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Movement Analysis of DIMAS SAPUTRA Smash with Kinovea in the West Kalimantan Regional KAPOLDA CUP I Volleyball Final

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Abstract

Study purpose. Biomechanics is a branch of science that studies the forms and types of human movement based on mechanical principles in a sport that can minimize the occurrence of sports injuries. The purpose of this study was to see the effectiveness of Dimas Saputra's smash open movement at the 2023 West Kalimantan Regional Police Chief Championship.

Materials and methods. The esearch technique in this study used observation techniques through documentation. The documentation is done by taking a video of Dimas Saputra's volleyball game and observing the video. In carrying out this research using biomechanical analysis related to Dimas Saputra's smash motion open technique by inserting the video into the Kinovea application and analyzing it.

Results. The results showed that in volleyball games, of course, a spiker is greatly helped by a height above 1875 cm. With this height, a person will find it easier and more effective when making jumping movements. Second, the right timing when doing the spike is also an important point for a volleyball athlete, good timing will also be influenced by the speed when doing the jump and arm swing before the topspin phase occurs.

Conclusion. Based on research that has been carried out on the analysis of Dimas Saputra's smash movements in the Final Four of the 2023 West Kalimantan Regional Police Chief Championship, it can be seen that an ideal volleyball player must have a height above 185cm for the spiker position, besides that volleyball players must also have good timing right in taking a bait. It can be trained by doing smash drills and ball coordination exercises. Finally, a volleyball player ideally must also have strong and fast arm swing strength supported by good core muscle strength.

Keywords: Volleyball, Biomechanics, Height, Speed

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Introduction

Sport is an activity that is needed by all levels of society for their movement needs to support stamina and health (Suhairi and Arifin 2022). Sport is a relatively conditional human activity because it is not limited by time and place. Sport is an activity that is needed by all levels of society for their movement needs to support stamina and health. The goal of every sport is the automation of correct technique, a process that requires many repetitions (Samsudin et al. 2023). Sport is a relatively conditional human activity because it is not limited by time and place. Volleyball is a fun and challenging sport that has developed into a major professional interscholastic and spectator event (Akarcesme and Hazir Aytar 2018). Volleyball is one of the sports that people like because it can be done by all people and all ages (Christiana 2017). In succeeding in playing volleyball several techniques must be mastered, namely service, receive, attack, block, toss, and dig, with the addition of consistent training and a good game strategy (Suhairi and Dewi 2021). Volleyball is often carried out on a national standard field in accordance with the rules of the game which measures 18 m x 9 meters and is bounded by a net measuring 2.43 meters (men) and 2.24 meters (women), with 6 players. trying to play the ball with the dominance of the use of the hands so that the ball does not fall in its field area (Winarno 2013).

Every volleyball team has at least four important roles in it, first, there is the tosser (or setter), then the spiker (smash), then the libero, and the last is the defender or what is commonly called a defender (Suganda and Suharjana 2013). Because volleyball is a game that is determined by the team that has the highest score to win, the presence and contribution of spikers here are very important and need to be taken into account. The spiker himself is tasked with hitting the ball so that it falls in the opponent's defense area and is tasked with destroying the opponent's defense to gain points. Spiker himself requires a lot of jumps to attack opponents with different smash techniques (Palao and Valades 2009). Spiker is a technique that has a greater chance of getting points compared to other techniques because there are elements of strength and speed in the movement to produce a fast-hitting ball due to the correlation between strength performance, body mass index, and speed (Shi et al. 2022). Hitting with a dive is an important factor in winning the game which is influenced by the speed and strength of the lower limbs when pushing (Alanne and Sierla 2022). Besides that, the spikers here also have an important role in executing passes from their teammates, especially from the tosser. Good spike ability and carefulness in reading the direction of the ball's movement are competencies that must be possessed by professional spikers. Starting from moving closer to the ball, jumping with the right timing, and hitting hard and directed to destroy the opponent's defense to add to the team's points.

