AN EXPLORATION INTO THE UTILIZATION OF VITAMINS AND MINERALS BY CHIROPRACTORS IN THE MANAGEMENT OF MUSCULOSKELETAL CONDITIONS IN RUNNERS

By

Lori Louise Niemand (21811876)

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I, Lori Niemand, do declare that this dissertation is representative of my own work in both conception and execution (except where acknowledgements indicate to the contrary)

__ _ _____28/08/2024_____

Lori Louise Niemand Date

BHSC: Chiropractic

Approved for Final Examination

__ _____ _____28/08/2024_____

Dr Ashura Abdul-Rasheed, Supervisor Date

PhD: Health Sciences; M.Tech: Chiropractic

___ ____ _____28/08/2024_____

Dr Yasmeen Thandar, Co-Supervisor Date

PhD: Pharmacology

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ABSTRACT

Background

Chiropractors are primary healthcare providers who provide a holistic form of healthcare for the treatment and management of neuromusculoskeletal disorders. The South African chiropractic scope of practice includes dietary advice or supplement recommendations in adjunct to other treatment options when managing a patient. Chiropractors treat a variety of runners of diverse levels, ages, genders and who participate in various domains of running. Runners are at a high risk of developing musculoskeletal (MSK) conditions, with numerous risk factors identified in literature. Musculoskeletal conditions may have a negative impact on a runner's recovery, performance, quality of life, psychosocial wellbeing and cause financial burdens. Chiropractic treatment is often used to manage MSK conditions in runners but it is unknown what role the utilisation of vitamins and minerals may have in the management of conditions in runners. The utilisation of vitamins and minerals by chiropractors when managing runners has not been investigated; thus, it is unknown how chiropractors prescribe, dispense, or provide nutritional education to runners. The type of supplement recommended for certain conditions in runners remains unknown and the influence that supplementation may have in the management of runners is also unknown. The benefits of understanding supplement utilisation methods by chiropractors will assist the profession in the prevention, treatment and management of MSK conditions in runners. Improved treatment outcomes will assist runners' recovery, performance and injury rates and promote beneficial outcomes in the chiropractic profession.

Aim of the study

The study aims to explore the utilisation of vitamins and minerals by chiropractors in the management of MSK conditions in runners.

Methodology

The study employed a qualitative, exploratory descriptive design to investigate how chiropractors utilise vitamins and minerals in the management of MSK conditions in runners. Interviews were conducted with 15 South African chiropractors, guided by predetermined open-ended questions in a semi-structured manner. The participants needed to be registered with the Allied Health Professions Council of South Africa (AHPCSA), practicing for a minimum of three years, regularly treat runners, and recommend nutritional supplements to runners. The research questions asked chiropractors how they utilise

vitamins and minerals when they manage MSK conditions in runners; what type of supplements they advise; for what conditions do they advise supplements; and if supplementation had an influence in the management of runners. The data were analysed to identify themes and sub-themes, using Tesch's method of data analysis.

Results

From the data, four main themes with their associated sub-themes emerged. The themes described the active utilisation of nutritional supplements by chiropractors for runners. Sub-themes described the factors and reasoning for the recommendation of supplements to runners by the chiropractors. Furthermore, supplement recommendations were identified for both MSK and non-MSK conditions in runners. The data revealed the type of supplements which the chiropractors recommended for certain conditions in the runners. A positive influence of supplementation in runners was reported by the chiropractors. The sub-themes described improvements in the treatment outcomes after supplementation, improved recovery and performance of the runner, and decreased injury rates. A theme of holistic management of runners by chiropractors emerged, which included the use of dietary advice, monitoring of supplementation and interdisciplinary care of the runner when necessary.

Conclusion

This study determined how chiropractors selected, prescribed and dispensed nutritional supplements to runners. This study revealed which nutritional supplements the chiropractors recommended to runners and for certain MSK and non-MSK conditions, as well as the influence of supplementation in runners. As previous literature has not investigated the recommendation of supplements by chiropractors in runners, this study generated new information to fill a gap in the literature.

Key words: Chiropractic, vitamins and minerals, nutritional supplements, nutritional advice, musculoskeletal conditions, runners, running

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ABBREVIATIONS

AHPCSA	—	Allied Health Professions Council of South Africa
ATP	—	adenosine triphosphate
BMD	—	bone mineral density
BMI	—	body mass index
CASA	—	Chiropractic Association of South Africa
DNA	—	deoxyribonucleic acid
DUT	—	Durban University of Technology
IREC	—	Institutional Research Ethics Committee
IC	—	integrative care
MSM	—	methylsulfonylmethane
MSK	—	musculoskeletal
MPS	—	myofascial pain syndrome
REDS	—	relative energy deficiency in sport
RICE	—	rest, ice, compression, elevate
RNA	—	ribonucleic acid
RRMI	—	running-related MSK injury
SDG3	—	Third Sustainable Development Goal sociopsychobiological
SPB	—	sociopsychobiological
UJ	—	University of Johannesburg

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter provides the background and context of this study. It further highlights the aims, objectives and research problem underpinning the study.

1.2 BACKGROUND

Chiropractors are primary healthcare providers who provide a holistic form of healthcare for the treatment and management of neuromusculoskeletal disorders (Sanders 2020). According to the Allied Health Professions Council, Act 63 of 1982 (as amended), the South African chiropractic scope of practice includes: adjustments, electrotherapy, exercise therapy and advice, thermal therapy, massage, traction, immobilisation, dry-needling, and dietary advice or supplementation. Chiropractors may include the use of vitamins and minerals as part of patient management and injury prevention strategies.

Chiropractors treat many different types of athletes at varying levels, including runners (Nelson *et al.* 2021). There is a large variation in the types of running and the classification of runners. The variations can be in the form of distances, durations, surfaces (example trail, track and road) and even multi-day events (Scheer and Krabak 2021). Runners can be classified as sprinters, short distance runners, long distance endurance runners, road, track or trail runners (Scheer and Krabak 2021). Many people participate in running for recreational, health or competitive reasons (Boullosa *et al.* 2020). Kakouris *et al.* (2020) stated that musculoskeletal (MSK) conditions are very common amongst runners. Runners may develop MSK conditions as a consequence of the high intensity nature of the sport (Francis *et al*. 2019). Bykowska-Derda *et al.* (2022) stated that when a runner does not adjust certain factors according to their training, there is a risk of developing a MSK condition.

Musculoskeletal conditions may inhibit a runner from training and performing at an optimum (Scheer and Krabak 2021). Musculoskeletal conditions may negatively affect a runner's physical, mental, emotional and psychosocial wellbeing (Kunene *et al.* 2019). Furthermore, MSK conditions may place unnecessary financial pressure on a runner due to medical bills and time taken off from work (Kakouris *et al.* 2020).

Chiropractic treatment is often used to manage MSK conditions in runners (van Niekerk 2014). Chiropractic treatment utilises manual therapies, such as manipulation and soft

tissue work (van Niekerk 2014). Additionally, vitamins and minerals play a vital role in the management of MSK conditions in runners. Understanding the protocols undertaken by chiropractors when prescribing, dispensing, or providing nutritional education to runners has not been investigated. Furthermore, it is unknown which vitamins and minerals are advised for which conditions, nor the influence of the recommendations. Therefore, an exploration into the utilisation of vitamins and minerals by chiropractors in the management of MSK conditions in runners is required.

This study employed a qualitative exploratory descriptive design in order to investigate how chiropractors utilise vitamins and minerals in the management of MSK conditions in runners. A total of 15 South African chiropractors were interviewed. The participants included South African chiropractors who are registered with the Allied Health Professions Council of South Africa (AHPCSA). The interviews consisted of predetermined open-ended questions in a semi-structured manner (Appendix A). The interviews were conducted both online and in person. The interviews were recorded using a digital recording device. The Tesch method of thematic analysis was utilised to analyse the study results, and to identify themes and sub-themes (Creswell *et al.* 2007 and Moser and Korstjens 2017).

1.3 CONTEXT OF THE STUDY

Chiropractic provides patients with a holistic approach when managing and treating conditions, and this may include nutritional education and supplement recommendation when necessary (Sanders 2020). Nutritional supplements encompass vitamins and minerals that aid to prevent deficiencies and manage chronic disorders (Beck *et al.* 2021). Chiropractors treat a variety of patients, such as runners.

Runners are at a high risk of developing MSK conditions due to the high intensity nature of the sport, as well as various intrinsic and extrinsic risk factors (Kakouris *et al.* 2020; van Wyk 2022). Musculoskeletal conditions may inhibit the runner from training and performing at an optimum level (Scheer and Krabak 2021). Furthermore, MSK conditions may cause increased healthcare costs, time off of work, and negatively impact a runner's mental and psychosocial wellbeing (Kunene *et al.* 2019 and Kakouris *et al.* 2020).

Chiropractors utilise manual therapies for the treatment and management of MSK conditions in runners (van Niekerk 2014). Runners have an increased need for vitamins and minerals (Beermann *et al*. 2020), which plays an important role in the management of MSK conditions. However, there is a paucity in the literature as to how chiropractors utilise vitamins and minerals in the management of MSK conditions in runners.

Independent studies conducted by Holtzman *et al.* (2007), Stuber *et al.* (2013), Adams *et al.* (2017) and Lee *et al.* (2018) found that chiropractors recommend supplements to patients and most frequently for MSK conditions. Adams *et al*. (2017) found that Australian chiropractors spoke about nutrition at least 50.5% of the time when discussing clinical management protocols with patients.

Stuber *et al.* (2013) reported which supplements chiropractors recommended to patients, but did not state which MSK conditions for which they were advised. Instead, a general statement was provided as the reason for the supplement recommendation, such as vitamin D for “bone health”. In contrast, Holtzman *et al.* (2007) stated which MSK condition chiropractors recommended supplements for the most, which were osteoporosis and osteoarthritis.

However, this study did not look at which particular supplements were recommended for such MSK conditions. More so, from the mentioned international studies, it is unknown which nutritional supplements were recommended by chiropractors for particular MSK conditions. Likewise, the method of utilisation of vitamins and minerals by chiropractors was not explored in these studies. Further to this, these studies did not look at the chiropractic utilisation of nutritional supplements for a specified population. Therefore, examining a specific population, such as runners, may provide a more in-depth insight into the role that vitamins and minerals may play in the management of MSK conditions within this group. It is unknown how a chiropractor utilises supplement recommendations for the management of the runner patient, and the influence that it may have on MSK conditions in runners.

Chiropractic that specialises in MSK care with athletes has been under studied with regard to the utilisation of vitamins and minerals in clinical practice. Wardenaar and Hoogervorst (2022) looked at a number of health professionals who prescribed nutritional supplements to athletes. Health professionals who recommend supplements to athletes included sports dieticians, physicians, coaches and other healthcare professionals. The study examined a wide range of supplements that the health professionals commonly recommend to athletes. The results reported which healthcare professionals prescribe supplements to athletes, and the supplements that were most frequently recommended. However, the study did not describe what the supplement recommendation was for, or how the health professionals prescribed or dispensed the supplements. Therefore, there is a paucity in the literature highlighting the chiropractic discipline and their management protocols of athletes.

Running is a very popular sport in low-income countries, such as South Africa, as it is cost-effective, easily accessible and requires minimal equipment (Kakouris *et al.* 2020). Thus, multiple socioeconomic groups take part in this sport. Runners are at a high risk of

developing MSK conditions due to the high intensity nature of the sport, as well as various intrinsic and extrinsic risk factors (Kakouris *et al*. 2020; van Wyk 2022). Running is associated with the highest rate of overuse injuries than any other aerobic sport (Francis *et al.* 2019). Low-income runners cannot "afford" to develop conditions that may threaten their daily income and, thus, effective treatment and prevention strategies of running conditions is vital (Kakouris *et al.* 2020).

Studies have been conducted on injury profiles in runners, the epidemiology of running conditions, and on various treatment options for runners, such as manual therapy (Mellinger and Neurohr 2019). However, no study has investigated the nutritional aspect of MSK conditions in runners and how supplements could be incorporated in the management of such conditions in this population. In this study, the investigation of vitamins and minerals as part of the management protocols in runners will highlight the supplement protocols to manage runners from a South African chiropractor's perspective.

This study's research objectives aimed to provide new information on nutritional supplement protocols commonly utilised by chiropractors when managing MSK conditions in runners. It aims to highlight which vitamins and minerals a chiropractor may consider for a particular MSK condition in a runner, and the method of selection of such vitamins and minerals. This study aims to fill the gap in literature by providing information on the utilisation of vitamins and minerals by chiropractors for a population, such as runners, who are at a higher risk of MSK conditions. Furthermore, this study will provide insight on how chiropractors utilise vitamins and minerals as part of their holistic management of runners, and provide an understanding on how vitamins and minerals may influence the management of MSK conditions in runners.

The outcomes of this study are aligned with the third Sustainable Development Goal (SDG3) as outlined by the World Health Organization (2017), which is to "ensure healthy lives and promote well-being for all at all ages". The SDG3 aims to provide healthcare for all which protects against financial burden, improves risk detection and prevention, and strengthens the management of these risks. One factor that has been identified as a contributor to the progress of SDG3 is nutrition. Therefore, through the results and publication of this research, there will be contribution to the progress of SDG3.

The information generated by this study may assist chiropractors in the management of runners that present to their practice, which in turn may contribute to the profession. Therefore, in a South African context, this study may guide chiropractors in the development of prevention strategies and management protocols for MSK conditions in runners. This could assist runners in decreasing their risk of developing MSK conditions, improve healing

time, and aid performance. The knowledge generated may, ultimately, decrease financial costs or the threat of losing income as a result of a running injury or other condition, aligning to the SDG3.

1.4 RESEARCH PROBLEM

Many people participate in running as it is cost-effective, easily accessible and requires minimal equipment (Kakouris *et al.* 2021). Thus, it is a very popular sport in South Africa (Miller, 2019).

Africa consists of a diverse population made up of numerous ethnicity and race groups, ages and economic levels. Ellapen *et al.* (2013) found a mixed ethnic diversity of runners at a marathon in South Africa. Furthermore, many people participate in running to improve their health and physical fitness; however, MSK conditions are very common amongst runners (Kakouris *et al.* 2021). Various intrinsic and extrinsic risk factors predispose a runner to the development of MSK conditions (van Wyk 2022). Runners have the highest risk of MSK injuries than any other aerobic sport (Francis *et al.* 2019). A variety of South African runners exist who participate in various domains of running, running frequency and variations in distance. Thus, there is a high prevalence of MSK injuries in South African runners, with Miller (2019) reporting between 18.2% to 94.2%.

Runners seek various forms of treatment for their MSK conditions, such as manual therapy, orthotics, therapeutic drugs, surgery and rubbing ointments (Johnston *et al.* 2020; Mbarak *et al.* 2019). One such manual therapy includes chiropractic (Harding *et al.* 2009; van Niekerk 2014).

Chiropractic provides a holistic healthcare that does not only use manual therapies to manage patients, but also includes the utilisation of vitamins and minerals (Sanders 2020). No study as yet has investigated the chiropractic utilisation of vitamins and minerals to manage MSK conditions in runners. It is unknown whether vitamins and minerals are used in the management of MSK conditions in runners, how supplementation is utilised in terms of prescribing and education, and the perceived impact that supplementation may have on the management of MSK conditions in runners.

1.5 AIM OF THE STUDY

The study aims to explore the utilisation of vitamins and minerals by chiropractors in the management of MSK conditions in runners.

1.6 OBJECTIVES OF THE STUDY

Objective 1: To explore the utilisation (selection, prescription, dispensing, education, recommendation) of vitamins and minerals by chiropractors in the management of MSK conditions in runners.

Objective 2: To explore and describe the specific vitamins and minerals utilised by chiropractors in the management of MSK conditions in runners.

Objective 3: To describe the influence of vitamin and mineral utilisation by chiropractors in the management of MSK conditions in runners.

1.7 CONCLUSION

This chapter outlined the current paucity in literature and the consequent need for this study to take place. The objectives of the study aim to fulfil such paucity.

The next chapter provides a more in-depth review of the existing literature.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter explores the South African chiropractic scope of practice, nutritional advice by chiropractors, topics relating to vitamins and minerals, musculoskeletal (MSK) conditions in runners, and how chiropractors utilise such supplements to manage these conditions. The risk factors associated with runners and running-related MSK conditions, will be discussed in-depth. Furthermore, this chapter will explore both the method and influence of supplement utilisation by chiropractors when managing a runner.

2.2 THE CHIROPRACTIC PROFESSION

Chiropractic is a branch of alternative medicine that provides conservative and holistic healthcare (Sanders 2020). Chiropractors are primary healthcare providers who specialise in the diagnosis, treatment and prevention of neuromusculoskeletal disorders (Sanders 2020). Although it is often thought that the chiropractic adjustment is the primary tool of treatment, the profession makes use of a wide range of modalities and counselling in the treatment and management of patients (Sanders 2020). According to the Allied Health Professions Council of South Africa (AHPCSA), Act 63 of 1982, as amended, the chiropractic scope of practice includes adjustments, electrotherapy, exercise therapy and advice, thermal therapy, massage and soft tissue work, traction, immobilisation, dry-needling, and dietary advice or supplementation.

Contrary to popular belief, chiropractic does not only treat and care for the spine, but includes the entire human body (Sanders 2020). Chiropractic focuses on the overall health and wellbeing of patients to ensure a holistic management, which is “the consideration of the complete person, physically, psychologically, socially, and spiritually, in the management and prevention of disease” (Rasweswe *et al.* 2021). Hence, patient management is tailored to the individual’s needs which may include, over and above treatment, lifestyle advice, such as stress management, managing unhealthy habits and promoting activity.

In South Africa, chiropractors are trained in the diversified adjustment technique, which is the delivery of a high-velocity, low-amplitude thrust to a specific dysfunctional joint (Frederick 2019). South African chiropractors most commonly utilise the diversified

adjustment technique, followed by lifestyle advice as the second most common patient management protocol (Johl *et al.* 2017).

Interdisciplinary management of patients is embraced by chiropractors, and if required, chiropractors may refer patients to external specialists (Nelson *et al.* 2021). In conjunction with interdisciplinary management, chiropractic care in South Africa employs and implements evidence-based practice methods when determining the most suited treatment and management protocols for the presenting case (Naidoo 2018; Tayob 2023).

The first formal definition of evidence-based practice was described by Sackett *et al.* (2000) as "the best available research evidence in conjunction with clinical expertise with the consideration of patient values". Therefore, the holistic and evidence-based practice manner, in which chiropractic patient management occurs, aims to achieve the best possible outcome for patients and their specific needs.

Many different types of patients utilise chiropractic treatment, for instance persons of all ages, occupations and with differing activity levels. Common populations that often seek chiropractic care include athletes, geriatrics and paediatrics, to name a few.

2.3 VITAMINS AND MINERALS

Nutritional supplements encompass vitamins and minerals, which are known as micronutrients, and intend to supplement the diet (Beck *et al.* 2021). The main role of supplements is to prevent nutrient deficiencies and, thus, decrease the risk of chronic conditions caused by these deficiencies. Alternatively, nutritional supplements can be taken to ensure optimal health and wellness (Beck *et al.* 2021).

Vitamins and minerals play a vital role in the functioning of various systems in the body, which include, and are not limited to, adequate nerve conduction, energy metabolism, muscle contraction, synthesis of red blood cells, immunity, bone density regulation, tissue healing and repair, inflammatory modulation, and cardiopulmonary function (Lalchhuanawma 2019; de la Puente Yagüe *et al.* 2020). Thus, micronutrients are essential to the human body and are required in minute quantities (Awuchi *et al.* 2020).

There are 13 different organic vitamins that have been identified and grouped into two main categories: water-soluble or fat-soluble (Brancaccio *et al.* 2022). Water-soluble vitamins include all the vitamin Bs (B1, B2, B3, B5, B6, B8, B9, B12) and vitamin C. These water-soluble vitamins are not stored in the body and are readily excreted from the body. Thus, water-soluble vitamins are continuously required from the diet.

Fat-soluble vitamins include vitamins A, D, E and K. This group of vitamins is absorbed via the intestinal tract with the aid of lipids (Awuchi *et al*. 2020). They are also stored in the

body, especially in the liver and adipose tissue and, therefore, do not need to be obtained daily (Brancaccio *et al.* 2022).

Generally, vitamins are acquired from food sources but there are some vitamins that may be obtained via other methods, such as a form of vitamin D that is synthesised in skin cells when exposed to ultraviolet light from the sun, and biotin and vitamin K are produced by certain microorganisms in the gut flora (Awuchi *et al.* 2020).

