NUTRITIONAL PRACTICES OF AEROBIC DANCE ATHLETES IN LIMPOPO PROVINCE: SHOULD WE BE CONCERNED?

Gerald Pabalelo MPHAFUDI[1*], Makoma Melicca BOPAPE[2], Sylven MASOGA[3]

[1] W.F Knobel Hospital, Dietetics Department, Limpopo Province, South Africa
[2] University of Limpopo, Department of Human Nutrition and Dietetics, Limpopo Province, South Africa
[3] LUNEX Higher Education Institution, Department of Nutrition, Fitness and Health, Luxembourg
*Corresponding author: mphafudigp@gmail.com

https://doi.org/10.35189/dpeskj.2024.63.3.4

Abstract. *Aerobic dance athletes in Limpopo province follow various nutritional practices, some of which may pose health risks. However, the specifics of these practices have not been clearly documented until now. A descriptive, cross-sectional study recruited 66 part-time aerobic dance athletes from Limpopo. Ethical clearance and written consent were obtained from Turfloop Research Ethics Committee and the athletes. Data was gathered on the characteristics of athletes, including their age, gender, and training profiles. The dietary intake and nutrient timing were collected using multiple (two) 24-hour-recall questionnaires. Energy and macronutrients data were loaded onto the South African Medical Research Council Food Finder and average values were considered for further analysis. All data were then loaded onto SPSS (v.26) for descriptive tests analysis to report the nutritional practices of athletes. A p-value of ≤0.005 was a criterion set for variables to be significant to each other. Female athletes dominated (78.8%), with a majority (63.6%) training 1 – 2 hours daily. Nearly half (46.3%) of the athletes consumed energy (70.1±16.6 kcal/kg) excessively, while fat intake (0.6±0.4 g/kg) was optimal (54.5%). Carbohydrates (2.3±1.3 g/kg) and protein (0.9±0.6 g/kg) were consumed suboptimally by 89.3% and 69.6% of athletes respectively. In general, athletes (63.6%) ate 3 – 4 meals per day. The majority (81.8%) did not consume any food before exercise, while 83.3% hydrated with water during exercise. About 65.1% ate within an hour after exercise. There was no significant correlation between energy and macronutrient intake and sports nutrition practices. Nutritional practices of aerobic dance athletes diverged from established sports nutrition recommendations.*

Keywords: nutritional practices, aerobic dance, athletes, energy, macronutrients.

Received: *28 July 2024* / **Accepted:** *7 September 2024* / **Published:** *30 September 2024*

Introduction

Aerobic dance exercise is commonly used by participants to improve cardiovascular function and decrease body fat mass, contributing to achieving an ideal body weight (Haskell et al., 2007). The nature of the dance exercise is intense, engaging large muscle groups at 60 – 80% of the maximum heart rate for 15 – 20 minutes or longer (Abdullah et al., 2016). Participation in this sport requires adherence to optimal dietary intake and nutrient timing to improve training performance and optimize recovery (Jäger et al., 2017; Trakman et al., 2017). The timing of energy and macronutrient consumption during the dance exercise sessions is thought to enhance tissue repair, muscle protein resynthesis, and recovery from injuries (Jäger et al., 2017). Therefore, tailored meal plans designed to meet the specific needs of aerobic dance exercises are expected to improve the long-term health outcomes of athletes sooner or later in life. So far existing research has predominantly focused on the nutritional practices of athletes in other sports, such as bodybuilding and soccer in Limpopo province (Masoga et al., 2019; Masoga et al., 2021). However, little information is currently available on the nutritional practices of aerobic dance athletes, despite the sport's growing popularity, particularly among adults in the Capricorn District of Limpopo Province, where it ranks third after soccer and netball. To date, no studies have explored the nutritional habits of these emerging athletes in Limpopo. Furthermore, there appears to be a lack of clear, sport-specific nutrition guidelines for aerobic dance athletes in South Africa. This gap in data may lead aerobic dance athletes to rely on nutritional advice and recommendations from a variety of sources such as coaches, teammates, and social media. Therefore, this research aimed to examine this group of athletes to establish a baseline of nutritional information and practices specific to aerobic dance exercises in Limpopo province. Additionally, this research intends to highlight the importance of maintaining optimal nutrition during sports engagement, providing insights that may be of interest to both athletes and sports health practitioners.

Energy

Energy acts as a fuel during exercise, with protein, carbohydrates (CHO), and fats serving as the main sources of supply (Schönfeldt & Hall, 2012). However, the amount of energy required to sustain the body weight is often lower than what is needed during exercise (Helms et al., 2014). Optimal energy intake is required to regulate the bone density, immunity, and endocrine functioning (Sale & Elliott-Sale, 2017). Individuals engaging in aerobic sports are advised to consume smaller, more frequent meals throughout the day to meet their nutritional needs. This practice helps minimize fatigue, replenish glycogen stores, build and repair tissue muscles, and maintain the desired weight (Odysseos & Avraamidou, 2017). During exercise and competitions, individuals should aim for an energy balance of 25 – 35 kcal/kg/day (105 – 147 kJ/kg/day) as this level of intake supports the body’s capacity for the intake of macronutrients (Kerksick et al., 2018).

