ADOLESCENTS AND COACHES/TRAINERS PERSPECTIVES OF ERGOGENIC SPORTS SUPPLEMENT USE WITHIN SOUTH AFRICAN PRIVATE HIGH SCHOOLS

BY

NICHOLAS JOHN BUTLER

THESIS

ORCID: 0000-0002-6108-8048

Submitted in fulfilment of the requirements for the Degree

Master of Science

Department of Human Kinetics and Ergonomics

Rhodes University, 2021

Grahamstown / Makhanda, South Africa

ABSTRACT

Sports supplements, also referred to as ergogenic aids, are used because of the assertion that they can enhance physical or athletic performance and/or physical appearance. Commonly used sports supplements include creatines, proteins, amino acids, stimulants, and in some cases pro-hormones. There is a relatively high and increasing prevalence of sports supplement use by the general population globally and in South Africa, particularly among adolescents and young adults due to various factors. While some research has explored supplement use among adolescents in a school setting, no study has explored this across the private school system in South Africa. Additionally, given the important role that coaches/trainers play in adolescent development, it is critical to also understand the role that they play regarding adolescent supplement use, given that there has been limited research around this topic in South Africa. Therefore, there were two aims of this study; Firstly, this study explored the prevalence and perceptions (knowledge; attitudes; beliefs) of sports supplements among South African private high school adolescents. Secondly, this study explored the perceptions (knowledge; attitudes; application of knowledge) towards sports supplements among adolescent coaches/trainers in South African private high schools. Considering the dual aim of this study, this thesis was structured as a two-part research study. Both parts took the form of a cross-sectional design, using an online questionnaire to collect qualitative and quantitative data. In total, a cohort of n=50 adolescents and n=49 coaches/trainers participated. Adolescent participants reported a high prevalence of sports supplement use (62%) with their main reasons for using them being recovery and performance. Adolescents were primarily influenced/advised by friends and coaches/trainers to start using sports supplements. Coaches/trainers primarily relied on other coaches/trainers and internet advertising/sites as a main source of information. Less than half of the participants from both groups reported having any formal education or training related to sports nutrition or sports supplements. Both groups thought that these products are being misused by adolescents, which may account for why a portion of the adolescent participants reported experiencing adverse side-effects from using sports supplements, and a few coach/trainer participants reported witnessing this in their practice. This may be a result of the professionalisation of school sport which places pressure on athletes and their coaches/trainers to perform and may in turn be the reason why some adolescents reported that they would use, and some coaches/trainers reported they would recommend the use of sports supplements even if they were aware of risk/dangers involved. Thus, there is a need for education/training among South African high school adolescents and their coaches/trainers with respect to the use of sports supplements, so that they can make informed decisions from reliable sources of information or advice in order to use these products safely and effectively.

ACKNOWLEDGEMENTS

I would like to acknowledge and thank the following people for their encouragement and support in conducting this study:

Firstly, to my supervisor, Dr. Jonathan Davy, thank you for providing me with guidance and support throughout my Master's degree and my entire university journey. I am truly grateful for the countless hours of support, constructive criticism, feedback, and patience that you gave me throughout this journey together. This long and challenging process has helped me develop important values and skills, but more importantly it has helped me become a more resilient and overall better person in all aspects of life. I would also like to thank my co-supervisor, Prof. Candice Christie, for providing me with the additional guidance along my Master's degree journey. I sincerely thank you for the time and effort you have put in, and for guiding me along this academic process. Secondly, I would like the thank the Department of Human Kinetics and Ergonomics of Rhodes University for assisting me in every way possible with attaining the knowledge, expertise and qualifications that have shaped the way I have developed over my years as a student. The environment in which we are afforded gave me the opportunity to develop as an individual and researcher. This department will always remain a special memory and excellent steppingstone in my academic career. Thirdly, I would like to acknowledge my family and friends who have encouraged and supported me through this lengthy process. I will always be grateful for the sacrifices you have made and giving me this opportunity. I am truly privileged to receive these opportunities and I hope someday I will be able to repay you with the same love, kindness, and selflessness you have shown me throughout my studies. Finally, I would like to thank those individuals who willingly offered up their time to participate and assist me during the time-consuming data collection period. Although the data collection period posed challenges due to the Covid-19 pandemic, I appreciate and am grateful for your assistance in this important research process. Without your valued input, none of this would have been possible.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

Introduction

Nutritional supplements, or dietary supplements, refer to the concentration or isolation of substances or nutrients found in foods, that typically take the form of tablets, capsules, liquids, or powders that are intended for oral ingestion (Gabriels *et al*., 2012; Kerksick *et al*., 2018; Mathews, 2018). According to several sources, nutritional supplements are commonly consumed to boost the nutritional content of regular food diet and for the purported health benefits, improvements to sports or exercise performance, and assistance in the prevention of illnesses (O'Dea, 2003; Lieberman *et al*., 2015; van der Walt and Coopoo, 2016). Nutritional supplements, as an overarching term, can be separated into various categories such as vitamins and minerals, herbal and homeopathic remedies, and sports/gym and weight management supplements (Mattila *et al*., 2009; Eichner and Tygart, 2016; Garthe and Maughan, 2018; Sekulic *et al*., 2019). The focus of this thesis is sports supplements.

Sports supplements, also referred to as ergogenic aids, are used because of the assertion that they can enhance physical or athletic performance or improve physical appearance (Dodge and Jaccard, 2006; Eichner and Tygart, 2016). Some examples of commonly used sports supplements include creatine, protein and amino acid products, stimulants, and in some cases pro-hormone products (Cermak *et al*., 2012; Pasiakos *et al*., 2015; Chilibeck *et al*., 2017; Kreider *et al*., 2017; Ricci *et al*., 2020). Many of these supplements, when used appropriately, do aid users in achieving the stated outcomes to a certain extent (Dodge and Jaccard, 2006; Maughan *et al*., 2018). In some cases, they may also be considered as an alternative to a regular food diet and assist in the improvement of health and performance of active athletes, without the adverse effects of using substances such as androgenic anabolic steroids (Jäger *et al*., 2008; Gradige, 2010; Barkoukis *et al*., 2015).

A position statement by the International Society of Sports Nutrition (ISSN) contended that many sports supplements are a safe and convenient way of ingesting nutrients (Jäger *et al.*, 2017). However, the physiological and performance-enhancing effects claimed by many of the sports supplement manufacturers when advertising and

marketing their products, are at times, not supported by scientific research (Gabriels *et al*., 2011; Gabriels *et al*., 2012; Barnes *et al*., 2016; Herriman *et al*., 2017). Many of these marketing strategies are misleading and make claims with little or no evidence to support claims (Gabriels *et al*., 2011; Barnes *et al*., 2016; Senekal *et al.*, 2019). Therefore, the efficacy and safety of a large proportion of sports supplements manufactured and sold to consumers are questionable, as the industry globally and within South Africa is poorly regulated, with products rarely undergoing rigorous testing or screening processes (Gabriels *et al*., 2012; Schoonees and Volmink, 2013; Cohen, 2014; Herriman *et al*., 2017; Mathews, 2017; Naidoo *et al*., 2018). Due to the poor regulation of this industry, there are multiple risks/dangers associated with supplement use (Skuland and Anestad, 2011; LaBotz and Griesemer, 2016; Maughan *et al.*, 2018; Hurst *et al*., 2019). Some of these risks/dangers include contamination, inadvertent doping, negligent use, and sports supplement-doping associations, all of which will be discussed in further detail.

Previous research indicates a relatively high and increasing prevalence of sports supplement use globally and in South Africa (Malik and Malik, 2010; Maughan *et al*., 2018; Hurst *et al*., 2019). Among adolescents specifically, this is also the case globally (Field *et al.*, 2005; Šterlinko *et al*., 2012; Kotnik *et al*., 2018; Tsarouhas *et al*., 2018), and within South Africa (Gradige, 2010; Van Aswegen, 2013; Welthagen, 2016; Mc Creanor *et al.*, 2017). Previous research with general adolescent populations in the United Kingdom; Germany; Finland; Ireland; Egypt; Slovenia; Greece; United States of America; and Jamaica all reported prevalence rates for supplement use between 45% and 98% (Nieper, 2005; Petróczi *et al*., 2008; Braun *et al*., 2009; Mattila *et al*., 2009; Walsh *et al*., 2011; Tawfik *et al*., 2016; Kotnik *et al*., 2018; Tsarouhas *et al*., 2018; Mas *et al*., 2019; Turfus *et al*., 2019). Although there is scarce literature, some South African studies have reported prevalence rates for supplement use from 30% up to 90% (Gradige, 2010; Van Aswegen, 2013; Nolte *et al*., 2014; Welthagen, 2016).

Multiple driving factors have been cited as to why adolescents use sports supplements. These include, but are not limited to the experimentation that is characteristic of adolescence; the increasing demands of, and competition associated with school sports, which has and continues to place pressure on adolescent athletes and their coaches/trainers; psychosocial pressure linked to body image and physical

appearance and the influence of other people who are closely involved in adolescents lives (i.e., coaches/trainers; friends; parents; professional athletes) (Muller *et al*., 2009; Gradige, 2010; Van Aswegen, 2013; Brown *et al*., 2017; Bruner *et al.*, 2017; Mc Creanor *et al.*, 2017; Allen and Waterman, 2019). In concert, these factors may contribute towards this group using sports supplements from a very young age (Allen and Waterman, 2019; WHO, 2019).

In addition to the above, the context of the secondary school education system needs to be considered. In South Africa, the secondary school system includes both private and public schools (SchoolGuide, 2019). The economic level of these schools often influences the activities learners can participate in (i.e., sports) as well as the resources available to the students to participate and develop in these activities (i.e., coaching) (Vosloo, 2014). Private schools generally have superior facilities and resources, which in turn attracts scholars from higher socio-economic backgrounds (Vosloo, 2014). Furthermore, these schools also often use their sporting prowess as an identity marketing tool (Vosloo, 2014). This may place pressure on adolescent athletes and their coaches/trainers to excel, which some argue may result in the use of various performance enhancing methods, such as sports supplements, to maximise the likelihood of succeeding (Gradige, 2010; Nwankwo and Ekechukwu, 2020).

In the context of the schooling environment, one of the main driving factors behind adolescents' decisions to use supplements is the role that coaches, and trainers play in advising or recommending their use in their capacity as influential figures in adolescents' lives (Kondric *et al*., 2013; Mandic *et al*., 2013). Evidence shows that coaches/trainers are frequently cited as primary sources of information and/or influence regarding supplements and sports nutrition around the world (Sundgot-Borgen *et al*., 2003; Nieper, 2005; Rodek *et al*., 2012; Sajber *et al*., 2013) and in South Africa (Gradige, 2010; Van Aswegen, 2013; Nolte, 2014; Welthagen, 2016; Kisten and Naidoo, 2019). This is of concern as their knowledge about sports nutrition and sports supplements may often be insufficient (Malik and Malik, 2010; El Khoury and Antoine-Jonville, 2012; Bastani *et al*., 2017; Kubayi *et al*., 2018). Further, coaches/trainers commonly rely on self-education or unreliable sources of information, which may, in turn, result in the dissemination of incorrect or poor-quality advice to adolescents (Rodek *et al*., 2012 Jacob *et al*., 2019; Sekulic *et al*., 2019). Although many

coaches/trainers believe they are advising with the best interests for the young athlete, it is important to note that some coaches' careers and/or income depend on the performance of their athletes (Stirling and Kerr, 2009). Thus, the pressures placed on the coach/trainer may lead to decisions that go against the well-being of the athlete (Stirling and Kerr, 2009; Nwankwo and Ekechukwu, 2020).

1.1 Overall aims and purpose of this study

In light of the above, there are two overarching aims of this study.

Firstly, while some studies have explored the prevalence and perceptions of sports supplement use in select schools or regions in South Africa, no study has attempted to look at this within the private schooling system across South Africa. Thus, there is a need for research that explores the prevalence and perceptions (including adolescent knowledge, attitudes, and beliefs) of sports supplements among South African private high school adolescents. This purpose of this research is necessary to facilitate a better understanding around the challenges of using supplements so that informed choices and decisions can be made by or for adolescents to use sports supplements safely, responsibly, and effectively.

Secondly, very few studies to date have explored the perceptions towards sports supplements among adolescent coaches/trainers in South African private high schools. Given the important role that coaches/trainers play in holistic adolescent development, understanding the attitudes, perceived knowledge, and application of perceived knowledge of coaches/trainers towards sports supplement use the purpose of this research is critical to ensure they provide the requisite advice and information to adolescents regarding these products. Further, this may help coaches/trainers make informed decisions about how to deal with adolescents who are exposed to harmful or illegal substances. Understanding this may also provide evidence as to whether there is a need for education or training programs for coaches/trainers regarding supplements.

1.2 Outline of the thesis

Considering the dual aim of this study, this thesis will be structured in two parts. Chapter 2 is a review of the general literature in which previous research about nutritional supplements, and specifically sports supplements is reviewed. Specifically,

insight into the scale of the global and South African supplement industry is provided. This is followed by a brief overview of some common types of sports supplements, and the general prevalence rates and driving factors behind their use generally. The chapter concludes with an overview of the general risks/dangers associated with the use of sports supplements. Chapters 3 and 4 represent two separate research studies and take the form of a typical manuscript structure (Introduction, Review of literature, Methods, Results, Discussion and Conclusions). Chapter 3 is the first research paper entitled *"The prevalence and perceptions (including the knowledge, attitudes, and beliefs) of sports supplement use among male and female adolescents attending South African private high schools".* Chapter 4 is the second research paper entitled *"South African private high school coaches/trainers' perceptions of adolescent sports supplement use and their (Knowledge; Attitudes; Application of knowledge) of sports supplements".* Thereafter, Chapter 5 briefly integrates the key findings from the two studies and highlights their overall importance and the implications for future research in this area.

CHAPTER 2

Review of Literature

2.1 The sports supplement industry

2.1.1 A global perspective of the sports supplement industry

A large proportion of the population use supplements and the popularity of these products is indicated by sales figures that show a growing multi-billion-dollar global industry (Timbo *et al*., 2006; Hämeen-Anttila *et al*., 2011; Garthe and Maughan, 2018). During the late 1990s, the United States annual sales of sports supplements accounted for approximately US$800 million (Green *et al*., 2001). Over the past two decades, the nutritional supplement market has experienced explosive growth, particularly within the sports supplement category where it is estimated to account for US$28.37 billion in 2016 and is expected to reach approximately US$45.27 billion by 2022 (Loraine, 2018; John, 2019). The global sports supplement industry had an estimated growth rate of 10.4% between 2011 and 2016 (Arenas-Jal *et al*., 2019). Increasing sales of sports supplements is a result of aggressive marketing and advertising strategies used by manufacturers of these products (Gabriels *et al*., 2011).

Sports supplements are commonly used and account for only one of multiple sectors in a multi-billion-dollar industry that primarily relies on athletes and health/fitness enthusiasts for sales (Garthe and Maughan, 2018). Related to this, multiple studies have indicated that the prevalence of sports supplements is generally higher among individuals from higher socio-economic strata (Gardiner *et al*., 2007; Gardiner *et al*., 2008). Households with higher income (i.e., between US$30-100 thousand annually) were more likely to purchase sports supplements, especially for the intentions of weight loss and muscle-building both of which are linked to body image or performance (Austin *et al*., 2017). The higher prevalence of use among individuals from higher socio-economic groups may be attributed to the price of these products, as sports supplements are generally relatively expensive (Maughan, 2005; SAIDS, 2018; Arenas-Jal *et al*., 2019).

Regulation of supplements globally

The World Anti-Doping Agency (WADA) is the global regulatory body for prohibited methods and substances in sport; however, it is not involved in the certification of any supplements, which means WADA does not certify or endorse manufacturers or their products (WADA, 2019). WADA hold that the risks from using sports supplements should always be weighed up against the potential benefits given the risk of individuals taking a contaminated product, which could result in inadvertent doping (WADA, 2019). The United States uses a regulatory body called the Food and Drug Administration (FDA), which regulates sports supplements through the Dietary Supplement Health Act (DSHEA) of 1994 (Loraine, 2018). The DSHEA mandates that all supplements must be safe for consumption and ensure that listed ingredients are in fact contained in the products (Loraine, 2018). European countries use a similar regulatory body called the Food Supplements Directive (FSD), which provides a list of substances that are permitted to be used by supplement manufacturers. The development of such regulatory authorities means there is more control over essential aspects of the safety, labelling, health-related claims, and quality of supplements (Soller *et al*., 2012).

2.1.2 The South African sports supplement industry

The South African sports supplement industry is growing at a rate of 7.7% annually, driven in part by the high demands for these products (Naidoo *et al*., 2018). The local market for sports supplements is not only limited to professional sports individuals or elite athletes (Naidoo *et al*., 2018), but extends to individuals who attend gyms regularly and individuals who are conscious about their health, wellness, and physical appearance (El Khoury and Antoine-Jonville, 2012; Naidoo *et al*., 2018). Many health professionals within South Africa are concerned about the increasing demands for supplements and the expansion of the supplement industry, as the current industry is insufficiently regulated, which means that supplements are not required to undergo safety and efficacy testing (Gabriels *et al*., 2012; Naidoo *et al*., 2018). However, the South African Institute for Drug-Free Sport (SAIDS), a public entity, promotes participation in sports free from the use of prohibited substances or methods intended to artificially enhance performance (SAIDS, 2019). According to SAIDS, the governance and regulation of the local supplement industry is inadequate, resulting in many products being marketed and sold with misleading claims and insufficient, inaccurate, or incorrect labelling (SAIDS, 2018). This has led to an increased

occurrence of harmful side effects and positive drug tests in youth and adults (SAIDS, 2018). Evidence of this will be addressed in sections to follow. SAIDS also states that the aggressive marketing of supplements in South African schools and among recreational and elite athletes has led to a large base of consumers (SAIDS, 2018). Most of these consumers use these products because they believe in the claims of the products without understanding the risks involved (SAIDS, 2018).

However, the South African sports supplement market has undergone some regulation changes since the establishment of the South African Health Products Regulatory Authority (SAHPRA) formed by the South African government in February 2018 (Naidoo *et al.*, 2018). SAHPRA is a public entity, whose role is to oversee the regulation of health products (SAHPRA, 2018). The regulatory authority of SAHPRA has the potential to enhance the monitoring, regulation, evaluation, investigation, inspection, and registration of medicines and related matters in the public interest (SAHPRA, 2018). With the establishment of SAHPRA, certain substances found within many sports supplements now fall under the bracket of “complementary medicines”, which are regulated by the General Regulations to the Medicines and Related Substances Act, 1965 (Act No. 101 of 1965) (SAHPRA, 2018). Substances that do not fall under the bracket of “complementary medicines” fall under the bracket of “foods” which is where some substances found in sports supplements are currently classified as. This means that these products will be regulated under the Department of Health R429 Draft Regulations Relating to the Labelling and Advertising of Foods (Naidoo *et al*., 2018). The establishment of this type of authority is necessary to reduce certain risks (e.g., contamination) associated with the manufacture, sale, and use of supplements (Naidoo *et al*., 2018).

2.2 Common categories of sports supplements

This section will focus on the common categories of sports supplements, which include a variety of products. Each of these sports supplement products has intended outcomes, and many of them have evidence-based benefits. However, there are also potential risks/dangers and side effects linked to the use of specific substances. Therefore, this section will discuss these issues concerning commonly used and marketed sports supplements.

2.2.1 Creatines

Common examples of creatine supplements: Creatine Monohydrate; Creatine Ethyl Ester; Creatine Ethyl Ester Malate; Creatine Gluconate; Creatine HCL; Tri Creatine Malate; Tri Creatine Orotate (Jäger *et al*., 2011).

Common methods of consumption: Pre-workout products; Capsules; Powders.

Creatine is an organic non-protein amino acid compound, which is synthesised endogenously by the liver, kidneys, and pancreas at a rate of approximately 1 gram per day (Kreider *et al*., 2017; Butts *et al*., 2018). It is predominantly stored within the skeletal muscle where it is found in its free and phosphorylated form (Phosphocreatine) (Clark, 2006; Gradige, 2010; Kreider *et al*., 2017; Butts *et al*., 2018). Following the oral administration of creatine, there is an increase of creatine taken into muscle cells (Clark, 1997). The increased intake of creatine leads to higher intracellular phosphocreatine levels (Clark, 1997). The significance of phosphocreatine is in its ability to rapidly resynthesise adenosine triphosphate (ATP) from adenosine diphosphate (ADP) (Clark, 2006; Jagim *et al*., 2018). Thus, creatine supplements are used to increase the synthesis of adenosine triphosphate (ATP), which is important for high intensity and short bursts of physical activity (Juhász *et al*., 2009; Kreider *et al*., 2017). Therefore, creatine supplements are used to boost the body's endogenous levels of creatine, which is an important source of fuel providing energy at a rapid rate at the beginning of intense exercise (Gradige, 2010; Claassen and Galant, 2011; Kreider *et al*., 2017).

Creatines are commonly consumed exogenously via dietary sources such as red meat, fish, or using supplements (Clark, 2006; Hall and Trojian, 2013). The International Society of Sports Nutrition (ISSN) states that creatine monohydrate, which is the purest form of creatine, is the most effective sports supplement available to athletes for high-intensity exercise and increases in lean muscle mass (Kerksick *et al*., 2018). From a performance perspective, creatine supplements have a positive influence on both muscle and brain function (Dolan *et al*., 2019). Multiple studies have indicated that creatine supplements increase single and repetitive bouts of high intensity activity, muscular endurance, and changes in training adaptations (i.e., Increased muscle mass and strength) (Clark, 2006; Chilibeck *et al*., 2017; Kreider *et al*., 2017; Ricci *et al*., 2020). In addition to these findings, creatine supplements enhance glycogen re-

synthesis and anaerobic/aerobic exercise capacity (Graef *et al*., 2009; Roberts *et al*., 2016; Ricci *et al*., 2020).

Creatine is one of the most popular and widely used sports supplement products on the market and is often manufactured in isolated forms or combined with other common sports supplements (Kreider *et al*., 2017; Butts *et al*., 2018; Catalani *et al*., 2021). There have been numerous claims made by media that creatine use is associated with side effects such as muscle cramps, heat intolerance, or kidney and liver damage, however, many of these claims have not been supported with evidence (Kreider *et al*., 2003; Shao and Hathcock, 2006). There is limited evidence to suggest that creatine supplements have negative effects on health from long-term usage when strict guidelines for use are adhered to (Kreider *et al*., 2017; Peeling *et al*., 2018). In a consensus statement by the International Olympic Committee (IOC), it was contended that there are no negative health effects found with long-term (up to 4 years) use of creatine supplements when appropriate protocols of use are followed (Maughan *et al*., 2018).

However, the International Society of Sports Nutrition (ISSN) argued that there is a lack of research on the safety of creatine supplement use among the adolescent population, thus further research is needed before creatine supplements can be recommended to adolescents (Buford *et al*., 2007; Van Aswegen, 2013). In a more recent position stand by the ISSN, several studies looking at the use of relatively high doses of creatine supplements among toddlers, infants, and adolescents provided no evidence to suggest the use of creatine at recommended doses poses a health risk to individuals under 18 years of age (Kreider *et al*., 2017). However, the International Society of Sports Nutrition (ISSN) recommended that creatine supplements only be considered for use by adolescent athletes who are involved in serious/competitive supervised training, consuming a well-balanced and performance enhancing diet, are knowledgeable about appropriate use of creatine, and do not exceed recommended dosages (Kreider *et al*., 2017).

2.2.2 Proteins and Amino Acids

Common examples of Protein supplements: Whey Protein; Casein Protein; Soy Protein; Plant or Pea Protein; Beta-hydroxy-beta-methylbutyrate (HMB) (Metabolite of Leucine).

Essential amino acids: Histidine; Isoleucine; Leucine; Lysine; Methionine; Phenylalanine; Threonine; Tryptophan; Valine; L-Carnitine (Mixture of Lysine and Methionine).

Conditionally essential amino acids: Arginine; Glycine; Glutamine.

Non-essential amino acids: Alanine; Asparagine; Citrulline; Glutamate; Proline; Serine; Taurine; Tyrosine.

Common methods of consumption: pre-workout products; post-workout products; energy drinks; tablets; capsules; powders; gels (Ibrahim, 2018).

Proteins are made up of hundreds of smaller units called amino acids which are bound together in a chain-like formation via peptide bonds (National Research Council, 1989). The human body uses twenty-one different amino acids for protein synthesis which is needed for human growth and functioning, however, only nine amino acids are considered essential (Semba *et al*., 2016; Hoffer, 2017). Essential amino acids cannot be produced by the body; thus, they are obtained through the diet (Hoffer, 2017). There are also amino acids that are considered as “conditionally” essential amino acids because they only become essential when the body is under certain circumstances such as high stress or illness, whereas non-essential amino acids are readily synthesized in the body from widely available intracellular carbohydrate molecules (Hoffer, 2017). Three essential amino acids including Isoleucine, Leucine, and Valine are known as branch-chain amino acids (BCAA’s), which are the most frequent amino acids found in sports supplements. This is due to their purported benefits of anabolic properties (Holeček, 2018).

Many proteins and amino acid products have been marketed as sports supplements to physically active individuals due to the beliefs and purported benefits of possessing ergogenic potential (Williams, 2005; Holeček, 2018). Protein sports supplements are generally used to increase muscle mass; increase muscle recovery; prevent protein catabolism during prolonged exercise; promote muscle glycogen re-synthesis following exercise; and prevent sports anaemia by promoting an increased synthesis of haemoglobin, myoglobin, oxidative enzymes, and mitochondria during aerobic training (Williams, 2005; Gradige, 2010; Claassen and Galant, 2011; Van Aswegen, 2013). Protein supplements used after single bouts of resistance training can also

stimulate net muscle protein accretion (breakdown and synthesis in the body) for post-exercise recovery (Cermak *et al*., 2012). Furthermore, as the duration and frequency of resistance training increases for untrained or trained individuals, ingestion of protein supplements promotes greater gains in lean mass and muscle strength (Pasiakos *et al*., 2015). Therefore, the current intensive training regimes placed on young athletes creates a demand for higher protein intake, greater metabolic adaptation, better remodelling, and faster tissue repair (Jovanov *et al*., 2019). This is important as a balance between stress (training and competition load, other life demands) and recovery is essential for athletes to achieve continuous high-level performance (Kellmann *et al.*, 2018). Thus, many individuals may decide to use these products due to the potential ergogenic benefits associated with them.

Proteins and amino acids are considered the most popular sports supplements on the market (Williams, 2005; Goston and Correia, 2010; Whitehouse and Lawlis, 2017; Catalani *et al*., 2021). In 2016 whey protein sports supplements represented a global market value of approximately US$7.7 billion and this is estimated to grow to approximately US$9 billion by the year 2021 (Affertsholt and Fenger. 2013; Keogh *et al*., 2019). According to the International Society of Sports Nutrition (ISSN), the use of powdered protein supplements is a safe and convenient way to meet athlete's protein intake requirements with high-quality protein (Campbell *et al*., 2007; Jäger *et al*., 2017). Protein and amino acid sports supplements are generally safe to use, but it has been highlighted that there are possible risks associated with long-term use of high intakes of protein supplements such as dehydration, gout, urinary calcium loss, renal damage, diarrhoea, bloating and possibly colon cancer (Duellman *et al*., 2009). Additionally, protein and amino acid supplements that contain only single amino acids should be avoided as they may cause imbalances in amino acid absorption, which may affect eating patterns (Duellman *et al*., 2009). According to SAIDS, adolescents are at risk of dehydration when too much protein is consumed, and this may place more stress on the liver and kidneys from long-term use (Claassen and Galant, 2011). Moreover, many adults and adolescents self-prescribe protein supplements, thus, putting themselves at risk for the consumption of excess protein, which is inefficiently used by the human body and can have harmful effects on bones, the kidneys, and the liver (Delimaris, 2013).

2.2.3 Pro-hormones

Common examples of Pro-hormone supplements: Androstenediol; Androstenedione; Dehydroepiandrosterone (DHEA); Tribulus Terrestris.

Common methods of consumption: Capsules; Tablets.

Pro-hormone sports supplements often contain substances such as androstenediol, androstenedione, dehydroepiandrosterone (DHEA), and herbal forms such as saw palmetto and tribulus terrestris (Claassen and Galant, 2011). These supplements are often claimed to help boost the production of testosterone, which is an essential hormone for muscle growth, strength, body fat reduction, and ultimately performance enhancement (Brown *et al*., 2006; Claassen and Galant, 2011). Thus, they are often marketed as legal alternatives to androgenic anabolic steroids that can be used to increase hormones, however, many of these supplements are on the World Anti-Doping Agency banned list (King *et al*., 2012).

There are multiple risks associated with pro-hormone supplement use. Pro-hormone supplement use may increase oestrogen levels in the body and increase low-density cholesterol, which increases the risk of cardiovascular disease (King *et al*., 2012). Moreover, long-term use may decrease inherent testicular and adrenal testosterone production (King *et al*., 2012). According to SAIDS, there are multiple risks associated with the use of pro-hormone supplements, in particular adolescents and young adults who are at risk for premature cessation of bone growth, early onset of puberty, along with many other risk factors (Claassen and Galant, 2011).

2.2.4 Stimulants and Amphetamines

Common examples of Stimulant and Amphetamine supplements: Adrenaline; High doses of Caffeine; Cathine; Ephedrine; Pseudoephedrine; Phenylephrine; Methamphetamine (Momaya *et al*., 2015).

Common methods of consumption: Pre-workout products; Energy drinks; Capsules; Tablets; Gels.

Stimulant and amphetamine sports supplements are often used due to the claims and purported benefits that they can increase or improve blood circulation, concentration, alertness, metabolic rate, and caloric expenditure which results in fat loss and therefore

improves overall performance (Baume *et al*., 2006). These substances are commonly found in pre-workout supplements, energy drinks as well as fat and weight loss supplements such as “fat burners” (Claassen and Galant, 2011). It has also been reported that the use of these products has been associated with increased strength, speed, muscular power, and acceleration (Momaya *et al*., 2015).

When stimulants and amphetamines are ingested, they exhibit an indirect sympathomimetic action (mimic the effects of agonists in the sympathetic nervous system), a response that is caused by the release of norepinephrine, which is stored in the sympathetic nerve endings (Momaya *et al*., 2015). Norepinephrine is a neurotransmitter that also serves as a hormone, which influences different parts of the body and stimulates the central nervous system (Nall, 2018). This may explain why the ingestion of these substances has been associated with the effects described above.

Stimulants and amphetamines in sports supplements are often found in high doses, according to SAIDS, with risks associated with high intakes of stimulants including hypertension, arrhythmias, anxiety, tremors, insomnia, seizures, paranoid psychosis, cerebral vascular accident (stroke), heart attack, kidney damage and death (Claassen and Galant, 2011). Caffeine is a common stimulant found in high doses in sports supplements whereby many individuals believe the greater the dose, the greater the effect. However, overconsumption of a substance like caffeine may result in one or multiple negative effects described above, which outweigh the purported benefits of use (Peeling *et al*., 2018; Hurst *et al*., 2019).

2.3 The prevalence of sports supplement use by the general population

2.3.1 The prevalence of use by general populations globally

The global use of sports supplements by athletes and non-athletes of all ages and abilities is relatively high (Malik and Malik, 2010; Maughan *et al*., 2018; Hurst *et al*., 2019). According to a systematic review and meta-analysis, it is estimated that between 40 and 70% of all people use/have used some form of supplement with sports supplements being one of the most common categories (Knapik *et al*., 2016).

Table 2.1 captures examples of some global studies on a proportion of general populations that reported on the prevalence of all nutritional supplements. Importantly, this table captures the percentage of specific sports supplements used by individuals

who use or have used some sort of supplement. These studies were selected because they reported prevalence rates and provided a contrast between different countries around the globe. These studies also used similar methodologies with a survey/questionnaire data collection instrument, a similar method was used to collect data in this specific study.

Evidence from the studies in Table 2.1 indicates that reported sports supplement use is generally high and is one of the most common categories of nutritional supplements used by individuals in general global populations. This may account for the growth of the industry. However, reported use may not necessarily be the same as actual use, thus more evidence is needed to understand the prevalence of use better.

In the United Kingdom one study reported a lower prevalence rate of supplement use among high level athlete participants (Petróczi and Naughton, 2008), compared to participants in the general population (Evans *et al*., 2017). This may be significant as athletes are generally believed to have a higher prevalence of use due to the pressure for constant performance enhancement (Petróczi and Naughton, 2008; Mettler *et al*., 2020). This may be a result of the extensive drug testing programs, which places elite or professional athletes in a position where the use of these products is too much of a risk (Petróczi and Naughton, 2008; Mettler *et al*., 2020).

The increasing popularity of these products not only among elite athletes but also among non-elite recreational exercisers or gym goers, indicates that the prevalence of sports supplement use may be shifting (Petróczi and Naughton, 2008; Evans *et al*., 2017; Catalani *et al*., 2021). A study in Spain found that the use of substances to improve performance and fitness has spread to people who attend gyms regularly (Oliver *et al*., 2008). Similarly, a study in India found that performance-enhancing practices are not limited to athletes and that they have now spread to health clubs, high schools, and other populations (Malik and Malik, 2010). Moreover, a study in Saudi Arabia showed that the popularity of supplements along with their easy access often results in the consumption among regular gym users, who commonly engage in sport for pleasure and not for monetary gain or professional benefits (Jawadi *et al*., 2017).

Table 2. 1: Summary of global studies indicating the prevalence of supplement use among a proportion of the general population.

Studies	Sample size (n)	Country	Prevalence of supplement use (%)	Prevalence of sports supplement use (%)	Methodology
Oliver *et al*. (2008)	415	Spain	56%	Proteins (28%) Stimulants (18.3%) Creatine (17.1%)	Questionnaire.
Goston & Correia (2010)	1102	Brazil	36.8%	Proteins (38%) Creatine (8%)	Questionnaire.
Malik & Malik (2010)	273	India	63.8%	Proteins/Amino Acids (20.4%) Creatine (9.9%) Stimulants (8.1%)	Questionnaire.
El Khoury & Antoine-Jonville (2012)	512	Lebanon	36.3%	Proteins (39.8%) Amino Acids (34.9%) Creatine (19.4%)	Questionnaire.
Saeedi *et al*. (2013)	1625	Iran	66.7%	Creatine (22.4%) Amino Acids (9.6%)	Questionnaire.
da Silva *et al*. (2014)	180	Brazil	58.3%	Proteins (74.3%) Creatine (25.7%) Pro-hormones (4.8%)	Interview questionnaire.
Evans *et al*. (2017)	114	United Kingdom	72%	Proteins/Amino Acids (74%) Creatine (46%)	Questionnaire.
Jawadi *et al*. (2017)	299	Saudi Arabia	37.8%	Proteins (22.1%) Amino Acids (16.8%) Creatine (11.5%)	Interview questionnaire.
Keat *et al*. (2017)	77	Malaysia	59.7%	Proteins/Amino Acids (14%) Other sports supplements (11%)	Questionnaire.
Dreher *et al*. (2018)	492	Germany	56.9%	Proteins (48%) Creatine (28.7%) Stimulants (Caffeine) (25.6%) BCAA's (21.1%)	Questionnaire.
Gusmaya *et al*. (2019)	258	Indonesia	34.1% (Ergogenic supplements)	Proteins (62.1%) BCAA's (31%) Creatine (13.8%)	Questionnaire.
Mettler *et al*. (2020)	417	Switzerland	82%	Proteins (43%) Amino Acids (17%) Creatine (13%)	Questionnaire.
Ruano & Teixeira (2020)	459	Portugal	43.8	Proteins (80.1%) BCAA's (36.8%) Creatine (28.4%)	Questionnaire.

2.3.2 The prevalence of use by the South African general population

It was argued that the supplement availability and use by consumers across the populations that can afford these products are ever increasing (Claassen and Galant, 2011; Gabriels *et al*., 2011; SAIDS, 2018). However, very few studies have been published on the prevalence of supplement use by the general South African population (Senekal *et al*., 2019).

Table 2.2 summarizes the findings of studies that have been conducted in South Africa, which show the prevalence of supplement use among a proportion of general populations and athlete populations in various provinces. These studies did not report on the use of supplements by adolescents. Importantly this table indicates the percentage of specific sports supplements used by participants in these studies, which were generally high. These studies were selected as there have been very few studies conducted in South Africa that have observed the prevalence of all nutritional supplement use and in particular, the use of sports supplements.

Table 2. 2: Examples of studies that reported on the prevalence of sports supplement use by general South African populations and athlete populations.

Studies	Sample size (n)	Prevalence of sports supplement use (%)	Age Range	Province	Methodology
Potgieter *et al*. (2011)	26 (Triathletes)	All types of sports supplements (90%)	18-70	Western Cape	Self-administered questionnaire and food record.
Gabriels & Lambert (2013)	258	Nutritional supplements (78%) (Prevalence of sports supplements not mentioned)	19-40	Western Cape	Self-administered questionnaire.
Mc Creanor *et al.* (2017)	364	Proteins (84%) Creatine (67%) Stimulants (Caffeine) (59%)	18-49	Gauteng	Self-administered questionnaire.
Senekal *et al*. (2019)	301 (Male participants)	Creatine (19.4%) Proteins (12.9%) Amino acids (8.7%)	21-30 & ≥45	Western Cape	Self-completion questionnaire.
Svova (2020)	351	Dietary supplements (53.4%)	18-45	Gauteng	Self-administered questionnaire.

All the studies selected in Table 2.2 used a questionnaire as their data collection tool, a similar tool was used in this specific study for data collection. Gabriels and Lambert

(2013) reported a high percentage for the prevalence of nutritional supplement use; however, the percentage of specific sports supplements used by those participants was not mentioned. Similarly, Mc Creanor *et al.* (2017) found that the percentage of specific sports supplements used was high although the total prevalence for nutritional supplement use was not reported. Potgieter *et al*. (2011) found a high percentage of participants using sports supplements, however, they did not indicate percentages of specific sports supplements used, while also only sampling a small number of triathletes. Research on supplement use is important as the reported prevalence of use rates found in a few South African studies are relatively high.

2.4 Main drivers for sports supplement use by the general population and athletes

The prevalence of sports supplement use by the general global population has increased rapidly over the past two decades for various reasons (Knapik *et al*., 2016; Maughan *et al*., 2018; Naidoo *et al*., 2018; Hurst *et al*., 2019). Firstly, the commercialisation of sport has increased rapidly, which places pressure on athletes to perform (Camporesi, 2017). Moreover, it has resulted in increased advertising and marketing strategies that make use of endorsement contracts, which help influence consumers to use certain products (Lear *et al*., 2009; Arazi *et al*., 2014; Ethan *et al*., 2016; Maughan *et al*., 2018). Secondly, there are increasing social pressures being placed on individuals to look a certain way physically, which is driven by the media portraying the idea of the perfect/ideal body size/figure (Arazi *et al*., 2014; Kotnik *et al*., 2017; Yang *et al*., 2017). Thirdly, the ease of access and availability of sports supplements due to globalisation and technology allows consumers to purchase products from across the globe via online sources and more generally in pharmacies and local retail stores (Van Thuyne *et al*., 2006; Herriman *et al*., 2017; Dwyer *et al*., 2018). These are expanded on in the next section.

2.4.1 Commercialisation and pressures of sports

Sports are becoming more competitive and demanding evidenced by the ever-improving results and record performances by athletes (Van Thuyne *et al*., 2006; Gradige, 2010; Van Aswegen, 2013; Bastani *et al*., 2017; Marck *et al*., 2017). Moreover, the rapid commercialisation of the sports industry has led to large increases in revenues, particularly from broadcasting rights (Walters *et al*., 2018). Thus, the

increasing financial investments within the sporting industry incentivises athletes to consistently maintain peak performance physically and mentally (Camporesi, 2017).

There has been increasing attention given to sports materialism and economic events by athletes, coaches, and sports authorities over the past few decades (Arazi *et al*., 2014; Vosloo, 2014; Walters *et al.*, 2018). As such, many successful athletes, sports professionals, and celebrities are endorsed by companies to use and promote their products, which serves as a form of advertising commonly used by sports supplement companies (Lear *et al*., 2009; Alonso and Fernández-García, 2020). These athletes, sports professionals, and celebrities generally make large financial gains from endorsing products, which are rarely dependent on whether the product influenced them to achieve their success (Maughan *et al*., 2018; Alonso and Fernández-García, 2020). Thus, many sports supplement companies use endorsement contracts as a marketing strategy to drive sales by intentionally influencing individuals to believe the use of a specific product or brand will help them enhance their performance and success like that of the endorsed individual (Ethan *et al*., 2016; Maughan *et al*., 2018; Alonso and Fernández-García, 2020).

This has resulted in increased use of sports supplements due to the beliefs, perceptions and in some cases, evidence, that indicates that these products can help maintain and/or improve performance and/or speed up recovery (Gradige, 2010; Van Aswegen, 2013; Camporesi, 2017). Evidence of these perceptions were reported in a study in the United Kingdom where 67% of participants who were non-elite recreational exercisers indicated “Providing energy”, 62% indicated “Improving performance” and 57% indicated “Increasing strength” as the main reasons for using supplements. This aligns with other research in Lebanon, which reported that 34.4% of participants who were regular exercisers indicated “Enhanced strength” as the main reason for using supplements (El Khoury and Antoine-Jonville, 2012). Moreover, a study among general fitness studio visitors in Germany reported “Improvement of physical and sporting performance” as the most frequent reason for using supplements (Dreher *et al*., 2018). A South African study reported that 83% of male and female adult participants believed sports supplement use in South African gyms is increasing, and 74% indicated that the increased use is due to peer pressure by training friends who

perceive the use of these products as performance-enhancing and enhancing the speed of recovery (Mc Creanor *et al*., 2017).

