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Anthropometric characteristics and dietery intake of swimming athletes with disabilities before the competition

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ABSTRAK

Latar belakang: *Kajian status gizi pada atlet renang merupakan hal yang fundamental karena berperan dalam menunjang performa. Sementara itu atlet difabel memiliki beberapa karakteristik yang berbeda dengan atlet biasa, sehingga perlu memperoleh perhatian tersendiri. Studi mengenai kajian status gizi pada atlet difabel di Indonesia belum pernah dilakukan, sehingga penulis mencoba mengkaji status gizi atlet difabel cabang olahraga renang dari aspek antropometri serta asupan makanan dan cairan.*
Tujuan: *Mengkaji status gizi atlet renang difabel dari segi antropometri serta asupan makanan dan cairan.*
Metode: *Subjek yang terlibat adalah atlet difabel renang sebanyak 18 orang (16 laki-laki dan 2 perempuan) berusia 15-34 tahun yang sedang menjalani masa karantina untuk persiapan ASEAN Para Games 2017 di Malaysia. Pengukuran antropometri meliputi komponen berat badan, tinggi badan, persen lemak, dan somatotype. Penentuan status gizi berdasarkan Indeks Massa Tubuh (IMT) dan Lingkar Lengan Atas (LLA). Kajian asupan makanan dan cairan dilakukan dengan wawancara recall 24-hours yang menanyakan asupan makan dalam satu hari terakhir dan Semi Quantitative Fluid Frequency yang menanyakan asupan cairan selama satu minggu terakhir. Seluruh data dianalisa secara deskriptif serta ditampilkan dalam bentuk rata-rata dan nilai simpang baku (SD).*
Hasil: *Sebanyak 11 dari 18 atlet memiliki status gizi normal, sementara sisanya memiliki status gizi berlebih atau overweight. Hasil pengukuran persen lemak adalah 16% pada atlet laki-laki dan 29% pada atlet perempuan, lebih tinggi dari persen lemak atlet renang profesional (13% dan 26%). Somatotype atlet renang difabel didominasi kategori ectomorphic mesomorph. Asupan energi zat gizi makro dan mikro masih tergolong kurang dengan pemenuhan di bawah 80% dari kebutuhan yang direkomendasikan.*
Kesimpulan: *Beberapa aspek antropometri belum sesuai dengan standar atlet profesional, dan pemenuhan asupan makanan serta cairan belum optimal sesuai dengan kebutuhan. Diperlukan pemberian diet dan latihan yang tepat untuk mencapai perawakan fisik terbaik dan meningkatkan asupan makanan.*

KATA KUNCI : *difabel, renang, antropometri, asupan makan, status gizi*

ABSTRACT

Backgrounds: *In the strategy of fostering athletes' performance, examining their nutrition status is essential as the guide to plan the proper diet and physical training. However, physical impairment in disabled athletes gives extra challenge in assessing the nutrition profile, particularly on anthropometric measurements.*
Objectives: *To identify the nutrition status based on anthropometry value, food and fluid intake of disabled swimming athletes.*
Methods: *Descriptive quantitative design was used in this study. Subjects participated in the study were 18 disabled swimmers in national training camp for 2017 ASEAN Para-Games. Anthropometry measurement consists of body weight, height, %body fat, and somatotype. Nutrition status was identified according to*

BMI and MUAC. Food and fluid intake were assessed using 24-hour dietary recall and Semi Quantitative Fluid Frequency Questionnaire. Descriptive statistical analysis was done using SPSS software version 16, and the result was presented in mean and deviation standard.

