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The Contribution of Protein Intake and Training Frequency to Cardiovascular Endurance of Kendari Rowing Athletes

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Abstract

The aim of the study was to analyze the contribution of protein intake and exercise frequency to the cardiovascular endurance of rowing athletes in the Student Sports Education and Training Center, known as PPLP, in Kendari. The research sample consisted of 50 athletes, including 25 junior PPLP rowing athletes aged 16-19 years and 25 formers senior PPLP rowing athletes aged 25-30 years. This research included an observational study with a cross-sectional design. The collected data were analyzed using the Pearson and Spearman correlation statistics tests. The instrument for measuring protein intake was the Nutrition Adequacy Rate based on WNPG VII 2019. Exercise frequency data were obtained through interviews using a questionnaire. Cardiovascular endurance was measured by the athlete's maximum mileage from a 15-minute running test. The results of the Spearman correlation test between exercise frequency and cardiovascular endurance showed no significant results ($p > 0.05$). Exercise frequency had a significant positive relationship with cardiovascular endurance ($p = 0.004$, $r = 0.395$). It showed that there was a significant relationship between protein intake and cardiovascular endurance ($p = 0.003$, $r = 0.415$). The junior rowing athlete group generally had moderate cardiovascular endurance (80.0%), while the former senior rowing athlete group generally had sufficient (48.0%) and less (44.0%) cardiovascular endurance. On average, the cardiovascular endurance of the junior rowing athlete group (40.1 ml O_2/kg BW/min) was higher and significantly different ($p < 0.05$) compared to the former senior rowing athlete group (36.2 ml O_2/kg BW/min). Athletes with normal protein intake (75%) had a good cardiovascular endurance. Most athletes with normal protein intake had sufficient cardiovascular endurance (45.4%). Meanwhile, the athlete with a severe protein deficiency had less cardiovascular endurance (38.4%). This study concludes that the higher the sports activity, the higher the need for protein consumption, which eventually increases the work function of the heart, especially in rowing athletes in PPLP Kendari.

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INTRODUCTION

The achievements of rowing athletes in Indonesia have not been optimal, one of which is influenced by an unbalanced nutritional intake. According to research of (Oktavia & Effendi, 2019), the level of nutritional intake of rowing athletes in Agam Regency who practiced and did not practice, in terms of consumption of carbohydrates, protein, fat, and energy, was mostly below 100% except for protein consumption levels, which were mostly above 100% in the normal category. Rowing is developing in Indonesia, evidenced by increased public awareness of sports and an increase in the frequency of championships competed in by athletes at the provincial, national, and international levels (Oktavia & Effendi, 2019). Competing athletes require an adequate nutritional intake to support their activities, so dietary factors must be taken seriously. A planned and well controlled food consumption can help. Nutritional components, such as water, vitamins, minerals, proteins, fats, and carbohydrates must be present in sufficient amounts in the body to support activities.

Some of the findings from Nutritional Strategies to Optimize Performance and Recovery in Rowing Athletes, research conducted by (Jooyoung & Kim, 2020), state that the study was aimed to carry out a literature review of published experimental research on rowing athletes and provide scientific evidence- based nutrition strategies to optimize the performance and recovery of rowing athletes (Stellingwerff, et al., 2011). Its goal was to undertake a literature review of published experimental studies on rowing athletes and to give scientific evidence-based nutritional methods to improve rowing athlete performance and recovery. Research conducted by (Lee & Lim, 2019) states that nutrition not only improves performance by optimizing an athlete training adaptation, but is also important for maintaining an athlete health (Lee & Lim, 2019).

The study of (Boegman & Dziedzic, 2016) claims that an individualized and flexible nutrition plan is vital to fulfill the daily, weekly, and cyclic nutritional requirements of rowing athletes. Meanwhile, (Lewis, et al., 2018) conducted a study by implementing a four-month nutritional intervention for rowing athletes with unexplained performance syndrome (UUPS; also known as overtraining syndrome) and demonstrated evidence of improved performance, with the particular achievement of becoming European champions. In general, sport protein drinks that are low in fat, low in protein, and low in fiber are consumed as supplements if a rowing athlete competes in low-level events while ignoring their carbohydrate intake (Philp, et al., 2012).