2.4.2 Social pressures and physical appearance

The increasing social pressures placed on individuals to look a certain way is another reason for the increased prevalence of use (Martin and Govender, 2009; Gradige, 2010; Yager and O'Dea, 2014; Kotnik *et al*., 2017). This is evident with extensive media marketing and advertising of what is perceived to be an ideal body shape or body image (Arazi *et al*., 2014; Yang *et al*., 2017; Rousseau and Eggermont, 2018). The idea of a perfect physical appearance is highly valued today, especially among younger individuals (Yang *et al*., 2017). This is often a result of the media playing a major role in driving physical beauty standards on what is perceived as the perfect physical image (Silva *et al*., 2011). These idealised media images or physical beauty standards often place strong emphasis on slenderness or thinness for females and muscularity for males (Rousseau and Eggermont, 2018). Thus, it has been suggested that currently, society aspires to perfection not only mentally but also physically (Mooney *et al*., 2017).

Perfectionism is described as a personality trait, which is characterised by striving for flawlessness and setting exceedingly high standards of performance, which is accompanied by concerns over mistakes and fears of negative evaluations (Frost *et al*., 1990; Hewitt and Flett, 1991). The aspiration of physical perfection has been considered a global phenomenon and is evident in several studies which have found a high prevalence of body dissatisfaction among individuals (Yager and O'Dea, 2014; Yang *et al*., 2017). An example of body dissatisfaction was captured in a study conducted among a general adult population in Brazil, where, from a sample of 1720 male and female participants between the ages of 20-59, 14.2% of males and 6.1% of females were dissatisfied with their body by being lighter in body mass than what they perceived as the ideal (Silva *et al*., 2011). Of greater concern this study found that 66.6% of females and 46.3% of males were dissatisfied with their bodies as they perceived being heavier in mass than what they believed was the ideal (Silva *et al*., 2011).

Linked to this is that physical appearance enhancement is, alongside performance improvement, one of the main drivers for the use of sports supplements (Yager and

O'Dea, 2014; Kotnik *et al*., 2017). This was evident in a study in Spain, which reported 57% of participants who were gym-goers indicated "Improvement of physical appearance" as the main objective or reason for using supplements (Oliver *et al*., 2008). Similarly, a study in Saudi Arabia reported 47.7% of participants who were gym users involved in non-professional sports, indicated "Appearance" as a major reason for using supplements (Jawadi *et al*., 2017). This contrasts with a study in Lebanon, which reported 47.3% of participants indicated "Promotion of muscle gain" as their primary reason for supplement use (El Khoury and Antoine-Jonville, 2012).

2.4.3 Access and availability

The sale of sports supplements is no longer limited to local consumers, as many sports supplements, and their ingredients are sourced and manufactured outside of the country where they are sold (Dwyer *et al*., 2018). Due to globalisation and the increased use of technology, sports supplement products can be purchased from around the globe with ease, via online internet stores where products are imported and exported freely via global shipping networks (Van Thuyne *et al.*, 2006; Evans *et al*., 2017; Catalani *et al.*, 2021). Combined with the poor regulation of the supplement industry, these products are easily accessed and available to individuals over the counter from many local health stores or supermarkets (Herriman *et al*., 2017; Dwyer *et al*., 2018). The ease of access and availability of supplements and their information thereof, have increased rapidly due to the use of globalisation and technology (Van Thuyne *et al.*, 2006; Evans *et al*., 2017; Catalani *et al.*, 2021).

This was evident in studies conducted in the United Kingdom, Lebanon, and Saudi Arabia, all these studies reported the internet and online sources as the most common place for information and purchasing of supplements (El Khoury and Antoine-Jonville, 2012; Evans *et al*., 2017; Jawadi *et al*., 2017). Similarly, a study in Germany reported that participants predominantly purchased supplements from pharmacies and supermarkets (Braun et al., 2009), while a study in Egypt reported that 40.2% of participants purchased sports supplements from sports centres, and 38.3% purchased them from retail stores (Tawfik *et al*., 2016). In contrast, a study in Greece reported that 63% of participants purchased their supplements from the internet (Tsarouhas *et al*., 2018), while a South African study reported that sports supplements can be easily ordered via internet sites (Van der Bijl, 2014).

2.5 General risks/dangers of sports supplement use

The use of supplements is not part of any governmental nutritional or health recommendation and is therefore a self-administering practice (Skuland and Anestad, 2011). In a recent consensus statement by the International Olympic Committee (IOC), it was argued that the use of sports supplements outside the optimal protocol may have serious repercussions to the user (Maughan *et al.*, 2018). Thus, multiple risks/dangers have generally been associated with the use of sports supplements. Apart from the risks associated with specific sports supplement products mentioned earlier, some of the common general risks/dangers of use include contamination, inadvertent doping, negligent use, and sports supplement-doping associations.

2.5.1 Contamination

Contamination occurs when an undesired, harmful, or illegal substance is found within a product's contents by mistake or without mention on the labelling (Maughan, 2005; Martínez-Sanz *et al*., 2017; Mathews, 2017). Contamination often occurs because of poor-quality control when manufacturing and storing supplements or through intentional and deliberate action by manufacturers (Maughan, 2013; Hurst *et al*., 2019). Sports supplements, particularly those that have not undergone rigorous testing, are considered high-risk for contamination with illegal substances due to the demands for a speedy and noticeable result on the consumer's behalf which, if effective, will often promote continued use of the supplement (Hurst *et al*., 2019). Therefore, to drive continued use, some manufacturers add addictive or fast working pharmaceutical substances to their products (Van Thuyne *et al.*, 2006; Mathews, 2017). Sports supplements containing these kinds of unknown or untested substances put consumers at risk, as the effects of added pharmaceutical drugs may be unknown, particularly when there is an interaction between different drugs (Mathews, 2017).

Examples of contamination include cases where multiple athletes failed urine drug tests from using a widely available pre-workout sports supplement from USA and European supplement stores, which were contaminated with a new methamphetamine analogue substance (Cohen *et al*., 2014). Methamphetamine is a powerful and highly addictive stimulant, which affects the central nervous system (Anglin *et al*., 2000). In the USA it was reported that over 500 supplements contained pharmaceuticals that included new stimulants, anabolic steroids, unapproved antidepressants, banned

weight-loss products, and other untested substances (Cohen, 2014). Poor regulation and surveillance of supplement content before they reach shelves of shopping stores is a common reason for contamination (Cohen, 2014). Thus, even in countries (i.e., USA) where supplement regulation systems are in place, there is still a possibility that products being marketed and sold to consumers may be contaminated (Cohen *et al*., 2014). It is also possible that regulation systems may not be efficient in reducing contamination, or possibly that online stores may give consumers access to supplements that have not gone through relevant regulatory systems (Cohen, 2014; Cohen *et al*., 2014).

An international study on sports supplements found 15% of 634 supplements purchased from 13 different countries were contaminated with androgenic anabolic steroids that were not mentioned on the product contents label (Geyer *et al*., 2008). It is clear that regulatory processes need to be improved and interventions developed during the production and sale of sports supplements to reduce these risks/dangers. The World Anti-Doping Agency states that athletes must appreciate the negative consequences of an anti-doping rule violation from taking a contaminated supplement (WADA, 2019). Thus, the benefits and risks of using a sports supplement should always be weighed up before consumption.

Research on contamination of sports supplements in South Africa

Contamination of sports supplements has also been shown in South Africa. According to the findings of one study, 40% of supplements bought over the counter from different South African manufacturers contained substances that are on the World Anti-Doping Agency prohibited list, and 6.7% were contaminated with unknown substances and incorrectly labelled (Van der Merwe and Grobbelaar, 2004). More recently it was reported that 47% of 138 different sports supplements produced and purchased in South Africa, as well as sports supplements imported and purchased in South Africa, tested positive for the presence of a dangerous substance called melamine (Gabriels *et al*., 2015). Melamine is a synthetic compound often used for manufacturing plastics and cleaning supplies (Tyan *et al*., 2009). The effects of ingesting melamine are severe particularly among infants and children where it can cause urinary tract stones and sand-like calculi (Gabriels *et al*., 2015). According to SAIDS, many supplements, including those thought to be harmless can be contaminated with harmful or banned

substances not mentioned on the label (SAIDS, 2018). Despite these findings, very few studies have observed contamination of sports supplements produced and purchased in South Africa.

2.5.2 Sports supplement use and doping

There is growing evidence suggesting that an individual's use of sports supplements over time is linked to an increased likelihood of doping (Backhouse *et al*., 2013; Hurst *et al*., 2017). Doping is defined by WADA as an athlete or athlete-support staff (e.g., coach, physiotherapist, doctor) committing an anti-doping rule violation (Hurst *et al*., 2019). There are 11 violations mentioned in article 2 of the 2021 WADA code, these include: 2.1 Presence of a prohibited substance or it's metabolites, or markers in an athlete's sample; 2.2 Use or attempted use by an athlete of a prohibited substance or prohibited method; 2.3 Evading, refusing, or failing to submit to sample collection by an athlete; 2.4 Whereabouts failures by an athlete; 2.5 Tampering or attempted tampering with any part of doping control by an athlete or other person; 2.6 Possession of a prohibited substance or a prohibited method by an athlete or athlete support person; 2.7 Trafficking or attempted trafficking in any prohibited substance or prohibited method by an athlete or other person; 2.8 Administration or attempted administration by an athlete or other person to any athlete in-competition of any prohibited substance or prohibited method, or administration or attempted administration to any athlete out-of-competition of any prohibited substance or any prohibited method that is prohibited out-of-competition; 2.9 Complicity or attempted complicity by an athlete or other person; 2.10 Prohibited association by an athlete or other person; and 2.11 Acts by an athlete or other person to discourage or retaliate against reporting to authorities (WADC, 2021). The WADA code adopted these violations to ensure the protection of athlete's fundamental rights to participate in doping-free sport and promote health, fairness, and equality among athletes worldwide (WADC, 2015; WADC, 2021). The code also ensures harmonized, coordinated, and effective anti-doping programs concerning detection, deterrence, and prevention of doping (WADC, 2015; WADC, 2021). There are theories and models which explain the association between sports supplement use and doping among adolescents and the general population (Backhouse *et al*., 2013; Petróczi, 2013; Hurst *et al*., 2019). Although these theories and models are relevant to the use of sports supplements, the

use of illegal or banned substances is beyond the scope of this study, therefore, further research on this topic is needed for a better understanding of these specific risks.

2.5.3 Inadvertent doping

According to the World Anti-Doping Agency (WADA) code, there is strict liability placed on all athletes, this means athletes are liable to be sanctioned if they are found guilty of using a substance on the WADA prohibited list (WADC, 2015). The strict liability means that the athlete will be held liable even if there was no intention of using a prohibited substance or if the use of a prohibited substance was due to negligence on behalf of the athlete (WADC, 2015).

Many athletes are at high risk of inadvertent doping due to the prohibited substances frequently found within the contents of sports supplements because of contamination or intentional action by manufacturers (Mathews, 2017; Hurst *et al*., 2019). The poorly regulated nature of the supplement industry has resulted in many supplement companies regularly creating products with different combinations and varying concentrations of substances (Molinero and Márquez, 2009). It is estimated that 6.4% to 8.8% of doping infringements in professional and elite athletes are due to the use of sports supplements, which contain prohibited substances (Outram and Stewart, 2015). Inadvertent doping is generally caused by misinformed and careless use of sports supplements, which along with intentional doping, may explain why WADA places strict liability on athletes (WADC, 2015; Mathews, 2017).

Although there is limited evidence showing the risk of inadvertent doping in South Africa, inadvertent doping through the use of sports supplements is common among athletes (Van der Merwe and Grobbelaar, 2004). Examples of inadvertent doping in South Africa have been mentioned in *SA Rugby Magazine,* where four springbok rugby players tested positive for using substances listed on the WADA prohibited list, which were allegedly contained in the sports supplements they had used (Goliath, 2019). In the year 2000, Cobus Visagie a former provincial and international rugby player tested positive for the presence of Nandrolone which is a type of anabolic steroid used to increase muscle mass (Goliath, 2019). It was alleged that this substance came from a sports supplement given to him by the South African Rugby Football Union (Goliath, 2019). In 2010, two other former provincial and international South African rugby players tested positive for a banned substance, Johann Goosen and Chilliboy

Ralepelle tested positive for a prohibited stimulant called Methylhexaneamine (Goliath, 2019). In both cases, the banned stimulant was traced back to sports supplements the athletes had used, which Goosen allegedly bought over the counter from a Bloemfontein store. In 2018, Ashley Johnson, another former international and provincial South African rugby player tested positive for a banned substance called Hydrochlorothiazide, which is a diuretic medication (Goliath, 2019). Allegedly the substance was traced back to a fat burner (stimulant) sports supplement produced and purchased in South Africa, which did not mention the prohibited substance on the supplement contents label (Goliath, 2019).

Importantly, inadvertent doping can be reduced with the help of coaches/trainers engaging with athletes on the topic of supplement use (Mathews, 2017). This process can be facilitated with the use of online resources such as the Australian Institute of Sport (AIS), which uses an up-to-date database ranking sports supplements in categories of low risk or permitted, unknown risk or not advocated for and restricted/banned, with all categories based on scientific evidence (Mathews, 2017). The Informed-Choice Organization also plays an important role with regulation and testing of sports supplements, intending to reduce inadvertent doping cases (Laboratory of the Government Chemist Limited, 2019). Informed-Choice uses a monitoring program for quality assurance of sports supplements, suppliers to the sports supplement industry, and sports supplement manufacturing facilities (Laboratory of the Government Chemist Limited, 2019). This program certifies that sports supplements have been tested for banned substances; this reduces the risk of testing positive for substances listed on the World Anti-Doping Agency prohibited list (Laboratory of the Government Chemist Limited, 2019). Thus, inadvertent doping is a common risk when using sports supplements, however, it is also a preventable risk if safe practices and procedures are followed before using sports supplements.

Currently, there is no regulatory body in South Africa that provides a database for consumers to check the safety of sports supplements like that of the Australian Institute of Sport (AIS). According to the SAIDS, there is an increase in the number of sports supplements resulting in positive drug tests for both youth and adults in South Africa (Claassen and Galant, 2011; SAIDS, 2018). SAIDS has observed this through the comprehensive drug testing programmes that they have implemented from school

level to elite professional sports (Claassen and Galant, 2011). Thus, all athletes and sports personnel need to be educated and made aware of the risk of inadvertent doping before deciding to use sports supplements (SAIDS, 2018).

2.5.4 Negligent use

The risks/dangers of using sports supplements go beyond that of contamination and inadvertent doping; there is also the risk of adverse effects when using sports supplements irresponsibly (Mathews, 2017; Maughan *et al*., 2018). Manufacturers are not always at fault for causing adverse effects to consumers using sports supplements. It may also be a result of negligence on the consumer's behalf by either mixing different products without regard to dosage or without consideration of the possible interactions between various ingredients contained in different products (Maughan *et al*., 2018). Negligent use of sports supplements may also encourage the use of stronger and faster-working substances such as anabolic steroids (Hurst *et al*., 2017). Recently, it was argued that taking high doses or combinations of sports supplements or consuming them for a long period can be harmful to health, as these substances can cause damage to major organs (i.e., liver, kidneys, and heart) (Mazzeo *et al*., 2020). Athletes and non-athletes commonly use supplements in combination; this was evident in a study in the United Kingdom, which reported 76% of participants who were regular exercisers used 2-4 different supplements on average (Evans *et al*. 2017). Similarly, a study in India found each participant who were male gym-goers, consumed an average of 2.6 supplements (Malik and Malik, 2010).

2.6 Summary

Over the past two decades, the nutritional supplement market has experienced explosive growth globally, particularly within the sports supplement category (Loraine, 2018; John, 2019). The global use of sports supplements by athletes and non-athletes of all ages and abilities is relatively high (Maughan *et al*., 2018; Hurst *et al*., 2019). The global prevalence of use has increased rapidly over the past two decades for various reasons. The South African sports supplement industry is also growing annually, due to the high demands of these products (Naidoo *et al*., 2018; SAIDS, 2019). Many health professionals in South Africa are concerned about the increasing demands and the expansion of the supplement industry, as currently it is insufficiently regulated, meaning that supplements rarely undergo safety and efficacy testing (Gabriels *et al*.,

2012; Schoonees and Volmink, 2013; Naidoo *et al*., 2018; SAIDS, 2018). Thus, multiple risks/dangers have generally been associated with the use of sports supplements including contamination, inadvertent doping, negligent use, and sports supplement-doping associations.

Due to the relatively high prevalence and popularity of sports supplements found among general populations and athlete populations and given the associated risks/dangers involved with these products, it is important to look at the use of these products among impressionable and developing members of the population; adolescents (Šterlinko *et al*., 2012; Kotnik *et al*., 2018). Adolescence is an important stage of life for human development where changes during this time may have lifelong health effects to the individual (Vella *et al*., 2011; Brown *et al*., 2017; WHO, 2019). However, sports supplement use by adolescents cannot be looked at in isolation, as coaches/trainers play an important role in the positive development of adolescents, as well as the choices they make (Vella *et al*., 2011; Kondric *et al*., 2013; Mandic *et al*., 2013; Jovanov *et al*., 2019. Therefore, understanding coaches/trainer's attitudes, knowledge, and application of knowledge towards sports supplement use would also be critical to ensure that any possible risks/dangers associated with adolescent supplement use are mitigated.

CHAPTER 3

Adolescent study

"The prevalence and perceptions (including the knowledge, attitudes, and beliefs) of sports supplement use among male and female adolescents attending South African private high schools".

Introduction

According to the World Health Organisation (WHO), adolescence is a transformational period of life and a bridge between childhood and adulthood that generally occurs between the ages of 10-19 years (WHO, 2019). It is a period of life where rapid phases of human development occur (Allen and Waterman, 2019; WHO, 2019).

During the early stages of adolescence (i.e., 10-13 years), overall development, physical differences, rate of growth, and physical skills development vary widely because of different points at which the onset of puberty occurs for each individual (Brown *et al*., 2017; Allen and Waterman, 2019). Due to these changes, adolescents are often preoccupied with, among other things, body-image concerns (Brown *et al*., 2017; Mendo-Lázaro *et al*., 2017). These body-image concerns are often linked to the assertion that early adolescents seek approval from their peers and may go to great lengths to gain acceptance from them (Brown *et al*., 2017; Bruner *et al.*, 2017; Allen and Waterman, 2019). Therefore, many young adolescents engage in behaviours that may be considered high risk (i.e., through the use of various substances), to achieve a physical appearance that is socially desirable (Brown *et al*., 2017; Mendo-Lázaro *et al*., 2017).

There is a continued physical and cognitive growth during the middle stages of adolescence (i.e., 14-16 years) (Brown *et al*., 2017). During this phase of development, they often rely on peers as a frame of reference and use peer feedback to set goals and rules of conduct (Brown *et al*., 2017; Bruner *et al.*, 2017). Similarly, adolescents are affected and influenced by certain characteristics such as respect, popularity, and belonging among their peer groups (Bruner *et al.*, 2017; Adibelli *et al*., 2020). Some argue that sports participation and achievements during this time are often used to impress peers or achieve a certain social status (Brown *et al*., 2017; Mendo-Lázaro *et*

al., 2017). This is because successful athletes are often perceived as high social status individuals among adolescents (Calfee and Fadale, 2006). Moreover, the portrayal of successful athletes by the media may exert an influence during this stage of life, which commonly leads to unrealistic expectations of personal and financial success from participation in sport (Patel *et al*., 1998; Brown *et al*., 2017).

Adolescents in their later stages of development (i.e., 16-19 years) are generally reaching their full physical maturity (WHO, 2019), and are therefore said to be more adept at dealing with successes and failures, as well as potential pressures from parents, coaches, peers, societal expectations, and sports demands (Brown *et al*., 2017; Allen and Waterman, 2019). However, the stressors and changes during this period of life may predispose individuals to start using substances such as sports supplements. These stresses may be a result of the increasing professionalism of high school sport, which places unrealistic expectations on adolescents to enhance their physical prowess and/or improve performance (Patel *et al*., 1998; Brown *et al*., 2017; Mendo-Lázaro *et al*., 2017). However, it could also be a result of social pressures placed on adolescents to look a certain way (Fitzgibbon *et al*., 2000; Yager and O'Dea, 2014; Mendo-Lázaro *et al*., 2017).

While the use of sports supplements is reasonably well governed and researched in the professional sporting sphere as outlined above, it is rarely regulated and is largely under-researched among non-professional athletes, the general public, and the adolescent population (Corazza and Roman-Urrestarazu, 2017; Reuter and Pardo, 2017). This poses potential problems as a large proportion of sports supplement consumers are adolescents and young adults (Gradige, 2010; Van Aswegen, 2013; Wardenaar *et al*., 2016; Kotnik *et al*., 2017). This is evident in several studies where the prevalence of sports supplement use has been reported to range between 40-80% among global adolescent populations (Braun *et al*., 2009; Mattila *et al*.,2009; Walsh *et al*., 2011; Šterlinko *et al*., 2012; Tawfik *et al*., 2016; Kotnik *et al*., 2017). The use of sports supplements in South Africa is also quite prevalent among the adolescent and young adult populations (Gradige, 2010; Van Aswegen, 2013; Mc Creanor *et al*., 2017).

Although there is evidence suggesting a relatively high prevalence of sports supplement use among adolescents, there is limited research globally and in South

Africa around this. The research is particularly scarce among female adolescents and adolescents who participate in non-mainstream school sports/physical activities. While it would be important to explore the prevalence of sports supplement use among all adolescent, the costs associated with these products may be a driver for a higher prevalence of use in more affluent populations, as evidence suggests that socio-economic status influences sports supplement use (i.e., there is generally a higher prevalence of sports supplement use among individuals from higher socio-economic strata) (Maughan, 2005; Gardiner *et al*., 2007; Gardiner *et al*., 2008; SAIDS, 2018; Arenas-Jal *et al*., 2019). In light of this, performance enhancing practices such as supplement use may be more frequent within private schools compared to public schools in South Africa as private schools generally have superior facilities and resources, which in turn attracts scholars from a higher socio-economic stratum. Furthermore, there is often very high value placed on sporting prowess within these schools, resulting in an increased expenditure and professionalisation of school sports. While there has been some research in South African schools, this research has been restricted to certain parts of the country. Thus, there is a need to explore the prevalence of use and perceptions around the use of these products more broadly. Therefore, the overall aim of this arm of the study is to explore the prevalence and perceptions (knowledge; attitudes; beliefs) of sports supplement use among male and female adolescents attending South African private high schools.

3.1 The prevalence of supplement use among global adolescent populations

As argued in Chapter 1, the reported prevalence of supplement use is relatively high irrespective of age; but some argue that the prevalence of use is generally higher in younger individuals such as adolescents (Field *et al.*, 2005; Gradige, 2010; Van Aswegen, 2013). According to a national health interview survey, a substantial number of adolescents in the USA use a variety of supplements such as creatine to improve sporting/athletic performance or physical appearance (Evans *et al*., 2012). Outside of the USA, studies focusing on the prevalence of supplement use by adolescents are scarce, however, the few studies that have been conducted in this domain provide some evidence of a relatively high prevalence of use (Petróczi *et al*., 2008; Šterlinko *et al*., 2012; Pacifici *et al*., 2016; Kotnik *et al*., 2018).

3.1.1 Examples of global studies observing the prevalence of supplement use by adolescents

Table 3.1 summarises findings of global studies that have reported the prevalence of nutritional supplement use by adolescents. The prevalence of use includes all categories of nutritional supplements and is not limited to sports supplements or ergogenic aids. Importantly, this table captures the percentage of specific sports supplements used by adolescents. These studies highlight the contrast of the prevalence rates between proportions of adolescent populations from different countries. This table did not include prevalence rates for supplement use by adults.

It is evident from the studies in Table 3.1, that there is a high prevalence of reported sports supplement use by adolescent populations. The prevalence of use is tentatively higher among the adolescent populations than that of the global adult populations (Kotnik *et al*., 2018). This is said to be a result of supplement companies targeting adolescents and young adults with intense and specialised marketing or advertising efforts (Perko *et al*., 2000; Story and French, 2004; Kotnik *et al*., 2018).

While these studies provide an important overview of the prevalence rates, each of them do have limitations that need to be considered. Mattila *et al*. (2009) only focused on supplement use for performance-enhancing reasons, which may limit the understanding of supplement use for physical appearance purposes. Kotnik *et al*. (2018) only included participants who used several supplements per year, limiting participants who may have used supplements in the years before the study started and individuals who had prolonged use of a single supplement. Petróczi *et al*. (2008), Braun *et al*. (2009), and Tawfik *et al*. (2016) only included elite athlete participants, therefore limiting the understanding of supplement use among adolescents who do not participate in sports. Similarly, Walsh *et al*. (2011) focused on male adolescent rugby players, limiting the understanding of supplement use among females or individuals who participate in other sports or no sports at all. Petróczi *et al*. (2008) used a questionnaire with a closed list of ten different nutritional supplements, and, as a result, only a few sports supplements were included and participants who might have used supplements other than those listed in the questionnaire were not accounted for in the data. It is important to point to the limitations in these studies for consideration of future research so that one can get a more holistic picture of adolescent supplement use.

Table 3. 1: Examples of selected global studies indicating the prevalence of supplement use among proportions of adolescent populations.

Studies	Sample size (n)	Age range	Country	Overall prevalence of supplement use (%)	Prevalence of sports supplements used (%)	Methodology
Field *et al.* (2005)	10 449	12-18	United States	N/A	Proteins (8.9%) Creatines (1.9%) Other sports supplements (9.9%)	Questionnaire.
Nieper (2005)	32 (Track & Field Athletes)	18 (Mean Age)	United Kingdom	62%	N/A	Questionnaire.
Petróczi *et al*. (2008)	403 (Elite Athletes)	12-21	United Kingdom	48.1%	Proteins (44.3%) Creatines (27.8%) Stimulants (Energy drinks: 86.6%)	Modified questionnaire.
Braun *et al*. (2009)	164 (Elite Athletes)	10-25	Germany	80%	N/A	Questionnaire.
Mattila *et al*. (2009)	22 519	12-18	Finland	45%	Proteins (6%)	Anonymous questionnaire.
Walsh *et al*. (2011)	203 (Male rugby players)	15-18	Ireland	64.5%	N/A	Questionnaire.
Pacifici *et al*. (2016)	404	14-17	Italy	N/A	Stimulants (Energy drinks: 31.4%) Performance-enhancing substances (16.3%)	Questionnaire.
Tawfik *et al*. (2016)	358 (Athletes)	13-18	Egypt	48.9%	Creatines (54.3%)	Interview questionnaire.
Kotnik *et al*. (2018)	1463	14-19	Slovenia	69%	Proteins/Amino Acids (30.5%) General Sports supplements (61%)	Electronic questionnaire.
Tsarouhas *et al*. (2018)	170	14-18	Greece	58.8%	Proteins/Amino Acids (84%) Creatines (78%) Pro-hormones (12%)	Self-administered questionnaire.
Mas *et al.* (2019)	120 (Athletes)	12-19	United States	98%	Proteins/Amino Acids (56%) Other ergogenic aids (13%)	Questionnaire.
Turfus *et al*. (2019)	127 (Athletes)	12-19	Jamaica	67%	Proteins (21%) Creatine (16%) Amino Acids (12%)	Questionnaire.

3.2 The prevalence of supplement use among South African adolescent populations

There is less research reporting on the prevalence of sports supplement use among adolescents living within South Africa (Gradige, 2010; Claassen and Galant, 2011; Van Aswegen, 2013), despite evidence showing that there is a high prevalence among them globally (Petróczi *et al*., 2008; Šterlinko *et al*., 2012; Pacifici *et al*., 2016; Kotnik *et al*., 2018). Attempts have been made by SAIDS to educate and create awareness around supplements by indicating the risks of use in school-going adolescents through nationwide campaigns (van der Walt and Coopoo, 2016). Despite these efforts, some studies have reported that the prevalence of sports supplement use among adolescents within South African high schools seems to be increasing rapidly over the past two decades (Gradige, 2010; van der Walt and Coopoo, 2016; Welthagen, 2016).

3.2.1 Examples of South African studies observing adolescent supplement use

Table 3.2 captures a few studies conducted in South Africa among a proportion of the adolescent population. These studies were selected as they reported on the prevalence of supplement use among adolescents between the ages of 10-19 years of age. There is limited research observing the prevalence of supplement use by adolescents in South Africa, however some of the studies that did explore this aspect are shown in Table 3.2.

All of the studies in Table 3.2 used a self-administered questionnaire instrument tool to collect data. The age range of these South African studies is similar to those of other global studies, which observed adolescent supplement use (Field *et al*., 2005; Mattila *et al*., 2009; Walsh *et al*., 2011; Pacifici *et al*., 2016; Tawfik *et al*., 2016; Kotnik *et al*., 2018; Tsarouhas *et al*., 2018).

Gradige (2010) reported the prevalence and perceptions of performance-enhancing substance use among male adolescents 15-18 years of age who were involved in 1st or 2nd team sports and attended a public or private Johannesburg boy's high school. This study reported a 30% prevalence rate for the use of performance-enhancing substances and supplements, from a sample of 100 participants where there was a high prevalence of protein and creatine product use (Gradige, 2010). Similarly, Van Aswegen (2013) reported on the prevalence of performance-enhancing substances or supplements among male adolescents between 15-19 years of age that were involved

in a 1st or 2nd team sport in the central metropolitan area of Cape Town. This study reported on a sample of 122 male adolescent participants and found a prevalence rate of 35% for performance-enhancing substances or supplements (Van Aswegen, 2013). Similarly, Nolte *et al*. (2014) observed the attitudes, beliefs, and knowledge of competitive high-school athletes in Gauteng province and found a 45% prevalence rate for supplement use. Welthagen (2016) reported on the knowledge and attitudes of elite adolescent athletes and found a high reported prevalence of use among 90% of participants.

Table 3. 2: Studies indicating the prevalence of supplement use by a proportion of South African adolescents.

Studies	Sample size (n)	Overall prevalence of supplement use (%)	Prevalence of specific sports supplement use (%)	Age Range	Province	Methodology
Gradige (2010)	100 (Male)	30%	Proteins (61%) Stimulants (57%) Creatines (32%) Other (14%)	15-18	Gauteng	Self-administered questionnaire.
Van Aswegen (2013)	122 (Male)	35%	Proteins (24%) Creatines (10%)	15-19	Western Cape	Self-administered questionnaire.
Nolte *et al*. (2014)	346 (Athletes)	45%	Any sports supplement (45%)	N/A	Gauteng	Self-determined questionnaire.
Welthagen (2016)	20 (Athletes)	90%	Any sports supplement (90%)	15-17	Free State	Draft questionnaire.
Mc Creanor *et al.* (2017)	364	83%	(Prevalence of sports supplements not mentioned)	10-18	Gauteng	Self-administered questionnaire.

Each of the studies in Table 3.2 presented limitations, which may have resulted in the differences observed between studies. Mc Creanor *et al.* (2017) did not indicate what types of supplements were used or the percentages of specific sports supplements used by those individuals who reported using nutritional supplements. Similarly, Nolte *et al*. (2014) and Welthagen (2016) did not report specific types of sports supplements used, and participants were all athletes. Gradige (2010) and Van Aswegen (2013), on

the other hand, only included male adolescents' participants that played 1st or 2nd team sports, which means they did not report on data from female adolescents or adolescents who did not participate in formalised school sports. The exclusion of female participants is a limitation as there is evidence that the prevalence of sports supplement use among female adolescents globally is very similar to that of male adolescents (Field *et al*., 2005; Muller *et al*., 2009). Thus, there is an important gender gap in research linked to the use of sports supplements by female adolescents in South Africa.

The exclusion of adolescents who do not participate in any sports/physical activities or those who only participate in non-mainstream sports/physical activities (i.e., gym; CrossFit) needs to be addressed. This is important given that the use of sports supplements is no longer limited to athletes, and that their popularity extends to individuals of all abilities who may participate in any form of activity (i.e., those who attend gyms regularly and/or those who are conscious about their health, wellness, and physical appearance) (El Khoury and Antoine-Jonville, 2012; Naidoo *et al*., 2018). It is important to highlight these limitations as they may indicate opportunities for more research and better understanding, some of which are addressed in this thesis. Although there are limitations to these studies, they are still very important as they contribute valuable information regarding supplement use in South Africa, which up to date is relatively scarce. Thus, additional literature is needed for a more comprehensive and holistic understanding of the use of these products.

3.3 Main drivers for the prevalence and perceptions of sports supplement use among adolescents

Multiple reasons have been reported by adolescents as to why they use the sports supplements (Muller *et al*., 2009). Improving performance, increasing speed and endurance, gaining energy, boosting strength, assisting with recovery, and aiding in altering physical appearance are just a few common examples. This section will discuss some of the main driving factors for adolescents' perceptions around using and reasons for using supplements by observing the experimentation and lack of knowledge/understanding; the competition and pressures of school sports; body image dissatisfaction/social pressures placed on young individuals; and sources of influence to use supplements.

3.3.1 Experimentation and lack of knowledge/understanding during adolescence

Along with the general reasons for using sports supplements mentioned in Chapter 2, younger individuals are often very likely to explore and experiment (WHO, 2019), which may explain why many adolescents currently use or have previously used sports supplements. Experimentation during this period of life is one of the reasons adolescents are believed to be the most susceptible age group to sports supplement use, as many will experiment with various substances without understanding the consequences of use (Šterlinko *et al*., 2012; Kotnik *et al*., 2018). This is evident in previous research where most adolescents who reported using supplements were unaware of what the supplements they used were supposed to achieve (Yager and O'Dea, 2014). In some cases, adolescents exhibited a relatively low level of knowledge on the proper and intended use of sports supplements (Jovanov *et al*., 2019). Therefore, they are often considered a misinformed population concerning the risks/dangers of supplement use; and many will use any product to achieve a positive result or goal (Šterlinko *et al*., 2012; Herriman *et al*., 2017; Kotnik *et al*., 2018). This mentality has been reported in a study which found that adolescent supplement use is generally more "performance-focused" than that of their adult counterparts who appear to be more "health-conscious" – the performance focused drivers may be the result of the environments in which adolescents live and interact (Petróczi *et al*., 2008). A worrying finding linked to this reported that 14.7% of adolescent male participants indicated that they would use any substance to reach their fitness goals even if it damaged their health, while 8.6% of participants in this study indicated they would use this type of supplement even if it shortened their life (Hoffman *et al.*, 2008).

Therefore, these young people may be experimenting with sports supplements without fully understanding or having knowledge of any associated risks. A lack of understanding and experimentation during adolescence may explain why many individuals globally and in South Africa start using supplements from a young age. This was reported in a South African study where 23% of 364 participants who were gym users, reported first time use of supplements between the ages of 10-12 years old, and 60% of these participants reported first using them in high school between the ages of 13-18 years old (Mc Creanor *et al.*, 2017). However, this finding may be inaccurate as participants from this particular study were adults ranging from 18-49 years of age, which meant they were reporting on what they could recall from their long-term

memory. Another South African study found 3% of participants reported using performance enhancing supplements in primary school, and 26% reported using them in high school (Van Aswegen, 2013). While this finding is important, it is possible that participants from this study were not fully aware of all the different types of performance enhancing substances.

A study in Germany provided some evidence of a lack of knowledge or understanding among elite athlete adolescents, where only 36% of participants reported being aware of the risk of contamination linked to supplement use (Braun *et al*., 2009). More recently a study in Greece reported that 85.6% of adolescents indicated not reading the label of supplements before using them, and 9% of these participants had been exposed to anabolic androgenic steroids, pro-hormones, or other modulating properties from using supplements (Tsarouhas *et al*., 2018).

Given that adolescents are often unaware of the risks or dangers of supplements, special provisions should be taken for supplement retailers who may be providing these products to young consumers (Tsarouhas *et al*., 2018). While this has been underreported in the literature, one South African study reported that 80% of elite athlete adolescent participants indicated that they had received education about the use of sports supplements (Welthagen, 2016). However, another South African study emphasized that there is a need for an improved contribution by high schools, coaching staff, parents/guardians, SAIDS, and medical practitioners to provide more education regarding supplement use to adolescents (Gradige, 2010).

The lack of understanding/knowledge and experimentation may also explain why many adolescents have used multiple supplements or combinations of supplements. According to Kotnik *et al*. (2018) an average of 2-3 different supplements were used by each participant. Similarly, Petróczi *et al*. (2008) reported an average of 2.96 different supplements used by participants. Moreover, Tsarouhas *et al*. (2018) found that only 42% of participants indicated using more than one type of supplement and from those participants, 85% used supplements more than three times per week. This may indicate that it is common practice for adolescents to use multiple supplements, which may result in both a higher likelihood of adverse reactions and in those reactions being more severe (Petróczi *et al*., 2008). Therefore, when taking adolescent nutrition

into account, supplements should only be recommended in specific situations, such as nutritional deficiencies (Mattila *et al*., 2009).

3.3.2 Competition and pressures of school sports

One of the main reasons for the increasing prevalence of supplement use among adolescents is due to school sports becoming more professional and possibly as competitive as elite professional sports (Gradige, 2010; Vosloo, 2014; Camiré and Santos, 2019). The demands of competing in high-level sports as well as the potential economic gains associated are considered potential driving factors, which may motivate adolescents to use performance-enhancing substances to succeed (Welthagen, 2016).

Evidence linked to adolescents' use of sports supplements to improve sports/physical performance was reported in a Finnish study, which found that supplement use among adolescents was associated with frequent participation in sports (Mattila *et al*., 2009). This supported findings from a more recent study in Slovenia, which asserted that supplement use by adolescents was positively associated with higher physical activity, although this study did not mention which types of supplements were being used (Kotnik *et al*., 2018). In contrast, a study in Egypt reported that 40.8% of adolescent participants indicated their main reason for using supplements was to "achieve better athletic performance" (Tawfik *et al*., 2016). Moreover, two South African studies both reported that the main reason for sports supplement use among adolescent participants was the belief that they helped improve sporting performance (Gradige, 2010; Van Aswegen, 2013).

3.3.3 Psychosocial factors relating to body image and physical appearance

Psychosocial factors relating to body image or physical appearance play a major role in influencing the use of sports supplements (Tsochas *et al*., 2013). This stems from increasing social pressures being placed on young individuals to look a certain way physically (aesthetically) (Ganesan *et al*., 2018). Adolescents' body image dissatisfaction and social influences are among the main reasons for using supplements from a young age (Fitzgibbon *et al*., 2000; Yager and O'Dea, 2014). This is supported by the fact that young males often perceive themselves as less muscular than their ideal body image and therefore use products to try to enhance this (Herriman *et al*., 2017). Similarly, it was argued that there is an increasing desire among young

females to obtain a lean body shape, which has resulted in increased consumption of supplements mainly aimed at weight loss (Muller *et al*., 2009).

Evidence of these social pressures were reported in a study in the United States, where 12% of males and 8% of females from a sample of 10 499 adolescents reported using ergogenic sports supplements or anabolic steroids to gain and/or improve muscle mass, physical strength and/or physical appearance (Field *et al*., 2005). Importantly, this study found that adolescents who thought about wanting more defined muscles or wanting to gain weight were more likely to use sports supplements than that of their adolescent peers (Field *et al.*, 2005). Adolescent males who read men's fashion or health/fitness magazines, and adolescent females who were trying to look like females in the media, were significantly more likely to use sports supplement products to improve their physical appearance (Field *et al.*, 2005). This may be driven by many factors, one of which is body dissatisfaction.

Body dissatisfaction is a common trend globally among children and adolescents. A study in Canada reported that from a sample of 1515 with ages ranging from 9-15 years old, 50.5% of females and 39.5% of males indicated that they wanted a thinner body shape (Dion *et al*., 2016). This study also found that 21.1% of males and 7.2% of females wanted a larger body shape (Dion *et al*., 2016). A similar finding was reported in Australia among male adolescents from a sample of 1148 who answered questions relating to body image and body dissatisfaction (Yager and O'Dea, 2014). Results showed that only 35.2% of participants wanted to remain at their current weight, and 30% indicated they would rather be lighter and 27.6% indicated they would rather be heavier (Yager and O'Dea, 2014). This supports the findings of a study in Egypt, which reported that the most frequent reason for using sports supplements was to "Maintain or obtain healthy and good physical appearance" as indicated by 44.4% of all participants (Tawfik *et al*., 2016).

In South Africa specifically, some of the social pressures placed on physical appearance have become a major concern among the more recent generations of adolescents (Martin and Govender, 2009; Gradige, 2010; Van Aswegen, 2013). Many teenagers in South Africa who regularly attend gymnasiums are socially influenced to use sports supplements with a common intention of improving body image (Mc Creanor *et al.*, 2017). A South African study reported that 32% of male adolescents felt

pressured to use sports supplements because they were concerned about physical image and body weight (Gradige, 2010). Research linked to the use of supplements by adolescent females in South Africa is underreported, despite evidence that indicates the global prevalence of sports supplement use among adolescent females is like that of adolescent males (Muller *et al*., 2009; Kotnik *et al*., 2018). The increase in body dissatisfaction of adolescent females globally has increased the frequency and diversity of strategies used for modification of the body and physical appearance, such as the use of sports supplements (Field *et al*., 2005; Muller *et al*., 2009; O'Dea and Cinelli, 2016). Media marketing and advertising often play a major role in creating these social pressures (Field *et al*., 2005; Martin and Govender, 2009; Muller *et al*., 2009; Gradige, 2010; O'Dea and Cinelli, 2016; Kotnik *et al*., 2018).

3.3.4 Sources of influence for sports supplement use among adolescents

Social influences are among the most consistent and important factors that directly and indirectly affect the likelihood that an adolescent will engage in substance use (Kobus, 2003; Cox *et al*., 2017). This may be the reason why several studies have argued that adolescents are easily influenced by their parents, peers, and coaches/trainers to take substances like sports supplements (Šterlinko *et al*., 2012; Yager and O'Dea, 2014).

