AMERICAN UNIVERSITY OF BEIRUT

EVALUATION OF FACTORS INFLUENCING FOOD CHOICES AMONG AUB WEIGHTLIFTERS AND FOOTBALL PLAYERS

by
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A thesis
submitted in partial fulfillment of the requirements
for the degree of Master of Science
to the Department of Nutrition and Food Sciences
of the Faculty of Agricultural and Food Sciences
at the American University of Beirut

Beirut, Lebanon
April 2024

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Date of thesis defense: April 24, 2024

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my advisor, Dr. Elie-Jacques Fares, for their unwavering support, guidance, and invaluable feedback throughout the entire process of conducting this research and writing this thesis. His expertise, encouragement, and dedication have been instrumental in shaping the direction and quality of this work.

I am thankful to Drs. Ammar Olabi and Ali Chalak, who were part of my thesis committee, for their insightful comments and dedication to maintaining the rigor and academic integrity of this work. Their specialized expertise in their domains has expanded my research and perspectives. I am also grateful to the American University of Beirut for providing the resources and financial support necessary for carrying out this research project, as well as the team at Charles Hostler Center who helped in recruiting the subjects.

I would like to extend my heartfelt acknowledgement to my sister and parents for their unwavering love, encouragement, and understanding throughout this journey. They provided me with an unlimited source of power and motivation to keep pushing through.

Last but not least, I am deeply grateful to my friends and colleagues who have offered their support, encouragement, and understanding during the ups and downs of this academic journey.

ABSTRACT

OF THE THESIS OF

Anna Maria Georges Al Dannaoui for Master of Science
Major: Nutrition

Title: Evaluation of Factors Influencing Food Choices Among AUB Weightlifters and Football Players

General sports recommendations state that athletes need a balanced nutritional diet to optimize their performance, prevent nutrient deficiency, and reduce chronic diseases. Although the current literature focuses on energy and macronutrient content, athletes often make poor choices. The most reported factors influencing food choices include food sensory, psychological, economic, nutrition knowledge, beliefs, and convenience. Since the athletes' food choices are multidimensional and are influenced by their sport, training period, and nutrition knowledge, specialized nutrition plans should be tailored to each athlete to optimize their performance.

This study aims to assess the food choices of athletes, specifically weightlifters and football players, on rest and workout days in a free-choice environment during lunch. Factors influencing the athletes' food choices in terms of performance factors, nutritional knowledge, food sensory factors, and emotional influences were evaluated. Moreover, the athletes' usual dietary practices during their rest and workout days were investigated through a 24-hour dietary recall interview in order to evaluate the quality of the athletes' diet and food intake.

With a convenient sample of 60 AUB athletes (30 football players and 30 weightlifters), the project took place at T-Marbouta on AUB premises over a period of one week per participant. The subject were asked to participate in four experimental sessions. During the morning visit, the anthropometrics and a body composition analysis (BIA) were measured and a 24-hour dietary recall was documented. During the afternoon session, the athletes reported back to fill in a food choice questionnaire. The same procedure was conducted on a rest day as well as on a workout day where athletes were rewarded a monetary amount of $20 ($10 for a free lunch meal and $10 as a compensation) on the Sayrafa rate of 70,000 LBP, which was equivalent to 1,400,000 LBP per experimental day. Analysis of the four 24 HRs was done using the Nutritionist Pro (NutriPro) software (version 7.1.0, 2019, Nutritionist Pro, Axxya Systems, USA) to estimate energy and macronutrients' intakes. The data collected was analyzed using SPSS software.

Results showed no significant differences in the NI of both sports during the rest day and significant changes in their protein intake during their workout day with

184.88±229.13 g in footballers and 178.94±58.71 in weightlifters. When comparing the NI of weightlifters during both experimental days, significant differences were found in terms of EI (2998.23±706.43 kcal during the workout day and 2536.78 ± 716.36 kcal during the rest day), protein (178.94±58.71 g during the workout day and 144.96 ± 54.46 g during the rest day), fats (134.32±49.01 g and 103.93 ± 42.94 g respectively), as well as SFA, MUFA, PUFA, K, Ca, and vitamin D. As for the football players, significant differences were only observed in terms of EI (4077.69±6589.82 kcal on the workout day and 2745.21 ± 984.06 kcal on the rest day) and protein (184.88±229.13 g and 131.59 ±52.99g respectively). As for the factors affecting the food choices of participants, weightlifters' food choices varied between rest and workout days. Nutritional attributes (32%), sensory attributes (25%), familiarity (19%), emotional influences (8%), health awareness (6%), exploring new food (5%), and following a nutrition plan were the main factors. On workout days, these factors were also significant. As for football players, the meal choices were influenced mainly by familiarity (33%), nutritional attributes (23%), sensory attributes (21%) and health awareness (11%) during the rest day and by the meal's nutritional attributes (34%), followed by the meal's familiarity (22%), meal's sensory attributes (19%), and exploring new food (7%) on the workout day.

This study revealed a significant difference mainly between the rest and workout days in both group categories in terms of energy and protein intake, which can be linked to the finding of the food choice questionnaire. Both weightlifters and football players were more likely to base their food choices during their workout days on the meal's nutritional attributes compared to their rest day, which was reinforced by their NI that showed that they generally consumed more energy and protein on their workout day compared to their rest day. The studies exploring this certain topic are limited and more studies including a larger sample size are needed to further confirm the results of this study.

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ABBREVIATIONS

<: Less than

%: Percent

ACSM: American college of sports medicine

ADP: Air displacement plethysmography

AHA: American heart association

AND: Academy of nutrition and dietetics

ATP: Adenosine triphosphate

AUB: American University of Beirut

BCM: Body cell mass

BIA: Bioimpedance analysis

BIVA: Bioelectrical vector analysis

BMI: Body mass index

BMR: Basal metabolic rate

Ca: Calcium

CHDC: Charles Hostler Diet Center

CHO: Carbohydrates

CRP: C-reactive protein

DC: Dietitians of Canada

DEXA: Dual-energy X-ray absorptiometry

ECW: Extracellular water

EE: Energy expenditure

EI: Energy intake

FFM: Fat-free mass

g/kg/day: Gram per kilogram per day

g: Gram

ICW: Intracellular water

IU: International unit

K: Potassium

Kcal: kilocalories

L: Liter

LBP: Lebanese pound

Mg: Magnesium

mg: Milligram

MMA: Mixed martial arts

MPS: Muscle protein synthesis

MUFA: Monounsaturated fatty acids

Na: Sodium

NI: Nutritional intake

NutriPro: Nutritionist pro software

O2: Oxygen

PUFA: Polyunsaturated fatty acids

QMR: Quantitative magnetic resonance

RDA: Recommended dietary allowance

RDI: Recommended daily intake

RM: Repetition maximum

SD: Standard deviation

SFA: Saturated fatty acids

SMM: Skeletal muscle mass

TBW: Total body water

TEA: Thermogenic effects of activity

TEE: Total energy expenditure

USC: University of the Sunshine Coast

Vit C: Vitamin C

Vit D: Vitamin D

Vit E: Vitamin E

Zn: Zinc

μg: Microgram

CHAPTER I

INTRODUCTION

A proper nutritional diet is key to maintain health and well-being (American Dietetic Association, 2009). Athletes, in particular, are required to make conscious and appropriate food choices in order to optimize their sports performance, to prevent nutrient deficiency and to decrease the risk of chronic diseases (Misner et al., 2006). The majority of available literature on athletes' diet and nutrition tends to focus on quantifying dietary intake based on energy and macronutrient content (Thomas et al., 2016). Although dietary guidelines based on such studies offer athletes recommendations on the variety, types, and servings of the various food groups, athletes have generally demonstrated poor skills when choosing meals that meet these guidelines (Wirt and Collins, 2009; Burkhart and Pelly, 2016). For example, Jonnalagadda et al. (2001) suggested that collegiate football players tend to eat too much fast food and small amounts of fruits and vegetables. Fraczek and Gacek (2013) investigated the frequency of consumption of specific food products in a group of Polish athletes. Their results suggested that the athletes did not meet the qualitative recommendations given by the Swiss Food Pyramid, specifically in regards to the frequency of consumption of vegetables, fruits, whole grain cereals, low-fat dairy products, fish, oils, nuts and pastry (Fraczek and Gacek, 2013).

Current literature sheds little light on the ability of athletes to practically translate nutritional recommendations into appropriate food choices that guarantee a nutritious diet and ensure high sports performance. Investigating the factors influencing athletes' food choices is key to understanding athletes' dietary practices, and consequently to improving their food choices. People on average make approximately 220 food choice decisions per day (Wansink and Sobal, 2007). Each of these small decisions is influenced by a variety of different factors, such as food sensory factors, psychological factors, economic factors, nutrition knowledge, beliefs, and convenience among others (Sobal and Bisogni, 2009). Food and nutrition are an integral part of an athlete's life, and so athletes are more likely to be influenced by a number of additional factors than the ones stated above. Achieving specific physique and body weight goals for performance purposes, for example, influences athletes' food choices (Byrne and McLean, 2002). Some sports such as gymnastics and swimming favor a lean and slim physique which may put an added pressure on the athlete to lose weight (Committee on Sports Medicine and Fitness, 2005). Athletes can also be influenced by their coaches' instructions, by other athletes' practices as well as by the culture within a sport (Ono et al., 2012; Long et al., 2011). Moreover, athletes tend to become much more conscious of their food choices when preparing for competitions (Birkenhead and Slater, 2015). Another factor that affects athletes' food choices is their competition level, i.e. whether they are competing at a recreational or elite level since this is directly related to their goal performance (Lamont and Kennelly, 2010).

Very few studies have examined the multidimensional nature of food choices among athletes despite the extensive research on this topic with general populations. Investigating the influence of the different food choice drivers among athletes necessitates the evaluation of several variables, such as the type of sport practiced, the training period and the level of nutrition knowledge of the athletes in addition to the other more common reasons that affect food choice. Different types of training regimes, for example, necessitate different levels of protein and carbohydrate intake. Hypertrophy training uses a variety of moderate to high-intensity exercises performed at approximately

67 to 85% of one-repetition maximum (1RM), which is defined as the heaviest weight that can be lifted with maximum effort in one repetition, with an average of six to 12 repetitions per set and about three to six sets per session (Mangine et al., 2015; Baechle and Earle, 2000). This type of training, which is popular among weightlifters, wrestlers and boxers, requires high levels of protein intake since its aim is to increase muscle mass (Baechle and Earle, 2000). Endurance exercises, on the other hand, involve activities that increase breathing and heart rate and improve the muscle's ability to perform repetitive movements for long periods of time (Thompson, 2018; Morici et al., 2016). Such a training program, which is essential for runners, cyclists, and swimmers, requires high levels of carbohydrate intake (Thompson, 2018). Moreover, although athletes tend to focus on specific training programs, such as endurance or hypertrophy, they commonly shift between these programs in order to achieve better performance and reduce risk of injury (Phillips et al., 2016). Additionally, an athlete's intensity and duration of activity, which affect food choice, vary not only on a weekly or monthly basis, but also from day to day, i.e. a work-out versus a rest day. Thus, it becomes important for athletes to know what to eat during each training phase and on workout and rest days.

The project at hand aims to assess the food choices of athletes, specifically weightlifters and football players, on rest and workout days in a free-choice environment during lunch. Factors influencing the athletes' food choices in terms of performance factors, nutritional knowledge, food sensory factors, and emotional influences were evaluated. Moreover, the athletes' usual dietary practices during their rest and workout days were investigated through a 24-hour dietary recall interview in order to evaluate the quality of the athletes' diet and food intake.

CHAPTER II

LITERATURE REVIEW

A. Definition of endurance and resistance training

1. Definition and benefits of endurance training

An athlete's endurance is a key indicator of their athletic abilities and symbolizes the muscles' ability to stave off tiredness throughout prolonged physical activity (Sun et al., 2022). Such endurance training mainly include running, swimming, cycling, football, volleyball, skiing, and other winter sports (Morici et al., 2016).

One of the main characteristics of endurance sports are the repeatedly contracted large skeletal muscle groups that occur during exercises performed at submaximal intensity. It is also worthy to note that the main goal of endurance exercise is to gradually raise the anaerobic threshold and delay fatigue, which means pushing the start of lactate production and anaerobic metabolism towards higher levels of intensity (Morici et al., 2016). As its name indicates, anaerobic metabolism does not require oxygen to provide fuel for the muscle during workouts that take place over a short time frame at very high intensities and is defined as the production of ATP from glycogen breakdown and fermentation of lactate resulting in eventually lactic acid build-up (Patel et al., 2017). Endurance training pushes the lactic acid threshold and the onset of fatigue through numerous changes made at the level of the metabolism in the muscles, including changes in the type of fiber, and increase of the capillarization of the muscle fibers as well as of the mitochondrial density and oxidative enzymes, which are required for energy production (Morici et al., 2016). In other words, endurance training increases the oxidative capacity of the muscle, stimulates the production of more efficient contractile proteins, and shifts the proportions of the motor units towards more resistance subtypes (Mrówczyński et al., 2019).

When it comes to daily training, the term endurance takes a turn and gets split into anaerobic and aerobic components. On one hand, the term “aerobic endurance" describes the period of time in which the human body and muscles can be utilized in a setting with plenty of oxygen supply, while on the other hand, the term “anaerobic endurance” refers to whether the muscles can sustain a long-term workout by getting its energy supplies from anaerobic pathways. This is why both anaerobic and aerobic endurance need to be performed at the same time in order to effectively improve athletic skills and accomplish the whole training's intended outcome. Overall, it is undeniable that athletes require a certain level of sports skills in order to achieve the results they are aiming for either during competitions or during practices, which makes endurance training an important factor that needs to be taken into consideration in the athletes’ training (Sun et al., 2022).

Apart from improving performance aerobic exercise endurance training was also shown to play a potent role in achieving positive metabolic and cardiovascular outcomes compared to other types of sports due to the fact that large skeletal muscle groups undergo repetitive isotonic contractions during endurance sports. In order to give the muscles the energy they need to convert it into actual mechanical work, aerobic training needs the respiratory and cardiovascular systems to be coordinated. First of all, an increase in cardiac output is required for the skeletal muscles involved to receive the increasing supply of arterial blood and oxygen they need, as well as for the continuous removal of the resulting metabolic wastes, like carbon dioxide and lactate, released by the exercising muscles. At the same time, to contribute to the increased stroke volume in order to match the demand, the left heart ventricle dilates which results in the increase in the heart's ability to contract due to the sympathetic stimulation during the exercise. Furthermore, endurance exercise stimulates the production of nitric oxide at the vascular endothelium level, which is a key player in decreasing the risk of artery stiffness and vasodilation. This is why elite athletes usually have a higher rate of cardiac output compared to sedentary people, which can go up to 40 L per minute during exercise compared to the usual rate of 5 to 20 L per minute (Morici et al., 2016).

The effects of endurance training go beyond the trained muscle itself by reaching the whole human body and improving the overall physical competence. Doing frequent endurance exercises has a direct effect on how the spinal motor neurons function, which in turn impacts how the skeletal muscles contract, acts as a protective factor against metabolic syndrome, regulates fat metabolism, lowers blood glucose levels, which in turn decreases the risk of developing type 2 diabetes, and ultimately lowers the risk of heart problems and cardiovascular diseases while also improving cardiac function. Moreover, endurance training also acts as a protective factor against the development of certain degenerative neurological conditions and mental disorders, increases the antioxidants levels in the body, has an impact on immunity functions, decreases the risk of osteoporosis by increasing bone density, and can delay aging (Mrówczyński et al., 2019).