Carbohydrates

Dietary carbohydrates (CHO) enhance recovery, optimize glycogen stores, and maintain the blood glucose levels during exercise (Potgieter, 2013). CHO intake is essential for both aerobic and anaerobic pathways of metabolism, serving as the primary nutrient for muscle contraction during exercise (Rudolf & Yulia, 2018). This macronutrient is stored in the body as glycogen (Henselmans et al., 2022), which is released for use during physical activity in the form of glucose (Indoria & Singh, 2016). Suboptimal CHO intake during exercise may result in reduced blood glucose levels, production of lactate, and increased hydrogen ion concentrations, which often results in muscle contraction (Jenner et al., 2019) and fatigue (Facey et al., 2013). While CHO intakes of 3 – 5 g/kg/day are recommended for individuals engaging in general fitness exercises, those participating in moderate to high-intensity exercises, such as aerobic dance athletes, should aim for an intake of 5 – 8 g/kg/day (Kerksick et al., 2017).

CHO before exercise

Glycogen stores could be limited and easily depleted during prolonged high-intensity exercises (Dunford & Doyle, 2019), such as aerobic dance exercise, potentially leading to muscle fatigue (Henselmans et al., 2022). Therefore, to delay the onset of fatigue, it is recommended to consume a meal containing 1 – 4 g/kg of CHO at least 3 – 4 hours before exercise (Kreider et al., 2010; Kerksick et al., 2018).

CHO during exercise

For events lasting an hour or more, such as aerobic dance exercise, a CHO amount of 30 – 60 g/hour is recommended (Smith et al., 2015). In addition to this, consuming 150 – 200 ml of a fluid containing 6 – 8% CHO solution is recommended every 15 – 20 minutes to help maintain serum glucose levels throughout the exercise (Llorenten-Cantarero et al., 2018).

CHO post exercise

The main nutritional goal during post-exercise period is to restore depleted glycogen stores (Kerksick et al., 2017). To achieve this, it is recommended to consume 1–1.2 g/kg CHO immediately after exercise (Payne et al., 2022). An additional intake of 1.5 g/kg of CHO is recommended 30–240 minutes post-exercise to ensure optimal glycogen resynthesis (Pritchett et al., 2017).

Protein

Protein is a key component of muscles, ligaments, and skin, and is also used as an energy source (Valenta & Dorofeeva, 2018). During exercise, *plays a role in nutrient transport*, connective tissue support, and muscle repair (Indoria & Singh, 2016). Protein intake can improve endurance performance, speed up recovery from injuries (Jäger et al., 2017), increase muscle glycogen stores, and reduce muscle damage (Potgieter, 2013). Therefore, endurance athletes, such as aerobic dance participants, should receive about 1.2 – 1.8 g/kg/day of protein (Kreider et al., 2010). Protein intake exceeding 2 g/kg/day should be avoided due to potential risks such as osteoporosis, impaired renal function, and dehydration (Valenta & Dorofeeva, 2018).

Protein before exercise

Pre-exercise meal containing 0.25 – 0.4 g/kg or 20 g of protein should be consumed (Dunford & Doyle, 2019) at least 1 – 4 hours prior to the aerobic dance exercise (Egan, 2016). To achieve optimal muscles repair, high biological value protein, for instance, in the form of fish or eggs, combined with CHO should be the focus of intake immediately after the exercise (Schönfeldt & Hall, 2012).

Fat

Fat is primarily used as a fuel source during low to moderate-intensity exercises, provides structure to cell membranes, and helps in the absorption of fat-soluble vitamins (Indoria & Singh, 2016). Adequate fat intake is recommended to ensure optimal health, maintenance of energy balance, optimal intake of essential fatty acids, and the replenishment of intramuscular triacylglycerol stores (Potgieter, 2013). For athletes to prevent high serum cholesterol levels and essential fatty acid deficiencies, a daily fat intake of 20 – 35% of total energy is suggested (Kerksick et al., 2018).

Fluid

Fluid, especially water, plays a crucial role in regulating body temperature, lubricating joints, and transporting nutrients to active tissues (Indoria & Singh, 2016). Sweat loss during exercise leads to the depletion of bodily fluids and electrolytes, making it essential for athletes to consume fluids with added electrolytes to maintain balance (Casazza et al., 2018). Dehydration from suboptimal fluid intake reduces the strength and power output of athletes, impairing physiological function and exercise performance (Gordon et al., 2015). Therefore, athletes should start their aerobic dance exercise sessions in a well-hydrated state (Dunford and Doyle, 2019). An amount ranging from 5 – 10 ml/kg is recommended before exercise. Fluids should be ingested at the rate of 0.5 – 2 litres/hour to maintain balance and prevent hypo-hydration (Kreider et al., 2010). Alternatively, athletes can consume 150–200 ml of fluids every 15–20 minutes during exercise (Potgieter, 2013). The summary of energy, macronutrient, and fluid recommendations for athletes engaging in aerobic exercises, such as aerobic dance, are shown in Table 1.

