



Physical Condition Analysis of Junior Athletes of LAVANI Volleyball Club

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Abstract

This study aims to analyze the physical condition of junior athletes of the LAVANI Cikeas Bogor volleyball club including cardiovascular endurance, muscle strength, muscle explosive power, flexibility, and body composition. This physical component is important to support the appearance of athletes in volleyball. The method used is descriptive research with measurements using valid and reliable field tests. The study population was all junior athletes of the LAVANI Cikeas Bogor volleyball club totaling 30 people with total sampling techniques. The instruments used include multi-stage running tests, push-up tests, vertical jump tests, sit and reach tests, and anthropometric measurements. The results showed that the average cardiovascular endurance of athletes was in the good category, arm and shoulder muscle strength in the sufficient category, leg muscle explosive power in the less category, flexibility in the good category, and body composition of most athletes was in the ideal range. Overall, the physical condition of the junior athletes of the LAVANI Cikeas Bogor volleyball club is considered quite good but still needs to be improved, especially in the explosive power component of the leg muscles to support optimal performance in playing volleyball.

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INTRODUCTION

Volleyball is one of the sports games that requires excellent physical condition to be able to play well (Lenberg, 2020). Physical condition components such as cardiovascular endurance, muscle strength, muscle explosive power, flexibility, and ideal body composition are important factors that support the appearance of volleyball athletes (Bompa, T. O., & Haff, 2009). A volleyball athlete is required to have good endurance to be able to play for a long duration. Muscle strength and explosive power are required to perform explosive punches and jumps. Good flexibility can prevent the risk of injury, while ideal body composition helps optimize movement while playing (Sheppard, J. M., Gabbett, T. J., & Borgeaud, 2007).

The results of initial observations and surveys at the volleyball club LAVANI Cikeas Bogor showed that some junior athletes looked tired at the end of the match which indicates a lack of endurance. There are also athletes who seem to have difficulty jumping to attack or do maximum smashes. This indicates a problem in the physical condition component of the athletes.

The importance of good physical condition for volleyball athletes is also supported by research conducted by Anwar (2017) which states that there is a significant relationship between physical condition and volleyball playing skills. The better the physical condition of the athlete, the skills of playing techniques such as serve, passing, smash, and others will increase (Anwar, 2017).

Previous research conducted by Kristiyanto (2012) on female junior volleyball athletes in Sleman showed that the physical condition of athletes is still relatively low, especially in the components of aerobic endurance and leg muscle explosive power (Kristiyanto, 2012). Meanwhile, young male volleyball athletes in Surabaya found that most athletes have a fairly good physical condition except for the body composition component which tends to be excessive (Ismoko, A. P., & Patience, 2015).

Based on these problems, the formulation of the problem in this study is "What is the physical condition of the junior athletes of the LAVANI Cikeas Bogor volleyball club including cardiovascular endurance, muscle strength, muscle explosive power, flexibility, and body composition?". The purpose of this study is to analyze the physical condition to find out what components need to be improved.

The hypothesis in this study is that the phy-

sical condition of junior athletes of the LAVANI Cikeas Bogor volleyball club is still not optimal, especially in the components of cardiovascular endurance, leg muscle explosive power, and body composition. The results of the study are expected to provide recommendations for training programs to improve the physical condition of athletes in accordance with the needs of volleyball.

Cardiovascular Endurance

Cardiovascular endurance or aerobic endurance is one component of physical condition that is very important for a volleyball athlete. This sport requires good endurance considering that in one match, players have to play for a long time with high intensity. A professional volleyball player can spend about 60-70% of the game time moving in the maximal heart rate zone (Lidor, R., & Ziv, 2011).

Good cardiovascular endurance will help athletes to be able to maintain their performance during the game without experiencing excessive fatigue. It is also associated with faster recovery ability after performing explosive movements such as jumping, running, or hitting hard (Gabbett, T. J., & Georgieff, 2007).

Some studies show that increased cardiovascular endurance can improve the performance of volleyball players, a 12-week endurance training program can increase the aerobic and anaerobic capacity of adolescent male volleyball players (Stanganelli, et al., 2008). In addition, research conducted by Martins et al. (2016) also found that volleyball athletes with better cardiovascular endurance had better physical performance and playing technique skills than athletes with low endurance.

