Moreover, a control group was designed to observe the effects of diversified sports activity modules on the physical fitness and psychological health of children.

Methods

Research objects

Overall, 60 preschoolers aged 4-5 yr from two kindergartens in Nanhu and Xiuzhou Districts of Jiaxing City, Zhejiang Province, China were collected randomly using convenient clustering sampling technique from Mar-Oct 2019. They were divided into the experimental group (n=30) and the control group (n=30). The experimental group had 16 boys and 14 girls, of which 13 were 4 yr old and 17 were 5 yr old. The control group had 18 boys and 12 girls, of which 12 were 4 yr old and 18 were 5 yr old. The experimental and control groups had no statistically significant difference in terms of gender and age (P>0.05). All research objects had a normal motor ability, without congenital physical defects. All parents agreed to participate in this experiment.

Methods

Design of the diversified sports activity module

According to the sports activity system for children and concerning the diversified intelligence course model for children, a diversified sports activity module composed of eight modules was built. Details are introduced as follows: 1) concerning the agility of children, the module focuses on the movement, space, and interpersonal development simultaneously. Activities include repeated crawl×2, zigzag run×2, basketball shot×2, and pairwise ball catching 5 times×2. 2) For the physical coordination of children, the module focuses on the movement, interpersonal, and music development simultaneously. Activities include three-legged race ×2, ball patting training 5 times ×2, Wushu, and the game of "turning windmill". 3) For the physical strength of children, the module includes movement, space, and natural intelligence development simultaneously. Major activities are cart relay×2, double-feet jumping through hoops×2, leg raise×2, and football pair playing×2. 4) For the speed of children, the module emphasizes movement, logic, and space intelligence development simultaneously. Activities include repeated run by hitting the ball ×2, chasing game ×2, and single-foot hopping×2. 5) For the balance of children, attention is given to movement, space, and interpersonal intelligence development simultaneously. Activities include walking on single-plank bridge ×2, standing on one foot 1min×2, slide running 10m×2, and balance standing ×2. 6) For the flexibility of children, the module emphasizes movement, space, and natural intelligence development simultaneously. Activities include worm crawling ×2, forward jumping ×2, side kicking 5 times ×2, and rhythmic exercises. 7) For the comprehensive quality of children, the module emphasizes movement, language, and interpersonal intelligence development simultaneously. Major activities include repeated run 10m×2, pass-and-catch ×2, walking on single-plank bridge ×2, and singing and dancing. 8) Concerning the comprehensive quality of children, the module concerns movement, space, and introspection intelligence development simultaneously. Major activities include walking on a balance beam, throwing sandbag×3, running around bars ×2, and inter-group pass-and-catch ×2.

Implementation of activities

The experiment lasted from Mar to Oct 2019 excluding holidays. The experimental group had outdoor activities every day according to the diversified sports activity module. Each module lasted for 30–45 min (10:00–11:00 or 15:00–16:00) per day, 5 d per wk, 2 weeks. Hence, the experimental group was trained for 16 wk continuously. The control group had conventional sports activities, including jogging, sliding, gymnastics, games, and free activities.

Activity intensity control

Activity intensity was divided into four levels according to the average heart rate of children during sports activities: 1) low level (<120 beats/min), middle level (120–140 beats/min), high level (141–160 beats/min), and very high (>160 beats/min). Heart rates of children during sports activity were collected using the Polar heart rate table. Facial expressions, breathing, and sweating of children during sports activities were observed according to the *Evaluation Scale of Sports Activity Intensity for Children*. The intensity and time of sports activity were kept consistent between the experimental and control groups.

Quality control

Before the experiment, a one-month pre-test was carried out to observe the acceptance of children of the different activities and to evaluate the reasonability of the experiment, which laid the foundation for the official experiment. After the pre-test, experimental contents were determined again and the experimental design was modified according to experimental situations. The final sports activity scheme was determined by reviewing relevant literature and books, which could assure the ordered performances of the sports activity system. Two kindergarten teachers who had rich experiences in teaching and another two

professional physical training teachers for children were invited to be responsible for implementing sports activities throughout the experiment. The two kindergarten teachers were also asked to supervise, coordinate, and maintain experimental order.

Evaluation indices

Body shape and physical tests were performed regarding China's *Standard Manual of National Physical Fitness Measurement (Preschoolers)* before and after the intervention. Researchers who had professional training were responsible for completing the measurements on the same day (12). 1) Body shape indices: height and weight of children were measured using a height-weight scale. 2) Physical fitness indices: standing long jump, balancing on one foot, tennis shot distance, sit-and-reach, double-feet continuous jump, and 10m repeated run. These indices were used to evaluate explosive force, balance, strength, flexibility, coordination, speed, and agility of children. 3) Psychological health evaluation: the "psychological health questionnaire of preschool" (13) was used. This questionnaire has 38 questions in "yes" (1 score) or "no" (0 score). The questionnaire was filled by parents and the evaluation indices included action development, language development, cognitive development, living habit development, and social development. The test-retest reliability and homogeneity reliability of this questionnaire were 0.72–0.86 and 0.63–0.87, respectively.

