ORIGINAL ARTICLE

The effect of ankle strengthening exercise on balance in youth basketball players

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Abstract

Background and Study Aim: Balance is an important factor in basketball, so the level of balance that is still low needs to be improved to support future achievements, especially for youth basketball players. This study aims to improve the right and the left balance of adolescent basketball players aged 16 and 18 years old and determine the difference in the effect of theraband exercise and bosu ball exercise. The study was conducted to determine the effect of ankle strengthening exercise using bosu ball exercise and theraband exercise on the balance of male basketball players aged 16 years and 18 years is a type of quantitative research.

Material and Methods: The research design used is experimental research with 2x2 factorial analysis, and the level of significance was set a 0.05 for all samples. The sample in this study amounted to 64 men's basketball players, with details of 32 players in the age group 16 and 32 players in the age group 18. Players in the age group 16 and age 18 were each divided into 4 sample groups using the ABBA formula, so that the number in each sample group consists of 8 players.

Results: Pre-test left theraband exercise and post-test left theraband exercise = 5% (0.05) > sig. (2-tailed) 0.000, it can be interpreted that there is a significant change in left balance for basketball players aged 16 years after being given theraband exercise treatment. Pre-test left bosu ball exercise and post-test left bosu ball exercise on left balance the value of = 5% (0.05) > sig. (2-tailed) 0.001, then it can be interpreted that there is a significant change in left balance for basketball players aged 16 years after being given bosu ball exercise treatment. Pre-test left theraband exercise and post-test left theraband exercise = 5% (0.05) > sig. (2-tailed) 0.005, it can be interpreted that there is a significant change in left balance for basketball players aged 18 years after being given the theraband exercise treatment. Pre-test left theraband exercise and post-test left theraband exercise = 5% (0.05) > sig. (2-tailed) 0.005, it can be interpreted that there is a significant change in left balance for basketball players aged 18 years after being given the theraband exercise treatment.

Conclusions: Characteristics of the age group of 16 years and 18 years are not much different. Bosu ball exercises give a better effect than theraband exercise. Although statistically not too significant, there is a difference in the average. That condition is because the motor system works more, starting from the legs, back, and abdomen muscles. The motor system that works when doing theraband exercise tends to be on the muscles in the legs.

Keywords: ankle strengthening exercise, theraband exercise, bosu ball exercise, balance.

Introduction

Basketball is a dynamic sport. The movement relies heavily on the feet to rest and serves as the center of mass (COM) so that the movement is very active [1, 2]. The foot that acts as the center of support is very dependent on the condition of the ankle in maintaining body balance, so if the body balance is good, it can be concluded that the condition of the ankle and the ankle propulsion muscles are also in good condition [2, 3]. Exercises and treatments that can help improve the condition of the moving muscles in the ankle are needed so that the balance of basketball players is not disturbed. Balance training for basketball players in Boyolali Regency has not been well controlled, and this is because there is no specific program to help improve the balance of basketball players. This condition is reinforced based on data findings in the field that the balance level of teenage basketball players in Boyolali Regency between the right and Left body balances has a significant difference, the average balance score of right is 94.87, and left is 100.41 with an average difference of 5 .53 points. Right balance details score 80-90: 13.33%, 91-99: 63.33%, and 100-110: 23.33%. Balance details left score 80-90: 16.66%, 91-99: 33.33%, 100-110: 43.33%, 111-120: 6.66%. Based on these data, the balance of right and left of teenage basketball players in Boyolali Regency is still quite low because

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the balance of right 76.66% is still below the score of 100 points, and the balance of left is 49.49% below the score of 100 points.

Poor balance conditions can certainly increase the percentage of lower extremity injuries. Foot and ankle injuries are very common in athletes and individuals who perform physical activities or sports [4]. Injuries to the ankle joint can occur when walking, running, and jumping, with the percentage of injuries reaching 50% of cases occurring in the ankle ligament [5]. Most injuries in basketball occur in the lower extremities, especially in the ankles and knees. Most injuries are orthopedic, namely ankle sprains, ACLs, and fractures [6]. Research data on observations of 12,960 injuries in basketball, 63.7% occurred in the lower extremities, with 2,832 (21.9%) ankle injuries and 2,305 (17.8%) knee injuries [7]. Based on the research data, it can be seen that the risk of injury to the lower extremities in basketball is high. There need to be actions that are focused on minimizing the risk of lower extremity injuries in basketball.

Research has been conducted by giving treatment using a bosu ball given to 18 women and 16 men with an average age of 21 years, showing an increase in balance and leg muscle strength [8]. Research on ankle strengthening conducted on students who had an ankle injury did not show significant results on balance growth. The exercise was given for six weeks after the student finished college [9]. Based on the results of these studies, of course, further research needs to be done regarding ankle strengthening exercises. Research on ankle strengthening exercise that is more specific is about the differences in the effect of theraband exercise and bosu ball exercise in improving the balance of male basketball players in the age group of 16 years and 18 years. Ankle strengthening exercise treatment is given after the players finish doing regular exercises in the field. The treatment given to the theraband exercise consists of four movements, namely: 1) Ankle Flexion Exercise, 2) ankle extension exercise, 3) ankle inversion exercise, and 4) ankle eversion exercise. The movement in the bosu ball exercise also consists of four movements: 1) single leg stand, 2) runner touch, 3) chest-passing in single-leg stance, and 4) forward-behind in single-leg stance. The research hypothesis is based on the existing theory that there is a balance between before and after training. There is a difference in balance between basketball players aged 12 and 18 years.