Table 1. *Energy and Macronutrients (Kerksick et al., 2018)*

Energy	
General: 105–147 kJ/kg/day (25 – 35 kcal/kg/day) Distributed throughout the day	
Carbohydrates	
General: 5 – 7 g/kg/day Fitness and moderate exercise programs	Pre-exercise: 1 – 4 g/kg/day CHO type: Moderate glycaemic index Timing: Consumed 2–3 hours before exercise
During exercise: 6 – 8 % (or 60 g/hr) CHO type: Dextrose solution, Timing: Every 15–20 minutes	After training: 1 – 1.5 g/kg CHO type: High glycaemic index Timing: 30 minutes post-exercise, then up to 3–4 hours)
Protein	
General:1.4 – 1.8 g/kg Fitness and moderate exercise programs	Pre-exercise: 0.25 – 0.4 g/kg Protein type: High biological value Timing: 2 – 3 hours before exercise
During: No clear recommendation	Post-exercise: 0.25 – 0.3 g/kg Type: High biological value Timing: 30 minutes post-exercise
Fat	
General: 0.5 – 1 g/kg/day During: No recommendation	Pre-exercise: Avoid intake

Methodology

Purpose

The aim of this study was to determine the nutritional practices of aerobic dance exercise athletes in Capricorn district, Limpopo province, South Africa.

Participants and Procedure

A descriptive, cross-sectional study was conducted, involving a convenient sample of 66 participants selected from the 86 aerobic dance exercise athletes in the Capricorn district.

Most of the athletes were females (78.8%), aged 18–40 years, with either a degree or diploma (63.6%) or a high school diploma (15.1%). The majority of athletes (72.7%) trained four or more days per week, for one to two hours daily. Most of the female participants (63.6%) trained for 1to 2 hours daily. Social media influenced the sports nutrition decisions of 53.0% of athletes.

Convenient sampling method was deemed appropriate as data collection occurred immediately after the COVID-19 lockdown restrictions were gradually lifted between September and November 2021. Therefore, only athletes attending gymnasiums (gyms) at that time were recruited. The study achieved a response rate of 77%. All pandemic prevention protocols were strictly followed.

Participants were part-time affiliates of an aerobic dance exercise team and registered members of various gyms in the Capricorn district of Limpopo Province. Researchers obtained ethical clearance from the Turfloop Research Ethics Committee (TREC/99/2020: PG). Permission was secured from both the gym managers and coaches, and written consent was obtained from participants after the purpose of the study was explained. Demographic data collected included, but was not limited to age, gender, education level, training profile, and timing of nutrient intake during dance exercise.

Dietary intake data, including energy and macronutrient consumption, were collected using two 24-hour recall questionnaires—one administered during the week and the other over the weekend to account for variations in dietary habits. Participants were requested to report food and fluid intake from the previous day, aided by food models and marked household utensils to assist in the identification of food items and estimation of portion sizes. Researchers probed on activities that might have occurred on the previous day to assist participants during the recall process.

A Food Frequency Questionnaire (FFQ) was used to validate the food items recalled by the athletes. Energy and macronutrient data were analysed using the South African Medical Research Council (SAMRC) Food Finder (version 3). Mean intakes from the two recalls were considered, and the results were exported to Statistical Package for Social Sciences (SPSS) (version 27) for descriptive analysis. Data were presented as percentages, means, and standard deviations (±SD). Pearson’s (*r*) correlation test was used to determine relationships between continuous variables, with a significance level set at p-value of ≤ 0.05 and a 95% confidence interval (CI). This was a criterion set for variables to be significant to each other. The participants' nutritional practices were compared to the recommendations of the International Society of Sports Nutrition (ISSN) by Kerksick et al. (2018).

Results

Athletes' energy intake exceeded recommended levels, while fat intake generally fell within optimal ranges. However, protein and CHO consumption were suboptimal. Additionally, athletes did not consume any meals prior to exercise, nor did they hydrate with water during or after their dance sessions.

The energy and macronutrients intakes of athletes are presented in Table 2. According to this Table, almost half (46.9%) consumed energy (294 kJ/kg [70.1±16.6 kcal/kg]) above recommendations, while just over half of the athletes (54.5%) consumed fat optimally (0.6±0.4 g/kg). On the other hand, CHO intake (2.3±1.3 g/kg) and protein intake (0.9±0.6 g/kg) fell below recommended levels in 89.3% and 69.6% of athletes, respectively.

Table 2. *Energy and Macronutrient intakes of athletes*

Analyte	Min	Max	Mean (±SD)	Below [n (%)]	Within [n (%)]	Above [n (%)]
Energy (kJ/kg/day)	37.7	81.0	70.1±16.6	19 (28.7%)	16 (24.2%)	31 (46.9%)
CHO (g/kg)	0.6	6.3	2.3±1.3	59 (89.3%)	5 (7.5%)	2 (3.0%)
Protein (g/kg)	0.1	3.9	0.9±0.6	46 (69.6%)	16 (24.2%)	4 (6.0%)
Fat (g/kg)	0.0	1.8	0.6±0.4	27 (40.9%)	36 (54.5%)	3 (4.5%)

The timing of meal intake was also investigated, revealing that the vast majority of athletes (81.8%) did not consume any meals or fluids before their dance exercises. Among the minority who did (18.1%), consumption occurred between 1 – 3 hours before the exercises. However, during the exercises, 83.3% of athletes drank 150 – 200 ml of fluid in the form of pure water every 10 – 15 minutes. Also, almost two- thirds of the athletes (65.1%) consumed a meal three hours after their exercises.