Hypovitaminosis is a term used to describe a vitamin deficiency (Brancaccio *et al.* 2022). Primary hypovitaminosis often occurs when the diet does not provide adequate amounts of particular vitamin/s, resulting in an insufficient intake. Such diets in which primary hypovitaminosis commonly occurs are a vegan lifestyle or low caloric diet. Secondary hypovitaminosis is usually as a result of a disease or condition that decreases the absorption or use of vitamins. Lifestyle factors can also influence the absorption of vitamins, such as substance abuse, smoking and even certain medications (Awuchi *et al.* 2020). Consequently, nutrient deficiencies can result in severe, and occasionally irreversible, conditions. Conversely, excessive vitamin consumption may result in side effects, such as nausea, diarrhoea, vomiting, headache and kidney stones. In those cases, the symptoms should be alleviated by simply ceasing or decreasing the vitamin dose (Brancaccio *et al.* 2022).

Minerals are inorganic substances required for daily living and a healthy functioning body. Minerals can also be divided into two main groups, major minerals (macrominerals) and minor minerals (trace elements). Macrominerals are calcium, magnesium, sodium, potassium and phosphorous, and trace elements include iron, copper, zinc, iodine, sulphur, cobalt, selenium and chloride. Minerals are usually consumed by food sources that are rich in the element of interest, for example iron in spinach or calcium in milk (Awuchi *et al.* 2020).

Akram *et al*. (2020) and Awuchi *et al.* (2020) researched the functions and health benefits of various micronutrients. Table 2.1 summarises the literature noted in the studies and gives the important physiological functions of micronutrients.

Table 2.1: The physiological role of various micronutrients in the body (Akram *et al.* 2020; Awuchi *et al.* 2020)

Micronutrient	Physiological role
Vitamin A	Vision, anti-oxidant, growth and development, healthy skin and bones, reproduction, formation of red blood cells.
Vitamin B1 (thiamine)	Plays an important role in brain function and carbohydrate metabolism.
Vitamin B2 (riboflavin)	Important factor in glucose production, and acts as an anti-oxidant.
Vitamin B3 (niacin)	Assists in the reduction of low-density lipoprotein, also known as the "bad cholesterol". Important in decreasing the risk of cardiovascular disease.
Vitamin B5 (pantothenic acid)	Plays an important role in hormone and energy production.
Vitamin B6 (pyridoxine)	Important cofactor for cellular metabolism.
Vitamin B7 (biotin)	Promotes glucose utilisation and energy metabolism, produces the building blocks for proteins, and maintains healthy hair and nails.
Vitamin B9 (folic acid)	Important during the development of foetus and reduces risk of neural tube defects and involved in DNA and RNA synthesis.
Vitamin B12	Important during cellular metabolism, DNA synthesis, nervous function and production of red blood cells.
Vitamin C (ascorbic acid)	Supports immune function, has anti-oxidant properties, needed for wound healing and collagen synthesis.
Vitamin D	Regulates calcium and phosphorous metabolism and absorption to maintains strong bones and also involved in stimulating muscle contraction.
Vitamin E	Powerful anti-oxidant, involved in the formation of blood vessels and supports immunity.
Vitamin K	Important factor in blood clotting: formation of prothrombin and other clotting factors. Also regulates blood calcium levels, bone metabolism and collagen synthesis.
Calcium	Bone growth and calcification in children, maintains strong bones and teeth in adults, involved in contraction of muscles, blood clotting, cardiac function and nerve conduction.
Iron	Involved in the production of haemoglobin which is needed for oxygen transportation in red blood cells. Also involved in the formation of other proteins.
Sodium	An important electrolyte ensuring adequate blood fluid volume, nerve conduction, and is the main extracellular ion.
Potassium	An important electrolyte involved in nerve conduction, blood fluid volume and normal cardiac functioning. Potassium is the main intracellular ion.
Phosphorous	An important component of DNA, ATP (a source of energy) and cell membranes. Involved in energy processing, and the formation of bones and teeth.
Zinc	Supports cell mediated immunity, bone and tissue growth, and foetal development. Involved in sexual maturity and fertility.
Magnesium	Ensures appropriate muscle contraction and functioning, regulates the cardiac cycle, promotes nervous functioning, and maintains electrolyte balance.
Iodine	Synthesis of thyroid hormones, thus crucial for metabolism, reproduction, growth and development.
Chloride	Involved in the production of stomach hydrochloric acid, and is considered an important electrolyte to maintain adequate blood fluid volumes.
Copper	Needed for the formation of red blood cells (haematopoiesis) and assists with intestinal absorption of iron. Also forms part of many enzymes.

2.4 ADDITIONAL NUTRITIONAL SUPPLEMENTS

Nutritional supplements, sometimes called nutraceuticals, are substances which aid the diet and function to maintain healthy physiological states (González Carvajal *et al*. 2021). De Felice (1995) originally described a nutraceutical as “a food or part of a food that provides medical or health benefits, including the prevention and/or treatment of a disease” (Rusciano and Bagnoli 2023).

Nutritional supplements which are commonly consumed, in addition to vitamins and minerals, include but are not limited to: omega 3 fatty-acid, chondroitin, glucosamine, co-enzyme Q10, protein supplements, methylsulfonylmethane (MSM), collagen, probiotics, and fibre. Many of these substances cannot be consumed by the diet in adequate amounts, thus many people will purchase and consume these products for health benefits (Sanders 2020).

In order to understand the major health benefits of nutritional supplements, Table 2.2 summarises the literature reported by Nachvak *et al*. (2019), Nagaoka (2019), Sanders (2020), Mishra and Ganguli (2021), Mobasheri (2021), Elango (2022), Muizzuddin and Benjamin (2022) and Koroljević (2023). The studies noted the role that the nutritional supplements may play in the body, and the potential benefits that a person may experience when consuming such products.

Table 2.2: Nutritional supplements and the associated health benefits

Nutritional supplement	**Health Benefits**
Chondroitin	Important for cartilage repair and regeneration. Also has anti-inflammatory and anti-oxidant properties.
Co-enzyme Q10	Has anti-inflammatory and anti-oxidant properties, is involved in energy production, and reduces symptoms in patients with coronary artery disease, neurological diseases, diabetes and fibromyalgia.
Collagen	An essential protein needed in body tissues, plays an important role in regeneration and healing processes, and maintains healthy bone, articular cartilage, intervertebral discs, ligaments, tendons and skin. Also thought to have anti-inflammatory and anti-oxidant properties.
Curcumin	A powerful anti-inflammatory and anti-oxidant, known to reduce pain levels and improve joint function.
Fibre	Regulates gastrointestinal function and prevent constipation, also known to prevent obesity, diabetes, cancer and cardiovascular disease.
Glucosamine	Has an inhibiting effect on collagen degradation and promotes collagen synthesis, thus maintaining healthy articular cartilage.
Methylsulfonylmethane (MSM)	MSM has powerful anti-inflammatory effects. Often used for joint or muscle aches, arthritis, and for its anti-oxidative properties.
Omega 3 fatty-acid	Promotes skin and eye health, prevents cardiovascular disease, known to have anti-inflammatory properties.
Probiotics	Promote the growth of “good” bacteria in the body, thus enhancing the absorption of nutrients in the intestine. Decreases the risk of obesity, diabetes, inflammation and cancer. Often used in irritable bowel syndrome and gastrointestinal issues.
Protein supplements	Essential for tissue growth and healing, important for the functioning of numerous systems (musculoskeletal, nervous, cardiovascular, renal, hepatic and gastrointestinal).

2.5 VITAMINS AND MINERALS IN THE CHIROPRACTIC PROFESSION

The South African Food Based Dietary Guidelines, which were developed by the World Health Organization in 2004, found a link between diet and the prevalence of disease (Sanders 2020). The guidelines aim to support healthcare professionals when looking after the community, and to promote good nutrition to prevent chronic diseases. Many MSK conditions that present to the chiropractor may be as a result of a nutrient deficiency, for example osteoporosis, stress fractures, myofascial pain syndrome (MPS) and muscle spasms (Lalchhuanawma 2019). Thus, in South Africa, the chiropractic scope of practice includes nutritional education and recommendations if a patient requires such management (Sanders 2020).

The AHPCSA, Act 63 of 1982, as amended, permits for the recommendation, prescription and dispensing of nutritional supplements to patients. The chiropractic curriculum in South Africa includes clinical nutrition as a subject (Chiropractic Handbook 2021). This is keeping within the holistic nature of chiropractic, which aims to address the patient as a whole and advises on nutrition accordingly.

De Gouveia (2009) investigated the utilisation of a range of substances by South African chiropractors in conjunction with manipulation. These substances included vitamins and minerals, herbs, topical products and pharmaceuticals. Of the surveyed chiropractors, 86.6% had a positive perception towards the utilisation of vitamins and minerals in chiropractic practice. The chiropractors felt that the utilisation of vitamins and minerals improved patient management and the patients were likely to return to the practice. Of the surveyed chiropractors, 76.2% recommended vitamins and minerals to their patients. De Gouveia (2009) further found that vitamins and minerals were most commonly recommended for the MSK system (84.4%), followed by the neurological system (57.4%). The chiropractors who did not recommend vitamins and minerals to patients reported to refer the patients to nutritionists, homeopaths or other health professionals who they considered more trained in that field.

Sanders (2020) looked at the chiropractic utilisation of nutritional guidance for patient management in South Africa. The study found that a large proportion of participants who were chiropractors provided nutritional advice to patients. The study found that chiropractors consider nutritional supplementation as an effective method of treatment and prevention for MSK conditions. The study gave examples of some nutritional guidance given by the chiropractors according to the patients' needs, such as portion sizes, calorie intake, healthier food and drink options, and nutritional supplements. Nutritional advice was

provided for both MSK and non-MSK conditions, such as osteoporosis, obesity, underweight and malnutrition, cardiovascular disease, inflammatory conditions (like arthritis), anaemia, pregnancy, diabetes, and gastrointestinal disease. Nutritional supplements commonly advised by the chiropractors included probiotics, vitamins/multivitamins, minerals, essential fatty acids, fibre, protein, enzymes and herbal remedies. It was noted that the conditions the nutritional advice was provided for most commonly were inflammatory conditions, and the supplement advised most frequently for this was Omega-3 fatty acid.

Sanders (2020) also reported that most chiropractors in the study referred and consulted first with dieticians to manage patients, followed by general practitioners, and then naturopaths. Less than half of the participating chiropractors used dietary questions in the first assessment to determine nutritional recommendations. Furthermore, a minor percentage of the chiropractors used investigations to provide nutritional advice to patients. The chiropractors gained nutritional knowledge from dieticians, literature and additional education via courses, seminars, lectures or workshops. Sanders (2020) noted a variety of methods to provide nutritional education to patients, such as articles and journals, brochures, general books and magazines, working in the same practice as a homeopath, who displays the information, and working with dieticians.

In various parts of the world, such as Australia, America and Canada, supplement recommendation was found to be the most commonly utilised form of nutritional education by chiropractors (Holtzman *et al.* 2007; Stuber *et al.* 2013; Adams *et al*. 2017; Lee *et al.* 2018). The studies found that supplement recommendation was most commonly provided for MSK conditions. Adams *et al.* (2017) found that Australian chiropractors discussed diet and nutrition 50.5% of the time when planning clinical management protocols with patients. The study noted conditions with which patients presented to the chiropractor. The management protocols for the conditions were not investigated and, thus, no link was made with the utilisation of nutrition for certain conditions.

Lee *et al.* (2018) further explored the recommendation of nutritional supplements by Australian chiropractors. The study found that 92% of the participants had advised nutritional supplementation to patients. The study noted that the chiropractors based the nutritional advice on the first consult, which assessed the patient's lifestyle, diet, exercise, medication use, supplementation and body mass index, to name a few. The most common nutritional supplement advised was probiotics, followed by fatty acids, vitamins, minerals, protein, fibre, herbal remedies and enzymes. The chiropractors also provided dietary and nutritional recommendations to the patients, such as diet plans and healthier food choices. Nutritional advice was provided for inflammatory conditions, osteoporosis, pregnancy,

diabetes, anaemia and gastrointestinal disorders. The study did not investigate which nutritional supplements were recommended for which condition.

Stuber *et al.* (2013) explored the recommendation of dietary supplements by Canadian chiropractors. Every participant provided nutritional advice to patients, with 99% recommending dietary supplements. The most common supplements recommended to patients included calcium, vitamin D, vitamin C, omega 3, multivitamins, glucosamine sulphates and probiotics. Furthermore, the supplements were recommended most commonly for general health, followed by "bone health", "rheumatologic, arthritic, degenerative, or inflammatory conditions" and MSK conditions. The study did not report which supplements were recommended for which conditions, instead a general statement was provided as a rationale for the supplement recommendation, such as vitamin D for bone health.

Holtzman *et al.* (2007) investigated the use of nutritional counselling by American chiropractors in practice. The study found that 80% of participants utilised nutritional advice as part of their chiropractic management protocols. The most common nutritional advice provided to patients was dietary supplements. Furthermore, the study found osteoporosis and osteoarthritis to be the most common MSK conditions for which supplements were recommended. However, the study did not look at which particular supplements were recommended for MSK conditions. The chiropractors additionally recommended supplements for non-MSK conditions, such as coronary artery disease, fibromyalgia and obesity.

A study conducted by Page *et al.* (2012) explored the sale of nutritional supplements by Canadian chiropractors. No recent study related to this topic has been conducted since. The study revealed that 89,4% of participating chiropractors sold health products from the practice, which included vitamins, minerals and other nutritional products. The chiropractors believed that the sale of such products to patients was to act in the best interest of the patients. Additionally, the chiropractors believed the sale of such products enhanced patient care, ensured a high standard of product quality, improved patient compliance, and provided convenience for the patients. Some chiropractors expressed concerns that product sales may be unethical and that chiropractors may not have enough knowledge to support product sales. However, the chiropractors who did sell health products emphasised that sales were completely at the patient's discretion and purchased voluntarily. Therefore, chiropractors both prescribe and dispense nutritional products from the practice, at the chiropractor's discretion. The AHPCSA, Act 63 of 1982, as amended, permits for the dispensing and sale of nutritional products to patients in South Africa. However, no study has investigated the sale of nutritional supplements by South African chiropractors.

In addition to the general population, chiropractors treat many different types of athletes at varying levels. Athletes partake in a range of sporting disciplines that vary in intensity (Nelson *et al.* 2021). Nelson *et al.* (2021) highlighted the multimodal approach of many chiropractors when managing athletes, which included nutritional education. This includes the recommendation of nutritional supplements, such as vitamins and minerals. This is owing to the fact that many athletes are at risk of developing nutrient deficiencies due to increased metabolic demand and energy production, decreased gut absorption of micronutrients, and loss of micronutrients through sweat, urine and stool (Grozenski and Kiel 2020).

An athlete's performance can be negatively affected as a consequence of nutrient deficiencies, which can result in decreased muscle strength, decreased endurance and stamina, and an increased risk of injuries (Holtzman and Ackerman 2021). Thus, supplement recommendation and nutritional education play an integral role in chiropractic patient management, of athletes in particular.

Wardenaar and Hoogervorst (2022) conducted a study on a number of sports health professionals who prescribed nutritional supplements to athletes. At the time, the study was the first to explore the knowledge and attitudes of health professionals regarding the consumption of nutritional supplements by athletes. A list of health professions was provided, for example sports dietician, sports physician, physiotherapist, sport scientist and even coaches. The study also had a "different" category as an option on the list but the types of health professions classified as "different" were not described. Thus, it is unknown if chiropractors were included in this study. Nonetheless, the study stipulated that more than 95% of athletes consumed supplements at some point in their career and resorted to sports health professionals, coaches and family members for advice. This shows the crucial role that health professionals play in supplement recommendations to athletes.

Furthermore, Wardenaar and Hoogervorst (2022) emphasised the importance of health professionals providing appropriate guidance to athletes to select the right supplement and adhere to the correct methods of consumption. The study stated that health professionals who advise nutritional supplements to athletes need to be aware of the associated risks, such as supplements that have not been tested for sports-prohibited contaminants. The study examined a wide range of supplements, sports foods and ergonomic substances that the health professionals recommended to athletes. The results by Wardenaar and Hoogervorst (2022) revealed which supplements were most commonly recommended to athletes by sports dieticians in comparison to other professions. Table 2.3 summarises the top three most commonly recommended supplements, sports foods and ergogenic

supplements by the professions. An ergogenic supplement is the ability of a substance to enhance an athlete's performance (Heffernan *et al.* 2019).

It was noted that longer experience in the field was associated with a greater level of nutritional knowledge, and practitioners were more likely to provide athletes with nutritional advice.

Table 2.3: Nutritional supplements and products most commonly recommended to athletes by sports dieticians and other healthcare professions

	Sports Dietician	**Other healthcare professionals**
Top three supplements most commonly recommended	Vitamin D, multivitamin, fish oil	Multivitamin, fish oil, magnesium
Top three sport foods most commonly recommended	Carbohydrate-electrolyte drink, recovery drink, energy bar	Carbohydrate-electrolyte drink, recovery drink, with energy bar and protein drink recommended equally
Top three ergogenic supplements most commonly recommended	Probiotics, creatine, caffeine	Amino acids, creatine, caffeine

2.6 RUNNING AND THE RUNNING ATHLETE

Running is an aerobic sport (Francis *et al.* 2019) with various types of running and classifications of runners. The variations can be in the form of distances, durations, surfaces (for example trail, track and road) and even multi-day events (Scheer and Krabak 2021). Runners can be classified as sprinters, short distance runners, long distance endurance runners, or road, track or trail runners (Scheer and Krabak 2021). Runners of multiple levels train and/or compete at varying distances. Some may only run for recreational and health purposes, while others may train for races and marathons (Boullosa *et al.* 2020). Many people participate in running as it is cost-effective, easily accessible and requires minimal equipment (Kakouris *et al.* 2021). Thus, it is a very popular sport in South Africa (Miller, 2019).

South Africa consists of a diverse population made up of numerous ethnicity and race groups, ages and economic levels. Ellapen *et al.* (2013) found a mixed ethnic diversity of runners at a marathon in South Africa. Furthermore, runners can be divided into recreational groups who participate for health and enjoyment reasons, or those who participate for more competitive reasons (Scheer and Krabak 2021).

2.7 MUSCULOSKELETAL CONDITIONS IN RUNNERS

Running is a great way for people to adopt a healthier lifestyle and reduce the risk of cardiovascular disease but MSK conditions are very common amongst runners (Kakouris *et al.* 2021). A standard definition to describe a MSK condition in runners does not exist, as various studies provide varying interpretations. The common interpretations of MSK conditions in runners include a complaint, injury, pain or disorder of the MSK system as a result of running.

The most frequently used term is a running-related MSK injury (RRMI), which Gajda *et al.* (2020) defined at "MSK disease caused by running, which results in limited running speed, distance, duration, or frequency for at least one week". Additionally, Yamato *et al.* (2015) defined a RRMI as a MSK pain or complaint of the lower limbs, back or trunk as a result of running. However, Maselli *et al.* (2020) acknowledged that certain conditions in runners cannot be classified as an "injury" and that the term "disorder" may better describe certain multifactorial or non-specific painful conditions, such as lower back pain.

Maselli *et al.* (2020) noted that acute RRMIs are rare because most conditions in runners are from overuse, which is supported by Scheer and Krabak (2021) who also reported that RRMIs in ultramarathon runners occur as a result of overuse. Furthermore, Francis *et al.* (2019) stated that running is associated with the highest rate of overuse injuries than any other aerobic sport, such as swimming, walking or cycling. Running-related MSK conditions can result in temporary or permanent time out from running, financial costs and absence from work (Kakouris *et al.* 2021).

In addition to RRMIs and overuse disorders, runners may experience MSK conditions. Lopes *et al.* (2011) suggested that MSK complaints with a mild pain intensity are indicative of chronic MSK conditions, with Desai *et al.* (2020) reporting the same findings. The studies further suggested that these chronic MSK conditions are due to overuse injuries. Musculoskeletal conditions in runners include, but are not limited to, lower back pain, bone pathology, such as osteoporosis, stress fractures, inflammation, muscle stiffness, muscle damage, and muscle cramping (Istvan *et al.* 2019; Beermann *et al.* 2020; Maselli *et al.* 2020; Barrack *et al.* 2021; Hunt *et al.* 2021; Bykowska-Derda *et al.* 2022).