Muscle Strength

Muscle strength is a component of physical condition that is also very important for volleyball athletes. This sport requires good muscle strength in several parts of the body such as arms, shoulders, back, abdomen, and legs. Muscle strength will help players perform movements such as serve, passing, smash, and blocking more easily and efficiently (Marques, M. C., Gonzalez-Badillo, J. J., & Kluka, 2009).

Arm and shoulder muscle strength is indispensable for hard and accurate serves and smashes. While leg muscle strength is needed to perform high jumps when smashing or blocking. The strength of the back and abdominal muscles is also important to maintain body stability and prevent injuries while playing (Sheppard, J. M., Gabbett, T. J., & Stanganelli, 2007).

Research conducted by Sattler et al. (2012) showed that a 16-week strength training program can improve leg muscle strength, acceleration, and jumping ability in young male volleyball athletes. In addition, research conducted by Marques et al. (2009) also found that professional volleyball athletes have better muscle strength compared to amateur athletes, especially in the muscles of the arms, shoulders, and legs.

Muscle Explosive Power

Muscle explosive power or power is a component of physical condition that is very important in volleyball. Muscle explosive power is the ability to exert maximum force in a very short time (Bompa, T. O., & Haff, 2009). In the game of volleyball, muscle explosive power is needed to perform explosive movements such as jumping, smashing, and blocking.

The explosive power of the leg muscles is the most important component in the game of volleyball. A player with good leg muscle explosive power will be able to perform high and powerful jumps when smashing or blocking. In addition, the explosive power of the arm muscles and the explosive power of the leg muscles are the most important components in the game of volleyball. A player with good leg muscle explosive power will be able to perform high and powerful jumps when smashing or blocking. In addition, the explosive power of the arm and shoulder muscles is also needed to perform hard and fast smash blows.

Research conducted by Gabbett et al. (2007) showed that a plyometric exercise program can increase leg muscle explosive power and vertical jumping ability in young male volleyball athletes. In addition, research conducted by Sheppard et al. (2008) also found that professional volleyball athletes have better leg muscle explosiveness compared to amateur athletes.

Flexibility

Flexibility is a component of physical condition that sometimes receives less attention in volleyball. However, good flexibility is actually very important to prevent the risk of injury and maximize movement while playing. A player with good flexibility will be able to move more freely and perform movements such as splits, jumps, and punches more efficiently (Sheppard, J. M., Gabbett, T. J., & Stanganelli, 2007).

Good flexibility can also help improve athletes' performance in performing specific movements in volleyball, such as serving underhand or spike at a larger angle (Lidor, R., & Ziv, 2011).

Research conducted by Guedes et al. (2012) showed that an 8-week stretching exercise program can improve flexibility and prevent injuries in adolescent female volleyball athletes. The professional volleyball athletes have better flexibility compared to amateur athletes (González-Ravé, J. M., Arija, A., & Clemente-Suárez, 2011).

Body Composition

Body composition is a component of physical condition that is also important in volleyball. A player with ideal body composition will have advantages in terms of speed, agility, and aerobic endurance. Conversely, players with less than ideal body composition (for example excess body fat) will experience decreased performance because they have to carry a heavier body load (Sheppard, J. M., Gabbett, T. J., & Stanganelli, 2007).

In the game of volleyball, the ideal body composition is to have a low percentage of body fat and high muscle mass. This will help players in carrying out movements that require strength, explosive power, and high speed (Lidor, R., & Ziv, 2011).

Research conducted by Malousaris et al. (2008) showed that professional volleyball athletes have a lower percentage of body fat and higher muscle mass compared to amateur athletes. In addition, research conducted by Gabbett et al. (2007) also found that weight loss exercise programs and increased muscle mass can improve physical performance and playing technique skills in adolescent female volleyball athletes (Gabbett, T. J., & Georgieff, 2007).

METHODS

This research is a descriptive research with a quantitative approach. Descriptive methods are used to describe or analyze a measurement result obtained from research subjects (Sukmadinata, 2011). In this study, a descriptive method was used to describe the physical condition of junior athletes of the LAVANI Cikeas Bogor volleyball club including components of cardiovascular endurance, muscle strength, muscle explosive power, flexibility, and body composition.