Therefore, a good protein and nutrition management plays an important role in maintaining a good health to be able to train and compete well (Kusmawati, et al., 2019). (Agostini, et al., 2018) and (Ridwan, 2017) state that improving fitness cannot only be seen from physical activity alone, but there are other factors that can improve one's fitness, such as food intake, age, genetics, gender, and protein intake. Other elements, such as the amount of physical activity or exercise the athletes engage in, can also have an impact on an athlete fitness (Dewi & Kuswary, 2018). Nutrition, along with other aspects, supports the achievement of performance in the scope of athlete training and coaching, thus an athlete performance is greatly influenced by the quality of training, while a quality training can be attained if supported by a variety of factors, such as psychological conditions, athlete body fitness, organ physiology, biomechanics occurring in the body, and education which includes the athlete knowledge and training, social environment, health status, and nutritional status.

With a good nutrition, there will be enough energy available for physical performance that is beneficial for health, fitness, child growth, and sport coaching performance (Irianto, 2017). For athletes who engage in sports for a long time, muscle carbohydrate loading sometimes becomes an appropriate choice to provide sufficient energy reserves during trainings and competitions (Irianto, 2017). The application of nutrition management in athletes always encounters problems, namely the limited number of nutrition experts who can provide appropriate nutritional management to support the athlete performance. Research conducted by (Fox, et al., 2012) found that athletes often did not pay attention to the recommended level of nutritional needs, resulting in suboptimal performance. Similarly, research by (Arsani, et al., 2014) found that athlete nutrition management was carried out by the athletes themselves and their parents, where the nutritional suitability was not calculated based on the athlete calorie requirements. In addition, research by (Muharam, Damayantib, & Ruhayatic, 2019) found that the average calculation of the rowing athlete body mass index fell into the normal category with an average value of 21.32, but the average food consumed by the athletes was not good, as indicated by an average value of 67.13%.

Age characteristics are particularly crucial to understand because age is linked to heart rate. As someone gets older, their heart rate will decrease. According to (Sumosardjuno, 1996), the primary causes of a decrease in heart rate are a decrease in the flexibility of the heart walls and a gradual reduction in the time required to fill the heart with blood. Teenage period is an optimal period for growth and the most productive phase for the development of an athlete motor system skills and cardiovascular endurance. The rowing athletes who participated in the study were in this age group. Cardiovascular endurance can be measured through the maximum VO2 level achieved. Maximum VO2 is the maximum amount of oxygen that can be taken in during exercise (Hoff, Wisloff, Engen, Kemi, & Helgerud, 2012).

The research results showed that athletes with a maximum VO2 value of 80 mL/kg BW/min could run 5000m faster than athletes who only had a maximum VO2 value of 40mL/kg BW/min (Levine, 2012). The higher the maximum VO2 value, the better the cardiovascular endurance, so that athletes in sports with good cardiovascular endurance will have a better performance (Utoro, 2012). Good cardiovascular endurance can also be gained with adequate protein consumption, where protein intake is defined as the state of the body or health induced by the balanced food intake, protein absorption, and protein usage (Almatsier, 2001). Good protein intake can be obtained through a balanced diet (Widiastuti, et al., 2009).

Casein protein, which constitutes 80% of milk protein, is considered as nutritional strategies before sleeping because of its digestion and absorption rate, which can continuously supply amino acids to the body (Snijders, et al., 2015). Meanwhile, (Trommelen & van Loon, 2016) state that 40g casein protein intake 30 minutes prior to sleep, a period lacking in nutritional supply, can bring a number of advantages for recovery (Trommelen & van Loon, 2016). Research findings of (Areta et al., 2013) showed that, for recovery, 20-25g of protein (as part of a meal or snack) should be consumed every 3-5 hours in general (Areta, et al., 2013). To maximize protein synthesis, the intake of casein protein before sleeping is recommended (Res, et al., 2012).

The optimal performance of an athlete during competition is impacted by meeting balanced protein needs (Heather, et al., 2006). The physiological processes of the body are typically negatively impacted by consuming either too little or too much energy and protein (Narici, 2021). Research conducted in Bali showed that out of 26 athletes, 22 or 86.4% consumed energy according to their needs and had maximal VO2 values that met the standards. The remaining 4 or 15.4% athletes consumed less energy than needed and had lower maximum VO2 values than the standards (Immawati, 2012). Generally, a rowing athlete requires energy intake based on their needs with a carbohydrate content of 55-60% of total energy, fat content of 20-30% of total energy requirements, and protein content of 15-20% (Heather, et al., 2006).

