PPSDP International Journal of Education
Volume 3 (2) (Special Issue) 10-11 July 2024, 22-35
3rd International Conference on Education Universitas PGRI Palembang (INCoEPP 2024)
E-ISSN 2829-5196, P-ISSN 2830-3229

The Relationship of Arm Muscle Strength and Strength Force with Mash Results Spring in the Volleyball Game for Male Students

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Article History: Received on 9 July 2024, Revised on 20 August 2024,
Published on 5 September 2024

Abstract: This study aims to determine the relationship between arm muscle strength and muscle flexibility with semi-smash results in volleyball games in class X male students of SMA Negeri 1 Indralaya. This type of research is correlation research. The population used was male students in class X SMA Negeri 1 Indralaya. The sample for this research consisted of 70 male students. This research method uses method correlation. The data collection technique in this research used a test. The instruments used were the pull-up test, sit-and-reach test, and semi-smash test. The results of statistical analysis from multiple correlation analysis obtained an F-count of 68.63, then consulting the F-table with a significance level of 5%, obtained an F-table of 3.14. The magnitude of the double correlation (R) obtained is R= 0.82, and the coefficient of determination (R^2) obtained is 0.672, meaning (0.672 x100%) = 67.2% of the semi-smash results are determined by a combination of arm muscle strength and stick flexibility. Based on the results of this research, it can be concluded that there is a significant relationship between arm muscle strength and muscle flexibility with semi-smash results in volleyball games for male students in class X of SMA Negeri 1 Indralaya.

Keywords: Arm Muscle Strength, Togok Strength, Volleyball Performance

A. Introduction

Volleyball is a very interesting team game and is included in the group of attacking and defensive games. Likewise with other games, volleyball has certain characters and is played by two opposing teams (Drikos et al., 2022; Hernawati et al., 2023). This game is increasingly developing and becoming popular in society, especially in recent years. In line with the development of this game, training methods have also developed with a combination of new techniques that are more effective and efficient. According to Powers (2019), volleyball is a game that requires excellent brain abilities, especially tossers . The tosser must be able to regulate the course of the game. As the sport of volleyball continues to grow and evolve, so too does the approach to player development and training. The increasing complexity of the game has led to a refinement of training practices, emphasizing the integration of

advanced techniques and strategic insights. Coaches and players now focus on a holistic approach that combines physical conditioning with cognitive training, recognizing that success in volleyball is not solely dependent on athleticism but also on mental sharpness. For example, drills designed to enhance quick decision-making and improve situational awareness are now commonplace, reflecting the understanding that a tosser's ability to make rapid, accurate decisions is pivotal to a team's success. This evolution in training underscores the sport's dynamic nature and the necessity for players to adapt to new challenges, thereby continually pushing the boundaries of what is possible on the court.

Volleyball is a popular team sport played on a rectangular court divided by a net. The objective of the game is to score points by sending the ball over the net and into the opposing team's court, while also preventing the opposing team from doing the same. With its fast-paced gameplay and emphasis on teamwork, volleyball has become a widely enjoyed sport around the world. The game is typically played with six players on each side, with specialized positions such as setters, hitters, and defensive specialists. Players must work together to pass, set, and spike the ball in order to outsmart and outmaneuver their opponents. Volleyball requires a combination of physical skill, strategic thinking, and quick reflexes, making it a thrilling and dynamic sport to watch and play. In addition to its competitive aspect, volleyball also promotes camaraderie, sportsmanship, and physical fitness among players. Overall, volleyball is a versatile and exciting sport that appeals to people of all ages and skill levels (Sitti & Köroğlu, 2023).

Volleyball is an exhilarating and fast-paced team sport that necessitates a blend of skill, strategic planning, and cohesive teamwork to achieve success. This engaging game is played on a rectangular court divided by a net positioned at the center, with the primary objective being to score points by skillfully sending the ball over the net and into the opposing team's court in such a manner that the opposing team is unable to return it effectively. Each team consists of six players and the sport demands quick reflexes, excellent communication skills, and seamless coordination among teammates to outmaneuver the opposition. Volleyball can be played in various settings, including indoor courts and sandy beaches, each presenting unique challenges and requiring different adaptations. This sport offers a comprehensive workout that tests both the physical abilities and mental acuity of players across all skill levels, ensuring a challenging yet rewarding experience for all participants (Mitchell et al., 2020). Volleyball's dynamic nature and the diverse set of skills required make it a compelling and enjoyable sport for players and spectators alike.

