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ANTHROPOMETRIC STATUS AND MACRONUTRIENT INTAKE OF BODYBUILDING ATHLETES IN LIMPOPO PROVINCE, SOUTH AFRICA

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Abstract. *Bodybuilders in Limpopo Province adhere to various training and dietary routines to attain their desired physique. However, the anthropometric status and macronutrient intake of these athletes remain unknown. A total of ninety-three bodybuilders from the Capricorn District, Limpopo Province, who were members of IFBBSA, participated in the study. Ethics approval was granted by the University of the Free State Health Science. Athletes signed informed consent before participation Measurements of weight and height were taken to calculate body mass index (BMI), waist circumference (WC), mid-upper arm circumference (MUAC), and body fat percentage (BF%). Three 24-hour-recall questionnaires were completed. The SAMRC FoodFinder-3 was used to analyse macronutrients, with the mean values considered. Data were exported to the SPSS (v28), and descriptive statistics were applied. Pearson's correlation test was used to determine the relationship between variables. The BMI was 25.8±4.4 kg/m^2 in males and 24.9±3.6 kg/m^2 in females, while MUAC was 35.6 cm for males and 28.3 cm for females. About half of both genders exhibited excess BF% (9.9% for males and 17.3% for females). Most males (81.6%) and all females had acceptable WC. Energy intake was 148 kJ/kg/day and 142 kJ/kg/day while carbohydrate intake was 4.7 g/kg/day for males and 4.3 g/kg/day for females. Fat intake was high in both genders. However, protein intake was optimal in males (1.4 g/kg/day) and suboptimal in females (1.1 g/kg/day). About half of the bodybuilders exceeded the sport-specific recommendations for BF%. However, the energy and carbohydrate intakes were suboptimal, while protein and fat intakes were optimal and high respectively.*

Keywords: *Body mass index, body fat percentage, energy, macronutrients.*

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Introduction

Bodybuilding sport focuses on body structure, fat composition, and training methods (Money-Taylor et al., 2021; Barakat et al., 2020) to exhibit good poses and demonstrate muscle and cuts (striation) during competitions (Ogita, 2010). To achieve these sport specific requirements, most athletes adopt intense training and modified dietary practices (Maier et al., 2019; Helm et al., 2014).

Optimal body composition and fat percentage status are required for athletes to maintain good health while involved in sport. One study investigated the dietary intake of bodybuilders in Limpopo Province, and suboptimal intakes were reported (Masoga et al., 2019). However, the anthropometric status, energy and macronutrient intake of these athletes were not reported. Therefore, the current study investigated these variables amongst bodybuilders in the Capricorn District. The findings of this research may enable coaches and athletes to make informed decisions regarding health matters while pursuing bodybuilding as sport.

Bodybuilding sport

Bodybuilders train at a high intensity (Krzysztofik et al. 2019) to significantly influence body structure towards marginal body fat percentage (BF%) with optimal muscles (Barakat et al., 2020; Khubisa & Reddy, 2017). This training, however, often results in muscle soreness after the tearing of muscle fibres (Kessinger, 2018). Two phases govern this sport, bulking to achieve muscle mass and cutting to make muscles more prominent (Richards et al., 2020). During the bulking (off-season) phase, the carbohydrate (CHO) and protein intake are increased to support muscle building (Spendlove et al., 2015). This phase may last for months, after which the cutting (on-season) period follows around 8–16 weeks prior to the competition (Chappell et al., 2019). During this phase, bodybuilders aim to reduce body fat while retaining muscle mass (Mitchell et al., 2017) and definition (Helms et al., 2014) through the manipulation of food items within the meal plan (Barakat et al., 2020). At times, these dietary adjustments encourage high intake of some macronutrients, for example, protein >2 g/kg; at the expense of others (CHO <6 g/kg and fat <30 % of total energy) (Spendlove et al., 2015; Aragon et al., 2017; Escalante et al., 2021). Fluids restriction may be implemented to achieve greater muscle size (Alves et al., 2020), especially during "peak week" (Chappell & Simper, 2018). Furthermore, diuretics might be used to induce the frequent need to urinate (Mitchell et al., 2017). All these strategies are intended to develop a good physique through improved lean body mass with marginal BF% (Jeukendrup & Gleeson, 2019). However, some of the above dietary practices have weak scientific support, and pose a health threat to athletes (Mountjoy et al., 2018). Therefore, the careful integration of optimal nutrition strategies within the athletes' training schedule is significant to improve training adaptations (Jeukendrup, 2017).

