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## The usage of dietary supplements among Austrian endurance athletes

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Ingrid Haas

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# Danksagung

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Vielen Dank.

*"Let food be thy medicine and medicine be thy food."*

Hippocrates

## Abstract

The following thesis is about dietary supplements and their usage patterns among athletes. With the ultimate goal of good performance, the theoretical part thus outlines important aspects of an athlete's diet in general, and with regard to the two main stages (i.e. training and competition) in which an athlete can be, in more detail. The importance of sufficient carbohydrate- and fluid intake are discussed, both of which are considered to be crucial factors for successful performance, especially for endurance athletes.

This is followed by an evaluation of a selection of dietary supplements including their potentially negative side effects for athletes. In addition, motifs and influential factors for supplementation use are investigated. Results of the conducted survey could not confirm gender differences regarding the intake of supplements in the athletic population. Nevertheless, it was observed that participants who use supplements, on average perform 1.8 hours more endurance sport per week relative to participants who do not use supplements.

Clearly preferred types of supplements are vitamin- and mineral supplements, followed by protein- and carbohydrate supplements as well as ergogenic aids including caffeine, creatine and BCAAs. It was also found out that, whereas male and female athletes use vitamin and mineral supplements to an equal extent, there is a clear tendency that, additionally, male athletes use amino acids or creatine. Results furthermore showed that female motifs are more closely linked to a health-related notion of supplements, whereas males tend to use supplements in order to enhance performance during competitions and to recover from competitions. With regard to most influential factors for supplementation, participants listed friends, doctor's advice and personal research, preferably on the internet. The training or competition phase, however, is not seen as an influential factor for the intake of dietary supplements.

# Zusammenfassung

Diese Diplomarbeit beschäftigt sich mit Nahrungsergänzungsmitteln und ihrem Gebrauch im Sport. Mit dem Ziel, Athleten eine gute Performance zu ermöglichen, zeigt der theoretische Teil der Arbeit wichtige Aspekte der Ernährung unter der Berücksichtigung zweier Phasen, der Trainings- und der Wettkampfphase auf. Im Hinblick auf diese beiden Phasen wird eine ausreichende Kohlenhydrat- und Flüssigkeitszufuhr diskutiert, die in weiterer Folge, insbesondere Ausdauerathleten, zu einer bestmöglichen Leistung verhelfen sollen.

Danach werden verschiedene Nahrungsergänzungsmittel evaluiert und mögliche negative Nebeneffekte derselben beschrieben. Zusätzlich werden die Motive und Einflussfaktoren für die Einnahme aufgelistet. Ergebnisse der durchgeführten Studie konnten keine Unterschiede bezüglich des Geschlechts und der Einnahme von Nahrungsergänzungsmitteln bestätigen. Allerdings konnte beobachtet werden, dass jene Teilnehmer, welche Supplemente nutzen, im Durchschnitt 1.8 Stunden mehr Ausdauersport betreiben als jene, welche keine Supplemente zu sich nehmen.

Bevorzugte Nahrungsergänzungsmittel sind Vitamin- und Mineralstoffpräparate, gefolgt von Protein- und Kohlenhydratsupplementen und ergogenen Substanzen wie Kreatin, Koffein und BCAAs. Des Weiteren wurde festgestellt, dass Frauen und Männer gleichermaßen zu Vitamin- und Mineralstoffpräparaten greifen, Männer allerdings zusätzlich noch vermehrt Proteinsupplemente und Kreatin einnehmen.

Bezüglich der Motive für die Einnahme von Ergänzungsmitteln zeigt die Befragung, dass Frauen eher aufgrund von gesundheitlichen Gründen supplementieren, während Männer zu Supplementen greifen, um ihre Leistung im Wettkampf zu verbessern bzw. sich schneller von diesem zu erholen. Als mögliche Einflussfaktoren werden von den Befragten Freunde, ärztlicher Rat, sowie aber auch die persönliche Recherche, welche größtenteils im Internet erfolgt, genannt. Die Trainings- bzw. Wettkampfphase wird nicht als Einflussfaktor für die Einnahme von Nahrungsergänzungsmitteln gesehen.

# Table of contents

## List of figures

## List of tables



## List of abbreviations

| | |
|---|---|
| American College of Sports Medicine | ACSM |
| Australian Institute of Sport | AIS |
| Dietitians of Canada | DC |
| Basal metabolic rate | BMR |
| Thermic effect of food | TEF |
| Thermic effect of activity | TEA |
| European Food Safety Authority | EFSA |
| Institute of Medicine | IOM |
| Recommended Dietary Allowances | RDA |
| Free fatty acids | FFA |
| Branched-chain amino acids | BCAAs |
| World Anti Doping Association | WADA |
| World Health Organization | WHO |
| Body mass index | BMI |
| Food Frequency Questionnaire | FFQ |
| Int. Physical activity Questionnaire | IPAQ |

# 1. Introduction

The enhancement of performance and the ability to achieve the best possible result in a competition is something that every athlete, no matter if he is considered to be professional or recreational, strives for. This can, amongst others, be realised with the support of dietary supplements (also known as nutritional supplements, food supplements or nutritional ergogenic aids). This infinite demand for performance enhancement furthermore perpetuates a considerable amount of scientific research. However, many questions still remain unanswered due to insufficient examination. This in turn, leads to a plethora of products on the market. Unfortunately, not all products are completely safe and should thus be consumed with caution.

The structure of this paper is divided as follows: In the theoretical part, the main goal is to define terms such as endurance sports and strength sports as well as professional athletes and amateur athletes all of which are important terms for further discussion. This will be followed by a selection of dietary supplements which are commonly used among athletes. Moreover, arguments regarding risks of these supplements will be addressed. The empirical part is then concerned with the usage of dietary supplements among Austrian endurance athletes. In this section, common usage patterns shall be uncovered as well as thoroughly examined. Lastly, I want to answer the research question “Are dietary supplements frequently consumed among Austrian endurance athletes and if so, what are influential factors for the usage of these?”

In order to be able to answer this question, a small survey was conducted among 302 Austrian athletes. Employing a questionnaire, participants were asked to provide information about general eating habits, their level of physical activity, as well as specific sporting habits and dietary supplements.

# 2. Theoretical background

The main aim of this section is to provide detailed background information regarding dietary supplements. For this reason, important differences between endurance and strength sports on the one hand as well as between professional and recreational athletes on the other hand will be addressed first. The succeeding section briefly informs about exercise and energy demands with regard to athletic performance. This will be followed by a discussion on nutritional needs of endurance athletes who are either in the stage of training or those who are in competition. Lastly, a selection of dietary supplements will be presented which will be followed by an evaluation of potential dangers of these supplements.

## 2.1 Endurance sports vs. strength sports

To open the topic *endurance sports*, a general first definition of the term *endurance* has to be drawn. Saris et al. (2003) take up the widely accepted definition of 'endurance' as "resistance to fatigue" including both, "resistance to fatigue during brief intense exercise" as well as "during sub-maximal prolonged exercise of several hours" (Saris et al. 2003: 57). The authors furthermore explain that, in their terms, 'endurance' will be referred to as:

> [the] resistance to fatigue during a mode of exercise where the primary cause of fatigue is induced by substrate depletion or central factors. Typically endurance exercise is therefore 30 min or longer (Saris et al. 2003: 57).

With these aspects in mind, the term *endurance* will be used throughout this thesis. Endurance sports thus includes not only the typically associated kind of sports, such as running, cycling and swimming, but also team sports like tennis or football (cf: Åstrand 1992).

On the contrary, strength sports such as weightlifting, throwing or sprinting are characterised through "[t]he ability to generate explosive muscle power and strength" (Slater & Phillips 2011: 67). Saris et al. (2003) additionally explain that "[m]uscle strength and power are important determinants of performance in short maximal exercise requiring high muscle force production" (2003: 51).

In order to enhance these determinants, general resistance exercise is included in every athlete's training programme (Slater & Phillips 2011: 67).

## 2.2 Professional athletes vs. amateur athletes

In order to properly address the topic of dietary supplements among athletes, a distinction between professional athletes and amateur athletes has to be outlined.

Professional or competitive athletes, as they are often called, participate "in one of two manners, professionally or on a college/university varsity or other type of formal, highly organized team" (Van Dinter 1995: 5). Furthermore, this kind of athlete is characterised through a contract and thus through an obligation to participate in various competitions. The athlete in turn receives remunerations such as wages, a scholarship or free products for his performance (Van Dinter 1995: 5). In addition, the Australian Institute of Sport (AIS 2016a) states that, for example, a professional endurance athlete (distance runner), in order to perform well, usually completes 6 to 7 training sessions per week, possibly twice a day. This could mean a training load of 160-200 kilometres per week, primarily depending on the targeted event or on the stage of training (AIS 2016a). In other words, it could be argued that the life of a professional athlete is generally determined by a commitment to sport (Van Dinter 1995: 5).

In contrast, amateur or recreational athletes do not have such obligations. According to the Oxford Dictionaries Online (2016), the term *recreation* is defined as an "[a]ctivity done for enjoyment when one is not working". This notion of enjoyment is also an integral part of Laquale's (2009: 12) definition of the recreational athlete, which reads as follows:

> A *recreational athlete* can be defined as a person who is physically active but who does not train for competition at the same level of intensity and focus as a competitive athlete. He or she participates in sports to be physically fit, socially involved, and mostly to have fun.

This definition also in consent with Van Dinter (1995) who argues that "the recreational athlete covers a broad spectrum of participation" (1995: 15). In order to fulfil the characteristics of a recreational athlete, the author furthermore states that "the athlete must freely choose to participate on a regular basis for the purpose of fun" (1995: 15).

## 2.3 Exercise and energy demands

The aim of this section is to briefly summarise mechanisms of energy metabolism (i.e. energy balance and energy pathways), as these concepts are essential for further discussion (cf. ACSM 2009).

### 2.3.1 Energy balance

Maughan and Burke (2002) explain that our food can be regarded as our primary source of energy since it consists of various components which ensure the functioning of our body. Once the basal needs (i.e. the amount of energy that guarantees a fully-functioning and healthy body) have been met, "additional energy is needed to fuel muscular activity" (Maughan & Burke 2002: 3). The authors furthermore explain that different components make up total energy requirements of an athlete. These components include the basal metabolic rate (BMR), the thermic effect of food (TEF), the thermic effect of activity (TEA) and the cost of growth. In addition, factors such as body size and training programme (intensity, duration and frequency) are also considered to have an influence on energy expenditure (Maughan & Burke 2002: 3-4). Therefore, it could be argued that a balance between energy intake and energy expenditure is vital for athletes in terms of maintenance of good performance.

The Dietitians of Canada, henceforth referred to as DC, recently published a Position paper called *"Nutrition and Athletic Performance"* (DC 2016) in collaboration with the Academy of Nutrition and Dietetics as well as the American College of Sports Medicine (ACSM), which proved to be highly valuable for this thesis since it represents a systematic up-to-date review of major studies about nutrition as well as physical exercise. Furthermore, the work is based on evidence-based analysis, which makes it a reliable source for information. With regard to energy balance, for example, it is stated that "[e]nergy balance occurs when total Energy Intake (EI) equals Total Energy Expenditure (TEE), which in turn consists of the summation of basal metabolic rate (BMR), the Thermic Effect of Food (TEF) and the Thermic Effect of Activity (TEA)" (DC 2016: 7). Figure 1 tries to visualise this principle.

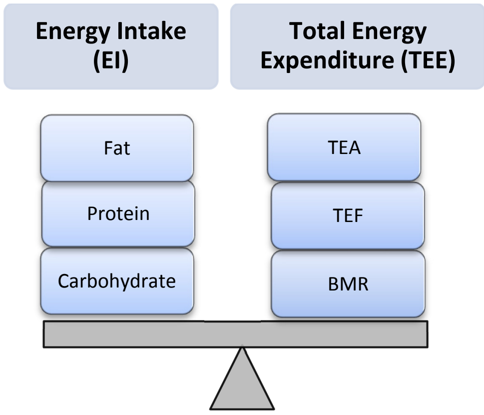



**Figure 1 Energy balance between EI and TEE**

In addition, Figure 1 highlights the fact that a possible imbalance between energy intake and expenditure, for example a lower intake than expenditure, might support the manipulation of body composition (DC 2016: 7), or to put it in other words, the loss of body weight.

For sedentary and moderately active individuals including recreational athletes, the Harris Benedict equations may help to estimate BMR. With a suitable activity factor applied, TEE may also be properly estimated. Regarding these individuals, RMR makes up approximately 60% to 80% of TEE. On the contrary, RMR of professional endurance athletes might be only 38% to 47% of TEE, due to the fact that they might have a TEA (including "planned exercise expenditure, spontaneous physical activity (e.g., fidgeting), and non-exercise activity thermogenesis") of up to 50% of TEE (DC 2016: 7).

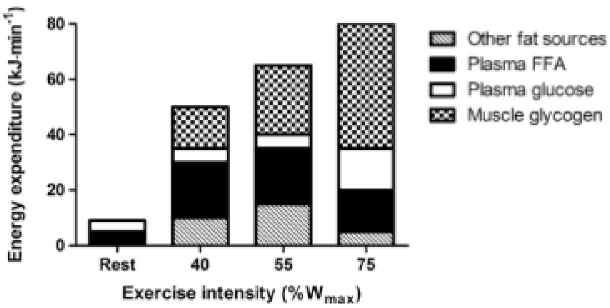
All in all, it could be argued that every athlete needs to meet his personal energy demands in order to sustain body functions and consequently stay healthy. Furthermore, a balanced energy intake, amongst other factors, is considered to have an influence on body composition as well as on "the capacity for intake of macronutrient and micronutrients" (DC 2016: 7).

### 2.3.2 Energy pathways

In general, knowledge and understanding about the human body's energy systems, substrate availability as well as about nutrient-training interactions are crucial factors for the appropriate intake of nutrients. Energy systems within the body consist of two major systems, namely the non-oxidative and the aerobic pathways. In general, the non-oxidative pathways provide energy for short-term exercise, whereas the aerobic systems generate energy for exercise with a longer duration (i.e. two minutes or more) (DC 2016: 12).

With regard to the non-oxidative pathway, it can further be distinguished between the phosphagen and the glycolytic (lactic acid) pathway, both of which supply energy for short-term exercise. Whereas adenosine triphosphate (ATP) and phosphocreatine, the substrates of the phosphagen system, supply energy for approximately 10 seconds, the glycolytic pathway supports exercise from 10 to 180 seconds through the metabolisation of glucose and muscle glycogen (DC 2016: 12).

As already mentioned, oxidative pathways (i.e. fat and carbohydrate oxidation) fuel exercise with a duration of more than two minutes. "The major substrates include muscle and liver glycogen, intramuscular lipid, adipose tissue triglycerides, and amino acids from muscle, blood liver and the gut" (DC 2016: 12). It is, however, important to note that these systems do not work completely independently but that factors, such as "intensity, duration, type of training, sex, and training level of the individual, as well as prior nutrient intake", rather act as influencing factors regarding the contribution of each pathway towards energy production and when changes between pathways occur (DC 2016: 12). Cermak and van Loon (2013) support this argumentation in their paper on carbohydrates as ergogenic aids by explaining that, even though both, "[c]arbohydrate and fat are the two primary fuel sources oxidized by skeletal muscle tissue during prolonged, endurance-type exercise [...], [t]he relative contribution of these fuel sources largely depends on the exercise intensity and duration as well as the athlete's training status" (2013: 1139). Figure 2 illustrates this concept.




Adapted from: Cermak & van Loon (2013: 1140)

**Figure 2 Relative contribution of plasma glucose, muscle glycogen, plasma FFA and other fat sources to energy expenditure**

As can be seen in Figure 2, the relative contribution of muscle glycogen towards energy expenditure increases in correlation with exercise intensity, eventually "becoming the most important substrate source" (Cermak & van Loon 2013: 1140). Moreover, it is argued that, despite the fact that carbohydrate stores within the human body are rather small, (~100g in the liver and ~350-700g in the muscle), "muscle glycogen represents an essential fuel source during prolonged moderate-to high intensity exercise" (Cermak & van Loon 2013: 1140). A summary of the various energy systems and their characteristics is provided in Table 1.

**Table 1 Energy systems used during different types of exercise**

| Type of exercise | Main energy system | Major storage fuels used |
|---|---|---|
| Maximal short bursts lasting less than 6 sec. | ATP-PC (phosphagen) | ATP and PC |
| High intensity lasting up to 30 sec. | ATP-PC<br>Anaerobic glycolytic | ATP and PC<br>Muscle glycogen |
| High intensity lasting up to 15 min. | Anaerobic glycolytic<br>Aerobic | Muscle glycogen |
| Moderate-high intensity lasting 15-60 min. | Aerobic | Muscle glycogen<br>Adipose tissue |
| Moderate-high intensity lasting 60-90 minutes. | Aerobic | Muscle glycogen<br>Liver glycogen<br>Blood glucose<br>Intra-muscular fat<br>Adipose tissue |

| | | |
|---|---|---|
| Moderate intensity lasting longer than 90 min. | Aerobic | Muscle glycogen<br>Liver glycogen<br>Blood glucose<br>Intra-muscular fat<br>Adipose tissue |

Adapted from: Bean (2013: 23)

## 2.4 Nutritional needs of endurance athletes

Maughan and Burke (2002) claim that, on a professional level, factors that were once responsible for success in competition such as the will to win, superior equipment, talent or hard training, are nowadays more or less equalised. The authors claim that this is when nutritional practices enter the stage because under such equal conditions, optimal nutrition of an athlete can be the decisive factor between winning and losing (2002: ix). Maughan, Depiesse and Geyer (2007) also argue that, even though a good choice of food does not compensate for lack of talent or missed training sessions, it will support athletes who are willing to give their best to do so. In addition, it is stated that "[a]n athlete's ability to sustain consistent intensive training and competition without succumbing to chronic fatigue, injury, and illness will be influenced not only by the types of foods eaten, but also by the amount and timing of food intake" (Maughan, Depiesse & Geyer 2007: 103). Due to this significance of nutrition in sport, nutritional needs of athletes will be scrutinised in this section.

According to the Dietitians of Canada (2016), it is important to understand that nutritional demands of an athlete are by no means a static entity. In order to achieve peak performance in a sports event, a programme consisting of a range of different workouts needs to be applied by professional as well as amateur athletes. This alternating programme can be divided into two major phases, namely the phase of training and the phase of competition which will be elaborated on in more detail in section 2.4.1 and 2.4.2 respectively. Due to these reasons, an athlete's nutrition, similar to the different workouts, needs to take into account the current stage of training in order to meet the demands of the body (DC 2016: 6). Unfortunately, it is beyond the scope of this thesis to provide a description of nutritional demands of various sports, thus, this section discusses general needs of athletes first and then focuses on the needs of endurance athletes in more detail.

Raschka and Ruf (2012: 29) explain that, in contrast to individuals who are not physically active, athletes have an increased energy demand as well as an increased demand of fluids. Due to the proportionally increased food intake of an athlete, however, the sufficient intake of essential nutrients (i.e. macro- and micronutrients) is ensured. Additionally, Maughan, Depiesse and Geyer (2007: 103) argue that a balanced diet which “contains a variety of foods and is eaten in amounts sufficient to meet the energy demands of training and competition should provide all the nutrients that an athlete needs”. As a consequence, it is argued that dietary supplements should not be regarded as a replacement for a whole-food diet (2007: 103). There are however certain cases, in which dietary supplements might play an important role for athletes. These cases will be elaborated in more detail in section 2.5.

Even though there is a consensus among researchers that general dietary recommendations are also valid for athletes (Williams & Leutholtz 2000: 356; ACSM 2009: 714), it is important to bear in mind that increasingly popular sport events such as half marathons, marathons or Ironmans require a certain amount of training sessions and, as a consequence, many people seek to optimize their nutrition in order to enhance performance in these competitions. For this purpose, the Swiss Forum for Sport Nutrition (2016) offers a valid Food Pyramid for Athletes (see Figure 3).

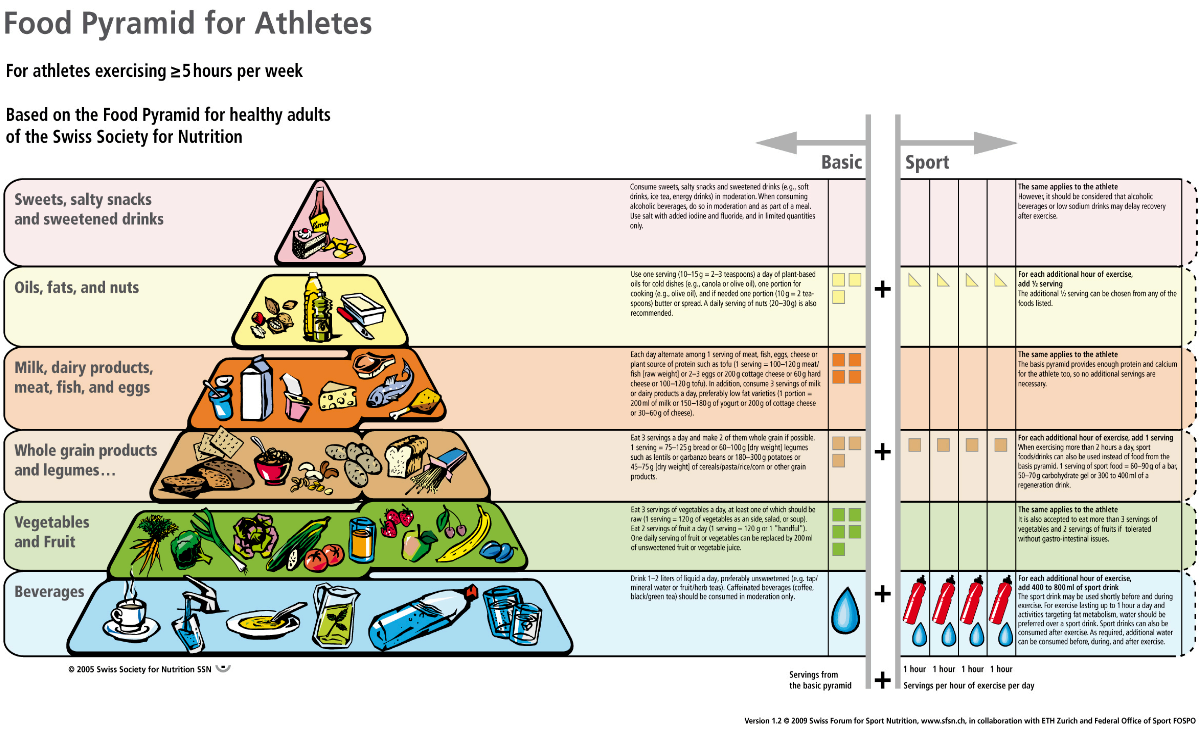



**Figure 3 Food Pyramid for Athletes**

Based on the Food Pyramid for healthy adults, which was developed by the Swiss Society for Nutrition, the Food Pyramid for Athletes is aimed at athletes who exercise for a minimum of 5 hours per week. Both pyramids share the recommendation of a balanced diet which ensures a sufficient intake of energy and various nutrients. Athletes, however, are advised to select a variety of products from each section and, more importantly, that they should meet the suggested guidelines consistently (i.e. on a daily basis) in order to sustain good performance. In contrast, the sedentary population does not have to adhere to recommendations on such a strict basis.

