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The Effects of Game-Based Aerobic Gymnastics Element Training on Improving Arm Strength, Balance, and Flexibility in Athletes Aged 7-8 Years Old

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Abstract

The primary objective of this research is to assess the impact of game-based aerobic gymnastics element training on improving arm strength, right-left balance, and right-left flexibility in 7-8-year-old athletes. Additionally, the study aims to investigate the correlation between the game-based aerobic gymnastics element training method and improvements in arm strength, right-left balance, and right-left flexibility in athletes aged 7-8 years. This research employs a quasi-experimental design method with a nonequivalent control group design. The study population includes all 36 individuals comprising aerobic gymnastics athletes aged 7-8 years from the Gunungkidul aerobic gymnastics club and gymnasts aged 7-8 years who have participated in the DIY gymnastics festival. Purposive sampling is utilized for sampling in this study. The research findings reveal the following: (1) Significant impact exists on arm strength, right-left balance, and right-left flexibility in 7-8-year-old aerobic gymnast athletes through training with a game-based aerobic gymnastics element training model, evidenced by an F value of 4.082 and a statistically significant p-value of 0.006 (<0.05). The experimental group utilizing the game-based training method demonstrated superior enhancements compared to the control group employing regular element training. (2) A significant interaction is observed in the balance of aerobic gymnastics athletes aged 7-8 years when using the game-based aerobic gymnastics element training model, supported by an F value of 80.931 and a highly significant p-value of 0.000 (<0.05).

Keywords: *Aerobic Gymnastics; Games; Arm Strength; Balance; Flexibility*

1. Introduction

Gymnastics serves as a beneficial physical activity that plays a vital role in enhancing children's development. The dynamic movements involved in gymnastics are particularly conducive to fostering children's growth as they entail physical prerequisites like muscle strength and endurance across various body regions. Furthermore, gymnastics plays a pivotal role in cultivating fundamental movements essential for engaging in other sporting activities. Typically, children commence gymnastics training at a tender age, laying a strong foundation for their physical and motor skills development (Werner, Williams, dan Hall, 2012).

The latest Federation *Internationale de Gymnastique* (FIG) website categorizes gymnastics into various disciplines, encompassing: Gymnastics for All, Men's Artistic Gymnastics, Women's Artistic Gymnastics, Rhythmic Gymnastics, Trampoline Gymnastics, Acrobatic Gymnastics, Aerobic Gymnastics, and Parkour. Within aerobic gymnastics, competition categories include the National Development category (9-11 years), the Age Group category (12-14 years), the Junior category (15-17 years), and the Senior category (18 years and above). Various sports incorporate biomotor components like flexibility, balance, strength, agility, power, speed, and coordination to enhance overall performance. Effective coaching, emphasizing systematic and accurate techniques, is crucial for fostering robust physical, technical, tactical, and mental foundations. Understanding the essential components for athlete performance and comprehending the performance development system are key aspects in gymnastics training.

The stages of sports achievement development typically follow the pyramid theory, consisting of three main phases: massing, breeding, and achievement development (Bompa & Buzzichelli, 2019). Achieving success in sports is a gradual process that requires considerable time and dedication. The amount of training time necessary varies across different sports. Each sport has its unique timeline for reaching the pinnacle of success, also known as the golden age, emphasizing that success cannot be attained overnight. The nurturing of young athletes from an early age demands consistent, continuous, fundamental, systematic, efficient, and integrated approaches. Therefore, it is essential to encourage children to engage in play and physical activities from a young age to promote the development of their physical faculties. By using a persuasive approach, young children can be encouraged to explore athletics, fostering their interest in becoming athletes. Encouraging children to participate in sports not only benefits their physical development but also increases the chances of identifying and guiding them towards specific sports based on their talents and potential (Said Junaidi, 2020:2)

The development of aerobic gymnastics in Indonesia has experienced rapid growth, expanding from regional to international levels and attracting participants of all ages, from children to seniors. A significant category in this sport is the National Development (ND) competition, catering to athletes aged 9-11 years. To ensure early training and talent identification, children with potential need to be scouted and nurtured for peak performance. Typically, the optimal age for selecting promising young athletes in aerobic gymnastics is 7-8 years, typically at the elementary school (SD) level. Through a rigorous selection process, these talented individuals can be groomed to become elite athletes. The ultimate goal is for these children to progress and excel in the sport as they transition into adulthood.