Materials and Methods

Participants

The population is a subject in an area and meets certain requirements related to the problem or object of research [9]. The population in this study were male basketball players aged 16 and 18 years (U-16 and U-18) in the Boyolali Regency who participated in the selection as members of the Boyolali Regency basketball team.

The sampling technique used is purposive sampling. Purposive sampling is sampling based on the researcher's assessment of anyone who deserves to meet the requirements to be sampled [10]. The requirements used to select the sample are by selecting players to take part in the Regional Student Sports Week and players prepared for the Regional Championship. Selection participants who pass to take part in the training center are taken as sample members. The sample in this study amounted to 32 male basketball players in Boyolali Regency, with details of 16 players aged 16 years and 16 players aged 18 years. Players in the age group of 16 and age group of 18 were each divided into 4 sample groups using the ABBA formula, with a total of 8 players in each sample group.

Study Design

The research conducted to determine the effect of ankle strengthening exercise using bosu ball exercise and theraband exercise on the balance of male basketball players aged 16 and 18 years is quantitative research. The research design used is experimental research with 2x2 factorial analysis. The research was conducted by providing an ankle strengthening exercise program consisting of two exercises: 1) theraband exercise and 2) bosu ball exercise given to male basketball players aged 16 years and 18 years. The purpose of this study was to determine the effect of the given exercise on the balance of male basketball players aged 16 and 18 years and to compare which exercise was better for improving the balance of male youth basketball players.

Table 1. Research Factorial Design [9)]

Ankle Strengthening Exercise (A) / Age Group (B)	Theraband Exercise (A1)	Bosu Ball Exercise (A2)
Age 16 years old (B1)	A1B1	A2B1
Age 18 years old (B2)	A1B2	A2B2

Instrumentation

The type of data in this study is primary data, so that data collection is carried out by testing [11]. Data were collected twice, namely pre-test and post-test. The pre-test and post-test data were carried out to determine the balance of KU-16 and KU-18 in Boyolali Regency before and after being treated. The data used in this study are the initial data (pre-test) and the final data (post-test).

Leg length measurements need to be done before doing the test using a predetermined instrument. The instrument used for data collection is the Y balance test (YBT) because the instrument has a

high level of relevance and is efficient for analyzing the condition of the lower extremities, especially the ankle condition [12]. Leg length data is used to calculate the level of balance, which will be included in the Y Balance Test formula.

Y balance test is a balance test instrument whose validity is recognized by doctors and scientists. The instrument was developed from the Star Excursion Balance Test (SEBT) instrument. The difference lies in the direction of movement that must be carried out, namely YBT consists of 3 directions of movement, and SEBT consists of 8 directions of movement [13]. The direction of movement of the Y balance test is: a) AD: anterior, b) PMD: posteromedial, c) PLD: posterolateral (fig. 1, fig. 2) [14]. Y balance test is a balanced instrument with a 95% confidence level and a validity value of 0.89 – 0.97 [15]. The right and left anterior direction is 135o while the angle between posteromedial and posterolateral is 90o [12].

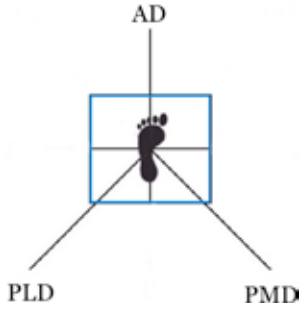

Figure 1. The direction of movement y balance test. [14]

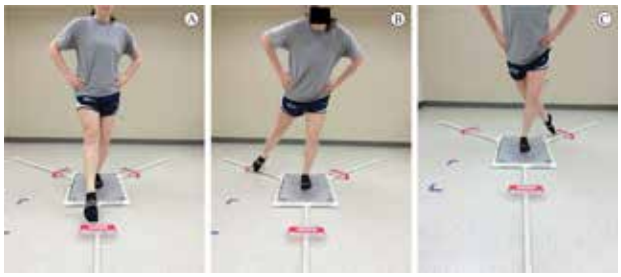

Figure 2. Y balance test. [16]

Information:
(A): anterior,
(B): posterior medial directions, and
(C): posterior lateral directions.

The Y balance test measurement tool can be modified using tape or a ruler attached to the floor according to a predetermined angle of 135o, while the angle between posteromedial and posterolateral is 90o [12, 17]. The value of the level of confidence and validity of the modification of the tool remains the same, namely 95% confidence and the validity value of 0.89 - 0.97 [17, 18]. Y Balance Test (YBT) is carried out to measure the balance on the right and left parts, measured alternately. Here is how to do the Y Balance Test (YBT):

1) The test taker stands on a point or platform with bare feet or wearing sports shoes.
2) Place both hands on the waist.
3) Test takers can try 3-6 times in each direction before taking the real test.
4) The actual test was carried out 3 times in each direction.
5) Participants are asked to move their legs to produce as far as possible and return their feet to the starting position.
6) The support leg must not be lifted or shifted when the other leg is moving.
7) The maximum coverage distance is then recorded in "cm" units.
8) Assessment of the Y Balance Test, the best achievement from each direction is then added and divided by three times the length of the leg (measured from the sias to the medial malleolus), multiplied by 100 as the normalized value.
9) The composite direction value is calculated by the formula: [(sum of the greatest reach in each direction) / (3 x limb length)] x 100

Exercise Protocol

Players selected as sample members were first examined regarding the condition of the muscles, ligaments, tendons, and joints in the lower extremities in general and specifically in the ankles. A team of physiotherapists carried out the examination, and the examination was carried out to ensure that basketball players aged 16 and 18 were allowed to perform ankle strengthening exercises with theraband exercises or bosu ball exercises. If the examination has been completed and the player is declared worthy of taking the exercise, the next step is to measure the balance using the Y balance test instrument. Balance measurements were carried out before and after the balance training program was completed.