The population in this study was all junior athletes of the volleyball club LAVANI Cikeas Bogor totaling 30 people with an age range of 14-17 years. The sampling technique used is total sampling, where the entire population is used as the subject of research.

The inclusion criteria of the research subjects are:

1. Junior athletes of volleyball club LAVANI Cikeas Bogor
2. 14-17 years old
3. Not in injury condition
4. Willing to take a series of measurement tests

While the exclusion criteria are:

1. Have a history of chronic diseases
2. Did not take the entire set of tests

The tools and instruments used in this study are:

1. Multi-Stage Fitness Test (MFT) to measure cardiovascular endurance. MFT is done by running back and forth over a distance of 20 meters repeatedly at an increasing speed until it is no longer able to follow.
2. Push-Up test to measure arm and shoulder muscle strength. Done face down, arms open shoulder-width apart, body straight and lift the body with a 90-degree elbow bend then return to the starting position.
3. Vertical Jump test to measure the explosive power of leg muscles. Tools in the form of wallboards with height markers and powder / powder to mark the highest jump.
4. Sit and Reach test to measure flexibility. The tool is a box / bench with a length of 30-35 cm.
5. Anthropometric measurements (height, weight, arm circumference, body fat) to determine body composition. Tools in the form of stadiometers, digital scales, measuring tapes, and fat calipers.

The type of data obtained in this study is quantitative data, namely the value or score of each component of the physical condition measured, including:

1. Cardiovascular endurance in MFT levels and VO2max estimation (mL/kg/min)
2. Arm muscle strength in the number of push-up reps
3. Limb muscle explosive power in centimeters vertical jump
4. Flexibility in centimeters of forward finger reach
5. Body composition includes height (cm), weight (kg), arm circumference (cm), and body fat percentage.

Before the test, all research subjects are given an explanation of the test procedure to be carried out and its purpose. Subjects are also given the opportunity to try and understand the instructions of each test item first. The test is carried out within 2 days to avoid excessive fatigue in the subject.

Day 1:

1. Anthropometric measurements (height, weight, arm circumference, % body fat)
2. Multi-stage running test (MFT)
3. Push-up test

Day 2:

1. Vertical jump test
2. Sit and reach test

Subjects were given adequate rest time between each test item. They were also instructed not to engage in strenuous physical activity 24 hours before the test.

The data obtained from the test results will be analyzed descriptively including the mean value, maximum value, minimum value and standard deviation. In addition, the calculation of the percentage of athletes who fall into the good, medium, and less categories for each component of physical condition is also carried out using certain assessment norms.

Percentage calculation formula:

$$\left(\frac{\text{Number of athletes in a particular category}}{\text{Total number of athletes}} \right) \times 100\%$$

Grouping good, medium and less categories for each component using assessment norms such as:

Cardiovascular Endurance (VO2max estimation from MFT test):

- Good: ≥ 42 mL/kg/min (male), ≥ 35 mL/kg/min (female)
- Medium: 34-41 mL/kg/min (men), 28-34 mL/kg/min (women)
- Less : < 34 mL/kg/min (men), < 28 mL/kg/min (women)

Source: (Shvartz, E., & Reibold, 1990))

Arm Muscle Strength (push-up test):

- Good: ≥ 35 times (male), ≥ 20 times (female)
- Medium: 20-34 times (male), 10-19 times (female)
- Less : < 20 times (men), < 10 times (women)

Source: (Physiology, 2003)

Limb Muscle Explosive Power (vertical jump test):

- Good: ≥ 60 cm (men), ≥ 45 cm (women)
- Medium: 50-59 cm (male), 35-44 cm (female)
- Less : < 50 cm (men), < 35 cm (women)

Source: (Chu, 1996)

Flexibility (sit and reach test):

- Good: ≥ 25 cm (men), ≥ 30 cm (women)
- Medium: 20-24 cm (male), 24-29 cm (female)
- Less : < 20 cm (men), < 24 cm (women)

Source: (Physiology, 2003)

Body Composition

(anthropometric measurements):

- Good: Fat percentage 8-18% (men), 17-28% (women)
- Medium: Fat percentage 5-7% or 19-24% (men), 13-16% or 29-32% (women)
- Less: Fat percentage <5% or >24% (men), <13% or >32% (women)

Source: (Lohman, 1992)

After descriptive analysis of data and grouping categories using the norms above, then a thorough discussion and interpretation of the results will be carried out.