Parents are often closely involved in their children's development of general beliefs, abilities, and sports-related value systems, as well as being able to promote their health (White *et al*., 2004; Lavoi and Stellino, 2008; Blank *et al*., 2015). Further, parents generally have a strong influence over adolescents, which may contribute to the use of substances like that of supplements (Van der Walt and Coopoo, 2016). This was evident in a South African study that reported children and high school adolescents primarily relied on their parents for knowledge regarding the use of supplements, despite evidence indicating that only 9% of 198 parents were well informed of supplements (Van der Walt and Coopoo, 2016). However, 30% of the 198 parents reported peers, and 28% reported coaches as the main motivations for their children using supplements (Van der Walt and Coopoo, 2016), which may be linked to the observation that at the age of around 10 years parental influence starts to fade and is replaced by the influence of peers and or coaches in the school space (Chan *et al*., 2012).

Peer influence plays a key role in the increase in risk-taking behaviour during adolescence and is one of the most proximal factors driving substance use (Van Hoorn *et al*., 2017; Henneberger *et al*., 2021). The presence of peers may increase the subjective value of rewards, for example by making rewards more arousing, and thereby also increasing the preference for a risky choice over a safe alternative (Albert *et al.*, 2013). Further, adolescent's peers often place strong subjective value on physical performance or appearance, which may encourage risky behaviours such as substance use (Albert *et al.*, 2013; Van Hoorn *et al*., 2017; Ganesan *et al*., 2018; Henneberger *et al*., 2021). However, this can also be encouraged by team cultures, which are largely influenced by coaches/trainers (Garthe and Ramsbottom, 2020).

Coaches/trainers generally have a strong influence over adolescents to use substances like supplements, surprisingly they often have more of an influence than that of nutritionists and general practitioners (Bastani *et al*., 2017). Several studies have found that coaches/trainers are the highest ranked source for recommending, influencing, or providing information on supplement use (Walsh *et al*., 2011; Tawfik *et al*., 2016; Tsarouhas *et al*., 2018; Jovanov *et al*., 2019). The influence and information provided by parents, peers and coaches/trainers may be inappropriate as they most likely have very little or no specialised education, knowledge, and/or training in nutrition and supplement use (Shifflett *et al*., 2002; Sato *et al*., 2009; Šterlinko *et al*., 2012). Thus, it would be best for these individuals to be educated, because they are important sources of information for adolescents' use of supplements (Kotnik *et al*., 2018). The influence of coaches/trainers concerning adolescent supplement use will be discussed in further detail in the chapters to come.

3.3.5 The South African secondary schooling system and socio-economic status

While there are many factors that may influence the use of supplements by adolescents, the context of the secondary school education system needs to be considered. In South Africa, the secondary school system includes both private and public schools (SchoolGuide, 2019). In the public sector, schools are classified into various quintiles based on the economic level of the community surrounding the school (SchoolGuide, 2019). This means that every year public schools in each province of South Africa are classified into five different quintiles from the poorest schools to the least poor schools (i.e., quintile one schools represent the poorest 20% of schools

within each province, whereas quintile five schools represent 20% of the least poor schools within each province) (SchoolGuide, 2019). Private schools operate independently, which means all the facilities, resources, and services must be paid for by the school (ISASA, 2020). This means that fees and fundraising are the primary income for private schools to offer educational services to learners (ISASA, 2020). Therefore, the economic level of schools often influences the activities learners can participate in (i.e., sports) as well as the resources available to the students to participate and develop in these activities (i.e., coaching) (Vosloo, 2014). Thus, private schools generally have superior facilities and resources, which in turn attracts learners from higher socio-economic backgrounds.

Furthermore, these schools also often use their sporting prowess as an identity marketing tool (Vosloo, 2014). The movement of school sport from traditional (amateur and organised by volunteers) to a more professional and commercial standard, indicates a new era in school sport with a more business-oriented basis (Vosloo, 2014; Camiré and Santos, 2019). Thus, adolescents and coaches within private schools may be pressured to be successful and may turn to the use of various methods, such as sports supplements, to maximise the likelihood of succeeding. This does not necessarily mean that performance enhancing methods are limited to the context of private schools. However, it is more likely to occur in these contexts due to the associated costs and availability of resources in these settings.

3.4 Summary and overall aim of this study

Adolescence is an important developmental stage of life (Allen and Waterman, 2019; WHO, 2019) that may predispose individuals to various stresses, which may be a result of the increasing professionalism of high school sport placing unrealistic expectations on adolescents to enhance their physical prowess and/or improve performance (Patel *et al*., 1998; Brown *et al*., 2017; Mendo-Lázaro *et al*., 2017). However, it was also argued that the changes that occur during adolescence due to the onset of puberty often results in individuals being preoccupied with body-image concerns (Brown *et al*., 2017; Mendo-Lázaro *et al*., 2017). Thus, many adolescents may experiment and engage in risky behaviours (i.e., substance use) to improve or enhance physical performance or appearance, and this is generally done with a lack of knowledge and

understanding (Šterlinko *et al*., 2012; Brown *et al*., 2017; Kotnik *et al*., 2018; Jovanov *et al*., 2019).

The prevalence of sports supplement use is relatively high among general populations globally and in South Africa, however, some evidence suggests that these products may be more prevalent among adolescent populations due to the characteristics of this period of life (Gradige, 2010; Šterlinko *et al*., 2012; Van Aswegen, 2013; Welthagen, 2016; Kotnik *et al*., 2018). There are multiple reasons and driving factors, which may influence or motivate adolescents to experiment or engage in the use of sports supplements. Some of these include the stage of life; competition and pressures from sport; psychosocial pressures relating to body-image; sources of influence or motivation (i.e., coaches, friends, marketing); and the context of schooling systems and social-economic status. In light of these factors and the relative scarcity or research in South Africa, this study explored the prevalence and perceptions (knowledge; attitudes; beliefs) of sports supplements among South African private high school adolescents. This is necessary to facilitate a better understanding and awareness around the challenges of using sports supplements so that informed choices and decisions can be made to use them safely, responsibly, and effectively.

3.5 Main objectives of this study

- To determine the prevalence of sports supplement use among male and female adolescents attending private high schools in South Africa, as well as the frequency of different types of sports supplements used by adolescents (i.e., proteins; amino acids; creatines; stimulants; pro-hormones).
- To determine the influential (i.e., sports coaches) and motivational (i.e., increased performance) factors behind adolescents' decisions to use sports supplements.
- To determine adolescents' perceptions of their knowledge/understanding of sports supplement use and interventions/solutions to reduce and or create awareness concerning the risks/dangers of use.

*Sports supplement: Ergogenic aids, which typically take the form of tablets, capsules, liquids, gels, or powders and are intended for oral ingestion. Commonly used to improve or enhance physical/athletic performance or physical appearance.

Methods

Study design

This study took the form of a cross-sectional design that focused on exploring the prevalence and perceptions (knowledge, attitudes, beliefs) of sports supplement use among a cohort of South African private high school adolescents. The study adopted a similar design to that used in previous South African studies by Gradige (2010) and Van Aswegen (2013).

Study data collection instrument

The data collection instrument (Appendix 1) was an anonymous and validated, self-administered online questionnaire that was adapted from Gradige (2010) and Van Aswegen (2013), who used validated questionnaires that were published in the public domain, thus, were freely available and accessible for use in the current study. It was shared online via “Google Forms” and consisted of five sections, which included closed and open-ended questions. The questionnaire collected qualitative and quantitative data on senior (Grade 10-12) high school adolescent’s prevalence and perceptions of sports supplement use. However, some minor alterations to the questionnaire were necessary to make it applicable for use in this study, which focused on “sports supplements” only. There were no questions in this study related to the use of illegal or banned substances as these do not fall within the scope of this study. All questions used in this study were taken or adapted from previous studies that used validated questionnaires.

Section 1: General demographic information.

This section required participants to give their general background information, this included: age; sex; grade; school location (Province); all sports participation; main sports participation. It also allowed participants to indicate non-participation in sports. This section was slightly adapted from Gradige (2010) and Van Aswegen (2013) as it included questions on sexes and school locations of participants but did not include a question on ethnicity as this aspect was not relevant for this study.

Section 2: The use of sports supplements.

This section required participants to answer questions related to the use of sports supplements, this included: frequency of use; first-time use; quantity of use; primary reasons for use; primary influences on use; the main reasons for not using (If never used). This section captured responses in relation to the prevalence and perceptions of all types of sports supplements. This section entailed questions used by Gradige (2010) and Van Aswegen (2013).

Section 3: The use of specific sports supplements.

This section required participants to answer questions related to specific sports supplements, which included: type of sports supplements used; claims on sports supplement label(s); understanding of how the supplement being used function; knowledge of product/brand certification; any questions participants wanted to know related to supplements in general or supplements they use/used. This section was used to understand the prevalence and perceptions of specific types of sports supplements used by the participants. This section was adapted from Gradige (2010) and Van Aswegen (2013) so that only questions related to ergogenic sports supplements were included, thus it did not include other categories of nutritional supplements (i.e., vitamins & minerals).

Section 4: Perceptions and understanding of the benefits or risks/dangers involved with the use of sports supplements.

This section required participants to answer questions related to their perceptions and understanding of the benefits and the risks/dangers involved with the use of sports supplements, which included: perceptions of benefits from supplement use; perceptions and knowledge of the risks/dangers from use and previous experience of negative side effects from use. This section aimed to explore the knowledge and experience of participants around the safety and dangers of the use of sports supplements. It was also used to help understand the influencing factors of participants when purchasing and using sports supplements. The questions used in this section were adapted from Gradige (2010) and Van Aswegen (2013).

Section 5: Knowledge, Perceptions, Interventions and Solutions for the use of sports supplements.

This section required participants to answer questions related to knowledge, interventions, and solutions for the use of sports supplements, this included: knowledge of the World Anti-Doping Agency (WADA) and/or the South African Institute for Drug-Free Sport (SAIDS); perceptions of sports supplements being used by South African adolescents; ideas for the education of supplement use; suggestions for interventions/solutions to reduce risks/dangers of supplement use. This section was used to explore the attitudes and knowledge of learners around sports supplements as well as their understanding of the global and national sport regulatory bodies who create awareness and educate individuals about the safe use of supplements. The questions used in this section were adapted from Gradige (2010) and Van Aswegen (2013) to include questions related to knowledge, perceptions, and interventions or solutions on sports supplement use.

Adaptations to the data collection instrument

Table 3.3 highlights the adaptations made to the current data collection instrument from that of the original data collection instruments used by Gradige (2010) and Van Aswegen (2013).

Table 3. 3: Adaptations to the data collection instrument from previous studies.

Adaptation criteria	Gradige (2010)	Van Aswegen (2013)	Current study
Sex	Male only	Male only	Male and Female
Age	15-18 years	15-19 years	16-19 years
Province	Gauteng	Western Cape	All provinces
Athletic ability	First and second-team sports	First and second-team sports	All activities
Focus	Performance-enhancing substances	Performance-enhancing substances and supplements	Sports supplements only

The questionnaires used by Gradige (2010), and Van Aswegen (2013) only included participants who were male adolescent athletes that participated in first or second-team level sports for their schools, they also focused on the use of performance

enhancing and illegal/banned substances/supplements. This questionnaire was adapted to become more inclusive for participants as it invited both male and female adolescents as well as participants of all athletic abilities. The instrument was also adapted to specifically focus on the use of sports supplements (i.e., over-the-counter products used as “ergogenic aids” to improve or enhance physical/athletic performance or physical appearance) rather than focusing on general nutritional supplements (i.e., vitamins and minerals). Lastly, the survey did not focus or include any sections that explored the use of androgenic anabolic steroids or any other illegal substances as these substances did not fall within the scope of this study.

Study sample

The source of the participants was a cohort of male and female adolescents between the ages of 16-19 years old (Grades 10-12), who were learners attending private high schools in South Africa. This is the general age range for senior South African high school students and is the age range that falls into the category of the middle-to-late adolescent period of life. This study used the World Health Organisation (WHO) (2019) definition of adolescence, which is the period of life where there is a transition from childhood to adulthood, generally characterised between the ages of 10-19 years.

Inclusion criteria

- Learners between and including 16-19 years of age.
- Learners who attended private high schools situated in South Africa.

Ethical approval and gatekeeper permission

Before the commencement of this study the “Rhodes University Human Ethics Committee” (RU-HEC) reviewed and gave provisional approval of the methodology, tracking number: (HKE-2018-22) (Appendix 5). Thereafter, gatekeepers who were interested in participating in the study were asked in the initial email to sign a permission form and return it to the researchers (Appendix 6). Once school gatekeepers had given signed permission to conduct the study within their school, this form was sent to “Rhodes University Human Ethics Committee” (RU-HEC) for final ethical clearance.

Procedures related to recruitment of participants

The researchers approached 37 private high schools listed by the Independent Schools Association of Southern Africa (ISASA, 2020); from these schools, there were seven that agreed to participate in this study. There were three situated in Gauteng province, two situated in the Eastern Cape province, one situated in Kwa-Zulu Natal province, and one situated in the Western Cape province.

Approaching the schools was done by contacting various school gatekeepers (i.e., school principals) via email (Appendix 2). The initial invitation email was sent to all the school gatekeepers on the 16th of April 2020. Due to the Covid-19 pandemic and hard lockdown restrictions implemented throughout the country during this period, schools faced great challenges and were unable to respond to the initial approach email. A follow-up email was sent on the 2nd of June 2020 to all the school gatekeepers who did not respond to the initial email (Appendix 3). A secondary email with all the names of learners who obtained parent/guardian consent was then sent to the school gatekeepers or other relevant stakeholders directly involved in the study (Appendix 4). Once the school gatekeepers or other relevant stakeholders directly involved in this study had received the names of these learners, they could email these learners the link to the online questionnaire to participate in the study, this was done through the school's administration.

Ethical considerations

Parent/Guardian informed consent

Once the relevant schools had granted permission to conduct the study (i.e., gatekeeper permission granted), an online parent/guardian informed consent form link was emailed to parents/guardians of all grades 10-12 learners via school administration. This online consent form (Appendix 7) hosted on "Google Forms" informed the parents/guardians of the rationale and purpose of the study as well as what would be required of their child/ward as well as their rights and responsibilities if they agreed to let them participate. Parents/Guardians had to select the agreement/disagreement option and give their child's name on the online form to give permission or not for their child to participate. Thereafter they had to submit the online form, which automatically got sent back to the researchers.

Participant assent

Once parents/guardians had submitted their response to the online informed consent forms, the names of the learners who had been given parental/guardian consent to participate were sent from the researchers to the school gatekeepers or other school stakeholders directly involved in the study. The school gatekeeper or other relevant stakeholders then emailed the online questionnaire link to these learners. The first page of the online questionnaire included an information letter inviting them to participate in the study as well as an indication of participant rights and responsibilities (Appendix 1). Below this letter was an assent form (Appendix 1). The participant had to select the agreement option on the assent form to allow them to participate in the study. The assent form ensured that participation in this study was voluntary and that they were permitted to withdraw from the study at any point, irrespective of any external influences placed on them. The assent form also ensured participants that withdrew from the study would not negatively affect the relationships between participants and the researchers or other individuals within the relevant schools. Once assent was obtained, the learner was able to participate in the study.

Data analyses

Initially, all collected data were analysed through descriptive statistical methods. Categorical parameters were descriptively analysed or displayed in tables and figures using frequencies and percentages. Mean ± SD were used for age and sports supplement prevalence of use. Sex and grade were compared using the Chi-squared test. The Fischer's exact test was used to analyse variables if frequencies were less than five. The statistical significance level was set at ($p < .05$). All statistical analyses were conducted using Microsoft® Excel® for Microsoft 365.

Open-ended questions were clustered into common themes of response using frequencies and percentages. The qualitative data was analysed using thematic analysis and included a six-step guide as outlined by Braun and Clark (2006). The first step was familiarisation with the data where the data was read and noted down for general ideas and understanding. The second step was generating initial codes systematically according to interesting or related features from the entire data set. The third step was searching for major themes by collating the initial codes generated in step two. The fourth step was reviewing the major themes to ensure that the initial

codes generated in step two worked within the theme; this was achieved through thematic mapping. The fifth step was defining and naming the major themes specific to the initial codes that fell within the specific themes. The sixth and final step was producing the report by collating the initial codes under the major themes into tables with the use of examples and direct quotations found in the data set.

Thus, the responses from participants were placed into common themes according to similarity (e.g., participants that reported they believed the sports supplements they used helped with fitness during sport or training fell under a common theme of response [I.e., performance], whereas participants who reported that they believed the sports supplements they used helped their physical appearance fell under a common theme of response [I.e., physical appearance]) for example. This was supported with direct quotations from participant responses.

Results

General demographic information

A total of 50 male and female adolescents from seven different South African private schools participated. From the total study sample, 35 (70%) were male participants and 15 (30%) were female participants, with a mean age of 17 ± 0.8 years.

Age and grade of participants

From the total 50 participants, most 18 (36%) were 17 years of age, and most 22 (44%) were in grade 12 (Table 3.4).

Table 3. 4: An overview of the age and grade of participants.

Age of participants (Years)	Male Participants (n)	Female Participants (n)
16	11 (22%)	6 (12%)
17	13 (26%)	5 (10%)
18	10 (20%)	4 (8%)
19	1 (2%)	0 (0%)

Grade of participants	Male Participants (n)	Female Participants (n)
10	9 (18%)	6 (12%)
11	10 (20%)	3 (6%)
12	16 (32%)	6 (12%)

All sports/physical activities participated in

In total there were 170 responses from the participants regarding sports/physical activity participation (Table 3.5). The most frequent sports/physical activities participated in were hockey 27 (54%); gym 23 (46%); and rugby 19 (38%). There were a total of 22 different sports/physical activities reported across the population group.

Male participants reported participating in 3.4 ± 1.6 sports/physical activities on average. The most frequently reported sports/physical activities by male participants were rugby reported by 19 (54%) participants; gym reported by 18 (51%) participants; hockey reported by 13 (37%) participants. Female participants reported participating in 3.3 ± 1.8 sports/physical activities on average. The most frequent sports/physical activities participated in by female participants were hockey reported by 14 (93%)

participants; cross-country running reported by six (40%) participants and gym reported by five (33%) participants (Table 3.5).

Table 3. 5: All physical activities/sports participated in by male and female participants.

Sports	Male Participants (n=35)	Female Participants (n=15)	Total participants (n=50)
Hockey	13	14	27 (54%)
Gym	18	5	23 (46%)
Rugby	19	0	19 (38%)
Athletics	11	3	14 (28%)
Cricket	11	1	12 (24%)
Cross-country running	5	6	11 (22%)
Swimming	8	2	10 (20%)
Waterpolo	6	3	9 (18%)
Golf	7	1	8 (16%)
Tennis	5	3	8 (16%)
Soccer	6	1	7 (14%)
Crossfit	2	4	6 (12%)
Boxing	2	2	4 (8%)
Cycling	2	1	3 (6%)
Basketball	2	0	2 (4%)
Dance	0	1	1 (2%)
Mixed martial arts	1	0	1 (2%)
Netball	0	1	1 (2%)
Rowing	0	1	1 (2%)
Squash	1	0	1 (2%)
Kayaking	1	0	1 (2%)
Surfing	0	1	1 (2%)
Total	**120**	**50**	**170**

The general use of sports supplements

The prevalence of sports supplement use

Thirty-one (62%) of the total sample reported “Yes” and 19 (38%) reported “No” to using a sports supplement before. Of the participants that answered “Yes”, 27 (87%) were male participants, and four (13%) were female participants. On average, participants who reported previous/current use of sports supplements each used 2.2 ± 1 sports supplements. From the participants that answered “No”, eight (42%) were male participants and 11 (58%) were female participants. Males were significantly (p < .001) more likely to use sports supplements than females.

From the 31 participants who indicated “Yes” to using a sports supplement, there were 14 (45%) participants that reported current use of sports supplements and 17 (55%) reported that they were not currently using. All 14 (45%) participants that reported current use were male participants. Males were significantly ($p < .004$) more likely to currently use sports supplements than females.

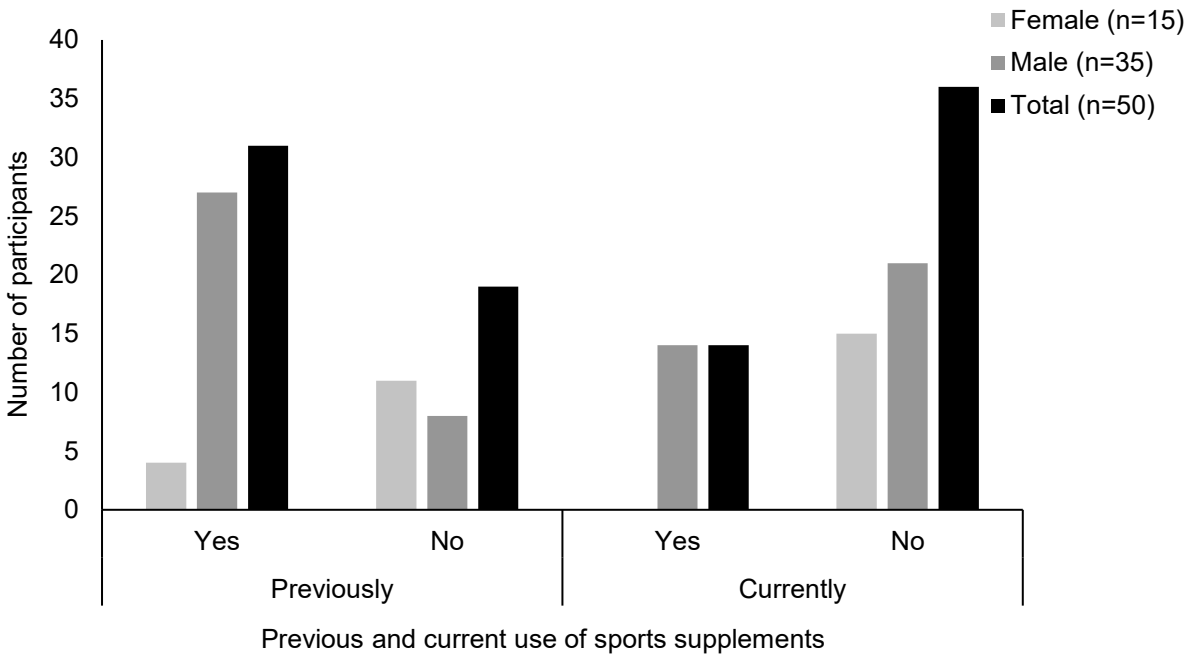


Figure 3. 1: Frequency of participant’s previous/current use of sports supplements.

Age of first-time use of a sports supplement

There was one (3%) male participant that reported first time use of a sports supplement before the age of eight years old, two (6%) female participants reported between 10-12 years old, one (3%) male participant and one (3%) female participant reported between 12-14 years of age. Most 16 (52%) male participants reported first using sports supplements between 14-16 years of age. Thereafter there were nine (29%) male participants and one (3%) female participant that reported between 16-18 years of age (Figure 3.2).

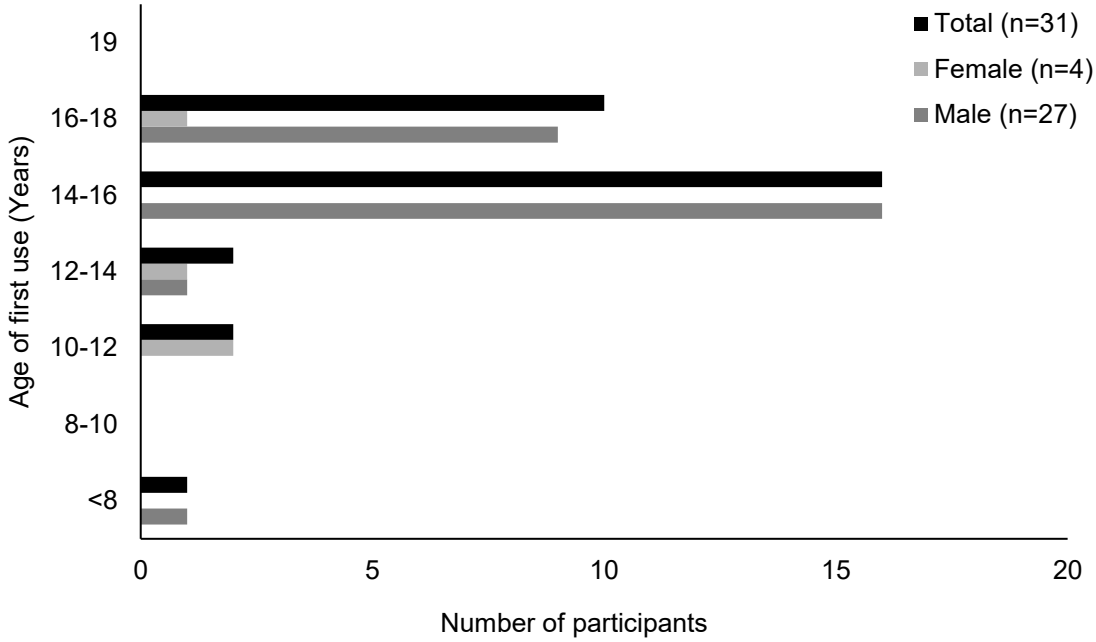


Figure 3. 2: Frequency of the age of first-time use of a sports supplement.

The frequency of use of sports supplements

From the 31 participants that reported previous/current use of sports supplements, 14 (45%) reported using supplements "*Only before/after/during sports or training*", six (19%) reported "*More than once a week*", six (19%) reported "*Once a day*", two (6%) reported "*Once a month*" and two (6%) reported "*Once a week*", and one (3%) reported "*Once every 6 months*". These were in response to how often they use/used sports supplements.

The main reasons for the use of sports supplements

From the 31 participants that reported previous/current use of sports supplements there was a total of 79 responses for their main reasons for choosing to use these products. There were 22 (28%) responses for "*I use it to recover from training, gym, or sport*", 15 (19%) responses for "*Helps improve my performance at gym*", and 12 (15%) responses for "*Helps me get bigger/heavier*". Other reasons are mentioned within the table (Table 3.6).

Table 3. 6: Frequency of main reasons for using sports supplements.

Main reasons	Male participants (n=27)	Female participants (n=4)	Total responses (n=79)
I use it to recover from training, gym, or sports.	20	2	22 (28%)
Helps improve my performance at gym.	15	0	15 (19%)
Helps me get bigger/heavier.	12	0	12 (15%)
I get more energy from using them.	6	4	10 (13%)
Helps improve the looks of my body (Aesthetics).	9	0	9 (11%)
I use them to replace meals.	4	1	5 (6%)
I feel healthier when I use them.	1	2	3 (4%)
I use it because it tastes nice.	0	2	2 (2%)
Helps me get smaller/lighter.	1	0	1 (1%)

The main reasons for not using sports supplements

From the 19 participants that had no previous/current use of sports supplements there was a total of 33 responses for their main reason/s for not using. There were 11 (33%) responses for "*I don't think it is necessary to take them*", five (15%) responses for "*I am afraid of what they may do to my health*", five (15%) responses for "*I believe a regular food diet is sufficient*", and four (12%) responses for "*It goes against what I believe*". There were two (6%) none responses for this question, these responses fell under the common theme of "No response" (Table 3.7).

Table 3. 7: Frequency of main reasons for not using sports supplements.

Main reasons	Male participants (n=8)	Female participants (n=11)	Total responses (n=33)
I do not think it is necessary to take them	4	7	11 (33%)
I am afraid of what they may do to my health	1	4	5 (15%)
I believe a regular food diet is sufficient.	2	3	5 (15%)
It goes against what I believe	2	2	4 (12%)
I am afraid they get me banned from playing sport.	0	3	3 (9%)
My parents/guardians do not allow me to use them.	0	2	2 (6%)
I do not believe they work	1	0	1 (3%)
No response	1	1	2 (6%)

Main sources of influence/advice on decisions to start using sports supplements

From the 31 participants that reported previous/current use of sports supplements there were a total of 52 responses for the main sources of influence/advice. There were 17 (33%) responses for "*Friends*", 10 (19%) responses for "*Coaches/Trainers*", and six (12%) responses for "*Parents/Guardians*". The other sources are mentioned within the figure (Figure 3.3).

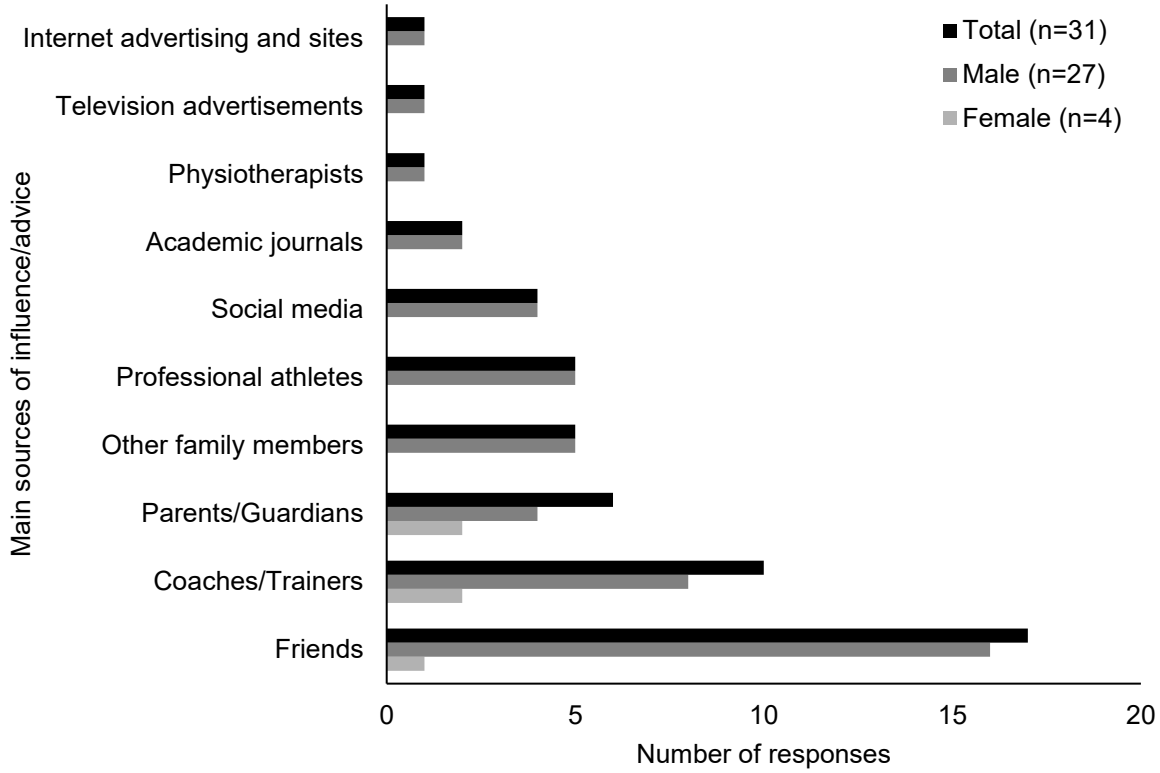


Figure 3. 3: Frequency of main sources of influence/advice to start using sports supplements.

The use of sports supplements

The prevalence of specific types of sports supplements

From the 31 participants who reported previous/current use of sports supplements there were a total of 67 responses for the specific types of sports supplements that they use/used. There were 27 (40%) responses for the use of "*Protein products*", 15 (22%) responses for the use of "*Creatine products*", 13 (19%) responses for the use of

"*Amino acid products*", 10 (15%) responses for the use of "*Stimulant products*", and two (3%) responses for the use of "*Pro-hormone products*" (Figure 3.4).

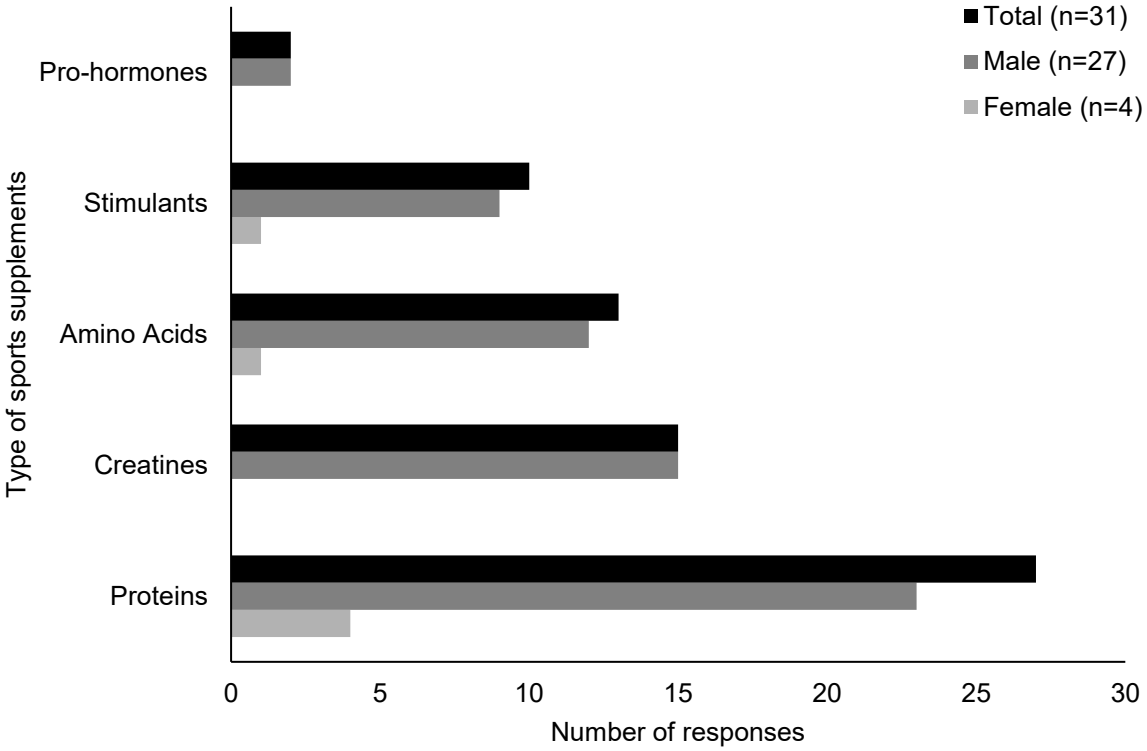


Figure 3. 4: The frequency of different types of sports supplements used by participants.

Knowledge of how sports supplements function within the human body

There were 24 (77%) participants who reported "*Yes I understand how it functions*", and seven (23%) who reported "*No I do not understand how it functions*" in response to knowing how the sports supplement they use/used, functions within the human body. Males were ($p < .001$) more likely to report having knowledge of how sports supplements function, than females.

General claims made on the labels of sports supplements used by participants

There were a total of 47 responses for claims made by sports supplement companies on the labels of the product/s that participants previously/currently used. There were 25 (53%) responses for claims of "Recovery" as a common theme, such as increases;

supports; aids; maintains; helps recovery. Thereafter, there were five (11%) responses for “Energy” as a common theme such as increases; boosts; provides mental and/or physical energy. There were 12 (26%) none responses for claims, these responses fell under the common theme of “Unknown” (Table 3.8).

Table 3. 8: Common themes of response for claims made on sports supplement labels.

Common themes of claims on sports supplement labels	Examples of direct quotations	Number of claims (n=47)
“Recovery” Increases/Supports/Aids/Maintains/Helps recovery	“Optimal Muscle support and recovery”. “Supports lean muscle growth”. “Muscle replenishment and building”.	25 (53%)
“Energy” Increases/Boosts/Provides mental and/or physical energy	“Boosts your energy”. “For physical & mental energy. High in Energy”.	5 (11%)
“Strength” Increases/Improves strength	“Improve strength”. ‘Increase size and strength’.	4 (9%)
“Weight loss” Assists weight loss	“Make you lose weight”	1 (2%)
Unknown	N/A	12 (26%)

Knowledge of certification of sports supplements

There were 21 (68%) participants who reported “Yes I know they have been certified”, and 10 (32%) participants who reported “No I do not know if they have been certified” in response to knowing if the sports supplement/s they use/used, had been certified (approved) by a regulatory authority or organization which tests the safety and effectiveness of sports supplements. There was no statistical significance between male and female participants for this question (p = .087).

Questions raised by participants regarding sports supplements

All 50 participants were given an opportunity to ask any questions they wanted to know regarding sports supplements in general or regarding sports supplements they use/used/looking to use. There were 43 (86%) participants that reported “No”, and seven (14%) participants reported the following questions:

"What are the different types of sports supplements used for and how do they affect your body for better performance?"

"What are all the different sports supplements used for and what is the point of athletes using multiple sports supplements at the same time?"

"What is the difference between the different protein sports supplements? (e.g., whey vs isolate)"

"What is the benefit versus the harm, why isn't everyone taking them?"

"Which sports supplements are optimal to use when trying to get lean?"

"How do sports supplements work and are there any benefit's to using them? Are some more effective than others? Are there any good dairy-free protein products?"

"What are the healthiest and beneficial sports supplements to take if you are looking at getting fit but have little time to do it?"

Perceptions and understanding of the risks/dangers involved with the use of sports supplements

Perceived benefits from the use of sports supplements

There were 40 (80%) participants who reported "Yes", and nine (18%) who reported "No" in response to whether they believed there are benefits from using sports supplements. There was no statistical significance between male and female participants for this question (p = .254). There was one (2%) participant that did not respond to this question.

From the 40 (80%) participants who reported "Yes" there were 56 total responses for perceived benefits. The most frequent response 15 (27%) was for "Recovery" as a common theme such as improves; promotes; helps; speeds up general recovery/recovery time and/or muscle recovery. Thereafter, seven (13%) responses for "Energy" as a common theme such as provides; increases; helps energy/intensity/concentration/alertness levels when training/playing sport. There were 11 (20%) none responses for perceived benefits, these responses fell under the common theme of "No comment/response" (Table 3.9).

Table 3. 9: Frequency of common themes of response for perceived benefits from using sports supplements.

Common themes of perceived benefits	Examples of direct quotations	Number of responses (n=56)
"Recovery" Improves/Promotes/Helps/Speeds up - general recovery/recovery time and/or muscle recovery	"They help with recovery of the muscles as well as the rebuilding of the muscle fibres". "In certain activities such as gym there are benefits such as decreased recovery time".	15 (27%)
"Energy" Provides/Increases/Helps – energy/intensity/concentration/alertness levels when training/playing sport	"Improved concentration and focus as well as energy and alertness". "For people who suffer from chronic condition are helped to play sport at a more intense level".	7 (13%)
"Overall performance" Increases/Enhances/Improves/Helps/Beneficial for - training performance and/or overall performance	"Improves overall performance". "Some sports supplements are beneficial to your performance".	6 (11%)
"Nutrient intake" Supplements/Replaces/Increases/Convenient - nutrient intake lacking from regular food diets and/or lost from training/sports	"Supplement extra nutrients missing from a diet you can't change". "Gives you extra nutrients than what you already have".	6 (11%)
"Physical growth" Increases/Helps/Quicker - overall growth, gain of mass, gain of muscle	"It helps me gain weight and it increases my calorie deficit". "Quicker muscle gain".	6 (11%)
"Physical performance" Faster/Better/Increased - strength, fitness, endurance	"Getting fitter faster". "I think I put more energy into training sessions and have better endurance".	4 (7%)
"Appearance" Improves aesthetic looks of the body	"Improves aesthetics".	1 (2%)
No comment/response	N/A	11 (20%)

Perceived risks/dangers from the use of sports supplements

In response to a question that asked participants whether they believed there are risks or dangers involved in the use of sports supplements, 42 (84%) participants reported "Yes", and eight (16%) reported "No". There was no statistical significance between male and female participants for this question (p = .407).

Table 3. 10: Frequency of common themes of response for perceived risks/dangers involved in sports supplement use.

Common themes of perceived risks/dangers	Examples of direct quotations	Number of responses (n=53)
"Incorrect/Negligent use" Overdose/Overuse/Excessive use, which may have negative/damaging effects	"Overuse which damages body". "Overdose on specific substance".	8 (15%)
"Major organ risk" Damage/Strain/Harm placed on major organs	"Creatine can be bad for your kidneys; high carbohydrates can be bad for your heart". "Protein drinks can harm kidneys".	8 (15%)
"Lack of knowledge/understanding" Incorrect/Misinformed use of sports supplements	"Usage of supplements when you don't know what they do". "If an individual is misinformed about the use of certain supplements".	6 (11%)
"Illegal/Banned substances" Consumption of uncertified/unnatural/dangerous/hidden substances or chemicals	"Products could be non-certified". "Many supplements contain active ingredients that have strong effects in the body".	6 (11%)
"Substance abuse" Addicted/Reliant/Dependant on using sports supplements	"Your body relies on them even after you stopped using them". "Become dependent on them and don't eat normal food".	5 (9%)
"Long-term risks" General and/or long-term health risks	"Health risks (such as long-term harm, depending on the supplement used)". "Bad for long term health".	4 (8%)
"Hormones" Effects normal hormone production/levels/balance	"The use of any supplements that effect hormone production". "Bad for your health if used incorrectly like hormone imbalances".	4 (8%)
Do not know/No response	N/A	12 (23%)

From the 42 (84%) participants that reported "Yes" there were a total of 53 responses for perceived risks/dangers. There were eight (15%) responses for "Incorrect/Negligent use" as a common theme such as overdose; overuse; excessive use, which may have negative/damaging effects. There were also eight (15%) responses for "Major organ risk" as a common theme such as damage; strain; harm placed on major organs. There

were 12 (23%) none responses for perceived risks/dangers, these responses fell under the common theme of “Do not know/No response” (Table 3.10).