The sample was divided into 4 groups consisting: 1) The age group of 16 years with theraband exercise, 2) The age group of 16 years with the bosu ball exercise, 3) The age group of 18 years with the theraband exercise, and 4) The age group of 18 years with the bosu ball. Exercise. The sample members gave the treatment after they finished doing regular exercises (skills and finishing) in the field. Ankle strengthening exercise treatment was given to each sample member for 16 meetings, with an exercise pattern of one day of exercise and one day of rest. Theraband exercise consists of four movements, namely: 1) plantarflexion (extension), 2) dorsiflexion (flexion), 3) inversion, 4) eversion. The Bosu ball exercise consists of four movements: 1) single-leg stance, 2) runner touch, 3) chest-passing in single-leg stance, 4) forward-behind in single-leg stance.

Statistical Analysis

Determining the statistical test used to process data needs to be determined precisely, using parametric or non-parametric statistics [19]. Data

testing using parametric statistics can be done if the data is normally distributed and homogeneous. The following is a normality and homogeneity test, which was analyzed using SPSS 25. The normality test of the ankle strengthening, ice therapy, and age group research variables used the Liliefors (L) test, calculated using SPSS 25 software. The level of significance used in the normality test was = 5% (0.05). The homogeneity test of the research variables of ankle strengthening, ice therapy, and age group using Fisher's test (F) was processed using SPSS 25 software. The level of significance used in conducting the homogeneity test was = 5% (0.05).

The data analysis technique used in this study is a two-way analysis of variance (ANOVA) at a significance level of = 0.05. Furthermore, to compare the mean pairs of the given treatments used the Newman Keuls range test [20].

Results

The average score of the pre-test balance of male basketball players aged 16 years on the right balance is 97.76, and the left balance is 93.83 (fig. 3). The average value of the balance changed after being given the theraband exercise treatment. The post-test mean of the right balance was 102.05, and the left balance was 98.81.

Figure 4 shows that the theraband exercise treatment given to basketball players aged 16 years after regular training for 16 meetings with an exercise pattern of 1 training day and 1 day of rest showed a positive impact on improving right and left balance. The average increase in the right balance is 4.29, and the left is 4.98. Pre-test right theraband exercise and post-test right theraband exercise = 5% (0.05) > sig. (2-tailed) 0.000, then it can be interpreted that there is a significant change in