2. *Definition and benefits of resistance training*

Usually, the term "resistance training" is associated with the idea of lifting weights and building muscles. Up until recently, athletes who competed in other sports generally believed that using weights would actually impair their athletic performance, and the majority of average people did not show any interest in participating in any weightlifting activity. These misconceptions were mainly due to the fact that weightlifting used to be strictly associated with strong men who participated in sports like Olympic lifting, football, bodybuilding, and powerlifting. At that point, it was evident that intense resistance training with high weights had a positive effect on their mesomorphic bodies, and thus that these athletes needed a lot of muscle mass and high levels of strength in order to succeed in their field of sports. As years passed by and lifestyles shifted towards more sedentary patterns, exercising on a regular basis started being promoted in order decrease the health risks that come hand in hand with a sedentary lifestyle and to achieve a healthy body weight. However, resistance training was still being kept in the dark as the light was shed on aerobic exercises instead (Westcott, 2012).

The tables have recently turned and resistance training became the center of attention due its relationship with muscle loss and bone loss prevention, especially in elderly. The loss of skeletal muscle increases the risk of glucose intolerance and related health problems due to the fact that it makes up to 40% of the total body weight, influences several metabolic risk factors, and is the main site for the disposal of glucose and triglycerides (Westcott, 2012). It has now become evident that resistance and strength training can positively impact the human body on different levels across all age groups, and can offer a wide array of health benefits including decreased risk of injury, metabolic syndrome, diabetes and increased lean muscle mass, metabolic rate and bone density. As for athletes, resistance training is naturally essential for athletes due to the increased strength, speed and power it provides and which they require. In addition, contrary to what was previously believed, resistance training can help athletes preserve their lean muscle mass whether they are competing in a weight class sports like wrestling, or in long-distance running or cycling (Thomas, 2016).

B. Sports nutrition and athletic performance

Athletic performance is influenced by many factors and nutrition is one of them. Being a corner stone in affecting athletic performance, setting an athlete's dietary pattern and requirements is not a uniform technique that depends on a number of factors, including the type of sport practiced, athletic goals, overall environment surrounding the athletes, and practicalities that may occur. This explains why the importance of personalized nutrition counseling that combines daily nutritional guidance with targeted counseling prior to, during, and following training and/or competition, is becoming more widely acknowledged (Beck, 2015). Accordingly, the American College of Sports Medicine, Dietitians of Canada, and the Academy of Nutrition and Dietetics all hold a shared position that smart dietary choices have a direct impact on improving both athletic performance and recovery (American College of Sports Medicine, 2016).

1. Nutrition and endurance sports

In the past few years, endurance sports have become a popular activity worldwide with a significant increase in the overall participation in all types of endurance competitions. However, the best sports nutrition recommendations for endurance sports still pose an issue of debate with several contrasting views being proposed by different healthcare professionals (Vitale, 2019). Sports like running, swimming, cycling, triathlons, skiing, or walking, as well as other subdisciplines within these sports, are all performed by endurance athletes. As a result, the energy needs of endurance athletes could significantly change across different types of sports and training cycles, as well as the distinct nature of the athlete's physiological state (Carlsohn, 2016).

a. Energy intake

One of the main characteristics of endurance sports is extended periods of aerobic exercise, which impose special demands on the athlete's energy systems. As a result, the total energy expenditure (TEE) of endurance athletes is usually 1.8 to 2.3 times higher than their resting energy expenditure, but can reach up to 4 times higher during short periods of time in elite endurance athletes (Carlsohn, 2016). To maximize performance and guarantee appropriate fueling methods, athletes, coaches, and sports scientists must demonstrate a thorough understanding of the energy requirements of endurance sports. When it comes to determining an athlete's energy requirements, a lot of factors can mix up the formula. To begin with, the training's periodization and competition cycle determine an athlete's energy needs, which in turn might fluctuate daily during the year due to fluctuations in training volume and intensity. Furthermore, exposure to cold or heat, anxiety, stress, high altitude, certain physical injuries, some drugs or medications that include caffeine or nicotine, and increases in fat-free mass are among the factors that increase energy needs over normal baseline levels. On the other hand, aging, decreased muscle mass and reduced training time can have a lowering effect on the daily energy requirements of the athlete (American College of Sports

Medicine, 2016). Overall, the main factors that influence endurance athletes' TEE include their weight, body composition, gender, age, non-exercise activities, as well as the frequency, duration, and intensity of their training. In endurance athletes, meeting the recommended energy intake is a major key player in improving performance and meeting goals (Carlsohn, 2016).

As a definition, energy balance is reached when TEE, which is made up of the total of basal metabolic rate (BMR), thermogenic effects of food (TEF), and thermogenic effects of activity (TEA), matches total energy intake (EI). When it comes to trying to estimate the value of energy expenditure (EE), athletes can benefit from the techniques usually used to estimate the TEE of sedentary and moderately active individuals. Nevertheless, this approach has significant limits, especially when it comes to highly competitive athletes (American College of Sports Medicine, 2016).

b. Carbohydrates intake

Athletes who compete in endurance sports improve their aerobic capacity to endure tough, long-lasting physical demands. It is worth mentioning that the amount of endogenous carbohydrates stored in the body and/or the availability of dietary carbohydrates (CHO) during athletic activities influence athletes' aerobic training fatigue and physical performance (Baranauskas, 2015). CHO have drawn a lot of interest in the field of sports nutrition by playing a role in determining how well athletes perform and adjust to training. To begin with, the amount of CHO stored in the human body can be rapidly manipulated through diet or even a single workout session on a daily basis. In addition, since glucose is used by both anaerobic and oxidative pathways, carbohydrates can serve as an essential fuel for the brain and central nervous system as well as a substrate that can fuel the muscle activity and can support exercise over a wide range of intensities (American College of Sports Medicine, 2016).

According to the American College of Sports Medicine (ACSM), Dietitians of Canada (DC), and the Academy of Nutrition and Dietetics (AND), endurance athletes doing moderate exercise equivalent to 1 hour per day are required to consume 5-7 g/kg of bodyweight per day of CHO, while those doing moderate to high intensity exercise equivalent to 1–3 hours per day need 6–10 g/kg/day. Furthermore, up to 8–12 g/kg/day may be required by ultra-endurance athletes who commit to extremely high levels of daily activity that is equivalent to 4-5 hours of moderate to intense exercise each day (Vitale, 2019).

Compared to fat, CHO in the form of blood glucose and muscle glycogen have the benefit of producing more ATP per volume of oxygen (O2) (Spriet, 2014). However, the depletion of CHO storage in the liver and muscles is linked to fatigue, impaired concentration and poor performance (Getzin, 2017). As a result, the focus on carbohydrate intake for endurance athletes was split between loading before the competition as well as during the event.

i. Loading before the event

On one hand, if the event was to last less than 90 minutes, athletes should consume a recommended intake of 7 to 12 g of CHO 24 hours prior to the competition (Jäger, 2017). On the other hand, if endurance athletes were to participate in an event lasting more than 90 minutes, a CHO loading of 10 to 12 grams, or glycogen supercompensation, is recommended 36 to 48 hours before the athletic event to optimize the athletes’ performance (Jeukendrup, 2005). Finally, a single dose of approximately 4 g/kg of CHO should be taken in the final 1 to 4 hours before the event in order to top off liver glycogen stores. This is usually done to reverse liver glycogen depletion, since endurance competitions usually take place in the early morning just after the overnight fast (Vitale, 2019).

ii. During and after the event

Administering CHO during the event, also known as fueling, can be crucial in delaying fatigue and improving performance. If the event lasts no more than an hour, no additional CHO are required. However, if the event lasts for 1 to 1.5 hours, 30 to 60 grams of CHO are required in the form of a 6 to 8% CHO concentrated solution taken every 15 minutes (Burke, 2011; Thomas, 2016). Moreover, higher CHO intakes of 60–70 g per hour, and even up to 90 g per hour if tolerated, are linked to better performance during events that last for more than 2.5 hours (Jäger, 2017).

When the event is over, or there is an eight-hour gap between the sessions, recovery is crucial to be able to replenish the stores drawn out during the competition. This is why an average amount of 1 to 1.2 g per kg per hour is recommended to be taken during the first 4 hours after the event (Carlsohn, 2016).

c. Protein intake

Unlike other sports that require a certain physical strength like resistance training or weightlifting, the nutrition focus in endurance training does not seem to focus on protein intake. However, it is undeniable that regardless of whether an athlete trains for endurance or resistance, adequate protein intake and timing are essential key players (Vitale, 2019). While recreational endurance athletes who exercise for thirty minutes four or five times a week don’t seem to need more than the recommended intake of 0.8 to 1 g of protein per kg of body weight per day (g/kg/d) for inactive individuals, athletes who compete in endurance sports should consume 1.2 to 1.4g/kg/d of protein and elite endurance athletes may need up to 1.6g/kg/d of protein (Carlsohn, 2016).

d. Fat intake

Although appropriate fat intake usually receives less attention from endurance athletes compared to CHO, it is important to shed the light on the role it plays as a valuable source of energy. Fats serve as essential constituents of cell membranes and provide essential fatty acids, like omega-3, to the athletes. They also play roles in nerve function, signaling and transport, as well as the protection of vital organs. This is why it is recommended that endurance athletes adhere to the public health guidelines in order to maintain appropriate fat intake which is at least 20% of their total energy intake. It should be noted that limiting fat intake prior to a race should only be considered during the CHO loading phase or directly before the event to prevent any gastrointestinal discomfort (Vitale et al., 2019).

e. Hydration

Endurance activities are known to be challenging and can make the athletes sweat more than other types of sports. However, it is worth mentioning that endurance athletes' sweat rates can significantly differ from one athlete to another depending on a variety of factors, including the type, intensity and duration of the sport, gender and fitness level of the athlete, as well as ambient conditions like temperature and humidity

(American College of Sports Medicine, 2007). A dehydration level exceeding a 2% loss of body weight was shown to affect the athlete's performance, especially in marathons, and induce an elevation in body temperature or hyperthermia. This is why athletes are prompted to stay hydrated in events lasting more than 90 minutes, which in reverse was shown to increase the chance of hyponatremia, or low sodium blood levels, at the end of the event if too much fluid is consumed (Vitale, 2019). Based on a study conducted by Noakes et al (2003), the International Marathon Medical Directors generated new recommendations regarding fluid intake during endurance events that suggest that the athletes start with 400 to 800 mL of fluid per hour. However, athletes should follow a customized hydration strategy that takes many factors into account such as sweating rates, sodium content in sweat, activity intensity, body temperature, ambient temperature, body weight, and kidney function. According to the American College of Sports Medicine (ACSM), athletes who are heavier and compete in warm conditions should drink more water whereas athletes who are lighter and compete in colder weather should have lower fluid recommendations (American College of Sports Medicine, 2019).

2. *Nutrition and resistance training*

Unlike endurance training, resistance training focuses on increasing power through an increase in muscle mass. In order to achieve that, the athlete needs to follow a proper nutrition plan to build muscles efficiently, which implies that gaining muscle and nutrition should work synergically to achieve that goal.

a. <u>Protein intake</u>

Several studies have investigated the association between diet, particularly protein intake, and muscle strength. Due to the fact that it is a primary structural component of skeletal muscle and that it promotes muscle protein synthesis through the mammalian target of the rapamycin signaling pathway, protein was found to have a strong nutritional role in muscle synthesis (Tagawa, 2022).

To begin with, it is important to shed the light on the mechanisms that endogenous protein goes through before being utilized by the body, and on the fact that the ability of skeletal muscle to use individual amino acids for muscle synthesis is surpassed by the ability to digest and absorb dietary protein (Stokes, 2018). Upon digestion, the intestines extract almost half of the ingested protein to be used in the gut as a source of energy and local protein synthesis. The remaining portion of amino acids is then released into the blood circulation to be used by other organs or tissues. Even though it is undeniable that the human skeletal muscle mass serves as a major storage facility for amino acids, not every amino acid released into the circulation is actually intended to be used in newly formed skeletal muscle tissues (Groen, 2015).

In addition, the fact that resistance training stimulates muscle protein synthesis (MPS) is undeniable. In fact, studies conducted by MacDougall (1995) and Philips (1997) showed that resistance training increased the rate of protein synthesis by almost 34% within 2 to 4 hours post-exercise and lasted for 24 to 48 hours. Furthermore, it should be noted that the absence of one or more essential amino acids in low quality proteins, such as plant proteins, decreases the rate at which MPS is stimulated compared to higher animal quality sources like meat. However, the increase in plasma amino acid concentrations after a high protein meal promotes the absorption across the muscle membrane regardless of the source of protein (Stokes, 2018). One way to briefly explain this relationship is that amino acid transport proteins genes expression can be induced by protein consumption, which could lead to an increase in the amount of amino acids entering the skeletal muscle (Bohe, 2001).

When it comes to actual daily protein intake, athletes can fall into the common mistake of being carried away and overconsuming protein mainly from supplements. While the timing, dosage, and source of protein do play a role in the effectiveness of protein intake and/or supplementation on MPS, they are not always correlated to improved muscle growth. In fact, when the training goal is to increase muscle mass with resistance training, a daily protein intake of approximately 1.6 g/kg/day or as high as 2.2 g/kg/day seems to be the most important aspect to take into account. Although these might seem like a lot, these numbers can be met by including high-quality protein sources in all meals and, if needed, by adding high-quality whey or casein protein supplements to the diet (Stokes, 2018).

b. <u>Carbohydrates intake</u>

Although carbohydrates are an essential source of energy and are considered a key player in the nutrition of endurance athletes, little research has focused on the daily recommendations in resistance training. However, what is certain is that resistance training's requirements can vary in terms of amounts of carbohydrates since it is metabolically different from endurance exercise and thus produces different adaptive responses to training (Henselmans, 2022). Given the high-intensity nature of RT and the differences between its energetic demands compared to endurance training, CHO consumption must be specifically tailored to the demands and unique stimuli of resistance training (King, 2022). A clear conflict is seen in the literature concerning the effect of acute CHO ingestion on resistance training performance. It appears that consuming carbohydrates does not increase maximal strength, peak isokinetic force, peak power, or peak torque. However, especially during longer resistance training sessions that last for more than 45 minutes, CHO consumption frequently enhances performance indicators such as total isokinetic activity accomplished, and total number of sets and repetitions completed to failure (Haff, 2001).

To further clarify the matter, carbohydrates are usually stored in the form of glycogen in the muscles and liver at 350–700 g and 80–120 g, respectively (Knuiman, 2015). What happens is that muscles resort to anaerobic glycolysis pathways to breakdown glycogen and generate energy during low high-load resistance training since there is not enough oxygen present for the aerobic system and fatty acids to produce energy quickly enough, which explains why low glycogen stores or even depletion can hinder performance (Ortenblad, 2013).

As for the recommended carbohydrates intake, previous studies have suggested intakes of 8–10 g/kg of bodyweight per day for heavy anaerobic training, whereas other research have suggested an intake of 4-7 g/kg/day for strength athletes to maximize strength, performance and hypertrophic responses (Pendergast, 2011; Slater, 2011).