According to Table 3, there was no significant correlation ($p > 0.05$) between energy and macronutrient intake and the sports nutrition practices of the athletes.

Table 3. *Association of energy and macronutrients to sports nutrition practice*

Analyte	Category	Energy kJ/day	p-value	CHO (g/day)	p-value	Protein (g/day)	p-value	Fat (g/day	p-value
Importance of pre-exercise meal	Yes	6563.7(±3637.0)	0.060	194.0(±110.3)	0.020	52.8(±35.9	0.060	54.5(±34.9)	0.020
	No	5085.6(±1089.6)		135.9(±55.9)		64.3(±31.4)		38.9(±20.6)	
	Not sure	9280.1(±4342.5)		291.9(±116.4)		151.7(±99.5)		419(±1071)	
Fluids before exercise	Yes	6366.5(±3619.7)	0.970	188.7(±3364)	0.255	69.7(±58.4)	0.250	106.4(±433)	0.860
	No	6136.7(±2660)		155.8(±57.55)		59.3(±26.8)		48.1(±34.1)	

Fluid timing during exercise	15 min	6421.9(±2656)	0.240	183.9(±81.6)	0.249	47.7(±22.8)	0.110	50.8(±32.4)	0.760
	30 min	6696.2(±4109)		196.7(±149.9)		82.4(±68.8)		151.2(±572)	
	45 min	6104.0 (±2572)		184.6(±94.8)		122.2(±72.2)		56.2(±47.4)	
	Other	3064.5(±1708)		78.2(±26.3)		68.5(±27.1)		31.2(±23.9)	
Intake of CHO containing fluids	Yes	6798.7(±2732.6)	0.250	193.0(±88.9)	0.290	55.8(±23.2)	0.071	62.3(±30.4)	0.610
	No	5074.5(±3353.2)		144.3(±99.8)		61.3(±45.4)		146.9(±584.6)	
	Not sure	7994.0(±3901.8)		247.7(±171.1)		117.9(±92.8)		38.9(3±4.3)	
Postexercise meal timing	<30 min	7286.0(±3166.1)	0.530	156.4(±64.0)	0.340	62.7(±20.4)	0.180	85.9(±39.1)	0.340
	45 min	7057.0(±1148.0)		216.9(±71.1)		79.4(±46.1)		243(±754.2)	
	Other	6201.4(±4035.7)		185.9(±138.5		76.2(±65.8)		37.8(±26.6)	

Discussion

This study investigated the dietary practices of aerobic exercise athletes and found that athletes consumed energy excessively and fat optimally, while CHO and protein were suboptimal. This raises a concern, since imbalances in nutritional intake may predispose athletes to poor performance and injury risks in sports. Participants in the current study could be at risk of "female athlete triad", a condition characterized by energy deficiency, disrupted menstrual function, and reduced bone mineral density (Potgieter, 2013), given that the majority of these athletes were females. Research on aerobic dance athletes is limited, making comparisons with other studies challenging. However, the findings of the current study align with those reported in two other studies, where most of the athletes consumed suboptimal energy (Renard et al., 2021; Masoga et al., 2021). The latter study, by Masoga et al. (2021), focused on soccer players, whose nutritional requirements may differ from those of aerobic dance athletes. In another study, the mean energy intake of 8674 kJ (range 2384–18009 kJ), which is also suboptimal, was reported among athletes (Burkhart & Pelly, 2016). Conversely, some athletes participating in Gaelic football consumed high-fat meals at 1.6 g/kg (135.8±23.9 g/day) (O'Brien et al., 2019). Athletes should aim to maintain optimal serum lipid profile while guarding against essential fatty acid deficiencies. Intake of healthy fatty acids, such as polyunsaturated fatty acids, have been suggested to enhance performance and recovery by reducing inflammation (Casazza et al., 2018). Given that fat is a concentrated source of energy offering 9 kcal/g which yields more energy density than other macronutrients, the excessive energy observed in this study may possibly stem from the total fat intake (Rolls, 2009). While the South African Food Based Dietary Guidelines (SAFBDG) (2013) recommend using fat, particularly saturated fat, in moderation (Vorster et al., 2013), athletes in the current study reported frying as their cooking method during food preparation. These athletes may need to be cautious about the frequent consumption of fried foods, as it often predisposes individuals to risks of cardiovascular diseases and diabetes mellitus (Dangal et al., 2024).