Statistical analysis

SPSS (ver. 22.0, Chicago, IL, USA) was used for data analysis. Measurement data conformed to the normal distribution and were expressed in ($\bar{x}$ ±s). A pairwise *t*-test (intra-group comparison) or group t-test (inter-group comparison) was performed. Enumeration data comparison used the R2 test. $P<0.05$ indicated that statistically significant differences existed.

Results

Comparison of two groups in body shape indices before and after the intervention

Before the intervention, no statistically significant differences in height and bodyweight of the experimental and control groups. After the intervention, the height and bodyweight of both groups were increased significantly ($P<0.05$). The experimental group achieved significantly higher growths compared to the control group ($P<0.05$) (Table 1).

Table 1: Comparison of height and bodyweight of two groups before and after the intervention ($\bar{x}$ ±s)

Groups	*Time*	*Height (cm)*	*Body weight (kg)*
Experimental group (n=30)	Before	109.36±1.68	18.85±1.75
	After	115.28±2.17[a]	20.87±1.96[a]
Control group (n=30)	Before	108.69±1.79	18.94±1.69
	After	114.12±2.06[ab]	20.27±1.87[ab]

Notes: Body shapes of two groups was [a]$P<0.05$ after the intervention compared to those before the intervention. After intervention, the body shape of the experimental group was [b]$P<0.05$ compared to that of the control group

Physical fitness of two groups before and after the intervention

Before the intervention, no statistically significant difference was observed in the experimental and control groups in terms of physical fitness. After the intervention, testing results of the physical fitness of both groups increased ($P<0.05$). Moreover, the experimental group was superior to the control group in terms of physical fitness ($P<0.05$) (Table 2).

Table 2: Comparison of physical fitness indices of the two groups before and after the intervention ($\bar{x}\pm s$)

Groups	*Time*	*Standing long jump (cm)*	*Double-feet continuous jump (s)*	*Balancing on one foot (s)*	*Tennis shot (m)*	*Sit-and-reach (cm)*	*10m repeated run(s)*
Experimental group (n=30)	Before	80.67±3.35	8.12±1.56	34.26±5.76	4.72±1.05	9.89±1.12	7.54±0.49
	After	93.64±4.86^{ab}	6.46±0.87^{ab}	44.89±7.46^{ab}	6.25±1.31^{ab}	12.42±1.45^{ab}	6.76±0.39^{ab}
Control group (n=30)	Before	81.37±3.89	8.05±1.43	33.87±6.14	4.79±1.12	9.92±1.17	7.61±0.51
	After	88.41±5.42^{a}	7.12±0.91^{a}	37.82±6.55^{a}	5.45±1.19^{a}	10.69±1.25^{a}	7.12±0.41^{a}

Notes: The physical fitness of the two groups showed $^{a}P<0.05$ after the intervention compared to those before the intervention. After the intervention, the physical fitness of the experimental group was $^{b}P<0.05$ compared to that of the control group

Psychological health of two groups before and after the intervention

Before the intervention, no statistically significant difference was observed in the experimental and control groups in terms of psychological health indexes. After the intervention, the active development, language development, and social development of the experimental group were improved significantly ($P<0.05$). For the control group, only the action development was improved ($P<0.05$). After the intervention, the active development, language development, and social development of the experimental group were better compared to the control group ($P<0.05$) (Table 3).

Table 3: Comparison of psychological health indices of the two groups before and after the intervention ($\bar{x}\pm s$, scores)

Groups	*Time*	*Action development*	*Cognitive development*	*Language development*	*Social development*	*Living habit development*
Experimental group (n=30)	Before	3.86±1.46	7.84±1.97	7.64±2.41	7.18±1.94	6.37±1.36
	After	5.27±0.89^{ab}	8.69±2.42	9.23±2.52^{ab}	8.31±1.52^{ab}	6.71±1.52
Control groups (n=30)	Before	3.74±1.42	7.61±2.23	7.49±2.33	7.26±1.65	6.29±1.44
	After	4.42±1.12^{a}	8.24±2.19	7.61±2.42	7.42±1.71	6.33±1.58

Notes: The psychological health of the two groups was $^{a}P<0.05$ after the intervention compared to those before the intervention. After the intervention, the psychological health of the experimental group was $^{b}P<0.05$ as compared to that of the control group.