Training for gymnasts, particularly in aerobic gymnastics, faces challenges in the field, such as the struggle to nurture talented athletes, as indicated by the situation in the Special Region of Yogyakarta. A preliminary research study revealed a scarcity of aerobic gymnasts under 17 years old in various districts and cities in Yogyakarta, highlighting a significant gap in age groups. For instance, Sleman boasts 4 aerobic gymnasts, including 2 aged 12, 1 aged 13, and 1 aged 14. Bantul, on the other hand, has only 1 athlete aged 14. In Kulon Progo, there are 4 athletes currently attending junior high school. Gunungkidul district stands out with 19 active athletes, with 18 falling within the 7-9 age range and 1 over 15. The surge in Gunungkidul's athlete count is attributed to the junior and senior gymnastics championships in 2022. Also, Yogyakarta has 4 athletes dedicated to aerobic gymnastics.

Becoming a proficient aerobic gymnast necessitates a blend of skills encompassing physical, technical, and mental aspects. Mastery of both basic and advanced skills, coupled with various biomotor components, is essential for excelling in this discipline. Previous research has highlighted a common shortfall among trained athletes, particularly in their physical capabilities. Many athletes struggle with executing simple elements outlined in the code of points, such as maintaining a straight body during push-ups (like the plank position), experiencing hand tremors while bending and straightening arms, failing to lock their bodies straight during aerial turns, losing balance upon landing, and facing challenges in executing the straddle support movement with ease. Assessing the physical abilities of athletes who have

received training alongside the distribution of existing athletes reveals a concerning trend. It is disheartening to observe that the physical development of young aerobic gymnasts is not yet optimized, underscoring the need for focused efforts to enhance their physical conditioning from an early age.

In aerobic gymnastics, some have devised training models tailored to enhance the physical conditioning of children under the age of national development (7-8 years). This training model is structured as a game, incorporating elements suited for early childhood, with the goal of effectively aiding athletes below the age of national development in cultivating their physique. Despite its promising premise, there is a lack of research assessing the training model's efficacy in improving athletes' physical attributes.

Childhood is a crucial period characterized by abundant playtime, during which children primarily engage in play activities. Play serves as a valuable tool for children to enhance their physical and motor skills as it necessitates body movement and coordination, enabling them to release pent-up tension. Through play, children can express their emotions and receive positive reinforcement, leading to a sense of relief and relaxation. Essentially, the act of playing acts as a catalyst for stimulating all facets of a child's development (Pratiwi Wiwik, 2017). The various aspects of child development are interconnected, emphasizing the need to engage in enjoyable activities that promote holistic development. Physical development serves as the foundation, with movement being the primary mode through which children respond and interact (Arie Paramitha and Sutapa, 2019).

The multilateral development stage initiates the coaching program for children aged 6-15, preceding the specialization stage. This phase focuses on developing and refining fundamental movements such as walking, running, jumping, throwing, and catching (Bompa, 2012). Training activities encompass various sports and play exercises involving these movements like walking, running, jumping, skipping, climbing, crawling, throwing, and catching. There are numerous methods available to monitor and enhance young athletes, including lower elementary school students who can commence gymnastics training at a young age. Children in lower elementary school, specifically grades 1-3, exhibit simple characteristics at this stage.

According to Burhaein (2017), early childhood is marked by a penchant for play, enjoyment of movement, enthusiasm for group activities, and eagerness for hands-on practice. Beyond psychological traits, it is crucial to align physical activities with the growth and development of elementary school children aged 7-8 (primary grades 1 and 2). Therefore, when designing training models, it is essential to tailor them to suit the specific characteristics of children in this age group. For 7-8-year-olds, emphasis should be placed on fundamental physical exercises, necessitating the implementation of straightforward, engaging, and enjoyable training models.

Drawing upon previous research findings and the context of the aforementioned issue, the researcher aims to investigate the efficacy of current training models in enhancing the physical fitness of young athletes. The primary objective is to ascertain whether these training models have the potential to boost the interest, aptitude, and physical capabilities of aerobic gymnasts.

2. Methodology

2.1. Research Design

Utilizing an experimental method, this research employs experimental research, known as the most comprehensive quantitative research approach, as it fulfills all criteria for examining cause-and-effect relationships. According to Sugiyono (2012:107), the experimental research method is characterized by its use in determining the impact of specific treatments on others within controlled settings.