RESULTS AND DISCUSSION**Cardiovascular Endurance**

The results of measuring the cardiovascular endurance of athletes using the multi-stage running test (MFT) can be seen in the following **Table 1**.

Table 1. Athletes' Cardiovascular Endurance Data

Category	Number of Athletes	Percentage
Good	12	40%
Medium	14	46,7%
Less	4	13,3%

From the **Table 1**, it can be seen that most athletes (46.7%) have cardiovascular endurance in the moderate category. Only 40% of athletes have good endurance, while 13.3% of athletes are still lacking.

Arm Muscle Strength

The results of an arm muscle strength test using a push-up test can be illustrated in the following **Table 2**.

Table 2. Athletes' Arm Muscle Strength Data

Category	Number of Athletes	Percentage
Good	6	20%
Medium	14	46,7%
Less	10	33,3%

The **Table 2** above shows that most athletes (14 people) are in the moderate arm muscle strength category. Only 6 athletes are in the good category, while 10 others are still in the less category.

Limb Muscle Explosive Power

The results of the limb muscle explosive power test using the vertical jump test are shown in the following **Table 3**.

Table 3. Athlete's Limb Muscle Explosive Power Data

Category	Number of Athletes	Percentage
Good	5	16,7%
Medium	11	36,7%
Less	14	46,6%

From the **Table 3** above, it can be seen that almost half of the athletes (46.6%) have less limb muscle explosive power. Only 16.7% of athletes were in the good category, while the rest (36.7%) were in the moderate category.

Flexibility

The results of the flexibility test using the sit and reach test can be seen in the following **Table 4**.

Table 4. Athlete Flexibility Data

Category	Number of Athletes	Percentage
Good	18	60%
Medium	9	30%
Less	3	10%

From the **Table 4**, it can be seen that most athletes (60%) have a good level of flexibility. Only 10% of athletes fall into the less category, while 30% of athletes are in the moderate category.

Body Composition

The results of measuring body composition through anthropometric measurements can be seen in the following **Table 5**.

Table 5. Body Composition Data

Category	Number of Athletes	Percentage
Good	16	53,3%
Medium	9	30%
Less	5	16,7%

The **Table 5** above shows that most athletes (16 people) have a body composition with fat percentage in the good category. There are 9 athletes who are in the medium category, while 5 others are still in the less category.

Thus, complete research data for the five

components of physical condition have been presented. In the next section, we will discuss the interpretation and discussion of the overall results.

Based on the data from the study, it can be seen that the physical condition of the junior athletes of the LAVANI Cikeas Bogor volleyball club is still not optimal overall, especially in the components of cardiovascular endurance, arm muscle strength, and leg muscle explosiveness. These results are in line with the hypothesis proposed at the beginning of the study. However, for the flexibility and body composition components, most athletes are already in the good category.

1. Most athletes (46.7%) had cardiovascular endurance in the moderate category, and 13.3% were moderate. Only 40% of athletes have good cardiovascular endurance.
2. For the arm muscle strength component, most athletes (46.7%) were in the moderate category. There are 33.3% of athletes who are still lacking, and only 20% are in the good category.
3. Almost half of the athletes (46.6%) had less leg muscle explosiveness. Only 16.7% of athletes were in the good category, while 36.7% were in the moderate category.
4. For the flexibility component, most athletes (60%) already have a good degree of flexibility. Only 10% fall into the less category.
5. Most athletes (53.3%) had a body composition with fat percentage in the good category. However, there are still 16.7% of athletes with less than ideal body composition.
6. Low physical condition in some components can be caused by factors such as lack of proper portion and intensity of exercise, poor diet, and growth and development factors in adolescence.

Cardiovascular Endurance

The data showed that only 40% of athletes had good cardiovascular endurance, while most (46.7%) were still in the moderate category, and 13.3% were deficient. Cardiovascular endurance or aerobic endurance is a very important component in volleyball. This is because in one match, the players have to play for a long time with high intensity.

A professional volleyball player can spend about 60-70% of the game time moving in the maximal heart rate zone (Lidor & Ziv, 2011). Therefore, good cardiovascular endurance will help athletes to be able to maintain their performance during the game without experiencing excessive fatigue.