A diet low in CHO is likely to predispose athletes to suboptimal performance during the aerobic dance exercise due to insufficient muscle glycogen stores. Maize meal porridge is an example of CHO-rich food that is generally known to be consumed in large quantities in Limpopo province (Mbhenyane et al., 2017), making the suboptimal CHO intake observed in this study quite surprising. However, researchers in the current study suspect that athletes may have intentionally limited CHO intake in their diets, believing that excessive intake contributes to weight gain (Potgieter, 2013). Another reason to explain the suboptimal intake of CHO could be the athletes' reliance on social media as a primary source of nutrition information. Some of the contents offered by the latter media may at times be misleading to athletes due to lack of strict regulations (Koen, 2023), especially on nutrition content. A study investigating the effect of a home-based aerobic exercise program among 23 female cancer survivors also found suboptimal CHO intake in more than half (57%; n=13) of the participants, compared to those (43%; n=10) participating in face-to-face exercises (Reis et al., 2021). Again, the SAFBDG advocate for adequate intake of minimally processed (unrefined) starchy foods by South Africans (Vorster et al., 2013). Suboptimal intake of CHO reported in the current research possibly limits the adequate intake of fibre (Baranauskas et al., 2020) depriving athletes of its potential benefits in weight management (Sarker & Rahman 2017).

Literature shows that protein requirements increase with the intensity of sports during training to maintain energy and protein balance, and muscle mass (Campbell et al., 2007). Intake of protein from high quality sources such as eggs and meat provide the body with amino acids, for example, leucine, which is important for muscle protein remodelling (Collins et al., 2021). As previously noted, most of the athletes in this study were female, a group identified as being at greater risk for higher calcium needs (Ahmed et al., 2023). These athletes could benefit from nutrient-rich protein sources such as milk and dairy products, which provide essential nutrients like calcium, phosphorus, and vitamin D necessary to support bone health during sports activities (Sale & Elliott Sale, 2017). Furthermore, South Africans are encouraged to consume protein-rich foods, including milk, maas, or yogurt, daily to help maintain body weight (Vorster et al., 2013). Despite these recommendations, insufficient protein intake was reported among the participants. Excessive protein consumption, however, should also be avoided, as it can lead to bone mineral loss and kidney damage, particularly in individuals with pre-existing kidney conditions (Tipton, 2011). According to the International Society of Sports Nutrition (2018), optimal protein intake improves endurance performance, increases muscle glycogen stores, and reduces muscle damage (Kerksick et al., 2018). The researchers in this study suspect that suboptimal protein intake observed may be linked to the low socio-economic status of the athletes, given the unemployment status of most of them.

Regarding nutrient dosing and the timing of meals before the aerobic dance sessions, athletes did not consume any food or fluids beforehand. This practice deviates from sports nutrition recommendations, which advise athletes to consume 1 – 4 g/kg of CHO at least 1 – 4 hours before physical activity (Mata et al., 2019). Such deviation is concerning, as consuming CHO in the form of dextrose is encouraged to ensure adequate glucose supply during the exercise sessions (Amawi et al., 2024). Athletes consumed less than 200 ml of pure water every 10 – 15 minutes during their aerobic exercise dance session. The consumed amount of fluid and the timing thereof are in accordance with sport nutrition guidelines; however, the fluid contained no CHO solution in it. This lack of CHO supplementation in the form of dextrose solution in the current study preceded even during the immediate post exercise hours (< 30 minutes) as meals were only consumed three hours later. Athletes are encouraged to consume a solution containing 60 g/hour of dextrose (Mata et al., 2019) during exercise and 1.0 – 1.5 g/kg within 30 minutes post-exercise, repeating this intake every two hours for 4 – 6 hours thereafter to maintain energy supply (Potgieter, 2013). This practice of athletes in the current research deviates from the sports nutrition recommendation that encourages consumption of CHO in combination with protein after the training session to replenish glycogen stores and support muscle recovery (Margolis et al., 2021).

This study found no significant correlation between the energy and macronutrients intake and the sports nutrition practices of the athletes. Similar findings have been reported in research elsewhere. For instance, in a study on the energy, macronutrients and physical activity of adolescents, no significant correction was found among these variables (Ramadhani et al., 2022). In another systematic review of 103 studies on energy, macronutrients and physical activity or exercise by Donnelly et al. (2014), evidence suggested that there is no effect of each of these investigated variables on another.

Conclusions

The study examined the nutritional practices of aerobic dance athletes in the Capricorn District, South Africa. Findings revealed that athletes consumed energy excessively and fat within optimal levels, while their intake of protein and CHO was insufficient. Additionally, no meals were consumed before the exercise sessions. However, fluid in the form of water was consumed by athletes during and after aerobic dance sessions, with the timing of consumption being within the recommendations. Therefore, the nutrition practices of these aerobic dance athletes in the Capricorn District, generally deviated from the established sports nutrition recommendations (Kerksick et al., 2018). This is concerning, as athletes may have overlooked the importance of maintaining optimal nutrition while persuading their aerobic dance sport. These findings, therefore, highlight a need for an urgent intervention by the sport practitioners in Limpopo province. Potential interventions could include tailored nutrition education programs, meal plans, and hydration guidelines designed specifically for this group. Such resources should also be made available to sports regulatory authorities in the province to ensure broader support for improving the nutritional practices of aerobic dance athletes.