C. Training and body composition

The health benefits of both endurance and resistance training have been well documented and mentioned earlier. There is no doubt that following a regular training program was shown to change the athlete’s body composition as well as significantly decrease inflammatory markers, especially the c-reactive protein (CRP), which in turn decreases the overall risk of developing cardiovascular and other chronic diseases (Reza, 2018). Apart from health benefits, athletes more than others care about their weights and body compositions according to the demands of every sport. As a result, athletes usually have to closely monitor their body compositions and modify their diet and training regimens based on the needs of their particular sport (Saltzmen, 2013).

1. Body composition measuring tools

Many tools have been designed to try to accurately measure the different components of the human body, of which fat mass, skeletal muscle mass and intracellular/extracellular water matter the most when it comes to athletes (Campa, 2021).

a. Bioimpedance (BIA)

The most popular technique for measuring body composition in both dietetic clinical settings and scientific research studies is the bioimpedance analysis (BIA). The main strength of this methos is that it can quickly and easily measure total body water (TBW), including extracellular and intracellular water. Furthermore, it can also give an estimation of the fat free mass (FFM) as well as the fat mass (Lemos, 2017). The machine operates using electrodes that can vary from two to eight with the accuracy increasing in parallel with the number of electrodes. Compared to traditional wrist-ankle measurement, the 8-electrode segmental system has been reported to be more accurate and to provide separate assessment of the trunk and limbs (Westphal, 2017). In addition to the fat and fat free mass, the BIA also generates a value known as a phase angle that is calculated using the reactance-to-resistance ratio's arctangent and provides insight on the hydration level and cell mass of the subject. Phase angle increases with increasing FFM and decreases with age and height. For instance, in individuals over 65, a low phase angle is linked to an increased risk of mortality as well as poorer overall health outcomes compared to those presenting higher values (Genton, 2017).

The main BIA's limitation is that it depends on fixed hydration assumptions, which makes the use of BIA for body composition calculations unreliable in clinical settings where the hydration varies. A clear example would be pregnancy where TBW rises by roughly 6 liters, which is against the 73% hydration recommendation. In this case, the BIA would most likely generate false results and overestimate TBW values (Lemos, 2017).

b. <u>Bioelectrical vector analysis (BIVA)</u>

The bioelectrical impedance vector analysis (BIVA) generated from resistance and reactance measurements is a method used to monitor the hydration status and to assess nutritional status in diverse populations. Unlike the BIA, the results obtained are plotted on a graph. For instance, when comparing groups with distinct characteristics, the BIVA can detect differences in the hydration status, where the resistance/height axis (long vector) is observed. Differences in the body composition components, such as body cell mass (BCM), are also detected where the reactance/height axis (short vector) is observed through the graph of individuals in ellipses plotted on the graph (Martins, 2022).

This method is particularly becoming more widely used in the athletic world due to the fact that it can detect athletes presenting a high risk of injuries by monitoring their hydration status and detecting a possible risk of dehydration that can significantly increase the risk of injuries (Castizo, 2018).

c. Quantitative magnetic resonance (QMR)

The QMR EchoMRI is relatively a new tool developed to assess body composition and has been validated for use in adults weighing less than 250 kg. Furthermore, an EchoMRI/Small has been validated to be used in children weighing between 3 to 50 kg, and the EchoMRI infants to be used in infants weighing a maximum of 12 kg (Ramos, 2017). This technique allows a relatively accurate measurement of lean mass, TBW, and fat mass. During the test, the individual is asked to lay horizontally with his face and torso facing up for 2 to 4 minutes. One major benefit of this technique is that it does not require the participant to stay completely still, which is very useful for evaluating newborns and children (Napolitano, 2008).

d. Air displacement plethysmography (ADP)

ADP is a quick, non-invasive procedure that doesn't require technicians to undergo serious training. Using air displacement inside a sealed chamber, this technique estimates body volume. Another version of the test (PEA POD) has been also validated for use in infants and is used to assess the body composition of newborns (up to 6 months or weighing up to 8 kg) (Lemos, 2017).

The presumption of a hydration constant for FFM is one of ADP's limitations since it is possible to overestimate or underestimate FFM hydration when it deviates from the assumption. For instance, FFM density will be increased resulting in an overestimation of FFM as well as an underestimation of fat mass if the FFM is dehydrated in comparison to the assumption. In return, the exact opposite could happen in case the FFM was overhydrated (Kendall, 2017).

e. Dual-energy X-Ray absorptiometry (DEXA)

Known to be used on people of all ages and to be relatively inexpensive, DEXA is considered to be one of the most frequently used methods for studying body composition. Furthermore, it is currently the only method for measuring bone density and can provide values for fat, bone, and bone-free lean for each leg and the trunk by the whole-body scan output (Lemos, 2017).

One of the main limitations of DEXA is that it requires the use of a low radiation dose and that it must be performed by a licensed radiology technician or physician. As a result, this method is not usually used on small children and is unsuitable for pregnant women (Bone, 2017).

2. *Body composition and performance*

It is undeniable that sports performance greatly depends on both the nutrition regimen followed by the athlete as well as their body composition. However, the light should be shed on the fact that athletic performance cannot be exactly determined by the athlete's body composition no matter how important that is, and thus, a specific body composition recommendation cannot be generated for a group of athletes (Borgen, 2013). Instead, tailored nutrition programs to reach body composition goals specific to each subject should be implemented.

As mentioned earlier, the existing relationship between body composition and athletic performance cannot be disregarded and does have a great impact on the athlete's career on certain occasions. On one hand, certain types of sports require the athletes to focus on increasing their body weight and/or fat-free mass in order to optimize their performance. For instance, athletes competing in sports related to strength and power, like bodybuilding, usually focus on increasing their lean muscle mass during the hypertrophy phase of their training. While some athletes strive for maximum size and strength, like bodybuilders, it is far more crucial to aim for maximum power to weight ratios rather than focusing on simply increasing power in other sports. In this case, athletes tend to focus on their own body weight rather than their body composition since they compete within weight divisions like combat sports (Stellingwerff, 2011). On the other hand, other types of sports like distance running and cycling actually require the athletes to maintain a relatively low body fat percentage and/or body weight to decrease the use of energy, improve their agility, increase their speed and to overall decrease sweating by decreasing the weight to surface area for heat dissipation (American College of Sports Medicine, 2016).

CHAPTER III

MATERIALS AND METHODS

A. Setting

The project at hand took place at T-Marbouta on AUB premises which consists of a range of service areas including a homemade breakfast area, a hot and cold sandwich area, a daily platter area, a Lebanese barbeque area, a Saj and oven area, and a salad area. This facility was specifically chosen to give the recruited athletes the free choice to choose their lunch from a variety of food items offered by this restaurant. The menu is attached in appendix A.

B. Subjects

A convenient sample of 60 male athletes (18-24 years of age) were recruited from the Charles Hostler Student Center at AUB. The project at hand targeted weightlifters (n=30), who mainly focused on hypertrophy training, and football players (n=30) who mainly focused on endurance training.

Athletes were selected based on the following inclusion criteria:

(a) They should be males;

(b) They should be weightlifters or football players;

(c) They should be committed to participating in 4 experimental sessions.

The participation in this study was voluntary, and athletes had the right to terminate their participation at any point during the experiment. In each of the experimental days, recruited athletes were rewarded a monetary amount of $20 ($10 for a free lunch meal and $10 as a compensation) on the Sayrafa rate of 70,000 LBP, which was equivalent to 1,400,000 LBP per experimental day.

C. Protocol

The project at hand took place over two experimental days, one rest day and one workout day. The experimental procedure is summarized in **Figure 1**. The morning session included a body composition analysis and a 24-hour dietary recall interview, whereby participants were asked to specify what they ate and drank in the last 24 hours. To be as accurate as possible, the quantities reported by the athletes were based on measuring cups and spoons models shown to the participants during the interview.

On the afternoon of that same day, athletes were asked to fill in a food choice questionnaire to specify what they had for lunch and what factors influenced their lunch choice. More details are provided in the upcoming sections.

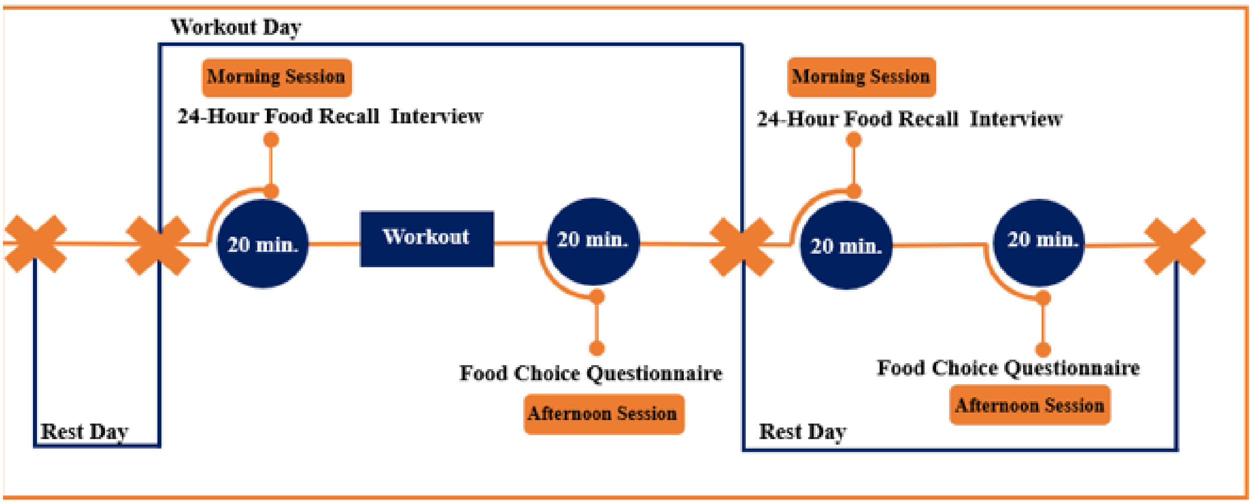


Figure 1 Summary of the experimental procedure

1. 24-hour dietary recall interview

The 24-hour dietary recall is a subjective and retrospective method that involves accurately recalling, describing and quantifying one's food and beverage consumption in a 24-hour period, i.e. from one's first intake in the morning until the last intake just before going to sleep (Castell et al., 2015). The interview was conducted face-to-face with each of the recruited athletes and targeted the 24 hours leading up to each experimental day. Various support tools were used, such as models of various serving sizes, food volumes, and ingredients of some food items in order to help the subjects with the recall procedure and to maximize the accuracy of the quantities reported. Collected information described the types of consumed foods, their characteristics i.e. whether they are fresh, pre-cooked, frozen, etc., their preparation methods, the estimated quantity of food consumed, and the time and place of their consumption (Castell et al., 2015). The designed 24-hour food recall questionnaire that was used in this project is provided in Appendix B. This questionnaire was adapted from samples provided by the Food and Agriculture Organization (FAO, 2018).

2. Food choice questionnaire

Recruited athletes were given a food choice questionnaire that included questions related to the athletes' demographic characteristics, training regime, source of nutrition information, any dietary regime followed, as well as pictures representing the percentage of food left on the plate. They were asked to select a menu item for lunch. Participants were also asked to specify the reasons for their food choice from a list of factors. These factors included the meal's nutritional attributes, the meal's sensory attributes, the meal's novelty or familiarity, the athlete's health awareness, any emotional influences, such as mood or stress, and whether or not that meal was part of a specific diet plan they were following. Moreover, athletes were asked to elaborate further on the reason for their lunch choice through an open-ended question in order to investigate specific reasons for the meal selection, in addition to the broader factors influencing food choice. Furthermore, the participants also needed to rate the overall acceptability of the meal that they selected on a nine-point hedonic scale as well as to specify the percentage of leftover food, if present. The designed food choice questionnaire that was used in this project is provided in Appendix C.

3. Anthropometrics and body composition

a. Height

The participants' height was measured during the initial visit using the Seca 274 stadiometer, that consists of a ruler and a sliding horizontal piece that allows to measure the subject's height once it is fixed at the top of one's head. The measures were taken to the nearest 0.1 centimeter.

a. Body composition

After having measured their height, the body composition was measured using the InBody 770 model. Before performing the test, the subjects were instructed on not eating a heavy meal or drinking sodas and caffeinated beverages at least 2 hours prior to coming to the lab. The participants were asked to remove any heavy accessories or material they might be carrying and to step on the machine barefoot to maximize the accuracy of the test. Upon inserting the participants' age and height, the machine measured their weight and generated a data sheet that included their body mass index (BMI), estimated basal metabolic rate (BMR), fat mass, skeletal muscle mass (SMM), total body water (TBW), intracellular water (ICW) and extracellular water (ECW).

D. Nutritional analysis

The nutritional analysis of the 24-hour recalls on both rest and workout days was carried out on the Nutritionist Pro (NutriPro) software (version 7.1.0, 2019, Nutritionist Pro, Axxya Systems, USA). The generated values taken into consideration were in terms of energy (kcal), protein (g), carbohydrate (g), fat (g), cholesterol (mg), saturated fatty acids SFA (g), monounsaturated fatty acids MUFA (g), polyunsaturated fatty acids PUFA (g), sodium (mg), potassium (mg), calcium (mg), sugar (g), vitamin D (IU), vitamin C (IU), vitamin E (IU), folate (mg), magnesium (mg), zinc (mg) and iron (mg). The values were used to evaluate the nutrition status of the athletes as well as to draw differences between both experimental days and between the two different sports studied.

E. Statistical analysis

SPSS, a statistical software (version 25, IBM Corporation, Armonk, NY, USA), was used to perform data analysis. Hypothesis testing was performed using a 95% confidence level to evaluate the association between the diet quality of the chosen meal with respect to the sports category, training day, and previous nutritional knowledge. After testing for normality, the difference in means of the BIA components as well as the NI between rest and workout days across both sports was done using the independent-t test for normal values and the Man-Whitney U test for not normal ones. The comparisons of the mean NI intake within the same sport category on both experimental days was performed using the paired sample t-test for normal values and the Wilcoxon test for the not normal ones. The frequency of selecting a food choice factor as a reason for the athletes' meal choice was also determined according to the type of sport and the training phase using proportions. The comparisons of these factors between the two experimental days as well as between the two sports category was performed using the Chi-square test. In all of the tests, statistically significant differences were determined at a p-values of <0.05.

CHAPTER IV

RESULTS

A. Descriptive data

1. Demographic Characteristics

The study was conducted on a total of 60 participants, which their demographic characteristics are represented in Table 1. The study sample consisted of only men athletes (100%) with an equal distribution between weightlifters (n=30) and football players (n=30). The participants' mean age was 20.19 ± 0.24 years.