Success in playing volleyball requires several techniques that must be mastered, namely service, receive, attack, block, toss, and dig, with the addition of consistent practice and a good game strategy. Playing skills in volleyball can be said as a way to play the ball effectively and efficiently in accordance with the applicable game rules for achieving optimal results. In Indonesia itself, there are many talent search events for volleyball at the student level starting from the elementary school level, one of which is the O2SN (National Student Sports Olympiad) to tertiary institutions, namely at the POMNAS (National Student Sports Week) level. Even at the general level, there are LIVOLI (Indonesian Volleyball League amateur level Championship) and PROLIGA (annual professional volleyball competition in Indonesia organized by PBVSI), and in 2023 the first continuous championships will be held starting from the Kapolres Cup, Kapolda Cup, and the pinnacle of the Kapolri Cup championship. This talent search event is the most prestigious event and is eagerly awaited by the Indonesian people, especially volleyball fans because the teams that play in it consist of the best Indonesian and even international players.

If you observe the game of volleyball teams in Indonesia, they are still not optimal compared to the games of volleyball teams from abroad, one of which is on the European continent, however, the enthusiasm and achievements of volleyball in Indonesia are getting better, especially if you look at comparisons in neighboring countries. If we look deeper into this, the Indonesian volleyball game strategy is still not optimal even though technically and physically the players are quite capable. But in reality, technique and physique alone are not enough to improve our national sports system, especially in volleyball. There needs to be a sports science role in it. Starting from the selection, coaching, and evaluation stages, it must be data-based to have a realistic reference according to the facts in the field. Real or actual data will make it easier for an agency and a club to take the actions it wants to take in the future. We can see this as an example, we will not be able to train someone's vo2max if we don't do tests and measurements first. When an athlete has carried out tests and measurements related to his *vo2max* ability, a coach can also see and monitor the athlete's progress. In addition, a data coach can also determine what training program an athlete needs to do to increase the performance he has (Milić et al. 2017). There are several disciplines contained in the use of sports science in sports. Starting from health, psychology, physics, nutrition, and medicine, to biomechanics. Talking about biomechanics, biomechanics is a branch of science that studies the forms and types of human movement based on mechanical principles in a sport (Suhairi, 2018). Measurements using biomechanics will be able to explain in detail the results of the resulting movement development and become one of the determinants for measurable training (Kalkhoven and Watsford 2020). Where with this discipline, one can find out and analyze the movements made by an athlete during training or competition. Good and effective movement will support the athlete's performance on the field, besides that through a biomechanical approach it is hoped that it can also minimize the occurrence of sports injuries (Kalkhoven and Watsford 2020). Therefore, through the description of the background above, the researcher is interested in taking the title of the research, namely "Analysis of Dimas Saputra's Smash Movement in the Final Four and Final of the West Kalimantan Regional Police Cup Championship in 2023" by taking several coaching points for the open technique smash movement because of the role and contribution of Dimas Saputra himself is statisticallyvery good so he can bring the Sanggau Police team into the Quarter Finals.

Materials and methods

Study Participants

Research subjects are people who are sources of research (Maksum 2012). In this study, researchers used Dimas Saputra as a research subject. Sampling using observation techniques by doing documentation. The documentation is done by taking a video of Dimas Saputra's volleyball game and observing the video. The research subject that will be the sample is the athlete Dimas Saputra in the smash movement in the volleyball game in the Final Four and the Final for the 3rd position in the 2023 Regional Police Chief Championship Cup I which was held at the Pangsuma Pontianak Sports Hall from June 11 to June 24, 2023. Dimas Saputra himself was taken as a sample because of his very prominent role in the club by providing some dangerous spikes that brought his team to the final four.

Study Organization

From the problems that have been formulated, the research technique in this study uses observation techniques through documentation. The documentation is done by taking a video of Dimas Saputra's volleyball game and observing the video. In carrying out this research using biomechanical analysis related to Dimas Saputra's smash motion open technique by inserting the video into the Kinovea application. The Kinovea application is a software

application or software as a tool for analyzing videos of physical conditions so that the results of training can be recorded and the results observed (Suhairi 2018).

The research design uses an evaluative descriptive design. The reason for using the evaluative descriptive method is to understand in depth the smash movement technique in volleyball games performed by athlete Dimas Saputra during a match to be able to use the motion technique properly and correctly so that athletes can use their energy as effectively as possible.

The source of data used in this research is secondary data. Secondary data is data obtained from existing or documented literature or other sources (Stefanus 2022). In this study, the data taken is data obtained from video recordings of matches in the Final Four and Final Scramble for Rank 3 in the 2023 Kapolda Cup I championship.

Statistical analysis.

