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Maximize Long Drive: The Role of Arm Muscle Strength in Balinese Woodball Athletes

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ABSTRACT

Introduction: Woodball is an outdoor sport played individually or in teams, where players hit a ball with a mallet to pass it through a gate using as few strokes as possible. Mastering the long drive shot is essential for success, as it helps cover long fairways in fewer strokes. This study examines the relationship between arm muscle strength and long drive distance in woodball athletes in Bali.

Methods: Using a cross-sectional approach, this observational analytic study used purposive sampling to select 50 athletes aged 15-18 who participated in the 2023 Youth Pledge Cup. Data were collected using a hand dynamometer to measure arm muscle strength and a 30-meter course to measure long drive distances. Athletes took two shots, and distances were categorized into over 30 meters and under 30 meters.

Results: Spearman-Rho analysis showed a p-value of 0.000 ($p < 0.05$) and an r-value of 0.569, indicating a statistically significant and direct correlation between increased arm muscle strength and long drive distance. The r-value suggests a moderate to strong correlation, emphasizing the importance of arm muscle strength in enhancing long-drive performance.

Conclusion: There is a strong correlation between arm muscle strength and long-drive performance in woodball athletes in Bali.

Keywords: arm muscle strength, long drive shot, woodball athletes

INTRODUCTION

Woodball is often compared to golf due to similar playing techniques, rules, and athletes' attire. However, several features differentiate woodball from golf, such as the mallet used for striking, the wooden ball, which is more prominent in size, and the goal, referred to as a gate, made from two wooden bottles connected by a metal rod with a wooden cup in the middle. The game is played by hitting the ball with the mallet, aiming to get it through the gate with the fewest strokes possible, and directing it towards the gate at the end of the track.[1]

Woodball is a relatively new sport that is gaining popularity globally and in Indonesia. The sport has since spread to various countries. It was created in 1990 by Ming-Hui Weng and Kuang-Chu Young from Chinese Taipei. As of 2016, the International Woodball Federation (IWbF) has 44 official member countries across five continents. Indonesia is one of the member countries and has established the Indonesian Woodball Association (IWbA), which has regional committees in 14 provinces.2 In 2016, woodball was included as an exhibition sport in the West Java National Sports Week (PON). In Bali, woodball officially became part of the Provincial Sports Week (Porprov) in 2015 and the Bali Student Sports Week (Porjar).3

Basic techniques are the key to success in woodball and must be continuously practised and applied in matches. These fundamental techniques include non-equipment techniques such as swings and setups and equipment techniques such as pressing routines using the mallet, long-distance shots, mid-range shots, short-distance shots, and shots aimed at the gate. Basic techniques are like a foundation; if executed correctly, they can prevent sports injuries by up to 50%. A woodball athlete must have a good stroke and be able to swing the ball smoothly and accurately, ensuring the ball reaches the desired target.[4] Kriswantoro (2011) explains that the movement techniques in woodball must minimize minor errors because woodball is a game that demands high accuracy and good target achievement. Therefore, mastering basic techniques is essential for woodball players. The impact of a missed or overly strong stroke can result in a loss of time and points for the player. In competitive matches, this can mean the difference between winning and losing. Consequently, tools such as the wood swing tool, developed to assist in forming the basic swing techniques of woodball, are crucial for improving stroke accuracy and reducing errors. 2

In woodball, there are various ways to strike the ball using a mallet, including the long drive shot. This shot is crucial and must be mastered by woodball athletes because it is used when traversing a long fairway. The long drive shot is essential for a woodball athlete as it serves as the opening shot and determines the number of subsequent

strokes the athlete will take. This shot requires careful attention and must be executed optimally, meaning it should be accurately aimed so that the ball moves close to the gate from the starting line without exceeding the fairway. However, some woodball players still need help with this technique. This difficulty arises because the long drive shot requires a longer swing than other woodball shots. Therefore, mastering this technique is necessary to achieve a maximum long drive shot.[5]

Strength is crucial for enhancing the quality of woodball play. Especially as a competitive sport, woodball requires good muscle strength. A woodball athlete needs to consider the strength necessary to direct the ball accurately, making this aspect particularly important. Arm muscles, in particular, play a vital role as they are heavily utilized when striking the ball. Therefore, developing and maintaining strong arm muscles is essential for woodball athletes to improve their performance and achieve better results.[6] Based on research conducted by Maulana M in 2021, arm muscle strength contributes 48% to the accuracy of long-distance shots, indicating a significant relationship between grip strength and long-drive shots.[7] Meanwhile, Adiatma's 2020 study found that arm muscle strength, grip strength, and body flexibility collectively influence long-drive shots by 27.60%. These findings highlight the importance of these physical attributes in executing effective long-drive shots in woodball. [8]