Body fat percentage

Monitoring body composition (BC) dimensions is crucial for assessing athletes' performance, training effectiveness, and the impact of dietary programs (Torstveit & Sundgot-Borgen, 2012). Due to higher training loads in men compared to women, and the naturally greater muscularity of men, there are often differences in BC between these groups (Pilis et al., 2019). For improved sport performance (Slater & Phillips, 2011), particularly in bodybuilding, male and female athletes generally maintain their body fat percentage (BF%) within the range of 5–8% and 10–15%, respectively (Ogita, 2010; Jeukendrup & Gleeson, 2019).

Body Mass Index

Body Mass Index (BMI) is used to determine the anthropometric status (Ashtary-Larky et al., 2018; Okorodudu et al., 2010) by considering weight and height (kg/m2) (Ballard et al., 2014). Strength-trained athletes, such as bodybuilders, increase their fat-free muscle mass (FFM) through intensive training, leading to an increase in BMI (Pilis et al., 2019). Therefore. caution is advised when applying BMI among athletes (Okorodudu et al., 2010) since it does not differentiate between lean and fat mass (Walsh et al., 2018). An athlete with extra lean mass, such as a bodybuilder, might be incorrectly categorized as overweight or obese (Buss, 2014). Consequently, BMI should be complemented with waist circumference (WC) (Batsis et al., 2016) and body fat percentage (BF%) for a better interpretation of the body composition status (Ballard et al., 2014).

Energy

Bodybuilders often expend more energy than they consume, with their diets typically restricted to around 126 kJ/kg/day (Sundgot-Borgen et al., 2013), which generally poses health risks (Kubisa & Reddy, 2019), including anorexia and bulimia nervosa, especially among female athletes. Other potential risks include compromised immunity, irregularities in the endocrine system, weight loss, and diminished bone density (Braun et al., 2020). It's generally recommended that athletes who train for 2–3 hours per day consume between 105 and 147 kJ/kg/day to maintain optimal bone health and reproductive function, particularly for female athletes (Grozenski & Kiel, 2020). However, due to the intense training regimen in bodybuilding, an energy intake ranging from 210 to 336 kJ/kg/day is advised (Kerksick et al., 2018).

Carbohydrates

Carbohydrates (CHO) serve as a fuel for the body during intense training sessions (Iraki et al., 2019). CHO provide energy to crucial systems such as the brain, central nervous system, and muscles (Thomas et al., 2016; Kessinger, 2018; Guleria et al., 2018; Vitale & Getzin, 2019; Iraki et al., 2019), facilitating the rapid generation of adenosine triphosphate (ATP) compared to other macronutrients (Vitale & Getzin, 2019; Lemon, 2000). For athletes training in moderate to high-intensity training sessions lasting 1–3 hours per day, such as bodybuilders, a recommended carbohydrate intake falls within the range of 6–10 g/kg/day (Vitale & Getzin, 2019; Kerksick et al., 2018). It's advisable to distribute carbohydrate consumption before, during, and after exercise sessions (Slater & Phillips, 2011).

Carbohydrates before exercise - Athletes participating in training sessions lasting ≤1 hour should generally use a mouth rinse carbohydrate (CHO) solution before training to mitigate fatigue (Valleser, 2020; Vitale & Getzin, 2019). The presence of CHO during the rinse is believed to activate the reward centre within the insular cortex for improved outcomes (König et al., 2019; Simpson et al., 2018), with a recommended solution concentration of 6.4–10% CHO to achieve this effect (Vitale & Getzin, 2019). Conversely, exercise lasting longer than 60–90 minutes results in the depletion of liver glycogen reserves (Vitale & Getzin, 2019). Therefore, it's recommended to consume 1–4 g/kg of CHO König et al., 2019), 1–4 hours before training (Dunford & Doyle, 2019, Thomas et al. 2016, Carlsohn, 2016), as this timeframe is considered reasonable to avoid gastrointestinal distress (Dunford & Doyle, 2019)*;* While the amount and timing of CHO intake should be guided by the practical needs of an athlete (Thomas et al. 2016), the type of CHO is another important aspect to consider (Bean, 2022).