It is often assumed that runners would suffer with joint pathology, such as osteoarthritis, due to the high impact at the joints when running. However, Hartwell *et al.* (2023) found the contrary to be true — that runners are not at a higher risk of osteoarthritis compared to the general population and running marathons did not increase the risk of developing joint pain. Gessel and Harrast (2019) proposed that smaller doses of running (mileage, intensity and frequency) may be protective against knee osteoarthritis, whereas higher doses of running

may increase a runner's risk of developing arthritis. Thus, a discrepancy in the literature remains regarding the link between joint degeneration and osteoarthritis, with running.

2.8 PREVALENCE OF MUSCULOSKELETAL CONDITIONS IN RUNNERS

The variation in injury prevalence and location differs between studies due to a variation of runners used as participants, study designs and the definition of a MSK condition (Kakouris *et al.* 2021). It has been noted that 50% of runners each year will experience an injury, 25% will be injured at any given time and those who participate in marathons have a 90% incidence of injury (Dempster *et al.* 2021 and Kakouris *et al.* 2021).

Teixeira *et al.* (2016) explored the prevalence of MSK pain in elite marathon runners. The study found that 75% of the elite runners had experienced pain within a 12 month period. Furthermore, the runners reported pain at more than one location, with 38.6% experiencing pain at two areas of the body. Teixeira *et al.* (2016) compared the study's results to previous literature, and found that the elite marathon runners in the study experienced MSK pain four times greater than recreational runners. Nevertheless, Maselli *et al.* (2020) noted that 11% to 85% of recreational runners suffer a MSK injury each year. Endurance runners participating in middle to long distance runs experience a prevalence of 19% to 92% of MSK injuries. Van Wyk (2022) suggested that the wide range of prevalence and incidence rates is due to the lack of standardisation for the definition of a running-related MSK injury or condition.

A study conducted by Francis *et al.* (2019) identified the top ten RRMI to be, in no particular order, patellofemoral pain syndrome, Achilles tendon injuries, medial tibial stress syndrome, plantar fasciitis, iliotibial band syndrome, calf strain, meniscus injury, stress fracture, patella tendinopathy, and gluteal injuries. However, multiple sources noted that the area most frequently affected in runners is the knee. Ellapen *et al.* (2013) found that the knee was the area most commonly injured in South African runners.

Hsu *et al.* (2020) examined MSK injuries in runners who participated in the Taroko marathons between 2013 and 2018, in Taiwan. The study found that the knee was the site of pain and injury most frequently reported by runners, both before and after a marathon. Other areas reported by the study with a high incidence of injury included the ankle, back, calf, thigh and foot. Furthermore, Lopes *et al.* (2011) investigated the prevalence of MSK pain in recreational runners in Brazil. Musculoskeletal pain was reported by 22% of the runners, with the knee as the area most frequently affected. Lopes *et al.* (2011) proposed that knee pain is suggestive of an overuse injury, such as a tendinopathy or patellofemoral

pain syndrome. Desai *et al.* (2020) explored the prevalence of MSK pain in both recreational and elite runners in South Gujarat, India. The study reported the knee to be the area that both groups of runners most frequently experienced pain. Additional areas of MSK pain in the runners were the foot, ankle, shin, calf, and lower back.

Mellinger and Neurohr (2019) noted that the three most common reported knee injuries in runners, were iliotibial band syndrome, patellofemoral pain syndrome and patella tendinopathy. Iliotibial band syndrome was found to be the most common lateral knee injury, with a prevalence of 5% to 14% in runners (Dempster *et al.* 2021). Maselli *et al.* (2020) investigated lower back pain in runners, and found the prevalence rate to be 13.6%. However, the study reported a reduced prevalence of lower back pain in runners compared to the general population.

Due to a variety of South African runners, domains of running, running frequency and variations in distance, there is a high prevalence of RRMI in the country, with Miller (2019) reporting up to 18.2% to 94.2%. A study conducted by Millar (2019) examined MSK injuries in trail runners, which noted a lower period prevalence of injuries in trail runners compared to road runners. The study found that the knee was the most common region for injuries to occur in trail runners, which aligned with past studies that reported the same finding in South African road runners.

Van Niekerk (2014) investigated the frequency of conditions in marathon runners in South Africa. The study found muscle strain to be the most common injury in the runners, followed by sacroiliac syndrome, myofascial pain syndrome, joint sprain, delayed onset muscle soreness, facet syndrome, iliotibial band syndrome, tendinitis, tendinopathy, patellofemoral pain syndrome, plantar fasciitis and medial tibial stress syndrome (also known as shin splits). Viljoen *et al.* (2021) similarly found muscle injuries and complaints to be the most commonly injured tissues in South African trail runners. This was supported by Hespanhol *et al.* (2017) who also noted muscles to be the most commonly injured tissue in Dutch runners. Both studies reported that tendon and ligaments were the second and third most commonly injured tissues.

Malliaropoulos *et al.* (2015) investigated the injury profile in Greek ultramarathon trail runners. The study reported 22% of overuse bone conditions and 16% were iliotibial band syndrome complaints. Additionally, the study noted muscle cramping in the runners. Vernillo *et al.* (2016) further noted muscle cramping in Italian trail runners. Ankle sprains are a common complaint amongst trail runners. Matos *et al.* (2021) reported an 11% incidence rate of ankle sprains in Portuguese trail runners, and Hespanhol *et al.* (2017) noted 7% of ankle sprains in Dutch runners.

2.9 RISK FACTORS ASSOCIATED WITH MUSCULOSKELETAL CONDITIONS IN RUNNERS

Various risk factors predispose a runner to developing a MSK condition. Bykowska-Derda *et al.* (2022) stated that when a runner does not adjust certain factors according to their training loads, there is an increased risk of acquiring an injury. Multiple studies have identified intrinsic and extrinsic risk factors associated with MSK conditions in runners. Intrinsic risk factors relate to the individual person and anatomy that usually cannot be changed, whereas extrinsic risk factors are not related to the individual and can be modified (van Wyk 2022).

Intrinsic factors include, and are not limited to, a family history of MSK conditions, previous history of a MSK injury, biomechanical factors (such as leg length inequalities, foot arch abnormalities, greater femoral Q-angles, excessive pronation), age, gender, heavy menstruation, hormone changes and irregularities (such as pre-menopausal and post-menopausal females), high sweat rates, overweight or underweight, and ligament laxity (Mbarak *et al.* 2019; Johnston *et al.* 2020; Beck *et al.* 2021; Dempster *et al.* 2021; Scheer and Krabak 2021; Bykowska-Derda *et al.* 2022).

Extrinsic factors include excessive training loads (intensity, frequency and mileage), increasing training too quickly, long distance endurance running, training surfaces, incorrect footwear, trauma, running with equipment, extreme environments (hot, humid, high altitude), inadequate rest, poor hydration, dietary preferences (like vegan or vegetarian) and insufficient diet and supplementation, resulting in nutrient and energy deficiencies (Mbarak *et al.* 2019; Johnston *et al.* 2020; Beck *et al.* 2021; Dempster *et al.* 2021;, Scheer and Krabak 2021; Bykowska-Derda *et al.* 2022).

Lopes *et al.* (2011) noted that greater running distances per week significantly increases the risk of MSK pain in runners. Teixeira *et al.* (2016) further noted a high training volume to be a contributing risk factor for the development of MSK pain in runners. Hsu *et al.* (2020) observed that runners with greater marathon experience, who train more frequently and run greater distances, experience a higher incidence rate of injuries. Furthermore, elite runners experience more MSK injuries than lower-level runners, possibly due to the greater training volume in elite runners. The study found an increase in injuries in male participants due to higher training loads than the female participants.

Istvan *et al.* (2019) noted that exercise intensity, extreme environments and dehydration increase a runner's risk of muscle damage. Van Wyk (2022) noted that trail running increases the risk of muscle damage due to the extreme terrain and conditions.

Furthermore, van Wyk (2022) suggested that an increased demand on the muscles, due to increased intensity, distance and duration of running, increases the risk of muscle cramping.

It has been found that endurance long distance running versus shorter sprints may have a negative influence on bone mineral density (BMD) (Bykowska-Derda *et al.* 2022). Bykowska-Derda *et al.* (2022) noted that a risk factor for low BMD in runners is as a result of high mileage running, decreased meals throughout the day and a reduced intake of dairy products. Bykowska-Derda *et al.* (2022) reported that elite endurance runners have a BMD equivalent to the non-exercising population. Thus, long distance running coupled with inadequate nutrition, may increase the risk of a runner developing a bone pathology, such as osteoporosis and pathological stress fractures.

Johnston *et al.* (2020) investigated the risk factors for stress fractures in female runners. The study stated that stress fractures occur in 20% of runners, more commonly in females than males, especially pre-menopausal and post-menopausal. The study found that the tibia was the most common site of stress fractures. Of the females who had experienced stress fractures, 40% had experienced more than one during their running career. The study identified risk factors associated with the development of stress fractures in female runners, which included inadequate nutrition, large training volumes, increasing mileage too quickly, training surfaces, inadequate strength training, incorrect shoes, menstrual irregularities and running despite pain. Johnston *et al.* (2020) identified nutritional deficiencies in approximately 67% of females who had experienced at least one stress fracture in their running career. Nutritional deficiencies in calcium, vitamin D, iron, and protein were identified, as well as an inadequate calorie intake. Additionally, it has been noted that female runners are more prone to hip injuries and pain than men (Boullosa *et al.* 2020).

Hsu *et al*. (2020) reported that underweight runners experienced a greater rate of thigh injuries compared to runners with a normal body mass index (BMI). However, runners with a high BMI displayed a higher incidence and risk of injury overall. In contrast, Desai *et al.* (2020) found no association between age, BMI and gender with the development of MSK pain in runners, although the study did find a correlation between weekly running distance and MSK pain in runners.

Maselli *et al.* (2020) identified intrinsic and extrinsic risk factors for the development of lower back pain in runners. Intrinsic factors included a high BMI, tight hip flexor muscles, tall height of the runner, leg length inequality, and poor flexibility of the hamstrings and back. Extrinsic factors include greater experience in running, higher competitive level, and the type of shoes.

South African runners are exposed to numerous risk factors associated with the development of a MSK condition and RRMI, especially runners from lower socioeconomic communities (Kunene *et al.* 2021). Runners from under-resourced communities do not have access to adequate rehabilitation services, and will often train or compete with an existing injury. Kunene *et al.* (2019) identified extrinsic risk factors which runners will experience from under-served communities, such as overtraining or undertraining, poor shoe condition, lack of warm-up exercises and running on hard concrete or tar surfaces. Furthermore, the unfavourable conditions predispose the runners to injuries, such as factors, including and not limited to, inappropriate or lack of health services available and limited access to coaches (Kunene *et al.* 2020).

Literature has identified nutrition as the extrinsic risk factor associated with MSK conditions in runners. Certain dietary preferences (like vegan or vegetarian), inadequate dietary intake and supplementation may result in a nutrient or energy deficiency in the runner (Beck *et al.* 2021). Runners are prone to developing relative energy deficiency in sport (REDS), which is “a syndrome referring to impaired physiological function including, but not limited to, metabolic rate, menstrual function, bone health, immunity, protein synthesis, and cardiovascular health caused by relative energy deficiency” (Beck *et al.* 2021). The presence of REDS in a runner increases the risk of developing a MSK condition (Beck *et al.* 2021).

The cause of REDS is as a result of an energy deficiency due to an inadequate energy consumption versus a higher energy expenditure (Beck *et al.* 2021). This can be as a result of the high nutritional demands of running, or consequently, the runners are not consuming enough nutrition due to either aesthetic reasons or for ideal performance body mass (Mathisen *et al.* 2019). Furthermore, running stresses metabolic pathways that require micronutrients so, therefore, runners have an increased need for vitamins and minerals due to the high-intensity nature of the sport (Beermann *et al.* 2020).

Running in extreme environments (temperature, altitude, and/or humidity) increases the nutritional requirements in runners (Martínez-Sanz *et al*. 2020). Thus, if diet and supplementation are not adapted to support training, then a nutrient deficiency may lead to the development of clinical conditions (Wirnitzer *et al*. 2021a, 2021b; Bykowska-Derda *et al.* 2022).

Lalchhuanawma (2019) stated that a risk factor for developing myofascial pain syndrome (MPS) was due to a nutrient deficiency. MPS may occur in any component of muscles, tendons and ligaments. MPS is characterised by myofascial trigger points, which are areas of hyperirritable muscle fibres in a taut band, resulting in muscle pain, stiffness, weakness

and decreased range of motion. Certain nutritional deficiencies could aggravate MPS, resulting in generalised muscle pain, trigger points, muscle cramping, muscle fatigue and generalised weakness (Lalchhuanawma 2019).

Runners are at risk of certain vitamin and mineral deficiencies, which then increases the risk for the development of associated MSK conditions in runners. Bykowska-Derda *et al.* (2022) noted that runners who consume less meals a day, with inadequate dairy products, are prone to a deficiency in vitamin D and calcium. Both Johnston *et al.* (2020) and Krabak and Scheer (2021) made a link with poor nutrition and REDS, to deficiencies in calcium and vitamin D. Runners who are at risk of a vitamin D deficiency compete or train indoors, at high altitude, before sunrise or after sunset, wear lots of clothing or sunscreen, are older in age and have a dark skin complexion (Grozenski and Kiel 2020).

A study on collegiate distance runners reported that 50% of females and 24% of males consumed less than the daily recommended allowance of calcium, and 95% of all runners did not meet the vitamin D daily requirements (Beermann *et al.* 2020). A deficiency in vitamin D and calcium leads to decreased BMD, resulting in osteoporosis and pathological and/or recurrent bone fractures (Akram *et al.* 2020 and Awuchi *et al.* 2020). A vitamin D deficiency can result in muscle weakness, decreased functioning, decreased muscle tone, myopathy, whereas a calcium deficiency can result in inadequate skeletal muscle contractions, muscle pain and cramps (Akram *et al.* 2020 and Awuchi *et al.* 2020).

Runners, especially females, are prone to an iron deficiency. This may be due to a number of factors, such as foot-strike haemolysis, inadequate iron consumption (often seen in vegan and vegetarian diets), menstrual blood loss, and training at high altitudes (Beermann *et al.* 2020). Beerman *et al.* (2020) reported that 75% of female runners and all of the male (100%) runners consume less than the recommended daily allowance of iron. The recommend daily allowance for iron is higher in pre-menopausal female athletes compared to men, post-menopausal athletes and sedentary individuals. An iron deficiency in athletes can result in muscle weakness, fatigue, breathlessness, headaches, and decreased stamina (Grozenski and Kiel 2020).

Runners are inclined to sweat, especially when running in a hot or humid climate, or training long distances (Tiller *et al.* 2019). Potassium, calcium, sodium and other electrolytes can be lost via the dermal layer in sweat (Close *et al.* 2019, Beermann *et al.* 2020 and Martínez-Sanz *et al.* 2020). If electrolytes and water are not replenished, it can result in dehydration and hyponatraemia, which is a deficiency of sodium in the blood (Lindner *et al.* 2022). Mild to serious life-threatening consequences can occur with hyponatraemia, such as nausea and vomiting, confusion, low blood pressure, raised intracranial pressure, cardiorespiratory

distress, seizures and death (Tiller *et al.* 2019 and Lindner *et al.* 2022). Hyponatraemia can result in MSK presentations, such as muscle cramping and weakness (Akram *et al.* 2020 and Awuchi *et al.* 2020). Beermann *et al.* (2020) reported that 44% of runners consume less potassium than the recommended daily allowance. A deficiency in potassium results in muscle cramps, weakness and paralysis (Akram *et al.* 2020 and Awuchi *et al.* 2020).

Runners who train for prolonged periods, or multiple times a day, are at risk of magnesium deficiency. Muscle utilisation of magnesium during exercise results in a 10% reduction in plasma magnesium concentrations (Hunt *et al.* 2021). Hunt *et al.* (2021) further noted that inadequate magnesium levels are often associated with MSK conditions. A magnesium deficiency can result in neuromuscular irritability, causing muscle spasms, muscular pain, irregular or inadequate muscle contractions (Akram *et al.* 2020; Awuchi *et al.* 2020).

Antioxidant deficiencies of vitamin A and E are prevalent in athletes with restrictive diets and increased oxygen use during running (Grozenski and Kiel 2020; Brancaccio *et al.* 2022). Antioxidant deficiencies can result in muscle stiffness, muscle weakness, and cardiovascular disease in athletes. Antioxidants are important in athletes to protect immune function and decrease inflammation (Grozenski and Kiel 2020).

2.10 THE IMPACT OF MUSCULOSKELETAL CONDITIONS ON RUNNERS

Running is a great way for people to adopt a healthier lifestyle and reduce the risk of cardiovascular disease. Many people participate in running to improve their physical fitness and gain positive health benefits (Kakouris *et al.* 2021). However, MSK conditions are common amongst runners and it can result in negative consequences to a runner's life, regardless of the type of MSK condition or location of a RRMI (Kakouris *et al.* 2021). Kunene *et al.* (2019) noted that in South African under-served communities, injuries and pain can negatively affect runners' physical, mental, emotional and psychosocial wellbeing.

2.10.1 Quality of Life

Musculoskeletal pain can reduce the pleasure of exercising and participation in running (Kakouris *et al.* 2021). Runners reported that injuries caused stress, demotivation and interfered with the social aspect of running (Kunene *et al.* 2019). Additionally, Maclachlan *et al.* (2017) reported increased stress, anxiety and depression levels in runners with a MSK condition. It was noted that pain caused a fear of movement in the runners. Similarly, Hespanhol *et al.* (2017) noted the negative consequences an injury may have on a runner's psychology and mental health. The injury may decrease the motivation to run, which counteracts the efforts to increase society's activity levels (van Wyk 2022).

2.10.2 Performance and Training

Running-related MSK injuries and conditions can vary in nature and severity. Runners who developed an injury during an event reported to notice a negative impact on their performance during the race. Furthermore, Scheer and Krabak (2021) also stated that RRMIs can lead to a reduction in the runner's performance overtime. Hespanhol *et al.* (2017) reported that 54% of injuries in Dutch trail runners result in a decrease in training and performance. Franke *et al.* (2019) further noted that clinical symptoms may reduce a runner's performance. Istvan *et al.* (2019) noted that overuse injuries, although minor, can negatively affect a runner's performance; however, Scheer and Krabak (2021) noted that acute injuries can affect a runner's race. Most injuries acquired during a race are minor but, nevertheless, the runner's performance is reduced and may even result in withdrawal from the race (Scheer and Krabak 2021). Tiller *et al.* (2019) found that dehydration and hyponatraemia can affect a runner's performance. Furthermore, inadequate hydration is often found in marathon runners who do not finish the race.

Gajardo-Burgos *et al.* (2021) explored the self-perceived effect of injuries in runners. Most of the runners (75%) believed that an injury would negatively affect their performance, and 3.5% did not participate in the race due to the belief that the injury would have a serious effect. Scheer and Krabak (2021) found that a severe condition can result in a runner withdrawing from races and taking time out of training in order to rest. South African runners reported that knee pain interfered with training, forcing runners to withdraw from training sessions and races (Kunene *et al.* 2020).

2.10.3 Financial Constraints

Musculoskeletal conditions and RRMIs may lead to financial implications and burdens on a runner (van Wyk 2022). Injuries may require medical care that ranges from conservative to more invasive treatments, which may become costly. Depending on the severity of the condition, it may result in a runner taking temporary or even permanent time off work (Kakouris *et al.* 2021).

Hespanhol *et al.* (2017) reported that runners with injuries incurred costs from both healthcare and time off work. However, the loss of income due to time off work was greater than the costs of treatment. South African low-income runners cannot afford to develop injuries that may threaten their daily income (van Wyk 2022), especially if the runner relies on prize money and sponsorships as a form of income. Kunene *et al.* (2020) further noted that runners often continue to train with untreated injuries, resulting in the development of serious complications which may end running careers. Furthermore, runners from under-

served communities do not have access to adequate rehabilitation services, which often results in an injury ending a runner's career (Kunene *et al.* 2019).

2.11 THE TREATMENT OF MUSCULOSKELETAL CONDITIONS IN RUNNERS

Running is a sport accompanied by a high rate of overuse injuries and MSK conditions compared to other aerobic sports (Francis *et al.* 2019). Thus, MSK conditions are prevalent in runners. Consequently, many treatment protocols and options exist to manage MSK conditions in runners, which will differ according to the type and location of the condition (Mbarak *et al.* 2019). Common treatment options include rest, ice, compression and elevate (the "RICE" protocol), orthotics, therapeutic drugs, manual therapy, surgery and rubbing ointments (Mbarak *et al.* 2019).