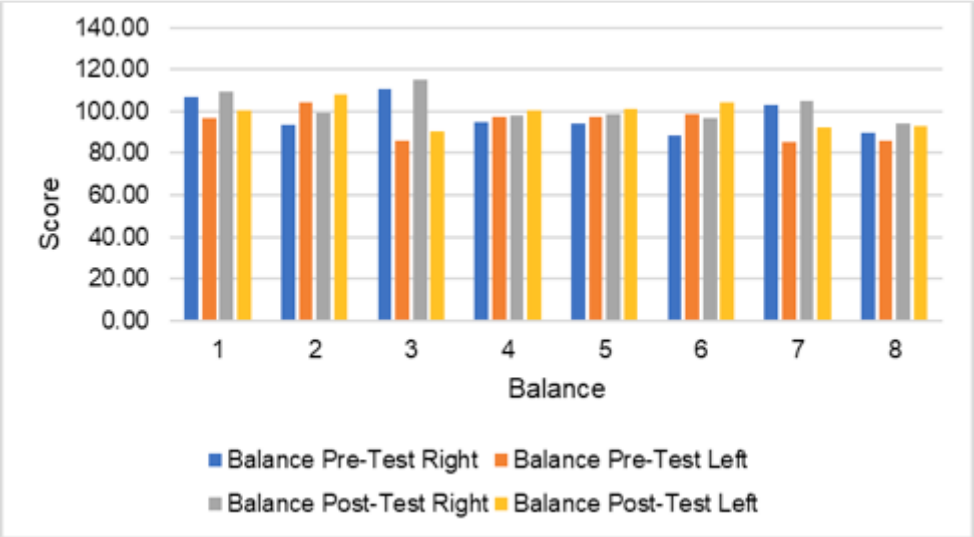

Figure 3. Data of balance theraband exercise 16 years old

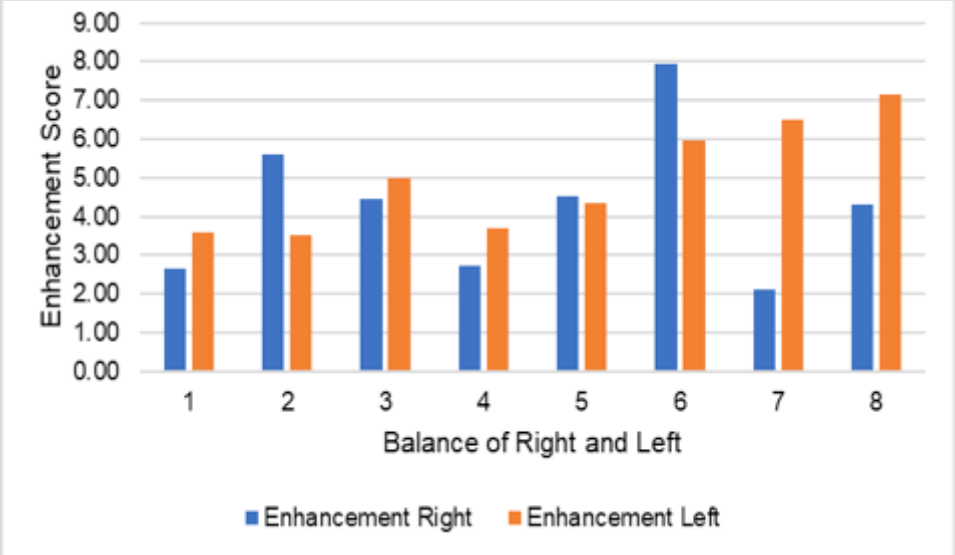

Figure 4. Enhancement of balance theraband exercise 16 years old

the right balance of basketball players aged 16 years after the theraband exercise treatment. Pre-test left theraband exercise and post-test left theraband exercise = 5% (0.05) > sig. (2-tailed) 0.000, then it can be interpreted that there is a significant change in left balance for basketball players aged 16 years after theraband exercise treatment.

The average score of the pre-test balance of male basketball players aged 16 years on the right balance is 98.27, and the left balance is 94.47 (fig. 5). The average value of the balance changed after being given the bosu ball exercise treatment. The post-test mean score for the right balance was 104.18, and the left balance was 100.64.

Figures 6 show that the bosu ball exercise treatment given to basketball players aged 16 years after regular training for 16 meetings with an exercise pattern of 1 day of training and 1 day of rest showed a positive impact on improving right and left balance. The average increase in the right balance is 5.91, and the left is 6.17. Pre-test right bosu ball and post-test right bosu ball exercise = 5% (0.05) > sig. (2-tailed) 0.000, then it can be interpreted that there is a significant change in the right balance of basketball players aged 16 years after being given bosu ball exercise treatment. Pre-test left bosu ball exercise and post-test left bosu ball exercise on left balance the value of = 5% (0.05) > sig. (2-tailed) 0.001, then it can be interpreted that there is a significant change in left balance for basketball players aged 16 years after being given bosu ball exercise treatment.

The average score of the pre-test balance of male basketball players aged 16 years on the right balance is 96.32, and the left balance is 104.10 (fig. 7). The average value of the balance changed after being given the theraband exercise treatment. The post-test mean score for the right balance was 100.34, and the left balance was 108.65.

Figures 8 show that the theraband exercise treatment given to basketball players aged 18 years after regular training for 16 meetings with an exercise pattern of 1 day of exercise and 1 day