Low cardiovascular endurance in most LAVANI athletes can be caused by several factors, such as lack of endurance training portions in the exercise program, improper exercise intensity, and poor diet and nutritional intake. In addition, the age factor of adolescents who are still in the period of growth and development can also affect their physical condition.

To improve cardiovascular endurance, a special exercise program with the right method is needed, such as interval training, continuous exercise, or a combination of both (Bompa & Haff, 2009). In addition, monitoring of athletes' nutritional intake and diet also needs to be done to support cardiovascular endurance improvement exercise programs.

Arm Muscle Strength

The results showed that most of the athletes (14 people or 46.7%) were in the medium arm muscle strength category. Only 6 athletes (20%) were in the good category, while 10 others (33.3%) were still in the less category. Arm and shoulder muscle strength is an important component in the game of volleyball, especially for performing movements such as serves and smashes.

A player with good arm muscle strength will be able to perform harder and more accurate serves and smashes (Marques, M. C., Gonzalez-Badillo, J. J., & Kluka, 2009). Low arm muscle strength in most LAVANI athletes can be caused by a lack of weight training and strength training portions in their training program.

To increase arm muscle strength, a weight training program is needed specifically designed to train the muscles of the arms, shoulders, and back. This exercise can be done using free weights such as dumbbells or weight machines (Baechle, T. R., & Earle, 2008). In addition, plyometric exercises such as medicine ball throws can also be applied to increase the strength and explosive power of arm muscles (Chu, 1996).

Limb Muscle Explosive Power

The explosive power component of leg muscles is one of the most important components in volleyball. This is because in volleyball games, a player must often do jumping movements, both to smash, blocking, and serve jumping. The data showed that almost half of the athletes (46.6%) had less leg muscle explosiveness. Only 16.7% of athletes were in the good category, while the rest (36.7%) were in the moderate category.

The low explosive power of the leg muscles in most LAVANI athletes can result in less than optimal jumping and smashing abilities.

This will certainly hamper the appearance and performance of athletes in matches. This condition can be caused by the lack of a special portion of exercise to increase the explosive power of the leg muscles in their exercise program.

To increase the explosive power of leg muscles, a plyometric exercise program and explosive weight training are needed. Plyometric exercises such as jump squats, box jumps, and depth jumps have been shown to be effective for increasing the explosive power of leg muscles (Chu, 1996). In addition, explosive weight training such as hang cleans, power cleans, and power snatches can also be applied to train the explosive power of leg muscles (Baechle, T. R., & Earle, 2008).

Flexibility

In contrast to the other components, most athletes (60%) already have a good level of flexibility. Only 10% of athletes fall into the less category, while 30% of athletes are in the moderate category. Good flexibility is very important in volleyball to prevent the risk of injury and maximize movement while playing (Sheppard et al., 2007).

A player with good flexibility will be able to move more freely and perform movements such as splits, jumps, and punches more efficiently (Lidor & Ziv, 2011). The high percentage of athletes with good flexibility can be caused by an adequate portion of stretching exercises in their training program, as well as the age factor of adolescents who still have good body flexibility.

Nevertheless, a regular and continuous stretching exercise program is needed to maintain and even improve the flexibility of the athletes. Both static and dynamic stretching exercises can be performed as part of warm-up and cool-down in each training session (Baechle & Earle, 2008).

Body Composition

The data showed that most athletes (16 people or 53.3%) had a body composition with a fat percentage in the good category. There are 9 athletes (30%) who are in the medium category, while 5 others (16.7%) are still in the less category. Ideal body composition, with a low percentage of body fat and high muscle mass, is very important to support an athlete's performance in volleyball. A player with ideal body composition will have advantages in terms of speed, agility, and aerobic endurance. Conversely, players with less than ideal body composition (for example excess body fat) will experience decreased performance because they have to carry a heavier body load (Sheppard et al., 2007).

The high percentage of athletes with good body composition can be caused by a fairly good diet and nutritional intake, as well as a balanced portion of exercise between exercises to increase muscle mass and lose body fat. However, there are still 16.7% of athletes who have a less than ideal body composition, which can be caused by poor diet or inappropriate portion of exercise.