Volleyball is a high-energy and rapidly evolving team sport that demands a perfect amalgamation of individual skills, tactical acumen, and harmonious team collaboration to secure victory. Played on a rectangular court that is symmetrically divided by a net set up at its midpoint, the fundamental aim of the game is to

accumulate points by deftly propelling the ball over the net and into the opponent's court, making it difficult for the opposing team to return the ball in a controlled manner. Comprising six players on each side, volleyball requires athletes to possess lightning-fast reflexes, superior communication abilities, and impeccable synchronization with their teammates to effectively counter and dominate the adversary's plays. The game of volleyball can be enjoyed in a variety of environments, ranging from polished indoor courts to scenic beach settings, each of which presents its own distinct set of challenges and necessitates specific tactical adjustments. This sport delivers an all-encompassing physical workout, simultaneously challenging the mental sharpness of the participants, thereby providing a multifaceted and stimulating experience for players of every proficiency level. As noted by Welters et al. (2019), the inherently dynamic characteristics of volleyball, combined with the wide array of skills it encompasses, contribute to its status as an enthralling and pleasurable sport for both those who play and those who watch.

Volleyball is a dynamic and engaging sport that was originally created to provide a suitable and enjoyable winter activity for people in America. This innovative and entertaining game was invented by William G. Morgan in the year 1895 in Holyoke, a city located in the eastern part of America. Volleyball, as a highly competitive and thrilling game, is played between two teams, with each team consisting of six skilled players. The primary objective of the game is to score points by strategically hitting the ball over the net and into the opponent's court, with the match continuing until one team reaches a total of 25 points before the other.

Within a volleyball team, there are four critical and specialized roles that each player can undertake: the tosser (also known as the setter), the spiker (or smash), the libero, and the defender. Each of these roles is essential to the team's overall strategy and success on the court, requiring unique skills and responsibilities. The tosser, also known as the setter, is responsible for orchestrating the team's offensive play by precisely passing the ball to teammates in a strategic manner and directing the flow of the game. This role demands a high level of precision, quick decision-making skills, and an in-depth understanding of the game dynamics. The spiker's primary responsibility is to aggressively hit the ball, aiming to land it in the opponent's defense area with force and accuracy, making it challenging for the opposing team to return the ball. The spiker's ability to execute powerful and well-placed hits is crucial for scoring points and gaining a competitive advantage over the opponent, often being the key player in turning the tide of the game.

The libero is a specialized defensive player who has the unique ability to move freely in and out of the game without the typical rotation restrictions that apply to other players. However, the libero is not permitted to perform an attack hit (smash) across the net. The primary function of the libero is to enhance the team's defense by

skillfully receiving and digging the opponent's attacks, thus preventing the ball from hitting the ground in their court. This role requires exceptional reflexes, agility, and the ability to anticipate the opponent's moves. Lastly, the defender, also known as the defensive specialist, plays a vital role in protecting the team's side of the court by receiving and blocking the opponent's attacks. The defender must be adept at anticipating the opponent's moves, reacting swiftly, and using strategic positioning to prevent the ball from scoring. This role is crucial for maintaining the team's defensive strength and ensuring that the opponent's offensive plays are effectively countered.

Each of these roles—the tosser, spiker, libero, and defender—contributes significantly to the overall dynamics and effectiveness of the team. According to Durdubas et al. (2021), the coordination and cooperation among these roles are essential for a team's success in the game of volleyball. The interplay between these positions requires not only physical skill but also strategic thinking, teamwork, and seamless communication. The combined efforts of the players in these roles create a cohesive and formidable unit that can adapt to the fast-paced and ever-changing nature of the game, ultimately leading to a thrilling and competitive experience for both the players and the spectators.