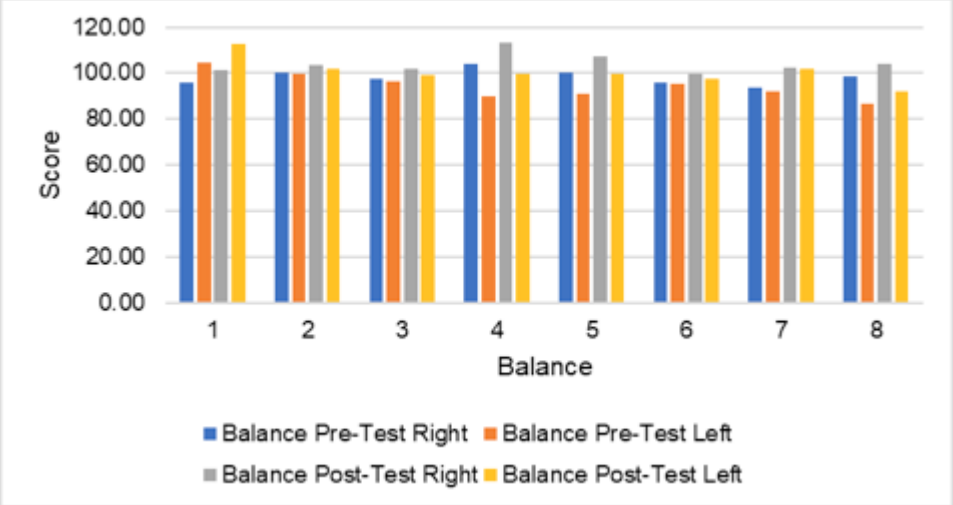

Figure 5. Data of balance bosu ball exercise 16 years old

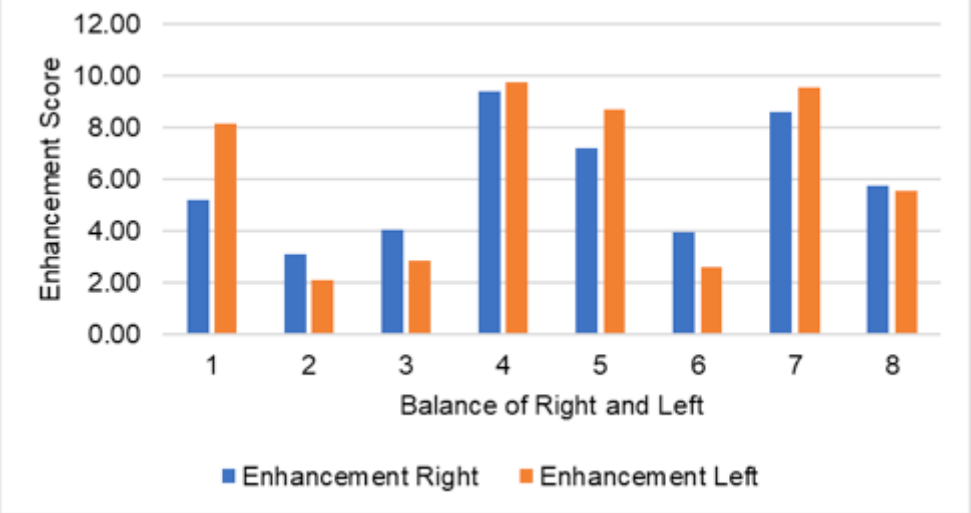

Figure 6. Enhancement of balance bosu ball exercise 16 years old

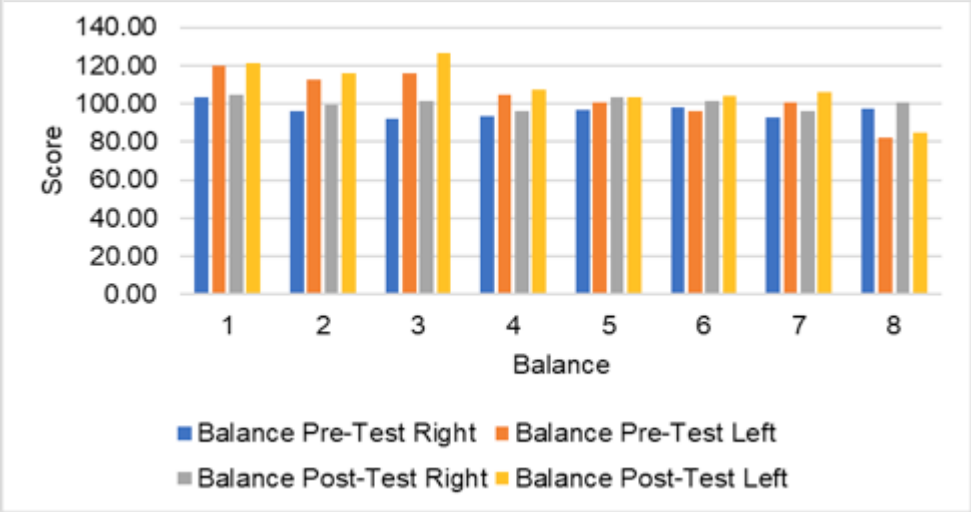

Figure 7. Data of balance theraband exercise 18 years old

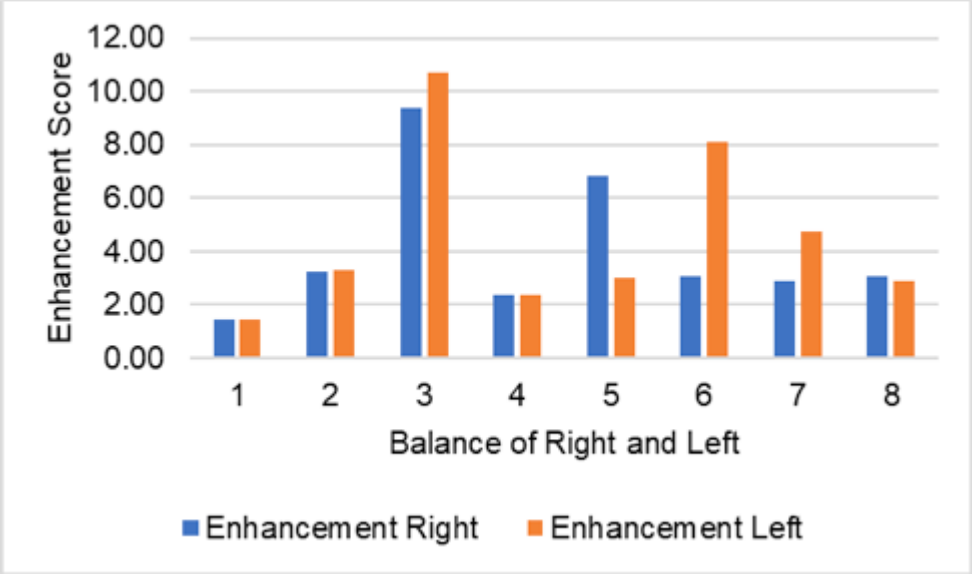

Figure 8. Enhancement of balance theraband exercise 18 years old

of rest showed a positive impact on improving right and left balance. The average increase in the right balance is 4.02, and the left is 4.55. Pre-test right theraband exercise and post-test right theraband exercise = 5% (0.05) > sig. (2-tailed) 0.004, then it can be interpreted that there is a significant change in the right balance of basketball players aged 18 years after the theraband exercise treatment. Pre-test left theraband exercise and post-test left theraband exercise = 5% (0.05) > sig. (2-tailed) 0.005, it can be interpreted that there is a significant change in left balance for basketball players aged 18 years after being given the theraband exercise treatment.