Table 1 Demographic characteristics of the study population

	n= 60
	Mean ± SD
Age (years)	20.19 ± 1.85
	n (%)
Gender	
Male	60 (100)
Sport	
Weightlifting	30 (50)
Football	30 (50)

2. Anthropometric Characteristics and Body Composition of the Study Sample

The table below depicts the anthropometrics measurements of the study sample. As shown in Table 2, the mean weight of all the subjects was 81.2 ± 3.13 kg with no statistically significant difference between weightlifters and football players. The mean height was 179.16 ± 6.96 cm with a statically significant difference between weightlifters (177.36 ± 6.39 cm) and football players (180.97 ± 7.15 cm). The mean BMI was 25.29 ± 3.13 kg/m^2 with no statistically significant difference between weightlifters and football players. As for the body composition analysis, no statistically significant difference between weightlifters and football players was found, with the mean fat percentage of all the participants being 15.53 ± 5.57 %, SMM percentage being 47.62 ± 3.8, TBW being 48.83 ± 8.01 L, ICW being 31.33 ± 3.62 L, and ECW being 18.27 ± 2.08 L.

Table 2 Anthropometric and body composition measurements of the study population

	Total (n=60)	**Weightlifters (n=30)**	**Football players (n=30)**	**P-values***
Mean ± SD				
Weight (kg)	81.2 ± 3.13	81.64 ± 12.23	80.77 ± 10.07	0.76
Height (cm)	179.16 ± 6.96	177.36 ± 6.39	180.97 ± 7.15	**0.04**
BMI (kg/m^2)	25.29 ± 3.13	25.94 ± 3.52	24.65 ± 2.57	0.11
Fat (%)	15.53 ± 5.57	15.52 ± 5.95	15.53 ± 5.26	0.99
SMM (%)	47.62 ± 3.8	47.41 ± 4.18	47.84 ± 3.45	0.61**
TBW (L)	48.83 ± 8.01	49.98 ± 6.16	47.68 ± 9.48	0.49**
ICW (L)	31.33 ± 3.62	31.6 ± 4.03	31.06 ± 3.21	0.56
ECW (L)	18.27 ± 2.08	18.38 ± 2.2	18.16 ± 1.98	0.69

*Independent t-test was conducted to compare between weightlifters and football players

**Man-Whitney test was used to compare between weightlifters and football players

3. Nutritional Intake of the Study Sample during Rest Days and Workout Days

The athletes' daily energy intake on rest and workout days as well as their intake of the major macro and micronutrients was estimated using the NutriPro software. Table 3 shows the energy and macronutrients intake of both weightlifters and football players during their rest day. The mean energy intake of weightlifters and football players was 2536.78 ± 716.36 kcal and 2745.21 ± 984.06 kcal respectively. The mean protein intake of weightlifters and football players was 144.96 ± 54.46 g and 131.59 ±52.99 g respectively. However, it is worthy to note that no statistically significant difference was found between the two categories. The rest of the data is shown in the table below.

Table 3 Energy and macronutrients intake during rest day

	Total (n=60)	**Weightlifters (n=30)**	**Football players (n=30)**	**P-value**
Mean ± SD				
Energy (kcal)	2640.99 ± 859.8	2536.78 ± 716.36	2745.21 ± 984.06	0.44*
Protein (g)	138.27 ± 53.7	144.96 ± 54.46	131.59 ±52.99	0.37*
Carbohydrates (g)	276.09 ± 135.24	257.67 ± 120.09	294.51 ±148.611	0.29**
Fats (g)	108.41 ± 45.59	103.93 ± 42.94	112.90 ±48.41	0.22**

Cholesterol (mg)	641.97 ± 413.54	746.49 ± 454.35	537.45 ±344.81	0.07*
SFA (g)	33.57 ± 12.83	31.49 ± 12.29	35.65 ±13.22	0.24*
MUFA (g)	41.9 ± 19.35	42.75 ± 22.38	41.05 ±16.1	0.92*
PUFA (g)	19.99 ± 11.14	17.66 ± 9.22	22.33 ±12.49	0.13*
Sugar (g)	77.09 ± 57.76	63.83 ± 39.94	90.35 ± 69.48	0.21*

*Mann-Whitney test to compare between weightlifters and football players
**Independent t-test to compare between weightlifters and football players

Table 4 depicts the energy and macronutrients intake during workout day of both categories. The mean energy intake of weightlifters and football players during workout days was shown to be 2998.23±706.43 kcal and 4077.69±6589.82 kcal respectively. While no statistically significant differences were shown in terms of energy, the mean protein intake of football players (184.88±229.13 g) was shown to be statistically significantly different and higher than that of weightlifters (178.94±58.71 g) during workout days (p=0.03). In addition, the cholesterol intake of weightlifters (783.3 ±494.17 mg) was shown to be statistically significantly higher than that of football players (576.53±590.27 mg) (p=0.01). No other statistically significant differences were observed.

Table 4 Energy and macronutrients intake during workout day

	Total (n=60)	**Weightlifters (n=30)**	**Football players (n=30)**	**P-value**
Mean ± SD				
Energy (kcal)	3537.97±4678.29	2998.23±706.43	4077.69±6589.82	0.63*

Protein (g)	181.92±165.85	178.94±58.71	184.88±229.13	**0.03***
Carbohydrates (g)	290.65±100.52	271.14±93.51	310.16±104.99	0.13**
Fats (g)	128.13±44.59	134.32±49.01	121.93±39.56	0.14**
Cholesterol (mg)	679.92±549.69	783.3 ±494.17	576.53±590.27	**0.01***
SFA (g)	36.73±14.62	39.03±15.62	34.41±13.42	0.31*
MUFA (g)	51.20±23.08	55.73±24.97	46.67±20.45	0.13*
PUFA (g)	22.95±11.67	24.64±13.66	21.25±9.21	0.45*
Sugar (g)	89.94 ± 93.58	74.68 ± 46.79	105.19 ± 123.01	0.28*

*Mann-Whitney test to compare between weightlifters and football players
**Independent t-test to compare between weightlifters and football players

Tables 5 and 6 represent the micronutrients intakes during rest days and workout days respectively. The only statistically significant difference observed between weightlifters and football players was in terms of vitamin D intake during their workout day (p=0.04) with a mean intake of 135.74±107.22 IU in weightlifters compared to a mean intake of 89.38±107.82 IU in football players.

Table 5 Micronutrients intake during rest day

	Total (n=60)	**Weightlifters (n=30)**	**Football players (n=30)**	**P-value***
Mean ± SD				
Na (mg)	2958.93±1507.11	2814.58±1364.31	3103.28±1648.21	0.66
K (mg)	2869.01±1390.72	2794.88±1114.46	2943.12±1637.54	0.77

Ca (mg)	1255.63±2191.31	931.07±455.26	1580.19±3056.81	0.32
Vit D (IU)	79.78±80.96	92.30±81.13	67.27±80.19	0.14
Vit C (IU)	67.72±93.28	58.75±52.49	76.69±121.59	0.97
Vit E (IU)	4.99±12.54	7.18±17.13	2.80±4.09	0.3
Folate (mg)	485.62±321.93	500.90±325.69	470.33±322.94	0.73
Mg (mg)	319.88±144.51	342.81±149.04	296.96±138.52	0.19
Zn (mg)	13.16±5.63	14.11±6.30	12.22±4.79	0.31
Iron (mg)	18.64±7.99	18.33±8.44	18.95±7.65	0.51

*Mann-Whitney test to compare between weightlifters and football players

Table 6 Micronutrients intake during workout day

	Total (n=60)	**Weightlifters (n=30)**	**Football players (n=30)**	**P-value***
Mean ± SD				
Na (mg)	3219.01±1467.42	3169.58±1455.99	3268.44±1502.97	0.35
K (mg)	3293.05±1494.73	3430.44±1532.14	3155.67±1470.39	0.4
Ca (mg)	1008.31±599.98	1162.75±654.58	853.88±504.52	0.09
Vit D (IU)	112.56±109.13	135.74±107.22	89.38±107.82	**0.04**
Vit C (IU)	72.31±85.45	63.65±74.3	80.96±95.81	0.32
Vit E (IU)	4.49±8.74	4.18±5.63	4.80±11.12	0.39
Folate (mg)	491.16±359.12	469.18±266.44	513.14±254.19	0.53
Mg (mg)	349.96±149.83	380.56±173.3	319.36±117.05	0.13
Zn (mg)	12.95±6.84	12.46±5.89	13.44±7.75	0.34
Iron (mg)	19.41±7.35	18.79±7.15	20.03±7.62	0.64

*Mann-Whitney test to compare between weightlifters and football players

4. *Food Choice Questionnaire*

a. Weightlifters

17% of participants reported being part of a varsity team at AUB that included rugby (n=2), MMA (n=1) and handball (n=2). 67% of the participants reported acquiring a professional nutritional opinion at some point, which is shown in figure 2. The majority of weightlifters (40%) sought nutritional advice from a dietitian outside the Charles Hostler Diet Center (CHDC) at AUB, 35% from the CHDC and 25% reported having acquired nutrition knowledge from other sources.

When asked whether they are following a certain nutrition plan or not, 53% of the weightlifters reported following a nutrition plan while 47% were not following a specific one. The following open-ended question asking the participants to elaborate on their answer collected a pool of similar answers that revolved around the focus on high protein intake in their diet. The most frequently repeated answers were as follows:

"Focusing on high protein intake"

"Following a high protein and moderate carbohydrates diet"

"Following a bulking diet"

"Following a high protein diet with maintenance calories"

When asked to indicate the factors that affected their food choices at T-Marbouta during the intervention, the answers varied between rest days and workout days. Figure 3 shows the percentage of answers reported by weightlifter on a rest day. The main factor contributing to their choice of meal was related to the nutritional attributes (32%), followed by the meal's sensory attributes (25%), meal's familiarity

(19%), emotional influences (8%), health awareness (6%), exploring new food (5%), and following a nutrition plan (5%).

As for the workout day, figure 4 shows that the main factor contributing to the food choices made was also related to the meal's nutritional attributes (38%), followed by the meal's sensory attributes (23%), meal's familiarity (20%), following a nutritional plan (9%), health awareness (8%), exploring new food (1%), and emotional influences (1%).

When asked to elaborate using an open-ended question, the most recurrent answers were:

"I chose a tawouk sandwich with a side of humus because it is high in protein and carbohydrates"

"I went for proteins and made sure to include fats and carbohydrates so I chose grilled chicken with fries"

"I chose a tawouk platter because it is high in proteins"

When asked about the meal's acceptability during the rest day intervention, the majority of weightlifters (37%) reported liking their meal moderately, 34% liked their meal very much, 13% extremely liked their meal, 13% slightly like it and 3% reported neither liking nor disliking it. The results are illustrated in figure 5. As for the workout day, most weightlifters (44%) reported liking their meal very much, followed by 40% of athletes liking it moderately, 13% liking it slightly and 3% also reported neither liking nor disliking it. The results are illustrated in figure 6.

Finally, when asked to state the amount of leftover food according to representative images, 73% of weightlifters reported not leaving any leftovers, 20% left only 5% of their plate, and 7% reported leaving 10% of their plate on the rest day intervention. On the workout day, 84% of athletes reported not leaving any leftovers and 16% reported leaving only 5% in the plate.