Volleyball always has a competitive character and therefore every player must master the basic techniques, namely service, passing, block and smash. Volleyball is a highly competitive sport that requires skill, strategy, and teamwork to succeed. With its fast-paced gameplay and intense rallies, volleyball demands quick reflexes and strong communication among players. In this sport, every point is crucial, and teams must constantly adapt and adjust their tactics to outsmart their opponents (Buekers et al., 2020). The competitive nature of volleyball pushes players to constantly strive for improvement and work together towards a common goal of victory. Players must be able to anticipate their opponent's moves, set up effective blocks, and execute powerful spikes in order to gain an advantage on the court. The pressure to perform at a high level can be intense, but it also fosters a strong sense of camaraderie among teammates as they work together to achieve success. In the end, the competitive nature of volleyball not only tests players' physical abilities but also their mental toughness and ability to problem-solve in high-pressure situations.

Smash is the form of attack that is most often used in an effort to gain points for a team in a volleyball game (Purnomo & Hariono, 2020). Smash is a strong blow, where the hand makes full contact with the ball at the top so that the ball travels steeply at high speed. According to Islam (2019), if a player wants to win a volleyball match, he or she must master the smash. Smash is an essential skill, the easiest way to win points.

In the game of volleyball, the term "smash" is often interchangeably used with

"spike". A spike is a powerful and aggressive form of attack that is central to the game of volleyball. The characteristics of a spiked ball are quite distinct; it dives rapidly toward the ground, is delivered with sharp precision, and travels at a high velocity, making it challenging for the opposing team to counteract effectively (Pavlov & Buzhinskiy, 2019). The player who executes this action is referred to as a smasher, and they can also be called a spiker. According to Cantú-González et al. (2022), an effective spiker is someone who possesses the ability to disrupt the opposing team's defense with every spike, significantly influencing the dynamics of the match and often turning the tide in favor of their team.

Furthermore, Jariono et al. (2023) emphasizes that the smash is not just a routine play but is considered the most critical element of an offensive strategy in volleyball. The execution of a successful smash requires a combination of power, precision, and timing, and it serves as a crucial tool for scoring points. A well-executed smash can decisively end a rally by making it nearly impossible for the opponents to return the ball, thereby either securing points directly or regaining control of the serve. The importance of the smash extends beyond its immediate impact on the score; it also serves as a psychological weapon that can demoralize the opposing team and boost the morale of the spiker's team.

A spiker must possess a variety of physical and mental attributes to perform at a high level consistently. Physically, a spiker needs to have explosive strength, excellent hand-eye coordination, and the ability to jump high and time their leap perfectly to meet the ball at its peak. Mentally, a spiker must have the ability to read the opponent's defensive setup, anticipate their movements, and make split-second decisions about the direction and force of their attack. According to Dong et al. (2022), a good spiker is a player who can effectively destabilize the cohesion of the opposing team in every match, using their spikes to create opportunities and exploit weaknesses in the defense.

Moreover, the smash is often the culmination of a well-coordinated team effort that involves precise setting and strategic playmaking. The setter plays a pivotal role in creating the perfect opportunity for a spike by delivering the ball with accuracy and the right trajectory, allowing the spiker to execute their attack with maximum effectiveness. The synergy between the setter and the spiker is vital for the successful execution of a smash, as it requires seamless communication and understanding of each other's timing and positioning.

In conclusion, the spike, or smash, is a fundamental and highly impactful element of volleyball, characterized by its sharp, fast, and diving trajectory. The ability to execute a powerful smash not only serves as a key offensive tool to score points but also plays a significant role in the psychological dynamics of the game. Effective spikers, as noted by Sousa et al. (2023), are invaluable assets to their teams, capable

of altering the course of a match through their skillful and strategic attacks.

Volleyball players must possess optimal physical, technical, tactical, and psychological conditioning to excel in the sport (Hunchenko et al., 2021). The seamless collaboration of these four essential factors significantly determines a player's performance and overall ability during a volleyball match, with particular emphasis on physical conditioning being a crucial determinant. Achieving peak performance in volleyball is largely dependent on maintaining an excellent physical condition, as it underpins the capacity to execute and sustain high-level play throughout a match.