Moving on to the more specific nutritional needs of endurance athletes, it should first of all be noted that, according to the Dietitians of Canada (2016: 6), nutrients such as carbohydrate and protein "should be expressed using guidelines per kg body mass [i.e. body weight] to allow recommendations to be scaled to the large range in the body sizes of athletes". Recommendations expressed in "percentage contributions to total dietary energy intake […] are neither user-friendly, nor related to the muscle's absolute needs for fuel" (Burke, Kiens & Ivy 2004: 21) and should thus be avoided. For this reason, the ACSM (2009: 710) recommends a carbohydrate intake between 6 and 10g/kg BW per day, a protein intake between 1.2 and 1.4 g/kg BW (2009: 715) for endurance athletes, and proposes a range of fat intake between 20% and 35% of EI.

On the contrary, the European Food Safety Authority (EFSA) proposes following recommendations for the general population, valid for both adults and children (EFSA 2010a: 2-3; 2010b: 2; 2012: 2).

- Carbohydrate: 45-60 %E
- Fat: 20 - 35%
- 0.83 g/kg BW per day

Following example will be used in order to highlight the previously mentioned weakness of the expression of guidelines as %E as it is realised, for instance, by Tomasits and Haber (2008: 248-253), who present their recommendations for endurance athletes as follows: carbohydrate between 58-60%; fat: max. 30%; protein 12%.

A 70-kg athlete with an energy intake between 4000 and 5000 kcal/d already meets his demands even when only 50% of the energy is provided by carbohydrate (i.e. 500-600 g) because the daily maintenance of carbohydrate stores is ensured with an intake of approximately 7-8 g/kg BW. In a similar way, if, for example, 10% protein intake is recommended, meaning an absolute intake of 100-125 g/d, this could exceed the recommendations of 1.2-1.4 g/kg per day or 84-119 g for the 70-kg athlete, respectively. On the other hand, in case of an energy intake below 2000 kcal, recommended 60% energy intake from carbohydrate might not be sufficient for a 60-kg athlete (4-5 g/kg) (ACSM 2009: 714). Due to these variations in athlete's body weight, the support of the expression of recommendations in g per kg BW, as it is already done by the ACSM, should be enforced.

In general, it can be seen from these numbers that an increased intake of carbohydrate is suggested for endurance athletes. In addition, it is important to distinguish between whether or not an athlete is in the phase of training or in a competition because in either of these cases, applied nutritional strategies for meeting the demands might differ considerably from people who do not perform endurance sport.

### 2.4.1 The phase of training

Generally speaking, recommendations for athletes who are in the stage of training, either for a certain competition or not, should follow the general dietary recommendations (see section 2.4). In addition to these general recommendations, however, two factors should be taken into consideration if an athlete regularly performs a certain amount of training sessions. These factors, which are sufficient carbohydrate intake and proper hydration, will be discussed in the following sections with regard to the phase of training and around competitions.

#### *2.4.1.1 Carbohydrate guidelines*

A lot of research on carbohydrate and its influence on performance has been carried out so far. According to the DC (2016: 12), reasons for this vast amount of research might be that, despite the fact that carbohydrate stores within the human body are rather small, there is scientific evidence that they can be manipulated either through exercise or by nutrition. Secondly, carbohydrate can be used by both anaerobic and oxidative pathways, which means that energy for a wide range of exercise, also with differing intensity, is provided by this substrate. In addition, it can be seen as a "key fuel for the brain and central nervous system" (DC 2016: 12). Thirdly, "there is significant evidence that the performance of prolonged sustained or intermittent high-intensity exercise is enhanced by strategies that maintain high carbohydrate availability" (DC 2016: 13).

Romijn et al. (1993: 387) were, amongst others, researchers who identified two substrates that are essential for the contracting muscle, namely muscle glycogen and blood glucose. Later on, muscle glycogen depletion and low blood glucose levels were associated with fatigue during endurance exercise, whereas high glycogen concentrations in the muscle as well as in the liver are seen as contributing factors towards good performance (Jeukendrup 2004; Burke, Kiens & Ivy 2004; Burke et al. 2011; Cermak & van Loon 2013).

Burke, Kiens and Ivy, for example, claim in their paper "*Carbohydrates and fat for training and recovery*" (2004) that, due to the fact that "carbohydrate sources (plasma glucose derived from the liver or dietary carbohydrate intake, and muscle glycogen stores) are limited […], the availability of carbohydrate as a substrate for the muscle and central nervous system becomes a limiting factor in the performance of prolonged sessions (>90 min)" (Burke, Kiens & Ivy 2004: 15). This has consequently lead to the promotion of carbohydrate intake beforehand and/or during a training session in order to fuel the respective session as well as after training with the primary goal of effective recovery (Burke, Kiens & Ivy 2004: 15). It is furthermore advised that athletes should fill glycogen stores immediately after performing exercise "because it provides an immediate source of substrate to the muscle cell to start effective recovery" (Burke, Kiens & Ivy 2004: 18). This is especially important if only approximately 4-8 hours are in-between exercise sessions.

Burke et al (2011) review in their paper "*Carbohydrates for training and competition*" well-supported arguments with regard to carbohydrate intake throughout the phase of training. Table 2 summarises their findings and presents the recommended daily intake of carbohydrate taking into consideration different modes of exercise (Light, Moderate, High and Very High).

**Table 2 Guidelines for daily carbohydrate intake by athletes**

| | | |
|---|---|---|
| **Light** | Low-intensity or skill-based activities | 3-5g/kg of athlete's BW/d |
| **Moderate** | Moderate exercise programme (i.e. app. 1 h/d) | 5-7 g/kg/d |
| **High** | Endurance programme (e.g. moderate-to-high intensity exercise of 1-3 h/d) | 6-10 g/kg/d |
| **Very High** | Extreme commitment (i.e. moderate-to-high intensity exercise of > 4-5 h/d) | 8-12 g/kg/d |

Adapted from: Burke et al. (2011: 20)

As Table 2 shows, the recommended dietary intake of carbohydrate considerably varies according to the mode of exercise. It should, however, be noted that these recommendations need to "be fine-tuned with individual consideration of total energy needs, specific training needs, and feedback from training performance" (Burke et al. 2011: 20). Furthermore, it is important to bear in mind that athletes may move in-between these categories as they obtain an alternating training programme with individual goals (Burke et al. 2011: 19). In other words, an ambitious recreational athlete who has successfully completed various marathons might want to prove himself in an Ironman event and thus has to complete a much more intense training load.

#### *2.4.1.2 Hydration*

In addition to proper carbohydrate availability, sufficient intake of fluid is seen as a prerequisite for good performance. Based on 13 studies focusing on the effects of body water loss on endurance exercise, the Institute of Medicine (IOM) comes to the conclusion that dehydration has an influence on "cardiovascular, thermoregulatory, central nervous system, and metabolic functions" (2005: 110). It is furthermore explained that, if "dehydration exceeds 2 percent of body weight", endurance exercise will be impaired. In fact, it was found out that deficits in performance correlated with increased temperature in which exercise is performed. "In addition, experimental evidence supports the concept that greater body water deficits result in a greater magnitude of performance decrements" (IOM 2005: 110).

Previously mentioned aspects of training could be summed up with the words of Burke, Kiens and Ivy (2004: 15), who state that the "goal of the athlete's everyday diet is to provide the muscle with substrates to fuel the training programme that will achieve optimal adaptation and performance enhancements". Consequently, it could be argued that the aim of an athlete's daily diet, which ultimately is to ensure good performance and fast recovery in-between training sessions, can be realised through the intake of a balanced and varied diet as well as the sufficient intake of fluid.

### 2.4.2 Competition nutrition

As many recreational athletes at some point during their sports career like to compete with other athletes, they decide to take part in increasingly popular competitions such as marathons, half marathons or even more popular Fun runs[1] with easy manageable distances between 5 and 10 kilometres. In this case, the correct choice of competition nutrition might contribute towards a good performance of an athlete. According to Maughan and Burke (2002: 75), the aim of competition nutrition is to delay factors that are ultimately responsible for fatigue (e.g. glycogen depletion, hypoglycaemia[2] or dehydration). If an athlete is able to prevent such states, he is in turn more likely to perform at his best. Nutrition strategies for meeting the demands therefore also vary according to the event per se (e.g. duration, intensity and mode of the event), the environment as well as on personal habits and the fitness level of the athlete.

Similar to the nutrition strategies during the training phase, also competition nutrition is an umbrella term for nutrition immediately before (i.e. hours or days) an event, during and after competition (Maughan & Burke 2002: 75). Glycogen depletion and hypohydration, two already mentioned factors which can be responsible for fatigue during exercise, will be elaborated in more detail with regard to the different stages of competition in this section.

#### *2.4.2.1 Before the event*

As already mentioned, carbohydrate can be regarded as an essential fuel for the muscle as well as for the central nervous system. Thus, “fatigue during prolonged exercise is most often associated with muscle glycogen depletion and reduced blood glucose concentrations” (Cermak & van Loon 2013: 1140).

With regard to this issue, Maughan and Burke (2002: 76) state that, in order to perform well in competitions with an estimated duration of more than 90 minutes, an athlete has consequently the opportunity to fill muscle glycogen stores in the days and hours before the event so that the estimated fuel costs are met. To put it

[1] German: Volkslauf

[2] Low levels of blood glucose

in other words, athletes should concentrate on filling up carbohydrate stores in the muscle as well as in the liver to a maximum before the intended competition. This strategy of maximising or super compensation is also commonly known as *carbohydrate loading* (Maughan & Burke 2002: 76).

As it has already been proven by Hawley et al. (1997), higher (i.e. supercompensated) glycogen stores offer beneficial aspects for endurance performance under the precondition that the duration is longer than 90 minutes. According to Jeukendrup (2011: 92) results of this particular review on carbohydrate loading are still valid. In brief, results showed that supercompensated muscle glycogen stores improved an athlete's performance compared to an athlete with a low or normal glycogen stores by 2-3% in events with a duration of more than 90 minutes. If, however, the duration of an event is less than 90 minutes, no significant differences on performance output could be observed between compensated and non-compensated muscle glycogen (Hawley et al. 1997: 80).

Furthermore, it should also be noticed that, similar to our understanding about certain nutritional practises, this technique developed as scientific insights emerged (Burke et al. 2011: 19). According to the authors, first studies on carbohydrate loading were conducted in the 1960s. These were characterised by "a period of depletion (3 days low carbohydrate + training) followed by a 3-day loading phase (taper + high carbohydrate intake)" (Burke et al. 2011: 19). These original carbohydrate loading strategies were, however, modified in the 1980s due to the fact that researchers discovered that athletes with a high training status "were able to supercompensate muscle glycogen stores without a depletion or 'glycogen stripping' phase" (Maughan & Burke 2002: 77). Nowadays, this depletion phase is therefore considered to be obsolete. In addition, it should be acknowledged that, achieving the recommended amounts of carbohydrate (7-10g kg BW) can be a challenging task, especially for athletes who do not have sufficient knowledge (Maughan & Burke 2002: 77). Thus, consulting a professional dietitian, for example, might yield valuable insights.

Considering fluid requirements of athletes who regularly exercise, it is first of all important to understand that these people have an increased demand of liquid because “[i]n addition to the usual daily water losses from respiration, gastrointestinal, renal and sweat sources, athletes need to replace sweat losses” (DC 2016: 23). The state, which occurs if sweat loss is not sufficiently replaced, is consequently called dehydration. Regarding endurance athletes, the occurrence of this state can have various reasons, for example, nervousness or stress before and during the race and, as a consequence, the disregard of its symptoms.

Due to the fact that with sweat loss, essential electrolytes such as sodium can be lost, athletes should always strive to avoid this state. Negative effects of dehydration were investigated by Shirreffs and Sawka (2011), who explained that “[h]ypohydration can degrade aerobic exercise performance, and increase physiological strain and perceived exertion during exercise in temperate, warm/hot environments” (Shirreffs & Sawka 2011: 39). In order to tackle this problem, Sawka et al. (2007) provide guidelines for exercise and fluid replacement. To start an activity euhydrated[3], the authors argue that athletes should begin several hours before the event with a process called ‘prehydration’ which enables “fluid absorption” and ensures “urine output to return to normal levels” (2007: 377). Ultimately, drinking the right amount of fluid also prevents electrolyte imbalance (2007: 377). In addition to these guidelines, Maughan and Burke (2002: 76) state that athletes need to individually experiment in order to determine how much volume still feels comfortable once the activity has begun. As a general rule, however, most athletes tolerate 300-400 ml of fluid. Sawka et al. (2007), on the other hand, provide slightly more precise recommendations, namely that athletes should drink approximately between 5 and 7 mL/kg BW “at least 4 hours before the exercise task” (Sawka et al. 2007: 384).

[3] Normal body water content (Sawka et al. 2007: 377)

#### *2.4.2.2 During the event*

Jeukendrup (2004) states in his review article "*Carbohydrate intake during exercise and performance"* that it has been repeatedly observed that carbohydrate intake has beneficial aspects in terms of improved endurance performance (Jeukendrup 2004: 670).

Cermak and van Loon (2013: 1150) also conclude their paper by stating that the intake of carbohydrate "during prolonged (>2 h) moderate to high-intensity exercise is essential for optimal performance of the endurance athlete". The authors furthermore recommend "a modest amount of carbohydrate" (i.e. 60 g/h) for exercise with a duration up to three hours. In order to enable such high rates of oxidation, "multiple transportable carbohydrates should be ingested (e.g. glucose or glucose polymers plus fructose or sucrose)".

An intake of 90 g per hour is suggested if the duration is longer than 2.5 hours with the remark that this amount "can be metabolized by well-trained athletes […]. However, as not all individuals will be able to tolerate such high carbohydrate intake rates, feeding strategies during prolonged exercise need to take into account personal preference and gastro- intestinal tolerance, and require proper practice" (Cermak & van Loon 2013: 1150).

Due to the fact that there is already a comprehensive amount of research on the effects of carbohydrate intake on endurance performance, Vandenbogaerde and Hopkins (2011) decided to publish the first meta-analysis about carbohydrate supplementation before and/or during exercise. Therefore, 88 studies were investigated, 73 of which met the research criteria. Results showed that there was a wide span between the effects of carbohydrate supplementation, ranging from positive to negative effects, depending on type of carbohydrate, timing of intake and individual differences. In brief, "[t]he best supplement inferred from the analysis consisted of a ~3-10% carbohydrate-plus protein drink providing ~0.7g/kg/h polymers, ~0.2g/kg/h fructose and ~0.2g/kg/h protein" (Vandenbogaerde & Hopkins 2011: 773).

In addition, carbohydrate intake during exercise might not only be relevant for long-term exercise but also for high- intensity, short duration exercise of approximately one hour, where a mouth rinse with carbohydrate appears to have measurable performance benefits (Jeukendrup 2011: 93). Findings of Carter, Jeukendrup and Jones (2004) suggest "that carbohydrate mouth rinse has a positive effect on 1-h time trial performance. The mechanism responsible for the improvement in high-intensity exercise performance with exogenous carbohydrate appears to involve an increase in central drive or motivation rather than having any metabolic cause" (Carter, Jeukendrup & Jones 2004: 2107).

With regard to hydration during competition, Sawka et al. (2007) explain that an athlete should always strive for a reduction of sweat losses by drinking sufficient fluids. Sweat rates, which are dependent on duration, fitness and intensity, can range from 0.5 to 2 L/h (2007: 378). Thus, dehydration should be avoided due to the fact that the loss of ">2% BW degrades aerobic exercise and cognitive/mental performance in temperate-warm-hot environments" (Sawka et al. 2007: 381). Additionally, it is stated that greater deficits further degrade performance.

All in all, it could be argued that the major goal of an athlete during competition should be the sufficient intake of carbohydrate, water and possibly electrolytes in order to delay factors which eventually cause fatigue (Maughan & Burke 2002: 84).

#### *2.4.2.3 After the event*

Regarding the refuelling of glycogen stores, Burke et al. (2011: 19) argue that "[i]n the absence of severe muscle damage, glycogen stores can be normalised with 24 h of reduced training and adequate fuel intake". According to Cermak and van Loon (2013: 1150), fast refuelling strategies are especially important for athletes who perform in competitions stretching over several days (e.g. tournaments), or for athletes who exercise twice a day. If this is the case, athletes are advised to ingest 1.2 g/kg/h carbohydrate for 4-6 h after completion of exercise. Furthermore, "[a] combination of glucose or glucose polymers with fructose or galactose is recommended to target both liver and skeletal muscle glycogen repletion" (Cermak & van Loon 2013: 1150-1151).

Guidelines for previously discussed fuelling strategies are summarised in Table 3 below.

**Table 3 Fuelling strategies**

| | | |
|---|---|---|
| **General fuelling up** | Preparation for events < 90 minutes | 7-12 g /kg/BW per 24h as for daily fuel needs |
| **Carbohydrate loading** | Preparation for events > 90 minutes of sustained intermittent exercise | 36-48 h of 10-12 g/kg/BW per 24 h |
| **Speedy refuelling** | <8 h recovery between 2 fuel-demanding sessions | 1.0-1.2 g/kg/h for first 4 h then resume daily fuel needs |
| **Pre-event fuelling** | Before exercise >60 min | 1-4g/kg consumed 1-4h before exercise |
| **During endurance exercise** | 1-2.5h | 30-60g/h |
| **During ultra-endurance exercise** | > 2.5-3.0 h | Up to 90 g/h |

Adapted from: Burke et al. (2011: 20)

With regard to the replacement of fluid and electrolytes, Sawka et al. (2007) state that it is just as important as the replacement of carbohydrate. For a recreational athlete who, for example, might has finished a half marathon, it is however satisfactory to consume “normal meals and snacks with a sufficient volume of plain water [in order to] restore euhydration, provided the food contains sufficient sodium to replace sweat losses” (Sawka et al. 2007: 386).

## 2.5 Dietary supplements

The focus of this section will be on dietary supplements. First of all, dietary supplements will be defined. Secondly, a selection of supplements will be elaborated, which will be followed by an evaluation of potential risks and dangers of these nutritional supplements.

### 2.5.1 Definition and historical background

Dietary, or food supplements, as they are referred to by the European Commission (EC), are defined as "concentrated sources of nutrients (or other substances) with a nutritional or physiological effect. Such food supplements can be marketed in 'dose' form, such as pills, tablets, capsules, liquids in measured doses, etc." (EC 2016). The US Congress, on the other hand, defined dietary supplements in the *Dietary Supplement Health and Education Act of 1994* (DSHEA), as:

> a product (other than tobacco) intended to supplement the diet that bears or contains one or more of the following dietary ingredients:
>
> (A) a vitamin;
> (B) a mineral;
> (C) an herb or other botanical;
> (D) an amino acid;
> (E) a dietary supplement used by man to supplement the diet by increasing its total daily intake;
> (F) or a concentrate, metabolite, constituent, extract, or combination of any ingredient described in clause (A), (B), (C), (D), or (E).

As it can be seen from these two examples, there is no generally accepted definition of dietary supplements. This can also be observed in scientific discourse, where the term *dietary supplement* is used differently among researchers (Braun et al. 2009: 97). Moreover, it is stated that "terms such *as nutritional supplement*, *nutritional ergogenic aid*, or *sports supplement* have also been used by authors in the same context" (Braun et al. 2009: 97-98).

From a historical perspective, nutritional ergogenic aids are not a new phenomenon. In fact, the desire for nutritional performance-enhancing substances goes back to the ancient Greeks. Warriors consumed deer liver or lion heart in order to enhance their performance. Moreover, the consumption should provide them with traits such as bravery, strength or speed (Mueller & Hingst 2013: 3). Even though the previously mentioned ancient approaches towards performance enhancement have vanished as soon as science and technology have developed, the insatiable human demand for performance enhancement still perpetuates the development of new ways to increase performance. In other words, the development of nutritional ergogenic aids will probably last as long as humans are competitive.

Maughan and Burke (2002: 129) list three aspects that athletes should always bear in mind when they consider the usage of dietary supplements, namely:

- the efficacy of the product (timing, amount and optimal performance conditions of intake);
- the possibility of side effects which contravene with the anti-doping code;
- the safety of the product.

With regard to the second point on the list, it should be noted that a possible contamination with banned substances like hormones, for example, is possible. However, this might be more relevant for professional athletes than for recreational athletes due to the possibility of disqualification of competition.

Concerning the last point, safety, the authors state that, unfortunately, the usage of supplements with scientifically proven side effects shows that many athletes do not recognise this risk (Maughan & Burke 2002: 129). These arguments lead Maughan and Burke (2002: 129) to conclude their argument by formulation following rule of thumb:

> [M]ost supplements that offer a direct performance-enhancing effect are against the rules of sport: this category includes drugs and hormones. Most substances that are not banned are not effective: this includes most of the vitamin and mineral supplements as well as the herbal products sold in health food shops.

Nevertheless, there are exceptions to these claims, as it is also stated by the authors. These shall be discussed in section 2.5.5.

### 2.5.2 Prevalence and motifs for usage

Regarding the prevalence of supplement use, surveys support the common assumption that athletes are more likely to use dietary supplements in contrast to the general population (see also: Sobal & Marquart 1994; Sundgot-Borgen, Berglund & Torstveit 2003; Braun et al. 2009).

Maughan and Burke furthermore (2002: 130) explain that, despite the fact that dietary supplements are commonly used, there are considerable differences regarding the kind of sport, gender and whether the participants are professional athletes or not. Sobal and Marquart (1994: 324) additionally list the "Level of Competition" as an influencing factor for the intake of dietary supplements.