Results: *Nutrition status of athletes based on BMI and MUAC illustrated that 11 (61%) athletes had normal nutrition status, 6 (34%) were overweight, and 1 (5%) was obese. Body fat percentage for female and male athletes were 29% and 16%, respectively, higher than recommended value (26.6% and 13%) Endomorphic mesomoprh was dominant as the somatotype value of athletes, contradicted to standard value in professional swimmer (balanced mesomoprh or central). Dietary intake of athletes was found to be inadequate with %intake for energy, protein, fat, and carbohydrate were 55%, 66%, 79%, and 49%. The inadequate fluid intake was also found with the intake was 3222 ml/day.*

Conclusions: *The results indicate that several anthropometry values such as %body fat and somatotype of disabled swimming athletes in this study were still differ from anthropometry standard of professional swimmers. Total energy, macro nutrients, micro nutrients, and fluid intake were inadequate compared to dietary recommendation.*

KEYWORDS: *disabled athlete, swimming, anthropometry, dietary intake, nutrition status*

INTRODUCTION

Physical impairment in disabled athletes is one of the challenge in their nutrition status measurements, especially in anthropometric values. However, measurements of athletes' nutrition status is a fundamental aspect as the "guideline" to choose the proper diet plan and physical training to enhance their performance (1). In swimming athletes, anthropometric values such as body composition and somatotype are related to the ability of the body to optimize the propulsion energy and minimize the drag force in the water, in order to achieve the determined distance in a shortest time. The study of swimming athletes' somatotype is important as well to understand the difference of muscle mass and fat distribution which is closely related to the body flexibility in the water (2).

Swimming is one of the sport category which has high volume and training intensity, such as long distance endurance swimming, interval training, sprint training, specific training specialized in certain style, and additional training such as jogging and long distance cycling. The high volume and intensity of those training demands a big amount of energy. Therefore, the adequate intake of energy and nutrients is important to help athletes achieve the expected performance (3). Previous study conducted in Greek top-level swimmers indicated that imbalance diet was still found among national level athletes (20). Meanwhile, assessment of top-level disabled swimmers in Indonesia has not been managed. The study was performed to identify whether or not the anthropometric value and dietary intake of disabled swimming athletes in Indonesia have met the standard value.

MATERIALS AND METHODS

This study was conducted using descriptive method with quantitative approach. Data variables were taken using quantitative measurements, analyzed and presented in descriptive method. Data collection process was undergone at athletes' dormitory in Surakarta, Central Java, in November 2016. The entire measurements of anthropometric, dietary and fluid recall were performed in one full day.

Subjects participated in this study were disabled swimming athletes under the guidance of Ministry of Youth and Sports Indonesia, which were selected from each region in Indonesia and going through training camp to prepare ASEAN Para Games 2017. The chosen subjects were athletes who stay in the athletes' dormitory and capable to perform every assessments during the collecting data period, 28th of November to 2nd of December 2016. The number of subject was18 athletes consisted of 16 males and 2 females. The age of subjects ranged from 15-34 years old.

Every subjects undergone several interview to identify their basic characteristics such as personal information (name, place and date of

birth, age, ethnic, religion), frequency of competition participation every year, duration of sleep, types of disability, disease history, training schedule, and supplement habit. Dietary and fluid recall were done by interview as well to identify dietary habit of athletes.

Identification of nutrition status based on athropometric value used Body Mass Index (BMI) and Middle Upper Arm Circumference (MUAC) as indicators. BMI criteria was classified into categories: underweight (BMI values <18.5), normal (BMI values 18.5-24.9), overweight (BMI values 25.0-29.9), obese-Class I (BMI values 30.0-35.9), obese-Class II (BMI values 35.0-39.9) and extremely obese (BMI values > 40.0) (19). MUAC value of 23.5 cm-32 cm was classified as normal whereas MUAC value of >32 cm was considered as overweight (22).

Karada Scan Body Impedance Analysis was used to measure percentage of body fat. Somatotype was identified using 10 measurement components: (1) body height, (2) body weight, (3) tricep skinfold, (4) subscapula skinfold, (5) suprailiac skinfold, (6) calf skinfold, (7) humerus bone width, (8) femur bone width, (9) flexed arm circumference, and (10) calf circumference. Lange Skinfold Caliper was used for skinfold measurements, Metlin measurement tape for body circumferences, and Meiden's Spreading Caliper for bone width. Measurement result was calculated with The Heath Carter Formula 2005.