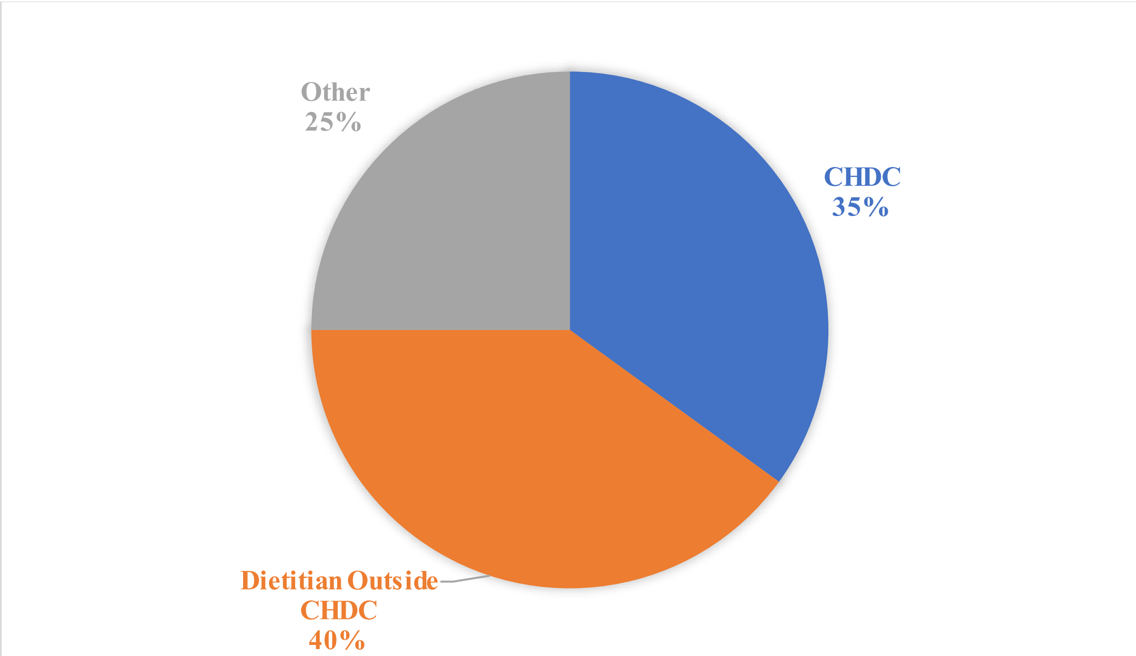


Figure 2 Source of professional nutritional opinion as reported by weightlifters

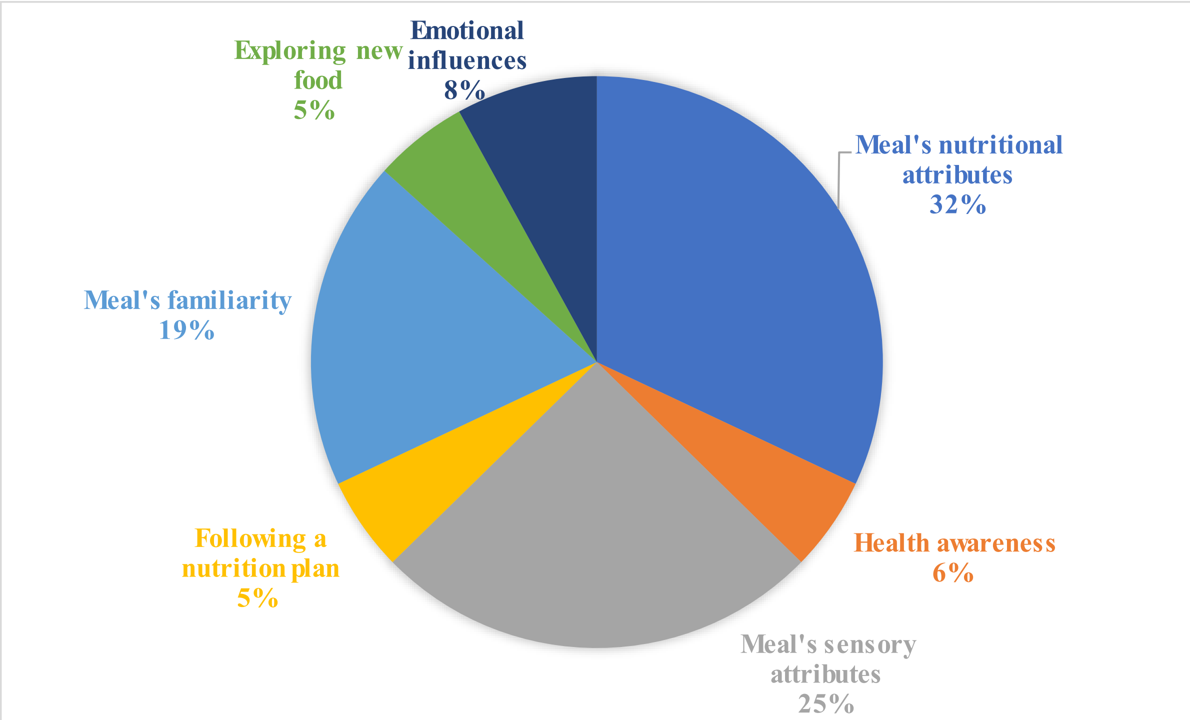


Figure 3 Factors affecting food choices of weightlifters Rest day

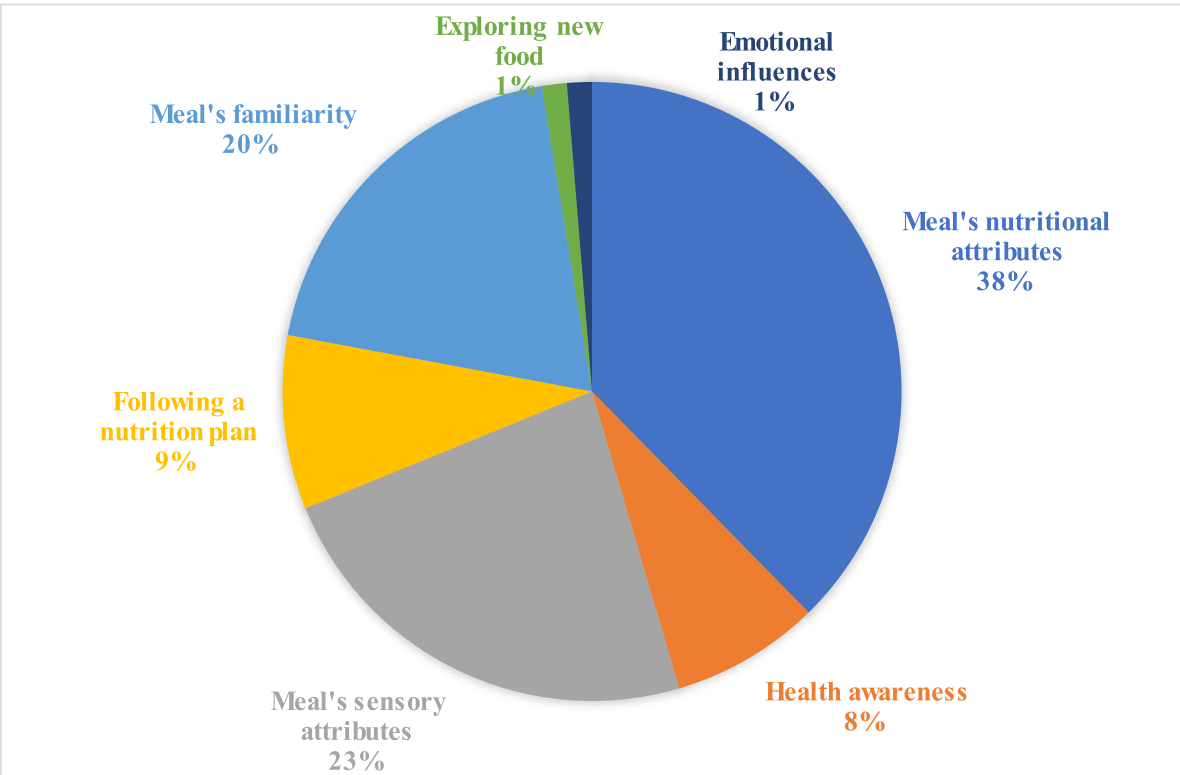


Figure 4 Factors affecting food choices of weightlifters Workout day

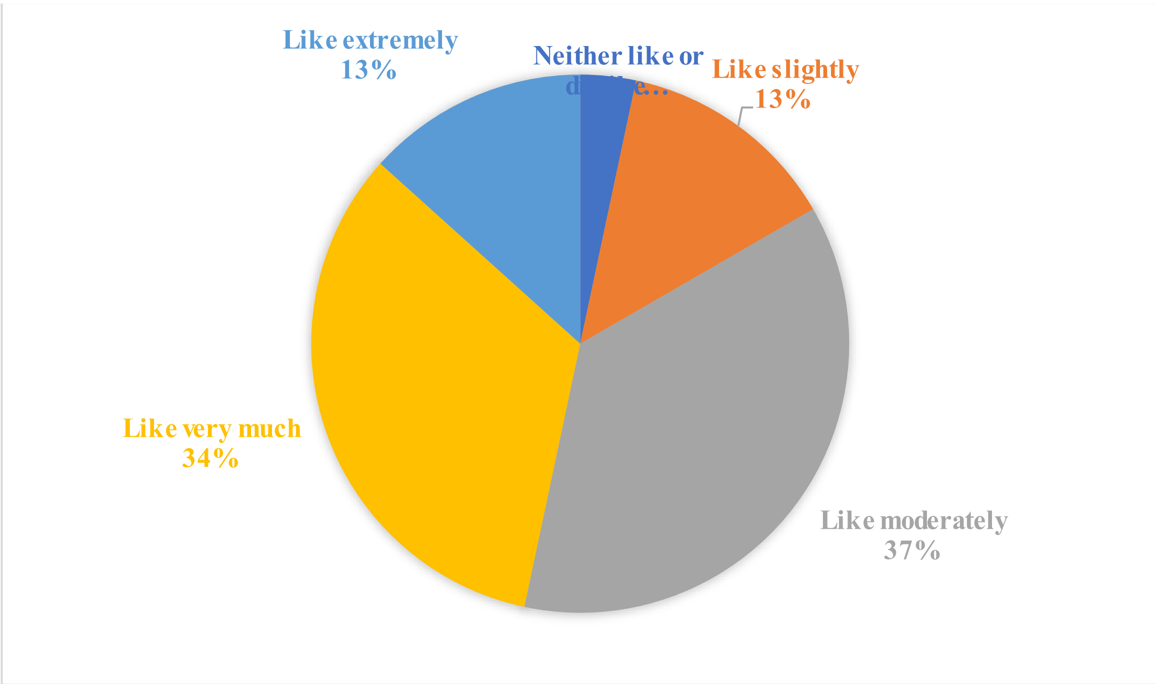


Figure 5 Meal's acceptability reported by weighlifters on rest day

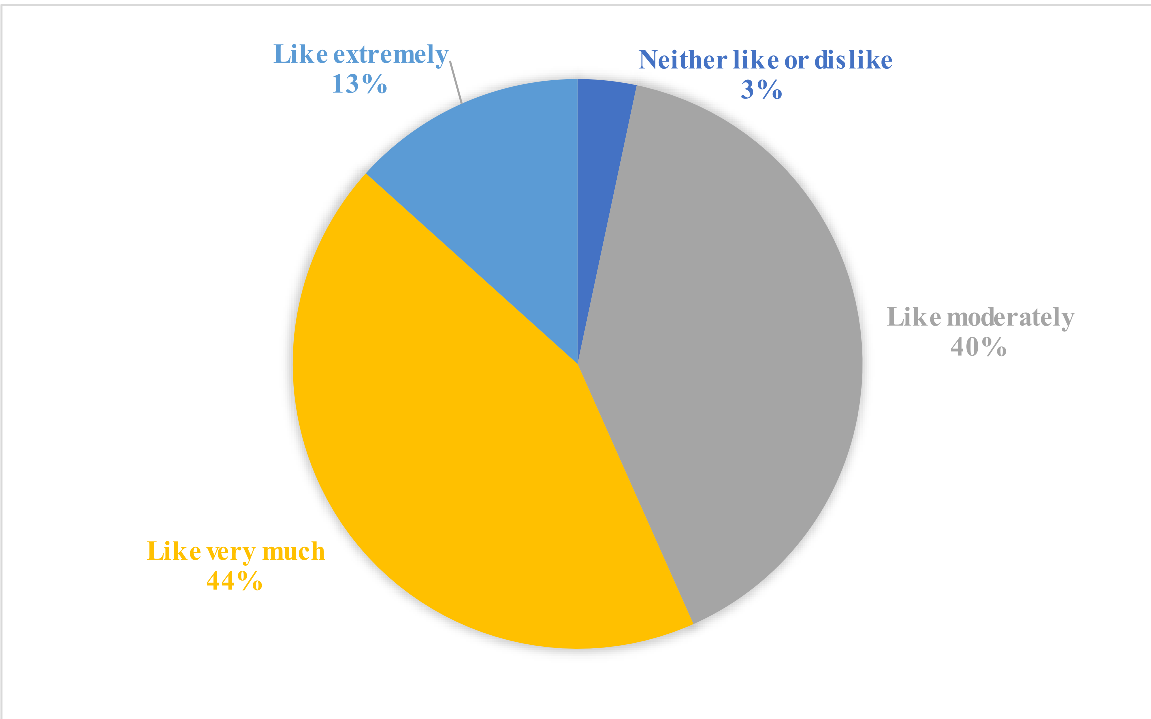


Figure 6 Meal's acceptability reported by weightlifters on workout day

b. Football players

To begin with, 53% of the football players were recruited from the junior varsity team JV and 47% were recruited from the AUB'S varsity team. Of the 30 participants, only 10 (33%) reported having ever acquired a professional nutrition opinion. The results are shown in figure 7. The majority of football players (54%) sought nutritional advice from a dietitian outside the CHDC at AUB, 13% from the CHDC and 33% reported having acquired nutrition knowledge from other sources.

When asked whether they are following a certain nutrition plan or not, only 20% of the football players reported following a nutrition plan while the majority were not following a specific one. The following open-ended question asking the participants to elaborate on their answer collected a pool of similar answers that revolved around the focus on high protein and caloric intake in their diet. The most frequently repeated answers were as follows:

"Aiming for 120-140 grams of protein per day"

"Following a high protein, high fiber, moderate carbohydrate and low fat diet"

"Focusing on a high caloric diet and high protein intake post workout"

When asked to indicate the factors that affected their food choices at T-Marbouta during the intervention, the answers varied between rest days and workout days. Figure 8 shows the percentage of answers reported by the football players on a rest day. The main factor contributing to their choice of meal was the meal's familiarity (33%), followed by the meal's nutritional attributes (23%), meal's sensory attributes (21%), health awareness (11%), exploring new food (5%), emotional influences (5%)

and only 3% reported choosing their meals because they were following a nutrition plan.

As for the workout day, figure 9 shows that the main factor contributing to the food choices made was also related to the meal's nutritional attributes (34%), followed by the meal's familiarity (22%), meal's sensory attributes (19%), exploring new food (7%), following a nutritional plan (6%), health awareness (6%), and only 4% reported choosing their meals because of emotional influences.

When asked to elaborate on their food choices using an open-ended question, the most recurrent answers on the rest day were:

"I had hummus, fries, and a salad because it tastes good"

"I had an escalope sandwich and fries because they are my favorite at T-Marbouta"

"I got a tawouk sandwich because I'm used to getting it at T-Marbouta"

When asked to elaborate on their food choices using an open-ended question, the most recurrent answers on the workout day were:

"I chose a tawouk sandwich because it tastes amazing and is high in protein"

"I had grilled chicken with a side of fries since it is filling and high in protein"

"I had a chicken burger because it tastes good and is high in protein"

When asked about the meal's acceptability during the rest day intervention, the majority of football players (55%) reported liking their meal very much, 23% liked their meal moderately, 13% extremely liked their meal, 3% slightly like it, 3% slightly disliked it and 3% reported neither liking nor disliking it. The results are illustrated in figure 10. As for the workout day, most weightlifters (40%) reported liking their meal very much, followed by 34% of athletes extremely liking it, 20% liking it moderately, 3% slightly liked their meal and 3% reported neither liking nor disliking it. The results are illustrated in figure 11.

Finally, when asked to state the amount of leftover food according to representative images, 66% of football players reported not leaving any leftovers and 34% left only 5% of their plate on the rest day intervention. As for the workout day, 77% of athletes reported not leaving any leftovers, 17% reported leaving only 5% in the plate and 6% reported leaving 10% of their plate uneaten.

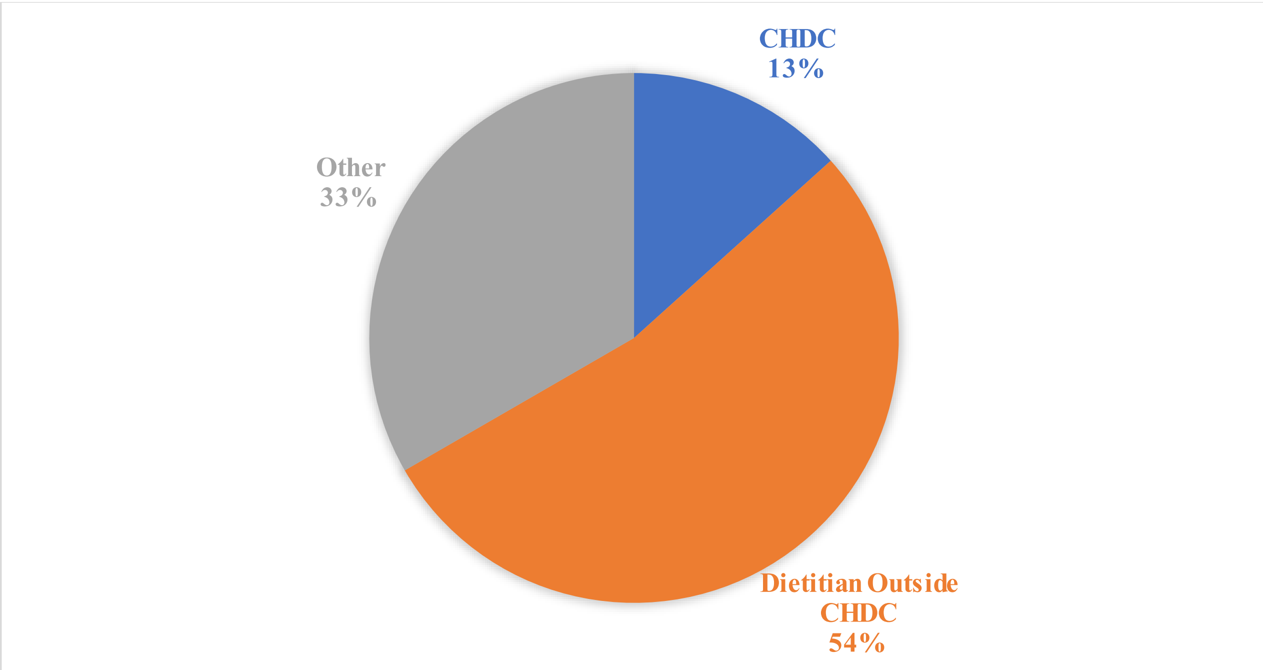


Figure 7 Source of professional nutritional opinion as reported by football players