For rowers, the energy expended during exercise must be balanced with the energy consumed from food (Husaini, et al., 2006). Optimal food consumption will result in energy production, leading to a better work capacity and recovery time (Widiastuti, et al., 2009). Balanced protein consumption is also used to improve and maintain protein fulfilments, build muscles, achieve an optimal height, maintain body conditions, and maintain physical fitness (Husaini, et al., 2006). Exercise in sports has been proven to have many benefits for the body and health, such as maintaining ideal body weight, increasing muscle mass, and improving cardiovascular endurance, which become the indicators of fitness level. Exercise and good nutrition are two important factors that affect fitness levels. In addition, exercise affects the increase in muscle mass, which is influenced by the level of energy and protein adequacy, where a deficit in energy and protein adequacy causes a decrease in muscle mass in athletes.

Research findings of (Doering, et al., 2016) found that while athletes are aware of the importance of nutrition, they were lack of significant knowledge about carbohydrate and protein intake. Meanwhile, (Heikkilä, et al., 2018) found that athletes and coaches were often lack of knowledge on nutrition. They suggested that athletes should obtain sufficient nutrition knowledge to understand the importance of food choices for competitions, recovery, and overall health.

For sports that require endurance and strength, foods containing protein is mandatory to consume. The diet can trigger protein catabolism, thus slowing down post-exercise recovery and causing muscle shrinkage or atrophy. In addition, physical activities performed by individuals with larger body size will require more energy expenditure than those with smaller body size. It is because moving a larger body requires more energy (Umasangaji, 2012). In this study, the majority of athletes were found to have good stamina, which could be influenced by physical training. The subjects had a regular physical training program with six training sessions per week to optimize their stamina, speed, strength, agility, balance, coordination, muscle explosive power, flexibility, cardiorespiratory endurance, and muscle endurance.

The higher the frequency and duration of physical exercise, the better the level of stamina will be. Programmed physical exercise is beneficial for maintaining and improving health and stamina (Moeloek, 2011). Programmed and measured exercise can provide an increase in stamina and VO2 Max capacity between 10% to 20%. Stamina (physical fitness), especially the aerobic capacity, can be improved through aerobic exercise by paying attention to some factors, such as exercise intensity, exercise frequency, and exercise duration in the training zone. The heavier the exercise load given, the greater the effect obtained. In addition to these factors, heart function, aerobic muscle metabolism, body weight, genetics, and gender also affect athlete stamina (Murray, 1997). Meanwhile, the research of (Jeukendrup, 2017) found that carbohydrate supplements for performance maintenance during training or competition should be easily digested and absorbed because the gastrointestinal (GI) tract plays an important role in transporting carbohydrates and fluids during training or competition.

Protein sources are not only important for sport performance. Meeting protein needs is an important part of meeting nutritional adequacy. The best food sources of protein include skinless chicken, turkey, beef, fish, egg whites, tofu, tempeh, and milk. Directly meeting the right diet requirements will have a positive effect on increasing athlete stamina and performance. Studies on several factors that affect athlete stamina, including age, genetics, gender, diet, and smoking habits (Martin, et al., 2006), are still limited in number. Therefore, this study was conducted to reveal the contribution of protein intake and exercise frequency on cardiovascular endurance in rowing athletes, especially in the PPLP Kendari

METHODS

A cross-sectional design was used in this study. Cross-sectional study is defined as an observational study analyzing variable data collected at a specific point in time across the entire population/sample or a pre-determined subset. This study was conducted at the PPL rowing dormitory in Kendari from April to July 2021. The data of this study were primary data, consisting of athlete characteristics, anthropometric weight and height, protein consumption, physical activities, training, and running test distance.

Participants

The samples of this study were 50 athletes, consisting of 25 athletes of the PPLP junior athlete group aged 16-19 years and 25 athletes of the former PPLP senior athlete group aged 25-30 years. Sample selection was based on these considerations: 1) both athlete groups were still actively training, where the difference was only in the training intensity, 2) the PPLP junior athlete group actively trained ≥ 3 times a week with high intensity, 3) the former PPLP senior athlete group actively trained ≥ 3 times a week with moderate intensity, and 4) the athletes were in good health and willing to participate in the study.