The average score of the pre-test balance of male basketball players aged 16 years on the right balance is 98.29, and the left balance is 102.16 (fig. 9). The average value of the balance changed after being given the theraband exercise treatment. The post-test mean score for the right balance was 103.57, and the left balance was 108.95.

Figures 10 show that the bosu ball exercise treatment given to basketball players aged 18 years after regular training for 16 meetings with a training pattern of 1 training day and 1 day of rest showed a positive impact on improving right and left balance. The average increase in the right balance is 5.29, and the left is 6.79. Pre-test right bosu ball and post-test right bosu ball exercise = 5% (0.05) > sig. (2-tailed) 0.000, then it can be interpreted that there is a significant change in the right balance of basketball players aged 18 years after being given bosu ball exercise treatment. Pre-test left bosu ball exercise and post-test left bosu ball exercise on left balance the value of = 5% (0.05) > sig. (2-tailed) 0.002, it can be interpreted that there is a significant change in left balance for basketball players aged 18 years after being given the bosu ball exercise treatment.

Figures 11 show no interaction between the treatment given to basketball players aged 16 and 18 years. The interaction did not occur because the

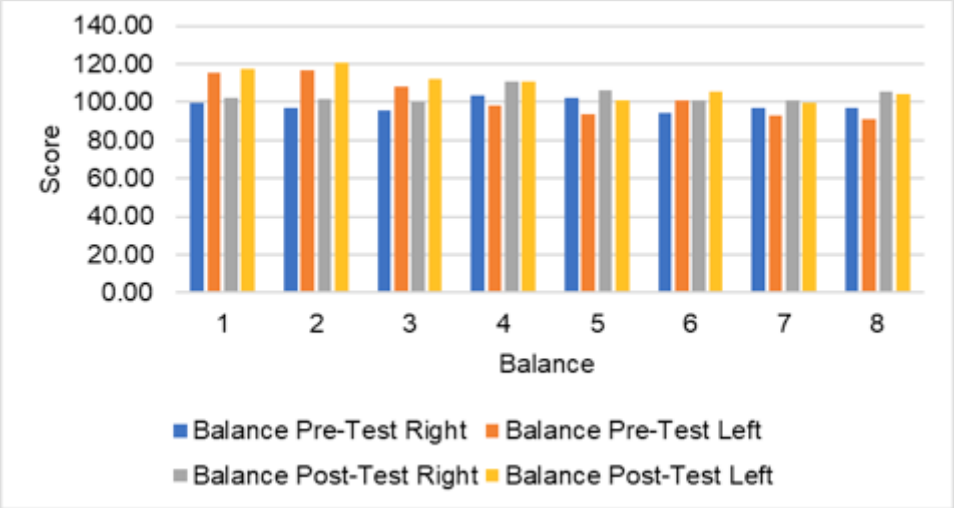

Figure 9. Data of balance bosu ball exercise 18 years old

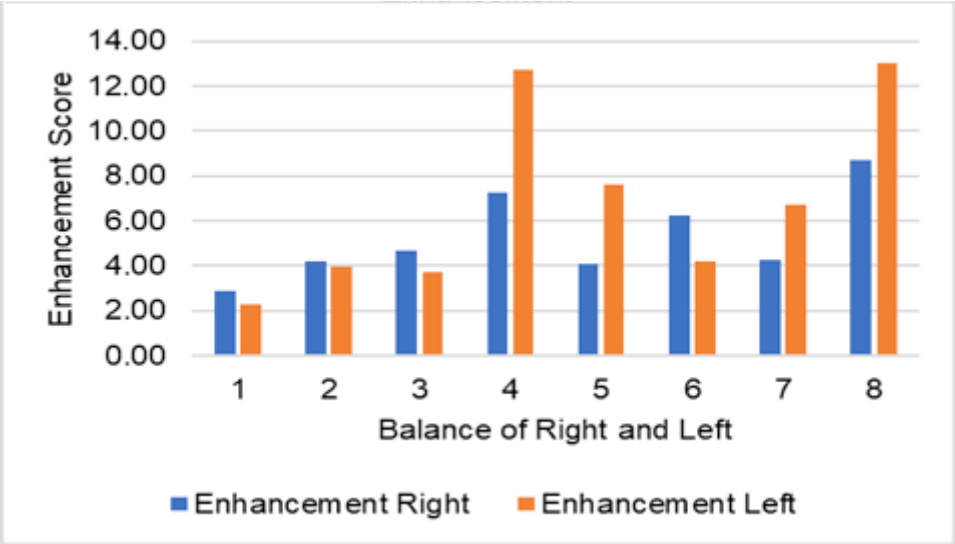

Figure 10. Enhancement of balance bosu ball exercise 18 years old

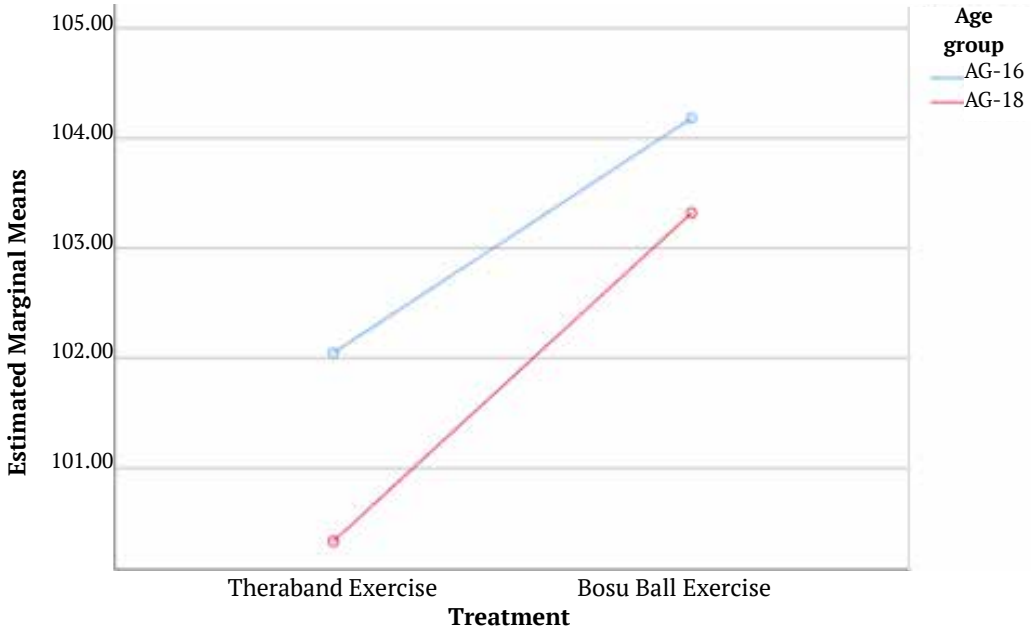

Figure 11. Raight balance