In this research, the researchers employed a quasi-experimental research method known as quasi-experimental design, specifically utilizing the non-equivalent control group design. This design closely resembles the pretest-posttest control group design in which the experimental group and the control group are not selected randomly. Both the experimental and control groups underwent initial assessments. Subsequently, the two groups were subjected to different treatments; the experimental group received a game-based aerobic gymnastics element training model, while the control group did not receive any game-based treatment. The study concluded with a final test administered to each group.

2.2. Research Population and Sample

The study's population consisted of aerobic gymnastics athletes aged 7-8 years from both the Gunungkidul aerobic gymnastics club and participants in the DIY gymnastics festival within the same age range. The sampling method employed in this study was purposive sampling, a technique that involves selecting samples based on specific criteria. According to Sugiyono (2019:133), purposive sampling is a method used to select samples based on particular considerations. The criteria set for sample selection in this study are as follows: inclusion of beginner athletes aged 7-8 years, regardless of gender; athletes who have undergone training for approximately 6 months; athletes who attend training sessions at least 3 times a week; athletes who are in good health, and athletes who are willing to adhere to the exercise program provided.

2.3. Data Collection Technique

In this research, data collection techniques involved the use of tests and measurements. Prior to and following the treatment, the samples underwent assessments for arm strength, balance, and flexibility. The instruments utilized in this study included: arm strength test conducted with push-ups; balance test performed using the air turn method; and flexibility test carried out through the vertical split assessment.

2.4. Data Analysis Technique

In this study, a prerequisite test was carried out, comprising a normality test and a homogeneity test. The normality test utilized the Shapiro-Wilk technique, specifically chosen due to the sample size being less than 50, and was conducted using SPSS 27. A p-value greater than 0.05 indicates that the data is normal, while a p-value less than 0.05 suggests the data is not normal. On the other hand, the homogeneity test in this research employed the F test with the assistance of SPSS 27. A p-value above 0.05 indicates data homogeneity, whereas a p-value below 0.05 signifies a lack of homogeneity in the data. Subsequently, hypothesis testing was performed using multivariate analysis of variance (MANOVA) with SPSS 27. MANOVA is a statistical analysis technique used to evaluate simultaneous differences among two or more dependent variables concerning one or more independent variables. The aim is to determine if significant differences exist between groups in specific dependent variables.

3. Research Results and Discussion

The research results and discussion will be presented in the following sequence, covering research data, analysis of prerequisite tests, and hypothesis testing. The hypothesis tests in this study will be presented sequentially, focusing on: (a) The impact of game-based aerobic gymnastics element training on enhancing arm strength, right-left balance, and right-left flexibility in athletes aged 7-8 years. (b) The interaction of game-based aerobic gymnastics element training methods on improving arm strength, left-right balance, and left-right flexibility in athletes aged 7-8 years. After the control group underwent treatment involving game-based aerobic gymnastics element training for 16 sessions, a posttest was conducted to assess arm strength, balance, and flexibility. The findings of the pretest and posttest for arm strength, balance, and flexibility of aerobic exercise athletes in Gunungkidul are detailed as follows:

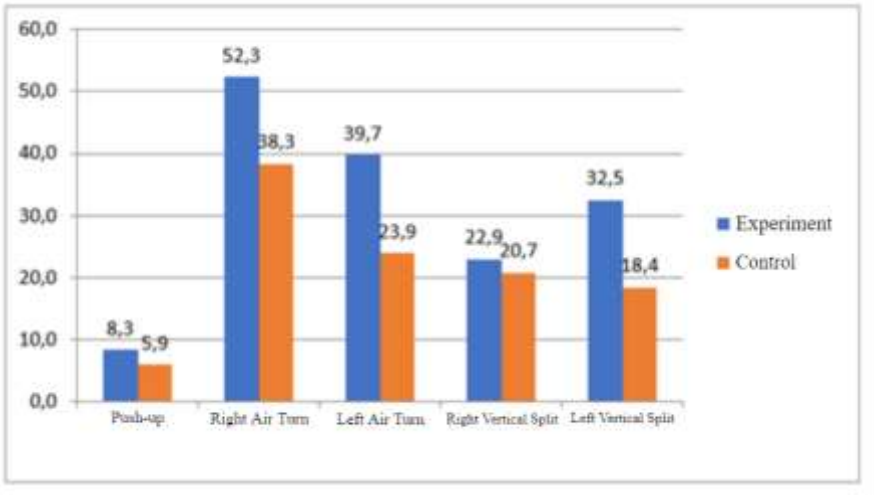
3.1. Pretest Results

Based on the average pretest results, the experimental group exhibited a strength measurement of 30.32, surpassing the control group's 28.49. In terms of right balance, the experimental group achieved a score of 242.50, higher than the control group's score of 230.83. Similarly, for left balance, the experimental group attained a value of 222.78, surpassing the control group's 215.83. The right flexibility value for the experimental group was 144.33, exceeding the control group's value of 140.00. Lastly, the left flexibility value for the experimental group stood at 165.33, outperforming the control group's 137.83.

3.2. Posttest Results

Based on the average posttest results, the experimental group demonstrated a strength measurement of 38.65, surpassing the control group's 34.41. In terms of right balance, the experimental group achieved a score of 294.78, higher than the control group's score of 269.11. Furthermore, for left balance, the experimental group recorded 262.50, exceeding the control group's 239.78. The right flexibility value for the experimental group was 167.22, outperforming the control group's 160.72. Lastly, the left flexibility value for the experimental group stood at 170.33, surpassing the control group's 167.22.

When displayed in a bar chart, the variance values between the pretest and posttest outcomes of both the experimental and control groups are depicted as follows:



The image above illustrates that the experimental group exhibited an average arm strength of 8.3, surpassing the control group's 5.9. Additionally, the experimental group's right balance averaged at 52.3, higher than the control group's 38.3. Moreover, the experimental group's left balance had an average of 39.7, exceeding the control group's 23.9. Furthermore, the experimental group's right flexibility average was 22.9, outperforming the control group's 20.7. Lastly, the left flexibility of the experimental group had an average of 32.5, significantly higher than the control group's 18.4.

3.3. Prerequisite Test Results

This normality test utilizes the Shapiro-Wilk formula and is processed using the SPSS 25 computer program. The results are detailed in the table below.

Tests of Normality

	Groups	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Push Up	Exp	.102	18	.200*	.981	18	.961
	Ctrl	.137	18	.200*	.963	18	.664
Right Air Turn	Exp	.133	18	.200*	.930	18	.196
	Ctrl	.184	18	.110	.928	18	.181
Left Air Turn	Exp	.162	18	.200*	.935	18	.235
	Ctrl	.174	18	.159	.956	18	.519
Right Vertical Split	Exp	.142	18	.200*	.928	18	.177
	Ctrl	.166	18	.200*	.943	18	.329
Left Vertical Split	Exp	.171	18	.172	.915	18	.105
	Ctrl	.161	18	.200*	.925	18	.156

From the results of the normality test in the table above, it is evident that all pretest-posttest data regarding arm strength, balance, and flexibility for both the experimental group and the control group have sig values > 0.05, indicating that all variables exhibit a normal distribution.

The homogeneity test aims to examine the similarity of variance between the pretest and posttest. In this study, the Levene Test was used for the homogeneity test. The results of the homogeneity test for this research are presented in the following table below:

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
Push Up	.062	1	34	.804
Right Air Turn	.407	1	34	.528
Left Air Turn	3.069	1	34	.089
Right Vertical Split	2.297	1	34	.139
Left Vertical Split	3.990	1	34	.054

The results of the variance homogeneity test shown in the table above are derived from statistical analysis conducted using the Levene Test Wilk test in Table 8. The calculated results yielded a significance value of ≥ 0.05. This indicates that the data group exhibits homogeneous variance, implying that the population has consistent variance.

Box's Test of Equality of Covariance Matrices[a]

Box's M	18.351
F	1.028
df1	15
df2	4654.421
Sig.	.422

The results of the variance homogeneity test shown in the table above are derived from statistical analysis conducted using the Levene Test Wilk test in Table 8. The calculated results yielded a significance value of ≥ 0.05. This indicates that the data group exhibits homogeneous variance, implying that the population has consistent variance.