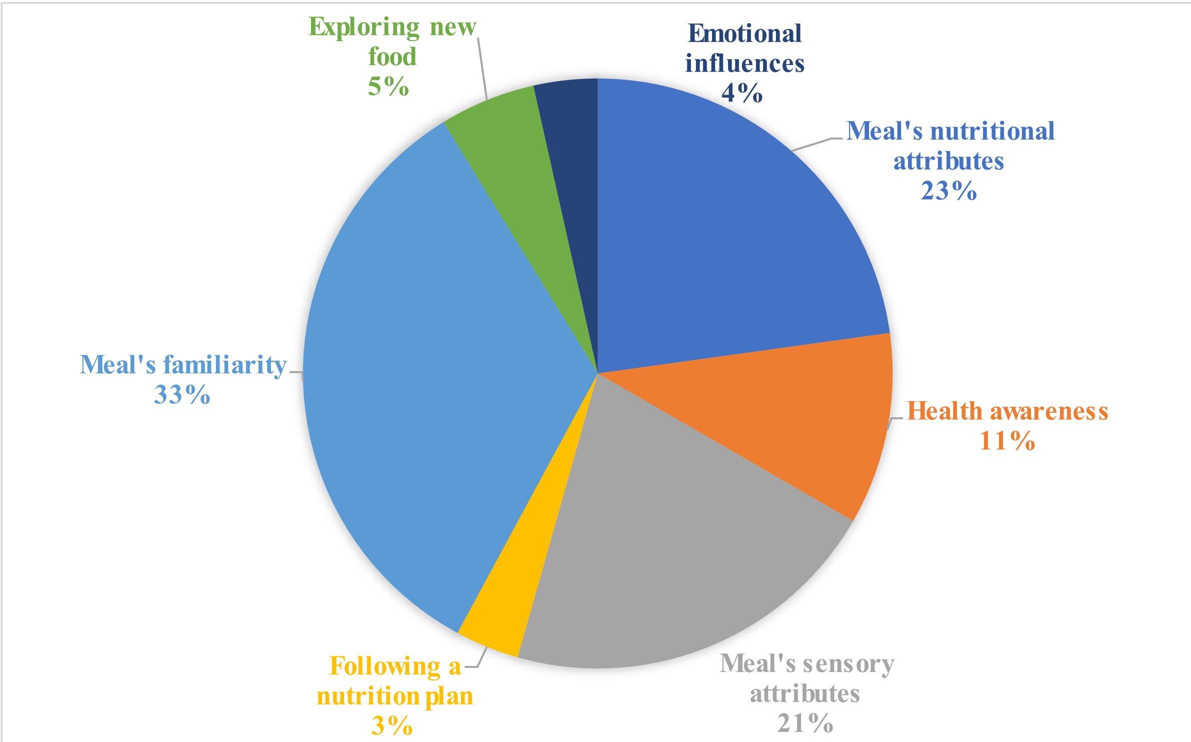


Figure 8 Factors affecting food choices of football players Rest day

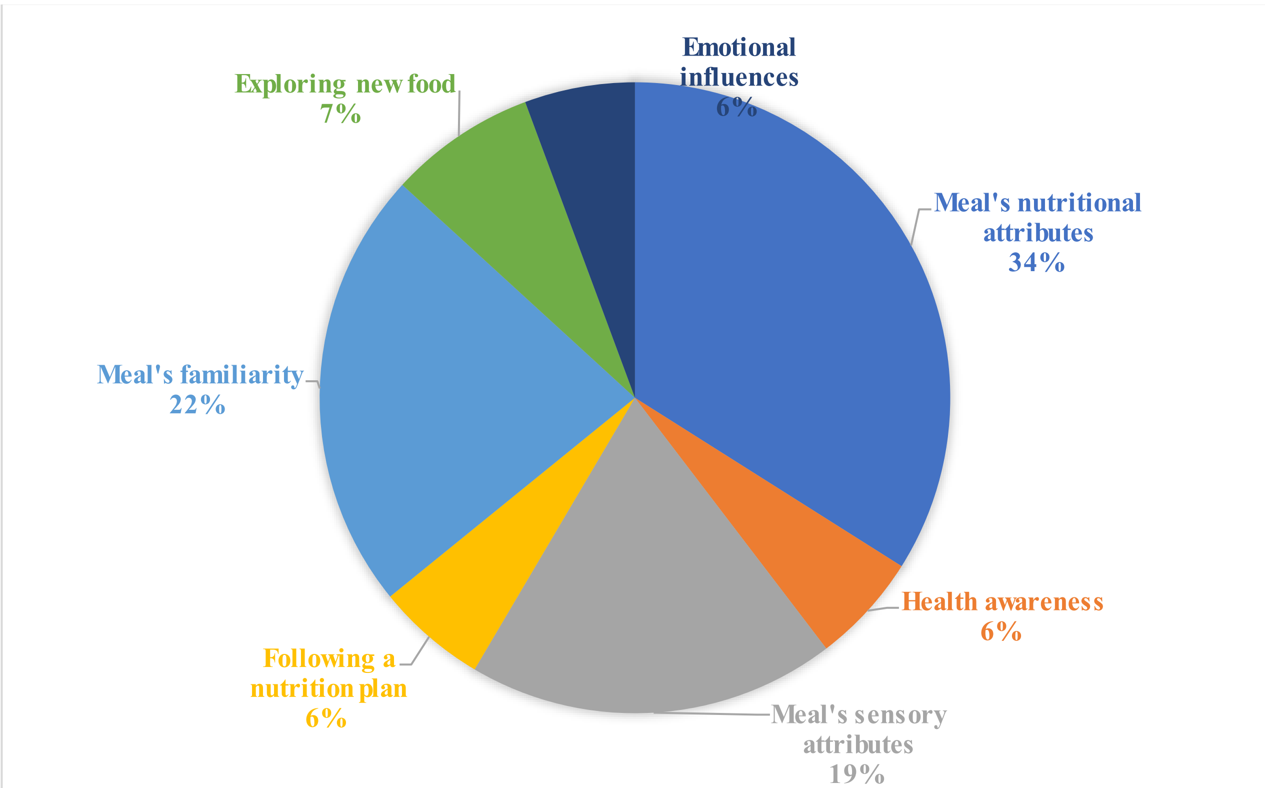


Figure 9 Factors affecting food choices of football players Workout day

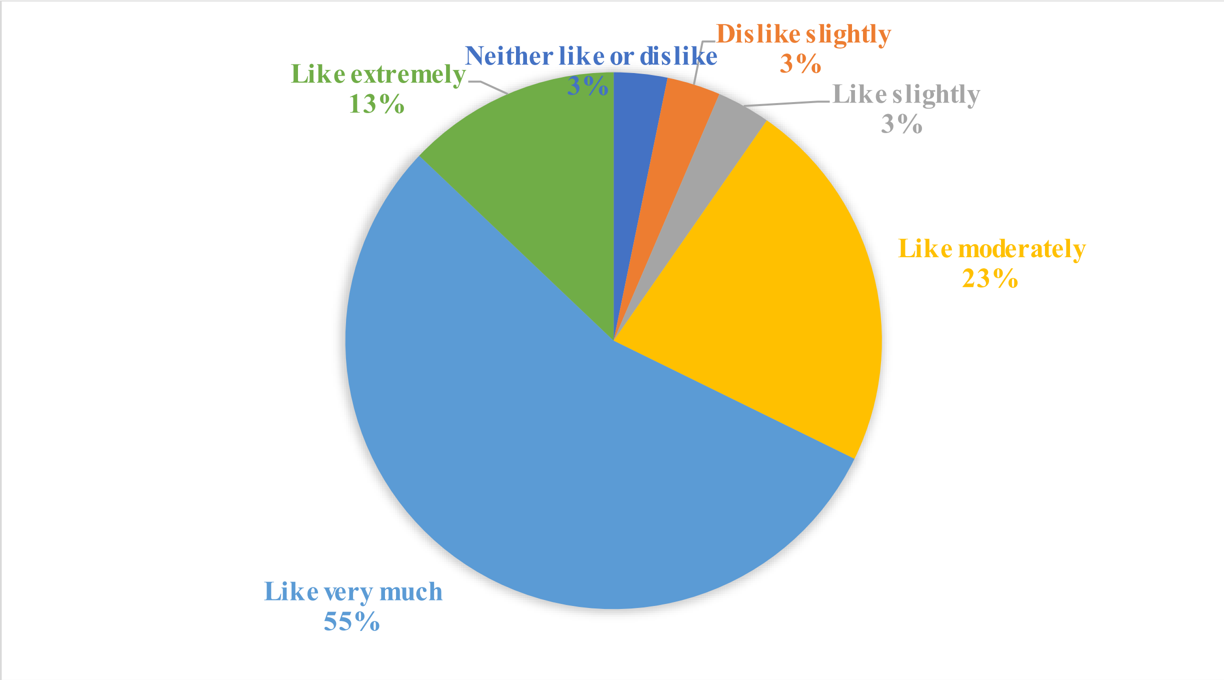


Figure 10 Meal's acceptability reported by football players on rest day

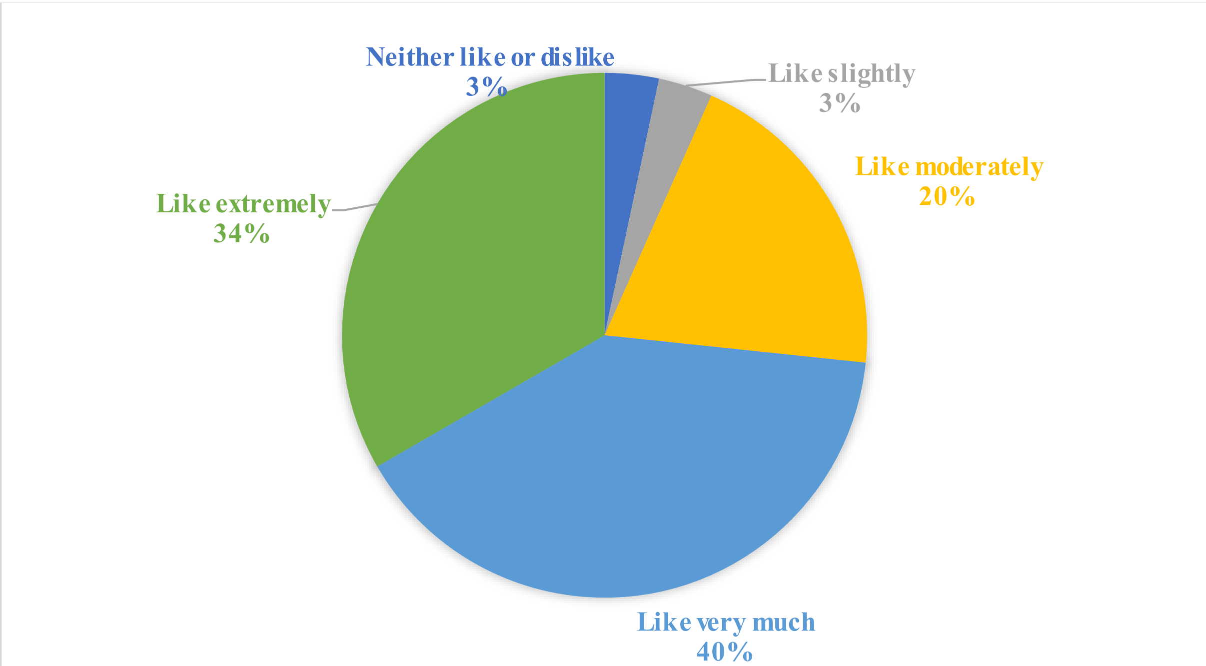


Figure 11 Meal's acceptability reported by football players on workout day

B. Comparisons between rest days and workout days

1. Comparisons of Nutritional Intakes between rest and workout days

Table 7 represents the difference between rest and workout days among weightlifters in terms of energy, macronutrients and micronutrients. Results showed that the difference in terms of energy and protein intake was highly statistically significant ($p \leq 0.001$) between rest and workout days with a higher mean energy intake observed during workout days. Furthermore, a statistically significant difference was observed in the mean fat intake (p=0.03), SFA (p=0.02), MUFA (p=0.01), PUFA (p=0.009), K (p=0.04), Ca (p=0.02), and vitamin D (p=0.04).

Table 7 Difference in nutritional intake between rest and workout days in weightlifters

	Rest Day	**Workout Day**	**P-value**
Mean ± SD			
Energy (kcal)	2536.78 ± 716.36	2998.23±706.43	**<0.001***
Protein (g)	144.96 ± 54.46	178.94±58.71	**0.001***
Protein (% from EI)	22.85%	23.87%	0.84
Carbohydrates (g)	257.67 ± 120.09	271.14±93.51	0.53**
Carbohydrates (%from EI)	40.63%	36.17%	0.06
Fats (g)	103.93 ± 42.94	134.32±49.01	**0.003****
Fats (% from EI)	36.87%	40.32%	**0.04**

Cholesterol (mg)	746.49 ± 454.35	783.3 ±494.17	0.95*
SFA (g)	31.49 ± 12.29	39.03±15.62	**0.02***
MUFA (g)	42.75 ± 22.38	55.73±24.97	**0.01****
PUFA (g)	17.66 ± 9.22	24.64±13.66	**0.009***
Sugar (g)	63.83 ± 39.94	74.68 ± 46.79	0.27*
Na (mg)	2814.58±1364.31	3169.58±1455.99	0.17*
K (mg)	2794.88±1114.46	3430.44±1532.14	**0.04***
Ca (mg)	931.07±455.26	1162.75±654.58	**0.02***
Vit D (IU)	92.30±81.13	135.74±107.22	**0.04***
Vit C (IU)	58.75±52.49	63.65±74.3	0.55*
Vit E (IU)	7.18±17.13	4.18±5.63	0.73*
Folate (mg)	500.90±325.69	469.18±266.44	0.95*
Mg (mg)	342.81±149.04	380.56±173.3	0.09*
Zn (mg)	14.11±6.30	12.46±5.89	0.51*
Iron (mg)	18.33±8.44	18.79±7.15	0.54*

*Wilcoxon test was used to compare between rest and workout days
**Paired samples t-test was used to compare between rest and workout days

Table 8 represents the difference between rest and workout days among football players in terms of nutritional intake based on the 24-hour recall. Results showed a highly statistically significant difference between both days in terms of mean protein intake (p=0.001). In addition, a statistically significant difference was also observed in the mean energy intake (p=0.03).