According to Bonilla et al. (2022), the components that constitute physical conditioning are multifaceted and can be categorized into five primary elements: 1) strength, 2) endurance, 3) explosive power, 4) speed, and 5) flexibility. Each of these elements plays a vital role in enhancing a volleyball player's capabilities and performance on the court. Strength, for instance, is fundamental for executing powerful movements and maintaining stability. Endurance is critical for sustaining high energy levels and performance throughout the duration of a match. Explosive power enables players to perform quick, forceful actions such as jumping and hitting. Speed is essential for rapid movements and positioning, while flexibility allows for a greater range of motion and reduces the risk of injuries.

The amalgamation of these five physical condition factors yields numerous benefits for volleyball players. Having a good physical condition, supported by a solid foundation in basic volleyball techniques, results in the development of high-quality players who can perform consistently at their best. In the game of volleyball, the smash, also referred to as a spike, is the dominant offensive movement. The smash is a critical maneuver used to attack the opponent with the aim of scoring points by forcefully sending the ball into their court, making it difficult for them to return.

To execute an effective smash, a player requires not only excellent technique but also significant arm muscle strength and flexibility. Arm muscle strength is crucial for generating the power needed to drive the ball with velocity and precision, while flexibility is necessary for achieving the optimal range of motion during the execution of the smash. The combination of these physical attributes ensures that the player can perform the smash with maximum efficiency, thereby enhancing their ability to score points and contribute to the team's success.

Moreover, the psychological condition of a volleyball player is equally important. A player with a strong mental focus, confidence, and resilience can maintain their composure under pressure, make quick strategic decisions, and recover swiftly from setbacks. This mental fortitude complements the physical, technical, and tactical aspects, creating a well-rounded athlete capable of excelling in competitive

scenarios.

In conclusion, the physical, technical, tactical, and psychological conditioning of volleyball players are interdependent factors that collectively determine their performance and proficiency in the sport (Durdubas & Koruc, 2023). Maintaining a robust physical condition, characterized by strength, endurance, explosive power, speed, and flexibility, is paramount for achieving peak performance. These attributes, combined with refined basic techniques, produce high-quality players capable of executing dominant movements such as the smash, which is pivotal in offensive play. By cultivating these qualities, volleyball players can enhance their abilities and contribute significantly to their team's success, as highlighted by Bisagno et al. (2019).

Arm muscle strength, in particular, plays a crucial role in enhancing performance during volleyball smashes, as it directly affects the power and effectiveness of the hit. Greater arm muscle strength enables players to generate a more forceful and impactful smash, thereby striking the ball with increased velocity and force, which significantly raises the difficulty for opponents to block or return the ball effectively. However, flexibility, particularly in the torso and limbs, is also a vital factor in optimizing smashing techniques in volleyball. The ability to move with a high degree of flexibility enables players to direct the ball with greater precision and control. Flexibility facilitates a broader range of motion, which in turn aids in achieving better alignment and positioning when executing a smash.

According to de la Motte et al. (2019), flexibility is defined as an individual's capacity to perform movements with a wide range of motion. A player with good body flexibility benefits from an expanded range of movement, allowing for more fluid and dynamic actions during play. Conversely, individuals with limited flexibility may exhibit stiffness in their movements, which can restrict their ability to execute effective and accurate smashes. As such, both arm muscle strength and body flexibility are integral components in maximizing volleyball performance, particularly when aiming to enhance smashing ability.

Recent observations and data collected from physical education teachers at SMA Negeri 1 Indralaya provide further insight into the practical implications of these factors. Among one class of 35 students, the results indicated that 22% (8 students) were able to perform semi-good smashes, 31% (11 students) demonstrated a fairly good ability to execute semi-smashes, while 47% (16 students) struggled to perform semi-smashes effectively. This disparity in performance is largely attributed to the students' insufficient arm muscle strength and lack of body flexibility. Many students were unable to hit the ball over the net during smashes, primarily because their arm muscles lacked the necessary strength to generate effective punches. Additionally, the students' limited flexibility hindered their ability to direct the ball

accurately and precisely into the opponent's area, often resulting in the ball going out of bounds. Moreover, the overall effectiveness of their semi-smash training was compromised, further contributing to their difficulties in performing semi-smashes proficiently.