The data collection technique in this study is to use observation. Observation is the systematic observation and recording of the symptoms that appear on the object of research (Megawati and Maksum 2022). This study observed the results of the video matches of the Final Four and Final Scramble for Rank 3 of the 2023 Kapolda Cup I championship. The activities studied were examining Dimas Saputra's open spike movement in volleyball in the Final Four and Final Scramble for Rank 3 of the 2023 Kapolda Cup I Championship with used the sagittal side for the analysis process at Kinova.

The data obtained from the observation sheet that occurred during the match will be grouped based on the criteria. The researcher processed the data from the results of observations made by watching the matches through video recordings of the Final Four matches and the Final Scramble for Rank 3 in the 2023 Kapolda Cup I championship. In this study, processing data from observations used quantitative data analysis techniques. Quantitative analysis techniques use statistics by operationalizing statistical formulas that are adapted to the type of research (Sugiono 2015).

Result

In the results of the study, based on video analysis through one smash movement performed by Dimas Saputra in the second set by analyzing through the sagittal side, several coaching points analyzed include: (1) *Take Off* Phase; (2) *Vertical Momentum* Phase; (3) *Pike Position* phase; and (4) *Topspin Impact* Phase.

Furthermore, the recording data that the researchers obtained were then analyzed and examined through the 2D Video Analysis application (Kinovea Software). And the following are the results of the researcher's observations using video recordings downloaded from YouTube and then analyzed using the tools in Kinova. The following is research data obtained through analysis using Kinovea with a focus on observing smash movements: (1) Take Off Phase, (2) Vertical Momentum Phase, (3) Pike Position Phase, and (4) Topspin Impact Phase, taken during a match is described as follows:

1. Fase *Take Off*

Figure 1. Dimas Saputra's *Take-Off* Movement (Source: Personal Documentation and Borneo TV Youtube)

The take-off phase is the stage of repulsion or continued support from the initial step in the volleyball smash stroke by placing the soles of the feet almost parallel to prepare to jump vertically. Seen in Figure 1. The Take-off Movement Dimas Saputra takes several prefix steps to do the smash the last step is to push the jump as high as possible with the position of both legs bent so that the knees form 103.0° with one of the legs located further forward as a springboard. When jumping, your heels and toes strike the floor, and then swing your arms, while pushing your body up using the strength of both legs.

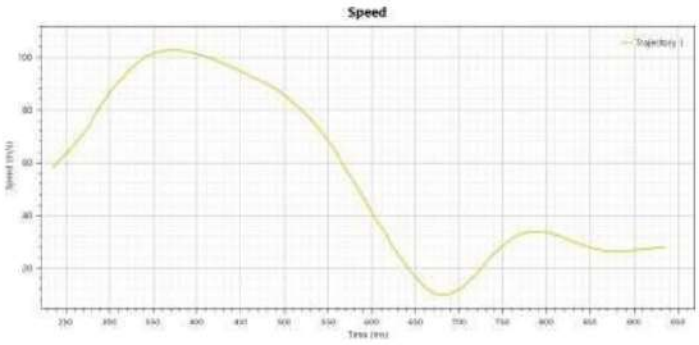

Figure 2. Graph of Linear Kinematic Take Off, (Source: Personal Documentation from Kinovea Results)

In this picture, Dimas Saputra is getting ready to take off in a position where the angle of the leg to knee bend is formed when the knee flexion forms an angle of 103.9° with one leg placed further forward as a pedestal for jumping. Meanwhile, Dimas Saputra's speed from take off to the topspin phase reached 101.2 m/s.

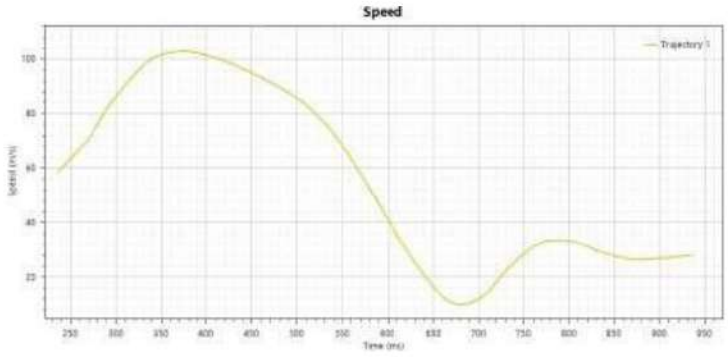

Figure 3. Take Off Speed (Linear Tool), (Source: Personal Documentation from Kinovea Results)

It can be seen from the speed chart that Dimas Saputra inscribed when taking off to do the smash movement, the resulting time was very fast, namely 101.2 m/s.