Mellinger and Neurohr (2019) reported which manual therapies were an effective treatment option for knee injuries in runners. Such manual therapies include dry needling, soft tissue work, joint mobilisations, stretching, exercise therapy, gait analysis and correction, electrical modalities, therapeutic drugs, orthotics, and taping. Soft tissue mobilisations can be performed by hand as a massage, ischaemic compression or cross friction, or with the use of a device. Electrical modalities include, but are not limited to, extracorporeal shockwave therapy, ultrasound and electrical stimulation. Furthermore, Mellinger and Neurohr (2019) emphasised the importance of addressing additional factors when treating a running injury. Such factors include the running frequency, intensity, mileage, and the runner's sleep patterns, hydration, and nutrition. Additionally, any biomechanical abnormalities or weaknesses need to be corrected with strengthening exercises used in adjunct to manual therapies and modalities. Thus, treatment is determined by the individual runner's needs and is patient dependent.

Harding *et al.* (2009) explored the utilisation of healthcare by runners to treat and manage conditions. Complementary and alternative medicine was utilised 21% compared to mainstream healthcare options, with the chiropractic utilisation to be 11% amongst runners. Van Niekerk (2014) investigated the chiropractic management of runners in South Africa. The study noted that management of acute injuries should employ the RICE protocol, and chronic conditions need to restore normal biomechanics through joint manipulation, mobilisation, soft tissue work, stretching and strengthening exercises. Furthermore, the cause of the injury, whether through intrinsic or extrinsic factors, needs to be addressed as injury prevention is crucial rather than cure.

A minor biomechanical abnormality in the runner may cause significant stress in a structure or area, resulting in an injury. Van Niekerk (2014) reported the treatment and management protocols utilised by chiropractors at marathons to consist of 82.8% manipulation, 57.2% soft tissue massage and 33.6% stretching. Manipulation was utilised for sacroiliac syndrome, muscle strains and MPS. Soft tissue massage was utilised for muscle strains and MPS. Other treatment and management protocols were utilised for the runners, such as dry needling, ischaemic compression, mobilisation, cross friction massage, strapping and ice. Van Niekerk (2014) noted that future management of the runner (such as rehabilitation, rest and return to running) after one treatment at the marathon, is difficult to monitor. However, the chiropractors did include advice to the runners about rest and referrals to other practitioners.

2.12 ROLE OF VITAMINS AND MINERALS IN RUNNERS

Supplement use by athletes is common and will be determined by the type of sport, intensity and duration in which the athlete partakes (Wirnitzer *et al.* 2021b). Athletes who have increased micronutrient requirements tend to participate in high intensity sports requiring high energy demands. Endurance athletes, such as runners, have higher macronutrient and micronutrient requirements to meet physiological needs, compared to other athletes (Wirnitzer *et al.* 2021b). Furthermore, various factors predispose an athlete to increased micronutrient requirements, such as increased sweat rates, dietary preferences (like vegan or vegetarian), menstruation, altitude training, extreme environments (hot and humid), indoor or winter sports, inadequate energy intake, increased training regimes and a diagnosed deficiency, to name a few (Beck *et al.* 2021). Thus, micronutrient supplementation plays an important role in supporting athletic performance, aiding recovery and adaptation to training.

Running stresses metabolic pathways that require micronutrients, therefore runners have an increased need for vitamins and minerals (Beermann *et al*. 2020). Runners are at a high risk of developing REDS, which can result in the development of a MSK condition (Beck *et al.* 2021). If an endurance athlete's nutritional intake is insufficient, it may lead to clinical conditions affecting both health and performance (Wirnitzer *et al.* 2021b). Thus, it is essential for runners to consume adequate amounts of vitamins and minerals to prevent nutrient deficiencies and resultant MSK conditions. Furthermore, adequate nutrition will support the damaging effects associated with the high intensity nature of running, such as inflammation, muscular changes, immune suppression and risk of infection (Beermann *et al.* 2020). Thus, sufficient amounts of macronutrient and micronutrients will prevent illness and injury, and positively influence performance.

Runners, especially long distance runners, frequently use supplements as a strategy to meet nutrient requirements (Wirnitzer *et al.* 2021b). Barrack *et el.* (2021) reported 26% of runners to consume dietary supplements, whereas Wirnitzer *et al.* (2021b) found the consumption among distance runners to be 50%. Supplement intake by runners may be due to various reasons, such as a history of a running-related bone pathology or stress fractures, previous history of a MSK condition, gender (female), older age, previous weight loss or trying to gain weight, insufficient food intake, an eating disorder, and following a vegetarian diet (Barrack *et el.* 2021). Other factors which may prompt a runner to consume supplements may be to meet the higher exercise induced nutritional needs, to enhance performance, speed up recovery post-runs, and enhance healing and rehabilitation of injuries (Wirnitzer *et al.* 2021b). Barrack *et el.* (2021) noted that the type of supplements taken by runners to include vitamin D, calcium, iron, multivitamin, vitamin B, zinc, vitamin C, magnesium, probiotics, creatine, protein supplements and amino acids, energy bars, and carbohydrate-electrolyte drinks.

Runners will have differing nutritional requirements based on individual training regimes, mileage, intensity and duration of running, such that a sprinter may not face the challenge of energy availability compared to a long-distance endurance runner (Wirnitzer *et al.* 2021a). Hence, it was noted that endurance runners consume more supplements than shorter distance sprinters, track and field runners. Furthermore, nutritional requirements will differ between elite runners versus recreational runners and, therefore, a runner's goals will determine supplement and nutrient intake. Nevertheless, recreational runners may also be at risk of nutrient insufficiencies to meet daily training and health needs (Wirnitzer *et al.* 2021a). Close *et al.* (2019) reported the efficiency of nutrition to reduce the risk of injuries, and promote recovery should an injury occur.

Optimal nutrition and a change in energy requirements during a muscle injury are important to prevent the loss of lean muscle and promote muscle repair (Close *et al.* 2019). Sufficient protein intake is needed during times of immobilisation of an injury, as the immobilisation decreases the protein synthesis in resting muscle. Thus, protein supplementation during a muscle injury will prevent muscular atrophy and promote healing of the injured tissues (Close *et al.* 2019). It is critical for runners to meet the daily protein requirements to aid muscle recovery post-training, aid muscle growth and maintain muscle mass (Tiller *et al.* 2019).

Additionally, omega-3 is thought to assist in the prevention of MSK injuries due to its anti-inflammatory properties. Omega-3 is believed to reduce the level of inflammation following exercise-induced muscle damage (Close *et al.* 2019). However, Close *et al.* (2019) did emphasise the lack of literature that exists regarding supplementation to prevent muscle

injuries and aid healing. Of the strategies that exist to reduce the degree of muscle damage and promote healing, the supplements are thought to act as anti-oxidant and anti-inflammatory aids.

Other supplements thought to assist with muscular injury are vitamin C, D and E, polyphenols and creatine (Close *et al.* 2019). Vitamin A and E supplementation may prevent muscular damage and stiffness by decreasing the degree of oxidative stress and enhancing muscular recovery post-exercise (Grozenski and Kiel 2020; Brancaccio *et al* 2022).

Runners are at a high risk of stress fractures, which increases with a high volume and intensity of running. Thus, runners should consume an adequate intake of vitamin D and calcium to optimise bone health, through both diet and supplementation, reducing the risk of stress fractures and bone pathologies (Beermann *et al.* 2020). Female runners who suffer with menstrual irregularities and/or low energy availability, should supplement with substantial doses of both calcium and vitamin D to maintain bone health, which is a critical factor in the female athlete triad (Beermann *et al.* 2020). The female athlete triad is a condition of three clinical issues which include menstrual dysfunction, poor bone health and a low energy availability (Beermann *et al.* 2020).

Currently, it is unknown if nutrient supplementation may prevent bone injury or aid recovery. However, selected nutrients may play a key role in bone formation and support, namely calcium, vitamin D, magnesium, phosphorous, potassium, protein, vitamins C, B, K and A, iron, zinc and fluoride (Close *et al.* 2019). Athletes suffering from stress fractures, bone pathologies, joint injuries, muscle pain or weakness may benefit from vitamin D supplementation, especially if they are exposed to other risk factors (Grozenski and Kiel 2020).

Iron consumption is important in long distance endurance runners, especially females due to menstrual blood loss. Adequate iron intake will maintain running performance (Beermann *et al.* 2020). Heffernan *et al.* (2019) reported running improvements from various studies which investigated iron supplementation in runners. Female runners who had supplemented with iron for six weeks recorded improved times in a 15 km time trial. The iron also increased ferritin and haemoglobin levels, resulting in greater transportation of oxygen to tissues. Heffernan *et al.* (2019) acknowledged another study which supplemented both iron deficient and non-deficient runners, which found a 110 second faster time trial in the iron-deficient population and improvements in mood and vigour. Multiple benefits of iron supplementation in endurance athletes were noted, such as prolonged lactic acid onset, a higher lactate threshold, faster running speed, quicker recovery times post-exercise, fatigue resistance and greater strength (Heffernan *et al.*

2019). The degree of iron supplementation efficiency can be influenced by the runners existing iron levels, route of iron administration and dose taken.

Wirnitzer *et al.* (2021a, 2021b) found that magnesium was the most frequently consumed mineral supplement by runners. Magnesium has been reported to improve sports performance through the enhancement of muscle recovery and function (Hunt *et al.* 2021). Furthermore, the consumption of magnesium and vitamin D together strengthen the benefits of each other. Magnesium is commonly utilised to reduce muscle cramping (Hunt *et al.* 2021). Additionally, the correction of a magnesium deficiency been found as an effective management for MPS (Lalchhuanawma 2019).

Tendinopathy injuries are common in runners, especially at an elite level (Close *et al.* 2019). Treatment strategies for tendon issues aim to increase tensile strength by increasing the density of collagen in the tendon, and correcting the orientation of the collagen fibres. In the past, this was thought to be achieved through tendon loading. However, recent protocols have included nutrition with tendon loading to improve collagen synthesis and enhance healing of tendons and ligaments (Close *et al.* 2019). Vitamin C plays a vital role in collagen synthesis. A deficiency in vitamin C will impact tendon and ligament health, but it is unknown if the consumption of vitamin C more than the daily recommended dose will increase collagen synthesis or prevent tendinous injuries (Close *et al.* 2019).

Proteins are also crucial for tendon health. It is believed that a considerable consumption of protein may aid tendon recovery and function after injury (Close *et al.* 2019). The daily consumption of hydrolysed collagen increases collagen synthesis, which is thought to decrease tendon and ligament injuries in athletes. Collagen has become a substance of interest for both the prophylactic and therapeutic effects in tendon and ligament health (Close *et al.* 2019). Other nutritional supplements have been suggested to aid tendon and ligament healing, improve function and prevent injury, including curcumin, taurine, Boswellic acid, arginine and bromelain. It is believed that the anti-inflammatory properties of these supplements will decrease inflammation, which is involved during the tendinopathy process, thus assisting in the recovery (Close *et al.* 2019).

Supplementation with phosphate has shown positive benefits on peak oxygen consumption and reduced lactate levels in endurance athletes (Heffernan *et al.* 2019). Reduced lactate levels result in decreased muscle fatigue, aches and stiffness.

Tiller *et al.* (2019) explored nutritional and hydration strategies in ultramarathon runners. The study noted that runners need to be cautious of hydrating with both water and electrolytes during training and races. The study reported that runners who experience dehydration or hyponatraemia is often as a result of insufficient hydration, excessive water

consumption without electrolytes, or inadequate electrolyte intake. Furthermore, runners need to increase electrolyte consumption when running in hot or humid environments due to increased sweat rates.

Additional factors that may influence hydration strategies in runners may include the race distance, a higher body mass index and individual sweat rates. Tiller et al. (2019) reported that athletes who most commonly suffer from hyponatraemia and associated dehydration symptoms, are those who participate in ultramarathons. Thus, the study suggested the importance of nutrition programmes for runners, to address hydration post-run for recovery and hydration during the day independent of running.

Additionally, Tiller et al. (2019) recommended the intake of fluid and electrolytes both pre-training and post-training to prevent dehydration and hyponatraemia. The study noted that inadequate hydration, resulting in dehydration and hyponatraemia states, increase a runner's risk of developing an injury or illness during an ultramarathon. Inadequate hydration may further decrease a runner's performance. Greater hydration has been found in runners who finish marathons, compared to those who do not.

Heffernan *et al.* (2019) noted that sodium supplementation was found to maintain fitness levels in resting athletes. There is limited research regarding the incorporation of sodium supplementation into rehabilitation strategies for injured endurance elite athletes. However, Heffernan *et al.* (2019) suggested further investigation into the utilisation of sodium to maintain fitness levels and pre-injured performance levels in endurance athletes.

Nutrient deficiencies have the ability to aggravate MPS and the development of trigger points (Lalchhuanawma 2019). Thus, it is important for runners who are at high risk of nutrient deficiencies to be aware of certain vitamins and minerals which could prevent MPS. These include vitamin C, the vitamin B group, folic acid, magnesium, calcium, vitamin D and iron. Vitamin D supplementation may alleviate muscle and joint "achiness" (Lalchhuanawma 2019).

Runners must consider both the benefits and potential risks when consuming supplement products, such as product contamination, adverse health effects, and gastrointestinal irritation causing nausea, vomiting or diarrhoea (Wirnitzer *et al.* 2021a).

2.13 CHIROPRACTIC UTILISATION OF VITAMINS AND MINERALS TO MANAGE MUSCULOSKELETAL CONDITIONS IN RUNNERS

Beck *et al.* (2021) emphasised the importance of a medical professional prescribing and advising the necessary supplements to an athlete when necessary. Nelson *et al.* (2021) noted that chiropractors included nutritional education and supplement recommendations

when managing athletes but the study did not mention a particular group of athletes. The study further did not note which specific supplements are commonly utilised by chiropractors and for which conditions.

Studies conducted by De Gouveia (2009), Holtzman *et al.* (2007), Stuber *et al.* (2013), Adams *et al.* (2017), Lee *et al.* (2018) and Sanders (2020) reported on the nutritional recommendations by chiropractors to the general population. The studies did not investigate the recommendation of supplements in a particular population, such as runners. Therefore, as it stands, it is unknown what the role of chiropractic utilisation of vitamins and minerals has on the management of MSK conditions in runners. Thus, it is unknown what influence the utilisation of nutritional supplements may have on the MSK conditions, such as improved healing time, decreased incidence of injuries, and whether this will improve performance, recovery time and training adaptation. Furthermore, it is unknown if such factors will then result in decreased medical costs (and therefore decreased financial pressure) for the runner patient, with less invasive procedures and time out of work. Additionally, it is unknown how chiropractors prescribe, recommend, educate and dispense vitamins and minerals to runners. Consequently, the patient outcomes as a result of the chiropractic utilisation of micronutrient supplements, when managing MSK conditions in runners, has not been determined.

2.14 MANAGEMENT OF RUNNERS IN LINE WITH THE SUSTAINABLE DEVELOPMENT GOAL AND SPORT IN SOUTH AFRICA

Running is a popular sport in low-income countries, such as South Africa, as it is a cost-effective sport option (Millar 2019). Low-income runners cannot afford to develop injuries that may threaten their daily income (Kakouris *et al*. 2021). Therefore, in a South African context, this present study may help chiropractors develop RRMI prevention strategies which will assist runners in decreasing their risk of injury, and improve healing time.

The knowledge generated could decrease financial costs or the threat of losing income as a result of a running injury. This aligns to the third Sustainable Development Goal (SDG3), which is to “ensure healthy lives and promote well-being for all at all ages” (World Health Organization 2017). The SDG3 aims to provide healthcare for all, which protects against financial burden, improves risk detection and prevention, and strengthens the management of these risks. One factor that has been identified as a contributor to the progress of SDG3, is nutrition. Therefore, through the publication of this research on supplement utilisation as

part of MSK management protocols by chiropractors, there will be contribution to the progress of SDG3.

2.15 PAUCITY IN THE LITERATURE

Although studies have investigated the chiropractic use of nutritional supplements in patient management, many factors regarding such utilisation still remain unknown.

De Gouveia (2009) found that vitamins and minerals were most commonly advised for MSK conditions, which was further confirmed by the same findings in the studies conducted by Holtzman *et al.* (2007), Stuber *et al.* (2013), Adams *et al.* (2017), Lee *et al.* (2018) and Sanders (2020). Sanders (2020) referred to conditions which the chiropractors recommended supplements for, such as osteoporosis and arthritis. Furthermore, the study identified inflammatory conditions to be the most common condition advised on, and omega-3 was the most commonly recommended supplement. Sanders (2020) further noted the nutritional supplements commonly recommended by chiropractors, but did not report which supplement was recommended for which condition.

Holtzman *et al.* (2007) found that osteoporosis and osteoarthritis were the most common MSK conditions for supplement recommendation, yet the type of supplement recommended was not mentioned. In contrast, Stuber *et al*. (2013) reported which supplements chiropractors recommended most often but the study did not identify which MSK conditions they were advised for. The studies did not investigate which specific vitamins and minerals were recommended for the management of specific MSK conditions. Therefore, a paucity in the literature exists as to which nutritional supplements a chiropractor may recommend for a particular MSK condition, and if such utilisation has an influence on patient management and outcomes. Moreover, the studies did not include questions regarding whether the chiropractors prescribed supplements for the patient to buy from an external source or if they dispensed and sold the supplements from their practice.

It is unknown how protocols may differ for various populations, and what education is provided alongside a recommendation. Further questions pertaining to supplementation utilisation did not include how the chiropractor determined a nutrient deficiency, such as sending the patient for investigations before prescribing. Only Sanders (2020) reported the use of investigations to determine nutritional advice by a minor percentage of chiropractors. However, neither the type of investigations utilised nor when the investigations were performed during the management of the patients were described. Furthermore, the studies did not investigate if dietary corrections were given before advising supplementation.

De Gouveia (2009) was the last study to be conducted in South Africa regarding the relation between chiropractic and the recommendation of vitamins and minerals in particular, not general, nutritional advice. Furthermore, both De Gouveia (2009) and Sanders (2020) did not look at the chiropractic utilisation of nutritional advice or the recommendation of supplements for a specified patient population. No study has researched chiropractic supplement recommendations and education for runners and for the specific MSK conditions presented by this population. As a result, no study has commented on whether supplement protocols differed for recreational versus competitive runners, female versus male runners, or between the different running styles (road, trail, ultramarathon). Thus, a paucity in the literature is noted on this topic and, hence, it still remains unknown how South African chiropractors may utilise nutritional supplements to manage runners, and the impact that it may have for both chiropractic treatment protocols and runners' injury profiles. It is, therefore, unknown if the chiropractic utilisation of supplements will impact a runner's performance or the financial burden of an injury, especially in a South African context.

A study conducted by Wardenaar and Hoogervorst (2022) investigated the recommendation nutritional supplements by health professionals to athletes. The study reported a wide range of supplements, sports foods and ergonomic substances that health professionals commonly recommended to athletes. However, the study did not describe what the specific supplements were recommended for, or how the health professionals went about recommending them to the athletes. The method of utilisation was not described, nor was the type of athlete who received such recommendation. The study did not elaborate on the influence that supplement recommendation had for the athlete, injury healing or performance.

This study will generate new information on nutritional supplement protocols and the education provided alongside. This will assist chiropractors in the prevention, treatment and management of MSK conditions in their running patients. This study will highlight which supplements are more commonly prescribed and which MSK conditions benefit the most from supplementation, thus aiding chiropractors when choosing which nutritional supplement to recommend to runners.

If the study reveals a higher quality of patient management and outcomes, it is possible that the chiropractic management of runners and MSK conditions will improve and this may result in other professions referring runners for chiropractic care. Furthermore, that may lead to a decreased number of invasive treatments and lower medical costs for South African runners.

2.16 CONCLUSION OF CHAPTER

This chapter presented the literature pertaining to chiropractic, vitamins and minerals, and MSK conditions in runners. The paucity in literature was highlighted as to how chiropractors may utilise nutritional supplement to manage MSK conditions in the running population.

The next chapter explores the framework guiding this research study.