High arm muscle strength is crucial as a driving force during long drive shots in woodball. However, in reality, many woodball athletes tend to exert and waste their strength on the field, resulting in long drive shots that are too strong and miss the gate. This increases the number of strokes for the athlete and moves them further from victory. Therefore, arm muscle strength becomes even more necessary to ensure that the shot results in good accuracy. By harnessing and controlling their arm strength effectively, woodball athletes can achieve better shooting accuracy, ultimately improving their performance on the field.[9]

The researchers selected a sample of woodball athletes in Bali due to the limited research investigating the relationship between arm muscle strength and long-drive shot distance in woodball in this region. Additionally, some studies have yet to utilize more objective measurement tools, such as a hand dynamometer. This study will use a hand dynamometer to measure arm muscle strength and correlate it with long-drive shot distance measured directly on the field. Therefore, based on the background information provided, the researchers believe that arm muscle strength in woodball athletes affects long-drive shot distance. Hence, they were interested in investigating this topic in a study titled "The Relationship Between Arm Muscle Strength and Long Drive Shot Distance in Woodball Athletes in Bali."

Research on the relationship between arm muscle strength and long drive shot distance in woodball athletes in Bali is crucial as it can assist athletes and coaches in improving performance through more effective training programs. By employing objective methodologies such as a hand dynamometer, this study contributes to the literature on physical factors influencing woodball performance and offers new insights from an under-researched region. With a holistic approach encompassing variables such as age, gender, and training experience, the findings of this study can be directly applied in training practice to provide tangible benefits for athletes and coaches. This research deepens our understanding of woodball and lays the groundwork for further study and developing more effective training programs.

METHOD

The research method employed was an analytical observational study with a cross-sectional approach, wherein variables were measured only once at a specific time. This study comprised two variables: one independent variable, arm muscle strength measured using a hand dynamometer test, and one dependent variable, the distance of woodball long drive shots measured using a long drive shot test. The research was conducted at the Bajra Sandhi field in Renon, with a sample of woodball athletes from Bali aged 15-18 years participating in the Youth Pledge Cup championship in October 2023. Data collection took place over one day at the Bajra Sandhi field in Renon, and all tests, such as the hand dynamometer test and the long drive shot test, were conducted on the same day.

The study utilized purposive sampling as the sampling technique. Purposive sampling involves selecting subjects based on specific characteristics relevant to the research objectives. In this study, purposive sampling ensured that the sample represented the population of woodball athletes meeting inclusion criteria such as age range (15-18 years), minimum training experience of 3 months, and involvement in woodball matches. This technique helped control confounding variables such as gender, age, and training experience, thereby enhancing the validity and reliability of the research findings.

The Lemeshow formula determined the sample size, resulting in a sample of 50 athletes. The Lemeshow formula was utilized to ensure that the sample size had sufficient statistical power to detect significant relationships between arm muscle strength and long-drive shot distance. By establishing a sample size of 50 athletes, the study anticipated adequate statistical power for correlation analysis using Spearman's rho test. This approach aimed to ensure good external validity of the research findings, allowing for generalization to a broader population of woodball athletes.

The primary data was obtained directly from the participants. Inclusion criteria for the study included woodball athletes aged 15-18 years, with a minimum of 3 months of training experience and willingness to provide informed consent. Exclusion criteria included fractures, wounds, or infections in the upper limbs as determined by a physiotherapist's examination, a history of upper limb surgery, and known disabilities, as reported in interviews. Controlling confounding variables such as gender, age, and athletes' physical activity levels was crucial to minimize potential biases affecting the research results and generalise the findings to a broader population of woodball athletes.

The study began with completing the research ethics clearance, obtaining permits to conduct the research, and communicating with the woodball athlete coaching team in Bali. The research was conducted under the guidance of a trained physiotherapist who facilitated the process of anamnesis, interviews, and data collection of arm muscle strength and shot distances. This ensured consistency and accuracy in measurements.

Several steps were taken to control and identify potential biases. First, arm muscle strength measurements using a hand dynamometer were standardised with validity test results of 0.880 and reliability test results of 0.938. This

test involved athletes gripping the hand dynamometer and pressing both hands inward, with their strength capacity directly visible on the measuring device. Second, long-drive shot distance measurements were conducted on the same field for each athlete, reducing variability due to different field conditions. The researchers also controlled confounding variables such as age, gender, and training experience by establishing clear inclusion criteria. Additionally, the tests were conducted alternately among participants to ensure consistent test conditions for all athletes. These efforts ensured the validity and reliability of the research results, minimizing potential biases that could affect the interpretation of the research findings.