Carbohydrate intake during exercise - Generally, athletes should consume 150–350ml of fluids containing a 6–8% CHO-solution every 10–15 minutes (König et al., 2019) or an intake of 0.7 g/kg every hour (Llorente-Cantarero et al., 2018). Athletes competing for 1–2½ hours or more should ingest 30–60g/hour (Bean, 2022) in a 6–8% CHO-containing solution (Vitale & Getzin, 2019).

Carbohydrate intake post-exercise - Immediately after exercise, CHO consumption is aimed at replenishing muscle glycogen stores (Mitchell et al., 2017). It's recommended to ingest around 1–1.2 g/kg per hour (Bean, 2022), within 30 minutes following training (König et al. 2019; Slater & Phillips, 2011), with an additional 1.5 g/kg suggested after 180 minutes post-exercise to improve the immune function and glycogen resynthesis (Carlsohn, 2016), as well as glycogen resynthesis (Bean, 2022).

Protein

Protein requirements are influenced by the intensity and frequency of training, as well as the carbohydrate and energy status of athletes (Thomas et al., 2016). Protein plays a vital role in creatine synthesis, muscle building, and blood pressure regulation for athletes (Karpik et al., 2020). Therefore, researchers (Guleria et al., 2018) recommend a protein intake of 1.2–1.8 g/kg/day for strength-trained athletes. However, bodybuilders usually require up to 2.0 g/kg/day of protein, given the intense nature of the sport (Vitale & Getzin, 2019). Many bodybuilders believe that an increased protein intake increases muscle formation (Tipton, 2011) but an intake of more than 2.0 g/kg/day has, in some cases, been associated with dehydration over time (Karpik et al., 2020). Therefore, athletes engaged in high-intensity activities like bodybuilding should aim for a protein intake between 1.4 and 2.0 g/kg/day (Kerksick et al., 2018; Vitale & Getzin, 2019). It's essential to prioritize the consumption of high-quality proteins with a high biological value (HBV), such as those found in chicken, beef, turkey, fish, milk, and eggs (Guleria et al., 2018).

Protein intake before exercise - Information regarding the amount of protein recommended before exercise is relatively scarce (Dunford & Doyle, 2019). However, the general view is that protein doses of 0.3 g/kg (Vitale & Getzin, 2019) or 0.25–0.4 g/kg taken 2–4 hours before the start of training should be the typical approach for athletes (Egan, 2016).

Protein intake post-exercise - Muscle protein synthesis is stimulated by training. Therefore, an HBV protein of 0.25–0.3 g/kg is recommended within 2 hours' post-workout (Grozenski & Kiel, 2020; Dunford & Doyle, 2019; Thomas et al., 2016). Intake of protein post-exercise is required to support muscle protein synthesis (Vitale & Getzin, 2019).

Dietary fat

The dietary fat recommendation in sport is similar to that made for non-athletes (Vitale & Getzin, 2019; Schek et al., 2019). Optimal intake facilitates the absorption of fat-soluble vitamins, produces cholesterol, hormones (Smith et al., 2015; Guleria et al., 2018), and prevents mental depression from excessive training (Grozenski & Kiel, 2020). Thus, a dietary fat intake of 20–30% of total energy (TE) (0.5–1 g/kg/day) is recommended (Collins et al., 2020; Iraki et al., 2020; Grozenski & Kiel, 2020; Chappell & Simper, 2018; Kerksick et al., 2018). Above this range, cardiovascular diseases, weight gain (Dunford & Doyle, 2019; Phillips, 2012; Smith et al., 2015) and hypercholesterolemia are risks (Dunford & Doyle, 2019). On the other hand, chronic fat restriction of ≤20% of total energy intake (TE) is linked with insufficient nutrient intake (Collins et al., 2020). Despite this, the recommended intake before, during, or after training sessions remains uncertain. However, the primary objective during sports activities is to prevent gastrointestinal discomfort (Slater & Phillips, 2011). A summary of energy and macronutrient requirements for athletes engaged in bodybuilding as a sport is provided in Table 1.