These observations highlight the crucial need for targeted strength and flexibility training to improve volleyball smashing techniques and overall performance. By addressing these areas, players can develop the necessary skills to enhance their smashing ability and achieve better results on the court. The results of observations and information obtained by researchers from physical education teachers at SMA Negeri 1 Indralaya, from one class of 35 students, there were 22% (8 students), who were able to do semi-good smashes, 31% (11 students) were quite good at doing smashes. Semi-smashes and 47% (16 students) could not do a semi-smash well. This is proven because when students do smashes spring. Most students are not yet able to hit the ball over the net. This happens because the student's arm muscle strength is still low in making punches. Apart from that, students also do not have good body flexibility, so that when doing a semi smash the students cannot direct the ball well and precisely in the opponent's area so the ball goes out. Also, students are less effective in doing semi-smash training is also a factor causing students not to be able to do semi-smashes well. Based on the problems and observations above, the researcher felt interested in conducting research related to the sport of volleyball, especially semi-smash.

B. Methods

The research used in this research is correlational. In this research, the author attempted to find or test the relationship between arm muscle strength and muscle - flexibility on semi-smash results - in a volleyball game for male students in class x SMA Negeri 1 Indralaya. This research uses a free correlational design (Correlational Design). The sample is a part or representative of the population studied. It is called a sample if we intend to generalize the results of sample research (Yuliani & Supriatna, 2023). In sampling correlation research, if there are less than 100 subjects, it is better to take all of them so that it is a population study. So, the sample used in this research was 70 male students in class X SMA N 1 Indralaya. Data collection techniques were the most strategic step in the research. Because the main aim of research is to obtain data. Without knowing data collection techniques, researchers will not get data that meets the specified data standards (Sugiyono, 2017).

The data collection technique in this research as a whole uses the Test and Measurement method. Before conducting research, the things that must be done to prepare for research are as follows: (1) Arrange for complete research permission letters. (2) Prepare the research site. (3) Preparing the facilities and infrastructure used in data collection. (4) Preparing assistant staff to carry out research when

collecting data. (5) Contact the physical education teachers who played a role in this research. (6) Carrying out tests on the variables studied. (7) Analyze the data that has been collected.

Research instruments relate to the validity and reliability of the instrument and the quality of data collection regarding the accuracy of the methods used to collect data. In this study, there are three variables from which data will be taken, two independent variables, namely arm muscle strength, muscle flexibility, and one independent variable, namely semi-smash results.

C. Results and Discussion

SMA Negeri 1 Indralaya is one of the leading schools in Indralaya. Indralaya 1 Public High School is located on Jalan Lintas Timur KM. 36, Indralaya (30662), Ogan Ilir Regency, South Sumatra Province. This school can be reached by public transportation because of its very strategic location. The environment looks very clean, comfortable, neat and beautiful because trees and various kinds of flowers are planted in the yard. Not only that, what makes this school look beautiful is that in front of each class there are flower gardens arranged in such a way that it adds to the beauty of the school environment. The sports facilities and infrastructure at SMA Negeri 1 Indralaya are quite adequate and really support sports activities. The fields owned by SMA Negeri 1 Indralaya are a futsal court, volleyball court, basketball court and badminton court.

This study used an arm muscle strength test (Pull-up) in order to compare the relationship between arm muscle strength and semi- smash results in volleyball. The results of the data collected regarding arm muscle strength showed that the highest score achieved was 16, while the lowest score was 3. After the data was analyzed, the average value was 7.58, mode 7.06, median 11.5, and standard deviation. 3.90. The frequency distribution of arm muscle strength variables can be seen in Table 1, and the frequency histogram can be seen in Figure 1.