On an international level, Maughan, Depiesse and Geyer (2007) examined the usage of dietary supplements (n= 310) among athletes. According to the authors, 85% of elite athletes make use of dietary supplements (2007: 105). Sundgot-Borgen, Berglund and Torstveit (2003) investigated usage patterns of elite athletes, as well as supplement use among the general population (i.e. control group). Their study included the entire elite athlete population (n= 1620) of Norway. Results generally showed that, in contrast to the general population (42%), the intake of supplements by elite athletes (53%) was significantly increased. Furthermore, a gender difference could be observed in the general population, namely that more female (52%) than male (32%) controls used dietary supplements. In contrast to this finding, no gender difference could be observed in the group of athletes (Sundgot-Borgen, Berglund & Torstveit 2003: 139-140), even though previous studies (Sobal & Marquart 1994: 324) suggested that more female athletes compared to male athletes use dietary supplements. A survey on young German elite athletes, conducted by Braun et al. (2009: 102), showed that 80% of 164 participants use or used dietary supplements. Moreover, it was observed that there was an increase of prevalence with increasing age. In other words, older (i.e. above 18) athletes were more likely to use dietary supplements than younger ones.

Closer examination of previously mentioned surveys furthermore revealed differences regarding the preferred type of supplement as well as motifs and influencing factors for consumption.

The most commonly used substances among internationally successful athletes "were vitamins and antioxidants (84%), minerals (73%), protein and creatine supplements (53%), and ergogenic supplements, including co-enzyme Q10, caffeine, ginseng, and ephedrine (52%)" (Maughan, Depiesse & Geyer 2007: 106).

Regarding Norwegian elite athletes, it could be observed that, whereas female athletes tend to use more vitamin and mineral supplements, male athletes rather use amino acids and creatine (Sundgot-Borgen, Berglund & Torstveit 2003: 141). Preferred supplements among young German elite athletes are minerals, vitamins and sport beverages (Braun et al. 2009: 102-103).

Possible motifs for consumption of dietary supplements are, according to Sobal and Marquart (1994: 327), "[p]erformance enhancement, prevention of illness, compensation for inadequate diet, providing extra energy, and meeting special nutrient demands from high levels of activity". In addition to these reasons, Maughan, Depiesse and Geyer (2007: 105) list "to aid in recovery from training" as one of the main reasons for supplements use. The most popular motif for consumption of dietary supplements among Norwegian athletes was the idea that they needed it in addition to their general diet. Similar reasons are assumed as an explanation for the high percentage of supplement users among the general population (Sundgot-Borgen, Berglund & Torstveit 2003: 140-141). Braun et al. (2009: 105) argue that the majority of participants use supplements for "health-related reasons", followed by "performance-related reasons". Interestingly, more protein and carbohydrate supplements were consumed by those who cited performance-related reasons, whereas more vitamin supplements were consumed by athletes who use supplements for health-related reasons (Braun et al. 2009: 105).

As influencing factors for supplementation, primarily coaches are listed, followed by doctors, parents and peers (Sobal & Marquart 1994: 327). Maughan, Depiesse and Geyer (2007: 106) in addition name the factor of personal research as source of information and consequently influencing factor. This development can possibly be traced back to research on the Internet.

Considering these surveys, it can be observed that all reported results from different surveys generally contradict recommendations of prestigious institutes, such as the ACSM, who explicitly state that, unless the athlete suffers from a deficiency, supplementation is unnecessary (ACSM 2009: 715). As a concluding remark, it should also be understood that supplements do not make up for missed training sessions and, moreover, do not turn a recreational athlete into a professional one (Feiden & Blasius 2003: 24). Maughan, Depiesse and Geyer additionally explain that, even though dietary supplements might be beneficial for some athletes under certain circumstances (see section 2.5.5), they should only be used after a professional dietician or nutritionist was consulted (2007: 104).

### 2.5.3 Carbohydrate supplements

Due to its various essential roles when it comes to energy supply, carbohydrate can be seen as highly important in sports nutrition.

Research results regarding carbohydrate and its effects on endurance exercise have lead to the common practice among athletes of carbohydrate ingestion during exercise (Cermak & van Loon 2013: 1140). And this trend, in turn, fuelled the development "of sports-specific carbohydrate-containing supplements that provide carbohydrate in various forms (solid, gel, or liquid), types (e.g. glucose, maltodextrin, and fructose), and concentrations" (Cermak & van Loon 2013: 1141).

Whether the carbohydrate supplements are consumed in liquid, semi-liquid, or solid form, however, does not influence its efficacy (Cermak & van Loon 2013: 1145). This argument is also in line with results published by Pfeiffer, Stellingwerff and Zaltas (2010: 2038), showing that there is no difference in oxidation rate for solid, semi-solid or liquid carbohydrate.

Cermak and van Loon (2013) thus state that athletes can decide according to their personal preference, which carbohydrate product they use, as long as their fluid intake is sufficient because this "is required to facilitate gastric emptying and to compensate for sweat loss" (2013: 1145-1146).

A convenient product that enables the athlete to cater for both, carbohydrate and fluid intake is a sports drink. (AIS 2014a: 1) These drinks generally contain carbohydrate, sodium and possibly protein. Quantities, however, may vary according to different brands. For a comprehensive list of different sports drinks and its respective composition, the fact sheet *Sports drinks (carbohydrate-*

*electrolyte drinks)* published by the Australian Institute of Sport (2014a) can be consulted. Mueller and Hingst (2013: 6) additionally explain that the first sport drink, Gatorade, was developed in 1965 in Florida. Its mixture of glucose and sucrose in water at approximately a 6% solution is furthermore said to be responsible for today's sport beverage and food market including "products such as energy gels (e.g. Powergel) or energy bars (PowerBar).

Sports gels, on the other hand, contain a much higher concentration of carbohydrate (65-70% or 65-75g/100ml) and thus offer "a large fuel boost in a single serve" (AIS 2014b: 1). Due to their special consistency, they are faster and possibly more conveniently consumed than sports drinks. Another beneficial aspect of sports gels might be that they "provide a performance benefit via the stimulatory effect of carbohydrate-sensing mouth receptors on the brain and central nervous system" (AIS 2014b: 1). Nevertheless, sports gels should always be ingested with sufficient fluid in order to avoid dehydration. Moreover, it is advised to test them beforehand, in a longer training session for example, in case the usage is intended in competition. This method minimises the risk of unwanted negative side effects such as gastrointestinal stress (AIS 2014b: 4).

### 2.5.4 Protein supplements

Protein supplements entered the stage when Eugene Schiff, a pharmacist, first developed a method that enabled him to process whey from milk in the 1930s. Only shortly after the company Schiff Bio-Foods was established, "it was found that supplemental protein could facilitate increases in muscle mass and gains in strength" (Mueller & Hingst 2013: 7), eventually leading to the introduction of protein powders as we know them today.

Today, there is a general consensus regarding protein recommendations for adults. Athletes, on the other hand, are advised to ingest between 1.2 and 1.7 g/kg protein in order to meet their demands (see section 2.4). According to Mueller and Hingst (2013), [p]rotein intake above these recommendations, especially at the expense of other valuable macronutrients [...] can jeopardize an athlete's performance instead of enhance it" (Mueller & Hingst 2013: 8). The authors furthermore argue that supplementation is in most cases unnecessary due to the fact that the majority of athletes consume a sufficient amount of protein with the help of a balanced diet. However, protein supplementation may offer beneficial aspects for athletes who follow a vegetarian or vegan diet “due to the lower quality and digestibility of plant protein sources” (Mueller & Hingst 2013: 8). Moreover, protein supplements might help athletes who reduce calories in order to lose weight but still want to preserve muscle mass (2013: 8).

Phillips (2012) investigated whether an intake above these recommendations provides beneficial aspects and comes to the conclusion that “it is not yet possible to say that protein intakes higher than those suggested will be beneficial” (Phillips 2012: 164). Thus, recommendations of 1.2 – 1.7 g/kg are still considered to be appropriate for athletes. In addition, it is stated that timing of intake can be seen as a crucial factor for beneficial effects of protein supplementation (Phillips 2012: 164).

### 2.5.5 Vitamin and mineral supplements

Casimir Funk coined the term ‘vitamin’ in 1912. The discovery of the relationship between thiamine and the cure of symptoms of beriberi further impelled research, eventually leading to the result of isolation of 13 vitamins, 9 of which are water-soluble and 4 of which are fat-soluble. In combination with 7 major minerals, as well as 10 trace elements, vitamins are known as ‘micronutrients’ (Mueller & Hingst 2013: 4).

Maughan and Burke (2002: 35) explain that “[v]itamins are organic compounds that are needed by the body in small amounts to enable key reaction of daily living to occur”. Due to the fact that the body itself cannot produce vitamins, the dietary intake of vitamins is essential. Mueller and Hingst furthermore (2013: 4) state that

> [b]eyond playing an important role in energy production, haemoglobin synthesis, maintenance of bone health, adequate immune function, and protection of the body against oxidative damage, micronutrients assist with synthesis and repair of muscle tissue during recovery from exercise and injury.

Maughan and Burke (2002: 35) elaborate the importance of vitamins in more detail stating that:

> [m]any vitamins, particularly from the B group, act as cofactors for reactions involved in energy metabolism-for example, glycolysis, the tricarboxylic acid cycle, the beta-oxidation of fatty acids, and oxidative phosphorylation. Vitamin C activates an enzyme regulating the synthesis of carnitine, which transports fatty acids into the mitochondria for oxidation. Other B vitamins act as cofactors for the synthesis of heme, which is involved in oxygen transport in blood and muscles.

With regard to minerals, it is argued that they are vital for the maintenance of "function of tissues and cells". Nevertheless, "deficiencies are considered to be a rare phenomenon except for possibly calcium, iron and iodine" (Maughan & Burke 2002: 38). Considering deficiencies, the authors furthermore argue that, due to the increased food intake of athletes, "dietary surveys show that athletes consume adequate intakes of minerals and trace elements and show similar biochemical and haematological status to their sedentary counterparts" (Maughan & Burke 2002: 38).

Due to the previously mentioned importance of micronutrients, the United States Food and Nutrition Board developed the *Dietary Reference Intakes (DRI)*, formerly called *Recommended Dietary Allowances (RDA)* (Mueller & Hingst 2013: 4). These recommendations give information about "the daily dietary intake level of nutrients, including vitamins and minerals, considered sufficient to meet the requirements of nearly all (97%-98%) healthy individuals in each life stage and gender group" (Mueller & Hingst 2013: 4). Regarding athletes, however, this knowledge about vitamins might result in the assumption that an additional intake of vitamins might result in improved health and/or performance (Maughan & Burke 2002: 36). If there is evidence to this popular belief will be investigated in this section.

Lukaski (2004: 641) claims that nonreflective vitamin and/or mineral supplementation does not improve an athlete's performance. Exceptions might be athletes who restrict food intake in order to meet weight restrictions or for competition (e.g. gymnasts or long-distance runners). Maughan, Depiesse and Geyer (2007: 104) also state that, if an athlete needs to restrict energy intake for specific purposes (e.g. weight loss, reduction of body fat), multivitamin and mineral supplements might help to ensure a sufficient intake of essential needs. It is furthermore stated that only athletes with a diagnosed deficiency profit from supplementation of the respective nutrient(s).

In addition to this issue, Maughan, Depiesse and Geyer (2007) state that "[i]n general, supplements should be used only when a deficiency has been confirmed by blood analysis, and then only as a shortterm solution under clinical supervision while dietary changes are being implemented" (2007: 104). This argumentation is also congruent with Mueller and Hingst (2013) who list athletes who reduce energy intake to ensure weight-loss, athletes who avoid one or more major food groups, athletes with food allergies, athletes who show an excessive level of training, or athletes who mainly consume highly processed food as those groups who might profit from a vitamin and mineral supplementation (Mueller & Hingst 2013: 5). All previously mentioned studies are thus in consensus with the ACSM (2009: 710), which states that supplementation with neither vitamins nor minerals is necessary, as long as the athlete follows a balanced diet and ensures appropriate energy intake.

As a concluding remark, it should be noted that, according to Maughan and Burke (2002), "[e]arly studies that showed beneficial effects of supplementation on performance were usually poorly designed, often with no proper control group against which to compare the effects of supplementation" (Maughan & Burke 2002: 37). It is thus likely that these observed effects were a result of the placebo effect.

To sum up arguments regarding the vitamin- and/or mineral supplementation, there is, against the common belief that additional intake results in improved health, no scientific evidence for performance-enhancing effects. This argument is also supported by the Dieticians of Canada (2016: 22), who state that "the literature to support micronutrient supplementation is often marred with equivocal findings and weak evidence".

### 2.5.6 Ergogenic aids

Williams and Leutholtz (2000: 356) define ergogenic aids as additional "aids" which are "purported to enhance sport performance beyond that associated with the typical balanced diet". According to the authors, the primary aim of these aids is the enhancement of performance. This can, in turn, be realised in different ways, for example (Williams & Leutholtz 2000: 357):

- increased energy supply in the muscle (e.g. creatine supplements)
- increased energy-releasing metabolic processes in the muscle (e.g. L-carnitine supplements)
- enhanced oxygen delivery to the muscle (e.g. iron supplements)
- increased oxygen utilization in the muscle (e.g. coenzyme Q10 supplements
- decreased production or accumulation of fatigue-causing metabolites in the muscle (e.g. sodium bicarbonate supplements

In the following, selected ergogenic aids will be reviewed and investigated in terms of their potential efficacy. Possible negative effects will be discussed in section 2.5.7.

#### *2.5.6.1 Creatine*

Creatine, is seen as "a naturally occurring nutrient that can be obtained in the diet from meat and fish. It can also be synthesized in the liver and pancreas from the amino acids arginine, glycine, and methionine" (Mueller & Hingst 2013: 104). In the human body, creatine occurs in the brain, liver, kidney and testes. The largest quantities, however, occur in the skeletal muscle. For an average man (70kg BW), "the total creatine pool amounts to approximately 120 g, of which 95% is situated in the muscle" (Greenhaff 2000: 367).

Maughan and Burke (2002: 130) explain that creatine phosphate (CP) occurs in the muscle together with ATP, which can be seen as the fuel for the contracting muscle as fatigue is the result of low ATP concentrations. In order to regenerate ATP, the “[t]ransfer of the phosphate group from CP to ADP is catalysed by the enzyme creatine kinase, resulting in the restoration of ATP an the release of free creatine (C)” (Maughan & Burke 2002: 130). Mueller and Hingst therefore state that creatine supplementation “ increases stores of phosphocreatine, allowing muscles to work at higher intensities for a longer time” (2013: 104). In turn, this leads to the conclusion that creatine is of particular interest for those athletes, who engage in strength sports.

According to the American College of Sports Medicine (2009: 722), creatine is even claimed to be the most commonly used substance among ergogenic aids. Maughan and Burke (2002: 130) also state that there is reason to believe that creatine offers a performance-enhancing effect which is of particular note. In addition, it appears to have no negative side effects as long as it is not consumed in excessive amounts.

Maughan and Burke (2002: 131) explain that supplementation usually involves a loading phase where 3 g/kg BW are consumed, which immediately results in elevated PC levels in the muscle. After approximately three weeks, this loading phase is followed by a continuous intake of 1-2 g creatine in order to maintain these levels. Co-ingestion with carbohydrate further supports positive results. If the athlete decides to stop supplementation, elevated creatine levels will gradually decrease until they reach initial concentrations. It should however be noted that if dietary intake is high, the synthetic pathway is suppressed (Maughan & Burke 2002: 131).

Even though creatine supplementation might have beneficial aspects for athletes who repeatedly perform high-intensity tasks, and for those who compete in field and court sports, there is a lack of information regarding creatine and its effects on endurance exercise. In fact, performance might even be hindered by weight gain (a side effect of creatine supplementation) (Maughan & Burke 2002: 131-132).

Interestingly, it is not yet entirely clear which mechanisms are responsible for the performance-enhancing effect. However, new “results indicate that the rate of CP resynthesis after intense exercise is enhanced after high-dose creatine supplementation. This allows faster recovery after sprints as well as allowing more work to be done during each subsequent high-intensity effort" (Maughan & Burke 2002: 132).

#### *2.5.6.2 Carnitine*

Ergogenic effects of carnitine are theoretically possible due to its important role in lipid metabolism. Williams and Leutholtz (2000: 360) state that "[a] primary function of L-carnitine is to facilitate transfer of free fatty acids (FFA) into the mitochondria to help promote oxidation of the FFA for energy. Theoretically, L-carnitine supplementation could enhance FFA oxidation and help to spare the use of muscle glycogen, which might be theorized to improve prolonged aerobic endurance capacity".

According to Maughan and Burke (2002: 133-134), it is due to its role in both fat and carbohydrate oxidation that there are claims related to enhanced performance as well as regarding the support of weight loss. These claims, however, solely serve as sales argument for retailers since there is no scientific support of such arguments. Raschka and Ruf (2012: 126) sum up scientific arguments against the efficacy of carnitine. The authors list, among others, as crucial for oxidation of FFA the aerobic capacity of the enzyme system as well as the availability of oxygen. Both of which can be increased with endurance training but not with carnitine intake. Thus, the authors claim that, due to the fact that carnitine is not the limiting factor for the oxidation of FFA, performance-enhancing results cannot be supported by scientific evidence. These arguments are also supported by long-term studies (cf. Wächter et al. 2002).

#### *2.5.6.3 Coenzyme $Q_{10}$*

Coenzyme $Q_{10}$, "is a non-essential lipid-soluble nutrient found predominantly in animal foods and in low levels in plant foods" (Maughan & Burke 2002: 138). Primarily located in the mitochondria, it functions as "a link in the electron transport chain within the mitochondria, thus playing a role in the final production of ATP" (Maughan & Burke 2002: 138). It is furthermore attributed to have anti-oxidative traits.

Coenzyme $Q_{10}$ is promoted, especially for athletes, as performance-enhancing, due to its potential contribution towards increased energy production. Furthermore, a reduction of oxidative damage is praised. However, there is no scientific evidence for such claims (Maughan & Burke 2002: 138).

According to Williams and Leutholtz (2000: 361-362), "studies involving $CoQ_{10}$ supplementation […] indicated that although blood levels of $CoQ_{10}$ may be increased, there was no effect on lipid peroxidation, substrate utilization, serum lactate levels, oxygen uptake, cardiac function or anaerobic threshold during submaximal exercise". These studies were characterised by duration of 4-8 weeks and an intake of 70-150 mg/d.

#### *2.5.6.4 Branched-chain amino acids (BCAAs)*

BCAA supplements contain the essential amino acids leucine, isoleucine and valine. These amino acids "are key stimulators of protein synthesis or muscle building and also play a role in the prevention of muscle breakdown". It is furthermore believed that, due to the fact that BCAAs can be oxidized in the muscle, they "can be used as fuel during exercise, producing performance benefits especially in longer-duration endurance sports" (Mueller & Hingst 2013: 69). However, scientific evidence regarding these claims is lacking (cf. Kreider et al. 2010).

It should also be noted that, even though it has been measured that during a 2-hour run 850 mg leucine was depleted, one glass of milk approximately contains 950 mg leucine. With this aspect in mind, one should reconsider the intake of BCAA supplements (Raschka & Ruf 2012: 83).

#### *2.5.6.5 Arginine, ornithine and lysine*

These amino acid supplements are claimed to increase the release of the human Growth hormone (hGH). "Increased serum levels of hGH in turn may stimulate production and release of insulin-like growth factor-1 that may lead to increases in muscle mass and strength" (Williams & Leutholtz 2000: 357).

From today's point of view, however, there is no evidence regarding positive effects on the release of hGH, strength or muscle mass (Williams & Leutholtz 2000: 358). In addition, it is argued that "potential adverse health effects of hGH administration are substantial, and most researchers caution that the long-term health risks of hGH administration [...] are unknown (Williams & Leutholtz 2000: 358).

#### *2.5.6.6 Glutamine*

Two claims are responsible for its popularity among athletes, namely the "beneficial effect on muscle glycogen resynthesis (Varnier et al. 1995; Bowtell et al. 1999), and immune system response (Castell et al. 1996; Castell and Newsholme 1998) following endurance exercise" (Candow et. al 2001: 142).

Due to the fact that previously mentioned studies were conducted in the context of endurance sport, Candow et al. (2001) decided to carry out the first study on the effects "of oral glutamine supplementation combined with resistance training in young adults" (Candow et. al 2001: 142). However the study could not confirm any positive effects of supplementation, possibly also due to the "fact that resistance training is not *stressful* enough to benefit from glutamine supplementation" (Candow et al. 2001: 146). Thus, it is suggested that future research should investigate training protocols that include a combination of strength and endurance training (Candow et. al 2001: 148).

#### *2.5.6.7 Taurine*

This non-essential amino acid occurs in the muscle as well as in organ tissue of heart and liver. It furthermore occurs naturally in fish, beef or lamb. Nowadays, it is well known due to it being an ingredient in various energy drinks. It "is believed to affect cellular excitability by increasing the release of calcium from the sarcoplasmic reticulum" (Mueller & Hingst 2013: 218). This would in turn "allow greater actin and myosin interaction improving muscle contractility and force production". In addition, as an antioxidant, taurine is "capable of combating oxidative free radicals produced during exercise" (Mueller & Hingst 2013: 218). The number of human studies, however, is considerably small and furthermore characterised through the usage of taurine in combination with other commonly used supplements, such as caffeine. Thus, possible ergogenic effects are most likely to be attributed to the ergogenic properties of caffeine.

#### *2.5.6.8 Bicarbonate*

Theoretically, ergogenic properties are attributed because of the buffering capacity of bicarbonate. Maughan and Burke (2002: 134) explain that several studies reported "a decrease in perceived exertion or an increase in performance during high-intensity exercise after bicarbonate administration". However, this finding was not shared by other studies. For this reason, Carr et al. (2011) conducted a meta analysis with the result that sodium bicarbonate does indeed enhance performance for short-term activities, such as sprints by approximately 2 percent. In order to achieve this result, an intake of 0.3 g/kg BW is suggested (Carr et al. 2011: 813).

#### *2.5.6.9 ß-Hydroxy-ß-methylbutyrate*

It is claimed that "[a]lthough its metabolic role in humans is uncertain, HMB supplementation is proposed to help exercisers maximize muscle gains during resistance training by counteracting the catabolic effects of exercise induced stress on protein metabolism" (Williams & Leutholtz 2000: 358). However, there are only few studies on this issue and thus, "replication from other laboratories is needed" (Williams & Leutholtz 2000: 358).