Table 1. *Energy and macronutrient requirements for bodybuilders (Kerksick et al., 2018)*

Recommendations	
Energy	**210 – 336 kJ** (50 – 80 Kcal)/kg/day
Macronutrient recommendation/kg/day	
Protein	Total 1.4 – 2 g/kg/day
	Pre-competition: 0.25–0.4 g/kg 2–3 hours before exercise or competition
	Post-competition: 0.25–0.3 g High-quality protein within 30 minutes post-competition or exercise
CHO	Total 8 – 10 g/kg/day
	Pre-competition: 1–4 g/kg High glycaemic index CHO, 1–4 hours before competition or exercise
	During competition: Exercise lasting <45 minutes, no specific recommendation, * 45 – 75 minutes, small amounts of CHO through mouth rinse, * 1 – 2 ½ hours, 30 – 60 g of CHO per hour* 6–8% of dextrose solution Every 15 – 20 minutes
	Post-competition: 1–1.2 g/kg Consumed within 30 minutes post-competition, then up to 1.5 g/kg, 3–4 hours thereafter
Fat	Total 0.5–1 g/kg/day

*Bean (2022)

Methodology

Participants and Procedure

Purposive sampling was used to recruit 93 bodybuilders from gymnasiums located in the Capricorn District. These participants were part-time competitive bodybuilders and members of the International Fitness and Bodybuilding in South Africa (IFBBSA). For sample characteristics, please refer to Table 2.

Ethics approval for this study was obtained from the University of the Free State (UFS) Health Sciences Research and Ethics Committee (UFS-HSD2020/1680/2302), and permission was granted by the management and coaches of the gymnasiums. Prior to participation at the study, the athletes provided an informed consent. Data collection took place in the afternoons, before training sessions, from February to April 2022.

Measures

Demographic information and information on training practices were collected using a self-reported questionnaire with the researchers available on site for support. The information covered, among other variables: age, gender, educational level, number of years in bodybuilding, and frequency of training per day and week.

Weight, height, and body composition - body fat percentage [BF%], waist circumference [WC], and mid-upper arm circumference [MUAC]) were measured as stipulated by the International Society for the Advancement of Kinanthropometry (ISAK). Weight was measured using digital measurements (813-high capacity), while height was measured using a portable stadiometer (213-height measure), both from Seca Company. These variables were used to calculate the body mass index (BMI). The WC and MUAC were measured using the 201 ergonomic measuring tape (from Seca). For the calculation of BF%, seven skinfold sites: triceps, supra-iliac, abdominal, subscapular, chest, midaxillary, and thigh were measured using the Harpenden Skinfold Calliper. The Siri predictive equation was used to calculate body density and then BF% of the athletes. All variables were measured on the left side of the athletes' bodies before the start of the training to avoid muscle and skin inflation. Three measurements were obtained at each site and the mean was considered. Dietary data were collected using three 24-hour-recall questionnaires, two during the week and one over the weekend, and was validated using food frequency questionnaire. Dietary data were first analysed on the South African Medical Research Council Food Finder (SAMRC FF-3) and the mean intake of macronutrients was considered. Data were then loaded into the SPSS software (v-28) for analysis.

Statistical analysis

The data were tested for normality, and parametric tests were then used to analyse the data. Standards stipulated by WHO (2011) were used to interpret BMI and WC, while cut-off points by Jeukendrup and Gleeson (2019) were used to categorise the BF% of the athletes. Pearson correlations and associated P-values were calculated to assess the association between the anthropometric status of athletes, their dietary intake, and some demographic variables.

Results

The results for the 93 bodybuilding athletes are reported in Tables 2 to 7. According to Table 2, there were 77 males (83%) and 16 females (17%) with the average ages of 24.5±4.1 and 23.0±3.5 years for males and females respectively. Most athletes were either still in high school or held a degree. Only a few males (7%) held postgraduate degrees. Most males and females were unemployed. Less than half of males (40%) and 18% of females used ergogenic substances.

Table 2. *Demographic profile (N=93)*

Variables	**Males (n=77; 83%)**	**Females (n=16; 17%)**
Age (yrs.)	24.5±4.1	23.0±3.5
Variable	**n (%)**	**n (%)**
Gender	77 (83%)	16 (17%)
Marital status	**n (%)**	**n (%)**
Single	73 (95%)	15 (94%)
Married	4 (5%)	1 (6%)
Education status	**n (%)**	**n (%)**
High School	27 (35%)	7 (44%)
Diploma	8 (10%)	2 (12%)
Degree	37 (48%)	7 (44%)
Other	5 (7%)	0
Employment status	**n (%)**	**n (%)**
Employed	18 (23%)	4 (25%)
Unemployed	59 (77%)	12 (75%)
Ergogenic use	**n (%)**	**n (%)**
Yes	31 (40%)	3 (18%)
No	46 (60%)	13 (82%)

According to Table 3, male athletes were typically involved in bodybuilding for an average of 2.5 years, whereas female athletes had an average involvement of 1.8 years. However, the average frequencies of training per day and per week were similar across all genders. Additionally, there was only a slight difference in the duration of training between male and female athletes.