Funding: This study did not receive any external funding.

Institutional Review Board Statement: Researchers obtained ethical clearance from the Turfloop Research Ethics Committee (TREC/99/2020: PG).

Informed Consent Statement: The written informed consent for the participant to take part in the study was obtained.

Data Availability Statement: Data can be made available upon request to the contact author.

Conflicts of Interest: The authors declare no conflicts of interest.

Acknowledgements: The researchers extend their gratitude to the aerobic dance athletes, coaches, and aerobics instructors from the Capricorn District in Limpopo Province for their participation in this study.

References

Abdullah, M. R., Eswaramoorthi, V., Musa, R. M., Maliki, M., Husain, A. B., Kosni, N. A., & Hague, M. (2016). The Effectiveness of Aerobic Exercises at difference Intensities of Managing Blood Pressure in Essential Hypertensive Information Technology Officers. *Journal of Young Pharmacists*, *8*(4), 483-486.

Ahmed, A., Saleem, M. A., Saeed, F., Afzaal, M., Imran, A., Akram, S., Hussain, M., Khan, A., Al Jbawi E. (2023). A comprehensive review on the impact of calcium and vitamin D insufficiency and allied metabolic disorders in females. *Food Science Nutrition*, *11*(9), 5004-5027. doi: 10.1002/fsn3.3519

Amawi, A., AlKasasbeh, W., Jaradat, M., Almasri, A., Alobaidi, S., Hammad, A. A., Bishtawi, T., Fataftah, B., Turk, N., Saoud, H. A., Jarrar, A. & Ghazzawi, H. (2024). Athletes' nutritional demands: a narrative review of nutritional requirements. *Frontiers in Nutrition, 10*: 1331854. doi: 10.3389/fnut.2023.1331854

Baranauskas, M., Jablonskienė, V., Abaravičius, J. A., & Stukas, R. (2020). Actual nutrition and dietary supplementation in Lithuanian elite athletes. *Medicina*, *56*(5): 247.

Burkhart, S. J., & Pelly, F. E. (2016). Dietary intake of athletes seeking nutrition advice at a major international competition. *Nutrients*, *8*(10): 638.

Campbell, B., Kreider, RB., Ziegenfuss, T., La Bounty, P., Roberts, M., Burke, D., Landis, J., Lopez, H & Antonio, J. (2007). International Society of Sports Nutrition position stand: protein and exercise. *Journal of International Society of Sports Nutrition*, 4: 8. https://doi:10.1186/1550-2783-4-8

Casazza, G. A., Tovar, A. P., Richardson, C. E., Cortez, A. N., & Davis, B. A. (2018). Energy availability, macronutrient intake, and nutritional supplementation for improving exercise performance in endurance athletes. *Current Sports Medicine Reports*, *17*(6), 215-223.

Collins, J., Maughan, R. J., Gleeson, M., Bilsborough, J., Jeukendrup, A., Morton, J. P., Phillips, S., Armstrong, L., Burke, L. M., Close, G. L., Duffield, R., Larson-Meyer A., Louis L., Medina D., Meyer, F., Rollo I., Sundgot-Borgen, J. , Wall, B. T.., Boullosa, B., Dupont, G., Lizarraga, A., Res, P., Bizzini, M., Castagna, C., Cowie, M., D'Hooghe, M., Geyer, H., Meyer, T., Papadimitriou, N., Vouillamoz, M., & McCall, A (2021). UEFA expert group statement on nutrition in elite football. Current evidence to inform practical recommendations and guide future research. *British Journal of Sports Medicine, 55*: 416. doi:10.1136/bjsports-2019-101961

Dangal, A., Tahergorabi, R., Acharya, D. J., Timsina, P., Rai, K., Dahal, S., Acharya, P., & Giufrè, A. M. (2024). Review on deep-fat fried foods: physical and chemical attributes, and consequences of high consumption. *European Food Research and Technology, 250*, 1537–1550. https://doi.org/10.1007/s00217-024-04482-3

Donnelly, J. E., Herrmann, S. D., Lambourne, K., Szabo, A. N., Honas J. J., & Washburn, R. A. (2014). Does Increased Exercise or Physical Activity Alter Ad-Libitum Daily Energy Intake or Macronutrient Composition in Healthy Adults? A Systematic Review. *PLoS ONE. 9*(1): e83498. https://doi:10.1371/journal.pone.0083498

Dunford, M., & Doyle, J. A. (2019). *Nutrition for Sports and Exercise, 4th ed.* Cengage Learning.

Facey, A., Irving, R., & Dilworth, L. (2013). Overview of lactate metabolism and the implications for athletes. *American Journal of Sports Science and Medicine*, 1(3), 42-46. https://doi:10.1269/ajssm-1-3-3

Egan, B. (2016). Protein intake for athletes and active adults: *Current concepts and controversies. Nutrition, 41*(3), 202-213. https://doi.org/10.1111/nbu.12215

Gordon, R. E., Kassier, S. M. & Biggs, C. (2015). Hydration status and fluid intake of urban, underprivileged South African male adolescent soccer players during training. *Journal of the International Society of Sports Nutrition*, *12*(1), 1-10.