Experienced side-effects from the use of sports supplements

From the 31 participants that reported previous/current use of sports supplements, five (16%) participants reported “Yes”, and 26 (84%) reported “No” in response to whether they had ever experienced negative side-effects from the sports supplement/s they use/used. There was no statistical significance between male and female participants for this question (p = .525).

The use of a sports supplement with knowledge of risk/dangers

From the total 50 participants, 14 (28%) reported “Yes”, 18 (36%) reported “No”, and 18 (36%) reported “Maybe” in response to whether they would use or continue using a sports supplement which helps them achieve their sports/athletic goals or physical appearance goals (body-image) even if they understood there were risks or dangers involved with the use of that sports supplement. There was no statistical significance between male and female participants for this question (p = .068) (Figure 3.5).

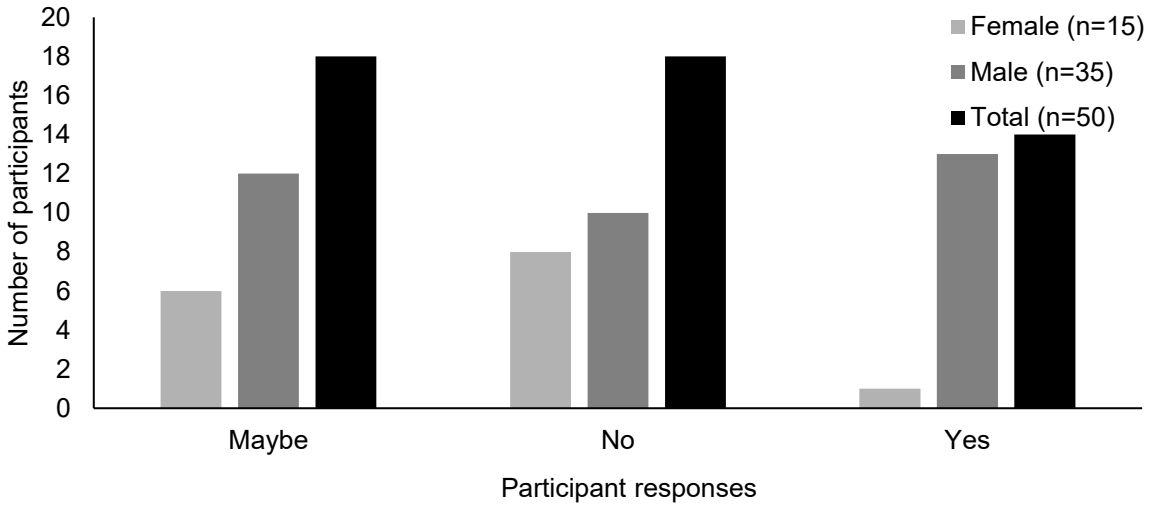


Figure 3. 5: Participant response to the use of a sports supplement which helps achieve sports/athletic goals or physical appearance goals (body-image) even if risks or dangers were involved.

Knowledge, Perceptions, Interventions, and solutions for the use of sports supplements

Perception of sports supplement use among pupils attending South African private high schools

Of the total sample, 42 (84%) participants reported “Yes”, five (10%) reported “No”, and three (6%) reported “Maybe” in response to the belief that the use of sports supplements is common among pupils attending South African private high schools. There was no statistical significance between male and female participants for this question (p = .863).

Training or formal education on sports nutrition or sports supplements

From the total 50 participants, 17 (34%) reported “Yes”, and 33 (66%) reported “No” in response to ever having any training or formal education related to sports nutrition or sports supplements. There was no statistical significance between male and female participants for this question (p = .948).

Knowledge of “WADA” and/or “SAIDS”

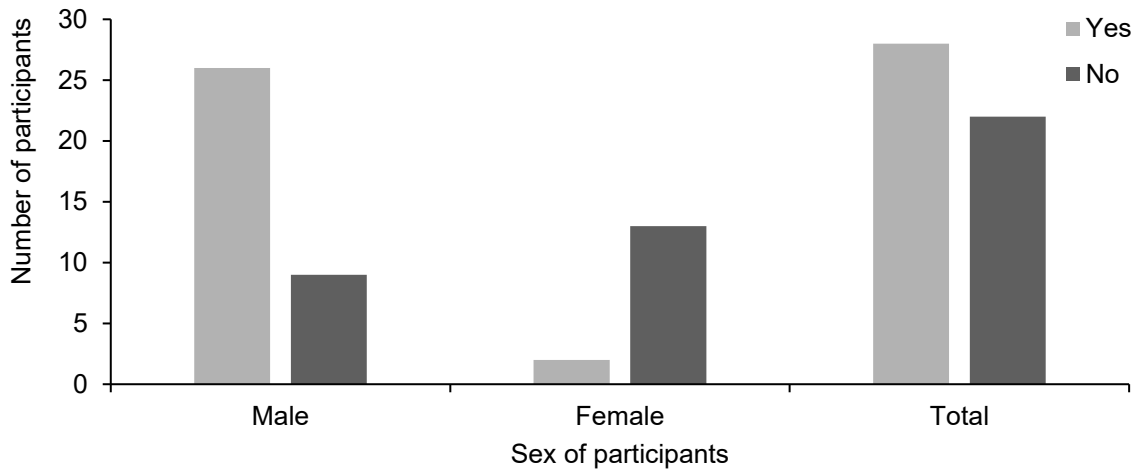


Figure 3. 6: Knowledge of the “World Anti-Doping Agency” (WADA) and/or the “South African Institute for Drug-Free Sport” (SAIDS).

There were 28 (56%) participants who reported “Yes”, and 22 (44%) who reported “No” as to whether they had knowledge of the “World Anti-Doping Agency” (WADA) and/or the “South African Institute for Drug-Free Sport” (SAIDS). From the total male

participants, 26 (74%) reported “Yes”, and nine (26%) reported “No”. From the total female participants, two (13%) reported “Yes”, and 13 (87%) reported “No”. Males were (p < .001) more likely to have knowledge of “WADA” and/or “SAIDS” than females (Figure 3.6).

Training or education by South African regulatory companies/organizations

Most participants 48 (96%) reported “Yes”, and two (4%) reported “No” in response to whether they believed South African regulatory companies/organizations should provide educational programs or training addressing the use of sports supplements by high school adolescents. There was no statistical significance between male and female participants for this question (p = .514).

Perception of sports supplement use within South African private schools

In response to a question that asked participants whether they believed the current use of sports supplements is a problem among pupils attending South African private high schools, 14 (28%) participants reported “Yes”, 17 (34%) reported “No”, and 19 (38%) reported “Maybe”. There was no statistical significance between male and female participants for this question (p = .066).

Suggested interventions/solutions for education/awareness of sports supplement use by adolescents attending South African private high schools

From the total sample there were 50 responses for one suggested intervention/solution that could be used to help educate and create awareness for South African high school adolescents around using sports supplements safely and effectively. There were 22 (44%) responses that fell under the common theme “Formal training/education” such as training; education workshop’s, programmes and/or sessions for learners and coaches/trainers or include sports supplements/nutrition lessons within the school syllabus/curriculum. Thereafter, 15 (30%) responses for “Informal training/education” as a common theme such as talks; expos held at schools by professional athletes or professionals in the field of sports supplements. Other responses made reference to the need for more testing, stricter rules, and better awareness. There were two (4%) none responses for one intervention/solution, these responses fell under the common theme of “Do not know/No response” (Table 3.11).

Table 3. 11: Frequency of common themes of response for suggested interventions/solutions.

Interventions/Solutions	Examples of direct quotations	Number of responses (n=50)
"Formal training/education" Training/Education workshops, programmes or sessions for learners and coaches/trainers within schools or include sports supplement/nutrition lessons within the school syllabus/curriculum	"Give courses to educate students on the pros and cons of taking sports supplements". "Introducing sport-focused nutrition and supplement education in subjects like LO and biology".	22 (44%)
"Informal training/education" Talks/Expo's held at schools by professional athletes or professionals in the field of sports supplements/nutrition	"Get talks from professionals in the field". "School sports expo's, held by regulatory authorities".	15 (30%)
"Testing" Increased frequency of doping tests within schools	"More doping tests in preseason and in season". "Test everyone a day before a match".	5 (10%)
"Rules" Implementation of rules/policies/protocols on sports supplement use within schools	"Limit the products that can be used to only products that a board approves for schools". "Let your schools' stock some products that are allowed, students purchasing solely from schools".	4 (8%)
"Awareness" Use of awareness campaigns/posters within schools	"Have a campaign that runs at sports festivals that educates athletes on such". "Posters around school campus. Much like bullying or depression awareness posters".	2 (4%)
Do not know/No response	N/A	2 (4%)

Discussion

This study found a prevalence rate of (62%) for sports supplement use by adolescents, supporting the findings of several other studies that reported prevalence rates ranging between 40-80% among adolescent populations (Braun *et al*., 2009; Mattila *et al*.,2009; Walsh *et al*., 2011; Šterlinko *et al*., 2012; Tawfik *et al*., 2016; Kotnik *et al*., 2017). Importantly, this shows that the use of nutritional supplements and, more specifically, the use of sports supplements is common practice and highly prevalent among adolescent populations (Muller *et al*., 2009; Gradige, 2010; Evans *et al*., 2012; Šterlinko *et al*., 2012; Van Aswegen, 2013). However, the overall prevalence rate found in this study differs from that of two previous South African studies performed by Gradige (2010) and Van Aswegen (2013), which reported prevalence rates as low as (30%) and (35%) respectively. The difference in overall prevalence rates found in this study compared to the two other South African studies may be attributed to multiple factors.

One factor important to note is that the prevalence rate found in this study may have been linked to the study's focus on just sports supplements and not on other categories of nutritional supplements (i.e., vitamins and minerals), or illegal/banned substances (i.e., androgenic anabolic steroids) as the two previous South African studies had. This may be indicative of the popularity of the sports supplement among this group of adolescents. Another factor that may be attributed to the difference in prevalence rates is the timeline of when the studies were performed, as this study is more recent, which may indicate the growth and expansion of supplement use among adolescents in South Africa over the past few years. While the size and representativeness of this sample are limitations, this observation supports the argument that the South African sports supplement industry is growing annually (Naidoo *et al*., 2018). The third reason could be the effect of the socio-economic status of participants, as this study only included participants who attended private high schools in South Africa. Previous studies have reported a higher prevalence of sports supplements among individuals from higher socio-economic strata (Gardiner *et al*., 2007; Gardiner *et al*., 2008). The overall population sample in this study was also comparatively smaller than the other South African studies, which could have resulted in a higher overall prevalence rate.

The relatively high prevalence of use found is of concern as the efficacy and safety of a large proportion of sports supplements remain questionable, due to poor regulation of the supplement industry within South Africa (Gabriels *et al*., 2012; Schoonees and Volmink, 2013; Cohen, 2014; Herriman *et al*., 2017; Mathews, 2017; Naidoo *et al*., 2018). The poor regulation of the supplement industry along with the improper use of these products may explain why some participants in this study reported first-hand experience of negative side effects from the use of sports supplements, which supports reports from SAIDS that there is an increasing occurrence of harmful side effects and positive drug tests in youth and adults from using these products (SAIDS, 2018). However, this study did not explore the specific side effects that participants experienced – future research should include this to help to understand whether the side effects are linked to certain sports supplement products or substances used by adolescents. Nevertheless, this finding is important as it signifies a need for regulatory authorities to assess and certify nutritional supplements to limit the risk of negative side effects associated with their use.

While significantly more males reported using sports supplements than females, this study only reflects responses from a small cohort of female learners from private schools. Despite the small sample of female participants, it is still an important finding as it indicates that sports supplement use is not limited to male adolescents in South Africa. Therefore, additional research that focuses on sports supplement use among female adolescents in South Africa is necessary to better understand the prevalence and preference of supplement use in this group. This is particularly important given that some studies argue that females frequently use substances intended to obtain a lean or slender body image, which is driven by the media as the ideal physical appearance (Silva *et al*., 2011; O'Dea and Cinelli, 2016; Rousseau and Eggermont, 2018). This has resulted in an increased consumption of sports supplements among females (Muller *et al*., 2009). However, this study did not focus on body image concerns and the role of the media, therefore, future research is needed to better understand the complexity of physical appearance and supplement use among male and female adolescents in South Africa.

The finding that protein and creatine were the most frequently used sports supplements among male participants, supports several studies that these two

products are the most popular and widely used sports supplements on the market (Williams, 2005; Kreider *et al*., 2017; Whitehouse and Lawlis, 2017; Butts *et al*., 2018). The use of these types of supplements were also highly prevalent among adolescent populations reported by studies in the United States, United Kingdom, Egypt, Slovenia, Greece, Jamaica (Field *et al.*, 2005; Petróczi *et al*., 2008; Tawfik *et al*., 2016; Kotinik *et al*., 2018; Tsarouhas *et al*., 2018; Turfus *et al*., 2019), and South Africa (Gradige, 2010).

The common use of these types of sports supplements is not necessarily a negative finding as they do have some beneficial effects for the user; for instance, protein supplements assist with post-exercise recovery, greater gains in lean mass and muscle strength (Cermak *et al*., 2012; Pasiakos *et al*., 2015). The International Society of Sports Nutrition (ISSN) contends that powdered protein supplements are a safe and convenient way to meet athlete's protein intake requirements with high quality protein (Campbell *et al*., 2007; Jäger *et al*., 2017). However, this may only be applicable to elite athlete's consumption of protein products, which means that the use of these products by adolescents in this study may be unwarranted considering that they may not be athletes or do not require this amount of extra protein. While the actual protein required by the participants in this study was not explored, it would be advisable that adolescents stick to a regular food diet to meet their dietary requirements or more specifically to meet their protein intake requirements (SAIDS, 2019).

The high prevalence of creatine sports supplement use by male participants in this study is also not necessarily a negative finding as there is evidence that supports the idea that it can have a positive influence on muscle function and performance (Kreider *et al*., 2017; Dolan *et al*., 2019; Ricci *et al*., 2020). Furthermore, a consensus statement by the International Olympic Committee (IOC) contended that there are no negative health effects found after long term (up to four years) use of creatine supplements when appropriate protocols and recommended doses of use are followed (Maughan *et al*., 2018). However, it is unknown whether the participants in this study followed the correct protocols of use when using creatine products. Conversely, the International Society of Sports Nutrition (ISSN) initially argued that there is a lack of research on the safety of creatine supplement use among the adolescent population, thus further research is needed before creatine supplements can be recommended (Buford *et al*.,

2007; Van Aswegen, 2013). More recently the International Society of Sports Nutrition (ISSN) recommended that creatine supplements only be considered for use by adolescent athletes who are involved in serious/competitive supervised training, consuming a well-balanced and performance enhancing diet, are knowledgeable about appropriate use of creatine, and do not exceed recommended dosages (Kreider *et al.*, 2017). Thus, creatine use by adolescents in this study may only be safe and effective when used exclusively under supervision and according to safe and recommended protocols. While this was beyond the scope of this study, it is an area that likely needs to be explored further.

What could be considered as a positive finding is the fact that there were only two participants who reported the use of pro-hormone sports supplements. Pro-hormone supplements are often marketed as legal alternatives to androgenic anabolic steroids that can be used to increase hormones (i.e., testosterone), however, many of these supplements are on the World Anti-Doping Agency banned list (King *et al*., 2012). Thus, the finding that so few of the participants in this study reported the use of pro-hormones means that either learners do not have access to these products, or they do not necessarily see the benefits of using them at this stage of their lives. However, it is also possible that learners were not truthful with their responses to this question, as they may have known that many of these types of sports supplements are illegal or banned in sport. Moreover, adolescents are often exposed to different kinds of drugs, and in particular pro-hormone supplements or androgenic anabolic steroids, which is evident from the large number of doping cases found among young sports individuals in South Africa (SAIDS, 2021). However, if this finding is true and accurate, it could be said that there is a lower chance that these adolescents are exposed to the dangers associated with pro-hormone supplements such as increased oestrogen levels; increased risk of cardiovascular disease; risk for premature cessation of bone growth, early onset of puberty, and many other risk factors (Claassen and Galant, 2011; King *et al*., 2012). Although adolescents may not experience side effects from the use of pro-hormone supplements in the short term, it is likely that their health may be affected in the long term.

Most participants believed the use of sports supplements is common among adolescent learners attending South African high schools, which corresponds with the

relatively high prevalence rates found in this study and a few other South African studies (Gradige, 2010; Van Aswegen, 2013; Nolte *et al.*, 2014; Welthagen, 2016; Mc Creanor *et al.*, 2017). The common use of these products by high school adolescents may be a result of the poor regulation of these products and ease of access/availability of them, where individuals can purchase sports supplements from online internet stores or over the counter from many local health stores or supermarkets (Herriman *et al*., 2017; Dwyer *et al*., 2018). Although most participants believed the use of these products is common, only a few believed the use of sports supplements is a problem among adolescent pupils attending South African high schools. This may point to the lack of understanding of the risks/dangers associated with sports supplements, which in turn may explain why many health professionals in South Africa are concerned about the increasing demands and the expansion of this industry (Gabriels *et al*., 2012).

The use of multiple supplements found in this study is consistent with previous research, which reported that it is common practice for adolescents to use multiple supplements, which may result in both a higher number of adverse reactions and in those reactions being more severe (Petróczi *et al*., 2008; Kotnik *et al*., 2018). This finding also supports previous arguments that in fact supplement manufacturers are not always at fault for causing adverse effects in consumers (Maughan *et al*., 2018). Rather, negligence on behalf of the consumer from either mixing of different products without regard to dosage or consideration of the interactions between various ingredients contained in different products may cause adverse effects (Maughan *et al*., 2018; Mazzeo *et al*., 2020).

Thus, the use of multiple sports supplements found in this study suggests that some participating adolescents are also subjecting themselves to this risky behaviour. This would especially be the case if they disregard the dosages of products they are using, and if the products have not been assessed/tested and certified by regulatory authorities or prescribed by a specialised professional in the field of sports supplements. However, understanding the certification and regulation of sports supplements was beyond the scope of this study, but should be an area for future research.

With reference to reasons for using sports supplements, male participants cited the need to recover from training, gym, or sports and thereafter, to help improve

performance at the gym as the main drivers. However, female participants mostly reported using them to get more energy. These findings support previous research, which argued that adolescent supplement use is generally centred on these products being “performance-focused” as opposed to “health-focused” (Petróczi *et al*., 2008; El Khoury and Antoine-Jonville, 2012; Dreher *et al*., 2018). Similar findings were also reported among male participants in two South African studies that found “improvement of sporting performance” as adolescents’ main reason for using these products (Gradige, 2010; Van Aswegen, 2013).

Using sports supplements for recovery purposes is important, as creating a balance between stress (training and competition load, other life demands) and recovery is essential for athletes to achieve continuous high-level performance (Kellmann *et al.*, 2018). This finding may also explain why protein and creatine products were the most prevalent type of sports supplement used by participants, as both products have been associated with recovery and performance enhancement (Cermak *et al*., 2012; Pasiakos *et al*., 2015; Kreider *et al*., 2017; Dolan *et al*., 2019). Furthermore, these reported reasons for use may be driven by the intensive training regimes placed on young athletes, which demand higher protein intake for greater metabolic adaptation, better remodelling, and faster tissue repair (Jovanov *et al*., 2019).

However, it is important to consider the fact that this study included adolescents who participated in non-mainstream school sports/physical activities (i.e., gym, crossfit). It also included participants who may not have competed in high level (1st or 2nd team for instance) sports but rather on a social level. This supports evidence that the use of sports supplements is no longer limited to conventional sporting athletes or high-level athletes, their popularity extends to individuals of all abilities across different activities (i.e., those who attend gyms regularly and/or those who are conscious about their health, wellness, and physical appearance) (El Khoury and Antoine-Jonville, 2012; Naidoo *et al*., 2018). Therefore, consistent with previous research, this study found that sports supplement use may not necessarily be linked to high level athletes, nowadays they are commonly used by adolescents who are involved in social or non-mainstream sports.

An important finding in this study was that friends, coaches/trainers, and parents/guardians were the most frequently cited sources of influence or advice for

adolescents' decisions to use sports supplements, which aligns with reports of previous research that adolescents are easily influenced by their parents, peers, and coaches/trainers to take substances (Šterlinko *et al*., 2012; Yager and O'Dea, 2014). Similarly, a South African study reported that adolescents often felt pressured by their peers and coaches/trainers to perform, which influenced their decisions to use performance-enhancing substances (Van Aswegen, 2013). The influence or advice by these sources may be inappropriate as many of them may have very little or no specialised education, knowledge and/or training in nutrition and supplement use (Shifflett *et al*., 2002; Sato *et al*., 2009; Šterlinko *et al*., 2012).

The fact that friends were most frequently reported as a primary source of influence or advice is a unique finding of this study. While this may be driven by many factors, it may be linked to how peer influence plays a key role in the increase in risk-taking behaviour during adolescence and is one of the most proximal factors for substance use (Van Hoorn *et al*., 2017; Henneberger *et al*., 2021). Adolescents often seek approval from their peers who place strong subjective value for physical performance or appearance and will often go to great lengths to achieve this (Albert *et al.*, 2013; Brown *et al*., 2017; Allen and Waterman, 2019). Thus, adolescents may rely on peers as a frame of reference and use peer feedback to set goals and rules of conduct (Brown *et al*., 2017). This means that adolescents may be engaging in risky behaviours such as substance use to gain acceptance or approval from their friends.

Although coaches/trainers were the second most frequently reported sources of advice or influence for adolescent supplement use, it is still an important finding and supports the findings of previous research that found coaches/trainers had a greater influence over adolescent's decisions to start using supplements, compared to that of nutritionists and general practitioners (Bastani *et al*., 2017). Thus, coaches/trainers need sufficient education or training in this area to ensure the dissemination of correct information so that the risks/dangers associated with adolescent supplement use may be mitigated. This is explored in more detail in the second part of this thesis.

It is also possible that the claims made by supplement manufacturers may have indirectly influenced adolescents to use supplements, as most participants reported claims of muscle growth/recovery and overall recovery on the label of the supplement/s that they use/used. This, in part, supports the argument that adolescents are

commonly influenced by the perceptions created through effective advertising and marketing strategies of supplement companies (Mc Creanor *et al.*, 2017; Mooney *et al*., 2017; Kotnik *et al*., 2018). Therefore, adolescents could be using these products because of their beliefs in the claims without understanding the product that they use/used (SAIDS, 2018). This may also account for why most participants (80%) believed that there are benefits from using sports supplements with "recovery purposes" as the most frequently cited benefit. However, this is only speculative and needs further investigation.

A large proportion of male participants reported knowing how the product they use/used functions within the human body, which contradicts previous research that has reported that most adolescents are unaware of what the supplements they used were supposed to achieve (Yager and O'Dea, 2014). However, this study did not test the actual knowledge of adolescents, thus they may only think they have the required or correct knowledge even if they do not. More recently, it was reported that adolescents exhibit a relatively low level of knowledge on the proper and intended use of sports supplements (Jovanov *et al*., 2019). Furthermore, adolescents may not understand how different sports supplements function within the human body given that very few had been formally educated or trained in supplement use, which supports the argument that there is a need for more education regarding adolescent supplement use (Gradige, 2010). Moreover, many participants did not know if the sports supplement/s they use/have used, were certified (approved) by a regulatory authority or organization that tests safety and effectiveness of sports supplements, which may be of concern as there is no guarantee that these products are free from contamination and unknown substances (SAIDS, 2018). As the governance and regulation of the local supplement industry is inadequate, many products are often marketed and sold with misleading claims and insufficient, inaccurate, or incorrect labelling (SAIDS, 2018). However, this may change over the next few years in South Africa due to the establishment of the South African Health Products Regulatory Authority (SAHPRA) formed by the South African government in February 2018 (Naidoo *et al.*, 2018). SAHPRA will oversee the regulation of health products and has the potential to enhance the monitoring, regulation, evaluation, investigation, inspection, and registration of medicines and related matters in the public interest (SAHPRA, 2018).

Most participants also believed that there are risks/dangers involved with the use of sports supplements, with most indicating “Incorrect/Negligent use” or “Major organ damage”, which is consistent with the arguments that consuming high doses or combinations of sports supplements for a long period can cause damage to major organs (i.e., liver, kidneys, and heart) (Mazzeo *et al*., 2020). There is also the risk of adverse effects when using untested or uncertified sports supplements (Mathews, 2017; Maughan *et al*., 2018). These findings could suggest that adolescents do have some sort of knowledge/understanding of potential risks/dangers involved with the use of these products, but whether this is enough to drive the cautious and informed use of sports supplements is difficult to determine.

Despite this, the reported prevalence of use found in this study is still relatively high with most participants using multiple supplements, and adolescents may be using sports supplements even with knowledge/understanding of risks/dangers associated. This could be attributed to participants perceptions of potential gains or achievements associated with sports supplements, which may be more important or outweigh their knowledge/understanding of potential risks/dangers associated with these products (Šterlinko *et al*., 2012; Herriman *et al*., 2017; Kotnik *et al*., 2018).

A critical finding of this study was that only a small number of participants indicated having some sort of training or formal education related to sports nutrition or sports supplements, a finding previously reported in a South African adolescent cohort (Van Aswegen, 2013). It however contradicts another South African study that reported most participants had been educated in some way about sports supplements (Welthagen, 2016). This difference, however, may have been due to the fact that Welthagen (2016) focused on elite adolescent athletes who need to be aware of the risks and benefits of sports supplements given the level they competed at. Education or training on supplement/substance use needs to extend beyond elite adolescent athletes and include those involved in recreational or non-mainstream sports or those involved in general or social physical activities/exercise. Therefore, the findings of this research and previous research stress that there is a need for an improved effort by high schools, coaching staff, parents/guardians, SAIDS, and medical practitioners to provide more education regarding supplement use to all high school adolescents (Gradige, 2010).

The lack of training or education may also account for why only just over half of the participants knew of the World Anti-Doping Agency (WADA) or the South African Institute for Drug-Free Sport (SAIDS). This is despite attempts that have been made by SAIDS to educate and create awareness around supplements among school going adolescents through nationwide campaigns (Van der Walt and Coopoo, 2016). This suggests that the important messages and information provided by these regulatory authorities might not be effective or have not reached adolescent populations. Despite only just over half of the participants having knowledge of these regulatory authorities, nearly all of the participants reported the need for regulatory companies/organisations to provide training or education addressing adolescent sports supplement use. This may be important as regulatory authorities such as WADA and SAIDS are valuable sources of information to help individuals weigh up the potential benefits against the risks/dangers of using supplements.

On the other hand, a critical question is whether the education and awareness programmes provided by regulatory authorities are even effective, as nearly a third of participants reported that they would use/continue using a sports supplement even if they knew/understood there were risks/dangers involved with that product. This supports previous findings in several other studies that many adolescents will use any product to achieve a positive result or goal regardless of the consequences (Šterlinko *et al*., 2012; Herriman *et al*., 2017; Kotnik *et al*., 2018). This shows that adolescents may take risks to achieve a desired goal regardless of the information or knowledge provided by such regulatory authorities. While there are likely many reasons for this, some include possible ignorance by young individuals or it could be the result of school sporting cultures that commonly value performance and success over wellbeing, which drive the choices of adolescents to find ways to improve their performance (Van Thuyne *et al.*, 2006; Gradige, 2010; Van Aswegen, 2013; Bastani *et al*., 2017; Marck *et al*., 2017). The unrealistic expectations placed on adolescents by these sporting cultures driven by influential figures such as friends and coaches/trainers, may increase the pressure to use substances to enhance performance (i.e., sports supplements) or to develop physical characteristics to improve performance (Patel *et al*., 1998; Brown *et al*., 2017). While this was beyond the scope of this study it would be important to explore this link to adolescent supplement use in future research.

Recommendations

Research recommendations

It is evident that there have been very few studies conducted in South Africa on the use of sports supplements, thus more studies are warranted. Due to the small sample size in this study, future research should include significantly more adolescent participants. A detailed power analysis should be conducted prior to running a study like this to ensure a representative sample size is known. This should include participants from both private and public schools, so that socio-economic and other unique contextual factors concerning supplement use can also be explored. Exploring female adolescent supplement use also needs attention as currently there is scarce research among these populations globally and in South Africa. Linked to this it would be particularly important to understand what supplements are used and the drivers around their use between male and female adolescents. Future studies should adopt different methods for data collection such as observation or interview methods as questionnaires may result in a bias of finding due to over reporting or under reporting or communication between individuals. While this study captured the types of supplements used by participants, it did not explore whether the supplements used met the claims made on the label, which is an area that should be taken into consideration for future studies. A few participants experienced negative side effects from using sports supplements, however, they were not asked what these side effects were and it is unsure whether these side effects were directly linked to supplement use, therefore this finding must be interpreted with caution and should be considered in future studies. Future research may also benefit from looking at the use of illegal/banned substances among high school adolescents given that there is a tendency of supplement use, which leads to the use of other substances such as androgenic anabolic steroids. Importantly, there is a need for future research to explore the link between systemic cultures within South African schools around sports prowess and achievement and how this may have an influence on supplement use among the learners within these schools. Linked to this there is a need for research observing possible interventions around regulation of the supplement industry locally and perhaps the effectiveness of interventions implemented within South African schools. This study was conducted during the Covid-19 pandemic; therefore, future research

should consider that some of the comparisons made between this study and studies conducted outside of Covid-19 limitations may be challenging.

Practical recommendations

Due to the relatively high prevalence of sports supplements use found among adolescents in this study as well as that in previous research, as well as the various attitudes and perceptions around the use of these products, a multi-pronged approach should be taken by schools to educate and create awareness around the use of these products. Firstly, schools should encourage a positive and open dialogue around supplement use, with the assistance of discussion forums for learners and their coaches/trainers to ask questions. Schools may also want to consider including a course on supplements and sports nutrition into the academic curriculum, which may help adolescents understand the possible risks/dangers and benefits associated with these products. It may also equip adolescents with the tools to identify products that have been passed through or certified by regulatory authorities. Another important approach that schools should consider is making use of regulatory authorities such as WADA and SAIDS to provide important information or services that will help adolescents and their coaches/trainers make safer decisions regarding nutrition and supplements. Moreover, schools may want to consider creating clear policies related to supplement use at schools to restrict the use of banned or dangerous substances.

Limitations of this study

There were limitations with this study. Due to the impact of the Covid-19 pandemic, it was difficult for the researchers to recruit participants from South African private high schools as many were trying to navigate online learning during the data collection period. As a result, many heads of schools or school gatekeepers declined to participate or did not respond to the invitation emails. This resulted in a small study sample particularly among female adolescents, which limited the ability to compare findings between sexes.

Further, the sample in this study did not reflect the broader adolescent population in South Africa as it only focused on adolescents from private high schools in certain areas of the country. This limits the generalisability of the study's findings to the broader private schooling sector and the public schooling sector.

There may have also been a selection bias as only participants who use/used or were interested in using sports supplements (or who were vehemently against their use) may have decided to participate in the study, thus leaving those who did not use or were not interested in using them out of the data set.

The environment in which participants answered the questionnaire was also not controlled, thus participants may have communicated with one another or with other personnel (i.e., parents), which may have affected the responses.

Some participants reported experiencing negative side effects from the use of sports supplements, however this study did not explore what these side effects were or whether these side effects were directly associated with sports supplement use. Therefore, it was unknown what negative side effects adolescents may be experiencing from the use of these products or whether it was these products that caused the side effects in the first place.

Lastly, this study did not focus on all types of nutritional supplements, which meant some participants may have used some sort of supplement but could not report it as the supplements they used did not fall within the “sports supplement” category, which was within the scope of this study.

Conclusion

In conclusion, this study found a relatively high prevalence of sports supplement use among a small sample of adolescents from South African private high schools. The use of these products was significantly more prevalent among male participants compared to females; however, this may have been a result of the very small sample of female participants. Most male adolescents reported their main reasons for using sports supplements were to recover from training, gym, or sports and thereafter, to help their performance at the gym. Female participants mostly reported the use of sports supplements to get more energy. Furthermore, the belief in recovery as a main reason or benefit for supplement use may explain why “protein products” were the most frequently reported sports supplement used male and female participants, likely given

the evidence that protein supplements have generally been associated with benefits linked to recovery and overall performance. These findings point to the fact that adolescents primarily use these products with the intention of increasing their performance. Apart from the perceived benefits to performance and recovery, the use of these products may also be driven by the influence of friends and coaches/trainers, given that both groups play a major role in the development and generally have a strong influence over the decisions and behaviours of adolescents. This finding is of concern given that several studies have reported these influential individuals often lack sufficient knowledge or education in this field and use unreliable sources for information. Moreover, the influence of these individuals along with the increasing professionalisation of South African high school sports, places undue pressure on adolescents to perform and is possibly the reason why some adolescents reported that they would take risks/dangers through the use of sports supplements. Furthermore, these risks may be the reason why some adolescents reported experiencing cases of negative side effects from the use of these products. Therefore, there is a need for ongoing research, education, and training programs by schools, with the assistance of regulatory authorities or organizations for adolescents to access information concerning sports supplements from reliable and credible sources, so that they can make informed decisions to use sports supplements safely, efficiently, and responsibly.

CHAPTER 4

Coach/Trainer study

"Coaches/trainers' perceptions (Knowledge; Attitudes; Application of knowledge) of sports supplement use in general and use among South African private high school adolescents".

Introduction

Adolescence is considered an important stage of life for positive development, which is needed for innate strengths and resources that they can build upon (Vella *et al*., 2011; Brown *et al*., 2017; WHO, 2019). The schooling space generally lays a platform for positive adolescent development through the creation and provision of various physical (e.g., physical structures and facilities), social (e.g., social support and social norms) or institutional (e.g., within-school rules and policies) support structures (Morton *et al.*, 2016). Participation in sport, which is one important component of holistic development associated with many general indicators of positive development, is one of the most popular activities that adolescents engage in (Hansen *et al*., 2003). However, mere participation in sport does not necessarily produce positive developmental outcomes (Holt and Neely, 2011), but rather the social interactions and connections that adolescents experience with other individuals in a sporting context may have a strong impact on their development (Truong *et al.*, 2021). These factors are largely based on how individuals such as coaches/trainers, parents, and peers contribute to the way adolescent sport is delivered and experienced (Holt and Neely, 2011).

Coaches/trainers play a significant role during the early stages of adolescents sporting careers, as they generally spend a lot of time together and as a result, adolescents can become very emotionally attached to and strongly influenced by coaches/trainers (Kondric *et al*., 2013; Mandic *et al*., 2013; Jovanov *et al*., 2019). Due to this connection, many coaches/trainers see themselves as responsible for the development of a holistic and diverse range of sport-specific and non-sport-specific competencies that are included in the notion of positive adolescent development (Vella *et al*., 2011). Adolescent coaches/trainers need to conduct themselves and their programs in a manner that is appropriate for the positive development of their athletes (Côté and

Gilbert, 2009). This is important as adolescent sports participation can be associated with numerous negative experiences, such as stress, negative peer interactions, social exclusion, negative group dynamics, inappropriate behaviour, and the use/misuse of substances (Siegenthaler and Gonzalez, 1997; Hansen *et al*., 2003; Fraser-Thomas and Côté, 2009; Holt and Neely, 2011; Boyes *et al*., 2017; Gustafsson *et al*., 2017). The interactions and mutual trust between young athletes and their coaches/trainers are important not only for their achievements but more importantly, for how these relationships may directly influence athletes' choices and behaviours (Kondric *et al*., 2013; Mandic *et al*., 2013). Moreover, a meaningful and supportive relationship between coaches and their athletes can potentially make a positive contribution to how adolescent athletes view themselves physically and psychologically (i.e., in their abilities; body image; overall performance) (Jowett and Cramer, 2010).

Over and above individual interactions, the team cultures generated in different sports may also influence athlete development and behaviors (Garthe and Ramsbottom, 2020). Team cultures, while complex and multi-faceted, are typically created by coaches, managers, and leaders of sports teams or clubs (Garthe and Ramsbottom, 2020) and influenced by other decision-makers within schools as well. Many underlying team cultures create an atmosphere that facilitates or encourages increased performance, regardless of the risks or negative consequences to the health and wellbeing of athletes (Garthe and Ramsbottom, 2020). In the context of a schooling environment, this is possibly a result of the professionalisation of adolescent sport, which has seen school sports become a commercial enterprise with high financial stakes not only for the adolescents but also for parents, administrators, coaches/trainers, and communities (Vosloo, 2014; Camiré and Santos, 2019). Due to adolescent sport becoming more competitive and adult-driven, team cultures may often adopt a "winning at all costs" mentality that has little consideration for the presence of undue pressure (Gradige, 2010; Nwankwo and Ekechukwu, 2020). Thus, adolescents may take various risks or means to ensure optimal performance at all times to achieve this success (Gradige, 2010; Nwankwo and Ekechukwu, 2020). However, the pressure of achieving successful performance is not only placed on adolescents but also coaches, which may in turn lead to coaches introducing adolescent athletes to substances such as sports supplements (Nwankwo and Ekechukwu, 2020).

Extensive evidence shows that adolescents are easily influenced by coaches/trainers (Sundgot-Borgen *et al*., 2003; Nieper, 2005; Rodek *et al*., 2012; Sajber *et al*., 2013), parents, and friends to use sports supplements (Gabriels *et al*., 2012; Šterlinko *et al*., 2012; Yager and O'Dea, 2014; Barnes *et al*., 2016). This is of concern as previous research has reported that coaches/trainer's knowledge about sports nutrition and sports supplements is often insufficient (Malik and Malik, 2010; El Khoury and Antoine-Jonville, 2012; Bastani *et al*., 2017; Kubayi *et al*., 2018). The knowledge about sports nutrition and supplements need not only be about what the products are used for or intended to achieve, but also how they should be used by each specific individual (Duvenage *et al*., 2015). Furthermore, the process of advising and prescribing supplements is intensive and requires an in-depth understanding of each athlete, while considering potential interaction with factors such as diet, medical history, lifestyle, and training (Duvenage *et al*., 2015). This accounts for why multiple studies have reported a need for intervention programmes to provide meaningful education and awareness on sports supplement use for coaches/trainers (Nieper, 2005; Gradige, 2010; Welthagen, 2016).

4.1 The influence of coaches/trainers on adolescent behaviours and decisions

Coaches/trainers are often placed in a position of leadership as they play multiple roles in adolescent's lives and are commonly relied on for both instruction and support (Keegan *et al.*, 2009). Adolescent athletes also require coaches'/trainers' specialised knowledge to refine their skills to perform optimally, and because of this, they generally develop a level of dependency on their coaches (Stirling and Kerr, 2009). Thus, coaches/trainers are generally perceived as credible sources of information (Nieper, 2005; Molinero and Márquez, 2009) and it is often assumed that they are providing advice in an area that they are knowledgeable in when in fact they are likely to be inaccurate (Cockburn *et al*., 2014).

Another reason why coaches/trainers have been regarded as a primary source of information and/or influence for sports nutrition and supplement use is that, in more recent years, coaches have shown increasing interest in controlling and enhancing adolescent athlete's nutrition (Sajber *et al*., 2013; Cherian *et al*., 2020). This stems from the fact that adolescent perceptions, dietary behaviours, and practices are still modifiable during this age, and it is a way of scientifically grooming the young athlete

(Manore *et al*., 2017; Cherian *et al*., 2020). Thus, the work of specialised professionals (i.e., sports nutritionists; dieticians; doctors) is often carried out by sports coaches/trainers (Cherian *et al*., 2020).

Although many coaches/trainers believe they are doing this in the best interests of the young athlete, it is important to note that some coaches' careers and/or income depend on the performance of their athletes (Stirling and Kerr, 2009). Thus, the pressures placed on the coach/trainer may lead to decisions that go against the well-being of the athlete regardless of their knowledge or understanding (Stirling and Kerr, 2009; Nwankwo and Ekechukwu, 2020). This was shown in a South African study where coaches reported that they often felt pressured to ensure that adolescents performed well at a competitive level and were positively inclined to using sports supplements to achieve this (Van der Walt and Coopoo, 2016).

Table 4.1 captures some examples of global studies that have reported on the role that coaches play as a source of information or influence around adolescent and young adults' choices about using supplements.

It is evident from several studies listed in Table 4.1 that coaches/trainers are frequently cited sources of influence, advice, and information for adolescent and young adult's decisions regarding supplements (Dascombe *et al*., 2010; Malik and Malik, 2010; Hozoori *et al.*, 2016; Jovanov *et al.*, 2019; Mas *et al*., 2019). Coaches/trainers are considered unreliable sources, yet they often have a greater influence than that of doctors and dieticians when it comes to young athlete's decisions about sports nutrition or supplement intake given their relationship with the adolescent athlete (Nieper, 2005; El Khoury and Antoine-Jonville, 2012; Jawadi *et al*., 2017). However, the internet or online sources are also frequently reported sources of influence, advice, and information (El Khoury and Antoine-Jonville, 2012; Hozoori *et al.*, 2016; Jawadi *et al*., 2017; Jovanov *et al.*, 2019), which likely reflects the ease of access that has been facilitated by increased use of technology, online shopping, and globalization (Van Thuyne *et al.*, 2006; Evans *et al*., 2017; Catalani *et al.*, 2021).

Table 4. 1: A summary of studies that reported on adolescent's primary sources of influence/information for sports supplement use.