3.4. Hypothesis Test Results

a. The first hypothesis posits that there is a significant impact of game-based aerobic gymnastics element training on enhancing arm strength, left-right balance, and left-right flexibility in athletes aged 7-8 years. Analysis of the MANOVA test data reveals an F value of 4.082 and a p-value of 0.006, which is less than 0.05. This indicates a notable difference in influence. The experimental group exhibited average differences in arm strength (8.3), right balance (52.3), left balance (39.7), right flexibility (22.9), and left flexibility (32.5) compared to the control group with arm strength at 5.9, right balance at 38.3, left balance at 23.9, right flexibility at 20.7, and left flexibility at 18.4. These findings confirm the research hypothesis that suggests a significant influence of game-based aerobic gymnastics element training on enhancing arm strength, left-right balance, and left-right flexibility in athletes aged 7-8 years.

b. The second hypothesis suggests that there is a notable interaction between game-based aerobic gymnastics element training methods in enhancing arm strength, left-right balance, and left-right flexibility among athletes aged 7-8. Examination of the MANOVA test data indicates an F value of 80.931 and a p-value of 0.000, which is less than 0.05. This signifies a substantial difference in influence. Hence, the research hypothesis proposing a significant interaction between game-based aerobic gymnastics element training methods for improving arm strength, left-right balance, and left-right flexibility in athletes aged 7-8 has been substantiated.

4. Discussion

The research's results discussion offers additional interpretation of the data analysis results presented. Further elaboration on the outcomes of this analysis can be provided as follows:

1. The Influence of Game-Based Aerobic Gymnastics Element Training on Increasing Arm Strength, Left-Right Balance and Left-Right Flexibility in Athletes Aged 7-8 Years

Based on the analysis results, it is evident that training using a game-based aerobic gymnastics element training model has a significant impact on arm strength, right-left balance, and right-left flexibility in aerobic gymnast athletes aged 7-8 years.

A game-based training model is an innovative training approach that integrates elements of play or fun into training sessions. This method is designed to enhance motivation, engagement, and learning outcomes. Specific game training models can positively influence the development of aerobic athletes by

instilling higher motivation and active involvement through the inclusion of game elements. Games introduce enjoyable and challenging aspects that encourage participants to engage actively and willingly. This training model offers a wider range of exercises, allowing participants to partake in various games or activities to accomplish their objectives instead of engaging in monotonous exercises.

Consequently, this game-based training model plays a crucial role in enhancing arm muscle strength, balance, and flexibility among athletes, ultimately leading to improved performance in executing techniques in aerobic gymnastics.

2. The Interaction of Game-Based Aerobic Gymnastics Element Training on Increasing Arm Strength, Left-Right Balance and Left-Right Flexibility in Athletes Aged 7-8 Years

Based on the findings outlined in this study, a significant interaction is observed when employing a game-based aerobic gymnastics element training model to enhance arm strength, balance, and flexibility in aerobic gymnastics athletes aged 7-8 years. This game training model demonstrates that the interaction of game-based training yields a substantial positive influence on improving arm strength, balance, and flexibility in aerobic gymnastics athletes aged 7-8 years. By adopting this approach, training becomes more engaging and enjoyable for athletes while also offering advantages in enhancing various aspects of physical skills crucial in aerobic gymnastics development.

Such exercises aid in athletes' skill development and promote the capacity to execute complex and hazardous elements securely and effectively. The results of the interaction analysis reveal that the primary research factors in the game-based aerobic gymnastics element training model have a notable impact on arm strength, balance, and flexibility in athletes aged 7-8 years. This research demonstrates a correlation between the training model and arm strength, balance, and flexibility, enhancing athletes' ability to execute aerobic gymnastics elements successfully.

Conclusion

Based on the research results and the results of the data analysis that has been carried out, the following conclusions are obtained:

1. In aerobic gymnast athletes aged 7-8 years, there is a notable impact observed in enhancing arm strength, left-right balance, and left-right flexibility through the utilization of a game-based aerobic gymnastics element training model. This impact is evidenced by an F value of 4.082 and a significant p value of 0.006, which is less than 0.05. The experimental group, utilizing the game-based training method, demonstrated superior performance compared to the control group employing the conventional elemental training method.

2. In aerobic gymnastics athletes aged 7-8 years, a significant interaction was observed when utilizing a game-based aerobic gymnastics element training model to enhance balance. This interaction is supported by an F value of 80.931 and a highly significant p value of 0.000, which is less than 0.05. The analysis indicates that the primary research factors within the game-based aerobic gymnastics element training model, focusing on arm strength, balance, and flexibility, exhibit a notable interaction. These results highlight the correlation between the training model and the enhancement of arm strength, balance, and flexibility to assist athletes in executing aerobic gymnastics elements effectively.

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