Haskell, W. L., Lee, I. M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., Macera, C. A., Heath, G. W., Thompson, P. D., & Bauman, A. (2007). Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation*, *116*(9): 1081.

Helms, E. R., Aragon, A. A., & Fitschen, P. J. (2014). Evidence-based recommendations for natural bodybuilding contest preparation: Nutrition and supplementation. *Journal of the International Society of Sports Nutrition*, *11*(1), 1-20. https://doi.org/10.1186/1550-2783-11-20

Henselmans, M., Bjørnsen, T., Hedderman, R., & Vårvik, F. T. (2022). The Effect of Carbohydrate Intake on Strength and Resistance Training Performance: A Systematic Review. *Nutrients, 14:* 856. https:// doi.org/10.3390/nu14040856

Jäger, R., Kerksick, C. M., Campbell, B. I., Cribb, P. J., Wells, S. D., Skwiat, T. M., Purpura, M., Ziegenfuss, T. N., Ferrando, A. A., Arent, S. M., Smith-Ryan, A. E., Stout, J. R.., Arciero, P J., Ormsbee, M. J., Taylor, L. W., Wilborn, C. D., Kalman, D. S., & Kreider, R. B., Willoughby D. S., Hoffman J. R., Krzykowski J. L., Antonio, J. (2017). International society of sports nutrition position stand: protein and exercise. *Journal of the International Society of Sports Nutrition*, *14*(1): 20. DOI: 10.1186/s12970-017-0177-8

Indoria, A., & Singh, N. (2016). Role of nutrition in sports: a review. *Indian Journal of Nutrition 3*(2), 1-6.

Jenner, S. L., Buckley, G. L., Belski, R., Devlin, B. L., & Forsyth, A. K. (2019). Dietary intakes of professional and semi-professional team sport athletes do not meet sport nutrition recommendations—a systematic literature review. *Nutrients*, *11*(5), 1-12. https://doi: 10.3390/nu11051160

Kerksick, C. M., Arent, S., Schoenfeld, B. J., Stout, J. R., Campbell, B., Wilborn, C. D., Taylor, L., Kalman, D., Smith-Ryan, A. E., Kreider, R. B., & Willoughby, D. (2017). International society of sports nutrition position stand: nutrient timing. *Journal of the International Society of Sports Nutrition, 14*(1), 2-17. https://doi.org/10.1186/s12970-017-0189-4

Kerksick, C. M., Wilborn, C. D., Roberts, M. D., Smith-Ryan, A., Kleiner, S. M., Jäger, R., & Greenwood, M. (2018). ISSN exercise & sports nutrition review update: research & recommendations. *Journal of the International Society of Sports Nutrition, 15*(1): 38. https://doi.org/10.1186/s12970-018-0242-y

Koen, N. (2023). Social media and nutrition (mis)information: Navigating the maze. *South African Journal of Clinical Nutrition, 36*(4), 1-2. https://doi.org/10.1080/16070658.2023.2283987

Kreider, R. B., Wilborn, C. D., Taylor, L., Campbell, B., Almada, A. L., Collins, R., Cooke, M., Earnest, C. P., Greenwood, M., Kalman, D. S., Kerksick, C. M., Kleiner, S. M., Leutholtz, B., Lopez, H., Lowery, L. M., Mendel, R., Smith, A., Spano, M., Wildman, R., Willoughby, D. S., Ziegenfuss, T. N., & Antonio, J. (2010). ISSN exercise & sport nutrition review: research & recommendations. *Journal of the International Society of Sports Nutrition*, *7*: 7. doi: 10.1186/1550-2783-7-7

Llorenten-Cantarero, F. J., Palomino-Fernandez, L., & Gil-Campos, M. (2018). Nutrition for the young athlete. *Journal of Child Science*, *8*(1), 90-98. https://doi.org/10.1055/s-0038-1669382

Margolis, L. M., Allen, J. T., Hatch-McChesney, A., & Pasiakos, S. M. (2021). Coingestion of Carbohydrate and Protein on Muscle Glycogen Synthesis after Exercise: A Meta-analysis. *Medical Science & Sports Exercise, 53*(2), 384-393. http://doi: 10.1249/MSS.0000000000002476

Masoga, S., Maja, M. T., Matsepane, M. P., & Sethemane, S. C. (2021). Dietary practices of soccer athletes registered at the University of Limpopo, Limpopo Province, South Africa. *Sport Sciences for Health*, *18*, 171-178. https://doi.org/10.1007/s11332-021-00790-3

Masoga, S., Makuse, S. H., & Bopape, M. M. (2019). Dietary intake of amateur bodybuilding athletes around Polokwane Municipality in Limpopo Province, South Africa. *Global Journal of Health Science*, *11*(9): 134. http://doi:10.5539/gjhs.v11n9p134

Mata, F., Valenzuela, P. L., Gimenez, J., Tur, C., Ferreria, D., Domínguez, R., Sanchez-Oliver, A. J., & Martínez, Sanz J. M. (2019). Carbohydrate Availability and Physical Performance: Physiological Overview and Practical Recommendations. *Nutrients*, *11*(5): 1084. http://doi: 10.3390/nu11051084

Mbhenyane, X. G., Seanego, A. M., Amey, A. K. A., Mabapa, N. S., Mushaphi, L. F., Mbhatsani, H. V., & Mandiwana, T. C. (2017). Dietary patterns and BMI status of adult women in Greater Letaba Municipality, South Africa. Food and nutrition challenges in Southern Africa. *Journal of Consumer Sciences*, *Special Edition, 2*, 28-45.