Procedure

The data obtained in this study consisted of primary data, namely athlete characteristics, anthropometry (body weight and height), protein intake, physical activity, frequency of training, and distance covered in a running test. Body weight measurements were obtained using a digital scale, while height measurements were taken directly using a microtoise. Protein intake data were obtained through interviews using a recall questionnaire method for 1 day, conducted twice, on a working day and a day off. Physical activity data were obtained through interviews using a questionnaire. Physical activity data were collected together with protein intake data, twice, on a working day and a day off. The athlete exercise activity data were obtained by interviewing them using a questionnaire covering the frequency of training.

The samples were asked to wear loose and comfortable sportswear that did not restrict body movements (Budiman, 2007). The test was conducted at 9:00 a.m. or approximately 2-4 hours after eating. Prior to the test, the samples were not allowed to smoke or eat anything, except for drinking. Distance data were obtained from a 15-minute running test. The samples were asked to cover as much distance as possible within 15 minutes by running or walking and were not allowed to stop or rest on the track. The day before the test, the samples were required to have an adequate sleep and regular meals.

Data Analysis

The collected data were analyzed using the Mann Whitney test, for group difference analysis, and Pearson and Spearman correlation tests. The difference test was conducted to analyze the difference in variables between the junior rowing athlete group and the former senior rowing athlete group. The correlation test was conducted to analyze the relationship between protein intake and exercise frequency with cardiorespiratory endurance in Kendari rowing athletes. Height and weight data were processed to obtain anthropometric protein intake data based on the Body Mass Index (BMI). The data were then categorized into underweight (BMI = 18.5), normal (BMI: 18.5-24.9), overweight (BMI: 25-29.9), and obesed (BMI > 30) (Depkes, 2004). Food consumption data were converted using the Food Composition List (DKBM) to obtain energy and protein intake data.

The intake data were then compared to the Nutritional Adequacy Score (AKG), based on the Indonesian Recommended Nutrient Intake VII in 2019 to obtain the protein intake level, and categorized as severely deficient (< 70% AKG), moderately deficient (70-79% AKG), mildly deficient (80-89% AKG), adequate (90-119% AKG), and excessive (>120% AKG) (Depkes, 1996). The maximum distance traveled by athletes during the 15-minute running test was then calculated using the Balke VO2 max calculator software to obtain VO2 max data (ml O2 /kg BW/min) using the following formula: % VO2 Max = [((total distance traveled/15)-133) x 0.172] + 33.3. VO2 max scores were then grouped to determine cardiorespiratory endurance categories, including poor (25-33 ml/min/kg BW), fair (34-42 ml/min/kg BW), and good (43-52 ml/min/kg BW) (Kemenkes, 2005). The weekly exercise frequency data were categorized into three categories based on the mean and standard deviation, including seldom (< 1 time/week), sufficient (1-3 times/week), and frequent (> 3 times/week).

RESULT

Athlete Conditions

During the study, the protein intake of the athletes was generally normal, both in the junior rowing athlete group (100%) and the former senior rowing athlete group (78%). Both groups were given incentives in the form of a relatively equal monthly allowance, namely Rp 2,135,000 (for junior rowing athlete group) and Rp 2,077,000 (for former senior rowing athlete group), as a motivation to undergo training. There was no significant difference in terms of protein intake and the amount of allowance between the two groups ($p > 0.05$).

Energy and Protein Intakes and Adequacy Levels

In moderate to high-intensity sports, such as rowing, a high protein intake is needed as a source of energy during the competition. The average protein intake of the junior rowing athlete group sample was higher and significantly different from the former senior rowing athlete group ($p < 0.05$). It might be because the junior rowing athlete group consumed a variety of protein sources. The difference between the two groups was particularly evident in milk consumption, where the average milk consumption in the junior rowing athlete group was higher than in the former senior rowing athlete group. In addition, the higher physical activity level in the junior rowing athlete group is also believed to be a factor in motivating athletes to consume more nutrients due to the high energy requirement.