Identification of nutrition status based on dietary and fluid intake was determined using 24-hour dietary recall to analyze food intake in the last 24 hours and Semi Quantitative Fluid Frequency to analyze fluid intake in one recent week. Energy requirement of each athletes was calculated as the accumulation of basal energy, energy for daily activities, and energy for specific training. Basal energy was determined by Karada Scan Body Impedance Analysis, corrected by age and sex. Energy for specific training was determined from the calculation of energy expenditure according to each duration, type, and frequency of training. Dietary intake and dietary fulfillment are presented in mean ± deviation standard. Calculation of protein, fat, and carbohydrate requirements was based on 15%; 20%; 65% total energy requirement. Requirement of micronutrients based on Recommended Dietary Allowance of Indonesian population aged 19-49 years old. Dietary fulfillment is dietary intake divided by dietary requirement. Total fluid intake was classified into three categories: inadequate (<4900 mL/day), adequate (4900-6500 ml/day), and excess (>6500 ml/day) (16).

Analysis of dietary intake data using Nutrisurvey software. The result from 24-hour dietary recall was compared to energy requirement of each athletes. Descriptive statistical analysis was done using SPSS software version 16, and the result was presented in mean and deviation standard. The study was under supervision of Ministry of Youth and Sports Republic of Indonesia Code Ref Number: 092.01.06.3827.006.001.052.

RESULTS

Characteristics of Subjects

Subjects involved in the study were 18 disabled swimmers in various style, consists of 16 male and 2 female athletes. Subjects' age ranged from 15-34 years old or 25 years old in average. The whole subjects were nurtured by National Paralympic Committee (NPC) Indonesia and Ministry of Youth and Sport (Kemenpora) Indonesia. The study was conducted in athletes training dormitory at the Center for Community Based Rehabilitation Development and Training in Solo, Central Java, Indonesia. Participating athletes are selected as delegates for Indonesia in ASEAN Para Games 2017 in Malaysia. The characteristics of subjects were presented in **Table 1**.

Anthropometric characteristics

Body height and weight assessments were performed in minimum clothes as the main indicator of nutrition status identification according to Body Mass Index (BMI), Meanwhile, for several athletes with physical disability such as amputee, cretinism, and leg length inequality (LLI), their nutrition status was determined from the middle upper arm circumference (MUAC) measurement. As much as 9 of 18 athletes used BMI as the nutrition status determinant and the other half used MUAC.

Table 1. Characteristics of subjects

Characteristics	n	%
Ethnics		
Sumatera	5	27.8
Jawa	5	27.8
Kalimantan	4	22.2
NTB	1	5.5
Papua	3	16.7
Total	18	100
Sex		
Male	16	88.9
Female	2	11.1
Total	18	100
Age		
15 - 25	11	61.1
26-35	7	38.9
Total	18	100
Religion		
Islam	12	66.7
Christian	6	33.3
Total	18	100.0
Competition frequency per year		
Beginner	1	5.5
1	12	66.7
2	2	11.1
3-4	3	16.7
Total	18	100.0
Education		
Junior High School	6	33.3
Senior High School	11	61.1
Bachelor	1	5.5
Total	18	100.0
Sleep durationperday		
< 8 hours	6	33.3
8 hours	8	44.4
> 8 hours	4	22.2
Total	18	100.0
Type of disability		
Physical impairment	12	66.7
Intellectual impairment	4	22.2
Visual impairment	2	11.1
Total	18	100.0

According to the measurements, the mean of athletes' body height and weight were 159.03±14.26 cm and 58.31±11.20 kg, consecutively. **Table 2** presents the anthropometry measurement results. The average of BMI value was 22.6±2 (n=9) and MUAC 32.4±3 cm (n=9). As shown in Table 3, there are 11 athletes who have normal nutrition status, 6 overweight athletes, and 1 obese athlete.

Formulation of measurements in body weight, body height, skinfolds, bone width, and body circumference forms three components of somatotype: endomorph, mesomorph, and ectomorph (4). Due to physical disability that could affect the result of somatotype measurement, only 8 of 18 athletes which the somatotype components can be obtained. The result shows that 8 of those athletes were classified in three categories: ectomorphic mesomorph (n=3), endomorphic mesomorph (n=4), and balanced mesomorph (n=1).