Table 8 Difference in nutritional intake between rest and workout days in football players

	Rest Day	**Workout Day**	**P-value**
Mean ± SD			
Energy (kcal)	2745.21 ± 984.06	4077.69±6589.82	**0.03***
Protein (g)	131.59 ±52.99	184.88±229.13	**0.001***
Protein (% from EI)	19.17%	18.13%	0.07
Carbohydrates (g)	294.51 ±148.611	310.16±104.99	0.41**
Carbohydrates (% from EI)	42.91%	30.42%	**0.02**
Fats (g)	112.90 ±48.41	121.93±39.56	0.24**
Fats (% from EI)	37.01%	26.91%	**0.03**
Cholesterol (mg)	537.45 ±344.81	576.53±590.27	0.95*
SFA (g)	35.65 ±13.22	34.41±13.42	0.37*
MUFA (g)	41.05 ±16.1	46.67±20.45	0.13**
PUFA (g)	22.33 ±12.49	21.25±9.21	0.86*
Sugar (g)	90.35 ± 69.48	105.19 ± 123.01	0.9*
Na (mg)	3103.28±1648.21	3268.44±1502.97	0.41*
K (mg)	2943.12±1637.54	3155.67±1470.39	0.12*
Ca (mg)	1580.19±3056.81	853.88±504.52	0.1*
Vit D (IU)	67.27±80.19	89.38±107.82	0.2*
Vit C (IU)	76.69±121.59	80.96±95.81	0.5*

Vit E (IU)	2.80±4.09	4.80±11.12	0.36*
Folate (mg)	470.33±322.94	513.14±254.19	0.29*
Mg (mg)	296.96±138.52	319.36±117.05	0.12*
Zn (mg)	12.22±4.79	13.44±7.75	0.5*
Iron (mg)	18.95±7.65	20.03±7.62	0.36*

*Wilcoxon test was used to compare between rest and workout days
**Paired samples t-test was used to compare between rest and workout days

2. Comparisons of the factors affecting the food choices of athletes

a. Comparisons of factors affecting the food choices of athletes between rest and workout days

Table 9 represents the difference in the factors affecting the food choices of weightlifters between rest and workout days. The results showed a statistically significant difference among all factors between both days. It is worth noting that on both days, the main factor contributing to their meal choice was the meal's nutritional attributes.

Table 9 Comparisons of factors affecting food choices of weightlifters

	Rest Day	**Workout Day**	**P-Value***
Percentage %			
Meal's nutritional attributes	32%	38%	**0.04**
Health awareness	6%	8%	**<0.001**
Meals' sensory attributes	25%	23%	**<0.001**
Following a nutrition plan	5%	9%	**<0.001**
Meal's familiarity	19%	20%	**0.03**

Exploring new food	5%	1%	**0.01**
Emotional influences	8%	1%	**0.01**
Total	**100%**	**100%**	

*Chi-square test was used to compare between rest and workout days

Table 10 represents the difference in the factors affecting the food choices of football between rest and workout days. The results showed a statistically significant difference among the following factors: meal's nutritional attributes, health awareness and health awareness. While the main factor contributing to their meal choice on the rest day was the meal's familiarity, the meal's nutritional attributes was the most frequently reported factor during the workout day.

Table 10 Comparisons of factors affecting food choices of football players

	Rest Day	**Workout Day**	**P-Value***
Percentage within day%			
Meal's nutritional attributes	23%	34%	**0.007**
Health awareness	11%	6%	**0.001**
Meals' sensory attributes	21%	19%	**0.025**
Following a nutrition plan	3%	6%	0.051
Meal's familiarity	33%	22%	0.1
Exploring new food	5%	7%	0.41
Emotional influences	4%	6%	0.11
Total	**100%**	**100%**	

*Chi-square test was used to compare between rest and workout days

b. <u>Comparisons of factors affecting the food choices of athletes between sports on both experimental days</u>

Table 11 represents the difference in the factors affecting the food on rest days across both categories of sports. The results showed a strong statistically significant difference when it comes to choosing the meal according to its nutritional attributes between weightlifters and football players.

Table 11 Comparisons of factors affecting food choices on the rest day

	Weightlifters	**Football Players**	**P-Value***
Percentage within sport %			
Meal's nutritional attributes	80%	43%	**0.003**
Health awareness	13%	20%	0.48
Meals' sensory attributes	63%	40%	0.07
Following a nutrition plan	7%	13%	0.39
Meal's familiarity	47%	63%	0.19
Exploring new food	13%	10%	0.68
Emotional influences	13%	7%	0.38

*Chi-square test was used to compare between rest and workout days

Table 12 represents the difference in the factors affecting the food on workout days across both categories of sports. The results showed a strong statistically significant difference only when it comes to choosing the meal according to its nutritional attributes between weightlifters and football players ($p<0.001$). The results of both tables 15 and 16 indicate that a significantly higher percentage of weightlifters prioritize the nutritional attributes of meals compared to football players on both rest days and workout days.

Table 12 Comparisons of factors affecting food choices on the workout day

	Weightlifters	**Football Players**	**P-Value***
Percentage within sport %			
Meal's nutritional attributes	97%	57%	**<0.001**
Health awareness	20%	30%	0.37
Meals' sensory attributes	60%	50%	0.43
Following a nutrition plan	23%	10%	0.17
Meal's familiarity	50%	47%	0.79
Exploring new food	3%	17%	0.08
Emotional influences	3%	13%	0.16

*Chi-square test was used to compare between rest and workout days

CHAPTER V

DISCUSSION

This study examined the nutritional intake (NI) of weightlifters and football players during their rest and workout days using a 24-hour recall conducted on each experimental day. The results showed no significant difference in terms of NI between the two categories. When comparing the NI of weightlifters to that of football players on their workout day, no statistically significant difference was found between the two sports in terms of energy and major macronutrients and micronutrients. These results are similar to the ones reported by Burke et al (1991) in their study where they examined the difference in energy and macronutrients intake during training days across several types of sports, including weightlifters and football players. Their results showed no difference in the total fat to energy ratio between the two groups as compared to the standard Australian diet back then. Furthermore, a study conducted by Pilis et al (2014) also examined the difference in the NI of weightlifters and endurance race walkers and found no significant differences between the two sports in terms of energy and macronutrients intake. In this study, a significant difference in terms of protein intake was found between the two sports where football players reported consuming a higher amount of protein (184.9±229.1 g) compared to weightlifters (178.9±58.7 g) during their workout day. In addition, vitamin D intake was significantly higher during the workout day among weightlifters compared to football players with a mean intake of 135.7±107.2 IU and 89.4±107.8 IU respectively, as well as in terms of cholesterol intake where weightlifters were found to be consuming higher amounts of cholesterol (783.3 ±494.2 mg) compared to football players (576.5±590.3 g) during the workout day. Unfortunately, no other studies that investigated the difference in the NI of weightlifters and football players were found in the literature to be able to draw a comparison.

When looking closely at the NI of each type of sport separately, comparisons with the recommended dietary allowances (RDA) could be drawn. On one hand, weightlifters reported on their rest days and workout days respectively consuming a mean of 2536.8 ± 716.4 kcal 2998.2±706.4 kcal, 144.9 ± 54.5 g and 178.9±58.7 g of protein, 257.7± 120.1 g and 271.1±93.5 g of carbohydrates, and 103.9 ± 42.9 g and 134.3±49.01 g of fats in terms of macronutrients intake. On the other hand, football players reported a mean intake of 2745.2± 984.06 kcal 4077.7 ±6589.8 kcal on their rest day and workout day respectively, 131.6 ±52.9 g and 184.9±229.1 g of protein, 294.5±148.6 g and 310.2±104.9 g of carbohydrates, and 112.9 ±48.4 g and 121.9±39.5 g of fats.

With a mean body weight of 81.6 ± 12.2 kg for weightlifters and 80.7 ± 10.07 for football players, the athletes were consuming respectively 1.7 ± 0.6 and 1.6± 0.6 g of protein per kg on their rest day in addition to 2.2 ± 0.7 and 2.2 ± 2.8 g of protein per kg on their workout day. These intakes fall into the recommended daily intake of 1.6 – 2.2 g per kg per day for both sports on both training days (Amawi et al., 2024). As for their carbohydrate intake, a significant difference was found compared to the RDA ($p<0.05$). Weightlifters and football players were respectively consuming around 3.16 ± 1.5 and 3.6 ±1.8 g per kg on their rest day as well as 3.3 ± 1.1 and 3.8 ± 1.3 g on their workout day which is slightly below the recommended 4 – 7 g per kg per day for both sports on both experimental days (King et al., 2022). Furthermore, the reported fat intake was equivalent to 36.87% and 40.3% of the energy intake on the rest and workout days respectively in weightlifters. Similarly, the fat % on both rest and workout days respectively in football players was 37.01% and 26.91%. A significant difference was found compared to the

RDA ($p<0.05$) and these values exceeded the recommended 20% - 35% fat intake from total energy in weightlifters on both experimental days, and in football players on only their rest day with their fat intake being within the recommended range on their workout day. (Amawi et al., 2024). In addition, the total SFA intake on rest day was equal to around 11.17% and 11.68% of total energy intake in weightlifters and football players respectively, and 11.71% and 7.59% respectively on workout day. These values are slightly above the recommendation that states that SFA should not exceed 10% of the total energy intake per day for both sports on both experimental days except for the football players' intake during the workout day (King et al., 2022). However, no statistically significant difference was found. According to the American guidelines, the daily sugar intake should not exceed the 10% of total energy intake, which was the case for both rest day (10.06%) and workout day (9.96%) in weightlifters, but not the case for football players with a mean sugar intake of 13.16% on rest day and 10.32% on workout day (CDC, 2021). However, no statistically significant difference was found. It is worth noting that a previous study conducted by Macuh et al (2022) reported the daily NI of football players and found that the subjects were consuming around 2694 kcal, 3.6 g of carbohydrates per kg per day, 1.8 g of protein per kg per day, 34.7% of fat and 10.5% of SFA, which are numbers that are somehow similar to the results obtained in this study.

The American Heart Association's (AHA) general recommendations state that the daily sodium intake should not exceed 2300 mg per day (AHA, 2024). However, the results of this study showed a highly statistically significant difference between the sodium intake and RDA ($p<0.001$) and both weightlifters and football players exceeded this amount on both rest and workout days with a mean sodium intake of 2814.6±1364.3 mg and 3169.6±1455.9 mg respectively for weightlifters and

3103.3±1648.2 mg and 3268.4±1502.9 mg in football players. Whenever the sodium intake is measured, it is important to mention potassium intake due to their close relationship in regulating blood pressure. In this study, weightlifters met the RDA of potassium of 3400 mg per day on their workout day with a mean intake of 3430.4±1532.1 mg and failed to do so on their rest day with a mean intake of 2794.9±1114.5 mg. Similarly, football players also failed to meet this RDA with an intake of 2943.1±1637.5 mg on rest day and 3155.7±1470.4 mg on workout day (NIH, 2022). A statistically significant difference was observed in terms of both minerals.

Furthermore, one of the most important minerals in an athlete's diet is calcium due to its important role in bone calcification and promoting bone density, which is crucial among athletes who are more prone to bone fractures. The calcium's RDA for male adult athletes is set at 1300 mg per day (King et al., 2022). However, the weightlifters in this study failed to meet the RDA on both days by reaching a maximum mean calcium intake of 1162.7±654.6 mg on their workout day. On the other hand, football players were able to meet these requirements only during their rest day with a mean calcium intake of 1580.2±3056.8 mg. However, no statistically significant difference was found. Moving forward with micronutrients involved in bone mineralization, the relationship between calcium and vitamin D should be highlighted. Vitamin D plays an essential role in increasing the absorption of calcium and increased bone mineral density. The RDA for adult athletes is 600 IU which was far not met by weightlifters and football players on both days since a highly statistically significant difference was found between the two days ($p<0.001$) with a maximum intake of 135.7±107.2 IU and 89.4±107.8 IU respectively on the workout day (King et al., 2022).

Another vitamin that was measured in the NI report was vitamin C due to its important antioxidant role as well as its connective tissue repair function that is specifically important in athletes who are prone to connective tissue damage. The recommended daily intake (RDI) of ascorbic acid is set at 45 mg per day which was met by weightlifters (63.6±74.3 mg and 58.7±52.5 mg) as well as football players (76.7±121.6 mg and 80.9±95.8 mg) on both rest and workout days respectively. Another vitamin that was also assessed in this study was vitamin E with a RDI of 15 mg per day or 22 IU due to its powerful antioxidant property that can prevent inflammation and injury in athletes. However, both weightlifters and football players in this study did not meet the RDI by far with a maximum intake of 7.1±17.1 IU and 4.8±11.1 IU respectively (Beck et al., 2021). Finally, the last vitamin of interest in this study was folate or vitamin B9 due to its important role in the regeneration of red blood cells which is crucial in athletes prone to hemolytic anemia. The general recommendation for folate intake is set at 400 µg per day which was met by the weightlifters (469.2±266.4 µg and 500.9±325.7 µg) as well as football players (513.1±254.2 µg and 470.3±322.9 µg) on both workout day and rest day (Woolf et al., 2006). However, no statistically significant difference was found in terms of the intake of these vitamins compared to the RDA.

Apart from sodium, potassium and calcium, other minerals were also assessed in this study including magnesium, zinc and iron. Magnesium is particularly important in an athlete’s diet since it plays a role in providing energy for the muscle by being a crucial factor in the production of ATP, prevents muscle cramps and maintains a healthy bone structure since half of the human body’s magnesium is stored in the bones. That being said, the magnesium’s RDA is set at 400 to 420 mg per day which was not met by the weightlifters and football players on both days, with a maximum reported intake of

380.6±173.3 mg and 319.4±117.05 mg respectively on the workout day (Zhang et al., 2017). These findings were reinforced by the significant difference observed ($p<0.05$). In addition, zinc is also an important mineral that has an effect on the muscle cells' proliferation and thus affects muscle regeneration. The zinc's RDA is set at 11 mg per day which was met by the weightlifters and football players on both workout day (12.5±5.9 mg and 13.4±7.7 mg) and rest day (14.1±6.3 mg and 12.2±4.8 mg) respectively. Finally, the last micronutrient assessed in this study was iron due to the important role it plays in hemoglobin formation, oxygen transport in the blood and thus proper muscle oxygenation and function. Notably, both weightlifters and football players in this study reported an adequate daily intake of iron on rest day (18.3±8.4 mg and 18.9±7.7 mg) and workout day (18.8±7.1 mg and 20.03±7.6 mg) respectively that exceeded the RDA of 8 mg per day (Beck et al., 2021). However, no statistically significant difference was found.

When it comes to comparing the NI of the weightlifters between their rest and workout days, a significant difference emerged in terms of energy intake (EI), protein, fats, SFA, MUFA, PUFA, K, Ca, and Vitamin D. The weightlifters reported consuming 2998.2±706.4 kcal during their workout day which is higher than the amount reported during their rest day (2536.8 ± 716.4 kcal). These results are consistent with the ones reported in a study that examined the dietary intake of male strength training athletes during off-seasons and training phases. Their results showed that 71.8% of the participants reported a generally higher intake of food on higher training days compared to active rest days. Furthermore, the athletes also reported eating more fat rich foods during these days which is concurrent with the results obtained in this study where weightlifters reported a significantly higher intake of fat on their workout day (134.3±49.01 g) compared to their rest day (103.9 ± 42.9 g), as well as other fat subcategories including SFA (39.03±15.6 g on workout day and 31.5 ± 12.3 g on rest day), MUFA (55.7±24.9 g on workout day and 42.7 ± 22.4 g on rest day) and PUFA (24.6±13.7 g on workout day and 17.7 ± 9.2 g on rest day) (King et al., 2022). In addition, a strong statically significant difference in terms of protein intake between the two experimental days revealed that the mean protein intake was higher during the workout day compared to the rest day. Unfortunately, no studies tackling the difference in protein intake between rest and workout days among weightlifters were found in the literature to be able to draw a comparison.

Moving forward to the NI of football players, a significant difference was observed between the two experimental days in terms of EI and protein where the mean intakes were higher during the workout day compared to the rest day. However, two prior studies that investigated the difference in the NI of soccer players did not find any statistically significant difference between the training and rest phases of the studies, which supports the findings of this study and contraindicates the energy and protein differences (Drenowatz et al., 2012; Bettonviel et al., 2016).