Studies	Sample Size (n)	Mean age range	Country	Primary source of influence/information (%)	Methodology
Nieper (2005)	32 (Track & Field Athletes)	18	United Kingdom	Coaches (>30%) Sports dietitians (30%) Doctors (25%)	Questionnaire
Dascombe *et al*. (2010)	72 (Athletes)	21.9	Australia	Self-Influence (17%) Coaches (15%)	Questionnaire
Malik & Malik (2010)	273 (Male participants)	20.4	India	Coaches (35.8%) Friends (34.5%)	Questionnaire
El Khoury & Antoine-Jonville (2012)	512	N/A	Lebanon	Coaches (44.6%) The Internet (36.6%) Physicians (34.4%)	Questionnaire
Hozoori *et al*. (2016)	195 (Male Athletes)	25	Iran	Coaches (64%) Nutritionists (24%) The Internet (23%)	Questionnaire
Tawfik *et al*. (2016)	358	14.3	Egypt	Coaches (46.4%)	Questionnaire
Jawadi *et al*. (2017)	299	27	Saudi Arabia	Online sources (38%) Coaches (35.4%) Physician (13.3%)	Interview questionnaire
Jovanov *et al.* (2019)	348 (Athletes)	15-18	Serbia; Germany; Japan; Croatia	Coaches (41.4%) The Internet (39.4%) Physician (8.1%)	Questionnaire
Mas *et al*. (2019)	120 (Athletes)	14.7	United States	Coaches (52%) Family members (34%)	Questionnaire

Table 4.2 captures some examples of South African studies that reported on adolescents and young adults' primary sources of information or influence for supplements, and specifically the role that coaches/trainers play as a source of information or influence on supplement use.

Table 4. 2: Examples of a few South African studies which reported young athletes' primary sources of influence/information for sports supplement use.

Studies	Sample Size (n)	Mean age range	Province	Primary source of influence/information (%)	Methodology
Gradige (2010)	100	15-18	Gauteng	Internet (74%) Magazines (72%) Coaches (66%)	Questionnaire
Van Aswegen (2013)	122	14-18	Western Cape	Coaches/Trainers (89%) Pharmacist (52%) Internet (43%)	Questionnaire
Nolte (2014)	346	<18	Gauteng	Coaches (29.7%) Parents (19.4%) Friends (16.5%)	Questionnaire
Duvenage *et al*. (2015)	84 (Male rugby players)	<16	All provinces	Non-nutritional medical staff (i.e., physio, pharmacist, biokineticist) (22%) Coaches (20%) Self (10%)	Questionnaire
Welthagen (2016)	20	15-17	Free State	Internet (35%) Coaches (30%) Friends (30%)	Questionnaire
Kisten & Naidoo (2019)	449 (Soccer players)	N/A	KwaZulu-Natal	Coaches (74.6%) Books (74.2%) Personal trainer (73.9%)	Questionnaire

According to studies in Table 4.2, it is evident that coaches/trainers are also commonly cited as a primary source of influence, advice, and information for adolescent supplement use in South Africa (Van Aswegen, 2013; Nolte, 2014; Kisten and Naidoo, 2019). Some authors argue that coaches/trainers often place pressure on adolescents to perform or succeed, which influences the use of substances like sports supplements (Gradige, 2010; Van Aswegen, 2013). However, some of these South African studies also reported the internet (Gradige, 2010; Welthagen, 2016), parents, and friends as primary sources (Nolte, 2014; Welthagen, 2016).

4.2 Coaches/trainers' sources of information regarding sport supplements

Several studies have found that most coaches/trainers declare self-education as their primary source of information regarding sports nutrition and supplements (Sundgot-Borgen *et al*., 2003; Rodek *et al*., 2012; Mandic *et al*., 2013; Sajber *et al*., 2013). Some examples of sources used for self-education include books, magazines, internet sites

and social media platforms (Sekulic *et al*., 2019). In one study, coaches mostly relied on the internet to source their information, which the authors argued may affect the quality of the information obtained (Cockburn *et al*., 2014). Self-education can be particularly risky, especially when it results in the dissemination of incorrect information (Rodek *et al*., 2012; Torres-McGehee *et al*., 2012), given that the use of sports supplements is generally only safe when they are prescribed (by a professional in the sports nutrition or sports supplement field) (Rodek *et al*., 2012). This ensures that sports supplements are chosen appropriately (i.e., tested/regulated supplements) and consumed in the right amounts (i.e., correct dosage or quantity) (Rodek *et al*., 2012). Ensuring that coaches (or those giving advice) are knowledgeable enough to do so may go a long way to limiting the risk of positive doping, which is typically higher when misinformed/uninformed coaches are involved in this process (Dascombe *et al.*, 2010). While more research is needed, it appears that the quality of information or advice that adolescents obtain from coaches/trainers may be considered questionable (Sundgot-Borgen *et al*., 2003; Nieper, 2005; Whitehouse and Lawlis, 2017; Sekulic *et al*., 2019).

4.3 Coaches/trainers knowledge and awareness of sports supplement use

Sports coaches/trainers often believe that supplementation and nutrition is an aspect that is not within their area of expertise (Allen *et al*., 2017). This was shown in a South African study, which reported that from a sample of 202 sports coaches, “Improving the technique/efficiency of athletes” and “Reducing the incidence of injury/illness in athletes” were their most preferred areas of coaching, whereas “Nutrition and supplementation for athletes” was one of their least preferred areas of coaching (Kubayi *et al*., 2018). This may be problematic as knowledge about sports nutrition and supplements is often linked to and may influence other areas of coaching/training when looking at a holistic approach towards athlete wellbeing, performance, and development (Kubayi *et al*., 2018). Moreover, the coaching process involves ‘*ologies*’ (e.g., psychology, biomechanics, exercise physiology, nutrition), sport-specific knowledge (technical/tactical), and pedagogy (e.g., motor cognitive learning, coach behaviour) that interact to achieve the end goal of coaching (Abraham *et al.*, 2006; Cockburn *et al*., 2014).

Coaches/trainers awareness is also important as adolescent athletes may be reluctant to change their habits unless they are supported by their coach/trainer (Nieper, 2005).

Their awareness of young athletes' sports supplement use can also be considered positive, in circumstances where they are fully aware and knowledgeable of the product being used, it's intended effects as well as the dosage thereof (Van Aswegen, 2013). However, evidence from one South African study found that most coaches were unfamiliar with the substances published on the WADA prohibited list, and many were unaware of what types of supplements were being consumed by their athletes (Kisten and Naidoo, 2019).

In part, coaches/trainers lack of understanding or awareness may stem from the fact that they often have no compulsory nutrition or supplement education, which means they generally lack appropriate knowledge in this area (Nieper, 2005). Moreover, the minimum requirements for obtaining a coaching/trainer license in most low-income countries are not as stringent as those in middle and high-income countries (Muwonge *et al*., 2017), with some authors arguing that coaches from low-income countries rarely undertake additional nutrition training as part of their continued professional development (Torres-McGehee *et al*., 2012; Cockburn *et al*., 2014; Muwonge *et al*., 2017) even though this is important. In contrast, coaches/trainers from high-income countries are required to complete specialised coaching education before being certified, a module of the curriculum entails sports nutrition and supplementation (Muwonge *et al*., 2017). Therefore, a basic understanding and knowledge in multiple fields of sports science need to be incorporated in coaching certification to assist them in giving informed advice during their coaching practice rather than solely relying on personal experiences, as they are generally at the 'sharp end' where the application of this information is required (Haff, 2010; Kubayi *et al*., 2018).

4.4 Interventions and educational programs for coaches/trainers

Although coaches/trainers may have a better understanding and knowledge of sports nutrition and supplements than their athletes, some argue that the level of knowledge and understanding must be improved (Mandic *et al*., 2013). It was even suggested that there is a need for the enforcement of education programs about sports supplements (Jovanov *et al*., 2019), as the education of both coaches/trainers and young athletes is a key strategy towards minimizing the risks associated with sports supplement practices (Whitehouse and Lawlis, 2017). Nutrition and supplement education or training programs may also improve the relationship and trust between

coaches/trainers and their athletes (Nieper, 2005; Mandic *et al*., 2013), and ensure adolescent athletes are provided appropriate guidance to make the correct choices (Hozoori *et al.*, 2016).

According to a South African study it was suggested that coaches/trainers should be educated on healthy and strategic physical conditioning practices (i.e., pre-season training), as this may reduce the pressures placed on young athletes to achieve physical attributes relevant for specific sports (Wright *et al*., 2014). Moreover, coaches/trainers should place more emphasis on a healthy and balanced diet and ensure that these interventions are not detrimental to the young athlete's health (Wright *et al*., 2014). Another South African study suggested that a structured program of intervention should be implemented to provide meaningful education to coaches/trainers, adolescents, and their parents/guardians on sports nutrition and the effects or side-effects of supplement use (Gradige, 2010). Similarly, schools should be encouraged through incentives to make use of regulatory authorities like the South African Institute for Drug-Free Sport (SAIDS), with coaches/trainers taking responsibility for this as they are generally the entity closest to adolescent athletes (Van der Walt and Coopoo, 2016).

4.5 Summary, rationale and overall aims of this study

Coaches/trainers are generally very closely involved and connected to the development of young athletes, and are frequent sources of influence, advice, and information concerning adolescent supplement use (Sundgot-Borgen *et al*., 2003; Nieper, 2005; Rodek *et al*., 2012; Kondric *et al*., 2013; Mandic *et al*., 2013 Sajber *et al*., 2013). They often do this with suboptimal knowledge or education in this area (Trakman *et al*., 2016; Jacob *et al*., 2019). Moreover, they commonly rely on sources that are not credible or unreliable, which may lead to the dissemination of incorrect or poor-quality advice or information (Rodek *et al*., 2012 Jacob *et al*., 2019; Sekulic *et al*., 2019). The lack of knowledge or understanding of sports nutrition and sports supplements is also said to be a result of coaches/trainer's belief that this aspect is not within their area of expertise (Allen *et al*., 2017; Kubayi *et al*., 2018). This has resulted in many coaches/trainers being unaware of the substances their athletes are using as well as the role that the regulatory authorities play regarding the use of many of these substances (Kisten and Naidoo, 2019). Furthermore, South African school sport has

become more professional, particularly within the private school sector (Vosloo, 2014). This has resulted in many of these schools using their sporting prowess as an identity marketing tool (Vosloo, 2014). This means coaches/trainers may often feel pressured to achieve success through their athletes and may turn to the use of various methods, such as sports supplements, to maximise this likelihood of succeeding. In light of this, there is a need for education programs for both coaches/trainers and young athletes to help minimise the risks/dangers associated with sports supplement practices (Whitehouse and Lawlis, 2017; Jovanov *et al*., 2019). Despite literature indicating that coaches/trainers are frequently cited sources of influence, advice, and information for adolescent supplement use, there is relatively limited research within this domain in South Africa and across private schools in particular, therefore, this study will observe coaches/trainers' perceptions (knowledge; attitude; application of knowledge) of sports supplement use generally and among private high school adolescents.

4.6 Main objectives of this study

- To determine coaches/trainers' knowledge/awareness towards sports supplements. This includes perceived knowledge/awareness and experiences of sports supplements.
- To determine the application of knowledge of sports supplements by coaches/trainers. This will explore how coaches/trainers' practice and/or make decisions on the use of sports supplements by high school adolescent learners, based on their perceived knowledge.
- To determine the attitudes/beliefs of coaches/trainers towards the use of sports supplements. This includes their attitudes/beliefs towards sports supplements in general as well as their attitudes/beliefs towards high school adolescent's use of these products.

*Sports supplement: Ergogenic aids, which typically take the form of tablets, capsules, liquids, gels, or powders and are intended for oral ingestion. Commonly used with the intention of improving or enhancing physical/athletic performance or physical appearance.

Methods

Study design

This study adopted a cross-sectional design that focused on exploring a cohort of South African private high school sports/physical activity coaches/trainer's perceptions (knowledge; attitudes; application of knowledge) of sports supplement use in general and in relation to their interactions with their high school adolescents. This study took a similar design to that used in a previous study by Bastani *et al*. (2017), which explored the knowledge, attitudes, and practice of Iranian bodybuilding coaches surrounding sports supplements and advising athletes.

Study data collection instrument

The study data collection instrument (Appendix 8) was an anonymous, self-administered online questionnaire. All questions used in this data collection instrument were taken or adapted from validated questionnaires that were used in previous studies, all of which were published in the public domain and freely available and accessible to use. It was hosted online via "Google Forms" and consisted of five sections which included closed and open-ended questions. The questionnaire collected qualitative and quantitative data on the perceptions (knowledge; attitudes; application of knowledge) of sports supplements among coaches/trainers who worked within the private schools that agreed to participate in this study. The questions used in sections two, three, and four were adapted from a previous study by Bastani *et al*. (2017), which was designed based upon the comments of experts and from the study by Mehralian *et al*. (2014) respectively, which focused on the knowledge, attitude, and practice of pharmacists regarding dietary supplements. Moreover, the questions in sections two, three, and four were all based on a Likert scale and scored from one: "strongly disagree" to five: "strongly agree".

Section 1: General demographic information.

This section required participants to give their general demographic information, such as age; sex; school location, and sport/physical activity coached/trained.

Section 2: Knowledge of sports supplements.

This section required participants to answer questions related to their perceived knowledge of sports supplements. The questions used in this section focused on

general knowledge of sports supplements, efficacy, side effects, dosage, and administration, and sports supplement-drug interactions (Bastani *et al*., 2017).

Section 3: Attitude towards sports supplements.

This section required participants to answer questions related to their attitudes towards the use of sports supplements. The questions used in this section focused on attitudes towards the impacts, efficacy, dispensing, and education around the use of/about sports supplements (Bastani *et al*., 2017).

Section 4: Application of sports supplement knowledge.

This section required participants to answer questions related to their perceived application of knowledge of sports supplements. The questions used in this section focused on participant's advice, recommendations, education, supervision, and administration of sports supplements (Bastani *et al*., 2017).

Section 5: General questions related to the use of sports supplements among high school adolescents.

This section required participants to answer closed and open-ended questions related to sports supplement use. The questions in this section were used in previous studies conducted by Zinn *et al*. (2004); Judge *et al*. (2010) and Cherian *et al*. (2020) respectively. This section gave coaches/trainers an opportunity to elaborate on their personal attitudes; beliefs and experiences relating to sports supplements in general and there use among adolescents. Many of the questions used in this section were also used in the adolescent study (cited above), this was done to explore the similarities and differences in findings between the two population groups (Appendix 8).

Ethical approval and gatekeeper permission

Prior to the commencement of this study the "Rhodes University Human Ethics Committee" (RU-HEC) reviewed and gave provisional approval of the methodology, tracking number: (HKE-2018-22) (Appendix 5). Thereafter, the initial email was sent from the researchers to various school gatekeepers. Heads of schools who were interested in participating in the study were asked to sign a permission form and return it to the researchers (Appendix 6). This signed form was then sent to RU-HEC for final

ethical clearance. This process happened at the same time as the abovementioned adolescent study.

Recruitment of participants and procedures of the study

The researchers approached 37 private high schools listed by the Independent Schools Association of Southern Africa (ISASA, 2020); from these schools, there were seven that agreed to participate in this study. There were three situated in Gauteng province, two situated in the Eastern Cape province, one situated in Kwa-Zulu Natal province, and one situated in the Western Cape province. Only private schools were approached because of the effect that socio-economic status has on sports supplement use (i.e., the literature indicates that there is generally a higher prevalence of sports supplement use among individuals with higher socio-economic strata) (Maughan, 2005; Gardiner *et al*., 2007; Gardiner *et al*., 2008; South African Institute for Drug-free Sport, 2018; Arenas-Jal *et al*., 2019).

Initially, school gatekeepers (i.e., school principals) were contacted via email and invited to participate (Appendix 2). The initial approach email was sent to all the school gatekeepers on the 16th of April 2020. Due to the Covid-19 pandemic and hard lockdown restrictions implemented throughout the country during this period, schools faced great challenges and were unable to respond to the initial approach email. Therefore, a follow-up email was sent on the 2nd of June 2020 to all school gatekeepers who did not respond to the initial email (Appendix 3). Once school gatekeepers had given signed permission to conduct the study within their school and "RU-HEC" had given final ethical clearance. The researchers sent a secondary email that requested school gatekeepers or other relevant stakeholders directly involved in the study to email all high school sports coaches/trainers working within their school and to invite them to participate in the study.

Ethical considerations

Participant consent

Coaches/trainers who worked within the private high schools that agreed to participate in this study were sent an invitation email via school administration. The email included a link to the online questionnaire. The first page of the online questionnaire included an information letter inviting them to participate in the study as well as an indication of participant rights and responsibilities (Appendix 8). Below this letter was a consent box

(Appendix 8). The participant had to select the agreement option on the consent form to allow them to participate in the study.

Study sample

Within the seven private schools that agreed to participate in the study, 49 coaches/trainers met the inclusion criteria and agreed to participate in the study. We were interested to explore this alongside the results from the adolescent study, the participants of whom were from the same private schools.

Inclusion criteria

Coaches/trainers that worked at South African private high schools where gatekeeper/s or other relevant stakeholders believed this study was relevant for their school (i.e., School principal believed the use of sports supplement use is prevalent in their school) and gave signed consent for the study to commence within the school.

Data Analyses

Initially, all collected data were reduced and analysed through descriptive statistical methods. Categorical parameters were descriptively analysed or displayed in tables and figures using frequencies and percentages. Mean ± SD were used for the age of participants and Likert scale scores were adapted from the approach taken from Bastani *et al*. (2017). The Likert scales scored from one to five, each individual response was numerically scored and an average of all participants responses to each of the questions was calculated (i.e., 1 “strongly disagree”; 2 "disagree"; 3 "undecided"; 4 "agree"; 5 “strongly agree”). The average of these scores were then graded in the following way: 1 “Very weak”, 2 “Weak”, 3 “Intermediate”, 4 “Good”, and 5 “Excellent”, respectively and was based upon the approach taken by Bastani *et al*. (2017). All analyses were conducted using Microsoft® Excel® for Microsoft 365.

Open-ended questions were clustered into common themes of response using frequencies and percentages. The thematic analysis from Braun and Clarke (2006) was followed using a six-step guide. The six-step guide used for this study was the same as that used in “Chapter 3 - Adolescent study”. This means that the responses from participants went through a six-step thematic analysis and were placed into major themes and sub themes according to similarities (e.g., Participants that reported adolescents may get addicted to sports supplements, fell under the common theme of

[i.e., Substance abuse] whereas, participants that reported sports supplements may cause damage to kidneys, fell under the common theme of [i.e., Major organ risk]).

Results

General demographic information

Age and Sex of participants

A total of 49 coaches/trainers participated in this study. There were no participants from two of the seven schools that agreed to participate in the study. From the total study sample, there were 41 (84%) male participants and eight (16%) female participants. The mean age for the 48 participants that answered this question was 34 ± 11 years. There was one participant that did not report his/her age.

Location of private school's where participants worked

Most participants 33 (67%) were from "Gauteng", 10 (20%) from "Eastern Cape", four (8%) from "KwaZulu-Natal" and only one (2%) from "Western Cape". There was one (2%) participant that did not mention the province.

Sports/Physical activities participants coached/trained

Regarding the sports/physical activities the participants reported coaching/training a total of 96 responses were logged. Eighteen (37%) participants reported rugby, 17 (35%) reported hockey, and 12 (24%) reported cricket as the sport/physical activities they coached/trained. Other sports mentioned are shown in Table 4.3. There were two participants who did not report any sports/physical activities that they coached/trained (Table 4.3).

Table 4. 3: Frequency of sports/physical activities coached/trained by all participants.

Sports/Physical activities	Total participants (n=49)
Rugby	18 (37%)
Hockey	17 (35%)
Cricket	12 (24%)
Athletics	11 (22%)
Cross country running	7 (14%)
Soccer	5 (10%)
Waterpolo	5 (10%)
Basketball	4 (8%)
Gym	3 (6%)
Golf	2 (4%)
Netball	2 (4%)
Rowing	2 (4%)
Swimming	2 (4%)
Crossfit	1 (2%)
Equestrian	1 (2%)
Squash	1 (2%)
Tennis	1 (2%)
Mountain biking	1 (2%)
Underwater Hockey	1 (2%)
Not Mentioned	2 (4%)

Reported knowledge of sports supplements

The question with the highest mean score on the Likert scale (3.3 ± 1.2) was “I have sufficient knowledge about the side effects of sports supplementation”, so on average participants were “Undecided” or “Agreed” to this question, which was graded was as “Intermediate” – “Good” knowledge. The question with the lowest mean score (2.5 ± 1.3) was “I have sufficient knowledge about sport supplement-drug interactions”, so on average participants “Disagreed” or were “Undecided” about this question, which was graded as “Weak” – “Intermediate” for perceived knowledge. The other questions mean response scores all fell within the “Weak” – “Good” grade for perceived knowledge (Table 4.4).

Table 4. 4: Mean scores and grades for questions related to perceptions of knowledge of sports supplements.

Questions	Mean score and grade of all participants (n=49)
I have sufficient knowledge about the side effects of sports supplements.	3.3 ± 1.2 "Intermediate" – "Good"
Generally, I have sufficient knowledge about sports supplements.	3.2 ± 1.1 "Intermediate" – "Good"
I have sufficient knowledge about the efficacy (Effectiveness) of sports supplements.	3.2 ± 1.1 "Intermediate" – "Good"
I have sufficient knowledge about the dosage and administration of sports supplements for adolescents.	2.6 ± 1.2 "Weak" – "Intermediate"
I have sufficient knowledge about sport supplement-drug interactions.	2.5 ± 1.3 "Weak" – "Intermediate"

Attitudes towards regulation, efficacy, and education about sports supplements

Regarding coaches/trainers' attitudes towards sports supplements, participants were asked to rate their attitudes towards the questions from one: "Strongly disagree" to five: "Strongly agree". The question with the highest mean score on the Likert scale (4.4 ± 0.7) was "Pharmacists should be knowledgeable about sports supplements and consulting in this field should be part of their duties", which on average participants "Agreed" – "Strongly agreed" on. The question with the lowest mean score (2.1 ± 1) was "There is adequate educational content available in schools about sports supplementation", which on average participants "Disagreed" – "Undecided" on. The mean responses for participants' attitudes towards the other questions all fell within the "Disagree" – "Agree" attitude (Table 4.5).

Table 4. 5: Mean scores and grades for questions related to the attitude towards sports supplements.

Questions	Mean score and grade of all participants (n=49)
Pharmacists should be knowledgeable about sports supplements and consulting in this field should be part of their duties.	4.4 ± 0.7 "Agreed" – "Strongly Agreed"
Sports supplements should be sold in pharmacies under pharmacists' supervision.	3.9 ± 1.1 "Undecided" – "Agreed"
Sports supplements should only be dispensed according to a nutritionist or physician's prescription.	3.9 ± 1.3 "Undecided" – "Agreed"
Sports supplements have a positive impact on improving physical activities and energy.	3.2 ± 1 "Undecided" – "Agreed"
The therapeutic efficacy of sports supplements may be considered the same as other pharmaceuticals.	2.6 ± 1 "Disagreed" – "Undecided"
There is adequate educational content available in schools about sports supplements.	2.1 ± 1 "Disagreed" – "Undecided"

Application of sports supplement knowledge

With regards to coaches/trainers' application of sports supplement knowledge, the question with the highest mean score on the Likert scale (3.5 ± 1.3) was "I always inform adolescent pupils about possible adverse effects of sports supplements", so on average the participants were "Undecided" or "Agreed", which was graded as "Intermediate" – "Good" application of knowledge. The question with the lowest mean score (1.8 ± 1) was "I always recommend sports supplements to adolescent pupils with confidence about their effectiveness", which was graded as "Very weak" – "Weak" application of knowledge. The mean response grades for the other questions all fell within the "Weak" – "Good" bracket for application of knowledge (Table 4.6).

Table 4. 6: Mean scores and grades for questions related to the application of perceived knowledge of sports supplements.

Questions	Mean score and grade of all participants (n=49)
I always inform adolescent pupils about possible adverse effects of sports supplements.	3.5 ± 1.3 "Intermediate" – "Good"
I always devote my time to give advice to adolescent pupils that use/want to use sports supplements.	3.3 ± 1.3 "Intermediate" – "Good"
I have studied some scientific references regarding sports supplements.	2.8 ± 1.4 "Weak" – "Intermediate"
I can refer to valid web pages or scientific references regarding sports supplements if needed.	2.7 ± 1.3 "Weak" – "Intermediate"
I always check whether a particular sports supplement used by an adolescent pupil interacts with his/her medication.	2.4 ± 1.3 "Weak" – "Intermediate"
I always advise adolescent pupils about dosage and administration of sports supplements.	2.3 ± 1.3 "Weak" – "Intermediate"
I have self-confidence to recommend sports supplements.	2 ± 1.1 "Weak"
I always recommend sports supplements to adolescent pupils with confidence about their effectiveness.	1.8 ± 1 "Very weak" – "Weak"

General questions related to the use of sports supplements

Participants questions concerning sports supplements

Participants were given an opportunity to ask any questions they wanted to be answered regarding sports supplements in general or sports supplements South African high school adolescents use/have used/are looking to use. Most participants 41 (84%) reported "No" and eight (16%) reported the following questions:

> *"I would love to have a comprehensive list with all the necessary information of supplements that children use"*
>
> *"Why aren't WADA courses/modules a compulsory component of all coaching courses?"*
>
> *"Are there good supplements that adolescents can take for recovery etc.?"*
>
> *"If sports supplements have adverse effects on pupils, is there a possibility of controlling or reducing the intake of such products by the pupils?"*

"Who to talk to or send athletes to, should they require information on sports supplementation?"

"How can sports supplements be used in an effective yet safe way to help athletes?"

"Do children who do not have access to adequate nutrition at home, benefit by taking sports supplements that are provided by a school?"

"Why would high school pupils need sports supplements and for how long will they use them?"

Main sources of information/advice regarding sports supplements

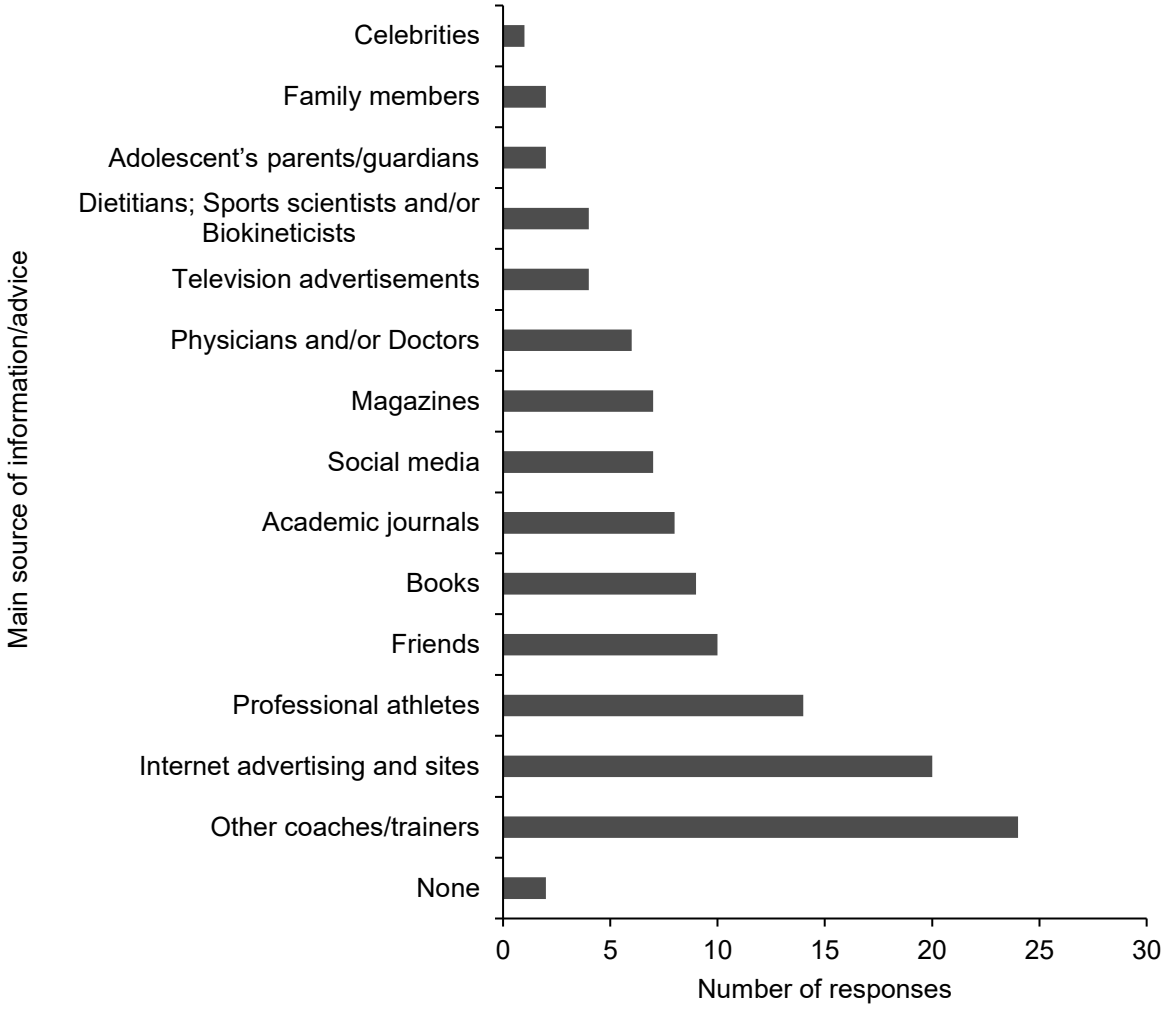


Figure 4. 1: Frequency of main sources of information/advice concerning sports supplements.

There were a total of 118 responses to the question that asked who/what their main source of information or advice was concerning sports supplements. The most frequently cited sources were 24 (20%) responses for “Other coaches/trainers”, 20 (17%) responses for “Internet advertising and sites”, and 14 (12%) responses for “Professional athletes”. Other sources that were reported included “Friends”, “Books”, “Academic journals”, “Social media”, “Magazines”, “Physicians and/or doctors”, “Television advertisements”, “Dietitians; Sports scientists and/or Biokineticists”, “Adolescent’s parents/guardians”. “Family members”, and “Celebrities” all of which are illustrated in Figure 4.1. There were two (2%) none responses for main sources of information/advice (Figure 4.1).

Participant’s awareness of the type of sports supplement used by adolescents

There were 71 total responses from 17 (35%) participants who reported “Yes” to being aware of the types of sports supplements used by adolescents. “Protein products” were the most frequently cited sports supplements that coaches/trainers were aware of adolescents using with 20 (28%) responses for this product, this was followed by 17 (24%) responses for “Amino acid products”, 15 (21%) responses for “Creatine products”, 15 (21%) responses for “Stimulant products”, and only four (6%) responses for “Pro-hormone products” (Figure 4.2).

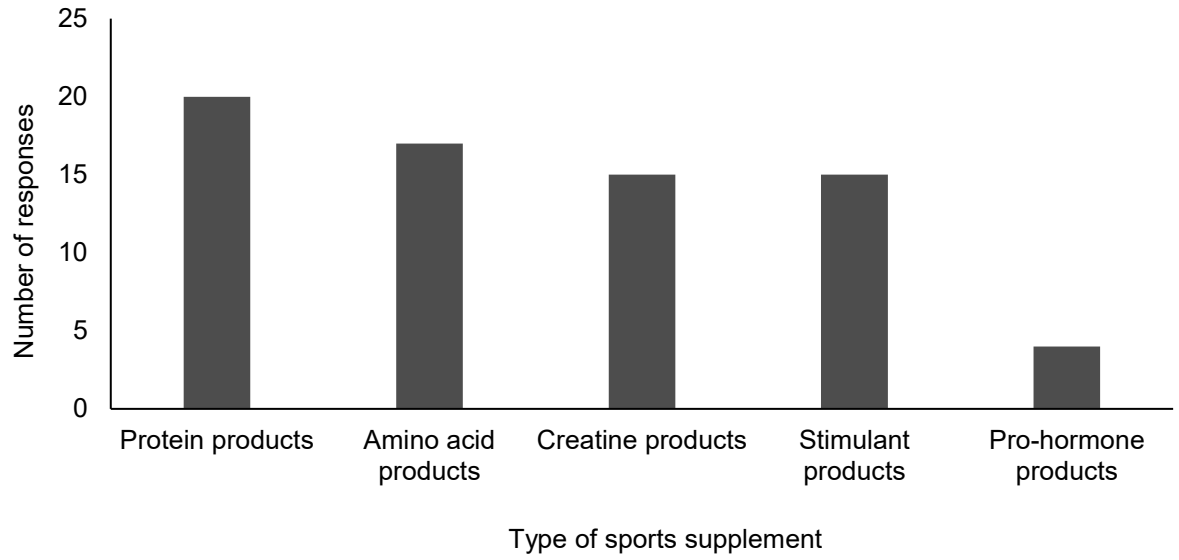


Figure 4. 2: Participant’s awareness of types of sports supplements used by adolescents.

There were 15 (31%) participants who reported “No” to being aware of the types of sports supplements used by adolescents, while 17 (35%) participants reported “Yes, I am aware, but do not know which types they use/have used”.

Perceptions of benefits from sports supplement use by adolescents

Thirty-three participants (67%) reported “Yes”, and 16 (33%) reported “No” in response to whether they believed there are benefits from using sports supplements by high school adolescents.

Table 4. 7: Frequency of common themes of response by participants who perceived benefits from sports supplement use by adolescents.

Common themes of perceived benefits	Examples of direct quotations	Number of responses (n=33)
“Recovery” Assists/Improves/Helps/Increase’s recovery	“Supplements repair muscles resulting in quicker recover”. “I tentatively say improved recovery in the absence of a proper diet”.	10 (30%)
“Performance” Assists/Enhances/Improves physical performance (I.e., Fitness; Stamina; Energy; Strength; Endurance)	“It can enhance performance and stamina”. “Sports supplements regardless of type enhance physical growth and performance levels”.	8 (24%)
“Nutrient intake” Fast/Convenient meal replacement or source of nutrients	“A shake can serve as a quick and healthy meal before and after training sessions”. “Convenience. Source of protein for teens experiencing rapid growth spurt”.	4 (12%)
No comment/response	N/A	11 (33%)

From the 33 (67%) participants that reported “Yes” there were 33 total responses for perceived benefits. Ten (30%) responses cited “Recovery” as a common theme for the perceived benefits. Thereafter, eight (24%) responses cited “Performance” as a common theme. Only four (12%) responses cited “Nutrient intake” as a common

theme. There were 11 (33%) none responses for perceived benefits, these fell under the common theme of “No comment/response” (Table 4.7).

Perceived risks/dangers from the use of sports supplements by adolescents

Most participants 47 (96%) reported “Yes”, and two (5%) reported “No” in response to whether they believed there are risks or dangers involved in the use of sports supplements by high school adolescents. Some examples of what coaches/trainers reported as perceived risks/dangers are cited in Table 4.8.

Table 4. 8: Frequency of common themes of response for participants perceived risks/dangers involved in sports supplement use by adolescents.

Common themes of perceived risks/dangers	Examples of direct quotations	Number of responses (n=47)
“Misguided/Lack of knowledge/understanding” Uninformed use/Lack of knowledge, understanding, information and risks/dangers OR Misinformed/Misguided information provided by Media/Sports supplement companies/Individuals with a lack of knowledge	“If not properly researched certain brands are able to have an effect on young boys and girls”. “Often adolescents use supplements without any research or consultation with professionals and are misinformed and misguided by social media”.	11 (23%)
“Major organ/body risk” Negative/Harmful/Damaging/Straining side effects placed on developing bodies and/or major organs	“It could have harmful effects on the body”. “The use of supplementation by adolescents is unwarranted. For example, the use of creatine could have adverse side effects on the kidneys”.	10 (21%)
“Illegal/Banned substances” Consumption/Use of uncertified/banned/unregulated drugs/substances/ingredients	“We are not always exactly sure what’s inside a sport supplement. (Might have some PEDs)” “Unregulated ingredients like ephedrine/caffeine and other restricted substances being added”.	6 (13%)
“Substance abuse” Over-dose/Inappropriate use/Addiction/Abuse of sports supplements	“When used inappropriately and without medical supervision”. “Substance abuse”.	4 (9%)
No comment/response	N/A	16 (34%)

From the 47 (96%) participants that reported “Yes” there were 47 total responses for perceived risks/dangers. There were 11 (23%) responses for “Misguided/Lack of knowledge/understanding” as a common theme. Thereafter, 10 (21%) cited “Major organ/body risk”, while six (13%) cited “Illegal/Banned substances” and four (9%) cited “Substance abuse” as potential risks/dangers. There were 16 (34%) none responses for perceived risks/dangers, these fell under the common theme of “No comment/response” (Table 4.8).

Encouragement of adolescent sports supplement use with known risks/dangers

Most participants 36 (73%) reported “No”, eight (16%) reported “Maybe”, and five (10%) reported “Yes” in response to whether they would encourage the use of, or the continued use of a sports supplement, which helps high school adolescents achieve their sports goals or physical appearance goals (Body-image) even if they understood there were risks or dangers involved with the use of that product.

Perceptions of sports supplement use among adolescents

There were 43 (88%) participants that reported “Yes”, five (10%) that reported “Maybe”, and only one (2%) that reported “No” in response to a question that asked participants whether they believed the use of sports supplements is common among adolescents attending South African private high schools. Moreover, in response to a question that asked participants whether they believed the current use of sports supplements is a problem among adolescents attending South African private high schools, 31 (63%) participants reported “Yes”, 13 (27%) reported “Maybe”, and only five (10%) reported “No”.

Regarding the question that asked participants whether they believed that South African regulatory companies/organizations should provide educational programmes or training addressing the use of sports supplements by high school adolescents, most participants 48 (98%) reported “Yes”, and only one (2%) reported “No”.

Proposed interventions/solutions for education and awareness of sports supplements

Regarding proposed interventions/solutions around education and awareness for adolescent supplement use, there were 49 total responses in total. Twenty-five (51%) responses cited “Formal training/education” as a common theme. Thereafter, 11 (22%) responses cited “Informal education/training” as a common theme. Six (12%)

responses cited “Rules”, while five (10%) responses cited “Support staff” as a common theme. There were two (4%) none responses for suggested interventions/solutions, these fell under the common theme of “Do not know/No response” (Table 4.9).

Table 4. 9: Frequency of common themes of response for suggested interventions or solutions around adolescent sports supplement use.

Common themes of Interventions/Solutions	Examples of direct quotations	Number of responses (n=49)
“Formal training/education” Training/Workshops/Short courses/Educational programmes held at schools for learners and coaches/trainers and/or include/incorporate lessons or courses and learning materials on sports nutrition/sports supplements in the school syllabus/curriculum (i.e., Life science; Life orientation; Physical education)	“Get education programs at the start of school year showing the effects of supplements”. “Including nutrition and supplementation education in the Grade 10 LO syllabus”.	25 (51%)
“Informal training/education” Talks/Seminars/Webinars/Presentations/Conventions/Awareness campaigns held at schools by professional athletes/regulatory authorities/professionals in the field	“Talks from experts and athletes delivered to students”. “Multiple SAID's conventions and talks throughout the schools”.	11 (22%)
“Rules” Increased regulations for sports supplement availability and use to adolescents through school policies/medical prescription/increased testing	“Approved supplements made available through the schools appointed physical trainer”. “You should not be able to play any sport in season unless you have attended a compulsory talk on supplementation”.	6 (12%)
“Support staff” Assistance/Educational content provided in schools by medical professionals/nutritionists/professionals in the field to advise learners and coaches/trainers on sports supplements	“Each school needs a Sport Nutritionist”. “Using the bio kineticist at school to help and assist - all private schools have them”.	5 (10%)
Do not know/No response	N/A	2 (4%)

Knowledge, education, and personal experiences concerning sports supplements

Thirty participants (61%) reported “No”, and 19 (39%) reported “Yes” in response to a question that asked participants whether they had ever had formal sports nutrition or sports supplement education or training.

Most participants 46 (94%) reported “Yes”, and only three (6%) reported “No” in response to whether they had knowledge of the World Anti-Doping Agency (WADA) and/or the South African Institute for Drug-Free Sport (SAIDS).

Regarding whether coaches/trainers had ever witnessed cases of negative side-effects to high school adolescents who use/used sports supplements, 18 (37%) participants reported “Yes”, and 31 (63%) reported “No”. This question did not ask what these side-effects were.

Discussion

An important finding in this study was that less than half of the participants reported having formal education or training on sports nutrition or sports supplements. This supports the arguments by Muwonge *et al*. (2017) that coaches/trainers in the context of low to middle-income countries, like South Africa do not necessarily require these kinds of qualifications when working in the private school context. Coaches/trainers from high-income countries are commonly required to complete specialised education before being certified, whereby a module of the curriculum entails sports nutrition and supplements (Muwonge *et al*., 2017). A lack of education on this topic could result in coaches/trainers not having sufficient knowledge on sports supplements, which may be of concern as they are frequent sources of information or advice to adolescents, which is evident in this study and previous research (Sundgot-Borgen *et al*., 2003; Nieper, 2005; Rodek *et al*., 2012; Sajber *et al*., 2013).

Moreover, most coaches/trainers reported that their information on these substances was obtained from “other coaches/trainers” and thereafter “internet advertising and sites” as their primary sources of information or advice for supplement use, which aligns with previous research (Sundgot-Borgen *et al*., 2003; Rodek *et al*., 2012; Mandic *et al*., 2013; Sajber *et al*., 2013). While likely a more accessible source of information, self-education from non-evidenced based sources may be particularly risky, especially if it results in the dissemination of incorrect information around the use of these products (Rodek *et al*., 2012; Torres-McGehee *et al*., 2012). Thus, participants may lack sufficient or appropriate knowledge and education on supplements to provide information or advice, especially because this process is intensive and requires an in-depth understanding of each individual’s diet, medical history, lifestyle, and training (Duvenage *et al*., 2015). Furthermore, the use of supplements is generally only safe and efficient when those using them are advised by a professional in the sports nutrition or sports supplement field (Rodek *et al*., 2012).