Table 1. Physical Average Energy Intake of Athletes

Protein Intake	Junior Athletes Average ± SD	% TKG	Senior A thletes Average ± SD	% TKG
Protein (g)	61.1 ± 16.0	95.9	50.6 ± 10.3	79.2
Carbohydrate (g)	331.1 ± 23.0	103.9	245.3 ± 54.5	75.4
Energy (kkal)	2340.7 ± 209.3	90.4	2001.3 ± 236.6	86.7
Fat (g)	68.2 ± 17.6	90.9	42.1 ± 13.4	68.3

Cardiovascular Endurance of the Athletes

The junior rowing athlete group generally had a fairly good cardivascular endurance (80.0%), while the senior former rowing athlete group was mostly categorized as fair (48.0%) and poor (44.0%) in terms of cardiovascular endurance. In comparison to the senior former rowing athlete group (36.2 ml O2/kg BW/minute), the average cardiovascular endurance of the junior rowing athlete group (40.1 ml O2/kg BW/minute) was significantly higher ($p < 0.05$). These results were still considerably below the 63.4 ml O2/kg BW/minute levels reached by professional rowing competitors (McMillan et al., 2005). This indicates that the physical training intensity of athletes in the junior rowing athlete group was still considered insufficient.

Protein Intake and Cardiovascular Endurance

The Spearman correlation test results showed no significant relationship between energy adequacy and protein adequacy ($p > 0.05$). Athletes with normal energy intake (75%) had a good cardiovascular endurance. The majority of athletes with normal energy intake had a sufficient cardiovascular endurance (45.4%), while those with severe energy deficiency had a lower cardiovascular endurance (38.4%). The Spearman correlation test results showed a significant relationship between energy/protein intake and cardiovascular endurance ($p = 0.003$, $r = 0.415$). The same trend was observed for protein adequacy.

Athletes with protein deficiency tended to have either poor and fair cardiovascular endurance, while athletes with normal protein intake tended to have sufficient and good cardiovascular endurance. The Spearman correlation test results showed a significant positive relationship between protein intake and cardiovascular endurance ($p < 0.05$; $r = 0.365$). The distribution of athletes with energy and protein intake is presented in Table 2. The table does not show a consistent trend between the two variables. There were athletes with severe and moderate deficiencies in energy and protein intake.

Table 2. Energy/Protein Intake Levels

Intake level	Poor		Fair		Good	
	n	%	n	%	n	%
Protein						
Severe Deficient	3	37.5	2	5.6	1	14.3
Moderate Deficient	2	25.0	8	23.2	2	28.6
Mild Deficient	1	12.5	11	31.4	2	28.6
Normal/Adequate	1	12.5	12	34.2	1	14.3
Excessive	1	12.5	2	5.6	1	14.3
Total	8	100	35	100	7	100
Energy						
Severe Deficient	3	37.5	1	2,8	1	14.3
Moderate Deficient	3	37.5	10	28.6	2	28.6
Mild Deficient	1	12.5	10	28.6	1	14.3
Normal/Adequate	1	12.5	14	40.0	3	42.8
Excessive	0	0	0	0	0	0
Total	8	100	35	100	7	100

Exercise Frequency and Cardiovascular Endurance

Athletes with good cardiovascular endurance exercised 1-3 times a week at the very least. The majority of athletes with fair (45.5%) and good (50%) cardiovascular endurance exercised on a frequent (> 3 times per week) and sufficient (1-3 times per week) basis. The Spearman correlation test results demonstrated a significant positive correlation between exercise frequency and cardiovascular endurance ($p = 0.004$, $r = 0.395$). This means that the more frequently someone exercises, the better their cardiovascular endurance will be.

Table 3. Exercise Frequency

Frequency (Weekly)	Poor		Fair		Good	
	N	%	n	%	n	%
Seldom (< 1 x)	1	14.3	6	16.7	2	28.6
Sufficient (1-3 x)	4	57.1	18	50	3	42.8
Frequent (> 3 x)	2	28.6	12	33.3	2	28.6
Total	7	100	9	100	7	100

DISCUSSION

The following is the description of the research findings. The Spearman correlation test results showed no significant relationship between adequate energy or protein intake ($p > 0.05$). According to (Lee & Lim, 2019), nutrition not only improves performance by optimizing an athlete exercise adaptation but is also essential for maintaining the athlete health. The expert analysis results showed that 75% of those with normal energy intake had good cardiovascular endurance. Meanwhile, (Boegman & Dziedzic, 2016) claim that individual and flexible nutrition is crucial to meet daily, weekly, and cyclical nutritional needs of rowing athletes. The study of (Lewis, et al., 2018) applied a four-month nutritional intervention to rowing athletes with unexplained performance syndrome (UUPS; also known as overtraining syndrome) and showed evidence of improved performance, with specific achievements. Most athletes with normal energy intake had sufficient cardiovascular endurance (45.4%), while those with severe energy deficiency had less cardiovascular endurance (38.4%).