Table 1. Frequency Distribution of Arm Muscle Strength Variables

No	Arm Muscle Strength	f_1	X_1	f_1X_1	X_1^2	$f_1X_1^2$
1	3-4	6	3.5	21	12.25	73.5
2	5-6	17	5.5	93.5	30.25	514.25
3	7-8	19	7.5	142.5	56.25	1068.75
4	9-10	14	9.5	71.5	90.25	1263.5
5	11-12	9	11.5	133	132.25	1190.25
6	13-14	4	13.5	54	182.25	729
7	15-16	1	15.5	15.5	240.25	240.25
Σ		**70**	**66.5**	**531**	**743.75**	**5079.5**

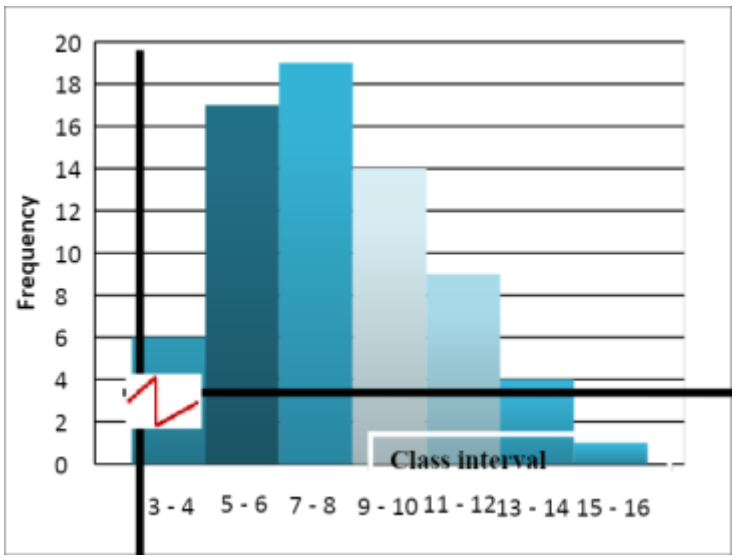

Figure 1. Frequency histogram

This study used the togok flexibility test (sit and reach test) in order to compare the relationship between togok flexibility and semi smash results in volleyball. The results of the data collected regarding the flexibility of the togok showed that the highest score achieved was 26 cm, while the lowest score was 6 cm. After the data was analyzed, the average value was 13.94 cm, the mode was 10.06 cm, the median was 18.34 cm, and the standard deviation was 5.09 cm. The frequency distribution of the togok flexibility variable can be seen in Table 2 and the frequency histogram can be seen in Figure 2.

Table 2. Frequency Distribution of Togok Flexibility Variables

No	Togok flexibility	F_2	X_2	F_2X_2	X_2^2	$F_2X_2^2$
1	6-8	9	7	63	49	441
2	9-11	20	10	200	100	2000
3	12-14	10	13	130	169	1690
4	15-17	14	16	224	256	3584
5	18-20	9	19	171	361	3249
6	21-23	4	22	88	484	1936
7	24-26	4	25	100	625	2500
	Σ	**70**	**112**	**976**	**2044**	**15400**