#### *2.5.6.10 Caffeine*

According to Jeukendrup (2011:96), "[c]affeine is one of the most common supplements used in endurance sports". It has been used for centuries in drinks and foods because of its associated effects. However, until 2004 caffeine was found on the international doping list (Jeukendrup 2011: 96). Caffeine is responsible for various effects within the body. Among these are: "stimulation of the central nervous system, cardiac muscle and epinephrine release and activity" (Maughan & Burke 2002: 135). It has furthermore numerous effects on the skeletal muscle, such as calcium handling, sodium-potassium pump activity, or effects on enzymes, for example, glycogen phosphorylase (Maughan & Burke 2002: 135). Underlying mechanisms of efficacy are complex and yet not fully understood. Thus, the authors argue that "[c]affeine supplementation is complex to investigate due to the difficulty in isolating individual effects of caffeine and the potential for variability between subjects" (Maughan & Burke 2002: 136).

Caffeine is different from other supplements in terms that its positive effects cannot be pinned down to one specific kind of exercise. This is also due to the fact that there is evidence for effects on short-term and long-term exercise as well as from low to high intensity exercise. Hence, there is reason to assume that several mechanisms are responsible for these effects (Maughan & Burke 2002: 136). The authors furthermore state that various studies which "focused on the effects of caffeine intake the performance of endurance exercise protocols", resulted in the observation of a prolonged amount of time until exhaustion of the participants. The average intake in these studies was 6 mg per kg BW, one hour before exercise. A similar research design was used by Cox et al. (2002: 998), who suggest an intake of up to 6 mg/kg BW immediately before or during exercise in order to achieve a positive effect.

These arguments are also in consensus with Doherty and Smith (2005), who published a recent meta-analysis of 21 studies called *"Effects of caffeine ingestion on rating of perceived exertion during and after exercise: a meta-analysis".* Observed outcomes of caffeine intake were, for example, "an increase in work output at a given rating of perceived exertion (RPE) or effort sense [...] or, more typically, a reduced RPE at a constant exercise intensity" (Doherty & Smith 2005: 69).

Due to this variety of proposed claims related to caffeine, the European Food Safety Authority published a thorough examination of this substance in 2011. With regard to brief high-intensity activities, the intake of caffeine is not associated with enhanced performance (EFSA 2011: 2). Considering endurance performance, however, the Panel stated "that a cause and effect relationship has been established between the consumption of caffeine and an increase in endurance performance" (EFSA 2011: 2). To be more precise, a minimum of 3 g caffeine per kg BW is linked to performance enhancement. Preconditions are the intake "at least one hour prior to exercise, and after at least one day of caffeine withdrawal in habitual caffeine consumers” (EFSA 2011: 2). Other positively associated effects, which can be achieved through the intake of caffeine, are increased endurance capacity as well as reduction of perceived exertion during exercise (EFSA 2011: 2-3).

To sum up ergogenic aids in terms of their efficacy, following three categories can be established for ergogenic aids (cf. ACSM 2009: 722).

1) Ergogenic aids that improve performance
2) Ergogenic aids with insufficient evidence for performance-enhancing claims
3) Ergogenic aids that do not improve performance.

Category 1) includes sports drinks and sports gels (i.e. carbohydrate supplements), protein supplements, creatine, caffeine and sodium, bicarbonate.

Category 2) includes glutamine and ß-hydroxymethylbutyrate.

Category 3) includes the majority of products which are commercially available. Among these are amino acids, branched chain amino acids, carnitine, coenzyme $Q_{10,}$

The Australian Institute of Sports (2016b) additionally lists a category containing substances which are “[b]anned or at high risk of contamination with substances that could lead to a positive drug test“. This category includes, for example ephedrine, strychnine, DHEA, and other prohormones. For a comprehensive, and regularly updated list, however, the website of the World Anti-Doping Agency (WADA) should be consulted.

### 2.5.7 Potential risks and dangers

If an athlete decides to use dietary supplements, possible side effects should be thoroughly considered as individual athletes may respond differently to dietary supplements, for example vitamin or mineral supplements.  Whereas athletes with a balanced diet are likely to observe no difference in performance, athletes with some sort of deficiency will probably respond well to supplementation (Maughan, Depiesse & Geyer 2007: 104). Moreover, it is argued that information regarding safety and efficacy for many supplements on the market is insufficient. In fact, there are numerous cases where "evidence is entirely lacking, while other 'evidence' relates to information from studies of isolated tissues exposed to unphysiological amounts of supplements" (Maughan, Depiesse & Geyer 2007: 104). Regarding this issue, also Maughan and Burke (2002: 139) state that "[m]any studies that purport to show beneficial effects are poorly designed, often with inadequate subject numbers and no control group, and few are published in reputable journals".

Especially with regard to professional athletes, it is important to stress the possibility of contaminated supplements. Thus, athletes are advised to carefully read labels in order to prevent possible positive doping outcome. In addition, there is also the possibility of products containing banned substances which are not explicitly listed as it has recently been reported by the IOC. "[U]p to 25% of supplements may contain low levels of unlisted steroids" (Maughan & Burke 2002: 139). Due to these reasons, professional athletes should carefully weigh potential benefits of supplementation against their risks because the usage of contaminated products might eventually result in "a ban from sport, and the loss of money and prestige (Maughan & Burke 2002: 139).

At this point, side effects of different dietary supplements shall be discussed. Even though it has been proven that high-dose creatine supplementation has no negative effects, long-term health risks of chronic creatine supplementation are not yet known (Greenhaff 2000: 371). For athletes who need to reduce body mass shortly before competition, however, the associated weight gain of 1-2 kg during acute supplementation might be considered to be disadvantageous (Maughan & Burke 2002: 133).

According to Williams and Leutholtz (2000: 361), it is important to note that regarding the supplementation with L-carnitine, users should make sure to use L- instead of D-carnitine. Otherwise, the synthesis of L-carnitine might be impaired which eventually leads to deficiency symptoms such as myopathy or muscular weakness. Regarding bicarbonate, Maughan and Burke list vomiting and diarrhoea as common side effects (2002: 134). The authors furthermore state that athletes who are sensitive to caffeine might suffer from “insomnia, headache, gastrointestinal irritation and bleeding, and a stimulation of diuresis” (2002: 136-137).

The description of only a selected number of dietary supplements, including their possible negative effects on performance as well as on the overall health status of an athlete, further support the argument that the usage of supplements should be well-considered and weighed against its possible negative effects.

### 2.5.8 Trends for the future: nutrigenomics

As a young but fast-emerging field of research, nutrigenomics combines knowledge and insights from genetics, nutrition and molecular biology. The main aim of nutrigenomics is thus to gain information about relations between nutritional status and gene expression. This understanding should in turn help to develop individual diets and, moreover, tackle public health issues such as cancer, obesity, cardiovascular diseases and diabetes (Getz, Adhikari, Medeiros 2010: 29).

Despite its valuable potential for public health, Bragazzi (2013) additionally argues that nutrigenomics are additionally relevant for professional athletes, namely in terms of individualized nutrition which can, in turn, contribute towards good performance. Until today, it “has been [...] applied to select proper macronutrients for treating and preventing heavy exercise-induced immuno-depression, for assessing and monitoring the athlete's nutritional status“ (2013: 163). However, certain ethical aspects regarding this particular field of research need to be re-evaluated (e.g. food safety) or even newly established (“personalized nutritional doping“) since this is a highly complex field of research (Bragazzi 2013: 163).

# 3. Empirical research

The following section deals with the empirical research which has been conducted as part of this thesis. First of all, the research method and the questionnaire will be elaborated. Secondly, the sample will be described and thirdly, in order to answer the research question, the established hypotheses are presented.

## 3.1 Material and methods

In order to gather information regarding specific aspects of dietary supplements, a small survey was conducted among Austrian endurance athletes. Due to the format of the collected data, a quantitative evaluation appeared to be the most reasonable way of evaluation.

For this reason, an online questionnaire (see Appendix) was designed with the help of the platform *Soscisurvey* and distributed among various internet forums. In addition to questions about dietary supplements, the questionnaire included questions from the Food Frequency Questionnaire (FFQ) as well as questions from the International Physical Activity Questionnaire (IPAQ). The questionnaire was then quantitatively evaluated with IBM SPSS 22. All results were analysed anonymously which was also communicated with the participants. At this point, it should however be noted that in order to reach more people, questions were in German instead of English.

To find out whether the questionnaire really tests the desired information, a so-called pre-test was conducted. Therefore, five people were asked to fill out the questionnaire and pay attention to possible ambiguities. Furthermore, this approach helped to estimate the necessary time to fill out the questionnaire. 15-20 minutes appeared to be sufficient.

The questionnaire was structured in five sections: First of all, the participants were asked to fill in personal data such as gender, age, height and body weight as well as educational background. In the second part, data concerning general eating habits of the participants were collected (i.e. how often certain food groups such as white bread, rice, fruits or vegetables are consumed). These questions were taken and adapted from FFQ. Thirdly, questions about physical activity, based on the IPAQ, were asked. These questions were implemented in order to gather information about the extent to which individuals are physically active (at work or in their leisure time). The fourth section then focused on endurance sport. Most importantly, this section distinguished between participants who regularly perform endurance sport, and those who do not. For this reason, a filter question ("Do you regularly perform endurance sport?") was inserted. If the question was answered with "No", the participant was redirected to the end of the questionnaire. This is important to note since the research interest was exclusively on individuals who consider themselves as endurance athletes (i.e. individuals, who perform endurance sport on a regular basis). Thus, if the question was answered with "Yes", the survey continued, including questions about the kind of sport in which the participants engage, how often they perform this kind of sport, if they are member in a sports club and if they participate in competitions. The last section dealt with dietary supplements. Here, information about habits of consumption, motifs, influencing factors and the personal attitude towards supplements was asked. Some questions related to this issue were taken and adapted from a questionnaire used in another diploma thesis (Pichlmair 2013).

Evaluation of the questionnaire as well as the testing of established hypothesis was realised with IBM SPSS 22. The most commonly used tools were cross-tab analyses in combination with the chi-square test in order to detect significant relations between the variables. Analyses dealing with average time, on the other hand, were realised with the t-test for independent samples. Finally, the Mann-Whitney-U test was used for ordinal data such as the agreement towards specific statements. In general, results were treated as significant if the p-value was bigger than 0.05.

## 3.2 The sample

In retrospective, the survey had a good response rate which can probably traced back to its distribution among various online forums. It generally reached numerous people who are, first of all, athletes of some sort and, secondly, willing to participate.

Due to the previously mentioned filter question, it was possible to exclusively evaluate data from the intended target group, namely endurance athletes. Whether the athletes considered themselves as professional or recreational ones, was not specifically asked since it was not considered being relevant for the evaluation.

All in all, 459 interviews were recorded. However, only 334 were completed by the participants and thus evaluated. Closer inspection of the postal code, which was incorporated as an indicator of Austrian participants, revealed that some of the participants either did not enter a valid postal code or were German citizens. These participants were consequently also excluded from the survey. This resulted in a total of 302 participants, with a nearly equal distribution of female and male participants (see Figure 4). With 136 (45%) male participants and 166 (55%) female ones, however, a slight surplus of female participants can be observed.

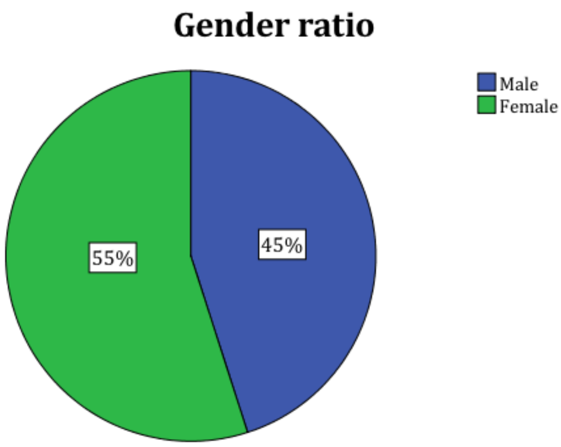



**Figure 4 Gender ratio (n= 302)**

Out of these 302 participants, 257 (85.1%) stated that they regularly perform endurance sport, which in turn, includes them in the majority of further analyses due to the fact that these participants were the primary target group.

The age distribution of the sample is illustrated in Figure 5. Overall, participants were between 18 and 68 years old. The average participant was 31.6 years old. For a better overview, however, six age groups were established.

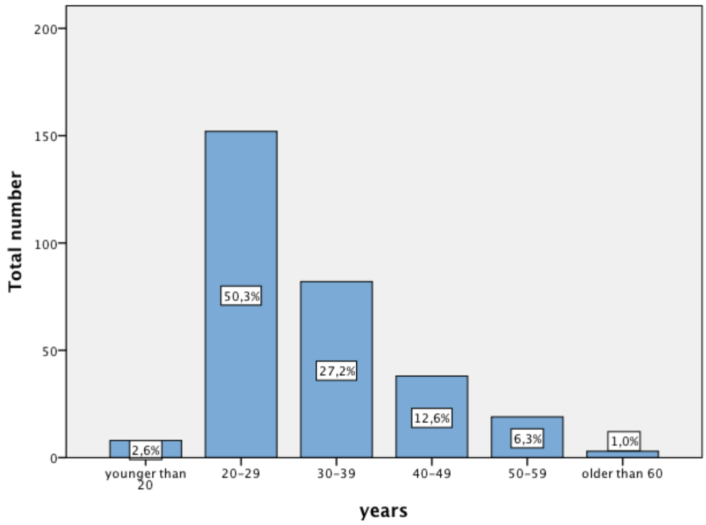



**Figure 5 Age groups (n= 302)**

As Figure 5 clearly shows, most participants (50.3%) were between 20 and 29 years old. Considering the educational background of the sample (see Figure 6), it can be observed that the majority of participants graduated either from upper secondary or from some institution of higher education.

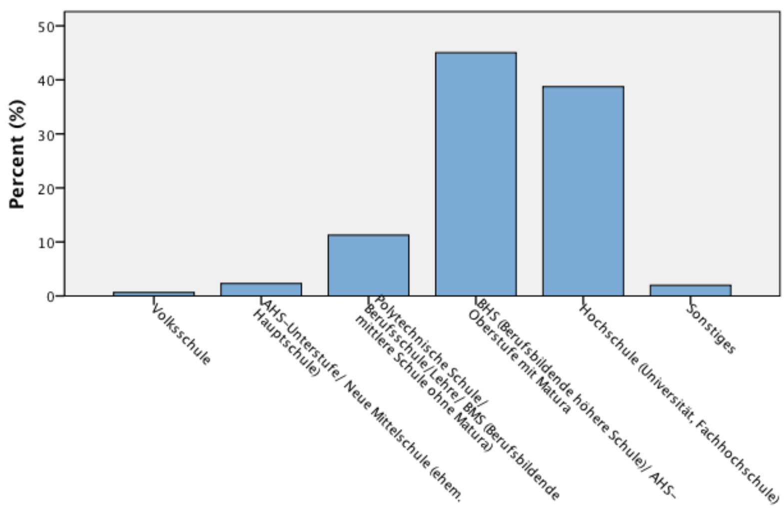



**Figure 6 Educational background (n= 302)**

With the support of the two remaining variables namely height and weight, the Body mass index (BMI) could be calculated. According to the World Health Organization (WHO 2016a), "[i]t is defined as a person's weight in kilograms divided by the square of the person's height in metres (kg/m2)". The BMI provides valuable information regarding nutritional status in adults. It therefore distinguishes between underweight, normal weight, pre-obesity and three classes of obesity. The WHO lists the following categories for adults over 20 years of age (WHO 2016a):

**Table 4 BMI classification**

| **BMI** | **Nutritional status** |
|---|---|
| Below 18.5 | Underweight |
| 18.5–24.9 | Normal weight |
| 25.0–29.9 | Pre-obesity |
| 30.0–34.9 | Obesity class I |
| 35.0–39.9 | Obesity class II |
| Above 40 | Obesity class III |

adapted from (WHO 2016a)

Even though this simple calculation helps to categorize most people, there are certain limitations to this approach. Strength athletes, for example might be mistakenly categorized as overweight due to the fact that the BMI does not distinguish between fat mass and muscle mass. For athletes who have to obey to strict weight regulations (ballet, gymnastics etc.), the BMI might, however, be considered as a valuable indicator for the prevention of underweight and, as a consequence, malnourishment (Raschka & Ruf 2012: 26).

Figure 7 illustrates the nutritional status of the entire sample. It can be seen that the majority (74.2%) can be classified in the category *normal weight*. The mean BMI of 22.9 $kg/m^2$ can also be classified as normal weight. The total range, however, lies between 15.3 and 39.6 $kg/m^2$.

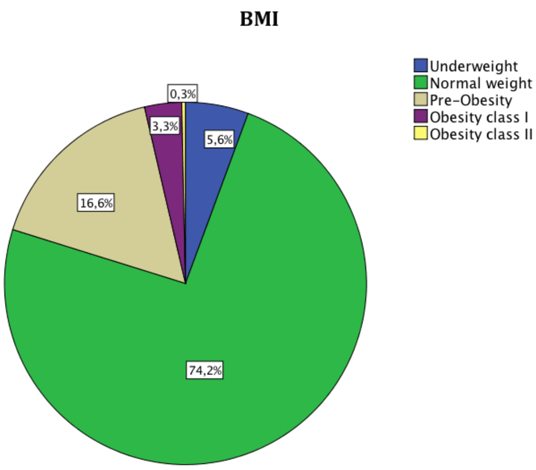



**Figure 7 BMI distribution (n= 302)**

General initial observations of certain frequencies (performance of endurance sport, participation in competitions, usage of dietary supplements), all of which are important for further analyses, lead to the following statistical variables, summed up in Table 5.

**Table 5 Frequencies of important variables**

| | | |
|---|---|---|
| **Total number of participants** | | **302** |
| | Male | 136 |
| | Female | 166 |
| **Participants who regularly perform endurance sports** | | **257** |
| | Male | 123 |
| | Female | 134 |
| **Participants of competitions** | | **211** |
| | Male | 105 |
| | Female | 106 |
| **Users of dietary supplements** | | **124** |
| | Male | 64 |
| | Female | 60 |

As can be observed from Table 5, all variables show a nearly equal distribution among male and female participants.

## 3.3 Hypothesis

Following hypotheses will be tested in section 3.4 *Results.* Even though, initial sections, dealing with eating habits and physical activity, were evaluated as well with regard to the athletic population, hypotheses were exclusively formulated for the two final sections of the questionnaire dealing with sporting habits of endurance athletes and dietary supplements. This is due to the fact that the primary focus of this thesis is on endurance athletes and their influential factors with regard to the intake of dietary supplements. Thus, only hypotheses related to this issue were formulated in order to answer the established research question. Whether factors, such as gender, age, BMI and the participation in competitions can be seen as influential factors for the usage of dietary supplements was tested with following hypotheses:

1. *$H0_1$: Gender does not affect the usage of dietary supplements.*
2. *$H0_2$: Age does not affect the usage of dietary supplements.*
3. *$H0_3$: BMI does not affect the usage of dietary supplements.*
4. *$H0_4$: Participation in competitions does not affect the usage of dietary supplements.*
5. *$H0_5$: The average exercise time per week does no influence the intake of dietary supplements.*
6. *$H0_6$: Gender does not affect the type of used supplement.*

   *$H0_{6a}$ Gender does not affect the intake of vitamin and/or mineral supplements*
   *$H0_{6b}$ Gender does not affect the intake of protein supplements.*
   *$H0_{6c}$ Gender does not affect the intake of carbohydrate supplements.*
   *$H0_{6d}$ Gender does not affect the intake of creatine supplements*
   *$H0_{6e}$ Gender does not affect the intake of BCAA supplements*

## 3.4 Results

This section presents the results of the conducted survey. First of all, demographic data of the athletic population will shortly be presented, including information regarding gender ratio, age distribution, education and BMI. Following this, general eating habits will be analysed in order to find out whether or not athletes tend to follow a balanced diet.

Then selected questions from the IPAQ will be used to determine whether or not athletes cycle or walk, instead of taking the car, for example, in order to travel from place to place. Furthermore, participants were asked to provide information on how much they walk in their leisure time. In combination, this set of questions will be used to gain small insights into the personal lifestyle of athletes. Moreover, the entire sample will be evaluated in terms of the mean time spent on moderate- or high-intensity exercise respectively. These results will be compared with the WHO's recommendations for adults and physical activity.

The main focus of analysis, however, will be on the last two sections (3.4.4 and 3.4.5), which deal with endurance sports and dietary supplements. Here, frequencies of intake will be described as well as influencing factors for the usage of supplements. Furthermore, possible motifs and attitudes towards supplementations will be investigated in these sections.

### 3.4.1 Demographic data

General information (gender distribution, age groups, educational background) about the entire sample was already presented in section 3.2. Looking at the gender distribution among those who regularly perform endurance sport (Figure 9), it can be seen that out of 257 participants, 134 are female and 123 are male which can be probably traced back to the slight majority of females in the study in general. Nevertheless, the gender distribution can be regarded as nearly equal. Considering those participants, however, who do not perform endurance sport on a regular basis (45 participants), the survey includes more than twice as much females (32) than males (13).

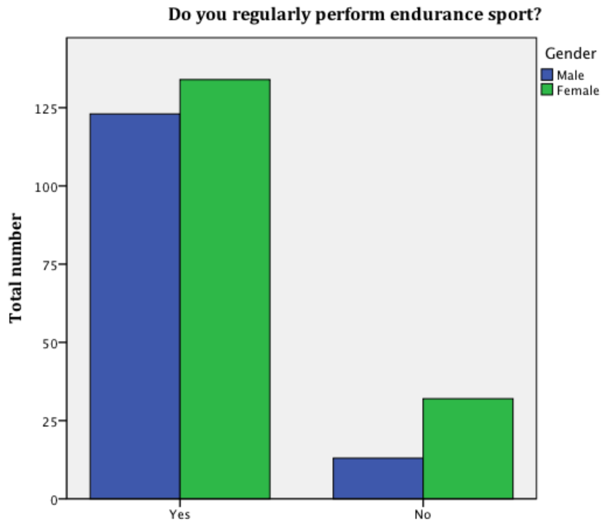



**Figure 8 Gender distribution among endurance athletes (n= 302)**

Looking at the age distribution of the athletic population, it can be observed that participants are generally between 18 and 63 years old. As can be seen in Figure 9, the majority (50.6%) of endurance athletes is between 20 and 29 years old. It furthermore appears that women are especially active during these years, whereas men are more physically active in the following years. The total number of athletes, however, consistently decreases with increasing age. These observations are also in consensus with a long-term study (n=8,000) about sporting habits of the entire Austrian population from 2008-2012 (IMAS 2013: 1).