To maintain and improve ideal body composition, it is necessary to monitor the nutritional intake and adjust the athlete's diet appropriately. A balanced diet with adequate intake of protein, carbohydrates, fats, vitamins, and minerals is essential to support athletes' growth and development, as well as increase muscle mass and decrease body fat (Lemon, P. W, 1998).

In addition, the exercise program should also be designed in such a way as to increase muscle mass and lose body fat simultaneously. Moderate to high intensity weight training can increase muscle mass, while moderate intensity cardiovascular exercise can help lower body fat (Baechle, T. R., & Earle, 2008).

Comparison with Previous Research

The results of this study are in line with several previous studies that show that the physical condition of junior volleyball athletes is still not optimal, especially in the components of cardiovascular endurance, muscle strength, and leg muscle explosive power. Kristiyanto's (2012) research on female junior volleyball athletes in Sleman found that the physical condition of athletes is still relatively low, especially in aerobic endurance and leg muscle explosiveness.

Meanwhile, Ismoko & Patience's (2015) research on young male volleyball athletes in Surabaya shows that most athletes have a fairly good physical condition, except for the body composition component that tends to be excessive. This difference in results can be due to different age, sex, and physical activity levels between study subjects.

Another study conducted by Anwar (2017) also supports the findings in this study, where a significant relationship was found between physical condition and volleyball playing skills. The better the physical condition of the athlete, the skills of playing techniques such as serve, passing, smash, and others will increase.

Thus, the results of this study further strengthen the importance of paying attention to and improving the physical condition of athletes, especially in components that are still lacking, in order to support optimal performance in volleyball.

Exercise Program Recommendations

Based on the results of research and discussion, recommendations for training programs can be given to improve the physical condition of junior athletes of the LAVANI Cikeas Bogor volleyball club. This exercise program should focus on improving components that are still lacking, such as cardiovascular endurance, arm muscle strength, and leg muscle explosive power, while maintaining other components that are already good.

Cardiovascular endurance exercise

- a. Interval training: interval running with variations in distance and intensity
- b. Continuous exercise: moderate-intensity long-distance running
- c. Circuit training: a combination of cardiovascular exercise and weight training

Arm Muscle Strength Training

- a. Weight training for arm, shoulder, and back muscles: bench press, shoulder press, pull-ups, rows, etc.
- b. Plyometric exercises: medicine ball throws, plyometric push-ups

Leg Muscle Explosive Power Training

- a. Plyometric exercises: jump squats, box jumps, depth jumps, bounding
- b. Explosive weight training: hang cleans, power cleans, power snatches

Flexibility Exercises

- a. Static stretching: performed before and after exercise
- b. Dynamic stretching: performed as part of a warm-up

Body Composition Monitoring

- a. A balanced diet with adequate intake of proteins, carbohydrates, fats, vitamins, minerals
- b. Weight training to increase muscle mass
- c. Cardiovascular exercises to lose body fat

The entire exercise program must be implemented regularly, measurably, and adapted to the correct exercise principles, such as the principle of overload, specification, reversibility, and variation (Bompa & Haff, 2009). In addition, the training program must also be adjusted to the age and level of development of athletes so as not to interfere with their growth process.

By implementing a proper and structured training program, it is hoped that the physical condition of the junior athletes of the LAVANI Cikeas Bogor volleyball club can improve op-

timally and support their performance in the match. Improvement in good physical condition will be positively correlated with improved skills of playing techniques such as serve, passing, smash, and blocking (Anwar, 2017).

CONCLUSION

Based on the results of research and discussions that have been presented, it can be concluded that the physical condition of the junior athletes of the LAVANI Cikeas Bogor volleyball club is still not optimal overall. There are several components that need to be improved, especially in cardiovascular endurance, arm muscle strength, and leg muscle explosive power.

Based on the conclusions above, a structured training program is needed and adjusted to the needs to be able to improve the physical condition of athletes in accordance with the demands of volleyball. Exercise program recommendations include cardiovascular endurance training, arm muscle strength, leg muscle explosive power, flexibility, as well as body composition monitoring through a balanced diet and proper exercise.

Improving optimal physical condition will have a positive impact on improving the skills of playing techniques and athletes' performance in matches. Therefore, the results of this study can be taken into consideration for coaches and club administrators in developing a comprehensive training program to develop the potential of their junior athletes.

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