Another important finding in this research is that the junior rowing athlete group generally had a fairly good cardivascular endurance (80.0%), while the senior former rowing athlete group was mostly categorized as fair (48.0%) and poor (44.0%) in terms of cardiovascular endurance. In comparison to the senior former rowing athlete group (36.2 ml O2/kg BW/minute), the average cardiovascular endurance of the junior rowing athlete group (40.1 ml O2/kg BW/minute) was significantly higher ($p < 0.05$). These results were still considerably below the 63.4 ml O2/kg BW/minute levels reached by professional rowing competitors (McMillan et al., 2005). This indicates that the physical training intensity of athletes in the junior rowing athlete group was still considered insufficient. The Spearman correlation test results showed a significant relationship between energy/protein intake and cardiovascular endurance ($p = 0.003$, $r = 0.415$). The same applied to the protein intake level. The athletes with a protein-deficient diet tended to result in less cardiovascular endurance, while adequate protein intake tended to result in good cardiovascular endurance.

Some athletes have shown that moderate-to-high intensity sports, such as rowing, require a high protein intake as an energy source during competitions. The average protein intake of the junior rowing athlete group sample was significantly higher than that of the former senior rowing athlete group ($p < 0.05$). The difference between the two groups was mainly observed in milk consumption, where the junior rowing athlete group consuming more milk on average than the former senior rowing athlete group. In addition, higher physical activity levels in the junior rowing athlete group were also thought to be a driving factor for athletes to consume more nutrients due to their high energy needs. This statement is in line with (Agostini, et al., 2018) and (Ridwan, 2017) who state that improving fitness cannot only be seen from physical activity alone, but there are other factors that can improve a person fitness, such as food intake, protein, age, genetics, gender, and protein intake.

This research had shown that athletes with good cardiovascular endurance had the habit of exercising at least 1-3 times a week. The majority of athletes with sufficient (45.5%) and good (50%) cardiovascular endurance had the habit of exercising moderately (1-3 times a week) and frequently (≥3 times a week). In rowing, athletes are expected to exercise regularly to improve their cardiovascular endurance. Furthermore, good protein and nutrition management plays an important role in maintaining health so that athletes can train and compete well (Kusmawati, et al., 2019).

According to (Dewi & Kuswary, 2018), there are other factors that can affect fitness that are not related to diet, such as the level of physical activity or exercise performed by athletes, as well as other aspects supporting performance in the field of athlete training and development. With good nutrition, sufficient energy will be available for beneficial physical performance for health, fitness, growth, and sports performance development (Irianto, 2017). For athletes who engage in sports for a long time, muscle carbohydrate loading sometimes becomes an appropriate choice to provide sufficient energy reserves during training and competitions (Irianto, 2017). The lack of nutrition professionals who can provide suitable nutrition management to promote athlete performance is a challenge that constantly arises when trying to adopt nutrition management in athletes. Based on the study of (Fox, et al., 2012), athletes often do not pay attention to the recommended nutritional requirements, resulting in suboptimal performance. Similarly, the study of (Arsani, et al., 2014) found that the athlete nutrition was managed by athletes themselves and their parents, while nutritional suitability was not calculated based on the athlete calorie needs. The study by (Muharam, Damayantib, & Ruhayatic, 2019) found that the average body mass index calculation of rowing athletes fell into the normal category with an average value of 21.32, but the average food consumed by athletes was not good, as shown by an average value of 67.13%.

According to (Sumosardjuno, 1996), age is also important to consider because age is related to heart rate. Previous studies have found that the main cause of a decrease in heart rate is a reduction in the elasticity of the heart wall and a decrease over time in the amount of blood needed to fill the heart. Previous research has shown that cardiovascular endurance can be measured through the maximum amount of VO2 that can be achieved. Maximum VO2 is the maximum amount of oxygen that can be taken in during exercise (Hoff, Wisloff, Engen, Kemi, & Helgerud, 2012).