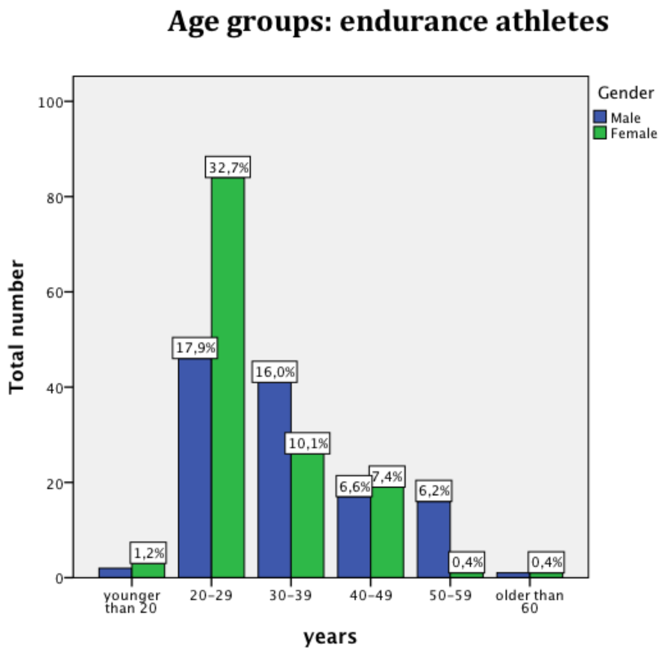



**Figure 9 Age groups: endurance athletes (n=257)**

As it has already been pointed out in section 3.2, participants generally have a good educational background. This is also reflected in the population of athletes since the majority stated to have either graduated from an upper secondary school or from university or college respectively.

Considering the BMI of 257 endurance athletes, most athletes (75.5%) are classified as normal weight. However, due to its previously mentioned limitations, certain athletes might have been mistakenly categorised as either over or underweight (see section 3.2).

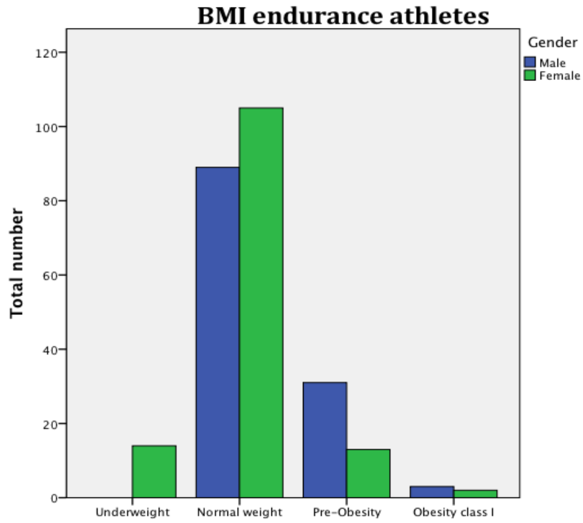


**Figure 10 BMI endurance athletes (n=257)**

As Figure 10 clearly shows, males are rather classified as obese, whereas females are to an equal extent classified as both underweight and obese.

### 3.4.2 General eating habits

In order to gain information regarding general eating habits of athletes, questions from the FFQ were used asking how often certain food groups are consumed.

Frequency analyses revealed that a varied diet is important for the majority of athletes. White bread, for example, was only consumed once per week or on a fewer basis. On the contrary, whole-grain bread, the healthier choice, was consumed by most athletes 2-3 times per week or more often. Carbohydrate-rich foods, such as rice and noodles, were consumed between two and three times per week. Potatoes are the preferred choice on 2-3 days or once per week. Vegetables are consumed by the majority on a daily basis, or twice a day, respectively. The same is true for fruit. Milk- and milk products are also consumed on a daily basis. Fish is consumed once per week by nearly half of the athletes. On the contrary, meat is consumed on 2-3 days or on 4-5 days respectively. Vegetarian alternatives to meat are not very popular among the athletic population as 117 participants stated not to consume them at all. Water is consumed up to 5 times per day, ensuring a sufficient fluid intake. Fruit juice is an equally popular choice between twice a day, up until once per month among participants. In contrast, light-drinks are not consumed by 135 of the participants. Coffee was consumed by most participants between 2-3 times a day.

Due to these analyses, it can be said that athletes generally follow a varied and balanced diet, ensuring the sufficient intake of macro- and micronutrients as well as fluid.

### 3.4.3. Physical activity

Using selected and adapted questions from the IPAQ, information regarding certain aspects of a healthy lifestyle could be gathered.

Results showed that 78.6% of the athletic population either walk or take the bicycle in order to get from place to place (e.g. to work or to go shopping). 37% of which stated to do this on a daily basis. On a typical day, participants on average spent 1.5 hours cycling or walking from place to place. 84% of the athletic population also stated that they regularly walk for more than 10 minutes in their leisure time, 31.9% of which stated to do this on a daily basis. On a typical day, participants on average spend 2 hours with walking in their leisure time. From these results it can be concluded that many athletes prefer to follow a healthy lifestyle.

As the WHO (2016b) published recommendations regarding adults between 18 and 64 years and physical activity, the entire sample will be used for the following calculations. It is stated that

> at least 150 minutes of moderate-intensity aerobic physical activity throughout the week or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week or an equivalent combination of moderate- and vigorous-intensity activity (WHO 2016b).

In case these recommendations are met, adults are less likely to suffer from coronary heart disease, high blood pressure, stroke, type 2 diabetes, metabolic syndrome and other diseases. Furthermore, they have better chances to maintain their weight and generally obtain a healthier body composition (WHO 2016b).

259 participants spent on average 174 minutes with vigorous-intensity activity and 135 participants spent 126 minutes with moderate physical activity. Thus, it can be stated that the recommendations are easily met. However, this might be due to the fact that most of the participants are endurance athletes, who regularly perform physical activity.

### 3.4.4 Sporting habits

257 participants (123 male, 134 female) were classified as endurance athletes based on the declaration of *regular* performance of endurance sport. If they considered themselves as professional or recreational was not regarded to be relevant for the analysis. Whether the factors gender and age can be linked to the performance of endurance sport was tested with the chi-square test.

Results showed that there is indeed a significant correlation between gender and the performance of endurance sport ($p= 0.018$). It should, however, also be noted that, even though there is a statistical relationship between gender and the performance of endurance sport, the relationship between those variables is very weak ($r= 0.136$). With regard to age, no correlation between age and the performance of endurance sport could be observed ($p=0.164$).

As a correlation between gender and the performance of endurance sport was observed, it was examined which sports are preferred among male and female athletes. In this respect, frequency analyses demonstrated that, in general, the most preferred sport is running (59.9%), followed by other (16%), cycling (12.8%), ball sports (7.8%) and swimming (3.5%) (see Figure 11). As can be seen, running is by far the most performed sport among both female and male athletes.

According to the previously mentioned long-term study, however, cycling (27%) is the most preferred endurance sport among Austrians, followed by running/jogging (23%) and swimming (21%) (IMAS 2012: 2).

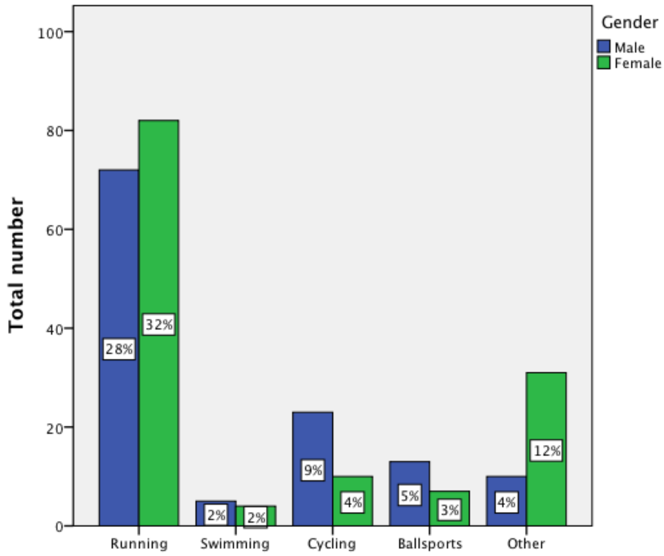



**Figure 11 Preferred sport among athletes (n= 257)**

Figure 11, however, also shows that, as far as the other sports are concerned, figures between the two genders might vary. Whereas running appears to be equally popular among both males and females, there are differences regarding the other endurance sports. Hence, the chi-square test was used in order to determine whether there is a relationship between these variables. According to the results (p=0.001), it can be said that there is a correlation between gender and the performance of a specific kind of endurance sport. To be more precise, females are more likely to have a broad field of interest in endurance sports, which is reflected in the category *Other.*

Whether age does affect the performance of a specific endurance sport, shall be discussed now. Figure 12 illustrates the general popularity of various endurance sports among the established age groups.

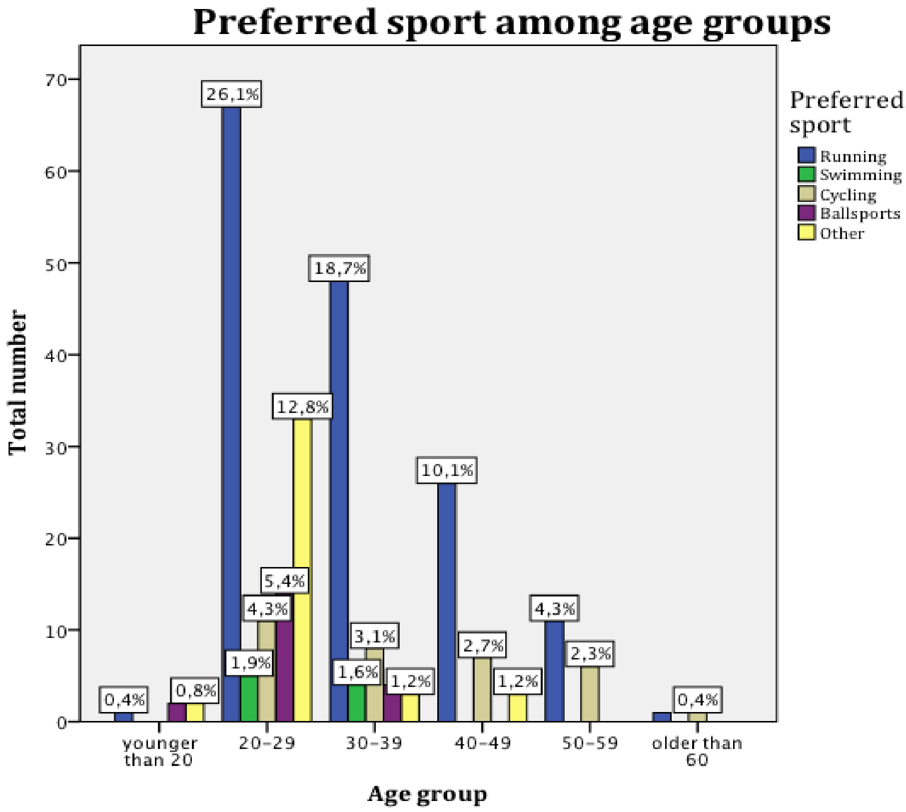



**Figure 12 Distribution of preferred sport among age groups (n= 257)**

As it can clearly be seen, the most preferred sport is, by far, running, being the preferred option among all participants between 20 and 59 years. In fact, analyses revealed that, according to the Likelihood ratio (p=0.000) there is a significant correlation between age and the performance of a specific kind of endurance sport. Thus, it can be said that running is the most popular endurance sport among most age groups (between 20 and 59 years). The Pearson correlation coefficient, however, is weak (r= -0.246). In a similar way, cycling is consistently popular among most age groups. Unexpectedly, the category *Other* was the second most popular choice among participants between 20 and 29 years. Reasons for this trend might be various fields of interest during this age. And since only very common endurance sports were listed, this category could include other popular sports, such as rowing, skiing, mountaineering etc. Furthermore, the category of participants under 20 years only included 5 participants, which is possibly due to a lack of interest in endurance sport at that particular age.

At this point, the frequency of performance of endurance sport shall be examined. All in all, the majority, namely 120 (46.7%) participants stated that they perform endurance sport on a basis of 3-4 times per week. 62 (24.1%) participants stated that they perform endurance sport once or twice a week on average. 63 (24.5%) claimed that they perform endurance sport 5-6 times per week and 12 (4.7%) stated that they engage in endurance sport even more than 7 times per week. The distribution, separated by gender, can be seen in Figure 13.

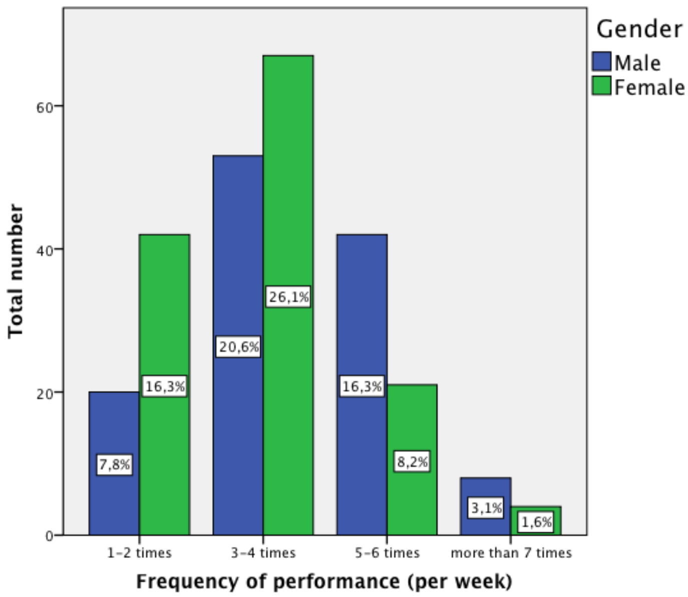



**Figure 13 Frequency of performance of endurance sport**

As Figure 13 shows, with regard to the frequency between 1 and 4 times per week, more females compared to males perform in endurance sport, whereas males tend to perform endurance sport on a more frequent basis (5-6 times per week or more than 7 times per week). Thus, the chi-square test was applied in order to find out whether this observation is supported by statistical evidence. In fact, results revealed that there is indeed a correlation between gender and the frequency of performance ($p=0.001$). Males tend to perform endurance sport on a more frequent basis than females.

Analyses of the average time spent with the performance of endurance sport, showed that athletes spend 5 hours per week with the performance of endurance sport. The total range, however, lies between 30 minutes and 30 hours per week. Separated by gender, it was observed that, with 95% certainty, the duration of endurance sport for males lies between 5.5 and 7.2 hours, whereas the duration of endurance sport for females lies between 3.5 and 4.4 hours (see Figure 14).

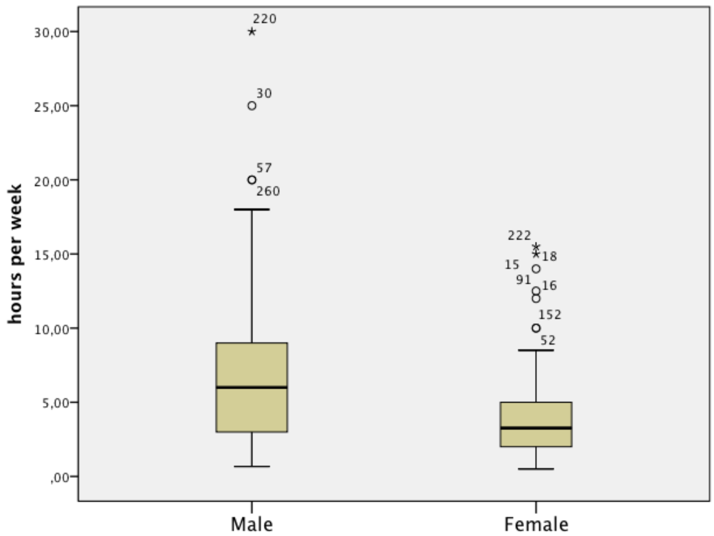



**Figure 14 Boxplot Male/Female duration of performance of endurance sport**

On average, results for the athletic population showed that males spend 6.4 hours per week on endurance sport, whereas females spend 3.9 hours per week with endurance sport. Women thus spend 2.5 hours less for endurance sport than males. In order to find out if this difference is significant, the T-Test of independent samples was applied. A p-value of 0.000 suggests that there is a significant relationship between gender and the duration of performance of endurance sport. For this reason, it can be stated that males tend to spend more time per week with the performance of endurance sport than females. With a 95% confidence interval, males spend between 1.5 and 3.4 hours more time with endurance sport than females.

Regarding the established age groups, the average duration of performance of endurance sports also varies considerably (see Figure 15). It is interesting to note here that the highest average duration occurs in the categories younger than 20 and 50-59 years, respectively. Both groups on average perform endurance sport for more than 7 hours per week. In order to determine whether this observation can be supported with statistical evidence, the ANOVA was applied. Results showed that there is indeed a significant difference between age and the duration of performance of endurance sport (p=0.035). Hence, participants who are either younger than 20 years or between 50 and 59 years show a tendency to spend more time per week with endurance sport than participants from other age groups.

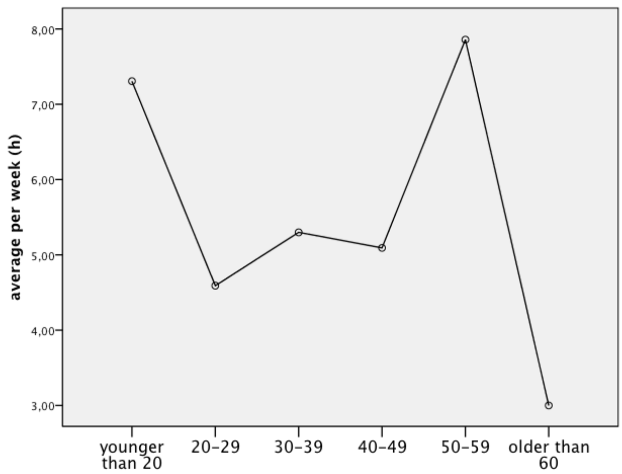



**Figure 15 Age groups and average time spent with endurance sport**

With regard to the membership in a sports club, 117 (45.5%) of the athletic population stated that they are members in a sports club. Males are slightly more prominent (56%) in these clubs in contrast to females (44%). Regarding the question which kind of sport they perform in the sport club, running was the preferred choice. Out of 117 athletes, 47 (40%) are in a running club. Other popular clubs were ball sport clubs (e.g. soccer club) (25%) or the option *Other.* Open answers to these other clubs include, for example, free diving, mountaineering, horse riding, Cross-Fit, martial arts, rock climbing, rowing or dancing. Whether this difference concerning gender and the membership in sports clubs is a significant one, was tested with the chi-square test. Results showed that there is a significant relationship between gender and being a member in a sports club (p=0.024). Males are more likely to be members of either a swimming club (p=0.009), a cycling club (p=0.001) or a triathlon club (p=0.001), whereas females are more likely to be members of other sports clubs which were not explicitly listed (p=0.000).

Looking at the participation in competitions, frequency analyses of a multiple-choice question revealed that Fun runs are the most popular type of competition among athletes. This is followed by half marathons and quarter marathons.

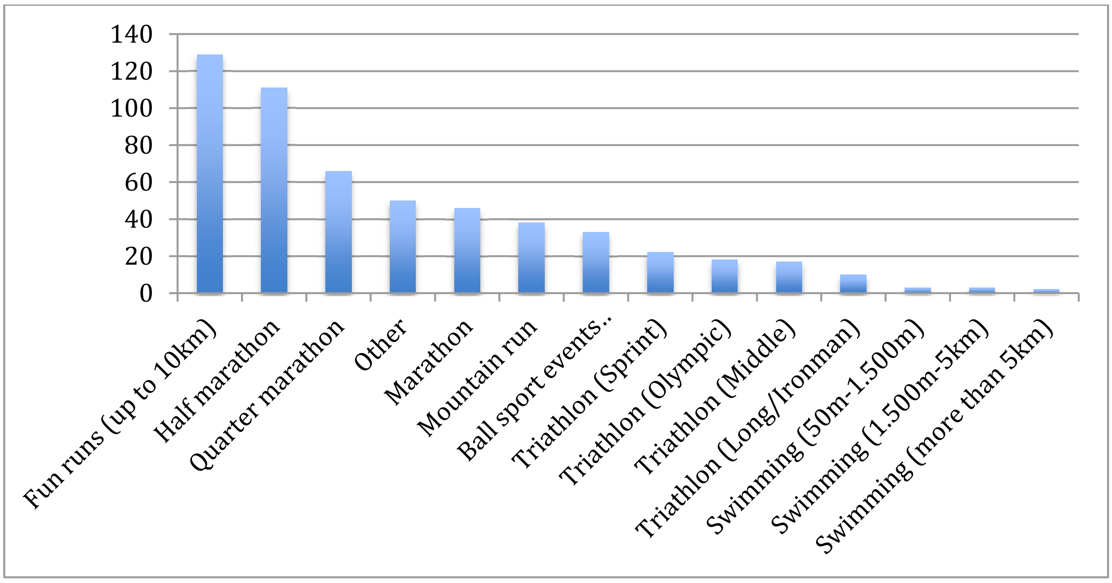



**Figure 16 Popular competitions (n=211)**

How often participants engage in competitions can be seen in Figure 17. Out of 257 participants, 46 (17.9%) do not participate in competitions at all. 90 athletes (35%) do participate in competitions every other month, 36 participants (14%) do participate once per year, and 39 participants (15.2%) do participate in competitions even more often than once a month. This leads to a total of 211 participants who participate in competitions on a regular basis.

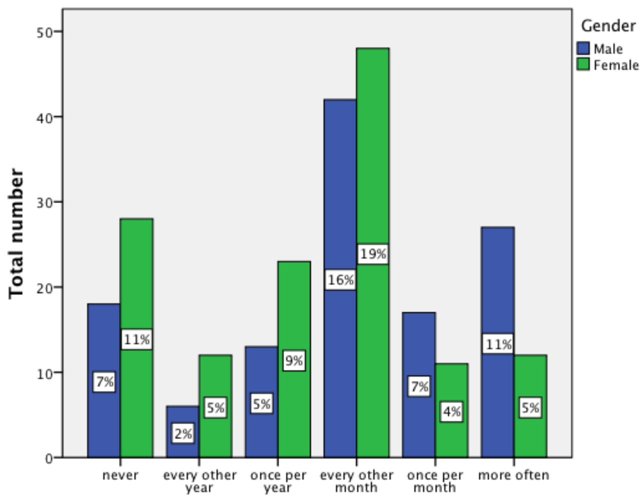



**Figure 17 Male/Female participation in competitions (n= 257)**

Interestingly, females are more likely, either not to participate in competitions at all, or to participate in competitions on a less frequent basis, whereas males tend to prefer to compete with other athletes on a more frequent basis (either once per month or more). If this observation can be supported with statistical evidence, was tested with the chi-square test. Results showed that there is a difference between gender and the frequency of participation in competitions (p=0.016). Males show a tendency to participate in competitions on a more frequent basis compared to females.