CHAPTER 3

THEORETICAL FRAMEWORK

3.1 THEORETICAL FRAMEWORK

A theoretical framework is “a logically developed and connected set of concepts and premises, developed from one or more theories, that a researcher creates to scaffold a study” (Varpio *et al.* 2020). This chapter presents the framework guiding this research study.

3.2 THE IMPORTANCE OF A THEORETICAL FRAMEWORK IN QUALITATIVE RESEARCH

A qualitative exploratory descriptive design is used by researchers to inquire more on a topic and participants may contribute further information beyond the set interview guide (Creswell 2009). A theoretical framework guides the methodology, data interpretation, reporting of results and discussion implemented in a study (Varpio *et al.* 2020). Thus, it is important for a framework to exist in qualitative research to provide a structure to the study and guide the researcher during the process. A framework assists the researcher to identify themes and concepts from the data to answer the study’s objectives and research questions. Furthermore, a framework ensures continual validity of the study (Varpio *et al.* 2020)

3.3 THEORETICAL FRAMEWORK UNDERPINNING THIS STUDY

Models were applied to this study to fully explore and understand the research problem, the aim of the study and the study objectives. The two models applied were the sociopsychobiological model to pain care and the integrative care model.

3.4 SOCIOPSYCHOBIOLOGICAL MODEL

The sociopsychobiological (SPB) model of pain care recognises all aspects that may contribute towards a patient holistically and the patient’s experience of pain. This model considers the relationship between the sociocultural, psychological and biological factors that contribute to both a person’s response and perception of the pain (Mardian *et al.* 2020). When the SPB model is applied in practice, it has been noted that a higher value of care is delivered; a more holistic approach is taken by the practitioner; the patient’s social and vocational functioning is considered; and treatments are less costly.

3.5 INTEGRATIVE CARE MODEL

The integrative care (IC) model is defined as “the appropriate merger and integration of conventional care, drugless approaches, including complementary and alternative medicine, and behaviour and lifestyle medicine” (Jonas and Rosenbaum 2021). The IC model encourages both lifestyle and behavioural changes, which encompasses nutrition. The model has been found to improve patient-reported outcomes in nutrition, vocation and pain management (Jonas and Rosenbaum 2021).

3.6 APPLICATION OF THESE MODELS IN THIS STUDY

Sanders (2020) stated that chiropractic provides a holistic form of healthcare to patients and also focuses on the overall wellbeing of the population. The holistic approach of the profession will thus take into account all aspects of the patient, such as the social, psychological and biological factors contributing to a presented injury or pain experience. An aspect of holistic care considers the lifestyle of the patient, and thus looks at an individual’s nutritional needs. The SPB model ensures to educate the patient and provide suitable recommendations (Mardian *et al.* 2020), which chiropractors have been found to do when patients require nutritional education and/or recommendations (Sanders, 2020).

The SPB model provides a cost-effective alternative to mainstream medicine, which is suitable for low-income runners as they cannot afford time off work or the financial burden of treatment interventions (Kakouris *et al.* 2021). Therefore, the SPB model was continuously applied throughout the study when exploring the research problem, aim and objectives of the chiropractic utilisation of nutritional supplements when managing a runner. The SPB model also involves team integration and a multiple-disciplinary approach to patient care, prioritising the functions of teams rather than a specific profession (Jonas and Rosenbaum 2021). This value, combined with the IC model, was used when evaluating how chiropractors provided nutritional education and supplement advise to runners — whether it was solely provided by them or if referrals were made to nutritional experts.

Referrals to other practitioners are supported by the IC model, as it aims to treat the patient as a whole by using a combination of evidence-based practices (Jonas and Rosenbaum 2021). This is reflected in the chiropractic profession through the engagement in a multi-disciplinary approach to patient care (Nelson *et al.* 2021). Furthermore, Nelson *et al.* (2021) found an increase in co-management of chiropractors with other professions. However, it is unknown in the literature what integration chiropractic has with other professions when utilising nutritional supplements specifically to manage patients, and at what level the integration may occur. Although it is unknown, other professions will play a role during the advising, educating and recommending of supplements to patients. Examples may include,

but are not limited to, advice from a pharmacist on a particular brand or dose to the patient after prescription from the chiropractor; education to the patient or chiropractor from a dietician; and even feedback from a patient on a particular supplement's influence on certain factors. Therefore, the IC model was applied to the study to yield more information on the chiropractic integration with other disciplines when utilising supplements to manage musculoskeletal conditions in runners.

3.7 CONCLUSION

This chapter defined a theoretical framework and the importance of having such a guide in qualitative research. The two models underpinning this study, the sociopsychobiological model of pain care and the integrative care model, were defined and applied to this study.

The next chapter will describe the study design and methods of data collection employed.

CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

The study design, method of data collection and analysis will be described in detail throughout this chapter. A description of the participants, sample size and the recruitment process has been included, as well as the ethical considerations implemented in the study.

4.2 STUDY DESIGN

This study made use of a qualitative exploratory descriptive design. A qualitative exploratory descriptive design allows the researcher to inquire more on a topic through the contribution of participants, and for more and/or new knowledge to be developed on the topic of interest (Creswell 2009). The study design may involve the use of interviews as a data collection tool (Creswell 2009). Thus, this particular design was selected by the researcher for an extensive exploration into the use of vitamins and minerals by chiropractors in the management of musculoskeletal (MSK) conditions in runners. The participants were encouraged to provide in-depth answers and contribute any additional information regarding the utilisation of vitamins and minerals in the management of MSK conditions in runners.

4.3 PARTICIPANTS

The participants in this study were South African chiropractors who are registered with the Allied Health Professions Council of South Africa (AHPCSA), and who have been practicing for a minimum of three years. Participants included chiropractors who regularly treat runners and who utilise supplement recommendation as part of their management protocols. A total number of 15 participants were interviewed.

4.4 SAMPLING STRATEGY

A purposive sampling strategy was utilised in this study. Purposive sampling is the selection of participants who possess the desired characteristic(s) to help the researcher answer the research problem and develop theories (Creswell et al. 2007). In this study, the desired characteristics of participants were registered South African chiropractors who utilise supplement recommendation as part of their management protocols for runners.

Snowball sampling was employed. This type of sampling involves the assistance of participants in the recruitment of other participants (Moser and Korstjens 2018). This was

carried out in the study through the recommendation of fellow colleagues in South Africa, or forwarding the research advertisement to other chiropractors.

4.5 SAMPLE SIZE

A sample size of 15 participants were purposively chosen, and 15 participants were interviewed due to thematic data saturation being reached (Creswell *et al*. 2007; Moser and Korstjens 2018). Thematic saturation refers to a point during the interview process when few or no new ideas or themes appear. Thus, the sample size was determined once a common trend or theme started to emerge.

4.5.1 Inclusion Criteria

- Chiropractors who are registered with the AHPCSA, with a minimum number of three years in practice.
- Chiropractors who include vitamins and minerals as part of their prevention, treatment and management protocols.
- Chiropractors who regularly treat runners in practice.

4.5.2 Exclusion Criteria

- Chiropractors who do not consent to be interviewed or recorded during the interview.
- Chiropractors who do not sign the informed consent form (Appendix C).
- Chiropractors who are no longer practicing.

4.6 PARTICIPANT RECRUITMENT

The study only commenced after ethical clearance from the Institutional Research Ethics Committee (IREC) was received (clearance number: 091/23) (Appendix D) and once gatekeeper permission had been attained from AHPCSA (Appendix E). An advertisement was sent via email to AHPCSA and the Chiropractic Association of South Africa (CASA) to distribute on behalf of the researcher to South African chiropractors (Appendix F). Additionally, the advertisement was shared on social media platforms by the researcher for South African chiropractors to view. The participants were welcome to distribute the flyer to fellow colleagues.

The chiropractors who expressed an interest to participate in the study, and who met the inclusion criteria, were then contacted privately via email. A time and date for an interview was arranged with each participant. The option was given to participants to be interviewed either online or in person at the participant's practice, given that they were based in Durban.

The participants were provided with a letter of information (Appendix B) and informed consent form (Appendix C), which were signed by each participant and returned to the researcher prior to the interview. The purpose of the study and the interview procedure was fully explained to each participant. It was emphasised to participants that they could, at any time, withdraw from the study, if they wished to do so. It was made clear to participants that the information shared during the interviews was for research purposes only, and that no one would have access to the information except for the researcher and supervisors of this study.

The participant recruitment aimed to include all South African chiropractors who met the inclusion criteria, and recruitment did attempt a representation of approximately three chiropractors from each province. Given that the study was qualitative, and the sample size was guided by thematic saturation, an equal numerical representation was not possible. From the 15 participants, eight were from KwaZulu-Natal, four from Gauteng and three from the Western Cape.

4.7 RESEARCH SETTING

The interviews were conducted both online and in person. The online interviews were conducted for participants living outside of Durban, or who preferred the online option for convenience purposes. The online interviews took place using the Microsoft Teams online meeting platform. The researcher was located in a quiet place with access to internet connection. A quiet location insured confidentiality for the participant to answer freely. The in-person interviews took place at the practitioners' practice rooms, which additionally ensured confidentiality through privacy and the ability to answer questions as they felt fit. Thus, participants could choose either online or face-to-face interviews, which reduces any researcher-participant imbalance that may exist (Hunter *et al.* 2019)

4.8 PILOT STUDY

A pilot study is a small-scale study conducted prior to the commencement of data collection, in order to determine the feasibility of the study. Pilot studies test the methodology to determine if any changes need to be made (Lowe 2019). A pilot study was conducted with two chiropractors who are registered with the AHPCSA, have been in practice for more than three years, regularly treat runners in practice, and utilise supplementation protocols for the management of runners.

For the pilot study interviews, one took place on Microsoft Teams online meeting platform, and the other took place at the participant's practice in Durban. Upon conclusion of the pilot

study, minor adjustments were made to the interview guide. The post pilot data collection tool was submitted and approved by IREC (Appendix A).

4.9 DATA COLLECTION

A letter of information (Appendix B) and informed consent form (Appendix C) were emailed to the participants prior to the interview. The interviews only commenced once the participant returned the signed informed consent and gave permission for the interviews to be recorded. The researcher used an interview guide that consisted of predetermined, open-ended questions in a semi-structured manner (Appendix A). This technique of using open-ended questions allowed for topics to be explored in depth and for the development of themes (Creswell 2009). The four predetermined questions provided consistency between interviews.

The questions were open-ended as the researcher was allowed to ask probing questions after each predetermined question. This encouraged participants to contribute additional information beyond the interview guide. The nature of conducting interviews in this manner was to ensure an extensive investigation into the utilisation of vitamins and minerals by chiropractors in the management of MSK conditions in runners. The interviews were recorded using a digital recording device. Recordings were taken in order for the researcher to focus on the interview guide, the participant and the information provided.

4.10 DATA TRANSCRIPTION

After each interview was conducted, the researcher transcribed the audio recording data verbatim onto Microsoft Word. The interviews were listened to carefully to ensure that all information provided by participants was recorded thoroughly and accurately in the documents. The transcriptions were verified by the researcher's supervisor/s to confirm that no significant details had been excluded.

Each participant was assigned a letter of the alphabet to maintain confidentiality and protect the participants' identity. The letter assigned was determined by the order of interviews conducted. Example, the first participant interviewed was assigned the letter "A".

4.11 DATA REDUCTION AND ANALYSIS

Data analysis is a process used in the effort of the researcher to answer the study aims and objectives using the data generated, ultimately to provide answers to the research problem (Creswell *et al.* 2007). The Tesch method of thematic analysis was utilised in this study to analyse the results and to identify themes and sub-themes (Creswell *et al.* 2007; Moser and Korstjens 2018).

The intention of the interview questions in this study was to explore the utilisation of vitamins and minerals by chiropractors in the management of MSK injuries in runners. The questions aimed to generate information regarding how chiropractors utilise supplements in the management of runners, and what the impact of utilising such supplements had on MSK conditions in runners.

The data collected during the interviews were recorded using an audio recording device, and then transcribed onto Microsoft Word. The participants were assigned a letter of the alphabet to ensure confidentiality, and only the researcher and supervisors had access to the data. The data were then analysed using Tesch's eight steps of thematic analysis. This method of data collection is commonly used in qualitative research.

The steps provide a guidance for transcribing unstructured data which then assists the researcher, in a systematic process, to analyse the transcribed text (Creswell 2007). This allows for a better identification and understanding of themes that have emerged from the data.

The following eight Tesch steps were used to analyse the data (Creswell 2007):

1. The researcher formed a sense of the whole by carefully reading all the transcripts. Any important facts were noted.
2. The researcher selected one interview to be read, and familiarised the data and possible themes that emerged.
3. After the second step was completed for all the transcripts, several transcripts were chosen to be analysed. A list of all the topics was formulated and similar themes were grouped together.
4. The researcher went back to the data and applied the themes. The topics were abbreviated into codes to organise the text into categories.
5. The researcher chose the most descriptive wording for the themes, and then grouped the themes into categories.
6. The researcher made a final decision on the abbreviation for each category and alphabetised the codes.
7. The data material of each category was assembled in one place and a preliminary analysis was performed.
8. If it was necessary, the researcher recoded the data.

4.12 DATA STORAGE

Once the data study had been concluded, all electronic data from the audio recorder were transferred onto a password protected storage device belonging to the researcher. All data on the audio recorder was deleted afterwards. Only the researcher and supervisors have access to the drive. After five years, the data will be permanently deleted off the storage drive, including audio recordings and transcripts. All physical documents will be destroyed with a shredder.

4.13 TRUSTWORTHINESS OF THE RESEARCH PROCESS

To establish trustworthiness in research, four dimensions must be met. These are credibility, dependability, confirmability and transferability (Creswell 2009). The dimensions of trustworthiness were used throughout the study.

Credibility, or internal validity, looks at how harmonious the research findings are with reality. There are a number of factors that could enhance credibility such as persistent observation, prolonged engagement, triangulation of data and methods, saturation, member checking, and rapport building (Creswell 2009). Credibility was enforced in this study by ensuring that the participants met the inclusion criteria.

Dependability can also be regarded as reliability. Dependability refers to the degree to which the research can be replicated. If there is more than one observer, all members must agree on the findings and, thus, draw similar themes and/or conclusions from the results (Creswell 2009). Dependability was ensured through the use of the same predetermined open-ended questions for all the participants and, thus, this study could be replicated in the future.

Transferability is a form of generalisability. Transferability is concerned with how the findings will relate to other contexts. This is achieved by thoroughly describing the context of the study (Creswell 2009). Thus, transferability may be achieved by finding common MSK conditions between sporting disciplines, and applying the results to this study accordingly. Transferability was also enforced in this study through the use of a purposive sampling strategy.

Confirmability is done through the use of objectivity throughout the study. This ensures that researchers remain neutral during the research process, and their own beliefs and experiences will not bias the interpretation of findings and influence the findings in any way. Reflexivity is crucial to managing bias in the research (Creswell 2009). Objectivity was enforced throughout the study by avoiding personal judgements and interpretations of the results. The use of predetermined questions prevented any bias persuasion from the researcher.

4.14 ETHICAL CONSIDERATIONS

The study employed autonomy, beneficence, confidentiality, justice and non-maleficence throughout. It is important that a researcher is aware of any ethical issues that perhaps had arisen, or handled new challenges that were unforeseen. Researchers must be prepared to protect their participants at all times during a study (Creswell 2009).

Autonomy is the respect for people's right to privacy and confidentiality, opposing any censorship of information, as well as maintaining a neutral position during information interpretation (Creswell 2009). This study employed autonomy as the participants had the choice to refuse or withdraw from the study at any given time, or one could have chosen not to answer all the questions. Prior to the interviews, the participants were provided with a letter of information (Appendix B) and informed consent (Appendix C). The researcher fully described and explained the purpose of the study to all the participants.

Beneficence is one's moral obligation to strive for the greatest outcome for another. Beneficence places another's concerns above one's own (Creswell 2009). This study upheld participants' well-being in all aspects, such as emotional, mental, financial and physical. The participants (chiropractors) may benefit from the study's results, which in turn may benefit their patients and treatment outcomes. Thus, this study will be beneficial to others, in addition to the researcher.

Confidentiality and anonymity are a moral obligation of non-disclosure and respecting the right to one's privacy (Creswell 2009). This study ensured confidentiality and anonymity by keeping participants' names anonymous, through the allocation of a letter of the alphabet to represent a participant. Only the researcher and supervisors have access to the data. Additionally, face-to-face interviews were conducted at the participants' practices which were secured venues to ensure the confidentiality of all information noted during the interview process. Confidentiality and anonymity were extremely important to protect any participants who belong to a vulnerable population.

Justice is an ethical consideration that promotes equality among all in every aspect. Justice acknowledges one's rights (Creswell 2009). This study treated all participants equally. The same pre-set questions were presented to each participant, and all participants were provided with the same letter of information (Appendix B). Furthermore, to ensure justice within this study, IREC approval was granted before data collection proceeded (Appendix D) and gatekeeper permission was attained from the AHPCSA before any communication with the participants (Appendix E).

Non-maleficence is the implication of beneficence to make sure no ill harm is done towards another (Creswell 2009). The topic of this study did not hold a risk for psychological harm

towards the participants. For the protection of the participants, the study needed IREC approval before commencement of data collection (Appendix D) and gatekeeper permission from the AHPCSA before any communication with participants (Appendix E).

4.15 CONCLUSION

This chapter outlined the study's methodology, which outlined the procedure for data collection and analysis.

The next chapter will present the results from this study.

CHAPTER 5

RESULTS

5.1 INTRODUCTION

This chapter presents the results obtained from 15 semi-structured open-ended interviews conducted with South African chiropractors regarding the utilisation of vitamins and minerals to manage musculoskeletal (MSK) conditions in runners. The themes and sub-themes identified from the results will be presented throughout the chapter.

5.2 DESCRIPTION OF STUDY PARTICIPANTS

The study participants consisted of 15 South African chiropractors. The chiropractors needed to be registered with the Allied Health Professions Council of South Africa (AHPCSA), regularly see runners in practice, and utilise vitamins and minerals in the management of runners. The chiropractors needed to be in practice for a minimum of three years; however, the participants had a variety in the number of practice years. The chiropractors practiced in KwaZulu-Natal, Western Cape and Gauteng, and either obtained their chiropractic qualification from the Durban University of Technology (DUT) or the University of Johannesburg (UJ). The participant's demographic data is detailed in Table 5.1.

Table 5.1: An outline of the participant's demographic data

Participant	Age	Race	Institute of chiropractic qualification	Number of years in practice	Province of chiropractic practice
A	43	White	DUT	19	KwaZulu-Natal
B	30	White	DUT	3	KwaZulu-Natal
C	31	White	DUT	6	Western Cape
D	35	White	UJ	10	Gauteng
E	47	White	DUT	7	KwaZulu-Natal
F	38	Coloured	DUT	7	KwaZulu-Natal
G	51	White	DUT	21	KwaZulu-Natal
H	48	White	DUT	24	KwaZulu-Natal
I	33	White	DUT	7	KwaZulu-Natal
J	31	Black	UJ	3	Gauteng
K	32	White	UJ	6	Gauteng
L	28	Indian	DUT	3	KwaZulu-Natal
M	28	White	UJ	4	Gauteng
N	46	White	UJ	20	Western Cape
O	46	White	DUT	20	Western Cape

5.3 CONCEPTUALISATION OF THEMES AND SUB-THEMES

The 15 South African chiropractors were interviewed using a semi-structured, open-ended interview guide. The interviews were conducted both online and in person. Upon completion, the interviews were transcribed verbatim and analysed using the Tesch method of analysis. Themes and sub-themes were identified regarding the utilisation of vitamins and minerals by chiropractors to manage MSK conditions in runners.