A concerning finding of this study was that most participants believed the use of sports supplements is common among South African high school adolescents and more than a third reported witnessing cases of negative side-effects from sports supplement use. This has not been reported on in previous research and is a unique finding of this study.

While these side-effects were not explored, this supports previous findings that have highlighted the negative side-effects from sports supplements and how this may often be driven by improper patterns of use or the use of these products outside the optimal protocol (Maughan *et al.*, 2018). This may explain why coaches/trainers reported "Misguided/Lack of knowledge/understanding" as a major risk/danger associated with adolescent supplement use. Interestingly, this could be the reason why nearly all the participants in this study and in previous literature reported that regulatory companies or organisations should provide educational programmes/training addressing sports supplement use among high school adolescents (Nieper, 2005; Mandic *et al.*, 2013).

Most participants were aware that their adolescent learners were using sports supplements as well as the types of supplements being used, which differs from the findings of another South African study where many were unaware of what types of supplements were being consumed by their athletes (Kisten and Naidoo, 2019). Coaches/trainers in this study cited "protein/amino acid products" and "creatine products" as the main types of supplements being used, which is in line with the findings of several other studies (Williams, 2005; Kreider *et al.*, 2017; Whitehouse and Lawlis, 2017; Butts *et al.*, 2018). This could be considered a positive finding, which demonstrates that some coaches/trainers are 'in touch' with what their athletes are using and in turn can provide better guidance on appropriate use and dosage of these products, while also being able to recognise possible overdoses or adverse effects from the use (Van Aswegen, 2013). Improving coaches/trainer's awareness and understanding of adolescent supplement use is critical, as this specific area of knowledge is important to ensure that coaches/trainers adopt a holistic approach towards athlete wellbeing, performance, and development (Kubayi *et al.*, 2018).

Participants in this study reported having a fairly good understanding of sports supplements, their efficacy and side-effects. Additionally, they also reported an "intermediate" - "good" score on average, regarding their decision to devote their time advising adolescents about supplements they use or want to use and inform them of possible adverse effects thereof. While their self-declared knowledge and willingness to advise their athletes was evident and indicative of their investment in and willingness to support their athletes (Vella *et al.*, 2011). Coaches/trainers also scored "very weak"

- “weak” regarding their self-confidence to recommend sports supplements to adolescents with confidence about their effectiveness.

Additionally, on average participants reported a “weak” - “intermediate” score for their abilities to do research, refer to scientific references regarding the general use of sports supplements, and perceived themselves to have a “weak” - “intermediate” level of knowledge for dosage/administration of adolescent supplement use and sport supplement-drug interactions. This is an important finding given that sports supplements need to be chosen and consumed appropriately (Rodek *et al*., 2012). And having evidence-based knowledge around how to do this safely is critical to ensuring that coaches/trainers can advise learners on how to consume these products. Taken together, these findings indicate that coaches/trainers may have some rudimentary knowledge of sports supplements, but not enough to feel comfortable to provide the necessary detail that may be required around supplement dosages and possible risks/dangers. This was a unique and important finding of this study, and further research is needed to get a better understanding of coaches/trainer’s knowledge and abilities to recommend and advise adolescents about safe and effective use of sports supplements. Although these findings are unique, they support the fact that coaches/trainers in this study have not had sufficient exposure to formal training or education around sports supplements, which ultimately affects their ability to advise adolescents adequately. It may also point to the fact that many coaches/trainers believe that sports nutrition and supplements are not within their area of expertise, as reported previously (Allen *et al*., 2017; Kubayi *et al*., 2018).

A critical and somewhat concerning finding of this study was that some participants reported that they would encourage the use/continued use of a sports supplement, even if they understood there were risks/dangers involved. This is consistent with another South African study that found coaches often felt pressured to ensure that adolescents performed well at a competitive level and were therefore inclined to recommend the use of any sports supplements to achieve this (Van der Walt and Coopoo, 2016). This can also be related to cultural issues around school sports, as cultural issues may be the reason that adolescents use these products in the first place (Garthe and Ramsbottom, 2020). Many of these cultures have resulted in adolescents and their coaches/trainers developing a “winning at all costs” mentality (Gradige,

2010). In the context of a schooling environment, this is possibly a result of the professionalisation of adolescent sport in South Africa, which has seen school sports become a commercial enterprise with high financial stakes not only for the adolescents but also for parents, administrators, coaches/trainers, schools, and surrounding communities (Vosloo, 2014; Camiré and Santos, 2019). While this finding was among a small group of participants, it is still significant as a few coaches/trainers may have a wide influence on a number of adolescent athletes (Keegan *et al.*, 2009). This particular finding points to the continued need for more research around how team cultures and pressure from school leadership affect coaches/trainers' decisions to recommend substances like sports supplements to adolescents.

However, the increasing access and availability of sports supplements may likely be a driver for the common use of these products, as they are easily ordered via internet sites or purchased over the counter from many local health stores/supermarkets (Van der Bijl, 2014; Herriman *et al*., 2017; Dwyer *et al*., 2018). While this aspect was not explored in this study, the ease of access and availability of sports supplements may be the reason why coaches/trainers "disagreed" or were "undecided" about these products having the same level of efficacy as registered pharmaceuticals, which supports the findings of several previous studies (Gabriels *et al*., 2012; Schoonees and Volmink, 2013; Cohen, 2014; Herriman *et al*., 2017; Mathews, 2017; Naidoo *et al*., 2018). Moreover, this perception may account for why coaches/trainers "agreed" or "strongly agreed" that pharmacists should be knowledgeable about sports supplements and consulting in this field should be part of their duties and that these products should only be sold in pharmacies under supervision. This is important as there were very few coaches/trainers in this study and previous research that found coaches/trainers obtained advice or information from health professionals such as doctors, physicians, or pharmacists (Nieper, 2005; El Khoury and Antoine-Jonville, 2012; Jawadi *et al*., 2017; Jovanov *et al*., 2019). Therefore, professionals with the requisite knowledge should always be consulted when considering the use of supplements or other methods of performance enhancement. These perceptions also support calls for more careful regulations like that proposed by the South African Health Products Regulatory Authority (SAHPRA) (Naidoo *et al.*, 2018). SAHPRA has the potential to enhance the monitoring, regulation, evaluation, investigation, inspection,

and registration of medicines and related matters (i.e., sports supplements) in the public interest (SAHPRA, 2018).

A key finding of this study was that on average participants “disagreed” or were “undecided” about there being adequate educational content about sports supplements in South African schools. This aligns with previous research that there is a need for the enforcement of programs about sports supplements to educate coaches and young athletes about the safe use and risks (Whitehouse and Lawlis, 2017; Jovanov *et al*., 2019). This supports the need for schools to engage more with authorities like SAIDS for support around educational programs, with coaches/trainers taking responsibility as they are generally the individuals that are closest to adolescent athletes (Van der Walt and Coopoo, 2016). The lack of educational content in schools may also explain why more than half of the participants suggested “formal education/training” as an intervention or solution to educate and create awareness for adolescent sports supplement use, which is another unique finding of this study. Previous research has found that formal and informal education/training interventions are important for coaches/trainers to ensure adolescent athletes are provided appropriate guidance to make the correct choices regarding nutrition and supplements (Hozoori *et al.*, 2016). However, it is also unclear as to whether educational and training will result in meaningful change in behaviour. Despite the attempts made by SAIDS to educate and create awareness around supplements in school-going adolescents through nationwide campaigns (van der Walt and Coopoo, 2016), this study, along with previous studies, provide some evidence of a relatively high and increasing prevalence of use among these individuals (Gradige, 2010; van der Walt and Coopoo, 2016) accompanied by some concerning perceptions towards their use.

Recommendations

Research recommendations

Given the scant research conducted in South Africa pertaining to coaches/trainers’ perceptions of sports supplements, there is a need for more research in this area, given the important role that coaches play in holistic adolescent development. Future research should include more participants from both private and public schools to ensure that more representative insights into coaches/trainers’ knowledge and

practices is obtained. To ensure a representative sample size is obtained a detailed power analysis should be conducted prior to running a study like this, as the current study was likely underpowered. This study observed participants reported knowledge, which was their subjective views and not actual knowledge, thus, future studies should try using objective measures such as in-depth interviews to explore critical issues around the main driving factors for adolescent supplement use. A few participants experienced cases of negative side effects to adolescents from using sports supplements, however they were not asked what these side effects were or what product caused them, this should be considered in future studies. Future research may also benefit from looking at the perceptions of illegal/banned substances among high school adolescents as this may be more problematic than that of sports supplements. Moreover, future research should observe whether interventions and educational programs have an effect on the knowledge of coaches/trainers around supplements. Due to the professionalism of school sports in South Africa, there is a need to also explore how this aspect and the pressure it places on coaches/trainers, which potentially influences their practice and advice they give to adolescents in relation to these products.

Practical recommendations

Due to the fact that coaches/trainers are frequent sources of information or advice for adolescent supplement use; schools should consider holding programs or workshops facilitated by knowledgeable professionals for coaches/trainers on a regular basis to discuss potential issues and solutions regarding the safe and effective use of supplements by adolescents. Linked to this, coaches/trainers should be encouraged to make regular use of regulatory authorities' resources such as those from SAIDS and WADA to gain valuable and recent insight into supplement use. Furthermore, coaches/trainers should encourage adolescents to have open and honest dialogue about supplement use with them so that they can work together to make safe and informed decisions. There may be a need for coach/trainer certification or induction in the schooling context, which requires them to have at least a basic understanding of supplements and sports nutrition so that they can correctly advise and provide information to adolescents. Coaches/trainers could also be closely involved in anything related to school policies on supplement use, as they are generally very closely involved with adolescents who use or are looking to use these products.

Limitations of this study

Due to the impact of the Covid-19 pandemic, it was difficult for the researchers to recruit participants from South African private high schools, with the result being a relatively small study sample, with female participant representation being particularly low. Thus, the results of this study are not generalisable to all coaches/trainers in a South African private high school setting, nor are they generalisable to coaches/trainers within South African public schools. There were also geographic limitations as most participants were from only two of the nine provinces in South Africa and some provinces had no participant representation. While the sample size was small, the number of adolescents that these coaches interact with may be significant which means that if their attitudes or perceptions towards these supplements are a certain way, they may have an influence on several students. There could have also been a selection bias as only coaches who had an interest in this topic, either because they felt strongly against it or for it, may have participated in the study. Lastly, this study did not focus on all types of nutritional supplements, which meant some participants may have had different perceptions but did not report them if they did not fall within the "sports supplement" category, which was the general scope of this study.

Conclusion

This study found that less than half of the coaches/trainers that participated in the online questionnaire had received formal education or training related to sports supplements, despite being one of the primary sources of influence or information for adolescents on this topic. Furthermore, most coaches/trainers reported using unreliable sources for information or advice about sports supplements and very few relied on healthcare professionals. This is concerning considering that most believed the use of these products is common among South African high school adolescents, with many reporting being aware of the products and the types being used. While coaches/trainers reported having relatively good knowledge regarding the general use, efficacy, and side-effects of sports supplements, many also reported having low self-confidence to recommend the use of these products to adolescents. This may explain

why the majority of coaches/trainers reported that there is inadequate educational content regarding sports supplements in South African schools and that there is a need for formal education or training held by schools with the assistance of regulatory authorities to address this. This is particularly important as some coaches/trainers reported witnessing negative side effects to adolescents from the use of sports supplements. This may be linked to participants' perceptions that this is a result of misguided and lack of knowledge on the part of their adolescent athletes around how to use these products safely. It was evident though that coaches/trainers' felt strongly about the need for more regulation or at least supervised control over the sale of sports supplements by professionals such as pharmacists.

However, what may be of further concern was that some coaches/trainers reported that they would or might encourage the use of sports supplements to adolescents even if they understood there were risks/dangers involved. While not obvious, this finding points to a concerning emergent trend driven by the culture around school sports, where winning and performance is favoured over what might be safe and in the best interests of the learner. However, this is only speculation and needs further investigation in future research to get a better understanding around the effects that sporting culture has in relation to adolescent sports supplement use. Therefore, a basic understanding and knowledge in multiple fields of sports science including supplement use is needed to assist coaches/trainers with making objective judgments in their coaching process, as they are generally at the 'sharp end' where the application of this information is required.

CHAPTER 5

Integrated Discussion and Concluding Comments

There were two overarching aims to this study. Firstly, there was a need for research observing the prevalence of sports supplement use and the perceptions (knowledge; attitudes; beliefs) towards the use of sports supplements among South African private high school adolescents. This arm of the overall study was important, given that the reported prevalence of use in this population group is high and that the use of sports supplement products is not always controlled or used correctly. Secondly, there was a need for research observing South African private high school coaches/trainer's perceptions (knowledge; attitudes; application of knowledge) towards the general use of sports supplements and the use among adolescents. This was necessary to gain insights of coaches/trainers given the important role they play regarding adolescent's behaviors, decisions, and holistic development.

There was a relatively high reported prevalence (62%) of sports supplement use among adolescent participants compared to previous South African studies, which aligned with the finding that most coaches/trainers agreed being aware of adolescents using these products. The prevalence of use found among adolescents in this study is comparable to several other studies (Braun *et al*., 2009; Mattila *et al*.,2009; Walsh *et al*., 2011; Šterlinko *et al*., 2012; Tawfik *et al*., 2016; Kotnik *et al*., 2017). However, the finding that most coaches/trainers were aware of adolescents using these products as well as the types used is unique to this study, as another South African study found most coaches were unaware of their athletes using supplements and the types of products being used (Kisten and Naidoo, 2019). Furthermore, both groups believed that the use of sports supplements is common practice among adolescents attending South African private high schools, which aligns with previous research from South Africa (Gradige, 2010).

Across the two groups there was alignment around their perceived benefits from sports supplement use: both groups reported "recovery" as the most common benefit, which was reported as one of the main reasons for supplement use in a couple of other South African studies (Van Aswegen, 2013; Welthagen, 2016). Thereafter, adolescents

reported “energy” and “overall performance”, and coaches/trainers reported “performance”, which included energy as a major factor of performance. These reported benefits also align with previous research from South Africa (Gradige, 2010; Van Aswegen, 2013; Welthagen, 2016; Senekal *et al.*, 2019). The similarities in these perceptions may be linked to one another due to the close interactions and relationships that coaches/trainers have with their adolescent athletes, supporting the argument that coaches/trainers play a significant role during the adolescents sporting careers, as they generally spend a lot of time together (Kondric *et al.*, 2013; Mandic *et al.*, 2013; Jovanov *et al.*, 2019). The reported reason surrounding “recovery” as a main benefit may be the reason why most adolescent participants reported using “protein products” and why most coach/trainer participants reported being aware of adolescents using “protein products”. Evidence has suggested that protein supplement use may be beneficial for recovery purposes (Williams, 2005; Gradige, 2010; Claassen and Galant, 2011; Cermak *et al.*, 2012; Van Aswegen, 2013), however, the risks of use must always be weighed up against the potential benefits. This may also point to why coaches/trainers need to be aware of the types of supplements being used by adolescents as there was a portion of coaches/trainers who did not know what was being used.

Adolescents mostly reported “friends” and “coaches/trainers” as their sources of advice or influence and coach/trainer participants mostly reported “other coaches/trainers” and “internet advertising and sites” as their sources of information for sports supplements. Both findings are significant to this study as coaches/trainers are the most frequently reported as adolescents’ main sources of influence in previous South African studies (Van Aswegen, 2013; Nolte, 2014; Duvenage *et al.*, 2015; Kisten and Naidoo, 2019), and coaches/trainers’ main sources of information on supplements has not been reported in previous research but needs further investigation. The use of unreliable sources may indicate that schools need to provide adolescents and coaches/trainers with education, training and reliable sources of information or advice going forward. This is particularly important given the fact that less than half of the participants from both groups reported having any formal education or training related to sports nutrition or sports supplements. The lack of formal education or training found among adolescents in this study differs from that of another South African study, which found 80% of elite athlete adolescents reported receiving education about the use of

sports supplements (Welthagen, 2016), however, this may indicate that education and training programs are aimed at elite athlete adolescents and not adolescents involved in recreational sports. Moreover, the finding that a large proportion of coaches/trainers lacked formal education and training supports the need for a module on supplements being incorporated in coaching certification or coaching induction at a school level. This may assist coaches/trainers in making objective judgments in their coaching practice rather than solely relying on personal experiences, as they are generally at the 'sharp end' where the application of this information is required (Haff, 2010; Kubayi *et al*., 2018). By reducing adolescents and coaches/trainers' reliance on unreliable or untrustworthy sources and providing them with education or training programs, it is less likely there will be the dissemination of incorrect information regarding these products. Further, it may reduce adolescents' exposure to illegal or dangerous substances and could help coaches/trainers with their confidence and abilities to recognise and possibly intervene around the efficacy and safe use of these products if needed.

Nearly all the participants from both groups reported risks/dangers involved in the use of sports supplements; adolescent participants mostly reported "incorrect/negligent use", and coach/trainer participants mostly reported "misguided or lack of knowledge/understanding". These findings are important as both groups see that these products are being misused by adolescents, which may be linked to the finding that "friends" were the primary source of influence as previous research reported that peer influence plays a key role in the increase in risk-taking behaviour during adolescence and is one of the most proximal factors driving substance use (Van Hoorn *et al*., 2017; Henneberger *et al*., 2021). This may also account for why a portion of the adolescent participants reported experiencing adverse side-effects to the use of sports supplements, and a few coach/trainer participants reported witnessing this in their practice. These are unique findings and point to the need for further investigation to establish the types of side effects experienced by adolescents or witnessed by coaches/trainers. What is of further concern, was that nearly a third of adolescent participants and five (10%) coach/trainer participants reported that they would use/continue using or encourage the use of a sports supplement that helps adolescents achieve sports/athletic goals or physical appearance goals (Body-image) even if they understood there were risks or dangers involved. While this study could

not determine the links between the responses from these two groups, these findings may point to the effects of broader systemic pressure being placed on adolescents and coaches/trainers within South African private high schools. This supports evidence that school sport has become more professionalised and commercial, resulting in many adolescents and coaches within private schools feeling pressured to be successful and therefore turn to the use of various methods, such as sports supplements, to maximise the likelihood of succeeding (Vosloo, 2014; Camiré and Santos, 2019).

Importantly, both groups suggested the use of “formal education/training” as an intervention or solution to help educate and create awareness for adolescents around using these products safely and effectively. Therefore, it may be important that organizations, which most participants from both groups were familiar with (i.e., World Anti-Doping Agency (WADA) and South African Institute for Drug-Free Sport (SAIDS)), conduct regular programs or training that addresses and informs high school adolescents and their coaches/trainers on this. These findings align with several other studies that reported education or training as an intervention or solution to help educate and create awareness for safe and effective use of these products (Gradige, 2010; Van der Walt and Coopoo, 2016; Whitehouse and Lawlis, 2017; Jovanov *et al*., 2019) However, education or training programs are not the only measures needed to reduce the risks/dangers associated with adolescent supplement use. It may be important to address the calls by coaches/trainers and, to some extent adolescents, for more regulatory control or at least guided, professional supervision around the sale and use of these products. More broadly, the complex systemic cultural issues within the South African schooling system (which may be influenced by society at large) around physical performance or appearance needs further interrogation, as these are possible driving factors for the use of various substances (i.e., sports supplements). Addressing these aspects will be critical for the notion of holistic adolescent development in South African private high schools.

REFERENCES

Abraham, A., Collins, D., & Martindale, R. (2006). The coaching schematic: Validation through expert coach consensus. *Journal of sports sciences*, *24*(6), 549-564.

Adibelli, D., Avci, Y. D., & Saçan, S. (2020). Evaluating the use of energy drinks, food supplements and nutrition habits among adolescents in terms of ecological approach: antalya sample. *Eastern Journal of Medicine, 26*(1), 30-39.

Affertsholt, T., & Fenger, M. (2013). Whey Book 2014-The Global Market for Whey and Lactose Ingredients 2014–2017.

Albert, D., Chein, J., & Steinberg, L. (2013). The teenage brain: Peer influences on adolescent decision making. *Current directions in psychological science*, *22*(2), 114-120.

Allen, B., & Waterman, H. (2019). Stages of Adolescence. *American Academy of Pediatrics.* Retrieved from https://www.healthychildren.org/English/ages-stages/teen/Pages/Stages-of-Adolescence.aspx [Accessed 25 February 2021].

Allen, J. B., Morris, R., Dimeo, P., & Robinson, L. (2017). Precipitating or prohibiting factor: Coaches' perceptions of their role and actions in anti-doping. *International Journal of Sports Science & Coaching*, *12*(5), 577-587.

Alonso, M. R., & Fernández-García, B. (2020). Evolution of the use of sports supplements. *PharmaNutrition*, 100239.

Anglin, M. D., Burke, C., Perrochet, B., Stamper, E., & Dawud-Noursi, S. (2000). History of the methamphetamine problem. *Journal of psychoactive drugs*, *32*(2), 137-141.

Arazi, H., Saeedi, T., Sadeghi, M. M., Nastaran, M., & Mohammadi, M. (2014). Prevalence of supplements use and knowledge regard to doping and its side effects in Iranian athlete university students participated in sports Olympiad at summer 2012. *Acta Kinesiologica*, *8*(2), 76-81.

Arenas-Jal, M., Suñé-Negre, J. M., Pérez-Lozano, P., & García-Montoya, E. (2019). Trends in the food and sports nutrition industry: A review. *Critical reviews in food science and nutrition*, 1-17.

Attlee, A., Haider, A., Hassan, A., Alzamil, N., Hashim, M., & Obaid, R. S. (2018). Dietary Supplement Intake and Associated Factors Among Gym Users in a University Community**.** *Journal of Dietary Supplements 15*(1), 88-97.

Austin, S. B., Yu, K., Liu, S. H., Dong, F., & Tefft, N. (2017). Household expenditures on dietary supplements sold for weight loss, muscle building, and sexual function: Disproportionate burden by gender and income. *Preventive medicine reports*, *6*, 236-241.

Backhouse, S. H., Whitaker, L., & Petróczi, A. (2013). Gateway to doping? Supplement use in the context of preferred competitive situations, doping attitude, beliefs, and norms. *Scandinavian journal of medicine & science in sports*, *23*(2), 244-252.

Baltazar-Martins, G., de Souza, D. B., Aguilar-Navarro, M., Muñoz-Guerra, J., del Mar Plata, M., & Del Coso, J. (2019). Prevalence and patterns of dietary supplement use

in elite Spanish athletes. *Journal of the International Society of Sports Nutrition*, *16*(1), 1-9.

Barkoukis, V., Lazuras, L., Lucidi, F., & Tsorbatzoudis, H. (2015). Nutritional supplement and doping use in sport: possible underlying social cognitive processes. *Scandinavian journal of medicine & science in sports*, *25*(6), 582-588.

Barnes, K., Ball, L., Desbrow, B., Alsharairi, N., & Ahmed, F. (2016). Consumption and reasons for use of dietary supplements in an Australian university population. *Nutrition, 32*, 524-530.

Bastani, P., Nia, A. A., Shabanpoor, M., Mehravar, S., & Kashefian, S. (2017). Knowledge, attitude and practice of Iranian pharmacists, body builders, and their coaches regarding sports supplements. *Journal of research in pharmacy practice*, *6*(3), 166.

Baume, N., Mahler, N., Kamber, M., Mangin, P., & Saugy, M. (2006). Research of stimulants and anabolic steroids in dietary supplements. *Scandinavian journal of medicine & science in sports*, *16*(1), 41-48.

Blank, C., Leichtfried, V., Müller, D., & Schobersberger, W. (2015). Role of parents as a protective factor against adolescent athletes' doping susceptibility. *South African Journal of Sports Medicine*, *27*(3), 87-91.

Boyes, R., O'Sullivan, D. E., Linden, B., McIsaac, M., & Pickett, W. (2017). Gender-specific associations between involvement in team sport culture and canadian adolescents' substance-use behavior. *SSM-population health*, *3*, 663-673.

Braun, H., Koehler, K., Geyer, H., Kleinert, J., Mester, J., & Schänzer, W. (2009). Dietary supplement use among elite young German athletes. *International journal of sport nutrition and exercise metabolism*, *19*(1), 97-109.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77-101.

Brown, G. A., Vukovich, M., & King, D. S. (2006). Testosterone prohormone supplements. *Medicine & Science in Sports & Exercise*, *38*(8), 1451-1461.

Brown, K. A., Patel, D. R., & Darmawan, D. (2017). Participation in sports in relation to adolescent growth and development. *Translational pediatrics*, *6*(3), 150.

Bruner, M. W., Balish, S. M., Forrest, C., Brown, S., Webber, K., Gray, E., McGuckin, M., Keats, M. R., Rehman, L., & Shields, C. A. (2017). Ties that bond: Youth sport as a vehicle for social identity and positive youth development. *Research quarterly for exercise and sport*, *88*(2), 209-214.

Buford, T. W., Kreider, R. B., Stout, J. R., Greenwood, M., Campbell, B., Spano, M., Ziegenfuss, T., Lopez, H., Landis, J., & Antonio, J. (2007). International Society of Sports Nutrition position stand: creatine supplementation and exercise. *Journal of the International Society of Sports Nutrition*, *4*(1), 6.

Butts, J., Jacobs, B., & Silvis, M. (2018). Creatine use in sports. *Sports health*, *10*(1), 31-34.

Calfee, R., & Fadale, P. (2006). Popular ergogenic drugs and supplements in young athletes. *Pediatrics*, *117*(3), 577-589.

Camiré, M., & Santos, F. (2019). Promoting positive youth development and life skills in youth sport: Challenges and opportunities amidst increased professionalization. *Journal of Sport Pedagogy & Research*, *5*(1), 27-34.

Campbell, B., Kreider, R. B., Ziegenfuss, T., La Bounty, P., Roberts, M., Burke, D., Landis, J., Lopez, H., & Antonio, J. (2007). International Society of Sports Nutrition position stand: protein and exercise. *Journal of the International Society of Sports Nutrition*, *4*(1), 8.

Camporesi, S. (2017). An alternative solution to lifting the ban on doping: breaking the payoff matrix of professional sport by shifting liability away from athletes. *Sport, ethics and philosophy*, *11*(1), 109-118.

Catalani, V., Negri, A., Townshend, H., Simonato, P., Prilutskaya, M., Tippett, A., & Corazza, O. (2021). The Market of Sport Supplement in the Digital Era: a Netnographic Analysis of Perceived Risks, Side-effects and other Safety Issues. *Emerging Trends in Drugs, Addictions, and Health*, 100014.

Cermak, N. M., Res, P. T., de Groot, L. C., Saris, W. H., & Van Loon, L. J. (2012). Protein supplementation augments the adaptive response of skeletal muscle to resistance-type exercise training: a meta-analysis. *The American journal of clinical nutrition*, *96*(6), 1454-1464.

Chan, D. K., Lonsdale, C., & Fung, H. H. (2012). Influences of coaches, parents, and peers on the motivational patterns of child and adolescent athletes. *Scandinavian journal of medicine & science in sports*, *22*(4), 558-568.

Cherian, K. S., Gavaravarapu, S. M., Sainoji, A., & Yagnambhatt, V. R. (2020). Coaches' perceptions about food, appetite, and nutrition of adolescent Indian athletes-A qualitative study. *Heliyon*, *6*(2), 3354.

Chilibeck, P. D., Kaviani, M., Candow, D. G., & Zello, G. A. (2017). Effect of creatine supplementation during resistance training on lean tissue mass and muscular strength in older adults: a meta-analysis. *Open access journal of sports medicine*, *8*, 213.

Claassen, A., & Galant, K. (2011). Position Statement of the South African Institute of Drug Free Sport (SAIDS) on the use of supplements in sport in school-going youth. *South African Institute for Drug-Free Sport*, 1-13.

Clark, J. F. (1997). Creatine and phosphocreatine: a review of their use in exercise and sport. *Journal of athletic training*, *32*(1), 45.

Clark, J. R. (2006). High-intensity exercise and recovery during short-term supplementation with creatine plus a protein-carbohydrate formula. *South African Journal of Sports Medicine*, *18*(4), 136-140.

Cockburn, E., Fortune, A., Briggs, M., & Rumbold, P. (2014). Nutritional knowledge of UK coaches. *Nutrients*, *6*(4), 1442-1453.

Cohen, P. A. (2014). Hazards of Hindsight — Monitoring the Safety of Nutritional Supplements. *The New England Journal of Medicine, 370*, 1277-1280.

Cohen, P. A., Travis, J. C., & Venhuis, B. J. (2014). A methamphetamine analog (N, α-diethyl-phenylethylamine) identified in a mainstream dietary supplement. *Drug testing and analysis*, *6*(7-8), 805-807.

Coopoo, Y., McCreanor, X., & Gabriels, G. (2020). Nutritional supplements use, cost, source of information, and practices by Johannesburg North gym goers. *South African Journal of Sports Medicine*, *32*(1).

Corazza, O., & Roman-Urrestarazu, A. (2017). Novel Psychoactive Substances: Policy, Economics and Drug Regulation. *Springer*.

Côté, J., & Gilbert, W. (2009). An integrative definition of coaching effectiveness and expertise. *International journal of sports science & coaching*, *4*(3), 307-323.

Cox, R. B., Criss, M. M., Harrist, A. W., & Zapata-Roblyer, M. (2017). Are negative peer influences domain specific? Examining the influence of peers and parents on externalizing and drug use behaviors. *The journal of primary prevention*, *38*(5), 515-536.

Dascombe, B. J., Karunaratna, M., Cartoon, J., Fergie, B., & Goodman, C. (2010). Nutritional supplementation habits and perceptions of elite athletes within a state-based sporting institute. *Journal of Science and Medicine in Sport*, *13*(2), 274-280.

da Silva, W. V., Silva, M. I. D. A. G., Toscano, L. T., de Oliveira, K. H. D., de Lacerda, L. M., & Silva, A. S. (2014). Supplementation prevalence and adverse effects in physical exercise practitioners. *Nutricion hospitalaria*, *29*(1), 158-165.

Delimaris, I. (2013). Adverse effects associated with protein intake above the recommended dietary allowance for adults. *ISRN nutrition*.

Dion, J., Hains, J., Vachon, P., Plouffe, J., Laberge, L., Perron, M., McDuff, P., Kalinova, E., & Leone, M. (2016). Correlates of body dissatisfaction in children. *The Journal of Pediatrics*, *171*, 202-207.

Dodge, T. L., & Jaccard, J. J. (2006). The Effect of High School Sports Participation on the Use of Performance-Enhancing Substances in Young Adulthood. *Journal of Adolescent Health, 39,* 367-373.

Dolan, E., Gualano, B., & Rawson, E. S. (2019). Beyond muscle: the effects of creatine supplementation on brain creatine, cognitive processing, and traumatic brain injury. *European journal of sport science*, *19*(1), 1-14.

Dreher, M., Ehlert, T., Simon, P., & Neuberger, E. W. I. (2018). Boost me: Prevalence and reasons for the use of stimulant containing pre workout supplements among fitness studio visitors in Mainz (Germany). *Frontiers in psychology*, *9*, 1134.

Duellman, M. C., Lukaszuk, J. M., Prawitz, A. D., & Brandenburg, J. P. (2008). Protein supplement users among high school athletes have misconceptions about effectiveness. *The Journal of Strength & Conditioning Research, 22*(4), 1124-1129.

Duvenage, K. M., Meltzer, S. T., & Chantler, S. A. (2015). Initial investigation of nutrition and supplement use, knowledge, and attitudes of under-16 rugby players in South Africa. *South African Journal of Sports Medicine*, *27*(3), 67-71.

Dwyer, J., Coates, P., & Smith, M. (2018). Dietary supplements: regulatory challenges and research resources. *Nutrients*, *10*(1), 41.

Eichner, A., & Tygart, T. (2016). Adulterated dietary supplements threaten the health and sporting career of up-and-coming young athletes. *Drug testing and analysis*, *8*(3-4), 304-306.

El Khoury, D., & Antoine-Jonville, S. (2012). Intake of nutritional supplements among people exercising in gyms in Beirut city. *Journal of nutrition and metabolism*, *2012*.

Ethan, D., Basch, C. H., Berdnik, A., & Sommervil, M. (2016). Dietary Supplements Advertised in Muscle Enthusiast Magazines: A Content Analysis of Marketing Strategies. *International Journal of Men's Health*, *15*(2), 194.

Evans, G. H., Lippitt, J., Bolt, J., Shah, Z., Ahmed, J., & Coulthwaite, L. (2017). 1 Prevalence of nutritional supplement and performance enhancing drug use in recreational exercisers. *British Journal of Sports Medicine, 2017*(51).

Evans, M. W., Ndetan, H., Perko, M., Williams, R., & Walker, C. (2012). Dietary supplement use by children and adolescents in the United States to enhance sport performance: results of the National Health Interview Survey. *The journal of primary prevention*, *33*(1), 3-12.

Field, A. E., Austin, S. B., Camargo, C. A., Taylor, C. B., Striegel-Moore, R. H., Loud, K. J., & Colditz, G. A. (2005). Exposure to the mass media, body shape concerns, and use of supplements to improve weight and shape among male and female adolescents. *Pediatrics*, *116*(2), 214-220.

Fitzgibbon, M. L., Blackman, L. R., & Avellone, M. E. (2000). The relationship between body image discrepancy and body mass index across ethnic groups. *Obesity Research, 8*(8), 582-589.

Frost, R., Marten, P., Lahart, C., & Rosenblate, R. (1990). The dimensions of perfectionism Cognitive Therapy and Research, *14*(5), 449-468.

Gabriels, G., & Lambert, M. (2013). Nutritional supplement products: does the label information influence purchasing decisions for the physically active?. *Nutrition journal*, *12*(1), 133.

Gabriels, G., Lambert, M., & Smith, P. (2012). Information on nutritional supplement labels: time for legislation?. *South African Journal of Clinical Nutrition, 25*(1), 22-26.

Gabriels, G., Lambert, M., Smith, P., & Hiss, D. (2011). Will the new Consumer Protection Act prevent harm to nutritional supplement users?. *South African Medical Journal*, *101*(8), 543-545.

Gabriels, G., Lambert, M., Smith, P., Wiesner, L., & Hiss, D. (2015). Melamine contamination in nutritional supplements - Is it an alarm bell for the general consumer, athletes, and 'Weekend Warriors'?. *Nutrition Journal, 14*, 69.

Ganesan, S., Ravishankar, S. L., & Ramalingam, S. (2018). Are body image issues affecting our adolescents? A cross-sectional study among college going adolescent girls. *Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine*, *43*(1), 42.

Gardiner, P., Buettner, C., Davis, R. B., Phillips, R. S., & Kemper, K. J. (2008). Factors and common conditions associated with adolescent dietary supplement use: an analysis of the National Health and Nutrition Examination Survey (NHANES). *BMC complementary and alternative medicine*, *8*(1), 9.

Gardiner, P., Kemper, K. J., Legedza, A., & Phillips, R. S. (2007). Factors associated with herb and dietary supplement use by young adults in the United States. *BMC complementary and alternative medicine*, *7*(1), 39.

Garthe, I., & Maughan, R. J. (2018). Athletes and supplements: prevalence and perspectives. *International journal of sport nutrition and exercise metabolism*, *28*(2), 126-138.

Garthe, I., & Ramsbottom, R. (2020). Elite athletes, a rationale for the use of dietary supplements: a practical approach. *PharmaNutrition*, 100234.

Goliath, J. (2019). Five Boks who failed drug tests. *SA Rugby Magazine*. Retrieved from https://www.sarugbymag.co.za/five-boks-who-failed-dope-tests/ [Accessed 15 September 2019].

Goston, J. L., & Correia, M. I. T. D. (2010). Intake of nutritional supplements among people exercising in gyms and influencing factors. *Nutrition*, *26*(6), 604-611.

Gradidge, P. J. L. (2010). *The use of performance enhancing substances by adolescent male athletes in selected Johannesburg boys' high schools* (Doctoral dissertation).

Graef, J. L., Smith, A. E., Kendall, K. L., Fukuda, D. H., Moon, J. R., Beck, T. W., Cramer, J. T., & Stout, J. R. (2009). The effects of four weeks of creatine supplementation and high-intensity interval training on cardiorespiratory fitness: a randomized controlled trial. *Journal of the International Society of Sports Nutrition*, *6*(1), 18.

Gusmaya, H. I., Sugiyanto, S., & Rachma, N. (2019). The Consumption of Ergogenic Supplements in Physical Fitness Training (Survey of Members of the Fitness Centers in Sleman District). *International Journal of Multicultural and Multireligious Understanding*, *6*(2), 311-322.

Gustafsson, H., Sagar, S. S., & Stenling, A. (2017). Fear of failure, psychological stress, and burnout among adolescent athletes competing in high level sport. *Scandinavian journal of medicine & science in sports*, *27*(12), 2091-2102.

Haff, G. G. (2010). Sport science. *Strength & Conditioning Journal*, *32*(2), 33-45.

Hall, M., & Trojian, T. H. (2013). Creatine supplementation. *Current sports medicine reports*, *12*(4), 240-244.

Hämeen-Anttila, K. P., Niskala, U. R., Siponen, S. M., & Ahonen, R. S. (2011). The use of complementary and alternative medicine products in preceding two days among Finnish parents-a population survey. *BMC complementary and alternative medicine*, *11*(1), 107.

Hansen, D. M., Larson, R. W., & Dworkin, J. B. (2003). What adolescents learn in organized youth activities: A survey of self-reported developmental experiences. *Journal of research on adolescence*, *13*(1), 25-55.

Henneberger, A. K., Mushonga, D. R., & Preston, A. M. (2021). Peer influence and adolescent substance use: A systematic review of dynamic social network research. *Adolescent Research Review*, *6*(1), 57-73.

Herriman, M., Fletcher, L., Tchaconas, A., Adesman, A., & Milanaik, R. (2017). Dietary supplements and young teens: misinformation and access provided by retailers. *Pediatrics*, *139*(2).

Hewitt, P. L., & Flett, G. L. (1991). Perfectionism in the self and social contexts: conceptualization, assessment, and association with psychopathology. *Journal of personality and social psychology*, *60*(3), 456.

Hoffer, L. (2017). Parenteral nutrition: Amino acids. *Nutrients*, *9*(3), 257.

Hoffman, J. R., Faigenbaum, A. D., Ratamess, N. A., Ross, R., Kang, J., & Tenenbaum, G. (2008). Nutritional supplementation and anabolic steroid use in adolescents. *Medicine and Science in Sports and Exercise, 40*(1), 15-24.

Holeček, M. (2018). Branched-chain amino acids in health and disease: metabolism, alterations in blood plasma, and as supplements. *Nutrition & metabolism*, *15*(1), 33.

Holt, N. L., & Neely, K. C. (2011). Positive youth development through sport: A review. *Revista Iberoamericana de Psicología del Ejercicio y el Deporte*, *6*(2), 299-316.

Hozoori, M., Safaei-Motlagh, A., & Marzban, A. (2016). The epidemiology of dietary supplements consumption in the athletes of Karaj Iran. *International Journal of Epidemiologic Research*, *3*(3), 222-231.

Hurst, P., Foad, A., Coleman, D., & Beedie, C. (2017). Development and validation of the sports supplementssupplement's beliefs scale. *Performance enhancement & health*, *5*(3), 89-97.

Hurst, P., Kavussanu, M., Boardley, I., & Ring, C. (2019). Sport supplement use predicts doping attitudes and likelihood via sport supplement beliefs. *Journal of Sports Sciences*, 1-7.

Ibrahim, O. O. (2018). What you must know about Dietary Supplements and its Legal Regulations. *EC Nutrition*, *13*, 551-562.

ISASA. (2020). Retrieved from https://www.isasa.org/ [Accessed 20 March 2020].

Jacob, R., Couture, S., Lamarche, B., Provencher, V., Morissette, É., Valois, P., Goulet, C., & Drapeau, V. (2019). Determinants of coaches' intentions to provide different recommendations on sports nutrition to their athletes. *Journal of the International Society of Sports Nutrition*, *16*(1), 1-10.

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

Jäger, R., Metzger, J., Lautmann, K., Shushakov, V., Purpura, M., Geiss, K. R., & Maassen, N. (2008). The effects of creatine pyruvate and creatine citrate on

performance during high intensity exercise. *Journal of the International Society of Sports Nutrition*, *5*(1), 4.

Jäger, R., Purpura, M., Shao, A., Inoue, T., & Kreider R. B. (2011). Analysis of the efficacy, safety, and regulatory status of novel forms of creatine. *Open access at Springerlink, 40*, 1369-1383.

Jagim, A. R., Stecker, R. A., Harty, P. S., Erickson, J. L., & Kerksick, C. M. (2018). Safety of Creatine Supplementation in Active Adolescents and Youth: A Brief Review. *Frontiers in nutrition*, *5*, 115.

Jawadi, A. H., Addar, A. M., Alazzam, A. S., Alrabieah, F. O., Al Alsheikh, A. S., Amer, R. R., Aldrees, A. A. S., Al Turki, M. A., Osman, A. K., & Badri, M. (2017). Prevalence of dietary supplements use among gymnasium users. *Journal of nutrition and metabolism, 2017.*

John, J. (2019). Global Sports Nutrition Market will reach $45.27 Billion by 2022: Zion Market Research. [online] StockGuru Trustworthy News On Stocks. Retrieved from https://stockguru.com/2017/01/09/global-sports-nutrition-market-will-reach-45-27-billion-by-2022-zion-market-research/ [Accessed 29 April 2019].

Jovanov, P., Đorđić, V., Obradović, B., Barak, O., Pezo, L., Marić, A., & Sakač, M. (2019). Prevalence, knowledge and attitudes towards using sports supplements among young athletes. *Journal of the International Society of Sports Nutrition*, *16*(1), 27.

Jowett, S., & Cramer, D. (2010). The prediction of young athletes' physical self from perceptions of relationships with parents and coaches. *Psychology of Sport and Exercise*, *11*(2), 140-147.