A long drive shot test was conducted to measure the athletes' shot distances. This test involved hitting the ball from the start area towards the end of a 30-meter track. Each participant was given two attempts, and the test was conducted alternately among participants. Markers were placed at the end of the track to indicate the results of each participant's shot. If the ball crossed the end line, the participant was awarded 1 point, indicating a shot exceeding 30 meters; otherwise, if the ball did not cross the end line, the participant was awarded 0 points, indicating a shot of less than 30 meters.

Data analysis included descriptive and bivariate analyses using non-parametric Spearman's rho test on IBM SPSS 27 software. The choice of Spearman's rho statistical method in this study was based on the continuous nature of the data and the possibility of non-normally distributed data. Spearman's rho is a non-parametric test suitable for measuring the strength and direction of the relationship between two ordinal or continuous variables. The research ethics committee of Udayana University reviewed and approved the ethical clearance for this research with reference number B/11466/UN14.2.2.V.7/PT.01.04/2023.

RESULTS

The study began with a preparatory phase, which included preparing the necessary equipment and materials and training the measurers to ensure consistency in measurements. Subsequently, participants were recruited based on the established inclusion and exclusion criteria. The inclusion criteria comprised individuals aged 15-18 with at least three months of training experience, resulting in 50 selected participants. Exclusion criteria included specific health conditions that could affect measurement results, but no participants were excluded based on these criteria.

Arm muscle strength was measured using a hand dynamometer for all 50 participants. Additionally, the distance of long drive shots was measured on the same field to reduce variability resulting from differences in field conditions. The collected data were analyzed using appropriate statistical methods, such as Spearman's rho test, to determine the relationship between arm muscle strength and long drive shot distance. The results of the analysis were then interpreted to conclude this relationship. The characteristics of the subjects based on age, gender, arm muscle strength, and long-drive shot distance can be seen in Table 1.

Table 1. Subject Characteristics in the Study

Variable	Frequency (n)	Percentage (%)
Gender		
Male	31	62
Female	19	38
Age, years		
15	8	16
16	13	26
17	17	34
18	12	24
Training Experience, months		
6	11	22
8	10	20
10	1	2
12	15	30
18	1	2
20	2	4
24	10	20
Hand Dynamometer Test		
Poor	5	10
Fair	10	20
Average	6	12
Good	17	34
Excellent	12	24
Long Drive Stroke Test		
More than 30 meters	31	62
Less than 30 meters	19	38

Based on Table 1 above, it is known that the sample consists of 50 individuals, comprising 31 males and 19 females. About 34% of the total sample is aged 17, and 16% are aged 15. Furthermore, the range of woodball training experience spans from 6 to 24 months, with 11 individuals having six months of training experience and ten individuals having 24 months of training experience. The hand muscle strength test found that most samples had good hand muscle strength (34%), with five individuals having poor hand muscle strength. In measuring long drive stroke distance, the research sample predominantly achieved distances of more than 30 meters (n=31 or 62% of the total sample).

Next, the significance of the relationship between independent and dependent variables is elucidated in Table 2.

Table 2. Correlation of Variables Tested Using Spearman's Rho Test

Variable	Correlation	P-Value
Hand Muscle Strength and Long Drive Stroke Distance	0.569	0.000

Based on Table 2, the test was conducted using Spearman's Rho test with a p-value of 0.000. H0 was rejected, and Ha was accepted based on the decision-making criteria that $p < 0.05$, proving the significance of the relationship between hand muscle strength and long drive stroke distance among woodball athletes in Bali.

Furthermore, the correlation coefficient value or r is 0.569 and is positive. A positive value indicates a positive correlation with a strong correlation level as the value falls between 0.51 – 0.75.

DISCUSSION

This research was conducted offline in the Renon field, Denpasar city, in October, coinciding with the woodball championship at the 2023 Youth Pledge Cup for students across Bali, targeting woodball athletes in Bali aged 15-18 years. The sample was determined using a purposive sampling technique, meaning the sample was selected based on specific objectives or according to predetermined inclusion and exclusion criteria, resulting in 50 athletes participating in the study. The research was carried out directly at the Bajra Sandhi field, Renon, for one day, during which all tests, such as the hand dynamometer test and the extended drive stroke test, were conducted.