Table 5.2: Themes and sub-themes

THEMES	SUB-THEMES
Theme 1: The active utilisation of vitamins and minerals in clinical practice by chiropractors for the management of MSK conditions in runners	**Sub-theme 1:** Factors and reasoning surrounding supplement recommendations by chiropractors to runners **Sub-theme 2:** Dispensing methods employed by chiropractors **Sub-theme 3:** Education provided in addition to the supplement recommendation
Theme 2: Commonality in vitamins and minerals utilised by chiropractors in the management of MSK and non-MSK conditions in runners	
Theme 3: The positive influence of supplementation in the management of MSK conditions in runners	**Sub-theme 1:** Treatment outcomes after supplement utilisation **Sub-theme 2:** Running performance after supplementation **Sub-theme 3:** Injury rate in runners after supplementation **Sub-theme 4:** Runners' perceptions and attitudes of supplementation
Theme 4: Holistic management of runners by chiropractors	**Sub-theme 1:** Dietary advice **Sub-theme 2:** Interdisciplinary management of runners **Sub-theme 3:** Monitoring supplement utilisation

THEME 1: THE ACTIVE UTILISATION OF VITAMINS AND MINERALS IN CLINICAL PRACTICE BY CHIROPRACTORS FOR THE MANAGEMENT OF MSK CONDITIONS IN RUNNERS

When discussing the participants' utilisation of vitamins and minerals in the management of runners, it was evident that a common theme of active utilisation of minerals and vitamins by chiropractors when managing runners emerged. A variation in this active utilisation was specific to the runner that each participant treated. Together with active utilisation of nutritional supplements emerging as a common theme, it was evident that nutritional education was also provided to runners. The following extracts from the data display this active utilisation:

> *"Typically, either if they ask, quite frequently I get 'what supplements should I be taking?', in which case I'll suggest or possibly, if I can see, say, we've got a runner*

who's cramping lots then I might say magnesium might be a good way, to look at that kind of supplement." (Participant B)

"… prescribe something or tell them where they could get whatever it is, whether whether it's magnesium, calcium, phosphate, Neurobion, etc…" (Participant F)

"… My main line of treatment is obviously chiropractic but I would advise on basic stuff like magnesium, vitamins, any supplements depending of course what sort of uh runner they are." (Participant G)

"… if they've come in with a certain complaint, for example, and I see that nutritionally, they're kind of deficient, that's when I would generally recommend like, have you taken this? Have you seen a nutritionist? Have you considered this supplementation?" (Participant I)

"Um usually, it's more a recommendation. Um firstly, just to ask what they are currently taking, and then relating it to their condition. I usually advise a further supplement, um if I feel they are not nutritionally sufficiently almost supplementing themselves." (Participant O)

Furthermore, a variation in this active utilisation emerged as some participants advised supplements to runners from the first appointment, while some participants only prescribed supplements to runners after a few appointments. The participants used nutritional advice and supplement recommendations in adjunct to other treatment and management protocols for MSK conditions in runners. The following extracts in the data show the variation in practice methods for the active utilisation of nutrition in runners:

"… I'd would say more than 50% of the time, but not 100% of them. More if they've asked about it, or if it looks or sounds like they're lacking something." (Participant B)

"… yeah, so that first appointment's when the case history happens, most of the diet and supplement conversation happens." (Participant C)

"… I got my threshold, it's two or three sessions, if I'm really not winning with things, then I start bringing these things on board." (Participant D)

"… if by the third consult, when we get to a point where it's manageable, so it's not gone completely but we've decreased pain, they are functioning properly, pain is still there but it's minimal. Um then we'll start going into, um, that's when I start thinking about okay, what else can we put into the body to give to give us that last 20% um of healing." (Participant J)

"… it's always in combination with treatment, so um just alone I've never ever just said take magnesium without treating them yeah. So, um yeah, so it's always in combination." (Participant O)

In addition to the main theme of active utilisation of vitamins and minerals by chiropractors when managing MSK conditions in runners, sub-themes surrounding and tying into the utilisation methods emerged. These were the factors and reasoning surrounding the recommendation of supplements, dispensing methods of the participants, education provided by the participants when recommending supplements, and how the participants monitor supplementation in the runners.

Sub-theme 1: Factors and reasoning surrounding supplement recommendations by chiropractors to runners

Common factors and reasoning surrounding supplement recommendations and utilisation were reported amongst the study participants. Factors which stood out collectively from the data were based on the clinical evaluation and discussions of the practitioners with their patients, and the patients themselves as amateur or professional runners. Participants emphasised case history; clinical presentation of the runner; the type of runner; investigations; a natural alternative to medicine; patient feedback; and the participant's knowledge and personal experience with vitamins and minerals being important factors. Participants also emphasised the prevention of MSK conditions as a key factor determining supplement recommendations. The following extracts display the common factors and reasoning surrounding supplement recommendations and utilisation by participants:

"… I look at the whole case and have a look to see if there's any indication in, with symptoms and signs um, where I feel there needs to be a a prescription around a a joint pathology, muscular skeletal issue. So, I kind of look at that whole case history … so I look at like an acute injury or chronic condition uh they may be battling with, and then looked at the signs and symptoms…" (Participant E)

"Yeah, depends on the runner. You know, whether they are weekend warriors, amateurs or elite runners … I do "DNAlysis" tests actually. So it's a, it's a genetic test … it gives you back reports, you know, whether you are predisposed to bony you know bone conditions like osteoporosis or whether you don't absorb B12 properly or vitamin D properly or I mean even if you have the Alzheimer's gene, it lists that there. So it's quite interesting. And then the main thing about it is it lists genes that are impacted by lifestyle, especially supplementation and diet and that kind of thing. So it makes suggestions, it's quite cool and then it gives other suggestions on further tests that can be done if someone is in a kind of red flag area

for this or that … Obviously blood tests, you know if there is some chronic fatigue going on, you know if they are vegetarian or they seem pale or malnourished, then I might look for B12 levels and vitamin D levels." (Participant C)

"… and then um if they are in pain, I prefer to bring the pain down naturally as opposed to going the cortisone route and and and and that is where your Traumeels and your um proteolytic enzymes would come in." (Participant N)

"… I take a lot of the advice that I give them from not only my educational experience, but I've also fortunately been fortunate enough to compete to quite a, quite a high international level in a number of different sports, obviously, a lot of things that I've learned along the way, um that have contributed towards better performance, quicker recovery, injury prevention, that kind of stuff." (Participant H)

"… mainly I'm doing it for preventative purposes, I don't think I have enough knowledge um to actually use it as a treatment therapy …" (Participant M)

Based on the clinical assessment of the runner, participants revealed common trends amongst the factors surrounding supplement recommendations and utilisation by the study participants. These common trends included the type of condition presented by the runner; re-occurring chronic injuries; clinical signs and symptoms; acute injuries; slow healing injuries; reported fatigue or lack of energy; exclusion diets, such as vegan or vegetarian; if a runner does not take supplements; inadequate replenishment during and after runs; and insufficient nutrients in the diet. Additionally, if the runner had not received advice from a dietician, then the participants would provide supplement and dietary recommendations.

The runner's goals were a common trend that emerged requiring supplementation. Such goals included achieving improved race times, running longer distances, improving strength, not falling sick, improving performance, and increasing training intensity and mileage. Alternatively, the runner may be seeking pain relief, faster healing rates, and reduced fatigue, which may require different forms of supplement recommendations. Furthermore, the type of runner was a common trend reported amongst participants. Participants prescribed and recommended supplements more frequently to elite runners, long distance endurance runners, older runners, female runners and menopausal runners.

Runners who put their bodies under greater demand will require increased supplementation to promote recovery and performance, and to prevent conditions such as iron deficiency anaemia, joint pathology, osteoporosis, stress fractures, and the female athlete triad. The following extracts from the data depict the common trends prompting supplement recommendations by chiropractors to runners:

"So basically, I'll ask a case history. On the case, if there's any nutritional or vitamin and mineral deficiency, you you would be able to pick that up … And I'll question whether they on anything to replenish what's lost from their output, prescribe something or tell them where they could get whatever it is … Basically, I would give a specific supplement if I know they lacking it in their diet, because one of my questions is diet. So, I'll ask "are you on any specific diets. Are you restricting anything?"… So if they can get what they need through their diet, I much 100% prefer them to do that first. Um and then, but like if they uh don't eat specific certain things, say the person is a vegetarian or vegan or something like that, um they can't eat specific things, then they have to bring in supplementation." (Participant F)

"… it also depends on um how uh how bad the injury is and if they have recurring injuries … And then it's also age dependent … the older the patient gets, then the more important it becomes um to to just look into what what they putting into their bodies basically." (Participant J)

"… immunity is a very big thing, when they're running that amount of distance per week… so then we need to ensure that the immune system is sufficiently supplemented if it's not coming from food um with some supplementation to maintain that they don't fall sick… So, bone density is a very, very important thing to look at and ensuring that they, so magnesium magnesium, iron and um obviously calcium, magnesium and vitamin D are very big things that I see and that is often required for perimenopausal as well as menopausal women ..." (Participant O)

"Of course, females will be different if there is something that would affect females more. For example, a female doesn't have enough nutrition. Maybe she's in a female athlete triad, I don't know if you've heard of it, where you going to have disordered eating, so they're not getting enough in. Then um there's amenorrhoea. And then there's disordered eating, amenorrhoea, then there's osteopenia and eventually osteoporosis. So my case history identifies that. So when I'm asking questions, if I can see they prone to that, and there's not enough nutrition coming in, then obviously, would advise accordingly." (Participant F)

"… what their goal is, you know. If they say for example, 'okay, well, I've run two kilometres twice a week, and I want to do 21 km in six months', you know, it's it's quite a rapid progression. So, you want to supplement them because obviously you're going to have to monitor things like stress fractures and and as it goes on, you know … If if a patient is saying, as I said to you, like, they have a goal, they

have a a race that they want to try and do something at or prepare for, then you know, we'll we'll obviously supplement accordingly." (Participant K)

"… there's a difference between somebody that wants pain relief, versus somebody that wants to strengthen ..." (Participant N)

Sub-theme 2: Dispensing methods employed by chiropractors

A common trend in practice style emerged when it came to dispensing methods or approaches employed by the participants. The majority did not dispense supplements from their practice but a few participants did dispense. Participants either instructed the patients to go source the product elsewhere, sold supplements to patients from the practice or practiced in a multidisciplinary centre where other practitioners dispensed the products. The following excerpts from the data display this:

"I'll give them the name to get them, to go source somewhere else. I don't dispense." (Participant B)

"No, they must source it somewhere else." (Participant J)

"So anything that isn't already available in the practice from the Homoeopath is then sourced from wherever." (Participant M)

"We dispense some of the main ones …" (Participant C)

"We stock a joint care and omega range, um but generally I send them up to our health shop up at our shopping centre just above us here." (Participant G)

"Um my husband and I are in practice together. So the supplementation is there. I um, prescribe it generally and I tell them that they will be able to source this at a pharmacy or a health shop. So as an example an example, if it's something like a Traumeel, I'll say to them you can get that at any any pharmacy including the Checkers and Clicks, etc. Otherwise you welcome to get it in the front. Um, there are specific ones like that um cramp mixture, the magnesium mixture that my husband makes. So there I'll say to them, my husband does this particular mixture which is very bioavailable. Otherwise, you need to look for a collated magnesium or a magnesium that is found like this. Please stay away from magnesium sulphate. So yes, the supplementation is there. No, I don't exclusively recommend my husband's practice." (Participant N)

Sub-Theme 3: Education provided with the supplement recommendation

Many participants emphasised the importance of patient education to improve compliance. The participants of the study explained to the runners why they need to take the

supplement, benefits of supplementation, possible side effects, and directions of use. The directions of use included the time of day that the supplement should be taken and whether it should be taken before or after food. The advice was determined by the type of supplement recommended, the patient and their goals, or depending on the injury.

The participants explained to the runners that they needed to take the supplement for a given period to see results, and they needed to take the supplement as instructed. The participants explained to the runners that they needed to train on the nutrition and supplements which they would use during a race, and not use products for the first time on the race day. Furthermore, the participants educated runners to continue supplementation after a condition or injury has healed.

The majority of the participants reported to advise the runner to continue the supplementation after an injury has healed to prevent the reoccurrence or progression of the condition. However, the dose of the supplement after an injury has healed depended on the type of supplement and condition presented. The participants further educated patients to be cautious of unwanted substances and ingredients in supplements. Some participants provided journal articles and links to runners who wanted to learn more about the supplement. The extracts as follows display this:

> *"… it's not an instant result thing. So that's, you know, managing patient expectations is is a very important thing. Um, and getting patients to actually read about what they're putting in their body is is also important. So, you know, the internet's a wonderful thing nowadays. Um, so I always just try and say, you know, go and read up why you would, why you need the vitamin D, and why you need this and and that. So that's, that's often what I do with patients in terms of education. Um getting them to understand the benefits of it. And also, as I said, managing their expectations that it's not, they can't take a supplement for a week, and then their symptoms suddenly feel better. Um, it's a … it's a lifestyle thing, it's a long-term thing, and and you really just have to kind of push that point through."* (Participant K)

> *"… for example, if their if their supplements have vitamin B in them if they lacking energy and they taking vitamin B tablets whether um they need to eat or it could make them feel nauseous, or if there's flushing or kind of side effects of the vitamin or mineral … Well, it just depends if I thought it was necessary, if it was necessary for like an acute injury, then they won't carry on using it. But if it's something I feel like it's a chronic condition or something that is preventative then they will, I recommend that they carry on using it."* (Participant E)

"Um, I do put a lot of emphasis on whatever nutrition they're using, and supplementation they're using, they need to use during training so that they're not um going into a race and kind of using it um, 'unexperienced' so to speak." (Participant H)

"… I do um particularly want my patients to just watch out for a lot of extra stuff in whatever they take. So, fillers, preservatives and stuff like that. So, to rather spend a little bit more and take something a little bit more pure." (Participant M)

"… I probably would say that I think I think if they found something that absolutely works for them, then absolutely. Um the one guy that I work with or I've, he he um, like I said, he does sodium testing or sweat testing, and I had a patient that I sent off to there and it's it's absolutely changed their game. So then I say that their, you know, that's part of your protocol …" (Participant D)

"Possibly depending on if I've suggested like maybe a slightly higher dose of magnesium roll that back a little bit to just one a day." (Participant B)

THEME 2: COMMONALITY IN VITAMINS AND MINERALS UTILISED BY CHIROPRACTORS IN THE MANAGEMENT OF MSK CONDITIONS IN RUNNERS

When discussing the participants' utilisation of vitamins and minerals in the management of runners, it emerged which common vitamins and minerals were recommended to manage runners. Supplementation was recommended by the participants for both MSK conditions and non-MSK conditions in runners. Magnesium was recommended to runners by all of the participants. Most of the participants recommended the following supplements to runners: vitamin D3, omega 3, electrolytes (sodium, potassium and chloride), chondroitin, glucosamine, vitamin B, collagen, calcium, iron and whey protein. Many of the participants reported to also advise on homeopathic remedies, herbal products, Traumeel and proteolytic enzymes. Supplements utilised by the participants less frequently included a multivitamin, zinc, methylsulfonylmethane (MSM), vitamin C, phosphorous, creatine, curcumin, probiotics, caffeine, carbohydrate supplements, vitamin K, folic acid, selenium, and hyaluronic acid. The extracts that follow show the common supplements recommended by participants to runners:

"… magnesium is a big one, um potassium and then just a general um multivitamin is what I put most people on …" (Participant G)

"… when you're looking more to stress fractures, or potential stress fractures, any bone density issues … obviously your calcium and that, but you know, if you if you're

lacking vitamin D, there's no absorption happening. So that's, that's really, that's quite important there … MSM, glucosamine, chondroitin sulphate… um, omega 3 is also a very good one…" (Participant K)

"… um protein, general sort of injury and then creatine if someone is struggling to recover…" (Participant C)

"… B12s um for for neural stuff so sciatica, piriformis syndrome." (Participant D)

"… so, I up like my electrolyte kind of um supplementation with them…" (Participant L)

The participants provided nutritional advice and supplement recommendations for certain MSK conditions in runners. The majority of the participants recommended supplements for muscle cramping. Most of the chiropractors advised supplements for joint pathology (pain, inflammation, arthritic changes), joint support, general inflammation, bone support, muscle pain and stiffness, muscular tears or strain, ligament tears or sprain, osteoporosis, and tendon injuries (tendonitis, tendinopathy, tendon tear). Very few participants recommended supplements for stress fractures, ligament laxity, lower back pain and muscle atrophy.

When discussing the utilisation of supplements for the mentioned MSK conditions in runners, the participants elaborated on which supplements are commonly advised for certain MSK conditions in runners. The participants responses are detailed in table 5.3.

Table 5.3: Nutritional supplements recommended by chiropractors for musculoskeletal conditions in runners

Musculoskeletal condition	Nutritional supplement
Bone support	Vitamin D, calcium, vitamin K
Cramping	Magnesium, electrolytes, water, vitamin B, iron, calcium, bicarbonate of soda, zinc
General Inflammation	"Anti-inflammatory supplements": Omega 3, proteolytic enzymes, curcumin, homeopathic remedies, Traumeel, MSM, alkalizing powders, Septogard
Joint pathology	Glucosamine, chondroitin sulphate, boswellia, MSM, omega 3, proteolytic enzymes, Traumeel, vitamin D, bone broth, collagen, hyaluronic acid, magnesium
Joint support and arthritic change prevention	Collagen, glucosamine, chondroitin sulphate, boswellia, omega 3, hyaluronic acid, Arnica supplements
Ligament laxity	Collagen
Ligament tears or sprain	Whey protein, creatine, collagen, magnesium, Traumeel, anti-inflammatory supplements, homeopathic remedies
Lower back pain	Joint support supplements, magnesium
Muscle aches, pain and stiffness	Magnesium, phosphorous, calcium, electrolytes, water, whey protein, vitamin B, vitamin K, multivitamin, Omega 3, zinc
Muscle atrophy	Omega 3, electrolytes, water
Muscular tears or strain	Whey protein, creatine, collagen, magnesium, Traumeel, anti-inflammatory supplements, homeopathic remedies
Osteoporosis	Vitamin D, calcium, vitamin K
Stress fracture	Vitamin D, calcium, vitamin K
Tendon injuries	Whey protein, creatine, collagen, magnesium, Traumeel, anti-inflammatory supplements, homeopathic remedies

"… So most of the time, people are dealing with cramp, that's like our biggest issue on a on a day to day basis. So magnesium is is really the best solution for that" (Participant K)

"… the muscular system, then I'll work with magnesium, phosphorus, um calcium, vitamin D, mainly for muscular conditions … And then specifically for joints, I look to see if there is inflammation in which case I often will prescribe um like an alkalising powder, if whole system, I can see like an overall inflammatory kind of state happening … and then I look particularly into the joint space. So, recommendations around for lubrication et cetera around your, for example, your omegas, inflammation MSM, the actual structure of the cartilage and joint so chondroitin sulphate, um glucosamine, um what else … glucosamine, chondroitin sulphate, hyaluronic acid. Um yeah. I'll also if I've done any x-rays then I'll obviously look at calcium levels if there's any osteoporotic kind of conditions happening … I look at then like collagen, so I look at the connective tissue make up and then I will also add on other, so non non-supplements, but like um I'll add on herbal and naturopathic kind of things. Um so we'll have a look if there's tears into tendons or ligaments et cetera, and add on various herbal remedies, 'Symphytum' and all those kinds of things." (Participant E)

"… um protein, general sort of injury and then creatine if someone is struggling to recover … something that affects the muscle. Muscle tear or a, you know, tendinopathy, any sort of overuse, repetitive strain or acute, yeah, even an ankle sprain. But then yeah, also just in general people are finding that they're struggling to recover … vitamin D. Um, obviously, you know, if you're seeing stress fractures, that is the first one that you'd go to." (Participant C)

"… a lot of my females do take collagen. And you know whether at the end of the day, it's a placebo effect or not, but some of them are like they swear by it, they like it fixed my hip joint pain and things like that. So like more like a collagen, bone broth. Those are probably the other types of supplementation that I recommend for like joint aches …" (Participant I)

"… omegas are so important, especially for athletes, to general athletes, so cricketers, rugby players, gymers, you know, because it helps in in in in muscles, uh muscle muscular issues, so any atrophy, dystrophy, preventing fatigue." (Participant L)

Participants further elaborated on the difference in supplement recommendations between acute and chronic injuries, stating that acute injuries required supplements to assist with inflammation, pain and healing. Whereas chronic injuries required supplement recommendations to address certain deficiencies and prevent the re-occurrence of the injury.