2. Fase *Vertical Momentum*

Vertical momentum is the ability to move or the magnitude of the thrust of an object. It can also be interpreted as the power of motion based on speed. This can be seen in the movement when performing the initial repulsion to make a jump. In addition to speed, leg muscle mass is also needed which influences the strength of the leg muscles in encouraging when jumping up when doing a volleyball smash vertically when doing a volleyball smash, where the initial movement must be fast.

Figure 4. Vertical Movement of Dimas Saputra, (Source: Personal Documentation and Borneo TV Youtube)

In the next phase, after Dimas Saputra kicked off, he was in a vertical momentum position. Where in this phase Dimas Saputra makes an angle of 165.6° on his legs, while in the shoulder flexion movement, it is 137.1°. So that you can see the position of Dimas Saputra's body when after taking off it bounces backward accompanied by a swing of the hand-pulled up the back to take the initial swing of the hand so that it seems as if it is reaching to hang in the air accompanied by taking a breath and holding it. It is this movement that makes Dimas Saputra's movement last a split second in the air (high jump factor).

3. Fase *Pike Position*

Figure 5. *Core* Angle at *Pike* Position from Dimas Saputra, (Source: Personal Documentation and Borneo TV Youtube)

When performing a volleyball smash, the ball is within optimal reach of the arm and above the net. Smash should be done by hitting the ball as fast and as high as possible with the ball's contact area in the palm of the hand with the upper center of the ball. In the picture above, Dimas Saputra makes a move in the pike phase position with an angle formed from the *Center of Gravity* of 119.1°.

Figure 6. Arm Angle in *Pike* Position from Dimas Saputra, (Source: Personal Documentation and Borneo TV Youtube)

Furthermore, in that position, Dimas Saputra also made the initial movement of bending his arm before doing a smash of 63.4°. As seen in the video, the movement of the wrist is actively jerking forward with the position of the palms of the fingers closing the ball.

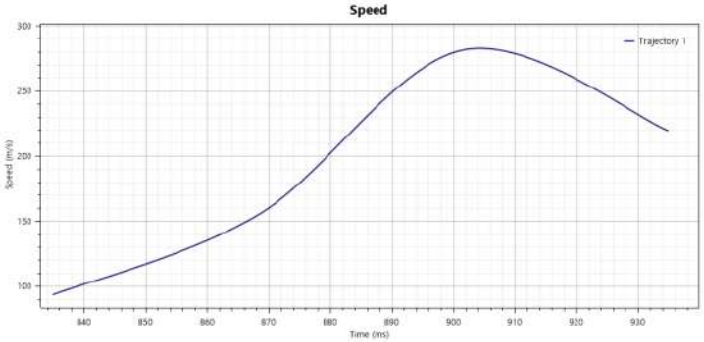

Figure 7. Dimas Saputra's Arm Swing Speed During Smash (Linear Tool), (Source: Personal Documentation from Kinovea Results)

It can be seen from the graph of the results of the linear tool analysis above in the Kinovea application, Dimas Saputra incised a swing speed of 284 m/s. This can provide great power to the ball's speed. With the speed of the swing that is made, the ball that is hit will be harder and go faster. As in Newton's Second Law, "the

acceleration of an object produced by a force is directly proportional to the magnitude of the force, in the direction of the force, and inversely proportional to the mass of the object".

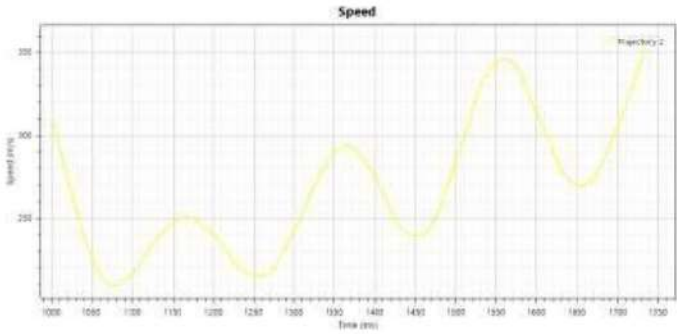

Figure 8. Smash Ball Velocity (Linear Tool), (Source: Personal Documentation from Kinovea Results)

From the results of the ball velocity analysis graph, the ball travels very fast and reaches a speed of 350 m/s. This is because the speed of the arm swing is fast so the result of the speed of the ball follows the speed of the arm swing.