Apart from nutritional analysis, this study also investigated the factors affecting the food choices of athletes during both experimental days, which was also highlighted in a similar study conducted at the University of the Sunshine Coast, Australia (USC). The study compared several types of sports during Olympic competitions, including weightlifters and endurance athletes using a questionnaire similar to the one used in this study. Their results showed that weightlifters mainly based their food choices depending on health awareness, followed by the meal's nutritional attributes, sensory appeal, usual eating practices and finally based on emotional influences (Thurecht, 2020). Although their study did not investigate between rest and workout days, and did not compare between male and female athletes, the results of this study showed similar results. During both rest and workout days respectively, weightlifters reported making decisions concerning their food choices mainly based on the meal's nutritional attributes (32% and 38%), followed by the meal's sensory attributes (25% and 23%), meal's familiarity (19% and 20%), health awareness (6% and 8%) and finally based on emotional influences (8% and 1%). When comparing both days, statistically significant differences were found when it came to choosing a meal based on health awareness, its sensory attributes and based on a nutrition plan. This indicates that weightlifters were more health aware and prioritized the meal's sensory attributes as well as a specific nutrition plan during their workout day. Unfortunately, no previous studies have examined these differences during rest and workout days to be able to draw a comparison.

As for the football players, the study conducted by Thurecht (2020) showed that endurance athletes were more likely to base their food choices on performance, followed by health awareness, meal's sensory attributes, meal's nutritional attributes, usual eating practices and finally emotional influences (Thurecht, 2020). The results of the current study also showed similar results where the football players mainly based their food choices during rest and workout days, respectively, on the meal's familiarity (33%) and meal's nutritional attributes (34%), followed by the meal's nutritional attributes (23%) and meal's familiarity (22%). The rest of the factors included meal's sensory attributes (33% and 22%), meal's sensory attributes (21% and 19%), health awareness (11% and 6%) and finally emotional influences on the bottom of the list (4% and 6%). A statistically significant difference was observed when comparing the two experimental days in terms of choosing the meal based on its nutritional and sensory attributes, as well as the health awareness. This indicates that, during the workout day, football players were more likely to base their meal choice based on its nutritional attributes, less likely to choose their meals based on its sensory attributes and were less health aware compared to when they had to eat during a rest day.

Furthermore, when comparing the factors that affected the food choices during both experimental days across the two sports categories, a statically significant difference was observed on both days when it came to choosing the meals based on its nutritional attributes. These results pointed out that the meal's nutritional attributes were more likely to affect the meal's choice of weightlifters compared to football players on both rest and workout days. However, this difference was not reported in the USC study where the meal's nutritional attributes came in the third place for both weightlifters and endurance athletes (Thurecht, 2020).

Unfortunately, not many studies have reported the different in the factors affecting the food choices of football players and weightlifters, however, the results reported in this study are concurrent with other studies that have reported the major factors influencing the food choices of male athletes. In their study, Pelly et al (2019) investigated the factors affecting the food choices of athletes and found that the major contributing factor was the meal's nutritional attributes (n=29), followed by meal's sensory attributes (n=27), performance (n=20) and finally by the meal's familiarity (n=8) and emotional influences (=3). Furthermore, similar results were reported in a study that investigated the key factors influencing the food choices of athletes in major international competitions, including athletes competing in weight and endurance sports. Apart from these commonly reported factors, another study that tackled the food choice of collegiate division athletes reported in their results that the athletes mainly based their food choices on food availability, promotion by their dietitian, preference and cost, which were all not reported in this study (Eck et al., 2021).

Finally, as mentioned earlier, this study revealed a significant difference mainly between the rest and workout days in both group categories in terms of energy and protein intake, which can be linked to the finding of the food choice questionnaire. As mentioned earlier, both weightlifters and football players were more likely to base their food choices during their workout days on the meal's nutritional attributes compared to their rest day, which was reinforced by their NI that showed that they generally consumed more energy and protein on their workout day compared to their rest day. Unfortunately, no studies relating the athletes' NI to their food choices have been found in the literature to be able to draw a comparison.

A. Strengths and Limitations

On one hand, this study's main limitation was the relatively small sample size of only 60 athletes and the geographical area of recruitment that was strictly restricted to AUB.

On the other hand, this study's main strength point was that it is considered one of the first studies to compare both the NI and the factors affecting the food choices of male weightlifters and football players. Thus, this study provided data that could be used to develop further studies on a larger scale.

CHAPTER VI

CONCLUSION

This study revealed a significant difference mainly between the rest and workout days in both group categories in terms of energy and protein intake, which can be linked to the finding of the food choice questionnaire. Both weightlifters and football players were more likely to base their food choices during their workout days on the meal's nutritional attributes compared to their rest day, which was reinforced by their NI that showed that they generally consumed more energy and protein on their workout day compared to their rest day. The studies exploring this certain topic are limited and more studies including a larger sample size are needed to further confirm the results of this study.

It is worth noting that this study was conducted on local college athletes who are not competing on a professional level compared to the studies found in the literature that tackled professional Olympic and professional athletes on a much larger scale, which could explain the difference found in some of the results obtained in this study.

APPENDIX A

T-Marbouta Menu

Food | Beverages

KAAKAT
SALADS
COLD MEZZA
HOT MEZZA
PLATTERS & GRILLS
SIDE ORDERS
SANDWICHES RESTO
RAW MEAT(EXCLUSSIVELY ON SATURDAYS AND SUNDAYS)
T MARBOUTA BURGER
SOUP
DESSERT
SANDWICHES DELIVERY

Kaakat

Served With Veggies

Cheese KAAKEH
5.00 $

HALAWE KAAKE
3.50 $

Shankleesh kaakeh
5.00 $

Labneh kaakeh
3.50 $

Zaatar kaakeh
3.50 $

KAAKEH HALLOUM
4.50 $

Salads

Tabbouleh
4.00 $

Fattoush
4.50 $

Arabic Salad
3.50 $

Rocca & Thyme
4.50 $

Beetroot Salad
5.00 $

Cabbage Salad
2.50 $

Yogurt With Cucumber
3.00 $

Lentil Salad
4.50 $

Raheb Salad
3.50 $

Cold Mezza

Hommos
3.50 $

SHANKLISH
5.00 $

Hommos Moutammam
With garlic, hot pepper, parsley
3.50 $

Hommos With Meat
7.00 $

Eggplant Mutabbal
4.00 $

CHARD MOUTABBAL
3.50 $

Balila
3.50 $

Laban fatteh
4.00 $

Pumpkin Kibbe
5.50 $

Tomato Kibbe
4.00 $

Lentil Kibbe
3.50 $

GRAPE Leaves
3.50 $

Eggplant musaqaa
4.00 $

Hindbeh
5.50 $

Labneh
4.50 $

Labneh With Rocca & Olives
5.00 $

Labneh With Garlic
5.00 $

Halloumi Plate
4.50 $

Hot Mezza

Eggplant Fatteh
4.50 $

MEAT WITH TOMATO
7.00 $

Fava Beans
4.50 $

Cheese Rolls
Fried or grilled 4 pcs
5.00 $

Fried Kibbe
4 Pieces
5.00 $

Mousakhan Rolls
4.50 $

Kibbe Mloukiyeh
With Eggplant, walnut & pomegranate
4.00 $

Potato With Coriander
4.50 $

French Fries
4.50 $

Grilled potato
3.50 $

Potato Omelette
4.50 $

Plain Omelette
4.00 $

Vegetable Omelette
4.50 $

Fried Cauliflower & eggplant
With taratour sauce
4.00 $

Sojok
With veggies or pomegranate sauce
7.50 $

Sausages
7.50 $

Chicken Liver
6.00 $

Chicken Wings
Fried or grilled 5 pcs

Chicken Mousakhan
6.50 $

Boiled Egg
4.00 $

Ras Asfoor
9.00 $

Platters & Grills

Arayes Kafta Small (4 Pieces)
Yogurt, lemon wedges & pickles
8.00 $

Kafta
Fries, hommos & pickles
8.50 $

Chicken Shawarma
Garlic paste, pickles, fries
9.50 $

Taouk Red
Garlic paste, pickles, fries
9.00 $

Half Grilled Chicken
Fries, garlic paste, pickles
12.50 $

Grilled Chicken Breast
Grilled potato, garlic paste, pickles
9.50 $

Chicken Escalope
Fries, coleslaw, garlic paste, pickles, mayo mustard sauce
9.50 $

Steamed rice In Clay Pot
Chicken with spicy tomato sauce
8.50 $

Mix Grill
100gr.Bbq meat,100gr.Taouk,100gr. Kafta,garlic paste, hommos
16.00 $

Shish Kabab
16.00 $

Kabab Khachkhach
8.50 $

Beef Shawarma (plate)

Side Orders

Tabbouleh, Potatoes and Hommos
3.50 $

100 GR CHICH TAOUK
2.75 $

50G.KAFTA
2.00 $

Basmati Rice
2.50 $

Yogurt
2.00 $

Fried Kibbe
2 Pieces
2.50 $

Cheese Rolls
2 Pieces
2.50 $

Add Kaake
1.00 $

100 gr. MEAT
5.00 $

Sandwiches Resto

Choice Of Bread : Arabic Bread Or Tannour

Taouk
Garlic paste, pickles & fries aside
4.50 $

Kafta
Hommos, biwaz, pickles, tomato
4.75 $

T Marbouta Burger

Lebanese burger
6.50 $

Lebanese Burger Platter
8.00 $

Chicken burger
5.50 $

Chicken Burger Platter
With french fries and coleslaw
7.00 $

Home Burger
6.00 $

Home burger plate
7.50 $

Soup

Lentil Soup
3.00 $

Dessert

Chocolate Cake Slice
2.50 $

KAAKEH HALAWE
3.50 $

NUT CAKE (1 PIECE)
2.50 $

Sandwiches Delivery

Choice Of Bread : Arabic Bread Or Tannour

Sausage
TOMATO , LEMON , MAYO , PICKLE
5.00 $

Sojok D
4.75 $

Chicken liver D
3.00 $

HINDBE D
4.00 $

Potato With Coriander D
3.00 $

FRENCH FRIES D
3.00 $

Sojok D
4.75 $

Chicken liver D
3.00 $

HINDBE D
4.00 $

Potato With Coriander D
3.00 $

FRENCH FRIES D
3.00 $

HOMOS D
2.50 $

Cauliflower Fried & eggplant D
3.00 $

ESCALOPE D
5.00 $

Chicken Breast D
3.50 $

Chicken shawrma D
4.00 $

Tawouk d
4.50 $

Kafta D
4.75 $

LABNE D
4.00 $

SANDWICH MEAT
7.00 $

Halloumi SANDWICH D
3.00 $

SANDWICH SHANKLEESH D.
3.00 $

Beef Shawarma Sandwich D
4.75 $

Falafel Sandwich D
2.00 $

Falafel Platter D
6.00 $

Rosto Sandwich D
6.00 $

Makanick Grilled Sandwich D
5.00 $

APPENDIX B

24-Hour Dietary Recall Questionnaire

American University of Beirut | Faculty of Agricultural and Food Sciences | Department of Nutrition and Food Science

Name: ________________ **Date:** ________________

Instructions:

1. Please report all the foods and beverages that you consumed in the last 24 hours.
2. Please start by describing the first thing you ate or drank in the morning and progressively move to the last item you ate or drank before waking up the next morning.
3. Please report the name, description, household measures (such as slices, teaspoons, etc.), quantity, preparation method and/or ingredients of each food or beverage item consumed.

Time: **Place:**

Name	Food Description	Household Amount	Quantity	Preparation/ Ingredients

Time: **Place:**

Name	Food Description	Household Amount	Quantity	Preparation/ Ingredients

Time: **Place:**

Name	Food Description	Household Amount	Quantity	Preparation/ Ingredients

APPENDIX C

Food Choice Questionnaire

American University of Beirut | Faculty of Agricultural and Food Sciences |
Department of Nutrition and Food Science

Name: ______________________________

Date: ______________________________

1. Age: ______________________________

2. Sport: ______________________________

3. Are you on AUB's varsity team? ☐ Yes ☐ No

If yes, please indicate which year you are in: ______________________________

4. What phase of the periodized training program are you in? ☐ Hypertrophy ☐ Endurance

5. Is today your rest or workout day? ☐ Rest day ☐ Workout day

6. Have you received any previous nutritional advice? ☐ Yes ☐ No

If yes, please indicate the source of this advice:

☐ CHDC ☐ Dietician outside the CHDC ☐ Other

7. Are you following a particular diet? ☐ Yes ☐ No

If yes, please describe that diet:

____

____

8. Please choose the reason(s) for your lunch choice:

☐ Meal's nutritional attributes

☐ Health awareness

☐ Meal's sensory attributes (such as taste or flavor)

☐ Following a nutrition plan

☐ Meal's familiarity

☐ Exploring new food

☐ Emotional influences (such as mood or stress)

9. Please elaborate further on your reasons for your food choice:

____

____

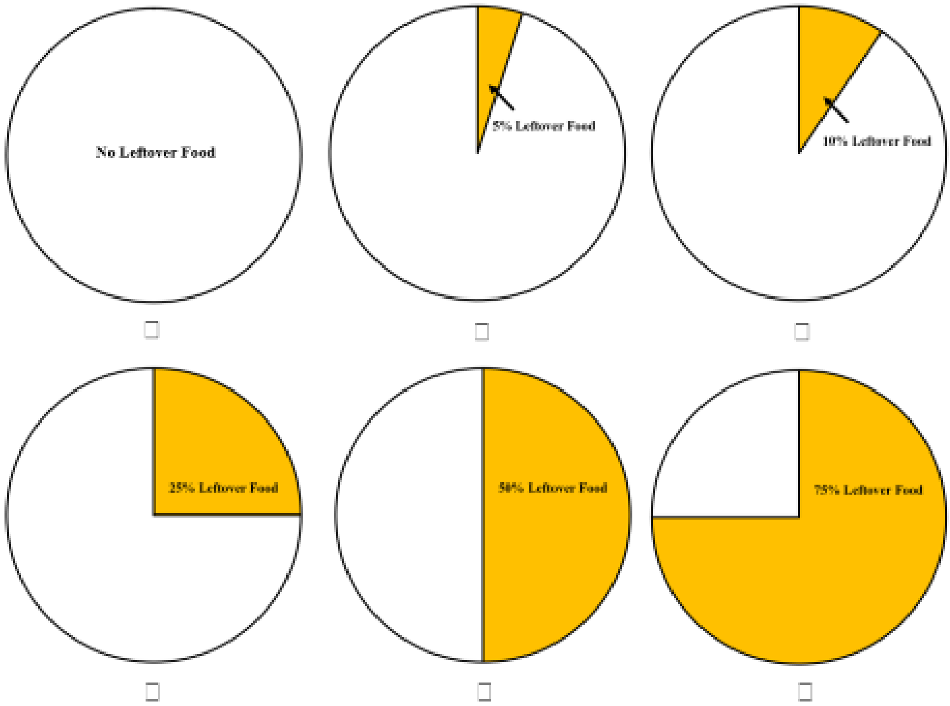
____

____

10. Please rate the overall acceptability of the meal using the following scale.

1	2	3	4	5	6	7	8	9
☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

11. Please specify the percentage of leftover food on your plate:



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