Dietary and Fluid Intake

The result of dietary assessment using 1x24 hour recall shows that average intake of energy and macro nutrients of athletes in this study is inadequate compared to recommended value. The result of dietary intake assessment was presented in **Table 4**.

Dietary assessment shows that the average intake of mostly athletes in this study (89%) was categorized as inadequate, in which the average intake for energy and macro nutrients was under 80% (energy 55%, protein 66%, fat 79%, and carbohydrate 49%). From the entire 18 athletes, only two of them had adequate intake. Meanwhile, there were two athletes with excessive protein intake and 5 athletes with excessive fat intake. All athletes in this study had inadequate carbohydrate intake.

Types of drink consumed by disabled swimming athletes in this study was quite vary. Mineral water, drinks from beans, fruit juice, and milk were the most consumed beverages. All athletes (n=18) consumed mineral water ± 2514 mL/day. Vitamin C drinks (39%) were not highly consumed, along with herbs and refresher drinks (28%). Isotonic drinks were consumed only by 17% of athletes while carbonated and non-carbonated drinks were consumed by 11 of athletes. Consumption of alcohol and energy drinks was not found in this study.

The average of total fluid intake of athletes in this study is 3222 ± 831 mL/day. Recommendation of fluid intake for athletes was 150-250 mL every 15 minutes, with assumption of training duration is 4 hours (2400-4000 mL/day). Total fluid intake is classified into three categories: inadequate (<4900

Table 2. Anthropometry assessments results

Assessment	Min		Max		Mean ± SD	
	M	F	M	F	M	F
Height (cm)	126.5	144.2	178.4	152.6	160.4±14	148.4±5.9
Weight (kg)	39	48.6	80.5	49	59.5±11	48.8±0.28
Fat percentage (%)	7.9	24.3	27	33.9	16.3±4.3	29.1±6.8
Skinfolds (mm)						
Triceps	3.5	8	7.8	17	5.7±1.5	12.5±6.36
Subscapula	8	10.2	16	20	10.9±2.69.01±3.4	15.1±6.92
Suprailiaca	4.8	9	15	17.7	7.2±2.2	13.3±6.15
Calf	4	10	13	12		11±1.4
Bone width (cm)						
Humerus	6.5	6,5	7.5	6.5	7.03±0.3	6.5±0.0
Femur	7.5	8	10.5	8.5	9.2±0.76	8.25±0.35
Body circumference (cm)						
Flexed arm circumference	28.3	27.2	38.8	33.6	32.4±2.4	30.4±4.52
Calf circumference	27.4	31.2	40	33.4	33.7±2.9	32.3±1.55
Somatotype (n=8)						
Endomorph	1.6	3.1	4.1	6.2	2.8±0.74	4.6±2.2
Mesomorph	4.1	5	9.3	7.2	6.5±1.7	6.1±1.5
Ectomorph	1	1	6.4	2	1.8±1.6	1.3±0.9

Table 3. Nutritional status according to body mass index (BMI) and middle upper arm circumference (MUAC)

Sex	Nutrition Status Based on BMI			Nutrition Status Based on MUAC		
	Category	Number (n)	Percentage (%)	Category	Number(n)	Percentage (%)
Male	Normal	6	75	Normal	4	50
	Over weight	1	12.5	Overweight	4	50
	Obese stage I	1	12.5			
	Total	8	100	Total	8	100
Female	Normal	1	100	Normal	0	0
	Over weight	0	0	Overweight	1	100
	Obese stage I	0	0			
	Total	1	100	Total	1	100

mL/day), adequate (4900-6500 ml/day), and excess (>6500 ml/day) (16). Therefore, compared to the recommended value, fluid intake of athletes in this study can be categorized as inadequate intake.

DISCUSSION

According to the BMI and MUAC measurement to identify the nutrition status, nearly half of the athletes were overweight. This result should be noticed as this condition may disrupt the sport performance. Undesirable weight gain especially from fat mass in athletes may decrease the strength and power of sport-specific training. Therefore, athletes require appropriate diet planning and training program to achieve their ideal nutrition status (21).