4. Fase *Topspin Impact*

Hitting or hitting the ball is done when it reaches the highest point of the jump, with the ball one arm's reach away, and the position of the ball in front of the head. Hitting the upper back of the ball with an open palm accompanied by a whipping of the hand to produce a topspin ball, dipping downwards. The position of the body facing the ball with the swing of the bat arm is kept straight by relying on the wrist protrusion when the ball hits the palm of the hand with the upper center of the ball accompanied by the fingers of the open hand gripping the balls.

Figure 9. Movement in the topspin position from Dimas Saputra, (Source: Personal Documentation and Borneo TV youtube

In this picture, it is known that Dimas Saputra made a smash movement during the *topspin*/peak phase, which can be seen from the *tracking* line from the start to the moment of impact on the ball. taking off to the topspin phase where the impact process on the ball occurs, Dimas Saputra takes off perfectly. The complete series of Dimas Saputra's open smash movements can be seen in Figure 10, as follows:

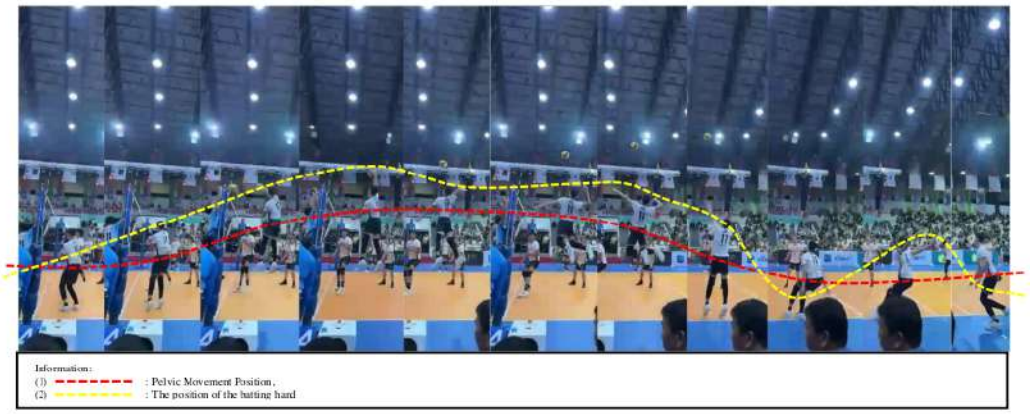

Figure 10. Series of Open Smash Movements from Dimas Saputra's Prefix, Repulsion, Impact, and Landing Position. (Source: Personal Documentation Final ¾ Kapolda Cup I West Kalimantan 2023).

Discussion

Volleyball has several characteristics that are different from other sports, which have resulted in a very significant increase in popularity. Therefore, before starting with educational theories, strategies, and methods, it is important to understand the nature of volleyball, because it helps us improve teaching principles and methods and train basic skills, especially improving smash abilities so that they are more effective. Volleyball is a very technical and physically demanding sport with many determinants to win the game including mastery of attack techniques in the form of smashes (Johansson et al. 2022). Volleyball is a team game that requires a lot of jumping movements both in defense (block) and attacking opponents with smash techniques (Muhadi et al. 2022). In the results of the biomechanical motion analysis that the researchers carried out on Dimas Saputra's open smash technique, it can be seen that Dimas Saputra carried out the stages after the steps were very extraordinary, as evidenced by the results of the analysis of several coaching points starting from the time the results were inscribed by Dimas Saputra when taking off to carry out The smash movement was recorded at a very fast time, namely 102 m/s. This proves that Dimas Saputra's reaction when receiving a bait is very good, so he doesn't easily lose the moment when he has to execute a bait to earn points for his team. As stated (Qohhar 2019) that producing a perfect smash hit requires arm swing speed and arm muscle strength.