Table 3. *Athletes' bodybuilding training history (N=93)*

	Males (n=77; 83%)			Females (n=16; 17%)		
Variables	Min	Max	Mean±SD	Min	Max	Mean±SD
Years in bodybuilding (yrs.)	1	7	2.5±4.1	1	4	1.8±0.8
Frequency of training per day	1	4	1.5±0.8	1	3	1.5±0.7
Frequency of training per week	1	5	3.6±0.8	2	5	3.5±0.8
Duration of training (hrs.)	1	5	2.3±0.7	1	2	1.9±0.2

Table 4 presents the mean Body Mass Index (BMI) for male athletes as 25.8 ± 4.4 kg/m² (44.8%), and 24.9 kg/m^2 for female (53.0%) athletes, categorizing them as overweight (25 – 30 kg/m²), and normal (18.5 – 24.9 kg/m²). Only 1.3% of males and 5.9% of females were classified as underweight (<18.5 kg/m²). Nearly half of both genders, 48.1% of males and 49.9% of females, exceeded the recommended body fat percentage for bodybuilding sport (>8% for males and >15% for females). Most males (86.8%) and all females (100%) had acceptable waist circumference (WC) values (<102 cm for men and <88 cm for women). However, a small percentage of males (13.2%) had increased WC (>95 cm). Mean values for Mid-Upper Arm Circumference (MUAC) and weight in all genders are also provided in Table 4.

Table 4. *Anthropometric measurements (N=93)*

Variable	Gender	Min	Max	Mean±SD	Below	Within	Above
Height (cm)	Males	156.0	186.0	171.3±6.1	-	-	-
	Females	145.0	168.0	157.5±5.5	-	-	-
Weight (kg)	Males	55.4	124.4	76.4±14.8	-	-	-
	Females	44.3	72.9	61.5±8.4	-	-	-
MUAC (cm)	Males	27.0	47.0	35.7±4.1	-	-	-
	Females	23.0	32.0	28.2±2.3	-	-	-
BMI (kg/m^2)	Males	19.2	40.8	25.8±4.4	1.3%	53.9%	44.8%
	Females	17.9	34.3	24.9±3.6	5.9%	41.2%	53.0%
BF% (%)	Males	3.6	25.8	9.9±4.6	7.6%	44.3%	48.1%
	Females	2.0	29.0	17.3±7.7	6.3%	43.8%	49.9%
WC (cm)	Males	65.0	121.5	80.7±10.3	0%	86.8%	13.1%
	Females	61.0	86.5	73.3±6.2	0%	100%	0%

Table 5 indicates that the majority of males (90.7%) and females (88.0%) consumed energy below the recommended range (males: 148 kJ/kg, females: 142 kJ/kg), as well as carbohydrate intake (males: 4.7 g/kg, females: 4.3 g/kg), which fell short of the recommended intake (210 – 336 kJ/kg and 8 – 10 g/kg, respectively). However, a significant portion of males (82.8%) and a smaller proportion of females (17.8%) consumed protein within the recommended range (1.4 – 2.0 g/kg), with only 1.3% of males below and 11.7% of females above the recommendations. Fat consumption exceeded 1 g/kg in both genders, with only 23.6% of males and 36.2% of females falling within the recommended range (0.5 – 1 g/kg).

Table 5. *Energy and macronutrient intake (N=93)*

Variable	Gender	Min	Max	Mean± SD	Below	Within	Above
Energy	Males	6.6	435.3	147.9±88.2	90.7%	5.2%	3.9%
(kJ/kg)	Females	13.0	384.0	144.4±94.4	88.0%	5.8%	5.8%
Protein (g/kg)	Males	0.1	5.4	1.4±0.8	1.3%	82.8%	15.9%
	Females	0.4	2.3	1.1±0.5	70.5%	17.8%	11.7%
Fat	Males	0.1	4.5	1.1±0.8	7.8%	23.6%	68.4%
(g/kg)	Females	0.2	5.2	1.3±1.2	17.6%	36.2%	47.0%
CHO	Males	0.8	18.6	4.7±2.9	90.7%	5.2%	3.9%
(g/kg)	Females	1.2	9.1	4.3±22.6	88.0%	5.8%	5.8%

Table 6 reveals significant correlations between the Body Mass Index (BMI) and Waist Circumference (WC) of the athletes with their age, duration of training, and education level. Additionally, there is a marginally significant correlation between BMI and education level. Furthermore, Body Fat Percentage (BF%) is positively correlated with age and negatively correlated with the frequency of training per week.