> *"Um it depends on how acute the condition is … so I utilised quite a lot of proteolytic enzymes to get the inflammation down."* (Participant N)

> *"… again, you know, that in the acute injury phases like musculotendinous injuries, um I do use a lot of Traumeel. I find that helps out a lot, and some stuff called "lymphomyosot" which is almost like a cell tonic, a homoeopathic concoction. Um I found that and Traumeel work really well together, just to help improve the environment of the the cell to help it heal a lot quicker."* (Participant H)

> *"… But if it's something I feel like it's a chronic condition or something that is preventative then they will, I recommend that they carry on using it."* (Participant E)

> *"… I think the number one thing for me is if this injury's reoccurred… and then how long the injury's been going on for and then just finding out how they taking care of themselves. So, what what precautions are they taking to, to manage."* (Participant J)

The participants additionally reported to recommend supplements to runners for non-MSK conditions. Many of the participants utilised supplements in runners for energy or fatigue, immune support, menstrual irregularities and support and iron deficiency anaemia. Fewer participants utilised supplements for gut health, menopause, sleep and vision related issues. When discussing supplementation for the mentioned non-MSK conditions in runners, the participants elaborated on which supplements are commonly advised for certain conditions. The participants responses are detailed in table 5.4.

> *"… when it comes to like your female athletes and your runners, iron is a is significant thing that I I often suggest. If they are more focused on doing your longer distance stuff, then then iron is certainly something that I recommend. Um you know, just because of the the, the impact for long distance runners, you you get that, you know, that breakdown in, in kind of the haemolysis process and all of that. So, um and again, female, especially with menstruation … and then again, um you know, if you've got more your long distance athletes, especially in females, um a lot of the time they they can you know become amenorrhoeic, and you do have to supplement, you know, supplement with with iron and ferritin and that … if you're looking at your older female athletes, menopause, things like that. So, I would*

definitely say iron is is a big one. Um obviously, calcium, but for me, if you if you have a significantly good diet, you will be getting calcium into you know, from from your diet, uh along with vitamin B and things like that." (Participant K)

"… the probiotics, not all the time just mainly with some of them that aren't on it already or some that have uh issues like gut related issues, that's the only time I do uh prescribe it to them." (Participant L)

"… vitamin B, if it's long distance, so yeah, I'd advise on a multivitamin and vitamin B if they're training quite hectically, and they're looking a bit rundown and just generally fatigued …" (Participant A)

"… immunity is a very big thing, when they're running that amount of distance per week, um you almost ride a line on your immunity. So then we need to ensure that the immune system is sufficiently supplemented if it's not coming from food um with some supplementation to maintain that they don't fall sick because if they fall sick then they can't run … ensure that they're getting sufficient vitamin C, vitamin B12, Neurobion, and then um zinc … immune boosting vitamins, especially during winter… getting closer to competition, the amount of intensity that he is running and the distance he runs is a lot greater." (Participant O)

Table 5.4: Nutritional supplements recommended by chiropractors for non-musculoskeletal conditions in runners

Non-musculoskeletal condition	Nutritional supplement
Energy and fatigue	Vitamin B, multivitamin, caffeine
Eye and vision related issues	Omega 3
Gut health	Probiotics
Immune support	Vitamin C, multivitamin, vitamin B, zinc, selenium
Iron deficiency anaemia	Iron, vitamin B
Menopause	Magnesium, calcium, vitamin D, anti-inflammatory supplements, homeopathic remedies
Menstrual support or irregularities	Iron, calcium, vitamin B, folic acid
Sleep	Magnesium, vitamin B

THEME 3: THE POSITIVE INFLUENCE OF SUPPLEMENT UTILISATION BY CHIROPRACTORS IN THE MANAGEMENT OF MSK CONDITIONS IN RUNNERS

The participants emphasised the positive influence of supplementation in the management of MSK conditions in runners. It was perceived that treatment outcomes improved, injury

rates reduced, running performance improved, and patients' perceptions on supplementation changed. The following extracts in the data show the positive impact of supplementation utilisation in runners:

> *"Anytime that you can make an athlete feel better, you going to have a better outcome, a positive outcome."* (Participant K)

> *"… supplementation, you notice that there is a gradual, and and I think a quicker progressive improvement to a patient compared to someone who's just coming to you twice a week or three times a week without supplementation."* (Participant L)

> *"I think it's pretty good. Um, I've seen positive changes with a lot of my runners, for the better. Um, and I think they feel the change."* (Participant N)

> *"… If they do it properly, and they get the right brand, and it works for their body, definitely a positive yeah."* (Participant O)

Although the main theme of a positive influence of supplementation in runners was established, various sub-themes regarding such influence became evident.

Sub-Theme 1: Treatment outcomes after supplement utilisation

The participants noted an improvement in the management of runners after advising supplementation. Common improvements included reduced pain, less stiffness, decreased post-run muscle soreness, a faster recovery rate, improved performance, less cramping, more energy, and faster healing and return to running. The participants objectively witnessed improvements in the runners' injury and clinical presentations, and subjectively the runners reported feeling better with an improvement in their performance. Although an improvement was noticed, many participants were unsure whether the nutritional component of the management was the only factor contributing to improved patient outcomes. The participants emphasised that it is the combination of treatments which assist the runner, and that everything goes "hand in hand" with each other.

> *"… patients tend to recover much quicker. Um, as well as you get a lot of uh trust from your patients, um because now they see that you know what you're doing because they are recovering quickly. Um and then whatever you tell them, like, okay, drink this supplement or try this out, um then they do it, you know, and they mostly compliant. So, um it definitely does help."* (Participant J)

> *"Normally performance and function. Um, I wouldn't say too much what I recommend is more pain focused. But again, cramping, feeling lethargic, just feeling flat during their runs- I've noticed an improvement."* (Participant B)

> *"Um I think definitely in their performance …"* (Participant D)

"… I will get feedback from people and saying, 'Okay, I've been using that for three months, whatever, I'm getting much better or um my knees are feeling better'." (Participant E)

"Yeah but it's very difficult to conclusively say if the nutrition was the only source of making them, you know, if their treatments were better, if they were coming in and and reporting if they were better. So, it's very hard for me to conclusively say, because they generally the ones that listen, are listening to an array of other advice at the same time." (Participant I)

"Not just with supplementation alone. It's never, it's always in combination with treatment …" (Participant O)

Sub-theme 2: Running performance after supplementation

Most of the participants received positive feedback from patients regarding improved performance after supplementation. Feedback from runners included feeling less tired and sore during the run which enabled them to push harder, running their fastest race time, decreased joint pain, recovering faster allowing the runner to perform at their optimum, less cramping, and even a stronger immune system to continue their training. Furthermore, the participants stated that the correction of the wrong supplementation indirectly aided performance.

"Like, if we talking about your general runner, if they feel like they're recovering better, and they're they not cramping during a run, they're naturally they're going to be performing better. So, I would just kind of make one equal the other if I'm honest, even if they haven't said, oh I feel like I'm performing better. They'll just go 'I'm feeling better on a run' or 'I'm recovering better'." (Participant I)

"… someone who will come in and say like, 'absolutely this stuff was absolute magic' … it's a daily electrolyte that I kind of suggested to him. He absolutely loved it, he felt like he was on fire. He won his race, he's now now he he's sold." (Participant D)

"… number of kilometres uh uh with their run and then they start feeling very fatigued. You put them on a vitamin B um um supplement or yeah, vitamin B supplements or injection or something like that, and um you see now, well they will always tell you that actually, now I can push longer you know, type of thing." (Participant J)

"So there was, so your certain patients if they take iron, um and it causes constipation because their body um can't digest it because of the components of the

specific iron. If they suffer from constipation, it has a major effect on dehydration, function and um recovery. So yes, of course, if they're on the wrong supplement, it can affect them depending on what they taking … So um again, sort of quite case dependent. Um but if it is the wrong supplements, can seriously affect their um, their performance. Yeah." (Participant O)

Sub-theme 3: Injury rate in runners after supplementation

Most participants reported a decreased rate of injuries in runners after supplementation. Factors which contributed to the decreased injury rate in runners after supplementation, was runner compliance to the supplement protocol and taking the supplement for an extended period of time. Many of the participants reported less muscle cramping after supplementation with magnesium.

"They all make it through they all run great comrades and they don't get injured from the race, you recover pretty quickly too." (Participant H)

"Yes. Definitely yes, but only when taken correctly, same time every day and you want it for longer than a month. And often under a month they will report it's not working. That's when we have to boost the patient compliance and having faith in your supplements …" (Participant E)

Sub-theme 4: Runner's perceptions and attitudes of supplementation

The participants reported a positive effect on the runners' perceptions and attitudes towards supplementation. The participants reported that the runners are happy to receive supplement recommendations and are willing to try products to assist their goals. The participants also reported that the more willing the runner is to comply, the better the patient outcomes. Furthermore, it was noted that runners have a positive, broader perspective of chiropractic after receiving nutritional advice. The patients build a trust with the chiropractor when they experience improved injury healing. Additionally, the perception of the runner that chiropractors only "click … spines" (Participant J) broadens to see that chiropractic can assist patients with a multitude of concerns.

"They think they doing better and they think they need it… and as long as they feel like they're taking something then they feel like it's working." (Participant A)

"Possibly a bit more of understanding for those that haven't been taking, that if you want it to run at this level, you need to treat your body right and bump up things like nutrition …" (Participant B)

"Yeah, I think they happy, most people are happy to take it or try it …" (Participant E)

"… it brings a body awareness, self-awareness. So, I think it gives them a positive attitude." (Participant M)

"… as soon as you start recommending supplements, uh um it it broadens your um your, well it broadens the patient's view of you um that you're not just here to to click my spine. Um but I can come to you for um any uh skeletal injuries, any muscular injuries, and then um you can also manage my my my issue, um long term as well." (Participant J)

THEME 4: HOLISTIC MANAGEMENT OF RUNNERS BY CHIROPRACTORS

When discussing the participants' utilisation of vitamins, minerals and nutritional supplements in the management of runners, a theme of holistic management of patients by the participants emerged. The participants emphasised the importance of managing all aspects of a runner to address all factors contributing to a condition. Furthermore, the participants utilised a variety of treatment modalities in addition to nutritional advice. The following extracts in the data show the holistic management of chiropractors:

"Okay, so not just with runners, but with everyone, I do believe that we we need to treat the patient as a whole. Um by only adjusting them or by managing the condition that is in front of us, whether it be an acute condition or maintenance, um I believe we are not actually doing our jobs correctly if all we're doing is adjusting and um mobilising. I believe that we have to discuss lifestyle… give them the whole package and the whole package includes supplementation, because we'd be a miss if we weren't discussing that." (Participant N)

"Preventative and holistic and for reaching goals." (Participant A)

"I've had a couple of um female stress fractures over the years. Um so that one I've got, I kind of make it a non-negotiable that I make sure that either they are checking there, you know, their Gynae once a year or twice a year, um and making sure that those levels are correct, because I think you know females can kind of avoid that stress fracture stuff and that bone density stuff. We've had some proper cold fractures, um with people really not maintaining that. So that I I I push quite hard." (Participant D)

"… it's also your um menopausal, older runner that when they are hormonal, that kind of aspects when they are lacking fatigue, that sort of stuff and it's yeah, then you do kind of go well look at getting your hormone HRT sort of stuff going, which

no, don't get involved and it just say go speak to your GP or gynaecologist." (Participant K)

Sub-theme 1: Dietary advice

Some of the participants attempt to correct the runner's diet first before recommending supplements, but the majority of participants do not try give dietary changes before recommending supplements to runners. The participants explained that patients find it easier to take a tablet than change their diet, and participants did not feel knowledgeable enough to make those dietary changes. The participants felt that if runners require in depth advice or present with a complicated case, then the participants would refer the runners to a nutritional specialist (such as a homeopath, dietician, and/or functional medical practitioner). The participants felt that they did not have enough knowledge on vitamins, minerals and nutrition to utilise in the management of MSK conditions in runners. The extracts in the data show the dietary advice provided by the participants to runners:

"Yes. So, if they can get what they need through their diet, I much 100% prefer them to do that first. Um and then, but like if they uh don't eat specific certain things, say the person is a vegetarian or vegan or something like that, um they can't eat specific things, then they have to bring in supplementation." (Participant J)

"I'll normally ask them a bit about their diet but that's not my strongest field. We actually have a dietitian here I will sometimes refer to." (Participant B)

"… not lots of people will try and get into a whole dietary change. Um I think if there's severe symptoms then people take it seriously. Otherwise, they much rather want to just pop some supplements before they before they go to changing their diet." (Participant E)

Many participants advised runners on hydration and water intake. The participants explained to the runners the importance of water consumption during the day, during runs and post-runs. Hydration was commonly advised to assist with muscle cramping.

"I don't think many people kind of get their, um, they don't get their, they don't sort out their their their hydration status. I do think that their hydration to get their hydration correct, they have to push for electrolytes." (Participant N)

"… from simple hydration um during the day, as well as during the event- um if you're not hydrating how you how you going to be expected to perform, and understanding why it's important to hydrate, so that you don't run into complications in terms of potential kidney damage, um and any other cellular damage that might go with dehydration … endurance type events and competing in um environments with

conditions that that are likely to to deplete things like electrolytes- education behind that is obviously important as well … the only specific on I always ask is hydration, is huge for muscle cramps … currently water is um we know that um according to your weight you need to drink 3.3% of your body weight just without any exercise 3% of your body is what we require each day. So if they are drinking that amount, that's great. And then when they exercise and most people in South Africa are exercising at least an hour, they need to ensure that they have even more than what their their body just requires." (Participant H)

The participants emphasised the importance of replenishing nutrients (both supplements and macronutrients) during and after runs. The most common reason for replenishment was due to the body being under demand and thus losing nutrients. Another reason for adequate replenishment included recovery, energy, performance and thus injury prevention. The participants gave further recommendations beyond supplementation to runners. The participants emphasised the importance of replenishing macronutrients pre-run, during and post-run.

"… but I do push for electrolytes so anything that's got potassium, magnesium, calcium, um and and then kind of just any kind of carb kind of thing. So I do push that they do electrolytes and carbs for during running... So I do push that they they they at least supplement during race and post um for electrolytes, and then then it all then it all kind of breaks down to kind of your macronutrients whether they they to replenish with carbs and protein and that sort of thing." (Participant D)

"… Um replenishment of protein and carbohydrates, again, to help with recovery, um so that you don't go into a depleted state, um and start running into things like rhabdomyolysis and all that kind of rubbish." (Participant H)

Some participants provided nutritional and supplement advice to runners of lower socioeconomic backgrounds. The participants first attempted to give dietary changes and advice to these runners, as they cannot afford to buy supplements. Only if the dietary changes did not help, then the participant would recommend a supplement or think of an alternative approach.

"So if it's a Comrades runner, contracts contracted in, um you you always have to, it's it's actually a bit difficult working with them, because they generally don't have money. And they do need to see a nutritionist or dietitian, um I would say pretty much all of them… um but then it does become very difficult because they don't necessarily have the money for it. Um so yes, but I'll always try and involve a nutritionist or dietitian for them, basically." (Participant J)

"… depending on the person's diets, you know, what demographic they're from, uh what access to nutrition they have." (Participant G)

"And it's also the socioeconomic aspects of it as well. So your sort of poor, your poor runner, that is because running does have a whole degree of socio economic runners from very, very poor to can't afford shoes to people who are multimillionaires. For the multimillionaire will happily take advice or whatever, the guy who's really, really poor, you're not, he's not going to take, he's not going to go and buy money on supplements and stuff like … I'll try and do it by nutrition. So, go eat bananas eat to make food, make sure you've got your starches, eat a balanced diet and try and do it that way first. Your welfare runner, well you can say, oh, go try go buy cramp supplements, go buy this thing, try that plan, try to use these products." (Participant A)

Sub-theme 2: Interdisciplinary management of runners

All of the participants reported to work with other practitioners to manage MSK conditions in runners. The participants commonly referred runners to dieticians, functional medical practitioners, homeopaths and even worked alongside coaches. The participants acknowledged that the nutritional practitioners were more specialised and could provide the runner with a greater standard of nutritional care. The participants felt comfortable referring to practitioners, and many practiced in a multidisciplinary centre.

"*Yeah if there's obviously a 'I eat no red meat, I get no protein, all I do is drink cool drinks all day' — obvious ones like that. But when it's bit more niche, often someone who specialises in that over and above me."* (Participant B)

"Yeah, functional nutritionist or a dietitian or a coach, depending on the athlete and what they're looking for." (Participant C)

"… if they're really not winning then off it goes to the nutritionist." (Participant D)

"I work closely with um homoeopaths. There's a homoeopath in my practice." (Participant M)

Sub-theme 3: Monitoring supplement utilisation in runners

The participants were asked if they monitored supplementation in runners to determine if they needed to continue supplementation or if the runners should cease consumption. A mixed response was reported by the participants. Some participants used investigations or an improvement in a runner's condition to monitor supplementation. Some participants did not monitor consumption as supplementation was for preventative purposes, only during training and racing periods, or during a short period of injury recovery. Thus, the runners

would not be on the supplements permanently. Additionally, participants found that it was difficult to judge patient compliance with supplementation. The following extracts show a variation in the monitoring of supplementation in runners by chiropractors:

> *"Typically, if they finding it's helping them and they've had a noticeable improvement or feeling something's helping, I would suggest continuing to using, to use it."* (Participant B)

> *"For a vitamin D, I will just I generally I'll put them on the lower dose … If someone comes in and they are on a mega dose from their GP or whatever, I'll make sure that they know that they need to get retested down the line and even if they are on anything, they should get a blood test and they should get retested and check that whatever they're taking is working."* (Participant C)

> *"… your ultimate um yardstick is is the performance in the recovery … you can look at things like heart rates, um if you really have got access to it, and you really want to focus on it, there's all sorts of lab tests you can do in terms of VO2 maxes and um lactate thresholds and all that kind of stuff, which gives you a little bit more scientific data… you can use general things like heart heart rate recovery. Um and then and then their performance performance markers, um to see that there's a gradual improvement in in their times, um in their strength ratios, all that kind of stuff …"* (Participant H)

> *"… I would ensure that they would maintain their supplementation right up to the run within the run, if it's long distance. Um and then afterwards, what you find is they usually take off um they, they take off some time … So, I I also usually recommend that they actually stop the supplementation for, um, quite a while, unless they are still continuing to train at that level. Um, uh otherwise, to almost have like a supplement holiday um and uh, and then once they training again, then they must, um then they can get back on to the stuff that works for them."* (Participant O)

> *"… depends what the supplement is. So as an example, if it's your magnesium, I normally recommend this to my runners, swimmers etc. As soon as they start cramping up, they need to be on that supplement for at least three months. And um, they can gauge after that if they want to stay on it permanently or not … um something like a collagen, a Boswellia, so your your arthritic ones, I would I just say to them just stay on it permanently … if it's an acute situation, I would up a dose. So as an example, would be um proteolytic enzymes. If they are very acute, I'd tell them to double and triple the dose for the first week, and then go on to a maintenance dose after that. But um, a lot of supplements I I prefer them to be on permanently*

because of long term … you have to build it up in your system for it to be effective." (Participant N)

"I think it's such a hard thing to do, you're never really going to be able to … you're never going to be able to monitor that … at the end of the day, it's their choice. Um you you, it's really a hard thing to do once they leave your room." (Participant K)

Furthermore, participants were asked when it was decided that supplementation was not assisting the injury, thus warranting referral to another practitioner or for more invasive treatment, such as surgery. Some participants reported a lack of improvement in the injury after a combination of chiropractic treatment, general advice and supplementation, while some participants used investigations to determine the need for patient referral. Other participants immediately referred runners without the attempt of supplementation, based on past experience or the injury falling outside of the chiropractic scope.

"… so usually by the third consult, I I I've already made a decision if uh if we need to go for ortho or um, or anything else, so um that's why I always I always tell people 'give me three consultations um to get you to a point where you are either the pain is gone or the problem is gone. Or uh it's manageable'." (Participant J)

"… depending on the outcomes that the runner wants, um they need to get more specialised sort of advice." (Participant G)

"… anecdotal stuff that I've picked up over the years …" (Participant D)

"… if the symptoms aren't getting better. Um or also if I've I've sent them for any imaging, et cetera, that calls for surgical intervention." (Participant E)

5.4 CONCLUSION

This chapter identified the themes and sub-themes in this study, with extracts from the data to support these findings.

The following chapter analyses the results as it relates to the existing literature.

CHAPTER 6

DISCUSSION

6.1 INTRODUCTION

This chapter interprets and discusses the results of this study in context of the existing literature.

6.2 OVERVIEW OF THE RESEARCH DISCUSSION

The aim of this study was to explore the utilisation of vitamins and minerals by chiropractors in the management of musculoskeletal (MSK) conditions in runners. The four main themes and the associated sub-themes were identified as follows:

Theme one: The active utilisation of vitamins and minerals in clinical practice by chiropractors for the management of MSK conditions in runners:

- **Sub-theme one:** Factors and reasoning surrounding supplement recommendations by chiropractors to runners.
- **Sub-theme two:** Dispensing methods employed by chiropractors.
- **Sub-theme three:** Education provided in addition to the supplement recommendation.