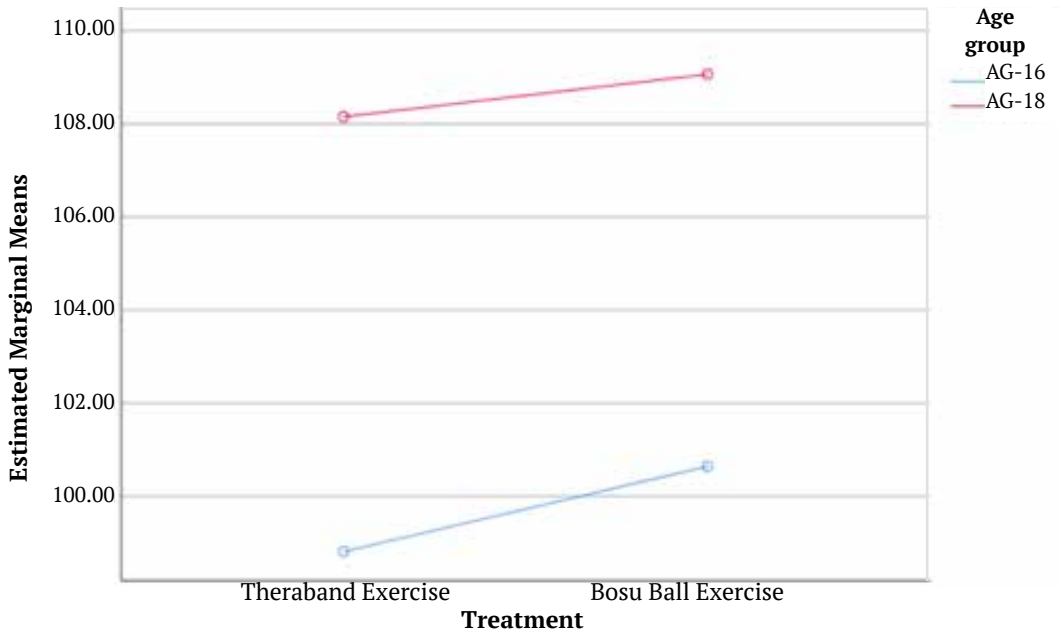

Figure 12. Left balance

growth and development phase of the 16-year-old and 18-year-old players were still in the adolescent phase. Characteristics of the age group of 16 years and 18 years are not much different.

Figures 12 show no interaction between the treatment given to basketball players aged 16 and 18 years. The interaction did not occur because the growth and development phase of the 16-year-old and 18-year-old players were still in the adolescent phase. Characteristics of the age group of 16 years and 18 years are not much different.

Discussion

Balance is divided into two, namely static balance and dynamic balance. Static balance (static balance) is the ability to maintain gravity in a stationary position such as standing and sitting. In contrast, dynamic balance can stabilize the body on an unstable surface or in moving conditions such as walking and running [21]. Balance can also be interpreted as an ability to control the center of the body (center of mass), the center of gravity (center of gravity), body position against the fulcrum (base of support) [22]. the law in biomechanics shows that the fulcrum is located on foot when standing, walking, and running, which shows that the ankle has a very large role in maintaining body balance [23]. The muscles that support the ankle when the foot is supported or moved will certainly contract so that the skin, muscles, tendons, and ligaments need to be given proprioceptive treatment in order to have a positive effect on balance [22, 24]. Joint and muscle movements are effectors that realize commands from the balance center [22, 24, 25].