Somatotype results was obtained by measuring anthropometric components such as body weight, body height, skinfolds, bone width, and body circumference. The result of skinfold measurement which was presented in Table 2 describes that the average of skinfold value in male athletes was smaller than in female athletes. Compared to skinfold value of semi-professional swimmers (male: 7.8 mm and female: 10.88 mm), the average of skinfold value of male athletes in this study was smaller, but it was bigger in female athletes.

Somatotype of professional swimmers tend to be dominant in ectomorphic mesomorph or balanced mesomorph area, as what Carassco et al. (5) described in his study of semi-professional disabled swimmers aged 14-15 years old, that the

Table 4. Average requirements, intake, and percentage of fulfillment of energy, macronutrients, and micronutrients (n=18)

Components	Requirement	Intake	Fulfillment (%)	Intake Category (%, n=18)		
				Adequate	Inadequate	Excess
Energy (kcal)						
Basal	1487 ± 198					
Activity	2191 ± 400					
Training	778 ± 187					
Total	2969 ± 473	1627 ± 632	55.5 ± 22	89	11	0
Macronutrients (g)						
Protein	111 ± 17	72 ± 30	66.4 ± 32	78	11	11
Fat	66 ± 10	51 ± 26	79 ± 42	44	28	28
Carbohydrate	482 ± 77	234 ± 96	48.7 ± 19	100	0	0
Micronutrients						
Iron (mg)	13-26	10	77			
Zinc (mg)	10-13	3.6	36			
Calium (mg)	1100	400	37			
Phosphor (mg)	700	780	111			
Magnesium (mg)	310	122	39			
Folic acid (mcg)	400	69	17			
Cholesterol (mg)	<300	203	68			
Fibre (g)	30-38	6.5	22			
Vitamin A (mcg)	600	232	39			
Viramin C (mcg)	75-90	56	75			
Vitamin D (mcg)	15	0.8	5			
Vitamin B12 (mg)	2.4	0.75	31			

Note:
Dietary intake and dietary fulfillment are presented in mean ± deviation standard. Calculation of protein, fat, and carbohydrate requirements are based on 15%; 20%; 65% total energy requirement. Requirement of micronutrients based on Recommended Dietary Allowance of Indonesian popolation aged 19-49 years old. Dietary fulfillment is dietary intake divided by dietary requirement.

somatotype of swimmers was classified in balanced mesomorph (3-4-3) for male athletes and central (3.5-3.7-3) for female athletes.

Optimal aerobic and anaerobic endurance is necessary for swimmers. Athletes require good speed, drag force in the water, and optimum aerobic capacity. Body weight, somatotype, bone width, muscle mass, and fat percentage closely related to buoyancy and drag force during swimming (6). Generally, body characteristics of swimmers are tall, board chest and shoulder, and higher muscle percentage compared to non-athletes. Swimmers have more muscle mass and less fat percentage on lower extremities than upper extremities (2). Meanwhile, previous study describes that there was no significant difference for Body Mass Index (BMI), fat percentage, and mesomorphic value of somatotype among swimmers in various style (7). In disabled athletes with physical disability such as amputee of arm or leg, cretinism, and short boned, bigger amount of energy and better balance ability are required due to the decline of propulsion force from disabled limbs (6).

Body fat percentage is one of important components in anthropometric measurement due to its close relation to every performance indicators such as strength, endurance, flexibility, speed, and agility (2). The result shows that body fat percentage for male and female swimmers in this study are 16% and 29%, respectively. The value of body fat percentage in female athletes is higher than male's, which is relevant to previous study concluded that body fat percentage in female population is normally higher than male (5). Fat distribution in male athletes is dominant in abdomen area, while in female is in lower extremities (2). The average of body fat percentage in both male and female athletes in this study is higher than recommended value of professional disabled swimmers ; 13% for male and 26.6% for female (8).