Table 6. *Correlation of anthropometry and demography (N=93)*

Variable	Mean	Age	No of yrs. In bodybuilding	Frequency of Training/week	Duration during training	Education level
	Mean±SD	P-value (r*)				
BMI (kg/m²)	25.4±5.1	0.024(0.235)	0.165(0.145)	0.994(-0.001)	0.002(0.313)	0.055(0.235)
BF% (%)	12.1±10.8	0.015(0.235)	0.315(-0.106)	0.012(-0.161)	0.655(-0.047)	0.226(0.127)
WC (cm)	79.3±10.1	0.001(0.334)	0.200(0.134	0.700(0.041)	0.019(0.242)	0.018(0.245)

Note. #BB=bodybuilding; *r = Pearson correlation coefficient

Table 7 summarizes the correlation between anthropometric measurements and the dietary intake of athletes. The analysis revealed no significant correlation between anthropometric variables and the energy and macronutrient intake of the athletes.

Table 7. *Correlation of anthropometry to dietary intake (N=93)*

Variables	Mean	Energy	Protein	Fat	CHO
	Mean±SD	P-value (r*)			
BMI (kg/m²)	25.4±5.1	0.367(-0.095)	0.317(-0.105)	0.635(-0.050)	0.594(-0.056)
BF% (%)	12.1±10.8	0.484(0.074)	0.194(-0.137)	0.970(0.004)	0.440 (-0.081)
WC (cm)	79.3±10.1	0.593(0.056)	0.735(-0.056)	0.900(-0.013)	0.916(-0.011)

Note. *r =correlation coefficient

Discussion

The objectives of this study were to assess the anthropometric status and dietary intake of bodybuilders. Our findings indicate that approximately half of the athletes had body fat percentages (BF%) above sport-specific recommendations, and their nutrient intake was found to be suboptimal. Most athletes in our sample were males (83%), and they were involved in bodybuilding for a longer period compared to females. This observation is consistent with previous research. A cross-sectional study involving 81 competitive bodybuilders during peak week and competition day found that 72% (n = 59) of the recruited athletes were males (Chappell & Simper, 2018). Similarly, in a study investigating the protein content in the diets of amateur bodybuilders, all 35 participants were males (Karpik et al., 2020). Additionally, Masoga et al. (2023) conducted a study in the Polokwane municipality with a sample of 51 athletes, among whom 94.1% (n = 48) were males, focusing on the use of ergogenic substances among bodybuilders.

In the current group, 44.1% of athletes were classified as overweight (25.4±5.1 kg/m²) according to their BMI. These results are comparable to the BMI (25.2±4.7 kg/m²) value found during the evaluation of the protein content and quality among 35 amateur male bodybuilders (Karpik et al., 2020). In their study, Karpik et al. associated the excessive intake of protein with an increased BMI, as protein intake above requirements contributes to additional energy intake. In another study, higher mean BMI were reported in male athletes (25.5±1.79 kg/m²) than in females (20.6±1.2 kg/m²) during the peak week investigations on nutrient intake elsewhere (Chappell & Simper, 2019). However, other results by Sukwong et al. (2022) revealed normal body weight classifications (20.8±1.5 kg/m²) among elite bodybuilders, while the novice group was overweight (26.6±3.2 kg/m²). In another study, overweight BMI categories for male