Anthropometrically Dimas Saputra also has a relatively tall body, so he only needs an angle of 106° to make an eccentric/descent movement in taking cues when jumping with a ratio of net height which is only 57cm compared to his height which is 187cm, with a smash reach of 360cm and 340cm block reach. In volleyball games, height differences usually determine playing positions and will affect the development of a more successful player level (Muhadi et al. 2022). There is a significant correlation between height and jump height. As it is stated that height has an influence on the height of the jump or reach both in service, block and smash in volleyball (Hiskya, Kuswoyo, and Umakaapa 2023; Pawlik and Mroczek 2023).

Physically tall players will have a higher reach over the net. Moreover, supported by the ability to jump high. A volleyball coach and player must be systematically involved in jump-increasing exercises to improve skills in smashes and blocks (Aguss, Fahrizqi, and Wicaksono 2021). A high vertical jump will make it easier for the player to place the direction of the shot while in the air, thus allowing the smasher to change direction as quickly as possible. In addition to practicing plyometrics, high jumps are influenced by the swinging arms of both hands when repulsing (Ummah, R. T., Raharjo, S., & Adi 2016). A good jump aims to produce a better reach so that you can do maximum smashes and blocks when playing volleyball (Hale et al. 2019). However, a significant level of height with jumps is only evident in the men's team. This needs to be considered from the results of the West Kalimantan 2023 Kapolda Cup I championship observations in women's matches. It is best to look for players who have natural agility and dynamics during recruitment and selection and consider training steps. for a maximum jump. This agrees as stated (Christiana 2017) specifically for the open technique of spiking and defensive and blocking techniques, jump height is an important factor besides the player's height. A high jump makes players more flexible in carrying out ball accuracy to the opponent's field.

When he was in the air which entered the vertical phase, Dimas Saputra was also clever in taking his shoulder angle by directing his left arm to aim for the ball's position, there he only made a 137° angle where the tip of his arm pointed to the place where the ball would later be taken. This is of course very good for a professional player, how the movements are adjusted to the direction where the ball is, while the other arm is focused on taking the swing signal and preparing the energy to smash. The resilience that is formed when the pike is in position will increase the thrust when hitting so that the resulting smash will be faster, making it difficult for the opponent to receive and has the potential to score (Rubiyatno et al 2023; Rubiyatno, Rajidin, and Suganda 2021) In addition to good basic technique, the role of arm muscle strength is needed when carrying out a vertical repulsion style, a volleyball player must have a very good vertical jump ability because it will be useful and support when the player is doing defense or blocking and smashing (Ambar Setiana Darma Sari et al. 2022). As stated by (Qohhar 2019) that to produce a perfect smash hit requires arm swing speed and arm muscle strength as well as extension resilience. extension of the stick will make the results of the smash hit more optimal due to the additional thrust of the stick extension so that the position of the arm is freer to pull back to st

Conclusions

Volleyball has several characteristics that are different from other sports, which have resulted in a very significant increase in popularity. With the effective movement and swing speed of Dimas Saputra when doing the smash, the resulting ball speed is 350 m/s. With such a fast ball speed, it seemed very difficult for the opposing team to read and hold on to, so the ball penetrated the opponent's blocking and added points to the Sanggau Police Chief team. In addition to the speed and strength of the leg and arm muscles in volleyball, of course, a spiker is greatly helped by a height above 185 cm. With this height, a person will find it easier and more effective when making jumping movements during defending/blocking or during offend/spikes because the distance between the net line and the tip of his hand will be closer. Second, the right timing when doing the spike is also an important point for a volleyball athlete, good timing will also be influenced by the speed when doing the jump and arm swing before the topspin phase occurs. With Dimas Saputra's height of 194cm, he only needs an eccentric movement of 104° to jump to take an open spike bait technique from his partner. In addition, he also only needs a 63° angle in preparation before making a spike swing to the ball. With his arm swing speed which reaches 283 m/s, he manages to bring the ball to a maximum speed of 350 m/s.

Based on research that has been carried out on the analysis of Dimas Saputra's smash movements at the West Kalimantan Regional Police Chief Championship Cup I, it can be seen that in addition to good basic technical movement automation, a volleyball player ideally must have a height above 185cm for the spiker position, besides that volleyball players must also have the right timing in taking a bait. It can be trained by doing smash drills and ball coordination exercises. Finally, a volleyball player ideally must also have strong and fast arm swing strength supported by good core muscle strength.

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Conflict of interest

All authors declare that there is no conflict of interest whatsoever in this research.

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