Previous study stated that body fat percentage of swimming athletes is higher than other athletes

such as boxing, wrestling, and athletic. Body fat percentage of sprint swimmers, which is dominant in anaerobic system energy, is also higher compared to aerobic type of sport such as marathon (2). Body fat percentage for swimming athletes is related to buoyancy and body temperature adaptation in the water. Fat has the ability as an isolator twice bigger than muscle, and gives protection for body against temperature change in the water. Athletes with low body fat percentage generally have higher sensitivity to temperature change (9).

Even though body fat is important, high value of body fat percentage is related to performance impairment. Higher body fat percentage is contradict with muscle growth and muscle strength (5). Excess of body fat reduces the speed, acceleration, and power of athlete's movement and increases energy production. Since speed and power are key factors in swimming, impairment of those will affect athlete's performance (10). Therefore proper training and diet intervention are essential to maintain normal body fat percentage, build ideal body composition, optimum nutrition status, and foster athlete's performance.

Generally, swimming athletes undergo various types of training including long distance endurance swimming, interval swimming, sprint swimming, training related to specific swimming style, and additional training such as running and cycling. High volume and intensity of training demand high energy intake as well (3). Therefore, adequate dietary intake is important to fulfill energy demand and enhance athletes to achieve their optimum performance.

Inadequate energy and nutrients intake in this study should be noticed, because dietary intake is closely related to athlete's performance (3). Adequate carbohydrate intake is essential as main energy source during high intensity training and maintain blood glucose level. Moreover, carbohydrate is important to maintain muscle glycogen storage which is depleted during exercise (11). Inadequate carbohydrate intake gives negative effects such as decreases oxygen supply and concentration, increases risk of muscle cramp and injury, increase fatigue risk, and decrease athlete's performance (12). Fat intake is essential as energy source, organs protection, and facilitates fat-soluble vitamins and essential fatty acids (3). Protein intake is important to produce enzymes and hormones, repair damaged tissue, and compensate protein breakdown due to the increasing of protein catabolism during exercise (13).

In line with inadequate energy and macro nutrients intake, micro nutrients intake of athletes in this study is still under 50% of recommended daily intake for 19-49 years old population in Indonesia. This finding should be noticed because vitamins and minerals have important roles in enhancing athletes performance and contribute in various metabolism process. Minerals play roles in nerve transmission, muscle contraction, and enzymes activity. Meanwhile, vitamins act as antioxidants and co-enzyme in several biochemical reactions such as energy production and protein synthesis (14,15). Mineral intake, particularly iron, needs special attention because swimming athletes tend to have iron deficiency due to iron loss and decreased plasma ferritin concentration during high intensity exercise (3). Less or excess intake of micro nutrients depends on total intake of macro nutrients and types of food. Inadequate micro nutrients can be solved by consuming food supplement, but modification of food intake is more recommended to prevent any negative side effects of supplement usage. Therefore, education of balance diet for athletes is important to help their improvement of dietary intake.

In general, types of drinks recommended for athletes are mineral water, electrolyte drinks, sport drinks, carbohydrate-contained drinks, and protein-contained drinks (17). Carbohydrate-contained drinks help to supply energy fuel in the form of solution to make it easier to absorbed, immediately replace blood glucose and help to achieve faster recovery. Protein-contained drinks such as milk are good to repair muscle tissue during recovery process. Fruit juices and vitamin C drinks have benefit as antioxidants to enhance immune system of body (18). However, our results provide important contributions on the description of anthropometric profile, somatotype, and dietary intake of disabled swimming athletes. A limitation of our study is the small sample size, which was dictated by our aim

to include only disabled swimmers who participated in systematic national-level training.

CONCLUSION AND RECOMMENDATION

Several anthropometry components such as body fat percentage and somatotype of disabled swimming athletes in this study are still incompatible compared to professional athletes, as shown in higher fat percentage, overweight in several athletes, and lower somatotype value. The average intake of energy, macro nutrients, and micro nutrients are inadequate compared to recommended value, therefore increase of dietary intake should be promoted to all athletes. Appropriate diet and training intervention are important to fulfill high energy demand, build optimum somatotype, and enhance athletes' performance.

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