The data obtained from this study aimed to support the research hypothesis, focusing on variables such as age, gender, and training frequency of athletes. The research sample aged 15-18 years consisted of 19 females (38%) and 31 males (62%), with the majority of athletes being 17 years old, comprising 17 individuals (34%). Following that, there were 13 individuals aged 16 years (26%), 12 individuals aged 18 years (24%), and the least number of individuals aged 15 years, totalling 8 (16%). Muscle strength increases in correlation with age, dimension, muscle anatomy, and sexual maturity. Muscle strength tends to increase with age. When males and females reach the age of 25, muscle strength reaches its maximum, and after that age, muscle strength begins to decline. Muscles experience a decrease of approximately 30% within the age range of 20-75 years. This aligns with the Physical Quality Development Center, which indicates that muscle strength in males and females will continue to increase until puberty.[10]

In Sukadiyanto's research, as cited in Ilham (2022), several factors influencing the accuracy of strokes were mentioned, including the level of difficulty, experience, prior expertise, type of expertise, feelings, and the ability to prevent motion. Similarly, Suharno also cited in Ilham (2022), outlined determinants affecting the precision of strokes as follows: (a) High synchronization, (b) Target size, (c) Sensory abilities and nerve control, (d) Target distance, (e) Mastery of technique, (f) Movement speed, (g) Feeling and accuracy, (h) Strength of movement. Therefore, based on these explanations, the factors mentioned above can be controlled based on age, as each age group exhibits significant differences in sensory synchronization, nerve control, technical proficiency, movement speed, accuracy, and strength of movement. Almost all motor components are influenced by age. Hence, the researcher opted for adolescent athletes because their body muscles are undergoing strength enhancement and maturation related to the learning experience.[11]

Based on the research findings, most athletes have woodball training experience of 1 year or 12 months, comprising 15 individuals (30%). Following this, 11 athletes (22%) have six months of training, while 10 (20%) have trained for 8 and 24 months each. Additionally, two athletes (4%) have trained for 20 months, and one athlete (2%) each with training durations of 10 and 18 months. With good training quality encompassing varied exercises and gradual loading, mastery of technique, coordination, and movement strength can improve as athletes gain more experience. The more repetitions an athlete performs in training, the faster they achieve good accuracy in long drive strokes, whereas the opposite may occur with less training experience.[6]

Based on the research findings from the hand dynamometer test, the most significant frequency was found in the "good" category with 17 athletes (34%), followed by the "excellent" category with 12 athletes (24%), "fair" category with ten athletes (20%), "average" category with six athletes (12%), and finally, the "poor" category with five athletes (10%). These results are also supported by Amin et al. (2012), where a study involving 20 male woodball club athletes found that the average score for hand muscle strength fell within the "good" category. Additionally, Utami et al. (2019) conducted a study involving 29 woodball athletes from the UNNES student activity unit (UKM), which revealed that hand muscle strength was predominantly in the "good" category with a score of 52.99.[12]

Based on the research findings from the extended drive stroke test, it was found that 31 athletes (62%) fell into the category with a stroke distance of more than 30 meters, while 19 athletes (38%) fell into the category with a stroke distance of less than 30 meters. These results are based on the distances achieved by athletes using the woodball field, which has a track length of 30 meters. If an athlete can hit the ball beyond 30 meters, they will score points; conversely, if an athlete hits the ball less than 30 meters, they will score 0 points.

Relationship between Hand Muscle Strength and Long Drive Stroke

Based on the non-parametric statistical analysis using Spearman's Rho (Table 2), a p-value of 0.000 ($p < 0.05$) and an r-value of 0.569 were obtained, indicating the significance of the relationship with a strong correlation level and a direct relationship between hand muscle strength and long drive stroke distance among woodball athletes in Bali. Several supporting studies suggest that hand muscle strength also affects the long-drive strokes of woodball athletes.

These findings are supported by Imaduddin's research (2020) on the hand muscle strength and eye coordination of subjects in long-distance woodball strokes. The findings, with a correlation coefficient of 0.821, demonstrate the relationship between hand muscle strength and athlete stroke outcomes. A correlation coefficient of 0.616 indicates the relationship between eye coordination and stroke outcomes. This study revealed that the contribution of hand strength dominantly influences athlete stroke outcomes (67.4%) compared with other variables, such as eye coordination (37.9%).[13]

Using the same method of measuring hand muscle strength as in this study, research conducted by Dewi (2020) on the farthest throws of softball balls aligns with the findings of this study. A p-value of <0.05 (p=0.000) was obtained, indicating a significant relationship between hand muscle strength and the farthest throws of athletes.[14]