Juhász, I., Györe, I., Csende, Z., Racz, L., & Tihanyi, J. (2009). Creatine supplementation improves the anaerobic performance of elite junior fin swimmers. *Acta Physiologica Hungarica*, *96*(3), 325-336.

Keat, L. L., Saad, H. A., & Phing, C. H. (2017). Intake of Nutritional Ergogenic Aids among Malaysian Team Sport Athletes. *International Research Journal of Education and Sciences*, *1*(1), 40-46.

Keegan, R. J., Harwood, C. G., Spray, C. M., & Lavallee, D. E. (2009). A qualitative investigation exploring the motivational climate in early career sports participants: Coach, parent and peer influences on sport motivation. *Psychology of sport and exercise*, *10*(3), 361-372.

Kellmann, M., Bertollo, M., Bosquet, L., Brink, M., Coutts, A. J., Duffield, R., Erlacher, D., Halson, S. L., Hecksteden, A., Heidari, J., Kallus, K. W., Meeusen, R., Mujika, I., Robazza, C., Skorski, S., Venter, R., & Beckmann, J. (2018). Recovery and performance in sport: consensus statement. *International journal of sports physiology and performance*, *13*(2), 240-245.

Keogh, C., Li, C., & Gao, Z. (2019). Evolving consumer trends for whey protein sports supplements: the Heckman ordered probit estimation. *Agricultural and Food Economics*, *7*(1), 6.

Kerksick, C. M., Wilborn, C. D., Roberts, M. D., Smith-Ryan, A., Kleiner, S. M., Jäger, R., Collins, R., Cooke, M., Davis, J. N., Galvan, E., Greenwood, M., Lowery, L. M., Wildman, R., Antonio, J., & Kreider, R. B. (2018). ISSN exercise & sports nutrition review update: research & recommendations. *Journal of the International Society of Sports Nutrition*, *15*(1), 38.

King, D. S., Baskerville, R., Hellsten, Y., Senchina, D. S., Burke, L. M., Stear, S. J., & Castell, L. M. (2012). A–Z of nutritional supplements: dietary supplements, sports nutrition foods and ergogenic aids for health and performance. *British Journal of Sports Medicine, 46*(9), 689-690.

Kisten, T., & Naidoo, R. (2019). The Perspectives of Amateur Soccer Players and their Coaches on the Use of Performance Enhancing Substances. *Global Journal of Health Science*, *11*(7).

Knapik, J. J., Steelman, R. A., Hoedebecke, S. S., Austin, K. G., Farina, E. K., & Lieberman, H. R. (2016). Prevalence of dietary supplement use by athletes: systematic review and meta-analysis. *Sports Medicine*, *46*(1), 103-123.

Kobus, K. (2003). Peers and adolescent smoking. *Addiction*, *98*, 37-55.

Kondric, M., Sekulic, D., Uljevic, O., Gabrilo, G., & Zvan, M. (2013). Sport nutrition and doping in tennis: an analysis of athletes' attitudes and knowledge. *Journal of sports science & medicine*, *12*(2), 290.

Kotnik, K. Z., Jurak, G., Starc, G., & Golja, P. (2017). Faster, Stronger, Healthier: Adolescent-Stated Reasons for Dietary Supplementation. *Journal of Nutrition Education and Behavior, 49*(10), 817-826.

Kotnik, K. Z., Jurak, G., Starc, G., Puc, M., & Golja, P. (2018). Use of dietary supplements in differently physically active adolescents. *Journal of Food & Nutrition Research*, *57*(3).

Kreider, R. B., Kalman, D. S., Antonio, J., Ziegenfuss, T. N., Wildman, R., Collins, R., Candow, D. G., Kleiner, S. M., Almada, A. L., & Lopez, H. L. (2017). International Society of Sports Nutrition position stand: safety and efficacy of creatine supplementation in exercise, sport, and medicine. *Journal of the International Society of Sports Nutrition*, *14*(1), 18.

Kreider, R. B., Melton, C., Rasmussen, C. J., Greenwood, M., Lancaster, S., Cantler, E. C., Milnor, P., & Almada, A. L. (2003). Long-term creatine supplementation does not significantly affect clinical markers of health in athletes. *Molecular and Cellular Biochemistry, 244*, 95-104.

Kubayi, A., Coopoo, Y., & Toriola, A. (2018). Analysis of sports science perceptions and research needs among South African coaches. *South African Journal of Sports Medicine*, *30*(1).

Laboratory of the Government Chemist Limited. (2019). About Informed-Choice. Retrieved from https://www.informed-choice.org/about [Accessed 18 June 2019].

LaBotz, M., & Griesemer, B. A. (2016). Use of performance-enhancing substances. *Paediatrics*, *138*(1).

Lavoi, N. M., & Stellino, M. B. (2008). The relation between perceived parent-created sport climate and competitive male youth hockey players' good and poor sport behaviors. *The Journal of Psychology*, *142*(5), 471-496.

Lear, K. E., Runyan, R. C., & Whitaker, W. H. (2009). Sports celebrity endorsements in retail products advertising. *International Journal of Retail & Distribution Management*, *37*(4), 308-321.

Lieberman, H. R., Marriott, B. P., Williams, C., Judelson, D. A., Glickman, E. L., Geiselman, P. J., Dotson, L., & Mahoney, C. R. (2015). Patterns of dietary supplement use among college students. *The European Society for Clinical Nutrition and Metabolism, 34*, 976-985.

Loraine, K. (2018). Supplement Regulation for Sports Nutrition Supplements. *Journal of Legal Medicine*, *38*(2), 271-285.

Malik, A., & Malik, S. (2010). Prevalence of nutritional supplements in gyms. *British Journal of Sports Medicine*, *44*(1), 44.

Mandic, G. F., Peric, M., Krzelj, L., Stankovic, S., & Zenic, N. (2013). Sports nutrition and doping factors in synchronized swimming: Parallel analysis among athletes and coaches. *Journal of sports science & medicine*, *12*(4), 753.

Manore, M. M., Patton-Lopez, M. M., Meng, Y., & Wong, S. S. (2017). Sport nutrition knowledge, behaviors and beliefs of high school soccer players. *Nutrients*, *9*(4), 350.

Marck, A., Antero, J., Berthelot, G., Saulière, G., Jancovici, J. M., Masson-Delmotte, V., Boeuf, G., Spedding, M., Le Bourg, É., & Toussaint, J. F. (2017). Are we reaching the limits of homo sapiens?. *Frontiers in physiology*, *8*, 812.

Martin, J., & Govender, K. (2011). “Making muscle junkies”: Investigating traditional masculine ideology, body image discrepancy, and the pursuit of muscularity in adolescent males. *International Journal of Men’s Health*, *10*(3).

Martin, N. J. (2020). Fostering Motivation: Understanding the Role Coaches Play in Youth Sport. *Strategies*, *33*(1), 20-27.

Martínez-Sanz, J., Sospedra, I., Ortiz, C., Baladía, E., Gil-Izquierdo, A., & Ortiz-Moncada, R. (2017). Intended or unintended doping? A review of the presence of doping substances in dietary supplements used in sports. *Nutrients*, *9*(10), 1093.

Mas, M. F., Ranal, J. L., Concepcion, R. A. R., Gonzalez-Sepulveda, L., Rivas-Tumanyan, S., Frontera, W. R., & Ramos, E. (2019). Use of ergogenic supplements by young athletes in a sports specialized school. *The Journal of the International Society of Physical and Rehabilitation Medicine*, *2*(3), 126.

Mathews, N. M. (2017). Prohibited contaminants in dietary supplements. *Sports health*, *10*(1), 19-30.

Mattila, V. M., Parkkari, J., Laakso, L., Pihlajamaki, H., & Rimpela, A. (2009). Use of dietary supplements and anabolic-androgenic steroids among Finnish adolescents in 1991–2005. *European Journal of Public Health, 20*(3), 306-311.

Maughan, R. J. (2005). Contamination of dietary supplements and positive drug tests in sport. *Journal of Sports Sciences, 23*(9), 883-889.

Maughan, R. J. (2013). Quality Assurance Issues in the Use of Dietary Supplements, with Special Reference to Protein Supplements. *The Journal of Nutrition,143*(11), 1843-1847.

Maughan, R. J., Burke, L. M., Dvorak, J., Larson-Meyer, D. E., Peeling, P., Phillips, S. M., Rawson, E. S., Walsh, N. P., Garthe, I., Geyer, H., Meeusen, R., van Loon, L., Shirreffs, S. M., Spriet, L. L., Stuart, M., Vernec, A., Currell, K., Ali, V. M., Budgett, R. G. M., Ljungqvist, A., Mountjoy, M., Pitsiladis, Y., Soligard, T., Erdener, U., & Engebretsen, L. (2018). IOC consensus statement: dietary supplements and the high-performance athlete. *International journal of sport nutrition and exercise metabolism*, *28*(2), 104-125.

Maughan, R. J., Shirreffs, S. M., & Vernec, A. (2018). Making decisions about supplement use. *International journal of sport nutrition and exercise metabolism*, *28*(2), 212-219.

Mazzeo, F., Rinaldi, M., & Tafuri, D. (2020). Sports and supplements: Educating to well-being through effective nutrition. *Sport Science*, *13*, 70-75.

Mc Creanor, X., Coopoo, Y., & Gabriels, G. (2017). Attitudes towards nutritional supplement use amongst adult gymnasium users in Johannesburg North. *South African Journal of Sports Medicine, 29*(1), 1-5.

Mehralian, G., Yousefi, N., Hashemian, F., & Maleksabet, H. (2014). Knowledge, attitude and practice of pharmacists regarding dietary supplements: a community pharmacy-based survey in Tehran. *Iranian journal of pharmaceutical research: IJPR*, *13*(4), 1457.

Mendo-Lázaro, S., Polo-del-Río, M. I., Amado-Alonso, D., Iglesias-Gallego, D., & León-del-Barco, B. (2017). Self-concept in childhood: the role of body image and sport practice. *Frontiers in psychology*, *8*, 853.

Mettler, S., Bosshard, J. V., Häring, D., & Morgan, G. (2020). High Prevalence of Supplement Intake with a Concomitant Low Information Quality among Swiss Fitness Center Users. *Nutrients*, *12*(9), 2595.

Molinero, O., & Márquez, S. (2009). Use of nutritional supplements in sports: risks, knowledge, and behavioural-related factors. *Nutrición Hospitalaria, 24*(2), 128-134.

Momaya, A., Fawal, M., & Estes, R. (2015). Performance-enhancing substances in sports: a review of the literature. *Sports Medicine*, *45*(4), 517-531.

Mooney, R., Simonato, P., Ruparelia, R., Roman-Urrestarazu, A., Martinotti, G., & Corazza, O. (2017). The use of supplements and performance and image enhancing drugs in fitness settings: A exploratory cross-sectional investigation in the United Kingdom. *Human Psychopharmacology: Clinical and Experimental*, *32*(3), e2619.

Morton, K. L., Atkin, A. J., Corder, K., Suhrcke, M., & Van Sluijs, E. M. F. (2016). The school environment and adolescent physical activity and sedentary behaviour: a mixed-studies systematic review. *Obesity reviews*, *17*(2), 142-158.

Muller, S. M., Gorrow, T. R., & Schneider, S. R. (2009). Enhancing appearance and sports performance: are female collegiate athletes behaving more like males?. *Journal of American College Health*, *57*(5), 513-520.

Muwonge, H., Zavuga, R., Kabenge, P. A., & Makubuya, T. (2017). Nutritional supplement practices of professional Ugandan athletes: a cross-sectional study. *Journal of the International Society of Sports Nutrition*, *14*(1), 1-10.

Naidoo, K., Naidoo, R., & Bangalee, V. (2018). Regulating the South African sport supplement industry:'Whey'overdue. *SAMJ: South African Medical Journal*, *108*(3), 166-167.

Nall, R. (2018). What's the Difference Between Epinephrine and Norepinephrine?. Retrieved from https://www.healthline.com/health/epinephrine-vs-norepinephrine [Accessed 13 January 2021].

National Research Council. (1989). Protein and amino acids. *Recommended Dietary Allowances: 10th Edition*. National Academies Press (US).

Nieper, A. (2005). Nutritional supplement practices in UK junior national track and field athletes. *British journal of sports medicine*, *39*(9), 645-649.

Nolte, K., Steyn, B. J. M., Fletcher, L., & Krüger, P. E. (2014). Doping in sport: Attitudes, beliefs and knowledge of competitive high-school athletes in Gauteng Province. *South African Journal of Sports Medicine*, *26*(3), 81-86.

Nwankwo, G. O., & Ekechukwu, R. O. (2020). Implications of Psychosocial Risks Associated with Adolescents' Sports Participation: Need for Sport Counselling. *Journal of Advances in Education Research*, *5*(3), 143.

O'Dea, J. A. (2003). Consumption of nutritional supplements among adolescents: usage and perceived benefits. *Oxford University Press, 18*(1), 98-107.

O'Dea, J., & Cinelli, R. L. (2016). Use of drugs to change appearance in girls and female adolescents. *Chemically Modified Bodies*, 51-76.

Oliver, A. J., Leon, M. T., & Hernández, E. G. (2008). Statistical analysis of the consumption of nutritional and dietary supplements in gyms. *Archivos latinoamericanos de nutricion*, *58*(3), 221-227.

Outram, S., & Stewart, B. (2015). Doping through supplement use: a review of the available empirical data. *International journal of sport nutrition and exercise metabolism*, *25*(1), 54-59.

Pacifici, R., Palmi, I., Vian, P., Andreotti, A., Mortali, C., Berretta, P., Mastrobattista, L., & Pichini, S. (2016). Emerging trends in consuming behaviours for non-controlled substances by Italian urban youth: a cross sectional study. *Annali dell'Istituto superiore di sanit* , *52*(1), 104-113.

Pasiakos, S. M., McLellan, T. M., & Lieberman, H. R. (2015). The effects of protein supplements on muscle mass, strength, and aerobic and anaerobic power in healthy adults: a systematic review. *Sports Medicine*, *45*(1), 111-131.

Patel, D. R., Pratt, H. D., & Greydanus, D. E. (1998). Adolescent growth, development, and psychosocial aspects of sports participation: an overview. *Adolescent medicine (Philadelphia, Pa.)*, *9*(3), 425-40.

Peeling, P., Binnie, M. J., Goods, P. S., Sim, M., & Burke, L. M. (2018). Evidence-based supplements for the enhancement of athletic performance. *International journal of sport nutrition and exercise metabolism*, *28*(2), 178-187.

Perko, M., Bartee, R. T., Dunn, M. S., Qi Wang, M., & Eddy, J. (2000). Giving new meaning to the term 'taking one for the team': Influences on the use/non-use of dietary supplements among adolescent athletes. *American Journal of Health Studies*, *16*(2).

Peterson, C. (2004). Positive social science. *The Annals of the American Academy of Political and Social Science*, *591*(1), 186-201.

Petróczi, A. (2013). The doping mindset—part I: implications of the functional use theory on mental representations of doping. *Performance Enhancement & Health*, *2*(4), 153-163.

Petróczi, A., & Aidman, E. (2008). Psychological drivers in doping: The life-cycle model of performance enhancement. *Substance abuse treatment, prevention, and policy*, *3*(1), 7.

Petróczi, A., & Naughton, D. P. (2008). The age-gender-status profile of high performing athletes in the UK taking nutritional supplements: lessons for the future. *Journal of the International Society of Sports Nutrition*, *5*(1), 2.

Petróczi, A., Naughton, D. P., Pearce, G., Bailey, R., Bloodworth, A., & McNamee, M. (2008). Nutritional supplement use by elite young UK athletes: fallacies of advice regarding efficacy. *Journal of the International Society of Sports Nutrition*, *5*(1), 22.

Potgieter, S., Labadarios, D., & Labuschagne, I. (2011). Body composition, dietary intake and supplement use among triathletes residing in the Western Cape. *South African Journal of Sports Medicine*, *23*(3), 74-79.

Reuter, P., & Pardo, B. (2017). Can new psychoactive substances be regulated effectively? An assessment of the British Psychoactive Substances Bill. *Addiction*, *112*(1), 25-31.

Ricci, T., Forbes, S. C., & Candow, D. G. (2020). Creatine Supplementation: Practical Strategies and Considerations for Mixed Martial Arts. *Journal of Exercise and Nutrition ISSN*, *2640*, 2572.

Roberts, P. A., Fox, J., Peirce, N., Jones, S. W., Casey, A., & Greenhaff, P. L. (2016). Creatine ingestion augments dietary carbohydrate mediated muscle glycogen supercompensation during the initial 24 h of recovery following prolonged exhaustive exercise in humans. *Amino acids*, *48*(8), 1831-1842.

Rodek, J., Sekulic, D., & Kondric, M. (2012). Dietary supplementation and doping-related factors in high-level sailing. *Journal of the International Society of Sports Nutrition*, *9*(1), 51.

Rousseau, A., & Eggermont, S. (2018). Media ideals and early adolescents' body image: Selective avoidance or selective exposure?. *Body Image*, *26*, 50-59.

Saeedi, P., Nasir, M. T. M., Hazizi, A. S., Vafa, M. R., & Foroushani, A. R. (2013). Nutritional supplement use among fitness club participants in Tehran, Iran. *Appetite*, *60*, 20-26.

SAHPRA. (2018). Strategic plan for the fiscal years 2018/19 – 2022/23. Retrieved from https://www.hpasa.co.za/wp-content/uploads/2018/06/SAHPRA-Strategic-Plan-2018-19-to-2022-23.pdf [Accessed 1 May 2019].

SAIDS. (2018). Supplement use under the spotlight. Retrieved from http://www.drugfreesport.org.za/wp-content/uploads/2019/05/Supplements-under-the-spotlight.pdf [Accessed 12 June 2019].

SAIDS. (2019). About us. Retrieved from http://www.drugfreesport.org.za/about-us/ [Accessed 12 June 2019].

SAIDS. (2021). Doping cases. Retrieved from https://drugfreesport.org.za/cases/ [Accessed 13 April 2021].

Sajber, D., Rodek, J., Escalante, Y., Olujić, D., & Sekulić, D. (2013). Sport nutrition and doping factors in swimming; parallel analysis among athletes and coaches. *Collegium antropologicum*, *37*(2), 179-186.

Sato, Y., Yamagishi, A., Hashimoto, Y., Virgona, N., Hoshiyama, Y., & Umegaki, K. (2009). Use of dietary supplements among preschool children in Japan. *Journal of nutritional science and vitaminology*, *55*(4), 317-325.

SchoolGuide. (2019). School Fees & Quintiles. Retrieved from https://www.schoolguide.co.za/for-parents/school-review-guidelines/1036-education-guide/10975-school-fees-quintiles.html [Accessed 9 December 2019].

Schoonees, A., & Volmink, J. (2013). The advertising of nutritional supplements in South African women's magazines: a descriptive survey. *South African Journal of Clinical Nutrition*, *26*(2), 12-18.

Sekulic, D., Tahiraj, E., Maric, D., Olujic, D., Bianco, A., & Zaletel, P. (2019). What drives athletes toward dietary supplement use: objective knowledge or self-perceived competence? Cross-sectional analysis of professional team-sport players from Southeastern Europe during the competitive season. *Journal of the International Society of Sports Nutrition*, *16*(1), 25.

Semba, R. D., Shardell, M., Ashour, F. A. S., Moaddel, R., Trehan, I., Maleta, K. M., Ordiz, M. I., Kraemer, K., Khadeer, M. A., Ferrucci, L., & Manary, M. J. (2016). Child stunting is associated with low circulating essential amino acids. *EBioMedicine*, *6*, 246-252.

Senekal, M., Meltzer, S., Horne, A., Abrey, N. C., Papenfus, L., van der Merwe, S., & Temple, N. J. (2019). Dietary supplement use in younger and older men exercising at gyms in Cape Town. *South African Journal of Clinical Nutrition*, *34*(1), 1-8.

Shao, A., & Hathcock, J. N. (2006). Risk assessment for creatine monohydrate. *Regulatory Toxicology and Pharmacology, 45*, 242-251.

Shifflett, B., Timm, C., & Kahanov, L. (2002). Understanding of athletes' nutritional needs among athletes, coaches, and athletic trainers. *Research Quarterly for Exercise and Sport*, *73*(3), 357-362.

Siegenthaler, K. L., & Gonzalez, G. L. (1997). Youth sports as serious leisure: A critique. *Journal of sport and social issues*, *21*(3), 298-314.

Silva, D. A. S., Nahas, M. V., de Sousa, T. F., Del Duca, G. F., & Peres, K. G. (2011). Prevalence and associated factors with body image dissatisfaction among adults in southern Brazil: a population-based study. *Body Image*, *8*(4), 427-431.

Skuland, S. E., & Anestad, S. E. (2011). The mainstreaming of sports nutrition consumption in the Norwegian food culture. *OpenEdition Journals, 7.*

Soller, R. W., Bayne, H. J., & Shaheen, C. (2012). The Regulated Dietary Supplement Industry: Myths of an Unregulated Industry Dispelled. *HerbalGram*, (93).

South African Institute for Drug-Free Sport "SAIDS". (2017). *Supplement Use Under the Spotlight*. Newlands, Cape Town: Imvakalelo Digital.

Stirling, A. E., & Kerr, G. A. (2009). Abused athletes' perceptions of the coach-athlete relationship. *Sport in Society*, *12*(2), 227-239.

Šterlinko, H. G., Stubelj, M. A., Besednjak-Kocijančič, L., & Golja, P. (2012). Nutritional supplement use among Slovenian adolescents. *Public health nutrition*, *15*(4), 587-593.

Story, M., & French, S. (2004). Food advertising and marketing directed at children and adolescents in the US. *International Journal of Behavioral Nutrition and Physical Activity*, *1*(1), 3.

Sundgot-Borgen, J., Berglund, B., & Torstveit, M. K. (2003). Nutritional supplements in Norwegian elite athletes-impact of international ranking and advisors. *Scandinavian journal of medicine & science in sports*, *13*(2), 138-144.

Svova, A. H. (2020). *Attitudes, choices and expenditures on dietary supplements among adult members at low-cost gymnasiums in Johannesburg* (Doctoral dissertation, North-West University).

Tawfik, S., El Koofy, N., & Moawad, E. M. I. (2016). Patterns of nutrition and dietary supplements use in young Egyptian athletes: A community-based cross-sectional survey. *PLoS One*, *11*(8), e0161252.

Fraser-Thomas, J., & Côté, J. (2009). Understanding adolescents' positive and negative developmental experiences in sport. *The sport psychologist*, *23*(1), 3-23.

Timbo, B. B., Ross, M. P., McCarthy, P. V., & Lin, C. T. J. (2006). Dietary supplements in a national survey: prevalence of use and reports of adverse events. *Journal of the American Dietetic Association*, *106*(12), 1966-1974.

Torres-McGehee, T. M., Pritchett, K. L., Zippel, D., Minton, D. M., Cellamare, A., & Sibilia, M. (2012). Sports nutrition knowledge among collegiate athletes, coaches, athletic trainers, and strength and conditioning specialists. *Journal of athletic training*, *47*(2), 205-211.

Trakman, G. L., Forsyth, A., Devlin, B. L., & Belski, R. (2016). A systematic review of athletes' and coaches' nutrition knowledge and reflections on the quality of current nutrition knowledge measures. *Nutrients*, *8*(9), 570.

Truong, L. K., Bekker, S., & Whittaker, J. L. (2021). Removing the training wheels: embracing the social, contextual and psychological in sports medicine. *British journal of sports medicine, 55*, 462-467.

Tsarouhas, K., Kioukia-Fougia, N., Papalexis, P., Tsatsakis, A., Kouretas, D., Bacopoulou, F., & Tsitsimpikou, C. (2018). Use of nutritional supplements contaminated with banned doping substances by recreational adolescent athletes in Athens, Greece. *Food and chemical toxicology*, *115*, 447-450.

Tsochas, K., Lazuras, L., & Barkoukis, V. (2013). Psychosocial predictors of nutritional supplement use among leisure time exercisers. *Performance Enhancement & Health*, *2*(1), 17-23.

Turfus, S. C., Smith, J. O. L., Mansingh, A., Alexander-Lindo, R. L., & Roopchand-Martin, S. (2019). Supplementation practices, perceptions and knowledge about anti-doping among Jamaican high school athletes. *Performance Enhancement & Health*, *7*(1-2), 100145.

Tyan, Y. C., Yang, M. H., Jong, S. B., Wang, C. K., & Shiea, J. (2009). Melamine contamination. *Analytical and Bioanalytical Chemistry, 395*(3), 729-735.

Van Aswegen, M. (2013). *The knowledge, attitudes and use of performance enhancing substances and supplements among male High-school first and second team athletes in the metropolitan area of Cape Town, South Africa*. Unpublished thesis. Centre for Exercise and Sports Medicine, University of Witwatersrand, Johannesburg.

Van der Bijl, P. (2014). Dietary supplements containing prohibited substances: A review (Part 2). *South African journal of sports medicine*, *26*(3), 87-90.

Van der Merwe, P. J., & Grobbelaar, E. (2004). Inadvertent doping through nutritional supplements is a reality. *South African Journal of Sports Medicine*, *16*(2), 3-7.

Van der Walt, V., & Coopoo, Y. (2016). A survey of the attitudes and knowledge of parents of high school children on the East Rand on the usage of nutritional supplements. *South African Journal of Sports Medicine*, *28*(3), 74-78.

Van Hoorn, J., Crone, E. A., & Van Leijenhorst, L. (2017). Hanging out with the right crowd: Peer influence on risk-taking behavior in adolescence. *Journal of Research on Adolescence*, *27*(1), 189-200.

Van Thuyne, W., Van Eenoo, P., & Delbeke, F. T. (2006). Nutritional supplements: prevalence of use and contamination with doping agents. *Nutrition Research Reviews, 19,* 147-158.

Vella, S., Oades, L., & Crowe, T. (2011). The role of the coach in facilitating positive youth development: Moving from theory to practice. *Journal of applied sport psychology*, *23*(1), 33-48.

Vosloo, J. J. (2014). *A sport management programme for educator training in accordance with the diverse needs of South African schools* (Doctoral dissertation).

WADA. (2019). Retrieved from https://www.wada-ama.org/en/questions-answers/prohibited-list-qa#item-1358 [Accessed 10 June 2019].

WADC. (2015). The World Anti-Doping Code. Montreal, Canada: The World Anti-Doping Agency. Retrieved from https://www.wada-ama.org/sites/default/files/resources/files/wada-2015-world-anti-doping-code.pdf [Accessed 1 May 2019].

WADC. (2021). The World Anti-Doping Code. Montreal, Canada: The World Anti-Doping Agency. Retrieved from https://www.wada-ama.org/sites/default/files/resources/files/2021_wada_code.pdf [Accessed 22 November 2021].

Walsh, M., Cartwright, L., Corish, C., Sugrue, S., & Wood-Martin, R. (2011). The body composition, nutritional knowledge, attitudes, behaviors, and future education needs of senior schoolboy rugby players in Ireland. *International journal of sport nutrition and exercise metabolism*, *21*(5), 365-376.

Walters, G., Hamil, S., & Irving, R. (2018). The governance and regulation of sport. In *Managing Sport Business* (pp. 109-125). Routledge.

Wardenaar, F., van den Dool, R., Ceelen, I., Witkamp, R., & Mensink, M. (2016). Self-reported use and reasons among the general population for using sports nutrition products and dietary supplements. *Sports*, *4*(2), 33.

Welthagen, A. (2016). *The development of a measuring instrument to determine the knowledge and attitudes of elite adolescent athletes about ergogenic aids and banned substances* (Doctoral dissertation, University of the Free State).

White, S. A., Kavussanu, M., Tank, K. M., & Wingate, J. M. (2004). Perceived parental beliefs about the causes of success in sport: relationship to athletes' achievement goals and personal beliefs. *Scandinavian journal of medicine & science in sports*, *14*(1), 57-66.

Whitehouse, G., & Lawlis, T. (2017). Protein supplements and adolescent athletes: a pilot study investigating the risk knowledge, motivations and prevalence of use. *Nutrition & dietetics*, *74*(5), 509-515.

Williams, M. (2005). Dietary supplements and sports performance: amino acids. *Journal of the International Society of Sports Nutrition*, *2*(2), 63.

World Health Organization. (2019). Adolescent development. Retrieved from https://www.who.int/maternal_child_adolescent/topics/adolescence/development/en/ [Accessed 10 June 2019].

Wright, H. H., Ford, R., & Botha, C. R. (2014). A desire for weight loss in season increases disordered eating behaviour risk and energy deficiency in athletes. *South African journal of clinical nutrition*, *27*(3), 120-126.

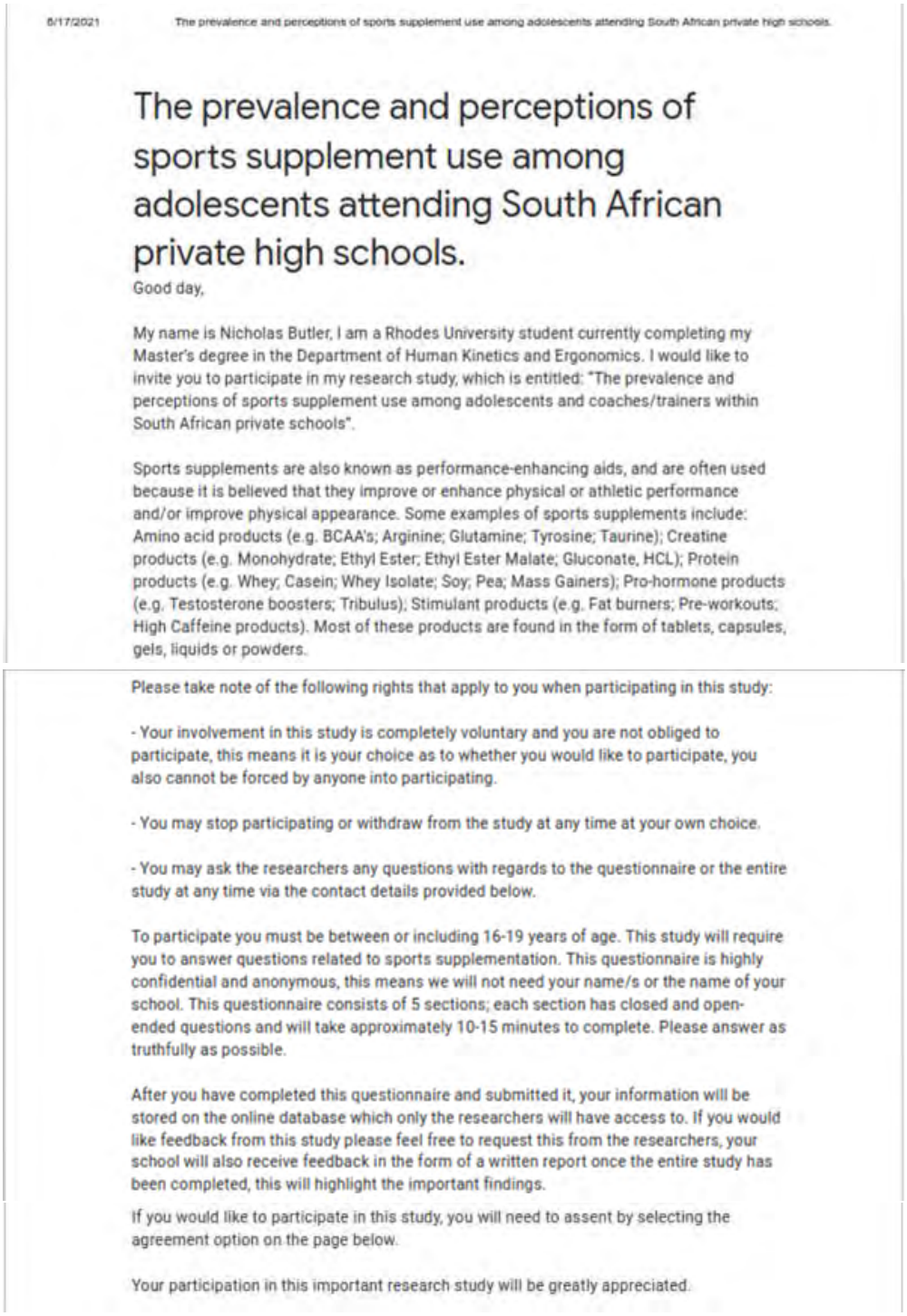
Yager, Z., & O'Dea, J. (2014). Relationships between body image, nutritional supplement use, and attitudes towards doping in sport among adolescent boys: implications for prevention programs. *Journal of the International Society of Sports Nutrition, 11.*

Yang, H., Yang, Y., Xu, L., Wu, Q., Xu, J., Weng, E., Wang, K., & Cai, S. (2017). The relation of physical appearance perfectionism with body dissatisfaction among

school students 9–18 years of age. *Personality and Individual Differences*, *116*, 399-404.

APPENDICES

Appendix 1 – Questionnaire, Information Letter & Assent Form (Adolescent Study).



The prevalence and perceptions of sports supplement use among adolescents attending South African private high schools.

Good day,

My name is Nicholas Butler, I am a Rhodes University student currently completing my Master's degree in the Department of Human Kinetics and Ergonomics. I would like to invite you to participate in my research study, which is entitled: "The prevalence and perceptions of sports supplement use among adolescents and coaches/trainers within South African private schools".

Sports supplements are also known as performance-enhancing aids, and are often used because it is believed that they improve or enhance physical or athletic performance and/or improve physical appearance. Some examples of sports supplements include: Amino acid products (e.g. BCAA's; Arginine; Glutamine; Tyrosine; Taurine); Creatine products (e.g. Monohydrate; Ethyl Ester; Ethyl Ester Malate; Gluconate, HCL); Protein products (e.g. Whey; Casein; Whey Isolate; Soy; Pea; Mass Gainers); Pro-hormone products (e.g. Testosterone boosters; Tribulus); Stimulant products (e.g. Fat burners; Pre-workouts; High Caffeine products). Most of these products are found in the form of tablets, capsules, gels, liquids or powders.

Please take note of the following rights that apply to you when participating in this study:

- Your involvement in this study is completely voluntary and you are not obliged to participate, this means it is your choice as to whether you would like to participate, you also cannot be forced by anyone into participating.

- You may stop participating or withdraw from the study at any time at your own choice.

- You may ask the researchers any questions with regards to the questionnaire or the entire study at any time via the contact details provided below.

To participate you must be between or including 16-19 years of age. This study will require you to answer questions related to sports supplementation. This questionnaire is highly confidential and anonymous, this means we will not need your name/s or the name of your school. This questionnaire consists of 5 sections; each section has closed and open-ended questions and will take approximately 10-15 minutes to complete. Please answer as truthfully as possible.

After you have completed this questionnaire and submitted it, your information will be stored on the online database which only the researchers will have access to. If you would like feedback from this study please feel free to request this from the researchers, your school will also receive feedback in the form of a written report once the entire study has been completed, this will highlight the important findings.

If you would like to participate in this study, you will need to assent by selecting the agreement option on the page below.

Your participation in this important research study will be greatly appreciated.

Co-Researcher:
Nicholas Butler
nicbutler8@gmail.com
+27 72 071 5520

Principal Researchers:
Dr. Jonathan Davy
jonathan.davy@ru.ac.za

Professor. Candice Christie
c.christie@ru.ac.za

* Required

1. Assent form *

I have read and understand the information on the research that is being done on "The prevalence and perceptions of sports supplement use among adolescents and coaches/trainers within South African private schools".

Check all that apply.

- [ ] I give my consent to participate in this research study.

Section 1: General demographic information.

This section will require you to give your general demographic information, this will include: Age; Gender; Grade; School Location and Sports participation.

Your name and other personal information is not required in this section or any other sections of this questionnaire.

2. What is your current age? *

Mark only one oval.

- ◯ 16
- ◯ 17
- ◯ 18
- ◯ 19

3. What is your sex? *

Mark only one oval.

- ◯ Female
- ◯ Male
- ◯ Prefer not to say

4. What grade are you currently in? *

Mark only one oval.

- ◯ 10
- ◯ 11
- ◯ 12
- ◯ Other: _____

5. Which province is your school located in? *

Mark only one oval.

- ◯ Eastern Cape
- ◯ Free State
- ◯ Gauteng
- ◯ KwaZulu-Natal
- ◯ Limpopo
- ◯ Northern Cape
- ◯ North West
- ◯ Mpumalanga
- ◯ Western Cape

6. Please indicate all the sports/physical activities you participate in. (Select the "None" option if you do not participate in any sports/physical activities) *

Check all that apply.

- ☐ Athletics
- ☐ Basketball
- ☐ Boxing
- ☐ Cricket
- ☐ Cross country running
- ☐ Crossfit
- ☐ Dance
- ☐ Equestrian
- ☐ Golf
- ☐ Gym
- ☐ Hockey
- ☐ Mixed Martial Arts
- ☐ Motor sports
- ☐ Netball
- ☐ Rowing
- ☐ Rugby
- ☐ Soccer
- ☐ Squash
- ☐ Swimming
- ☐ Tennis
- ☐ Waterpolo
- ☐ None

Other: ☐ _____

Section 2: The use of sports supplements.

This section will require you to answer questions related to the prevalence and perceptions of all types of sports supplements.

7. Have you ever used a sports supplement before? *

Examples of sports supplements include: Protein shakes/bars; Creatine powders/capsules; Stimulants [i.e. Fat burner tablets; Pre-workout drinks; Caffeine capsules]; Pro-hormones [i.e. Testosterone booster capsules]; Amino acids [i.e. BCAA's; Glutamine powder]) etc.

Mark only one oval.

- ◯ Yes
- ◯ No

8. Are you currently using a sports supplement? *

If you currently using or you used a sports supplement within the past few days or you are going to use a sports supplement within the next few days please select the "Yes" option.

Mark only one oval.

- ◯ Yes
- ◯ No

9. What age were you when you first used a sports supplement? *

Please select 1 answer. Select "N/A" if you have never used a sports supplement before.

Mark only one oval.

- ◯ N/A
- ◯ Younger than 8 Years old.
- ◯ 8-10 Years old.
- ◯ 10-12 Years old.
- ◯ 12-14 Years old.
- ◯ 14-16 Years old.
- ◯ 16-18 Years old.
- ◯ 19 Years old.

10. On average, how often do you/did you use the sport supplement/s? *

Please select 1 answer. Select 'N/A' if you have never used a sports supplement before.

Mark only one oval.

- ◯ N/A
- ◯ Once a year.
- ◯ Once every 6 months.
- ◯ Once a month.
- ◯ Once a week.
- ◯ More than once a week.
- ◯ Once a day.
- ◯ More than once a day.
- ◯ Only before/after/during sports or training.

11. Approximately, how many different types of sports supplements have you/do you use? *

Mark only one oval.

- ◯ 0 types.
- ◯ 1-2 types.
- ◯ 2-4 types.
- ◯ 4-6 types.
- ◯ More than 6 types.

12. What was/is your main reason for using sports supplement/s? *

Please select a minimum of 1 and maximum of 3 answers. Please select "N/A" if you have never used a sports supplement before.

Check all that apply.

- [ ] N/A
- [ ] Assists me in coping with the stresses of training.
- [ ] Helps improve my performance at gym.
- [ ] Helps improve the looks of my body (aesthetics).
- [ ] I get more energy from using them.
- [ ] I use it because it tastes nice.
- [ ] I use them to replace meals.
- [ ] Helps me get bigger/heavier.
- [ ] Helps me get smaller/lighter.
- [ ] I feel healthier when I use them.
- [ ] I use it to recover from training, gym or sports.
- [ ] Other: _____

13. What/Who had the greatest influence and/or advice on your choice to start using sports supplements. *

Please select a minimum of 1 and a maximum of 3 answers. Please select "N/A" if you have never used a sports supplement before.

Check all that apply.

- [ ] N/A
- [ ] Coaches/Trainers
- [ ] Internet advertising and sites
- [ ] Social Media
- [ ] Television advertisements
- [ ] Friends
- [ ] Parents/Guardians
- [ ] Other family members
- [ ] Professional athletes
- [ ] Celebrities
- [ ] Academic journals
- [ ] Books
- [ ] Magazines
- [ ] Other: _____

14. What are your main reasons for NOT using sports supplements? *

Please select a minimum of 1 and maximum of 3 answers. Please Select "N/A" if you USE/HAVE used sports supplements before.

Check all that apply.

- [ ] N/A
- [ ] I don't think it is necessary to take them.
- [ ] I do not believe they work.
- [ ] I am afraid of what they may do to my health.
- [ ] It goes against what I believe.
- [ ] They are difficult to get.
- [ ] My parents/guardians do not allow me to use them.
- [ ] I cannot afford them.
- [ ] I am concerned about getting addicted to them.
- [ ] I am afraid they get me banned from playing sport.
- [ ] I believe a regular food diet is sufficient.
- [ ] Other: _____

Section 3: The use of specific sports supplements.

This section will require you to answer questions related to the prevalence and perceptions of specific types of sports supplements used by you.

15. What type of sports supplements do you use / have you used? *

Please select all answers applicable. Please select "N/A" if you have never used a sports supplement before.

Check all that apply.

- [ ] N/A
- [ ] Amino acid products (e.g. BCAA's; Arginine; Glutamine; Tyrosine; Taurine)
- [ ] Creatine products (e.g. Monohydrate; Ethyl Ester; Ethyl Ester Malate; Gluconate, HCL)
- [ ] Protein products (e.g. Whey; Casein; Whey Isolate; Soy; Pea; Mass Gainers)
- [ ] Pro-hormone products (e.g. Testosterone boosters; Tribulus; Zinc magnesium aspartate(ZMA))
- [ ] Stimulant products (e.g. Fat burners; Pre-workouts; High Caffeine products; Conjugated linoleic acid (CLA))
- [ ] Other: _____

16. Do you know how the sports supplement you use/have used functions within the human body? *

If you have never used a sports supplement please select "N/A" below.