Research results showed that athletes with a maximum VO2 value of 80 mL/kg BB/minute could run 5000 meters faster than athletes who only had a maximum VO2 value of 40 mL/kg BB/minute (Levine, 2012). The higher the maximum VO2 value, the better the cardiovascular endurance, and hence athletes with good cardiovascular endurance will achieve a better performance (Utoro, 2012). Good cardiovascular endurance can also be obtained with adequate protein consumption, defined as a state of the body or health generated by a balance of dietary intake, absorption, and protein usage (Almatsier, 2001). Good protein intake can be achieved through a balanced diet (Widiastuti, et al., 2009).

To maximize protein synthesis, consuming casein protein before bed is recommended (Res, et al., 2012). According to (Heather, et al., 2006), a balanced protein intake affects an athlete peak performance during competition. Consuming less or more energy and protein than required will generally have a detrimental impact on the body physiological functions (Narici, 2021). Research conducted in Bali showed that out of 26 athletes, 22 athletes (86.4%) consumed energy based on their needs and had VO2 max values that met the standard. The remaining 4 or (15.4%) athletes consumed less energy than needed and had VO2 max values below the standard (Immawati, 2012). In general, a rowing athlete requires energy intake that meets their needs, with carbohydrate content making up 55-60% of total energy, fat 20-30% of total energy needs, and protein 15-20% of total energy needs (Heather, et al., 2006). For rowers, the energy expended during exercise must be balanced with the energy consumed from food (Husaini, et al., 2006).

Optimal food consumption generates energy, which improves work capacity and recovery time (Widiastuti, et al., 2009). A well-balanced protein consumption is also employed to increase and sustain protein fulfillment, muscle building, appropriate height, body condition, and physical fitness (Husaini, et al., 2006). Sport exercise has been shown to provide numerous health and fitness benefits, including maintaining an appropriate weight, growing muscle mass, and improving heart endurance, which is an indicator of overall fitness. Exercise and nutrition are two significant factors that influence fitness levels. Furthermore, exercise influences muscle mass gain, which is regulated by calorie and protein sufficiency and a lack of either can result in muscle loss.

The higher the frequency and duration of physical exercise, the better the level of stamina will be. Programmed physical exercise is beneficial for maintaining and improving health and stamina (Moeloek, 2011). It is also said that programmed and measured exercise can provide an increase in stamina and maximum VO2 capacity between 10% to 20%. Stamina (physical fitness), especially the aerobic capacity, can be improved through aerobic exercise by paying attention to some factors, such as exercise intensity, frequency, and duration in the training zone. The heavier the exercise load given, the greater the effect obtained. In addition to these factors, the function of the heart, aerobic muscle metabolism, body fat, genetics, and gender also affect an athlete stamina (Murray, 1997).

Protein intake is not only important for sports performance, but also vital for meeting nutritional adequacy. Exercise and proper dietary intake have been proven to have many benefits for the body and health, such as maintaining ideal body weight, increasing muscle mass, and improving heart endurance as an indicator of fitness. Good exercise and eating habits are two important factors that affect fitness levels. The contribution of protein intake and exercise frequency to heart endurance can help athletes improve their heart function, particularly in PPLP rowing athletes in Kendari.

CONCLUSION

The contribution of protein intake and training frequency to cardiovascular endurance is suitable to be applied to PPLP rowing athletes to help them improve their heart function. The average protein intake of the junior rowing athletes was higher and significantly different compared to the former senior rowing athletes ($p < 0.05$). Generally, the junior rowing athletes had a relatively fair cardiovascular endurance (80.0%), while the former senior rowing athletes were classified as fair (48.0%) and poor (44.0%). On average, the cardiovascular endurance of the junior rowing athletes (40.1 ml O2/kg BW/min) was significantly higher ($p < 0.05$) than that of the former senior rowing athletes (36.2 ml O2/kg BW/min).

However, these results were still far below those of professional rowing athletes, who achieved 63.4 ml O2/kg BW/min (McMillan et al., 2005). This indicates that the intensity of physical training for the junior rowing athletes was considered insufficient. Furthermore, athletes with a good cardiovascular endurance usually exercised with a frequency of at least 1-3 times per week. However, this may also be adjusted to the athlete capability. Most athletes with fair (45.5%) and good (50%) cardiovascular endurance exercised on a moderate (1-3 times per week) and frequent (> 3 times per week) basis. The Spearman correlation test results showed a significant positive relationship between training frequency and cardiovascular endurance

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CONFLICT OF INTEREST

The authors declared no conflict of interest.

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