Arm muscle strength is the ability of muscles to mobilize all force and power from the wrist to the shoulder. Strength is one factor that plays a role in hand swing, especially in woodball, making it vital to achieving long drive strokes accurately, particularly in arm muscle strength. With arm muscle strength, athletes can control the ball's swing and mallet when hitting the ball. Another aspect affecting the distance of the ball's launch in woodball is the length of the upper limb. This is due to the increased distance between the mallet and the ball, resulting in a more significant impact.[15]

Based on Rusmania as cited in Toma (2022), there are 4 phases in performing a long drive stroke. The first phase is the preparation phase, during which both arms are extended, forming a V shape with a neutral grip. Next is the initiation phase, where the arms are directed towards a full backswing motion, during which the arm muscles contract. When the arm muscles contract, the potential energy in the mallet increases and is converted into kinetic energy as it enters the third or execution phase. The higher the kinetic energy in the mallet, the faster and farther the ball launches in the subsequent phase.[6]

Training is essential to enhance arm muscle strength. Well-structured and detailed training programs are crucial for improving athletes' performance. Two ways to increase arm muscle strength are body weight (internal) and external weights. Internal resistance training is performed without additional weights beyond one's body weight, such as push-ups, sit-ups, and pull-ups. On the other hand, external resistance training involves using additional weights, such as lifting dumbbells and performing other weightlifting exercises.[16]

Coaches and woodball athletes also need to consider the frequency and intensity of training because high-intensity loads result in fewer repetitions. Increased loads cause the body to fatigue more quickly, necessitating breaks during training. In other words, endurance training has a higher stimulus frequency, whereas maximal strength and speed training have lower load frequencies. The frequency of training is also influenced by the number of training units performed each week. The better someone's ability, the higher the frequency of training they should engage in. Athletes with high performance should ideally undertake up to fifteen weekly training units, meaning two to three times daily. Conversely, novice athletes should train thrice a week, while advanced athletes should aim for five to ten weekly training units.

The researchers identified several limitations in this study. The study only focused on the relationship between arm muscle strength and long-drive stroke distance in woodball athletes. At the same time, other variables, such as gender and level of physical activity, were not controlled. This should be considered before generalising the research findings to a broader population. Additionally, other factors can affect long-drive stroke outcomes, such as the fairway, grass thickness, terrain shape, and slope, which cannot be controlled by the researchers and may influence the measurement of athlete strokes. Another factor affecting measurement outcomes is the equipment athletes use in the study, such as mallets and balls. To address these concerns, the mallets and balls used by athletes in measuring the stroke distance are the same tools used by other subjects.

Potential biases in measurement or sampling in this study can occur in several aspects. While appropriate to ensure specific characteristics of the sample, purposive sampling may introduce selection bias because not all population members have an equal chance of being selected. Additionally, measuring arm muscle strength using a hand dynamometer and long drive stroke distance in an open field can be influenced by environmental variables such as weather conditions, grass thickness, and slope, which the researchers cannot fully control. Variations in athletes' physical conditions during testing, such as undetected fatigue or minor injuries, can also affect measurement outcomes. All these factors must be considered when interpreting the research findings to ensure validity and reliability.

The results of this study have the potential to be applied to a broader population or different situations, although there are some limitations to consider. This study demonstrates a significant relationship between arm muscle strength and long-drive stroke distance among woodball athletes in Bali. However, generalising the results of this study should be done with caution because variables such as gender, level of physical activity, and uncontrolled environmental conditions can influence the outcomes. The use of purposive sampling techniques and cross-sectional design also limits the ability to generalize the findings of this study to a broader population. Nevertheless, these findings remain relevant and can serve as a basis for further research using different methods and populations to confirm these results.

CONCLUSION

Based on the research findings and Spearman's rho analysis, there is a significant correlation between arm muscle strength and long drive stroke distance among woodball athletes in Bali (p=0.000, p<0.05). The r-value of 0.569 indicates a strong and positive correlation. These findings align with previous research emphasizing the importance of arm muscle strength in improving long-drive stroke performance.

It is recommended for other researchers to use this study as additional information and consideration in their research. Subsequent researchers are expected to utilise more diverse populations and methods and control for more variables, such as environmental conditions and athlete fatigue levels. This is intended to provide a more detailed picture of the relationship between various variables.

Researchers also suggest that woodball coaches design training programs to increase arm muscle strength to enhance long-drive stroke abilities and athlete performance. Some exercises can include push-ups, weightlifting, and other resistance training. For athletes, it is essential to maintain arm muscle strength through regular exercise and pay attention to a balanced diet and nutrition intake every day. Optimal performance can be achieved through structured training and good nutrition.

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