### 3.4.5 Dietary supplements

Out of 257 athletes, 124 stated that they do use dietary supplements. If supplements are consumed, males (64) show a slightly higher tendency for supplementation than females (60). However, if supplements are refused, the number of females (74) is higher compared to males (59) (see Figure 18).

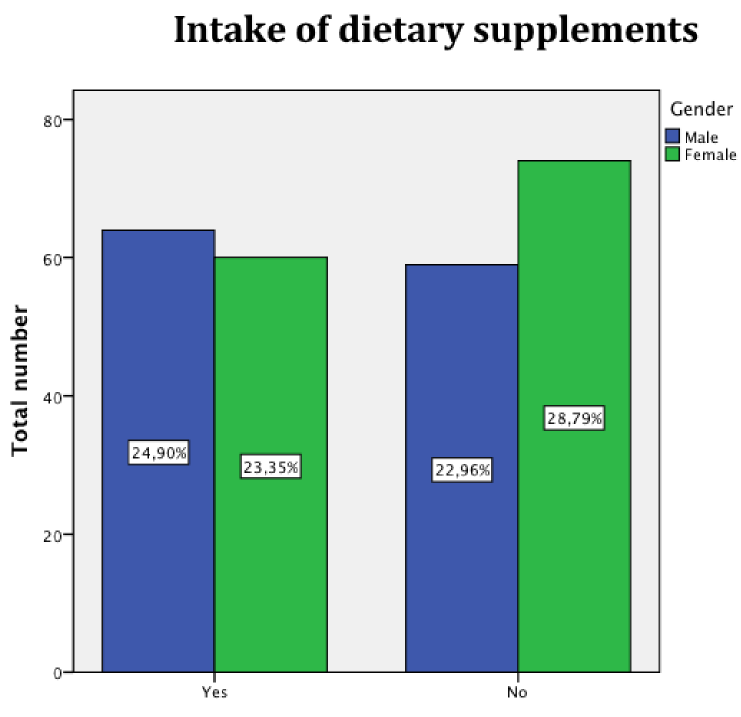



**Figure 18 Intake of dietary supplements separated by gender**

In order to determine whether gender can be regarded as an influential factor for the intake of dietary supplements, the following hypothesis was tested:

*$H0_1$: Gender does not affect the usage of dietary supplements.*

The chi-square test is used to determine whether or not there is a significant difference. A p-value of 0.245, however, shows that there is no difference between the variables and thus the null hypothesis is accepted.

Considering age as a possibly influencing factor for the usage of dietary supplements was tested with following hypothesis:

*$H0_2$: Age does not affect the usage of dietary supplements.*

Results clearly showed that there is no significant difference between age and the usage of dietary supplements (p=0.738). Hence, the null hypothesis is accepted.

If the Body mass index can be seen as an influencing factor regarding the intake of dietary supplements was tested with following hypothesis:

*$H0_3$: BMI does not affect the usage of dietary supplements.*

Applying the chi-square test, results showed that there is no significant difference between BMI and the general intake of dietary supplements (p=0.161). Thus, the null hypothesis is accepted.

If the regular participation in competitions can be seen as an influencing factor regarding the usage of dietary supplements was tested with following hypothesis:

*$H0_4$: Participation in competitions does not affect the usage of dietary supplements.*

Results of the chi-square test, as expected, showed that there is no significant difference between these variables (p=0.195). The null hypothesis is therefore accepted.

On top of that, an investigation whether or not the average duration of performance of endurance sport has an influence on the intake of dietary supplements was of particular interest. Thus, following hypothesis was tested:

*$H0_5$: The average exercise time per week does no influence the intake of dietary supplements.*

Results of the T-Test for independent samples revealed that, if participants use supplements, they perform on average 6 hours per week sport compared to 4.3 hours performed by those, who do not use supplements. Moreover, a significant difference could be observed (p=0.001) which means that the null hypothesis is rejected. Participants who use dietary supplements perform on average 1.8 hours more sport per week than those who do not use supplements.

### *3.4.5.1 Popular supplements*

With regard to the question which supplements are generally consumed, frequencies of a multiple-choice question were analysed (n=124). As can be seen from Figure 19, vitamin supplements were chosen by 74 (59.7%) participants, followed by mineral supplements chosen by 72 (58.1%) participants making them the most preferred type of supplement. Protein supplements were chosen by 60 (48,4%) participants, carbohydrate supplements were selected by 35 (28,2%) participants, BCAAs by 27 (22%), Other 27 (22%) and caffeine by 19 (15.3%) participants.

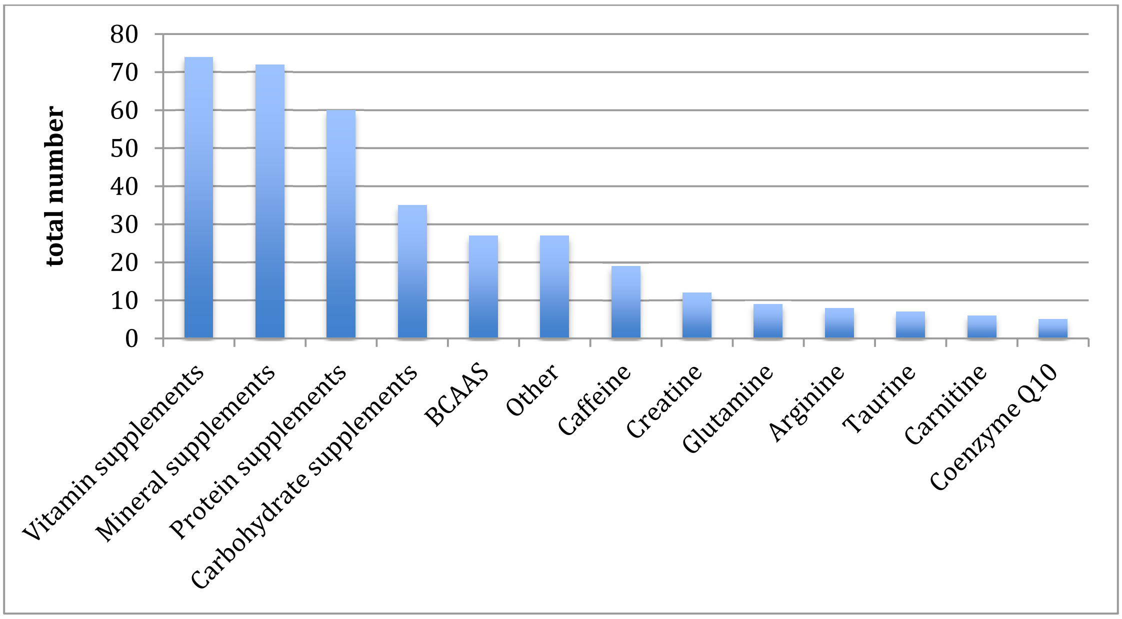



**Figure 19 Preferred supplements (n= 124)**

The popularity of the category *Other,* including all supplements that were not explicitly listed, could be explained with the plethora of available products on the market and the general interest of individuals in supplementation for various reasons. Other separately listed supplements provided by the participants, for example, included "omega 3", DHEA, iron, "fat burner", lysine or steroids.

Whether this general trend of preferred supplements is also reflected among male and female participants will be considered now. As can be seen in Figure 20, nearly the same number of participants stated to take vitamin and/or mineral supplements. With regard to other types of supplements, however, gender differences become observable.

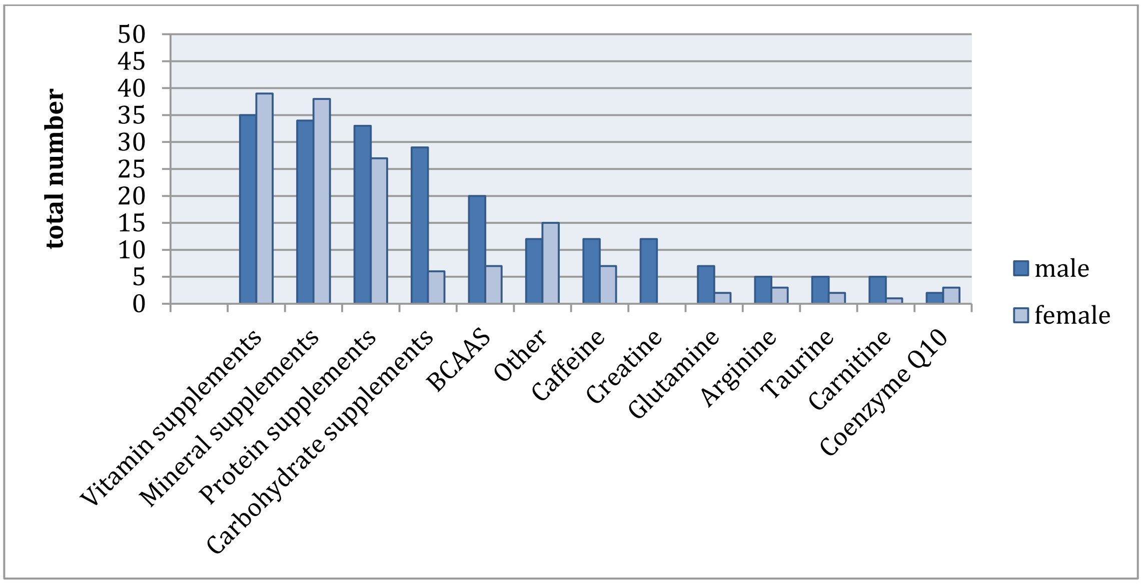



**Figure 20 Types of used supplements separated by gender (n= 124)**

Whereas 33 male participants stated to take protein supplements, only 27 of the female participants ticked this option. Considering carbohydrate supplements the gender difference becomes even more obvious (29 males; 6 females). This trend can also be seen for BCAAs, caffeine, glutamine, arginine, taurine, carnitine, and coenzyme $Q_{10}$. Most strikingly, 12 male participants stated to take creatine, whereas none of the female participants stated to do so.

Closer investigation of this pattern revealed significant statistical differences regarding gender and the type of used supplements. Thus the following hypothesis, including several sub-hypothesis, was tested:

*$H0_6$: Gender does not affect the type of used supplement.*

With regard to the different supplements, following sub-hypotheses were established:

*$H0_{6a:}$ Gender does not affect the intake of vitamin and/or mineral supplements.*

Considering this sub-hypothesis, no significant difference could be observed (p=0.242 and 0.250 respectively), thus $H0_{6a}$ is accepted. Males and females use vitamin and/or mineral supplements to an equal extent.

Similar results were observed for protein supplements (p=0.465). Therefore, following hypothesis is accepted as well:

*$H0_{6b:}$ Gender does not affect the intake of protein supplements.*

Concerning carbohydrate supplements, however, a significant difference could be detected with the chi-square test (p=0.000). Thus, the following null hypothesis is rejected in favour of the alternative hypothesis.

*$H0_{6c:}$ Gender does not affect the intake of carbohydrate supplements.*

It can be stated that males show a higher tendency for carbohydrate supplementation than females.

Furthermore, a difference between gender and creatine supplementation could be observed. Thus the following hypothesis is rejected:

*$H0_{6d:}$ Gender does not affect the intake of creatine supplements.*

There is a significant difference between gender and the intake of creatine supplements (p=0.000).

Similarly, a difference between the intake of BCAA supplements and gender could be observed ($p=0.008$). Thus, the following null hypothesis is rejected in favour of the alternative one:

*$H0_{6e}$ Gender does not affect the intake of BCAA supplements.*

To sum up the established sub-hypothesis, significant differences between gender and carbohydrate, creatine, and BCAA supplementation could be observed. Men are more likely to use these supplements. With regard to vitamin and/or mineral supplements no significant differences between genders could be observed.

Athletes were furthermore asked to name the place where they purchase dietary supplements. Frequency analyses revealed the most preferred option was the pharmacy (42.7%), followed by the internet (29.8%). Fewer athletes purchase their supplements in drug stores (21.8%), shops for sports nutrition (21%), the gym (8.1%) or at the supermarket (8.1%). Here again, it is interesting to note, that the internet with its vast amount of various products is becoming increasingly important for athletes.

### *3.4.5.2 Influencing factors*

Considering the question, who recommended the intake of dietary supplements (see Figure 21), most athletes named as influencing factors friends, followed by doctor's advice and the coach. The category *Other*, once again was quite popular. Examples given by the participants included influencing factors such as personal research or the internet.

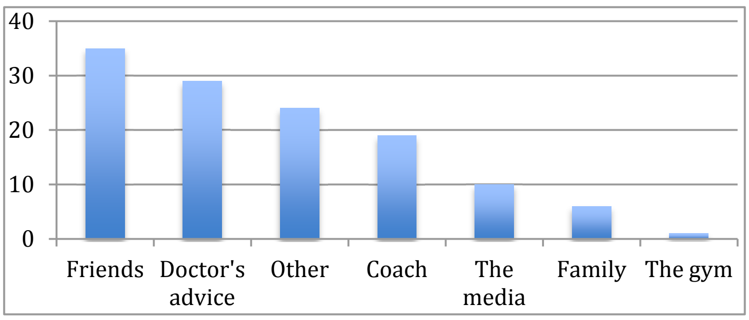



**Figure 21 Influencing factors for supplementation**

The two previously discussed stages in which an athlete can be, were also investigated in terms of being possible influencing factors for the intake of dietary supplements. As can be seen from Figure 22, the results of frequency analysis of multiple answer questions showed that regarding both, the training phase and the competition phase, most athletes (83 and 60 respectively) use supplements independently of these stages.

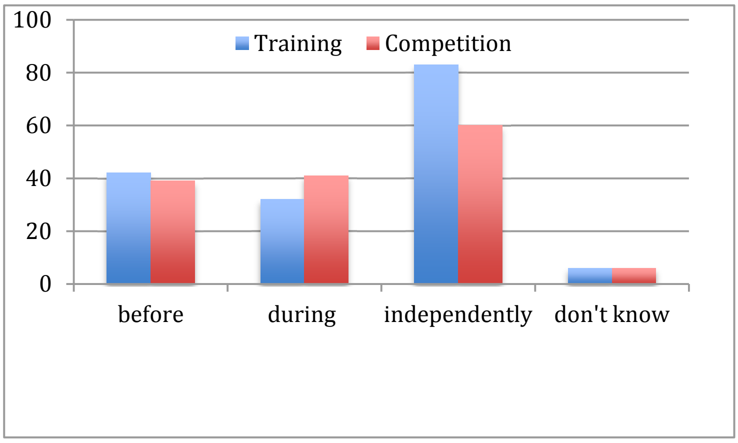



**Figure 22 Intake of supplements during training/competition**

Regarding the options *before* and *during*, answers were more or less equally distributed. Thus, the stage of training or competition, respectively, is not considered to be an influencing factor for the usage of dietary supplements.

### *3.4.5.3 Frequency of intake*

Considering the question of how often participants use supplements, 36% stated on a daily basis, 29% 1-3 times per week and 19% stated that they use supplements 4-6 times per week. Only 15% use supplements 1-3 times per month.

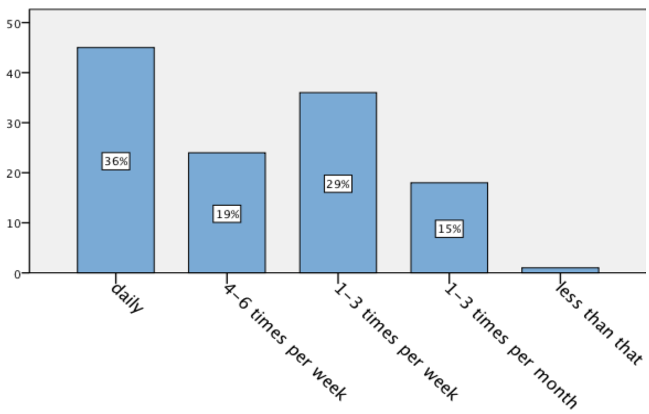



**Figure 23 Frequency of intake (n= 124)**

Whether certain variables (gender, age, the practice of a specific kind of endurance sport or the participation in competitions) have an influence on the frequency of supplementation shall be discussed at this point.

Separated by gender, a cross-tab analysis showed that 25 female and 20 male athletes respectively use supplements on a daily basis. In a similar way, 21 female and 15 male athletes respectively use supplements 1-3 times per week. Regarding the frequency of intake of 4-6 times per week, more male athletes (14), compared to female ones (10) use supplements on this basis. Similarly regarding the frequency of 1-3 times per month, more males (14), compared to females (4) use dietary supplements.

The distribution of the frequency of intake among the established age groups can be observed in Figure 24.

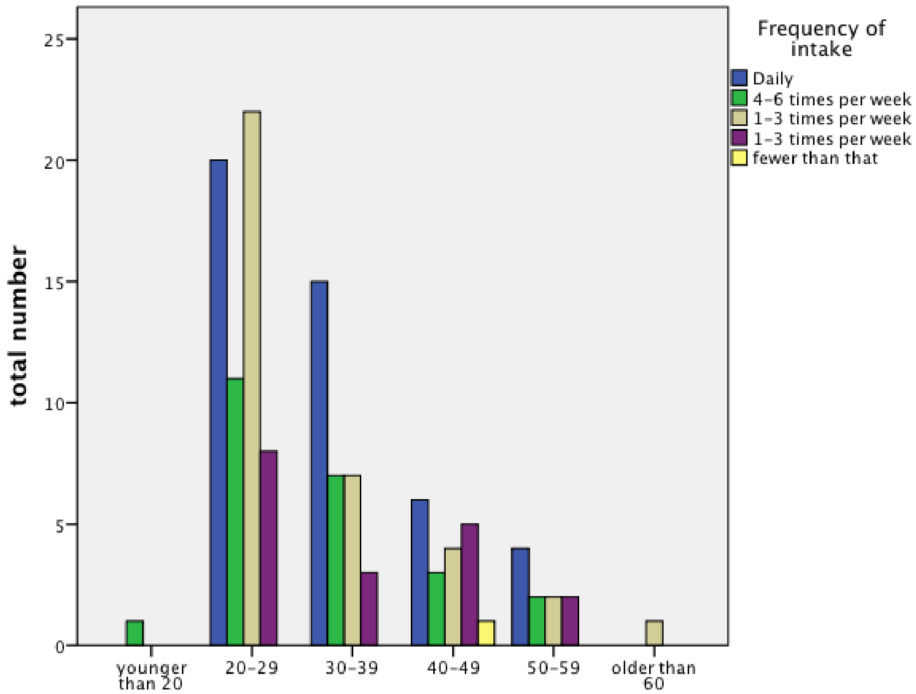



**Figure 24 Frequency of intake among age groups (n=124)**

With regard to the different age groups and the frequency of intake it can be observed that 20 participants between 20 and 29 years and 15 participants between 30 and 39 years use dietary supplements on a daily basis. 22 participants, who are between 20 and 29 years old, stated to use dietary supplements 1-3 times per week.

Considering specific endurance sports (i.e. running, swimming, cycling, ball sports and other), a cross-tab analysis showed that, first of all, the majority out of 124 supplement users are runners (80). 31 of these stated to use supplements on a daily basis. Regarding the category *Other,* 19 participants stated to use supplements, 10 of which do use them on a daily basis. As for the cyclists, 16 athletes stated to use dietary supplements with an equal distribution among the listed options.

Whether the participation and perhaps the frequency of it has an influence on the frequency of usage of dietary supplements, was also analysed with a cross-tab analysis. Results showed that the majority (49) of those athletes, who frequently use dietary supplements, participate in competitions every other month. The distribution of frequency appears to be more or less equally distributed among the other athletes who stated to participate in competitions on a less frequent or more frequent basis, respectively.

#### *3.4.5.4 Motifs*

In order to gather information about possible motifs for the usage of dietary supplements, athletes were asked to state their agreement towards various statements. Therefore, the following question was asked: "What motivates/motivated you to use dietary supplements?" In order to gain a better overview, these statements were afterwards categorised in three areas, namely health-related motifs, performance-related motifs, and external influences for supplementation. Health-related statements were formulated as follows:

a) *To sustain a balanced diet*
b) *To stay healthy*
c) *To speed up recovery from illness*
d) *Because diet is insufficient*
e) *To prevent malnourishment*
f) *To compensate malnourishment*

Performance-related motifs included following statements:

*g) To achieve better during training sessions.*

*h) To improve performance during competitions.*

*i) To speed up recovery from competitions.*

These statements were formulated as external influences for supplementation:

*j) My coach recommended the usage of dietary supplements.*

*k) My friends and/or family use dietary supplements and recommend the usage.*

Out of 124 athletes, 76 (61.3%) declared to agree on statement a). Even more athletes, namely 93 (75%), stated to agree on statement b). Regarding statement c), however, most participants (58.9%) did not agree. 63.7% of the participants agree on statement d) and thus think that the diet alone does not provide sufficient nutrients. A clear majority (78.2%) agrees on statement e), thinking that the intake of dietary supplements prevents malnourishment. 65.3% of the participants consequently agreed on statement f) regarding the ability of supplements to compensate malnourishment.

As there was, generally speaking, a lot of agreement on the mentioned health-related motifs, it was of interest, whether there are gender differences towards the agreement on these statements. Thus, the Mann-Whitney-U test for independent samples was applied. With regard to relationship between gender and health-related motifs, results can be seen in Table 6.

**6 Health-related motifs for usage of dietary supplements**

| Overview on hypotheses | | | | |
|---|---|---|---|---|
| | **Null hypothesis** | **Test** | **Sig.** | **Decision** |
| **a)** | The distribution of motivation: To sustain a balanced diet. is the same across categories of gender. | Mann-Whitney-U-Test for independent samples | ,012 | Reject Null hypothesis |
| **b)** | The distribution of motivation: To stay healthy. is the same across categories of | Mann-Whitney-U-Test for independent | ,016 | Reject Null hypothesis |

| | | | | |
|---|---|---|---|---|
| | gender. | samples | | |
| **c)** | The distribution of motivation: To speed up recovery from illness. is the same across categories of gender. | Mann-Whitney-U-Test for independent samples | ,153 | Retain Null hypothesis |
| **d)** | The distribution of motivation: Because diet is insufficient. is the same across categories of gender. | Mann-Whitney-U-Test for independent samples | ,224 | Retain Null hypothesis |
| **e)** | The distribution of motivation: To prevent malnourishment. is the same across categories of gender. | Mann-Whitney-U-Test for independent samples | ,075 | Retain Null hypothesis |
| **f)** | The distribution of motivation: To compensate malnourishment. is the same across categories of gender. | Mann-Whitney-U-Test for independent samples | ,703 | Retain Null hypothesis |
| Asymptotic significances are displayed. The significance level is .05. | | | | |

As Table 6 clearly shows, significant differences could be observed concerning statements a) (p=0.012) and b) (p=0.016). Thus, the null hypotheses of these statements are rejected and the alternative hypotheses are accepted. Females are more likely to agree to statements a) *(To sustain a balanced diet)* and b) *(To stay healthy).* As far as statements c) to f) are concerned, no significant differences could be observed. The null hypotheses were thus accepted.