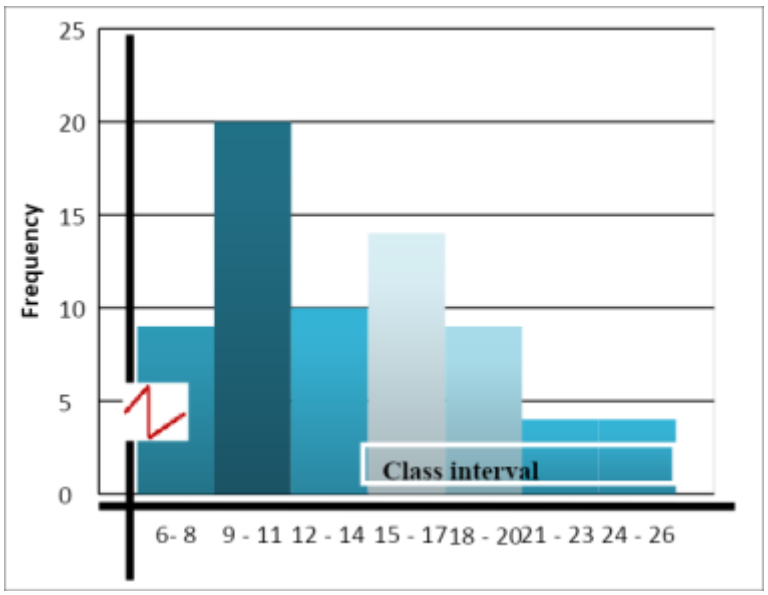

Figure 2. Muscle Flexibility Distribution Histogram

This research used tests *smash* semi as the dependent variable to determine the relationship between arm muscle strength and togok flexibility with semi *smash results.* The data collected regarding semi *smash results* obtained the highest score achieved at 86.6, while the lowest score was 40. Based on this data, the analysis obtained an average price of 63.6, mode 78.56, median 65.47, and standard deviation 14.59. The frequency distribution of semi *smash* result variables can be seen in Table 3, and the frequency histogram can be seen in Figure 3.

Table 3. Frequency Distribution of Semi *Smash Result Variables*

No	*Smash* Test Results	f3	X_3	f_3X_3	X_3^2	$f_3X_3^2$
1	40-46	12	43	516	1849	22188
2	47-53	9	50	450	2500	22500
3	54-60	12	57	684	3249	38988
4	61-67	7	64	448	4096	28672
5	68-74	7	71	497	5041	35287
6	75-81	14	78	1092	6084	85176
7	82-88	9	85	765	7225	65025
	Σ	**70**	**448**	**4452**	**30044**	**297836**

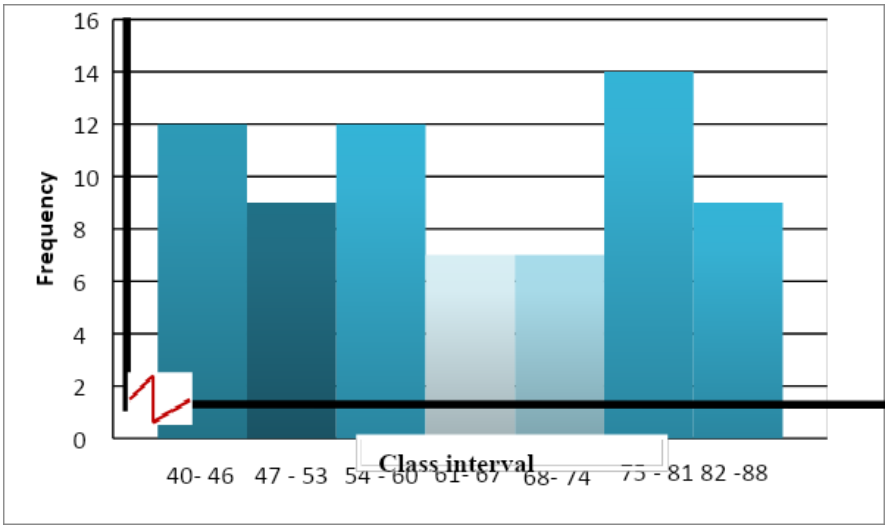

Figure 3. Frequency Histogram

D. Conclusions

Based on the results of data presentation and data analysis in this study, it can be concluded that there is a relationship between arm muscle strength (X1) and semi-smash results (Y) in the volleyball game for male students in class X SMA Negeri 1 Indralaya, proven by the correlation coefficient for a sample of 70 students. of 0.64 with a strong correlation level. There is a relationship between the flexibility of the muscle (X_2) and the semi-smash (Y) in the volleyball game among male students in class There is a relationship between arm muscle strength (X_1) and flexibility of the muscle(X_2) with semi-smash results (Y) in the volleyball game for male students in the class. It can be concluded that the greater the strength of a person's arm muscles and the better the flexibility of a person's stick, the better the semi-smash results.

E. Acknowledgement

Professional support and assistance from all respected reviewers have made this journal qualified to be published.

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