Odysseos, C., & Avraamidou, M. (2017). Weight Management for Athletes: Important Things to be Considered. *Arab Journal of Nutrition and Exercise (AJNE), 1*(3): 155. https://doi.org/10.18502/ajne.v1i3.1232

O'Brien, L., Collins, K., Doran, D., Khaiyat, O., & Amirabdollahian, F. (2019). Dietary Intake and Energy Expenditure Assessed during a Pre-Season Period in Elite Gaelic Football Players. *Sports (Basel), 7*(3): 62. https://doi:10.3390/sports7030062

Payne, J., Welshans, M., Seeland, S., & Nielsen, M. (2022). Nutritional Considerations for the Power Athlete. *Current Sports Medicine Reports*, *21*(7), 224-231.

Potgieter, S. (2013). Sport nutrition: A review of the latest guidelines for exercise and sport nutrition from the American College of Sport Nutrition, the International Olympic Committee and the International Society for Sports Nutrition. *South African Journal of Clinical Nutrition, 26*(1), 6-16. https://doi.org/10.1080/16070658.2013.11734434

Pritchett, K. L., Pritchett, R. C., & Bishop, P. (2017). Nutritional strategies for post-exercise recovery: a review. *South African Journal of Sports Medicine, 23*(1), 20-21. https://doi.org/10.17159/2078-516X/2011/v23i1a370

Ramadhani, F., Hatta, H., Nuryani, N., Maesarah, M., Adam, D., Sillehu, S., & Nugroho, HRW. (2022). Correlation of Energy, Protein, Carbohydrate, and Physical Activity Intake with Nutritional Status of Adolescents. *Macedonia Journal of Medical Science*, 10, 1440-1445. https://doi.org/10.3889/oamjms.2022.8110

Renard, M., Kelly, D. T., Chéilleachair, N. N., & Catháin, C. Ó. (2021). How does the dietary intake of female field-based team sport athletes compare to dietary recommendations for health and performance? A systematic literature review. *Nutrients*, *13*(4): 1235. https://doi: 10.3390/nu13041235

Reis, N. T., Kowalski, K. C., Mosewich, A. M., & Ferguson, L. J. (2021). That's how I am dealing with it – that is dealing with it': exploring men athletes' self-compassion through the lens of masculinity *Qualitative Research in Sport, Exercise and Health, 14*(2), 245-267. DOI: 10.1080/2159676X.2021.1920455

Rolls, B. J. (2009). The relationship between dietary energy density and energy intake. *Physiology and Behavior*; 97(5), 609-615. http://doi.10.1016/j.physbeh.2009.03.011

Rudolf, V., & Yulia, D. (2018). Sport nutrition: the role of macronutrients and minerals in endurance exercises. *Foods and Raw materials, 6*(2), 403-412. http://doi:10.21603/2308-4057-2018-2-403-412

Sale, C., & Elliott-Sale, K. J. (2017). Nutrition and Athlete Bone Health: Revie article. *Sports Medicine, 49*(2), S139-S151. https://doi.org/10.1007/s40279-019-01161-2

Sarker, M., & Rahman, M. 2017. Dietary fiber and obesity management: A review. *Advances in Obesity and Weight Management Control*, 7(3), 295–297. http://doi.10.15406/aowmc.2017.07.00199

Schönfeldt, H. C., & Hall, N. (2012). *Red meat in nutrition and health*. University of Pretoria.

Smith, J., Holmes, E. H., & McAllister MJ. (2015). Nutritional Considerations for Performance in Young Athletes. *Journal of Sports Medicine*, *2015:* 734649. https://doi.org/10.1155/2015/734649

Tipton, K. D. (2011). Efficacy and consequences of very-high-protein diets for athletes and exercisers. *Proceedings of the Nutrition Society*, *70*(2), 205-214. https://doi:10.1017/S0029665111000024

Trakman, G. L., Forsyth, A., Hoye, R., & Belski, R. (2017). The nutrition for sport knowledge questionnaire (NSKQ): development and validation using classical test theory and Rasch analysis. *Journal of the International Society of Sports Nutrition* 14(1): 26. https://doi:10.1186/s12970-017-0182-y

Valente, R., & Dorofeeva, A. Y. (2018). Sport nutrition: The role of macronutrients and minerals in endurance exercises. *Foods and raw materials, 6*(2), 403-412. https://doi:10.21603/2308-4057-2018-2-403-412

Vorster, H. H., Badham, J. B., & Venter, C. S. (2013). An introduction to the revised food-based dietary guidelines for South Africa. *South African Journal of Clinical Nutrition*, 26(3), S1-S164.