Closer inspection of performance-related motifs revealed that 81 (65.3%) of the participants agreed on statement g). On the contrary, only 64 (51.6%) of the participants agree on statement h) and thus think that dietary supplements enhance their performance during competitions. Considering statement i), however, the majority (64.5%) agrees on the motif that supplements support the recovery from competitions.

A similar analysis as for the health-related motifs was carried out in order to determine whether there are observable gender differences. Results of the evaluation of the variables gender and performance-related statements can be seen in Table 7.

**Table 7 Performance-related motifs for usage of dietary supplements**

| Overview on hypotheses | | | | |
|---|---|---|---|---|
| | **Null hypothesis** | **Test** | **Sig.** | **Decision** |
| **g)** | The distribution of motivation: To achieve better during training sessions. is the same across categories of gender. | Mann-Whitney-U-Test for independent samples | ,081 | Retain Null hypothesis |
| **h)** | The distribution of motivation: To improve performance during competitions. is the same across categories of gender. | Mann-Whitney-U-Test for independent samples | ,003 | Reject Null hypothesis |
| **i)** | The distribution of motivation: To speed up recovery from competitions. is the same across categories of gender. | Mann-Whitney-U-Test for independent samples | ,003 | Reject Null hypothesis |
| Asymptotic significances are displayed. The significance level is .05. | | | | |

Considering these hypotheses, significant differences, which can be seen in Table 7, could be observed for statements h) (p=0.003) and i) (p=0.003). Therefore, the null hypotheses are rejected and the alternative hypotheses are accepted. Males are more likely to agree to statements h) *(To improve performance during competitions)* and i) *(To speed up recovery from competitions)*. No significant differences could be observed regarding gender and the motif of performance-enhancement with regard to training sessions.

With regard to the last two possible motifs, which were subsumed under external motifs, the majority of participants did not agree. Hence, neither the recommendation of the coach, nor family and/or friends, respectively, appears to be a motif for the intake of dietary supplements.

Taking these results of the analyses of different motifs into consideration, it can be said that many athletes agreed on health-related motifs as well as on performance-related motifs. To be more precise, males and females have different motifs for the usage of dietary supplements. Females rather use supplements due a health-related notion, whereas males tend to use supplements in order to enhance performance during competitions as well as for recovery purposes.

### *3.4.5.5 Attitudes towards supplements*

In order to find out about different attitudes towards the usage of dietary supplements, various statements were formulated. Athletes were asked to state their agreement towards following statements:

1) *Dietary supplements are necessary in order to sustain a healthy life.*
2) *Dietary supplements do not have negative long-term effects on the body.*
3) *Dietary supplements enable a better performance during training/competition.*
4) *One can achieve the same (positive) results solely through a balanced diet.*

As Figure 25 illustrates, most participants clearly stated that, according to them, supplements are not needed to sustain a healthy life.

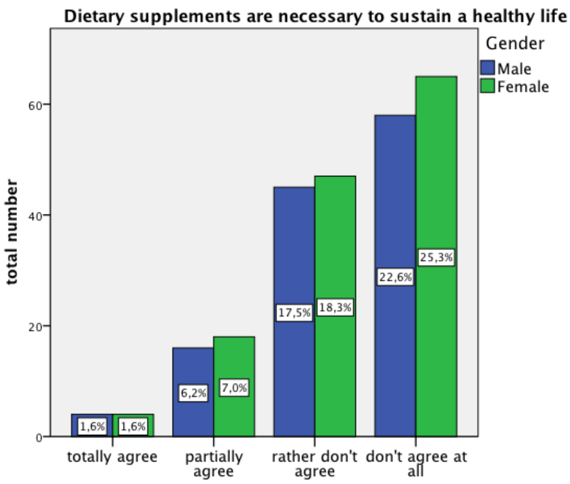



**Figure 25 Agreement towards statement 1)**

With the potentially negative side effects of supplements in mind, statement 2) was formulated in order to find out if athletes are aware of possible negative side effects of supplementation. Results can be seen in Figure 26, showing that, even though many athletes are aware of this fact, there are still athletes who do not think that supplements are not free of negative long-term effects on the body.

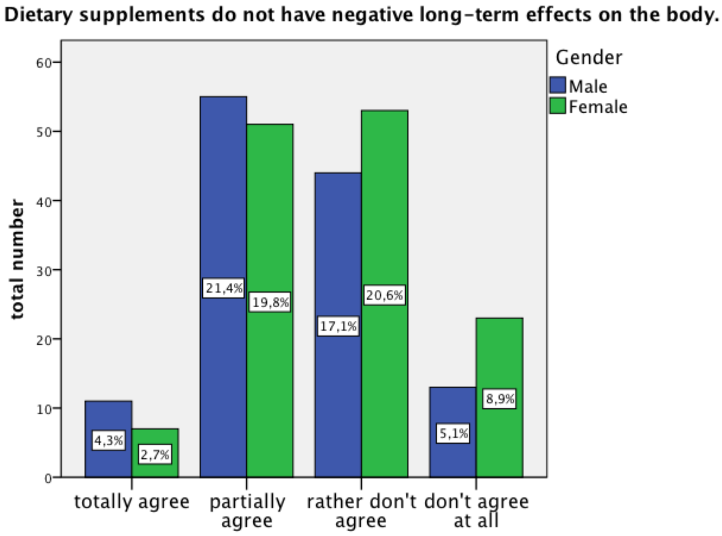



**Figure 26 Agreement towards statement 2)**

Figure 27 illustrates that the agreement towards a performance-enhancing effect of supplements is rather equally distributed among athletes of both genders.

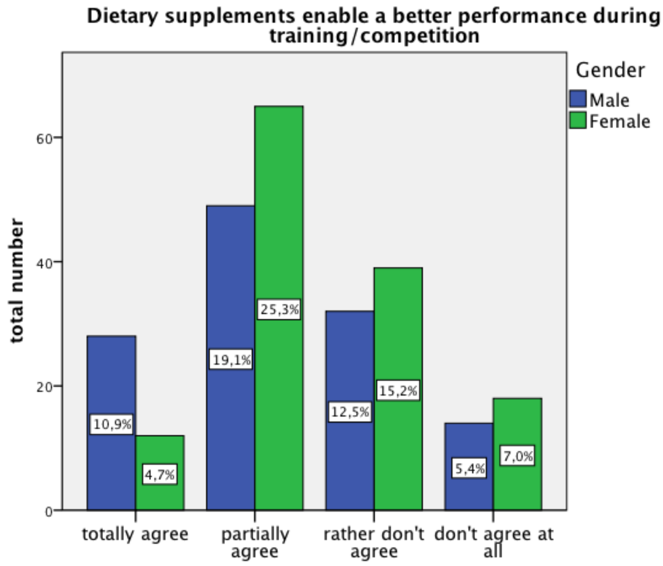



**Figure 27 Agreement towards statement 3)**

Whether athletes think that an athlete can achieve the same (positive) results with a balanced diet compared to a diet including dietary supplements, can be seen in Figure 28.

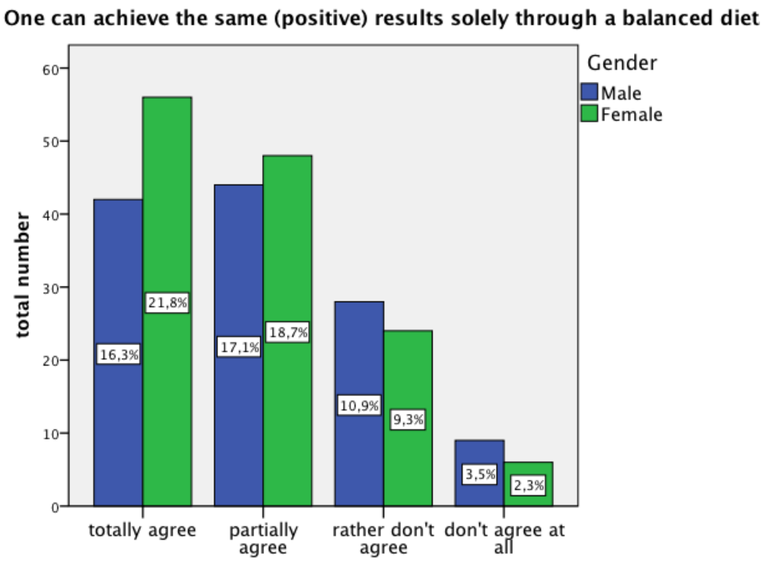



**Figure 28 Agreement towards statement 4)**

As Figure 28 illustrates, many athletes agree on the fact that a balanced diet equalises the need for supplementation. However, there are also athletes who do not share this opinion.

Taking all four statements into consideration, the variables gender, age, the participation in competitions and the intake of dietary supplements were tested for significant differences. With regard to gender, Table 8 shows that the only significant difference could be observed regarding statement 2) (p=0.047).

**Table 8 Attitudes towards supplements: gender**

| Overview on hypotheses | | | | |
|---|---|---|---|---|
| | **Null hypothesis** | **Test** | **Sig.** | **Decision** |
| 1 | The distribution of agreement: Dietary supplements are necessary in order to sustain a healthy life. is the same across categories of gender. | Mann-Whitney-U-Test for independent samples | ,868 | Retain Null hypothesis |
| 2 | The distribution of agreement: Dietary supplements do not have negative long-term effects on the body. is the same across categories of gender. | Mann-Whitney-U-Test for independent samples | ,047 | Reject Null hypothesis |
| 3 | The distribution of agreement: Dietary supplements enable a better performance during training/competition. is the same across categories of gender. | Mann-Whitney-U-Test for independent samples | ,060 | Retain Null hypothesis |
| 4 | The distribution of agreement: One can achieve the same (positive) results solely through a balanced diet.is the same across categories of gender. | Mann-Whitney-U-Test for independent samples | ,116 | Retain Null hypothesis |

| |
|---|
| Asymptotic significances are displayed. The significance level is .05. |

Gender thus affects the consideration of supplements to be free of negative long-term effects. Males are more likely to agree to this statement. Considering the other statements, no significant differences could be detected. Male and female agreement is equally distributed among these statements. Considering the variable age, however, no significant difference could be detected towards the various statements. Similar results were found regarding the participation in competitions.

Whether the usage of dietary supplements can be seen as an influencing factor towards the agreement on the established statements, can be seen in Table 9.

**Table 9 Attitudes towards supplements: supplement users**

| Overview on hypotheses | | | | |
|---|---|---|---|---|
| | **Null hypothesis** | **Test** | **Sig.** | **Entscheidung** |
| **1** | The distribution of agreement: Dietary supplements are necessary in order to sustain a healthy life. is the same across categories of intake. | Mann-Whitney-U-Test for independent samples | ,000 | Reject Null hypothesis |
| **2** | The distribution of agreement: Dietary supplements do not have negative long-term effects on the body. is the same across categories of intake. | Mann-Whitney-U-Test for independent samples | ,000 | Reject Null hypothesis |
| **3** | The distribution of agreement: Dietary supplements enable a better performance during training/competition. is the same across categories of intake. | Mann-Whitney-U-Test for independent samples | ,000 | Reject Null hypothesis |
| **4** | The distribution of agreement: One can achieve the same (positive) results solely through a balanced diet. is the same across categories of intake. | Mann-Whitney-U-Test for independent samples | ,000 | Reject Null hypothesis |
| Asymptotic significances are displayed. The significance level is .05. | | | | |

With regard to athletes who use supplements, significant differences could be observed for all statements. If athletes use dietary supplements, they are more likely to agree towards statements 1) to 3). Regarding statement 4), they are more likely to disagree.

With regard to the last question of the questionnaire, the entire athletic sample was asked to state their overall opinion on dietary supplements. To be more precise, they were asked to state whether they consider supplements to be generally useful. Results of this question can be seen in Figure 29.

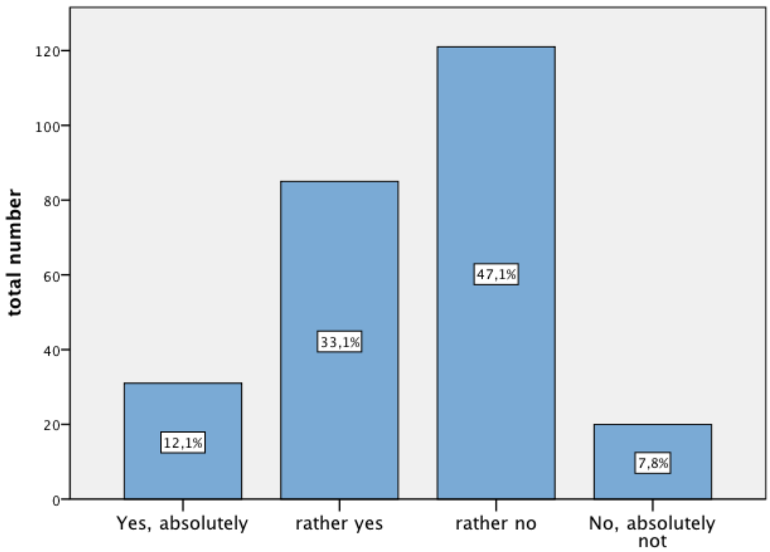



**Figure 29 Overall attitude towards dietary supplements (n= 257)**

As can be seen in Figure 29, the overall attitude on the usefulness of dietary supplements is distributed among all categories. Taking together both categories of agreement and disagreement, respectively, 141 (54.9%) participants do no consider supplements to be useful, whereas 116 (45.1%%) participants think that supplements are generally useful.

Whether variables such as gender, age, the participation in competitions or the average time spent with endurance sport can be seen as influencing factors for the consideration of supplements to be generally useful was tested with the chi-square test. With regard to variables gender, age and the participation in competitions, statistical analyses yielded similar results, namely that there are no significant differences between these variables and the consideration of dietary supplements to be generally useful. As a last possible influencing factor, the average time spent with the performance of endurance sport was taken into consideration. In order to determine whether the average time of performed sport per week has an influence on the general consideration of supplements to be useful, the univariate ANOVA was applied. Results of the ANOVA showed that there are significant differences regarding the agreement on supplements and the mean performance duration per week ($p=0.017$). Those participants, who perform the most endurance sport per week, are more likely to consider supplements to be generally useful.

## 3.5 Discussion

In this section, findings of the conducted survey will be compared with results by other similar surveys which have been elaborated in section 2.5.2.

Beforehand, however, limitations of dietary surveys need to be briefly elaborated. According to Maughan and Burke (2002: 9), it is important to note that "dietary surveys cannot present the *actual* and *usual* energy intakes of athletes. Rather they present the results of what athletes *report* eating during a *particular* period of time". This, in turn, leads to possible errors due to wrong or inaccurate reports provided by the athletes (Maughan & Burke 2002: 9-10). With these aspects in mind, the results shall be discussed.

All in all, 302 participants were included in the survey, 257 of which reported to regularly perform endurance sport. Results showed that 48% of the athletic population use dietary supplements. Other conducted surveys, with differing sample sizes, come to different results regarding the general usage of dietary supplements. For example, Maughan, Depiesse and Geyer (2007) examined the usage of 310 international athletes coming to the conclusion that 85% of elite athletes make use of dietary supplements (2007: 105). A survey, conducted among young German elite athletes (n= 164), stated that approximately 80% use or used dietary supplements (Braun et al. 2009: 102). On the contrary, Sundgot-Borgen, Berglund and Torstveit (2003: 139-140), whose study included entire elite athletic population of Norway (n= 1620), stated that 53% of athletes use dietary supplements.

With regard to gender differences, Sundgot-Borgen, Berglund and Torstveit (2003: 140) could not find any significant correlations, even though previous studies (Sobal & Marquart 1994: 324) suggested that more female athletes compared to male athletes make use of dietary supplements. Similar to the results of Sundgot-Borgen, Berglund and Torstveit, the conducted survey did not find any differences between gender and the usage of dietary supplements due to the fact that, according to analyses, male and female athletes to an equal extent use supplements.

Considering age, Braun et al. (2009: 102) stated that there was a rise in prevalence with increasing age, meaning that athletes, who are above 18 years old, are more likely to use supplements compared to their younger colleagues. This argument could not be confirmed by the conducted study as results showed no significant difference between age and the intake of dietary supplements. In addition, it should not be forgotten that Braun's survey was conducted with the primary target group of young athletes and thus the survey can not be properly compared.

Investigating the most popular dietary supplements, most surveys report vitamin and mineral supplements as the most preferred choices, followed by protein and creatine supplements as well as ergogenic aids such as caffeine (Maughan, Depiesse & Geyer 2007: 106). According to the survey at hand, vitamin supplements were chosen by 59.7% of the participants, followed by mineral supplements, chosen by 58.1% of the participants making them the most preferred supplement. Protein supplements were chosen by 48.4% of the participants and carbohydrate supplements were selected by 28.2% of the athletic sample. Thus, it can be stated that the findings are in consensus with previously conducted surveys (also see section 2.5.2).

With regard to gender differences and the type of used supplement, Sundgot-Borgen, Berglund and Torstveit (2003: 141) stated that, whereas female athletes tend to use more vitamin and mineral supplements, male athletes rather use amino acids and creatine. These findings slightly differ from those of the conducted study, namely in terms of missing statistical significance regarding gender and the usage of vitamin and/or mineral supplements. Nevertheless, significant correlations between gender and other supplements, namely carbohydrate, creatine, and BCAAs, could be confirmed. Male athletes are more likely to use these supplements compared to female ones.

As influencing factors for supplementation, Sobal and Marquart (1994: 327) list coaches as the biggest influencing factor for athletes, followed by doctors, parents and peers. Additionally, Maughan, Depiesse and Geyer (2007: 106) name personal research as influencing factor for the usage of supplements. These results generally coincide with the findings of the conducted survey. Closer investigation of the individual answers concerning the category *Other*, revealed that, here as well, personal research on the internet can be seen as a highly prominent influencing factor. Unfortunately, the questionnaire did not explicitly list *the internet.* It would have certainly yielded promising results.

Frequency analyses of the place where supplements are purchased also revealed that, here as well, the internet is highly popular among athletes. As the second-most popular choice, athletes are, however at risk of receiving contaminated products.

Examination of possible motifs for the usage of supplements, Sobal and Marquart (1994: 327) list, among others, "[p]erformance enhancement, prevention of illness, compensation for inadequate diet, providing extra energy, and meeting special nutrient demands from high levels of activity". In addition, Maughan, Depiesse and Geyer (2007: 105) list "to aid in recovery from training" as one of the main reasons for supplement use. Braun et al. (2009: 105), on the contrary, argue that the majority of participants use supplements for "health-related reasons", followed by "performance-related reasons". Regarding these two motifs, it was observed that more protein and carbohydrate supplements were consumed by those, who cited performance-related reasons, whereas more vitamin supplements were consumed by athletes who use supplements for health-related reasons (Braun et al. 2009: 105). As results of the conducted survey show, there are significant differences between gender and the motifs for usage. More females use supplements in order to maintain a balanced diet as well as to stay healthy, whereas males tend to use supplements due to performance-enhancing effects during competition and to recover from competitions. This is also interesting to note due to the significant correlations between males and the intake of carbohydrate, creatine and BCAAs, all of which are associated with performance-enhancing effects or recovery, respectively.

## 3.6 Conclusion

The present thesis dealt with dietary supplements and their usage among athletes. At first, a literature review provided essential information concerning the nutritional needs of athletes in general and then focused on the two stages in which an endurance athlete can be (training and competition), in more detail. This was followed by a discussion on dietary supplements including a brief elaboration on their historical background as well as a presentation of different definitions of dietary supplements showing that there is no consensus on one coherent definition. With regard to the selected dietary supplements, their respective field of application was presented as well in order to show their versatility. However, the importance of weighing out the potential positive effects against the negative ones was also highlighted due to the fact that, unless an athlete suffers from a diagnosed deficiency, supplementation is considered to be unnecessary. Moreover, potentially negative side effects of different supplements were separately elaborated.

The empirical part was concerned with the investigation of usage patterns of Austrian endurance athletes. The aim was thus to answer the following research question: "Are dietary supplements frequently consumed among Austrian endurance athletes and if so, what are influential factors for the usage of these?"

In order to do so, a small online survey was conducted and statistically evaluated with IBM SPSS 22. All in all, the survey included 302 participants, 257 of which consider themselves as endurance athletes, which in turn, included them in further analyses. According to the results, 48% of the athletic group frequently use dietary supplements. The most popular supplements were vitamin- and mineral supplements, followed by protein supplements and carbohydrate supplements. In addition, it was observed that the option *Other* was also frequently ticked. As this category included all supplements that were not explicitly listed, the popularity of this choice can be seen as a reflection of the vast amount of products which are available on the market.

With regard to influential factors for supplementation, it was observed that the average time spent with the performance of endurance sport might possibly be an influencing factor for the usage of supplements. Results showed that those participants, who perform more endurance sport per week, are more likely to use dietary supplements. Other listed influential factors for the usage of dietary supplements were friends, followed by doctor's advice and the coach.

Moreover, this thesis stressed the importance of savvy consumption of dietary supplements in order to avoid negative side effects. The reported numbers of athletes, who purchase their products from the internet, or use this medium as source of information regarding supplementation, however, show that still a lot of educational work needs to be done.

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# Appendix



Seite 01
SS

Sehr geehrte Damen und Herren!

Vielen Dank, dass Sie sich die Zeit nehmen, diesen Fragebogen auszufüllen!

Im Rahmen meiner Diplomarbeit beschäftige ich mich mit dem **Einsatz von Nahrungsergänzungsmitteln im Ausdauersport**. In diesem Sinne dient dieser Fragebogen zum einen der Erhebung von allgemeinen Ernährungsgewohnheiten von Hobbysportlern, sowie auch der Erhebung von Gewohnheiten und Motiven bzgl. der Verwendung von Nahrungsergänzungsmitteln im Ausdauersport.

Dauer: 15 - 20 min

Alle Daten werden selbstverständlich anonym behandelt.