Discussion

Table 1 shows statistically significant differences in height between the experimental and control groups after the intervention. The experimental group was superior to the control group, indicating that the diversified sports activity module could promote height growth among children. This finding was similar to Gong et al. (14), and may be due to sports activity not only stimulating the epiphyseal cartilage at two ends of the long bone and promoting proliferation and differentiation of cartilage cells but also improving the bone blood supply and global metabolism, thereby facilitating osteosis (15). The height of children aged 4–5 yr increased significantly after four months of physical-intelligence-skill class and interesting athletics class (16). Physical exercise might increase auxin content in blood, thereby promoting growth and development. In this study, the constructed diversified sports activity module was beneficial in facilitating the children's growth and development. The organic combination of movement and game, known as the inte-

gration of physical exercise and skills training into games, conforms to the interest of children. It can strengthen their interest in movement and promote the development of good exercise habits. Exercise intervention is also conducive to maintaining the normal body weight of children and decreasing the occurrence of obesity. In this study, two groups showed no statistically significant differences in body weight after the intervention, which could be due to the small sample size and short intervention time.

In Table 2, the scores of standing long jump, double-feet continuous jump, balancing on one foot, tennis shot, sit-and-reach, and 10 m repeated runs of both groups improved after the intervention. Moreover, the experimental group is superior to the control group, which demonstrates that the physical fitness indices of the children, including explosive force, balance, strength, flexibility, coordination, and speed, all improved significantly and that sports activity is conducive to strengthening the physical fitness of children. These findings conform to previous reports (17). Reflects the health of individuals, physical fitness is related to several factors, including genetic, environmental, nutrition, and exercise training. Preschool is the key stage for children to form good physical fitness (18). Although the physical fitness of Chinese children conforms to the growth and development law, a great gap can still be observed when compared with children in European and American countries, manifested mainly in the disadvantages of explosive force, strength, and speed (19). This gap might be related to the lack of effective physical intervention for Chinese children.

The Ministry of Education of the People's Republic of China issued the Guidelines on Study and Development of 3–6-year-old Children and Guidance Outline for Kindergarten Education in 2012, which stipulated that physical exercises should be prioritized for preschoolers. Outdoor time ≥2 h and physical exercise ≥1 h for children should be ensured. This study pointed out that a physical exercise course can effectively improve tennis shot distance (strength), standing long jump (explosive force), and walking on balance beam (balance) of children aged 4–5 yr, while interest athletics class can increase scores of sit-and-reach (flexibility), 10m repeated run (speed and agility) and double-feet continuous jump (coordination) of children. Gross motor training can increase scores of standing long jump, tennis shot distance, double-feet continuous jump, and 10 m repeated run among 5-year-old children. Setting-up exercises of children can increase standing long jump, balancing on one foot, tennis shot distance and 10 m repeated run. These findings all confirm the research results of the study, sports activity can strengthen the physical fitness indices of children. Based on the diversified intelligence theory, this study constructed eight modules with considerations to the physical fitness of children, including agility, strength, coordination, speed, balance, and flexibility. Guidance and intervention of sports activity for children have achieved considerable outcomes. In the present study, the control group used the original conventional sports activities that involve relatively single content. Although the physical fitness indices of the control group improved, it is far inferior to the experimental group, conventional sports activities can improve the physical fitness of children to a limited extent and room for considerable improvement remains. Therefore, sports activity management for preschoolers should be strengthened and diversified sports activity modules created for children. In this way, sports activity contents oriented to different aspects are developed to better promote the physical fitness development of children.

Table 3 shows that after the intervention, the active development, language development, and social development of the experimental group improved significantly. Meanwhile, only the active development of the control group was improved. The action development, language development, and social development of the experimental group after intervention were better than those of the control group, indicating that sports activity was conducive to improving the psychological health of preschoolers, which confirms another conclusion (20, 21). Sports activity could not only promote walking action of children and

strengthen their ability to use objects it could also promote vocabulary and oral expression ability through teacher-student interaction, word of command, and self-exhibition (22). During sports activities, the limb movements of children were enhanced and language communication strengthened. Children were liberated from the consciousness of self-closing, thereby increasing the desire for communication and interaction and developing their movement and language skills. Sports activity was conducive to improving interpersonal relationship (23). Aerobic activity could relieve anxiety and depression and promote psychological health (24). These findings conform to the conclusions of the study. That is, specific sports activity could not only strengthen the physical fitness of preschoolers but also promote psychological health. Sports activity had important significance in promoting healthy growth and improving the comprehensive quality of children.

Conclusion

A diversified sports activity module can not only promote the growth and development of preschoolers and strengthen their physical fitness but also improve the psychological health of children. Hence, strengthening sports activity intervention for children has important significance. The sports activity module conforms to the growth and development of children according to the diversified intelligence theory. The rich contents and strong specificity of the proposed module can help strengthen the physical fitness of children and aid them in developing good exercise habits.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interest.

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