The main system that functions as balance control in the human body consists of sensory, motor, and information processing centers [2, 3]:

1) Sensory
   a) Visual: the visual system is important in the sensory system because through vision, the body can make adjustments or adapt to environmental conditions, so that muscle responses respond synergistically to maintain body balance.
   b) Vestibular system: the vestibular system is located inside the ear, which has an important role in: 1) maintaining balance, 2) controlling head movement and position, and 3) controlling eye movement. Input received by the vestibular nucleus is via the receptor labyrinth, reticular formation, and the cerebellum. Output originating from the vestibular nucleus is transmitted to motor neurons through the spinal cord, especially motor neurons that innervate proximal muscles, neck muscles, and postural muscles (back muscles). The vestibular system works very quickly to control the postural muscles so that the body can adapt to the existing conditions to maintain balance.
   c) Somatosensory: the somatosensory system has an important role in maintaining body balance and motor control. The somatosensory system provides information related to body position and environmental conditions that can be received or responded to by: 1) the skin provides information about touch, 2) muscles are receptors that provide information about the position of the limbs and body. Movement control depends on constant and accurate information received through the somatosensory system.

2) Motor

Skeletal muscles and joints are motor movements that are part of the balance control system. Skeletal muscles and joints act as a movement system that can change the legs and body position. Muscles can respond appropriately so that the speed and strength produced can be adjusted to the activity or activity being carried out. The strength of the muscles of the legs, knees, and hips must be sufficient to maintain a balanced body position because muscle strength is directly related to its ability to resist gravity and other external loads. Joint range of motion or the breadth of joint motion also plays an important role in body movement so that the movements carried out can be directed properly so that the balance of the body can be maintained.

3) Information processing center

The central nervous system integrates inputs obtained from the sensory system, producing motor commands to control body position both in rest and in motion. The information process to control the balance is indeed controlled by the central system so that if there is damage to the unity of the system, the response given to control the balance will be disturbed. Disorders that occur can come from certain pathologies or decreased function of organs or the neuromuscular system.

Proprioceptive is the perception of stimuli on the balance of the body that is generated through the visual, vestibular, and sensory-motor systems [26]. Proprioceptive, locomotor exercise is needed to improve body balance because it can affect the performance of brain reflexes so that muscles and joints can provide an excellent locomotor response to maintain body position in stationary or moving conditions [26]. Basketball sports have complex biomotor component characteristics such as agility, speed, coordination, accuracy, endurance, and explosive power. The biomotor ability will be better if it is supported by good balance conditions [27]. A review of several articles recommended 10-20 minutes of balance training, but some were carried out 40-50 minutes. However, after research, it was recommended f two times per week for eight weeks with a training duration of 45 minutes [28]. Doing balance exercises for 30 minutes with a frequency of 2 times per week for 12 weeks can improve young basketball player's balance and vertical jump ability [29]. The average time to exercise using the theraband and bosu ball in this study ranged from 10-30 minutes per training session according to the number of repetitions that gradually increased.

The muscles in the legs are the muscles that support the ankle when the foot, when supporting or moving, will certainly contract so that the muscles, tendons, and ligaments need to be given proprioceptive treatment in order to have a positive effect on balance [24, 30]. Joint and muscle movements are effectors that realize commands from the balance centre [22, 24, 25].

Theraband exercise is an exercise that leads to movement-related strengthening. In contrast, the bosu ball exercise leads to balance training, which are ankle strengthening exercises that aim to improve the ankle's balance and functional capacity [5, 31]. Exercises using theraband and bosu balls for lower extremities given after regular training (drill skills) affect the proprioceptive system to help improve postural balance in the form of dynamic and static balance [29, 31, 32].

Ankle theraband exercise is an exercise that aims to increase strength, improve balance and proprioception, improve posture, reduce pain, increase leg muscle endurance, and restore ankle motion function [33]. The ankle theraband exercise consists of 4 movements, namely: 1) plantarflexion (extension), 2) dorsiflexion (flexion), 3) inversion, 4) eversion. Bosu ball is a sporting instrument in a hemispherical ball (half ball) with a bulging side like a dome with an unstable surface and a flat side made of hard rubber [34]. The Bosu ball is a multi-functional tool because various exercises can be done using the tool, such as exercises for fitness, core stability, balance, strength, and skills [35]. Bosu ball is a tool that can be used in functional training or exercises related to daily movements [35]. Based on this analysis, bosu ball exercise is better than theraband exercise because the muscle group responsible for maintaining balance in the training process is more complex, starting from the leg muscles to the back muscles [24, 35]. Whereas in theraband exercise, the balance guard muscles that are trained only focus on the muscles in the legs [36, 37].

Conclusions

The sample group that was given the theraband exercise treatment for ankle strengthening, which was given after regular exercise, could improve balance more significantly. A significant effect also occurred in the sample group that was given the bosu ball exercise treatment. The interaction between the treatment given to basketball players in the 16 and 18 years age group did not occur. The interaction between theraband exercise and bosu ball exercise did not occur because the growth and development phases of the 16-year-old and 18-year-old sample groups were still in the adolescent phase. Characteristics of the age group of 16 years and 18 years are not much different. Bosu ball exercises give a better effect than theraband exercise. Although statistically not too significant, there is a difference in the average. The motor system works more,

starting from the legs, back, and abdomen muscles. The motor system that works when doing theraband exercise tends to be on the muscles in the legs.

Conflicts of interest

The authors do not have conflict interest with anyone about this writing and/or writing this article.

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