Seite 02

## Persönliche Daten

Bitte geben Sie folgende Daten zu Ihrer Person an:

1. Geschlecht

- ○ Männlich
- ○ Weiblich

2. Wie alt sind Sie?
Bitte geben Sie Ihr Alter in Jahren an.

____ Jahre

3. Wie groß sind Sie?
Bitte geben Sie Ihre Größe in cm an.

____ cm

4. Wie schwer sind Sie?
Bitte geben Sie Ihr Gewicht in kg an.

____ kg

5. Wie lautet die Postleitzahl Ihres Wohnortes?

6. Was ist Ihre höchste abgeschlossene Ausbildung?

- ◯ Volksschule
- ◯ AHS-Unterstufe/ Neue Mittelschule (ehem. Hauptschule)
- ◯ Polytechnische Schule/ Berufsschule/Lehre/ BMS (Berufsbildende mittlere Schule ohne Matura)
- ◯ BHS (Berufsbildende höhere Schule)/ AHS-Oberstufe mit Matura
- ◯ Hochschule (Universität, Fachhochschule)
- ◯ Sonstiges

**Seite 03**
EG

## Ernährungsgewohnheiten

Zu Beginn möchte ich etwas über Ihre allgemeinen Ernährungsgewohnheiten erfahren. Bitte füllen Sie die folgenden Fragen so gewissenhaft wie möglich aus.

7. Wie oft essen oder trinken Sie normalerweise die folgenden Dinge

Weißbrot

| 4-5 mal/ Tag | 2-3 mal/ Tag | 6-7 Tage/ Woche | 4-5 Tage/ Woche | 2-3 Tage/ Woche | 1 Tag/ Woche | 1-3 Tage/ Monat | < 1 Tag/ Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

Reis, Nudeln

| 4-5 mal/ Tag | 2-3 mal/ Tag | 6-7 Tage/ Woche | 4-5 Tage/ Woche | 2-3 Tage/ Woche | 1 Tag/ Woche | 1-3 Tage/ Monat | < 1 Tag/ Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

Vollkornbrot

| 4-5 mal/ Tag | 2-3 mal/ Tag | 6-7 Tage/ Woche | 4-5 Tage/ Woche | 2-3 Tage/ Woche | 1 Tag/ Woche | 1-3 Tage/ Monat | < 1 Tag/ Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

Kartoffeln

| 4-5 mal/ Tag | 2-3 mal/ Tag | 6-7 Tage/ Woche | 4-5 Tage/ Woche | 2-3 Tage/ Woche | 1 Tag/ Woche | 1-3 Tage/ Monat | < 1 Tag/ Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Hülsenfrüchte (Linsen, Bohnen, ...)

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Gemüse

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Obst

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Milch und Milchprodukte

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Sojaprodukte

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Käse

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Fisch

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Fleisch und Fleischprodukte

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Rotes Fleisch (Rind, Schwein, ...)

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Weißes Fleisch (Huhn, Pute, ...)

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Vegetarische Fleischersatzprodukte (Tofu, Seitan, ...)

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Eier (inkl. verarbeitete Eier)

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Streichfett

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Speisefett (zum Braten, Salatöl, ...)

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Fast Food

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Wasser

| 4-5 mal/Tag | 2-3 mal/Tag | 6-7 Tage/Woche | 4-5 Tage/Woche | 2-3 Tage/Woche | 1 Tag/Woche | 1-3 Tage/Monat | < 1 Tag/Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Fruchtsäfte

| 4-5 mal/ Tag | 2-3 mal/ Tag | 6-7 Tage/ Woche | 4-5 Tage/ Woche | 2-3 Tage/ Woche | 1 Tag/ Woche | 1-3 Tage/ Monat | < 1 Tag/ Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Limonaden mit Zuckerzusatz

| 4-5 mal/ Tag | 2-3 mal/ Tag | 6-7 Tage/ Woche | 4-5 Tage/ Woche | 2-3 Tage/ Woche | 1 Tag/ Woche | 1-3 Tage/ Monat | < 1 Tag/ Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Light-Getränke

| 4-5 mal/ Tag | 2-3 mal/ Tag | 6-7 Tage/ Woche | 4-5 Tage/ Woche | 2-3 Tage/ Woche | 1 Tag/ Woche | 1-3 Tage/ Monat | < 1 Tag/ Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Kaffee/Tee

| 4-5 mal/ Tag | 2-3 mal/ Tag | 6-7 Tage/ Woche | 4-5 Tage/ Woche | 2-3 Tage/ Woche | 1 Tag/ Woche | 1-3 Tage/ Monat | < 1 Tag/ Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Süßes (Schokolade, Kekse, Riegel, ...)

| 4-5 mal/ Tag | 2-3 mal/ Tag | 6-7 Tage/ Woche | 4-5 Tage/ Woche | 2-3 Tage/ Woche | 1 Tag/ Woche | 1-3 Tage/ Monat | < 1 Tag/ Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Mehlspeisen (Torten, Kuchen, ...)

| 4-5 mal/ Tag | 2-3 mal/ Tag | 6-7 Tage/ Woche | 4-5 Tage/ Woche | 2-3 Tage/ Woche | 1 Tag/ Woche | 1-3 Tage/ Monat | < 1 Tag/ Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Salziges (Knabbereien)

| 4-5 mal/ Tag | 2-3 mal/ Tag | 6-7 Tage/ Woche | 4-5 Tage/ Woche | 2-3 Tage/ Woche | 1 Tag/ Woche | 1-3 Tage/ Monat | < 1 Tag/ Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Alkoholische Getränke

| 4-5 mal/ Tag | 2-3 mal/ Tag | 6-7 Tage/ Woche | 4-5 Tage/ Woche | 2-3 Tage/ Woche | 1 Tag/ Woche | 1-3 Tage/ Monat | < 1 Tag/ Monat | nie | weiß nicht |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Seite 04**
KA

## Körperliche Aktivität

Die folgenden Fragen beschäftigen sich mit der Zeit, die Sie in einer gewöhnlichen Woche mit **verschiedenen körperlichen Aktivitäten** verbringen.

Bitte beantworten Sie die Fragen selbst dann, wenn Sie sich selbst nicht für eine körperlich aktive Person halten.

## Körperliche Aktivität: Arbeit

Denken Sie zuerst über die Zeit nach, während der Sie arbeiten. Schließen Sei dabei all die Aufgaben ein, die Sie erledigen müssen, wie bezahlte und unbezahlte Arbeit, studieren/lernen, Aufgaben im Haushalt, Arbeitssuche, und auch ernten, fischen oder jagen. Wenn Sie die Fragen beantworten, denken Sie daran, dass „intensive körperliche Aktivitäten" diejenigen Aktivitäten sind, die große Anstrengung erfordern und daher Atmung und Puls stark zunehmen. „Moderate körperliche Aktivitäten" sind solche, die moderate Anstrengung erfordern und zu einer leichten Erhöhung der Atmung und des Pulses führen.

8. Beinhaltet Ihre Arbeit intensive körperliche Aktivität, bei der Atmung und Puls stark zunehmen, wie schwere Lasten tragen oder heben, graben oder Bauarbeiten mit einer Dauer von mindestens zehn Minuten/ Tag?

- ○ Ja
- ○ Nein

**Seite 05**
wvt

9. Wenn ja, an wie vielen Tagen in einer gewöhnlichen Woche betätigen Sie sich bei der Arbeit körperlich intensiv?

- ○ 1 Tag
- ○ 2 Tage
- ○ 3 Tage
- ○ 4 Tage
- ○ 5 Tage
- ○ 6 Tage
- ○ 7 Tage

**Seite 06**

10. Wenn ja, wie viel Zeit verbringen Sie an einem gewöhnlichen Tag bei der Arbeit mit intensiver körperlicher Aktivität?

Stunden Minuten

**Seite 07**
KAM

11. Beinhaltet Ihre Arbeit moderate körperliche Aktivität, bei der Atmung und Puls leicht zunehmen, wie flottes Gehen oder Tragen leichter Lasten mit einer Dauer von mindestens zehn Minuten/ Tag?

- Ja
- Nein

**Seite 08**

12. Wenn ja, an wie vielen Tagen in einer gewöhnlichen Woche führen Sie bei der Arbeit moderate körperliche Aktivität aus?

- 1 Tag
- 2 Tage
- 3 Tage
- 4 Tage
- 5 Tage
- 6 Tage
- 7 Tage

**Seite 09**

13. Wenn ja, wie viel Zeit verbringen Sie an einem gewöhnlichen Tag bei der Arbeit mit moderater körperlicher Aktivität?

Stunden Minuten

**Seite 10**
KAO

## Körperliche Aktivität: von Ort zu Ort

Die nächsten Fragen schließen die körperliche Aktivität bei der Arbeit, die Sie bereits erwähnt haben, aus. Nun wird gefragt, wie Sie sich von Ort zu Ort fortbewegen, beispielsweise von zu Hause zur Arbeitsstelle, zum Einkaufen, zum Markt oder zur Kirche.

14. Gehen Sie zu Fuß oder fahren Sie mit dem Fahrrad, um von einem Ort zum anderen zu kommen, mit einer Dauer von mindestens zehn Minuten?

- Ja
- Nein

**Seite 11**

15. Wenn ja, an wie vielen Tagen in einer gewöhnlichen Woche gehen Sie zu Fuß oder fahren Sie mit dem Fahrrad, um von einem Ort zum anderen zu kommen, mit einer Dauer von mindestens zehn Minuten/ Tag?

- 1 Tag
- 2 Tage
- 3 Tage
- 4 Tage
- 5 Tage
- 6 Tage
- 7 Tage

**Seite 12**

16. Wenn ja, wie viel Zeit investieren Sie an einem gewöhnlichen Tag, um zu Fuß oder mit dem Fahrrad von einem Ort zum anderen zu kommen?

Stunden Minuten

**Seite 13**
KAF

## Körperliche Aktivität: Freizeit

In diesem Abschnitt geht es um alle körperlichen Aktivitäten die Sie in den vergangenen 7 Tagen ausschließlich in Erholung, Sport, Leibesübungen und Freizeit verrichtet haben. Bitte keine Aktivitäten mit einbeziehen die Sie bereits angegeben haben.

17. Ohne die Fußwege die Sie bereits genannt haben, gehen Sie in ihrer Freizeit für mindestens mehr als 10 Minuten ohne Unterbrechung zu Fuß?

- Ja
- Nein

**Seite 14**

18. Wenn ja, an wie vielen der vergangenen 7 Tage sind Sie in ihrer Freizeit für mindestens 10 Minuten ohne Unterbrechung zu Fuß gegangen?

- ○ 1 Tag
- ○ 2 Tage
- ○ 3 Tage
- ○ 4 Tage
- ○ 5 Tage
- ○ 6 Tage
- ○ 7 Tage

---

**Seite 15**

19. Wie viel Zeit haben Sie für gewöhnlich an einem dieser Tage mit zu Fuß Gehen in ihrer Freizeit verbracht?

[ ] Stunden [ ] Minuten

---

**Seite 16**
KAA

20. Denken sie nur an die körperlichen Aktivitäten die Sie für mindestens 10 Minuten ohne Unterbrechung verrichtet haben. Haben Sie in den vergangenen 7 Tagen anstrengende körperliche Aktivitäten wie Aerobic, Laufen, schnelles Fahrradfahren oder schnelles Schwimmen in ihrer Freizeit verrichtet?

- ○ Ja
- ○ Nein

---

**Seite 17**

21. An wie vielen der vergangenen 7 Tage haben Sie anstrengende körperliche Aktivitäten wie Aerobic, Laufen, schnelles Fahrradfahren oder schnelles Schwimmen in ihrer Freizeit verrichtet?

- ○ 1 Tag
- ○ 2 Tage
- ○ 3 Tage
- ○ 4 Tage
- ○ 5 Tage
- ○ 6 Tage
- ○ 7 Tage

**Seite 18**

22. Wie viel Zeit haben Sie für gewöhnlich an einem dieser Tage mit anstrengender körperlicher Aktivität in ihrer Freizeit verbracht?

Stunden Minuten

**Seite 19**
KAM2

23. Denken Sie erneut nur an die körperlichen Aktivitäten die Sie für mindestens 10 Minuten ohne Unterbrechung verrichtet haben. Haben sie in den vergangen 7 Tagen moderate körperliche Aktivitäten wie Fahrradfahren bei gewöhnlicher Geschwindigkeit, Schwimmen bei gewöhnlicher Geschwindigkeit und Doppel-Tennis in ihrer Freizeit verrichtet?

- Ja
- Nein

**Seite 20**

24. An wie vielen der vergangenen 7 Tage haben sie moderate körperliche Aktivitäten wie Fahrradfahren bei gewöhnlicher Geschwindigkeit, Schwimmen bei gewöhnlicher Geschwindigkeit und Doppel-Tennis in ihrer Freizeit verrichtet?

- 1 Tag
- 2 Tage
- 3 Tage
- 4 Tage
- 5 Tage
- 6 Tage
- 7 Tage

**Seite 21**

25. Wie viel Zeit haben Sie für gewöhnlich an einem dieser Tage mit moderater körperlicher Aktivität in ihrer Freizeit verbracht?

Stunden Minuten

**Seite 22**
SG

## Sportliche Gewohnheiten

Die kommenden Fragen beschäftigen sich mit Ihren sportlichen Gewohnheiten.

26. Ich betreibe regelmäßig Ausdauersport (Laufen, Schwimmen, Radfahren, ...)

- Ja
- Nein

---

**Seite 23**

27. Welche Sportarten betreiben Sie regelmäßig?
Mehrfachnennung möglich

- Laufen
- Schwimmen
- Radfahren
- Ballspiele
- Sonstige

---

**Seite 24**

28. Welche Sportart betreiben Sie hauptsächlich?
Einfachnennung

- Laufen
- Schwimmen
- Radfahren
- Ballspiele
- Sonstige

---

**Seite 25**

29. Wie oft betreiben Sie durchschnittlich Ausdauersport pro Woche?

- 1-2 mal
- 3-4 mal
- 5-6 mal
- mehr als 7 mal

---

**Seite 26**

30. Wie viele Stunden pro Woche betreiben Sie durchschnittlich Ausdauersport?

Stunden Minuten

---

**Seite 27**

31. Sind Sie Mitglied in einem sportlichen Verein?

- Ja
- Nein

---

**Seite 28**
VN

32. Wenn ja, welche Sportart(en) betreiben Sie in einem Verein?
Mehrfachnennungen möglich

- Laufen
- Schwimmen
- Radfahren
- Triathlon
- Ballsportarten
- Sonstiges

---

**Seite 29**
wowk

33. Wie oft nehmen Sie an sportlichen Wettkämpfen teil?

- Nie
- alle paar Jahre
- 1 mal im Jahr
- alle paar Monate
- 1 mal im Monat
- Öfter

---

**Seite 30**
wk

34. An welchen Wettkämpfen nehmen sie teil?
Mehrfachnennung möglich

- Triathlon (Sprintdistanz)

- Triathlon (Olympische Distanz)
- Triathlon (Mitteldistanz)
- Triathlon (Langdistanz, Ironman)
- Marathon
- Halbmarathon
- Viertelmarathon
- Berglauf
- Volksläufe (bis 10km)
- Schwimmen (50m bis 1500m)
- Schwimmen Mittelstrecke (1500m-5km)
- Langstreckenschwimmen (ab 5km)
- Ballsportarten (Meisterschaft, Turniere,...)
- Sonstiges

---

**Seite 31**
NEM

## Nahrungsergänzungsmittel

Im letzten Abschnitt möchte ich mehr über Ihre Gewohnheiten und Motive bzgl. der Einnahme von Nahrungsergänzungsmitteln (NEM) erfahren. Bitte füllen Sie die folgenden Fragen so gewissenhaft wie möglich aus.

**Definition Nahrungsergänzungsmittel (NEM)** lt § 3 Ziffer 4 des LMSVG (Lebensmittelsicherheits- und Verbraucherschutzgesetz)

*"Lebensmittel, die dazu bestimmt sind, die normale Ernährung zu ergänzen und die aus Einfach- oder Mehrfachkonzentraten von Nährstoffen oder sonstigen Stoffen mit ernährungsspezifischer oder physiologischer Wirkung bestehen und in dosierter Form in Verkehr gebracht werden, d.h. in Form von z.B. Kapseln, Pastillen, Tabletten, Pillen und anderen ähnlichen Darreichungsformen, Pulverbeuteln, Flüssigampullen, Flaschen mit Tropfeinsätzen und ähnlichen Darreichungsformen von Flüssigkeiten und Pulvern zur Aufnahme in abgemessenen kleinen Mengen."*

35. Nehmen Sie zurzeit Nahrungsergänzungsmittel ein?

- Ja
- Nein

---

**Seite 32**

36. Wie oft nehmen Sie Nahrungsergänzungsmittel zu sich?

- Täglich
- 4-6 mal pro Woche
- 1-3 mal pro Woche
- 1-3 mal pro Monat

○ seltener

**Seite 33**

37. Welche Nahrungsergänzungsmittel haben Sie schon einmal zu sich genommen oder nehmen Sie derzeit zu sich?
Mehrfachnennungen möglich

- ☐ Vitaminpräparate (Multivitamintabletten etc.)
- ☐ Mineralstoffe, Spurenelemente
- ☐ Kohlenhydratkonzentrate („Power Gel" etc.)
- ☐ Eiweißkonzentrate (z.b. „Nitro Pure Whey")
- ☐ Kreatin
- ☐ Carnitin
- ☐ Glutamin
- ☐ BCAA's
- ☐ Coenzym Q10
- ☐ Arginin
- ☐ Koffein
- ☐ Taurin
- ☐ Sonstige

**Seite 34**

38. Zu welchem Zeitpunkt während der Trainingsphase nehmen bzw. nahmen Sie Nahrungsergänzungsmittel zu sich?
Mehrfachnennungen möglich

- ☐ Vor dem Training
- ☐ Während dem Training
- ☐ Unabhängig vom Training
- ☐ Weiß nicht

**Seite 35**

39. Zu welchem Zeitpunkt während der Wettkampfphase nehmen bzw. nahmen Sie Nahrungsergänzungsmittel zu sich?
Mehrfachnennungen möglich

- ☐ Vor dem Wettkampf
- ☐ Während dem Wettkampf
- ☐ Unabhängig vom Wettkampf
- ☐ Weiß nicht

## Seite 36
werwas

40. Wer oder was hat Sie auf die Idee gebracht Nahrungsergänzungsmittel zu sich zu nehmen?

- ○ Freunde
- ○ Familie
- ○ Werbung, Medien
- ○ TrainerIn, Sportverein
- ○ Fitnesscenter
- ○ Ärztlicher Rat
- ○ Sonstige

## Seite 37

41. Wo kaufen bzw. kauften Sie die Nahrungsergänzungsmittel?
Mehrfachnennung möglich

- ☐ Drogerie
- ☐ Apotheke
- ☐ Sportgeschäft
- ☐ Supermarkt
- ☐ Arzt
- ☐ Internet
- ☐ Fitnesscenter
- ☐ Fachgeschäft für Sportnahrung
- ☐ Sonstige

## Seite 38

42. Was motiviert bzw. motivierte Sie dazu Nahrungsergänzungsmittel einzunehmen?

| | trifft zu | trifft eher zu | trifft eher nicht zu | trifft gar nicht zu |
|---|---|---|---|---|
| Um mich ausgewogen und gesund zu ernähren. | ○ | ○ | ○ | ○ |
| Um gesund zu bleiben. | ○ | ○ | ○ | ○ |
| Um im Falle einer Krankheit schneller gesund zu werden. | ○ | ○ | ○ | ○ |
| Um einen besseren Trainingseffekt zu erzielen. | ○ | ○ | ○ | ○ |

| | | | | |
|---|---|---|---|---|
| Um meine Leistung im Wettkampf zu verbessern. | ◯ | ◯ | ◯ | ◯ |
| Um mich nach einem Wettkampf/Training schneller zu regenerieren. | ◯ | ◯ | ◯ | ◯ |
| Mein/e Trainer/in empfiehlt mir die Einnahme. | ◯ | ◯ | ◯ | ◯ |
| Meine Freunde und Familie nehmen auch welche und haben sie mir auf Grund der positiven Wirkung empfohlen. | ◯ | ◯ | ◯ | ◯ |
| Weil die Ernährung nicht ausreicht, um mich ausreichend mit den betreffenden Stoffen zu versorgen. | ◯ | ◯ | ◯ | ◯ |
| Um Mangelerscheinungen vorzubeugen. | ◯ | ◯ | ◯ | ◯ |
| Um Mangelerscheinungen auszugleichen | ◯ | ◯ | ◯ | ◯ |

## Seite 39

ZST

43. Inwiefern stimmen Sie folgenden Aussagen zu?

| | stimme voll zu | stimme eher zu | stimme eher nicht zu | stimme gar nicht zu |
|---|---|---|---|---|
| Nahrungsergänzungsmittel sind notwendig um gesund zu leben. | ◯ | ◯ | ◯ | ◯ |
| Nahrungsergänzungsmittel haben langfristig keinen nachteiligen Effekt auf den Körper. | ◯ | ◯ | ◯ | ◯ |
| Durch die Einnahme von Nahrungsergänzungsmitteln sind bessere Erfolge im Training oder Wettkampf möglich. | ◯ | ◯ | ◯ | ◯ |
| Man kann dieselbe körperliche Leistung erzielen, wenn man Nahrungsergänzungsmittel durch ausgewogene Ernährung ersetzt. | ◯ | ◯ | ◯ | ◯ |

## Seite 40

44. Halten Sie die Einnahme von Nahrungsergänzungsmitteln prinzipiell für sinnvoll?

◯ Ja, auf jeden Fall

◯ Eher ja

◯ Eher nein

◯ Nein, auf keinen Fall

**Letzte Seite**

## Vielen Dank für Ihre Teilnahme!

Wir möchten uns ganz herzlich für Ihre Mithilfe bedanken.

Ihre Antworten wurden gespeichert, Sie können das Browser-Fenster nun schließen.

Einladung zum SoSci Panel

Liebe Teilnehmerin,
lieber Teilnehmer,

das nicht-kommerzielle SoSci Panel würde Sie gerne zu weiteren wissenschaftlichen Befragungen einladen. Das Panel achtet Ihre Privatsphäre, gibt Ihre E-Mail-Adresse nicht an Dritte weiter und wird Ihnen pro Jahr maximal vier Einladungen zu qualitativ hochwertigen Studien zusenden.

E-Mail: Am Panel teilnehmen

Sie erhalten eine Bestätigungsmail, bevor Ihre E-Mail-Adresse in das Panel aufgenommen wird (Double Opt-In). So wird sichergestellt, dass niemand außer Ihnen Ihre E-Mail-Adresse einträgt.

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Ingrid Haas, Universität Wien – 2016