Mark only one oval.

- ◯ N/A
- ◯ Yes I understand how it functions.
- ◯ No I do not understand how it functions.

17. What are the claims made on the label of the sports supplement you use/have used? *

(Claims: What the label says the supplement will do). Please state at least 1-2 claims in the space provided below. If you have never used a sports supplement please type "N/A" in the space. If you do not know what claims were made please type "Unknown" in the space.

_____

18. Do you know if the sports supplement/s you use or have used, has been certified (approved) by a regulatory authority or organisation which tests the safety and effectiveness of these products? *

If you have never used a sports supplement please select "N/A" below.

Mark only one oval.

- ◯ N/A
- ◯ Yes I know they have been certified
- ◯ No I do not know if they have been certified

19. Do you have any questions you would like to know about sports supplementation in general or about sports supplements you use/have used/looking to use? *

If there are no questions you would like to ask or no information you want to know, please type "No" in the space below.

_____

_____

_____

_____

Section 4: Perceptions and understanding of the benefits or risks/dangers involved with the use of sports supplements.

This section will require you to answer questions related to your beliefs and understanding around the safety and dangers of use of sports supplements.

20. Do you believe there are benefits from using sports supplements? *

If you believe there are benefits, please specify at least 1 benefit in the space provided. Please type "No" if you do not believe there are any benefits.

_____

_____

_____

_____

_____

21. Do you believe there are risks or dangers involved in the use sports supplementation? *

If you believe there are risks or dangers involved, please state at least 1 risk/danger you know of. Please type "No" if you do not believe there are any risks or dangers.

_____

22. Have you ever experienced negative side-effects from the sports supplement/s you use/have used? *

If you have never used a sports supplement, please select "N/A" below.

Mark only one oval.

- ◯ N/A
- ◯ Yes
- ◯ No

23. Would you use or continue using a sports supplement which helps you achieve your sports/athletic goals or physical appearance goals (Body-image) even if you understood there were risks or dangers involved? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

Section 5: Knowledge, Perceptions, Interventions and Solutions for the use of sports supplements.

This section will require you to answer questions related to your perceptions and ideas on sports supplement awareness and education.

24. Do you believe the use of sports supplementation is common among pupils attending South African private high schools? *

Mark only one oval.

- Yes
- No
- Maybe

25. Have you ever had any training or formal education related to sports nutrition or sports supplementation?

Mark only one oval.

- Yes
- No

26. Do you know of the "World Anti-Doping Agency" (WADA) and/or the "South African Institute for Drug-Free Sport" (SAIDS)?

Mark only one oval.

- Yes
- No

27. Do you think South African regulatory companies/organizations should provide educational programmes or training addressing the use of sports supplements by high school adolescents? *

Mark only one oval.

- Yes
- No

28. Do you think the current use of sports supplements is a problem among pupils attending South African private high schools?

Mark only one oval.

- Yes
- No
- Maybe

29. Please suggest 1 intervention or solution that could be used to help educate and create awareness for South African high school adolescents around using sports supplements safely and effectively. *

Appendix 2 – Initial approach email to school gatekeepers.

RHODES UNIVERSITY
Where leaders learn

Invitation to participate in research on Sports Supplement use and perceptions in private high schools across South Africa.

Dear (Gatekeepers Name*),

My name is Nicholas Butler, I am a Rhodes University student currently completing my Master's degree in the Department of Human Kinetics and Ergonomics under the supervision of Dr Jonathan Davy and co-supervision of Professor Candice Christie. I write to you to ask if you would consider permitting your Grade 10 to Grade 12 students and relevant coaches and trainers to participate in my Master's research, which is entitled: "*The prevalence and perceptions of sports supplement use among adolescents and coaches/trainers within South African private schools*".

We acknowledge that the COVID-19 pandemic that the world is currently facing has severely disrupted your school's activities and realize that this request comes at a difficult time. Due to the seriousness of this pandemic, most activities at universities have also stopped, but researchers have been asked to continue to do what they can. To this end, we have had no choice but to conduct this research through an online survey to accommodate for and promote the practice of social isolation. Herewith a brief background to this study followed by an overview of the proposed method.
Sports supplements referred to as performance-enhancing aids, are often used because it is believed that they improve or enhance physical or athletic performance and/or improve physical appearance. Some examples of sports supplements include Amino acid products (e.g., BCAA's; Arginine; Glutamine; Tyrosine; Taurine); Creatine products (e.g., Monohydrate; Ethyl Ester; Ethyl Ester Malate; Gluconate, HCL); Protein products (e.g., Whey; Casein; Whey Isolate; Soy; Pea; Mass Gainers); Pro-hormone products (e.g., Testosterone boosters; Tribulus terrestris); Stimulant products (e.g., Fat burners; Pre-workouts; High Caffeine products).

Many of these supplements, when used appropriately, are safe and have been proven to be successful and beneficial in achieving their stated outcomes to a certain extent. However, the effects claimed by many supplement manufacturers when advertising and marketing their products are rarely supported by scientific research. Thus, the effectiveness and safety of a large proportion of supplements is questionable, as the industry globally and within South Africa is poorly regulated and therefore supplements rarely undergo rigorous testing or screening processes. According to literature, adolescents are considered the most susceptible population to use sports supplementation, and are commonly influenced by sports coaches, the media, parents, friends, or sports professionals as well as effective advertising and marketing strategies. The use of these products among adolescents maybe considered problematic as there is a possibility that these individuals may be exposed to dangerous or illegal substances from a young age, which may affect their health negatively.

Currently, there has been very little research into sports supplementation use and perceptions of these products amongst adolescents and the practices of coaches/trainers around the use of these products in South Africa as a whole. The few studies that have been conducted in South Africa have found a fairly high prevalence of use particularly among younger individuals with coaches/trainers being one of the primary sources of information and influence. Therefore, this study will explore the prevalence of use and perceptions of sports supplementation use among a cohort of adolescents and perceptions of their coaches/trainers within private schools across South Africa. This will help create a better understanding and awareness around these products so that adolescents can make informed choices to use these products safely, responsibly, and effectively.

This study is split into 2 parts. The first part of this study will focus on exploring the prevalence and perceptions of sports supplementation use among a cohort of senior high school adolescents. The second part of the study takes the same design as the first, however, it will focus on exploring the perceptions of sports supplement use among a cohort of coaches/trainers (i.e., Director of sports, coaches, strength and conditioning coaches etc.).

Participation in part 1 of this study will require senior adolescent learners (Grades 10-12) to answer a confidential (anonymous) and validated, self-administered questionnaire (Online) consisting of 5 sections. *Section 1* will require participants to give their general background information. *Section 2* will require participants to answer questions related to the use of sports supplements. *Section 3* will require participants to answer questions related to specific sports supplements. *Section 4* will require participants to answer questions related to their perceptions and understanding of the risks/dangers involved with the use of sports supplements. *Section 5* will require participants to answer questions related to knowledge, interventions, and solutions for the use of sports supplements.

Participation in part 2 of this study will require coaches/trainers to answer a confidential (anonymous) and validated, self-administered questionnaire (Online) consisting of 5 sections. *Section 1* will require participants to give their general background information. *Sections 2-4* will require participants to answer questions related to knowledge, attitudes, application of knowledge concerning sports supplements. The questions in these sections are all based on a Likert scale and score from 1 "strongly disagree" to score 5 "strongly agree". *Section 5* will require participants to answer a few open-ended questions related to sports supplement use. (A copy of each questionnaire has been attached in this email)

The questionnaires that will be used in this study are confidential and will not require any names to be submitted. The researchers will take all steps possible to protect the anonymity of the learners and coaches/trainers participating in the study as well as the school's name. Involvement in this study is completely voluntary and participants will be well informed that they may withdraw from the study at any time. The name of your school will not be presented in any way within this study to ensure anonymity. Once questionnaires have been completed, all data will be safely stored on the online questionnaire database or within the Human Kinetics and Ergonomics department, which will only be accessible by the researchers. The data will also be collectively analyzed and presented so that no individual data is presented. Once the entire study

has been completed, school gatekeepers (i.e., Executive heads and other relevant stakeholders) and all participants will receive a written report highlighting the findings of this study.

Participation by the learner's and/or coaches/trainers within your school will be greatly appreciated. Should you be interested in participating, I would be most grateful if you could indicate this by signing the form attached below "School Heads Permission" and returning it to the researchers via email, as we will need to submit this to our ethics committee for final clearance. We will also need to make sure the parents of learners are aware of the study, this will be facilitated though an informed consent form which has also been attached below "Parent/Guardian informed consent", this form will allow parents/guardians to make a decision regarding their child's/ward's participation in the study. If you have any questions, please feel free to contact the researchers.

Sincerely,

Co-Researcher
Nicholas Butler
nicbutler8@gmail.com
+27 72 071 5520

Principal Researchers
Dr. Jonathan Davy
jonathan.davy@ru.ac.za

Professor. Candice Christie
c.christie@ru.ac.za

Appendix 3 – Follow up email to school gatekeepers.

RHODES UNIVERSITY
Where leaders learn

Follow up email: Invitation to participate in research on Sports Supplement use and perceptions in private high schools across South Africa.

Dear (Gatekeepers Name*),

I hope this finds you in good health.

I write to follow up on my last email sent on 16 April 2020, in which I outlined the scope of my Master's research project, which aims to understand the prevalence and perceptions (knowledge; attitude; beliefs) of senior high school adolescents as well as coaches in private schools around sports supplement use.

We acknowledge that it is currently an extremely challenging time, the easing of lockdown measures and reopening of schools has caused immense stress and pressure.

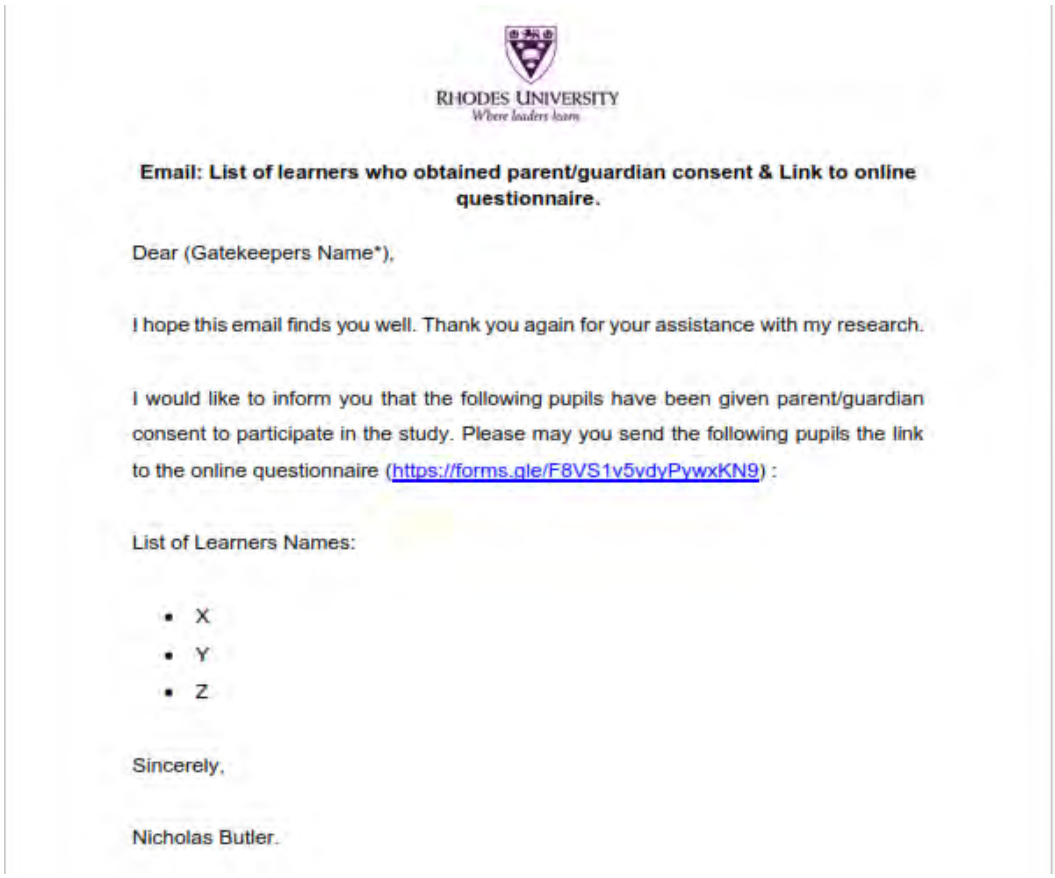
However, I would be most grateful if you could indicate if you would be interested in participating in this study, if now is not a good time, then perhaps in the near future?

We look forward to hearing from you.

Sincerely,

Nicholas Butler.

Appendix 4 – Email with names of participants and link to online questionnaire.



RHODES UNIVERSITY
Where leaders learn

Email: List of learners who obtained parent/guardian consent & Link to online questionnaire.

Dear (Gatekeepers Name*),

I hope this email finds you well. Thank you again for your assistance with my research.

I would like to inform you that the following pupils have been given parent/guardian consent to participate in the study. Please may you send the following pupils the link to the online questionnaire (https://forms.gle/F8VS1v5vdyPywxKN9) :

List of Learners Names:

- X
- Y
- Z

Sincerely,

Nicholas Butler.

Appendix 5 – Rhodes University Ethical Standards Committee provisional approval.

RHODES UNIVERSITY
Grahamstown • 6140 • South Africa

HUMAN KINETICS & ERGONOMICS
Tel: +27 (0)46 6038468
Fax: +27 (0)46 6038934
Email: m.mattison@ru.ac.za

17 October 2018

Nicholas Butler – g15B5708@campus.ru.ac.za
Jonathan Davy – j.davy@ru.ac.za

Dear Nicholas and Jono,

Provisional Ethical Clearance – Application HKE-2018-22

Your application for ethical clearance for the study titled "*The prevalence and perceptions of sports supplementation use among Human Kinetics and Ergonomics students at Rhodes University: A pilot study*" (reference number HKE-2018-22) has received final ethical clearance by the HKE Ethics Committee. This clearance is valid until the end of 2018.

Please note that any significant changes made to the study and procedures need to be communicated to the HKE Ethics Committee (this includes changes in investigators), and another full review may be requested.

Upon completion of your study, please submit a short report indicating when and whether the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the HKE Ethics committee should be aware of.

Sincerely,

M.C. Mattison
2018 HKE Ethics Chairperson
Department of Human Kinetics and Ergonomics
Rhodes University; Grahamstown
Tel: + 27-46-603 8468
Cell: +27-82 319 4626

www.ru.ac.za

Dear Dr. Davy,

Following your request for extension HKE-2018-22. A Chair's circular was sent out to the RUESC members for consideration. This was done per rollam, i.e. using technical means such as email, to allow for decision-making in between the monthly meetings of RUESC. Based on the results of the deliberations, RUESC Chair hereby grants the extension the ethical clearance of the application under the tracking number HKE-2018-22. This extension is valid until 28th February 2021.

Please ensure that RUESC is informed about an substantial changes in the protocols as approved in the original application, deviations from the approved protocols or any other changes in the conditions under which the original ethical or the current amendment/extension were or are granted.

Yours sincerely,

Roman Tandlich
Chairperson: Rhodes University Ethical Standards Committee

---------- Forwarded message ---------
Od: **Jonathan Davy** <jonathan.davy@ru.ac.za>
Date: st 26. 2. 2020 o 11:14
Subject: Request for amendment to ethics_Nic Butler
To: Roman Tandlich <roman.tandlich@gmail.com>, Roman Tandlich <r.tandlich@ru.ac.za>
Cc: Candice Christie <c.christie@ru.ac.za>, Nic Butler <nicbutler8@gmail.com>

Appendix 6 – Gatekeeper permission form.

RHODES UNIVERSITY
Where leaders learn

PERMISSION TO CONDUCT RESEARCH

Date: _____

Department of Human Kinetics and Ergonomics
Upper African Street
Grahamstown/Makhanda
6139

Study: "*The prevalence and perceptions of sports supplement use among adolescents and coaches/trainers within South African private schools*" survey study.

Principal Researchers:
Dr Jonathan Davy.
Professor Candice Christie.

Co-Researcher:
Nicholas Butler.

This letter serves to confirm that _____ (**School Name**), is a willing participant of the above mentioned study which will be conducted by the principal researchers and co-researcher mentioned above.

Yours sincerely,

_____
(**School Principal's Signature**)

Appendix 7 – Parent/Guardian informed consent online form.

(School Name*) - INFORMED CONSENT DECLARATION (Parent or Guardian)

Research title: "The prevalence and perceptions of sports supplement use among adolescents and coaches/trainers within South African private schools"

Co-researcher: Nicholas Butler under the supervision of Principal researchers: Dr Jonathan Davy and Professor Candice Christie from the Department of Human Kinetics and Ergonomics, Rhodes University has requested my permission to allow my child/ward to participate in the above-mentioned research project.

I am aware that:

1. The purpose of the research project is to capture, through an online survey, the prevalence and perceptions (Knowledge; Attitudes; Beliefs) of sports supplement use among adolescents attending private schools in South Africa.

2. Rhodes University has given ethical clearance to this research project and I may request to see the clearance certificate. [HKE-2018-22]

3. By participating in this research project my child/ward will be contributing to important research which will be used for educational purposes linked to the use of sports supplementation. Information such as the prevalence of use (i.e. Amount, Frequency, Type) and the Perceptions (Knowledge; Attitudes: Beliefs) of use (i.e. Influences or advice, Reasons, Understanding), which is important to understand as it may indicate possible problems associated with the use of these products. Thus, evidence from this study may address the problems associated with the use of sports supplements. This could help introduce interventions to educate and create awareness among young South Africans about the use of sports supplementation. Rather than creating a negative stigma around these products, the research plans to encourage an open and honest dialogue to create greater awareness and understanding. This is to help adolescents make informed choices about the use of sports supplements safely, responsibly and effectively.

4. My child/ward will participate in the project by answering a confidential (anonymous) and validated, self-administered questionnaire (Online) which will be used to collect qualitative and quantitative data. The questionnaire will entail five sections which include closed and open-ended questions related to sports supplement use. Self-administered means that the participants will receive the questionnaire from the researchers and will need to answer/fill in the questions by themselves.

5. My child's/ward's participation is entirely voluntary, and my child/ward must agree by signing an assent form provided to them by the researchers in order to participate. This will be at the start of the online questionnaire.

6. Should I or my child/ward at any stage wish to withdraw from participating further in the study, we/he/she may do so without any negative consequences.

7. My child/ward may be asked to withdraw from the research before it has finished if the researcher or any other appropriate person feels it is in their best interests, or if my child/ward does not follow instructions.

8. Neither my child/ward nor I will be compensated for participating in the research.

9. There may be risks associated with my child's/ward's participation in the project. I am aware that

a. The following risks are associated with participation:

- Learners may be unhappy if policies or interventions are changed or introduced with regards to the use of sports supplements in private schools due to the information highlighted and provided by this study.
- Learners participating in the study may start communicating about sports supplementation which may influence their decisions to start using these products.

b. the following steps have been taken to prevent the risks:

- This research does not intend to change or develop existing policies related to sports supplement use in South African private schools, but rather to educate and raise awareness (for both staff and learners) around how to make informed choices on using these supplements safely and responsibly. This will be the overriding argument put forward to schools prior to the onset of the study. Additionally, we plan to work closely with the relevant stakeholders (i.e. san sisters, coaches, heads of sports) to ensure that, rather than create a negative stigma around these products, we encourage an open and honest dialogue.

- Ample evidence suggests that the prevalence of sports supplement use among high school adolescents is fairly high (granted, not for the schools in focus here), as established in previous literature. This may highlight that already being in these contexts and thus being exposed to other learners, stooges, marketing strategies or coaches who already use these products or advocate for their use, may have alerted them or influenced learners to start using them anyway. Furthermore, as it stands, the supplements in the focus in this study are all considered legal products and are frequently available in many South African shopping stores and many are available for online purchase. Thus, if learners do wish to start using these products, this study does not advocate for the use of any products mentioned or any other illicit substances linked to the supplements mentioned.

10. The researcher intends publishing the research results in the form of a Master of Science (MSc) thesis. However, confidentiality and anonymity of records will be maintained and my child's/ward's name and identity will not be revealed to anyone who has not been involved in the conduct of the research.

11. My child/ward will receive feedback in the form of a typed report regarding the findings obtained during the study, this will be done once the entire study has been completed.

12. Any further questions that I might have concerning this research study or my child's/ward's participation will be answered by:

- Co-Researcher:

Nicholas Butler

nicbutler8@gmail.com

- Principal Researchers:

Dr. Jonathan Davy
jonathan.davy@ru.ac.za

Professor Candice Christie
c.christie@ru.ac.za

13. By allowing my child/ward to participate in this research study, I am not waiving any legal claims, rights or remedies that I or my child/ward may have.

I have read the above information and confirm that the above information has been explained to me in a language that I understand, and I am aware of this document's contents. I have asked all questions that I wished to ask, and these have been answered to my satisfaction. I fully understand what is expected of my child/ward during the research.

I have not been pressured in any way to let my child/ward take part. I voluntarily agree that my child/ward, may participate in the above-mentioned research project if they are willing to do so by means of signing an assent form provided to them by the researchers.

* Required

1. Parent/Guardian Consent. *

Check all that apply.

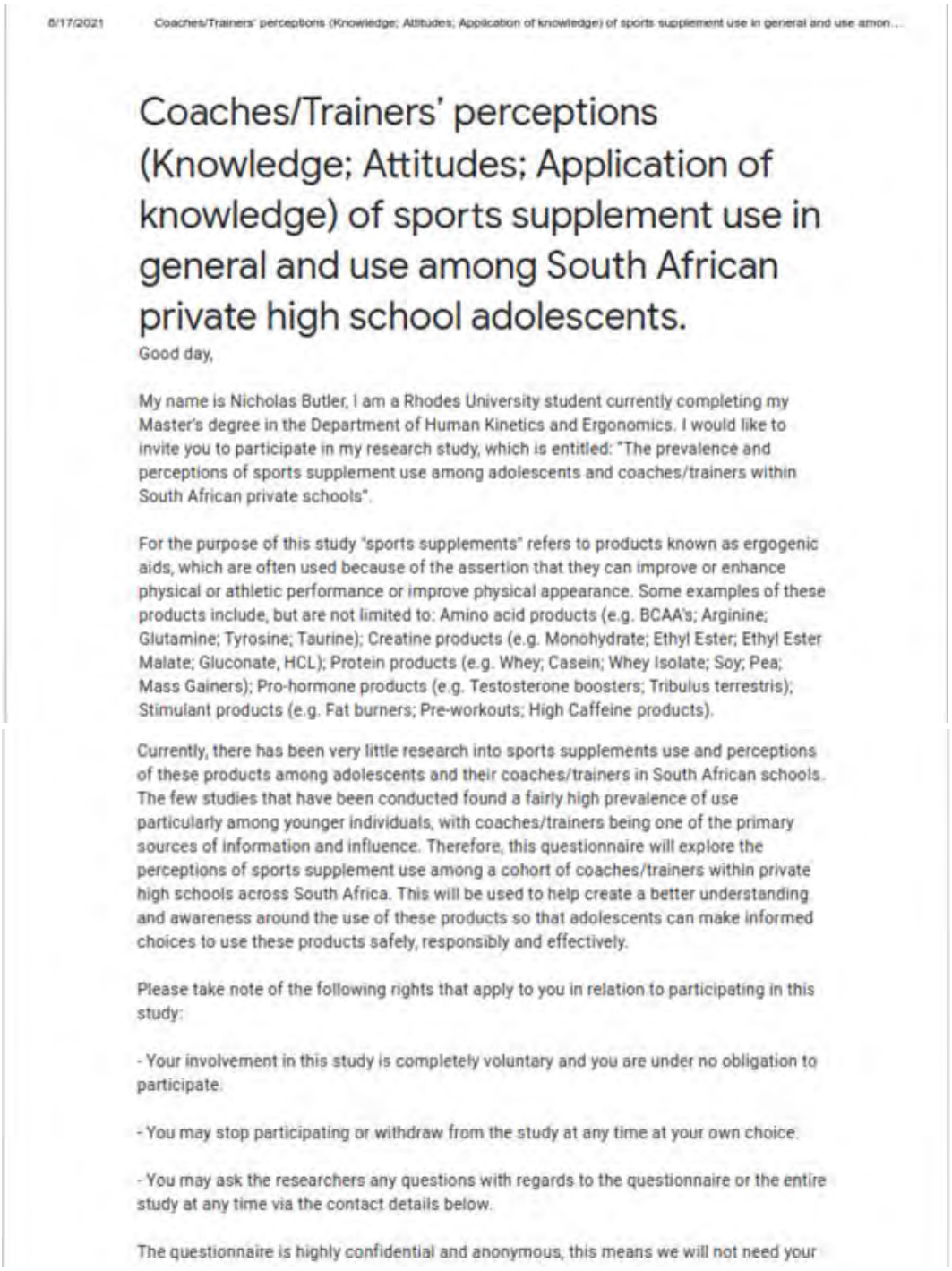
☐ I agree with the above-mentioned information and give consent for my child/ward to participate in the above-mentioned research study.

☐ I DO NOT agree with the above-mentioned information and DO NOT give consent for my child/ward to participate in the above-mentioned research study.

2. Name(s) of Child/Ward: *

Please provide your child's/ward's first name and surname in the space provided below. This is to ensure that the school can send out the links to learner's whose parents/guardians have given consent and not to learners who's parents/guardians who have not given consent. This data will be treated confidentially and will be given the relevant school authorities who are assisting with the research.

Appendix 8 – Questionnaire, Information letter & Consent Form (Coaches/Trainers study).



5/17/2021 Coaches/Trainers' perceptions (Knowledge; Attitudes; Application of knowledge) of sports supplement use in general and use amon...

Coaches/Trainers' perceptions (Knowledge; Attitudes; Application of knowledge) of sports supplement use in general and use among South African private high school adolescents.

Good day,

My name is Nicholas Butler, I am a Rhodes University student currently completing my Master's degree in the Department of Human Kinetics and Ergonomics. I would like to invite you to participate in my research study, which is entitled: "The prevalence and perceptions of sports supplement use among adolescents and coaches/trainers within South African private schools".

For the purpose of this study "sports supplements" refers to products known as ergogenic aids, which are often used because of the assertion that they can improve or enhance physical or athletic performance or improve physical appearance. Some examples of these products include, but are not limited to: Amino acid products (e.g. BCAA's; Arginine; Glutamine; Tyrosine; Taurine); Creatine products (e.g. Monohydrate; Ethyl Ester; Ethyl Ester Malate; Gluconate, HCL); Protein products (e.g. Whey; Casein; Whey Isolate; Soy; Pea; Mass Gainers); Pro-hormone products (e.g. Testosterone boosters; Tribulus terrestris); Stimulant products (e.g. Fat burners; Pre-workouts; High Caffeine products).

Currently, there has been very little research into sports supplements use and perceptions of these products among adolescents and their coaches/trainers in South African schools. The few studies that have been conducted found a fairly high prevalence of use particularly among younger individuals, with coaches/trainers being one of the primary sources of information and influence. Therefore, this questionnaire will explore the perceptions of sports supplement use among a cohort of coaches/trainers within private high schools across South Africa. This will be used to help create a better understanding and awareness around the use of these products so that adolescents can make informed choices to use these products safely, responsibly and effectively.

Please take note of the following rights that apply to you in relation to participating in this study:

- Your involvement in this study is completely voluntary and you are under no obligation to participate.

- You may stop participating or withdraw from the study at any time at your own choice.

- You may ask the researchers any questions with regards to the questionnaire or the entire study at any time via the contact details below.

The questionnaire is highly confidential and anonymous, this means we will not need your

name/s or the name of your school (Employer). This questionnaire consists of 5 sections and will take approximately 10-15 minutes to complete. Please answer as truthfully as possible. After you have completed this questionnaire and submitted it, your information will be stored on the online database which only the researchers will have access to. Feedback from this study will be sent to you in the form of a written report once the entire study has been completed, which will highlight the important findings.

If you would like to participate in this study, you will need to consent by selecting the agreement option on the page below.

Your participation in this important research study will be greatly appreciated.

Co-Researcher:
Nicholas Butler
nicbutler8@gmail.com
+27 72 071 5520

Principal Researchers:
Dr. Jonathan Davy
jonathan.davy@ru.ac.za

Professor. Candice Christie
c.christie@ru.ac.za

* Required

1. Consent Form *

I have read and comprehend the information on the research that is being done on "The prevalence and perceptions of sports supplement use among adolescents and coaches/trainers within South African private schools".

Check all that apply.

☐ I give my consent to participate in this research study.

Section 1: General demographic information

2. What is your current age? *

If you would prefer not to say please type N/A in the space provided.

_____

3. What is your sex? *

Mark only one oval.

- ◯ Female
- ◯ Male
- ◯ Prefer not to say

4. Which province is the school you work at located in?

Mark only one oval.

- ◯ Eastern Cape
- ◯ Free State
- ◯ Gauteng
- ◯ KwaZulu-Natal
- ◯ Limpopo
- ◯ Northern Cape
- ◯ North West
- ◯ Mpumalanga
- ◯ Western Cape

5. Which sport/s and/or physical activities do you coach/train? *

Please select all that apply.

Check all that apply.

- [ ] Athletics
- [ ] Basketball
- [ ] Boxing
- [ ] Cricket
- [ ] Cross country running
- [ ] Crossfit
- [ ] Dance
- [ ] Equestrian
- [ ] Golf
- [ ] Gym
- [ ] Hockey
- [ ] Mixed Martial Arts
- [ ] Motor sports
- [ ] Netball
- [ ] Rowing
- [ ] Rugby
- [ ] Soccer
- [ ] Squash
- [ ] Swimming
- [ ] Tennis
- [ ] Waterpolo

Other: [ ] _____

Section 2: Knowledge of sports supplements

The questions in this section as well as sections 3 and 4 are based on a Likert scale and score as follows: 1 "strongly disagree"; 2 "disagree"; 3 "undecided/neutral"; 4 "agree"; 5 "strongly agree".
These questions were used in a previous study by Bastani et al. (2017) which was approved using the comments of experts and according to Mehralian et al. (2014) respectively.

6. Generally, I have sufficient knowledge about sports supplementation. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

7. I have sufficient knowledge about the efficacy (Effectiveness) of sports supplementation. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

8. I have sufficient knowledge about the side effects of sports supplementation. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

9. I have sufficient knowledge about the dosage and administration of sports supplements for adolescents. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

10. I have sufficient knowledge about sport supplement-drug interactions. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Section 3: Attitude towards sports supplements

These questions are based off a Likert scale and score as follows: 1 "strongly disagree"; 2 "disagree"; 3 "undecided/neutral"; 4 "agree"; 5 "strongly agree".

11. Sports supplements have a positive impact on improving physical activities and energy. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

12. The therapeutic efficacy of sports supplements may be considered the same as other pharmaceuticals. *

"Therapeutic efficacy": The ability of a substance to treat or enhance.

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

13. Pharmacists should be knowledgeable about sports supplements and consulting in this field should be part of their duties. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

14. There is adequate educational content available in schools about sports supplementation. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

15. Sports supplements should only be dispensed according to a nutritionist or physician prescription. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

16. Sports supplements should be sold in pharmacies under pharmacists' supervision. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Section 4: Application of sports supplement knowledge

This section refers to the actions you take or have taken with regards to sports supplement use (i.e. Applying your knowledge of sports supplements into practice) These questions are based off a Likert scale and score as follows: 1 "strongly disagree"; 2 "disagree"; 3 "undecided/neutral"; 4 "agree"; 5 "strongly agree".

17. I always devote my time to give advice to adolescent pupils that use/want to use sports supplementation. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

18. I've studied some scientific references regarding sports supplementation. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

19. I am able to refer to valid web pages or scientific references regarding sports supplementation if needed. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

20. I always recommend sports supplements to adolescent pupils with confidence about their effectiveness. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

21. I always inform adolescent pupils about possible adverse effects of sports supplements. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

22. I always advise adolescent pupils about dosage and administration of sports supplements. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

23. I always check whether a particular sports supplement used by a adolescent pupil interacts with his/her medication. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

24. I have self-confidence to recommend sports supplements. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Section 5: General questions related to the use of sports supplements among high school adolescents.

25. Do you have any questions you would like to be answered in relation to sports supplementation in general or sports supplements South African high school adolescents use/have used/are looking to use? *

If there are no questions you would like to ask or no information you want to know, please type "No" in the space below.

_____

_____

_____

26. What/Who is your main source of information or advice regarding sports supplementation? *

Please select a minimum of 1 and a maximum of 3 answers.

Check all that apply.

- [ ] Other coaches/trainers
- [ ] Internet advertising and sites
- [ ] Social Media
- [ ] Television advertisements
- [ ] Friends
- [ ] Adolescent pupils parents/guardians
- [ ] Family members
- [ ] Professional athletes
- [ ] Celebrities
- [ ] Academic journals
- [ ] Books
- [ ] Magazines

Other: ☐ _____

27. Are you aware of any sports supplements that adolescents within your school use/have used? *

If you are not aware of any sports supplements used by the pupils please select "No". If you are aware, please select all the relevant types of sports supplements you are aware of them using/have used.

Check all that apply.

- [ ] No
- [ ] Yes I am aware, but do not know which types they use/have used.
- [ ] Amino acid products (e.g. BCAA's; Arginine; Glutamine; Tyrosine; Taurine)
- [ ] Creatine products (e.g. Monohydrate; Ethyl Ester; Ethyl Ester Malate; Gluconate, HCL)
- [ ] Protein products (e.g. Whey; Casein; Whey Isolate; Soy; Pea; Mass Gainers)
- [ ] Pro-hormone products (e.g. Testosterone boosters; Tribulus; Zinc magnesium aspartate(ZMA))
- [ ] Stimulant products (e.g. Fat burners; Pre-workouts; High Caffeine products; Conjugated linoleic acid (CLA))
- [ ] Other: _____

28. Do you believe there are benefits from using sports supplements by high school adolescents? *

If you believe there are benefits, please specify at least 1 benefit in the space provided. Please type "No" if you do not believe there are any benefits.

_____

_____

_____

29. Do you believe there are risks or dangers involved in the use of sports supplementation by high school adolescents? *

If you believe there are risks or dangers involved, please state at least 1 risk/danger you know of. Please type "No" if you do not believe there are any risks or dangers.

_____

_____

_____

30. Have you ever experienced cases of negative side-effects to high school adolescents who use/used sports supplement/s? *

Mark only one oval.

- ◯ Yes
- ◯ No

31. Would you encourage the use of, or the continued use of a sports supplement which helps high school adolescents achieve their sports goals or physical appearance goals (Body-image) even if you understood there were risks or dangers involved with the use of that product? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

32. Do you believe the use of sports supplementation is common among adolescents attending South African private high schools? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

33. Do you know of the "World Anti-Doping Agency" (WADA) and/or the "South African Institute for Drug-Free Sport" (SAIDS)? *

Mark only one oval.

- ◯ Yes
- ◯ No

34. Have you ever had formal sports nutrition or sports supplementation education or training? *

Mark only one oval.

- ◯ Yes
- ◯ No

35. Do you think South African regulatory companies/organizations should provide educational programmes or training addressing the use sports supplements by high school adolescents? *

Mark only one oval.

- ◯ Yes
- ◯ No

36. Do you think the current use of sports supplementation is a problem among adolescents attending South African private high schools? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

37. Please suggest 1 intervention or solution that could be used to help educate and create awareness for South African high school adolescents around using sports supplements safely and effectively. *

Appendix 9 – Statistics tables.

S2 (Q1) Have you ever used a ss before?									
	Observed	Yes	No	Total		P value and statistical significance			
	Male	27	8	35		Test	Fisher's exact test		
	Female	4	11	15		P value	0,0013		
	Total	31	19	50		P value summary	**		
						One- or two-sided	Two-sided		
	Expected	Yes	No	Total		Statistically significant (P < 0,05)?	Yes		
	Male	21,7	13,3	35					
	Female	9,3	5,7	15					
	Total	31	19	50					
			p-value	0,00075					
S2 (Q2) Are you currently using a ss?	Observed	Yes	No	Total		P value and statistical significance			
	Male	14	21	35		Test	Fisher's exact test		
	Female	0	15	15		P value	0,0044		
	Total	14	36	50		P value summary	**		
						One- or two-sided	Two-sided		
	Expected	Yes	No	Total		Statistically significant (P < 0,05)?	Yes		
	Male	9,8	25,2	35					
	Female	4,2	10,8	15					
	Total	14	36	50					
			p-value	0,004					
S3 (Q2) Do you know how the ss functions	Observed	Yes	No	Total		P value and statistical significance			
	Male	24	3	27		Test	Fisher's exact test		
	Female	0	4	4		P value	0,0011		
	Total	24	7	31		P value summary	**		
						One- or two-sided	Two-sided		
	Expected	Yes	No	Total		Statistically significant (P < 0,05)?	Yes		
	Male	20,9032258	6,0968	27					
	Female	3,09677419	0,9032	4					
	Total	24	7	31					
			p-value	7,24397E-05					

S3 (Q4) Do you know if *ss* used is regulated	Observed	Yes	No	Total		P value and statistical significance	
	Male	20	7	27		Test	Fisher's exact test
	Female	1	3	4		P value	0,0868
	Total	21	10	31		P value summary	ns
						One- or two-sided	Two-sided
	Expected	Yes	No	Total		Statistically significant (P < 0.05)?	No
	Male	18,2903226	8,7097	27			
	Female	2,70967742	1,2903	4			
	Total	21	10	31			
			p-value	0,0501			
S4 (Q1) Do you believe there are benefits *ss*	Observed	Yes	No	Total		P value and statistical significance	
	Male	30	5	35		Test	Fisher's exact test
	Female	10	4	14		P value	0,2542
	Total	40	9	49		P value summary	ns
						One- or two-sided	Two-sided
	Expected	Yes	No	Total		Statistically significant (P < 0.05)?	No
	Male	28,5714286	6,4286	35			
	Female	11,4285714	2,5714	14			
	Total	40	9	49			
			p-value	0,24			
S4 (Q2) Do you believe there are risks/dangers	Observed	Yes	No	Total		P value and statistical significance	
	Male	28	7	35		Test	Fisher's exact test
	Female	14	1	15		P value	0,4074
	Total	42	8	50		P value summary	ns
						One- or two-sided	Two-sided
	Expected	Yes	No	Total		Statistically significant (P < 0.05)?	No
	Male	29,4	5,6	35			
	Female	12,6	2,4	15			
	Total	42	8	50			
			p-value	0,24			

S4 (Q3) Have you ever experienced neg side effects	Observed	Yes	No	Total		P value and statistical significance	
	Male	4	23	27		Test	Fisher's exact test
	Female	1	3	4		P value	0,5249
	Total	5	26	31		P value summary	ns
						One- or two-sided	Two-sided
	Expected	Yes	No	Total		Statistically significant (P < 0.05)?	No
	Male	4,35483871	22,645	27			
	Female	0,64516129	3,3548	4			
	Total	5	26	31			
			p-value	0,61			
S4 (Q4) Would you use/continue using if you knew risk	Observed	Yes	No	Maybe	Total		
	Male	13	10	12	35		
	Female	1	8	6	15		
	Total	14	18	18	50		
	Expected	Yes	No	Maybe	Total		
	Male	9,8	12,6	12,6	35		
	Female	4,2	5,4	5,4	15		
	Total	14	18	18	50		
				p-value	0,068		
S5 (Q1) Do you believe *ss* is common among private	Observed	Yes	No	Maybe	Total		
	Male	30	3	2	35		
	Female	12	2	1	15		
	Total	42	5	3	50		
	Expected	Yes	No	Maybe	Total		
	Male	29,4	3,5	2,1	35		
	Female	12,6	1,5	0,9	15		
	Total	42	5	3	50		
				p-value	0,863		

S5 (Q2) Have you ever had training/education on ss	Observed	Yes	No	Total		P value and statistical significance	
	Male	12	23	35		Test	Fisher's exact test
	Female	5	10	15		P value	>0,9999
	Total	17	33	50		P value summary	ns
						One- or two-sided	Two-sided
	Expected	Yes	No	Total		Statistically significant (P < 0.05)?	No
	Male	11,9	23,1	35			
	Female	5,1	9,9	15			
	Total	17	33	50			
			p-value	0,948			
S5 (Q3) Do you know of WADA and/or SAIDS *	Observed	Yes	No	Total		P value and statistical significance	
	Male	26	9	35		Test	Fisher's exact test
	Female	2	13	15		P value	0,0001
	Total	28	22	50		P value summary	***
						One- or two-sided	Two-sided
	Expected	Yes	No	Total		Statistically significant (P < 0.05)?	Yes
	Male	19,6	15,4	35			
	Female	8,4	6,6	15			
	Total	28	22	50			
			p-value	0,0001			
S5 (Q4) Do you think SA companies should provide ed	Observed	Yes	No	Total		P value and statistical significance	
	Male	34	1	35		Test	Fisher's exact test
	Female	14	1	15		P value	0,5143
	Total	48	2	50		P value summary	ns
						One- or two-sided	Two-sided
	Expected	Yes	No	Total		Statistically significant (P < 0.05)?	No
	Male	33,6	1,4	35			
	Female	14,4	0,6	15			
	Total	48	2	50			
			p-value	0,529			

			p-value	0,529	
S5 (Q5) Do you think current use of *ss* is a problem in S	Observed	Yes	No	Maybe	Total
	Male	10	15	10	35
	Female	4	2	9	15
	Total	14	17	19	50
	Expected	Yes	No	Maybe	Total
	Male	9,8	11,9	13,3	35
	Female	4,2	5,1	5,7	15
	Total	14	17	19	50
				p-value	0,066