(28.8±3.9 kg/m^2) and female (28.5±4.4 kg/m^2) athletes were also reported (Ashtary-Larky et al., 2018). Related to the current research, higher BMI categories are usually expected among bodybuilders noting that the primary aim of this sport is muscle construction (Sukwong et al., 2022). Additionally, data were collected during the off-season (non-competitive) stage, during which muscle creation is the primary goal (Roberts et al., 2020). Considering that males generally have a higher proportion of muscle mass than females (Ashtary-Larky et al., 2018), it is possible that the Mid-Upper Arm Circumference (MUAC) values observed for male athletes (35.7 ± 4.1 cm) compared to females (28.2 ± 2.3 cm) could have contributed to the slightly higher Body Mass Index (BMI) values. However, due to the absence of BMI standards in sport (Mardiana et al., 2022), classifications in our group may be inadequate, as BMI alone is considered less sensitive in identifying obesity compared to when combined with body fat percentage (BF%) and waist circumference (WC) measurements (Zhu et al., 2022; Sukwong et al., 2022). Caution should therefore be exercised when interpreting BMI for bodybuilders (Ashtary-Larky et al., 2018), as the tool was originally designed for use in the general population (Okorodudu et al., 2010) and does not account for variations in body composition (Walsh et al., 2018).

Measurements of body fat percentage (BF%) are considered reliable indicators of obesity (Zhu et al., 2022). Our measurements revealed that nearly half of the athletes had excess BF% according to bodybuilding standards, with males averaging 9.9%±4.6%, and females averaging 17.3% ±7.7%. This finding is somewhat surprising, considering that the athletes in our study had been participating in bodybuilding for almost two years, training three times per week. However, it is not unprecedented for athletes to present with excess BF%, particularly among females, as reported in other studies. For instance, excess BF% among elite (17.5±3.7%) and novice (20.9±3.0%) bodybuilders in Thailand was reported (Sukwong et al., 2022). In another study involving body composition comparisons between different genders, BF% of 16.6±2.9% was reported among female athletes (Mascherini et al., 2017). Excess BF% is associated with chronic diseases (Ugelta et al., 2022). However, exercise is among other fat reduction strategies used to control body fat, particularly central obesity (Ugelta et al., 2022). The latter could possibly be factual for the current study given the acceptable WC values in the current research group suggesting marginal risk of metabolic complications.

In the current study, athletes exhibited suboptimal energy and carbohydrate (CHO) intake, which aligns with similar findings regarding CHO intake among bodybuilders in 2019 (Masoga et al., 2019). Starchy foods such as maize-meal porridge and bread are known to be the most commonly consumed foods in Limpopo Province. Therefore, these findings are unexpected. However, the timing of data collection in our study, which was the bulking phase, could possibly explain these outcomes. Although the unemployment rate was high (more than 70%) in our group, most males met protein recommendations compared to females, possibly to support muscle creation in men while women may have intended to lose weight. Intake of dietary fat was found to be high in the current research. Although the report for use of ergogenic substances in our group was minimal (males, 40% and females, 18%), possibly due fear of disclosure, this may partly explain the increased BF% obtained. Some ergogenic substances used by bodybuilding athletes may have contained a higher proportion of fat or illegal substances disadvantaging other macronutrients (Kerksick et al., 2018). Additionally, high use of ergogenic agents, for example anabolic steroids may potentially increase the risk for cardiovascular diseases and liver disfunction (Perry et al., 2020; De Souza et al., 2018). We found weak but significant correlations between BMI, BF%, and WC with some demographic variables such as age, duration of training, and education status of athletes. However, we found no correlation between anthropometry and macronutrient intake, contrasting with findings from another study where diet was reported among other factors affecting the anthropometric status of athletes (Makiel et al., 2020).

Similar to our findings, a significant association of BMI to MUAC and skinfold sites was found elsewhere among bodybuilders in the nocte group. In that group, an imbalance intake of macronutrients (low CHO and high protein) and fried foods were reported (Monteiro et al., 2012).

Conclusion

Roughly half of the bodybuilding athletes in the Capricorn District exhibited body fat percentages (BF%) exceeding the recommended levels for their sport. However, there was considerable variation in the macronutrient intake among these athletes: energy and carbohydrate (CHO) intake fell below recommended levels, protein intake was optimal for males but suboptimal for females, and fat intake exceeded recommendations for both genders. No significant correlations were observed between anthropometric status and macronutrient consumption.

Based on these findings, it is advisable for sports health practitioners, such as dietitians, to play a role in monitoring the overall dietary intake, health, and anthropometric status of athletes while assisting them in reaching their desired goals. Moreover, it is suggested that the biochemical profile of these athletes be investigated to gain a comprehensive understanding of their nutritional status. Additionally, conducting a similar study examining the body composition of bodybuilding athletes across different provinces using larger sample sizes is recommended.

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