Theme two: Commonality in vitamins and minerals utilised by chiropractors in the management of MSK and non-MSK conditions in runners.

Theme three: The positive influence of supplementation in the management of MSK conditions in runners:

- **Sub-theme one:** Treatment outcomes after supplement utilisation.
- **Sub-theme two:** Running performance after supplementation.
- **Sub-theme three:** Injury rate in runners after supplementation.
- **Sub-theme four:** Runner's perceptions and attitudes of supplementation.

Theme four: Holistic management of runners by chiropractors:

- **Sub-theme one:** Dietary advice.
- **Sub-theme two:** Interdisciplinary management of runners.
- **Sub-theme three:** Monitoring supplement utilisation.

The themes and associated sub-themes are discussed as follows.

THEME 1: THE ACTIVE UTILISATION OF VITAMINS AND MINERALS IN CLINICAL PRACTICE BY CHIROPRACTORS FOR THE MANAGEMENT OF MSK CONDITIONS IN RUNNERS

No previous study has looked at the utilisation of vitamins and minerals by chiropractors to manage runners in particular. However, previous literature has revealed the chiropractic utilisation of nutritional advice and supplement recommendations to patients of the general population. The South African chiropractors in this study utilised vitamins, minerals, nutritional supplements and nutritional advice when managing runners. This aligns with the study of Stuber *et al.* (2013) who reported that every Canadian chiropractor participant in the study provided nutritional advice to patients. Furthermore, the studies by Holtzman *et al.* (2007) and Lee *et al.* (2018) noted that the majority of chiropractors utilise nutritional advice with patients.

Although vitamins and minerals were utilised, this study found a variation in the active utilisation by chiropractors when treating runners. Some chiropractors recommended supplements to every runner to ensure a holistic management of the patient. This reflects the same motive provided by participants in the study conducted by Sanders (2020) to ensure holistic health in patients. Furthermore, the chiropractors in this study also reported the need to replenish lost nutrients after running, which is supported by Beermann *et al.* (2020) who emphasised the increased need for adequate vitamin and mineral consumption in runners due to the high intensity nature of the sport.

Alternatively, some chiropractors recommended supplements only to certain runners, such as those participating in long distance running, elite runners, or those at risk of a MSK condition. Sanders (2020) reported only a few South African chiropractors to “always” provide nutritional guidance to patients and most chiropractors to “sometimes or almost every time”. Similarly, Adams *et al.* (2017) found that nutritional recommendations made up half of the total management protocols discussed with patients.

The chiropractors in this study did not recommend supplements to all runners as some runners were already following a nutritional and supplement programme. This is in agreement with the findings of Barrack *et al.* (2021) and Wirnitzer *et al.* (2021b) who found supplement consumption amongst 26% of all runners and 50% of long-distance runners respectively.

Sanders (2020) noted that chiropractors provided recommendations less frequently to patients who were following a nutritional and supplement programme. Although this finding was not in runners, it reflects the same reason provided by many of the chiropractors in this study, that many of the runners were already managing their diet and supplementation.

This study found that some South African chiropractors recommend supplements to runners from the first appointment, while some participants only prescribe supplements after a few appointments. Similarly, Australian chiropractors in the study by Lee *et al.* (2018) based the nutritional advice on the first consult, whereas the majority of the South African chiropractors in the study by Sanders (2020) did not determine nutritional recommendations from the first appointment. The South African chiropractors in this study used nutritional advice and supplement recommendations in adjunct to other management protocols, which aligns to the same findings of De Gouveia (2009).

Various sub-themes emerged from this study regarding the active utilisation of vitamins and mineral in clinical practice by chiropractors when managing runners. The sub-themes include the factors and reasoning surrounding the recommendation of supplements, dispensing methods of the participants, education provided by the participants when recommending supplements, and how the participants monitor supplementation in the runners.

Sub-theme 1: Factors and reasoning surrounding supplement recommendations by chiropractors to runners

This study identified the key factors surrounding supplement recommendations by chiropractors to runners, based on the clinical evaluation and discussions with their patient. Common factors included the case history; clinical presentation of the runner; the type and level of the runner; investigations; a natural alternative to drugs; the chiropractor's personal experience with supplements; prevention of conditions; and patient feedback. No previous study has investigated the nutritional recommendations by chiropractors to runners. Thus, no literature currently exists regarding the factors surrounding supplement recommendations by chiropractors to runners. Comparisons to existing literature will be made where possible.

South African chiropractors recommend supplements to runners based on the runner's clinical presentation. This may include the type of condition the runner presents with, re-occurring chronic injuries, the clinical signs and symptoms, the severity of an injury, a slow healing injury, or if the runner reported fatigue or lack of energy. Literature has not investigated the clinical presentation of a runner as a reason for chiropractors to recommend supplements. However, Barrack *et al.* (2021) and Wirnitzer *et al.* (2021b)

supported the need for runners to increase supplement intake when there is a history of MSK conditions or the need for enhanced healing of injuries. Close *et al.* (2019) further supported the use of supplements for injury healing.

South African chiropractors utilise a case history as an important tool to determine nutritional advice and supplement recommendations to runners. The case history identifies factors which may indicate the need for nutritional advice, such as runners' diet, supplementation, type of running, their goals, and what their performance and recovery is like. These factors cannot be compared or supported by previous literature regarding chiropractic management of runners. However, Lee *et al.* (2018) noted that that the Australian chiropractors based their nutritional advice on the first consult, which assessed the patient's lifestyle, diet, exercise, medication use, supplementation and body mass index. Thus, this study reflects similar findings of Lee *et al.* (2018), that chiropractors may use factors from the case history as a motive for supplement recommendations.

Nutritional factors in a runner's case history, which prompt chiropractors to provide nutritional recommendations, include vegan, vegetarian or restrictive diets; not taking any nutritional supplements; inadequately replenishing during and after runs; lacking certain nutrients in the diet; signs of deficiencies; nutritional knowledge of the runner; and if the runner had not received advice from a dietician.

Chiropractors emphasised the importance of dietary conversations with runners, which aligns with the lifestyle risk factors identified by numerous studies for the development of MSK conditions in runners. Such factors include underweight or overweight runners, lack of supplementation, inadequate nutritional intake, nutrient or energy deficiencies, poor hydration and certain dietary preferences, such as vegan or vegetarian (Mbarak *et al.* 2019; Johnston *et al.* 2020; Beck *et al.* 2021; Dempster *et al.* 2021; Scheer and Krabak 2021; Bykowska-Derda *et al.* 2022). These nutritional factors are supported by Barrack *et al.* (2021) who noted supplement intake in runners with insufficient food intake, an eating disorder, vegetarian or trying to lose weight. Thus, it is important for chiropractors to inquire about these risk factors during a case history in order to provide the correct nutritional advice, and decrease the risk of resultant MSK conditions to runners. Close *et al.* (2019) further noted that some chiropractors provide dietary changes prior to recommending supplements. The South African chiropractic scope of practice includes dietary advice and supplement recommendations for patient management (2001 Regulations of Act 63 of 1982, as amended). The chiropractors in this study would only provide supplement recommendations if the dietary changes did not generate a desired result or, alternatively, if a runner could not consume certain foods (such as in the case of a vegan or vegetarian runner).

South African chiropractors largely base their supplement recommendations on the type of runner, which influences the type of supplement recommended, how often to take a supplement, when to take the supplement, and reason for the supplement recommendation. South African chiropractors provided different nutritional advice and supplement recommendations to long distance endurance runners, sprinters, serious or elite runners, recreational runners, female or male runners, and young or older runners. The results cannot be compared to literature as no previous study has explored the chiropractic supplement recommendations for different types of runners. However, the difference in supplement recommendations for different types of runners is supported by Wirnitzer *et al.* (2021a, 2021b) who stated that runners will have differing nutritional requirements based on individual training regimes, mileage, intensity and duration of running.

Chiropractors provided different nutritional advice to endurance runners and sprinters. Chiropractors recommended supplements more to endurance runners as they face a greater challenge of energy availability compared to shorter distance sprinters, track and field runners. This is supported by Wirnitzer *et al.* (2021b) who noted the difference in nutritional advice for sprinters and endurance runners because sprinters require nutrition for a fast release of energy and a quick recovery, compared to long distance runners who need to maintain energy throughout the run. Furthermore, long distance running is a risk factor for the development of MSK conditions, such a bone pathology (Bykowska-Derda *et al.* 2022).

The South African chiropractors in this study advised supplements far less frequently to recreational runners, which aligns with Wirnitzer *et al.* (2021b), who reported a difference in the nutritional requirements between elite runners versus recreational runners. The chiropractors recommended supplements more frequently to elite long-distance runners, as these patients experience a greater demand on the body with more joint damage compared to recreational runners. This aligns with Hsu *et al.* (2020) that elite runners experience more MSK injuries than lower-level runners, due to the greater training volume. The chiropractors provided supplement advice for joint support more in the endurance and elite runners, compared to short distance, recreational runners. This is supported by Gessel and Harrast (2019) who stated that higher levels of running may increase a runner's risk of developing arthritis.

Chiropractors further provided different supplementation advice amongst the long distance endurance runners based on their personal goals, experience in running and level of performance. The difference in advice is supported by Hsu *et al.* (2020) who noted that runners with greater marathon experience have an increased rate of injuries. The chiropractors recommended supplements to support Comrades runners in training,

performance, improved recovery, immune support, prevent cramping, prevent iron deficiency anaemia, prevent joint pathology and bone pathology. Similarly, Beermann *et al.* (2020) noted adequate nutritional intake for immune support in runners and Barrack *et al.* (2021) reported supplement consumption for bone pathology or stress fractures. Thus, supplementation is required in long distance runners to prevent and manage such conditions.

In this study, very few chiropractors provided different nutritional advice and supplement recommendations to trail runners and road runners. The advice was provided to trail runners only if the runner was participating in long distance races, requiring electrolytes, hydration and immune support. No literature exists regarding the difference in nutritional requirements between trial and road runners, especially in the chiropractic management of such runners. However, the advice reflects similar findings of the chiropractors for short distance and long-distance road runners. Millar (2019) noted a high prevalence of knee injuries in trail runners, which other studies further noted in South African road runners. However, the chiropractors in this study did not recommend joint support supplements to trail runners, which was recommended for long distance road runners.

South African chiropractors provided different supplement recommendations to runners of different age groups and genders. These results are synonymous with Barrack *et al.* (2021) reporting that supplementation requirements in runners are determined by sex and age but the variation in supplementation was not explored. Chiropractors in this study provided nutritional advice to older runners for both the management and prevention of arthritic change, compared to general joint support recommendations in young runners. However, young runners were recommended joint supplements if a serious injury or trauma had been sustained, or there was a presence of re-occurring joint injuries.

Chiropractors recommended supplements more frequently to female runners to prevent the female athlete triad, iron deficiency anaemia, osteoporosis and to support ligaments. Previous studies have not reported differences in supplementation between male and female runners. However, Beermann *et al.* (2020) did mention the importance of supplementation in female runners who suffer with menstrual irregularities and/or low energy availability, to prevent the development of the female athlete triad and osteoporosis. The chiropractors frequently recommended iron to female runners. This is supported by Beermann *et al.* (2020) who emphasised the importance of iron consumption in long distance female runners due to menstrual blood loss and the high risk of developing iron deficiency anaemia. Iron supplementation in female runners is further supported by Grozenski and Kiel (2020) who stated that the recommended daily allowance for iron is higher in pre-menopausal female athletes.

Various studies noted that ligament laxity was a contributing risk factor for a runner to develop a MSK condition, which substantiates chiropractors advising supplementation for ligament support in females. Furthermore, Johnston *et al.* (2020) noted that female runners have a higher risk of developing stress fractures compared to men, thus supporting the notion of chiropractors recommending supplements more frequently to female runners for bone support and pathology prevention.

The chiropractors provided different supplement recommendations for older menopausal female runners. The supplements recommended for this group of females were aimed to support bone density, fatigue and inflammation. Previous studies have not investigated nutritional advice by chiropractors to the older menopausal runners but various studies have recognised that hormonal changes (such as those that occur in pre-menopausal and post-menopausal females) are a risk factor for MSK conditions in runners. Furthermore, Johnston *et al.* (2020) noted a higher prevalence of stress fractures in pre-menopausal and post-menopausal runners, which supports the notion for chiropractors to recommend supplements to older female runners to support bone density.

This study found that chiropractors recommended supplements based on runners' goals, such as improved race times, running longer distances, improving strength, and increasing training intensity and mileage. Such goals will place higher energy demands on the runner, thus requiring additional nutritional intake compared to non-serious runners. These findings are congruent with Wirnitzer *et al.* (2021b) who acknowledged that the runner's goals and intensity of running will determine the type and dosage of supplementation.

Additionally, the chiropractors ensured through the supplementation that a runner's increased goals would not result in a nutrient deficiency. Holtzman and Ackerman (2021) noted that a nutrient deficiency can negatively affect an athlete's performance through decreased muscle strength, decreased endurance and stamina, and an increased risk of injuries. Furthermore, the findings in this study are supported by Bykowska-Derda *et al.* (2022) who stated the importance of adjusting diet and supplementation according to training, to decrease the risk of developing a MSK condition. Additionally, Scheer and Krabak (2021) reported MSK conditions to inhibit the runner from training and performing at optimum. Thus, chiropractors provided nutritional advice to runners to prevent MSK conditions and allow the runners to continue to train at an optimum in order to reach their goals.

Alternatively, chiropractors recommended supplements for runners who had different goals of pain relief, faster healing rates, not falling sick, and reduced fatigue. These goals may require different forms of supplement recommendations by chiropractors. Beermann *et al.*

(2020) noted the presence of immune suppression and a risk of infection in runners, thus supporting participants to advise runners on immune supporting supplements. Chiropractors advised supplements to aid the healing and recovery of injuries, thus aligning with Wirnitzer *et al.* (2021b), who noted supplementation in runners to speed up recovery, enhance healing and rehabilitation of injuries. The chiropractors did not elaborate on the specific supplements advised for the type of pain relief, whereas Lalchhuanawma (2019) reported that certain nutrient deficiencies could aggravate MPS and result in generalised muscle pain. Thus, the literature supports the notion of chiropractors advising supplementation for pain relief, through the correction and prevention of nutrient deficiencies causing pain.

Literature exists to support adequate nutrient intake and supplementation in runners for performance. The literature noted that the prevention of nutrient deficiencies and resultant MSK conditions may indirectly promote or maintain running performance. Beermann *et al*. (2020) suggested adequate amounts of both macronutrients and micronutrients to prevent injury and positively influence performance. According to Holtzman and Ackerman (2021), an athlete's performance can be negatively affected as a consequence of nutrient deficiencies due to an increased risk of injuries. Furthermore, Scheer and Krabak (2021) reported MSK conditions to inhibit the runner from training and performing at optimum, and noted that the development of an injury during an event negatively impacted a runner's performance. Thus, the literature validates the findings of this study that chiropractors recommended supplements to runners to support performance.

Many chiropractors provided nutritional advice to prevent and manage injuries, reporting to indirectly maintain runners' performance rather than enhancing performance, as supported by the literature. A lack of performance in runners, either as a result of an injury or nutrient deficiency, was another indicating factor for participants to advise supplementation, which reflects the findings of Scheer and Krabak (2021) that injuries can lead to a reduction in a runner's performance overtime. Additionally, the chiropractors emphasised the importance of nutrition to fuel optimal performance. This aligns with the study by Wirnitzer *et al.* (2021a, 2021b) that supplementation enhances a runner's performance, and Wardenaar and Hoogervorst (2022), who reported various health professionals to advise supplements to athletes for their perceived ergogenic effect.

This study did not identify specific supplements to improve performance directly, and did not identify an ergogenic aid for runners. In contrast, past literature has identified certain nutritional supplements to act as ergogenic aids in runners. Heffernan *et al.* (2019) reported running improvements from various studies which investigated iron supplementation in runners and found faster running times in both iron deficit and non-deficit female runners.

Beermann et al. (2020) noted adequate iron intake may maintain running performance. Wardenaar and Hoogervorst (2022) identified probiotics, amino acids, creatine and caffeine as ergogenic aids advised to athletes by sports dieticians and other health professionals.

Chiropractors recommended supplements to runners for recovery purposes, such as improving injury healing rates, ensuring recovery post-training to prevent injuries, and if runners felt a lack of recovery after training. Wirnitzer *et al.* (2021b) also noted the consumption of supplements in runners for improved recovery post-runs and enhanced injury healing. This is further supported by the findings of Close *et al.* (2019) on the efficiency of nutrition to promote recovery after an injury.

The supplements recommended by chiropractors to aid recovery in runners include creatine, recovery drinks, electrolytes, whey protein and amino acids. Wardenaar and Hoogervorst (2022) reported that recovery drinks and carbohydrate-electrolyte drinks were amongst the top three sport foods most commonly recommended to athletes by sports dieticians and other health professionals. The recommendation of protein supplements to runners for recovery is supported by Tiller et al. (2019), that runners need to meet the daily protein requirements to aid muscle recovery post-training. Furthermore, the findings in this study are congruent with the findings of Barrack et el. (2021) which observed runners to consume creatine, protein supplements, amino acids and carbohydrate-electrolyte drinks, among other supplements. Close *et al.* (2019) further reported the role of protein supplementation in tendon and ligament health, and the importance of such supplements to aid recovery and function of these tissues after injury.

In contrast, previous literature has identified additional supplements to aid recovery in athletes and runners, which the chiropractors in this study did not recommend. Anti-oxidants and vitamins A and E were found to enhance muscular recovery post-exercise by Grozenski and Kiel (2020) and Brancaccio *et al.* (2022).

The chiropractors recommended supplements as a natural method for inflammation control, pain relief and injury healing. Additionally, the chiropractors provided nutritional and supplement advice if the runners requested a more natural and long-term option in preference to taking drugs. No literature exists on chiropractic utilisation of vitamin and minerals as a natural alternative option compared to mainstream drugs for patient management. Furthermore, literature has not explored this subject with regard to the management of runners. However, Sanders (2020) noted that chiropractic provides conservative and holistic healthcare. Therefore, the chiropractors who recommended supplements to runners as a natural option to manage MSK conditions aligns with the conservative methods of chiropractic.

The chiropractors in this study provided a mixed response regarding the use of investigations to guide nutritional advice to runners. Most chiropractors utilised investigations and additional tests to guide nutritional recommendations to runners. Investigations included blood work, x-rays, gene testing, sweat testing and bone scans. Some of the chiropractors used the investigations to guide initial recommendations, compared to chiropractors who only sent runners for investigations if a condition was not improving, showing a lack of recovery or improvement in the clinical signs and symptoms. Previous literature has not explored the use of investigations to guide supplement and nutritional recommendations by chiropractors to runners. However, Sanders (2020) found that a small percentage of chiropractors use investigations to guide nutritional advice to patients.

In contrast, some chiropractors did not use investigations when advising supplements and nutrition to runners. The chiropractors did not think investigations were necessary for generalised supplement recommendations. If a certain case required further investigations, then the runner would be referred to a dietician.

Some chiropractors provided nutritional recommendations to runners based on personal experience as an athlete themselves, and their own experience with utilising supplements. Previous literature has not acknowledged the aspect of the chiropractor's personal experience as a motive for supplement recommendations to runners. Thus, the findings in this study have generated new information which cannot be compared to existing literature. The chiropractors recommended supplements that personally benefited themselves in terms of recovery, performance, and injury prevention. The supplements which the chiropractors found beneficial included natural anti-inflammatories, zinc, and whey protein.

Previous literature has not acknowledged patient feedback as a factor surrounding supplement recommendations by chiropractors to runners. The chiropractors in this study utilised positive patient feedback regarding supplementation as a factor for making the same recommendation to other runners. If runners reported improvements in clinical conditions or how they felt after utilising supplementation, this prompted the chiropractors to recommend similar supplementation to runners experiencing the same concerns. Runners would report beneficial outcomes such as decreased cramping, faster recovery and injury healing, less fatigue, the ability to push harder on runs, and improved immune support. These outcomes supported the use of a certain supplement in runners.

The South African chiropractors recommended supplements to runners to prevent the development of MSK conditions. The chiropractors described a mixed variation in prevention methods. Some chiropractors recommend supplements to every runner as a

precaution, due to the increased demand on the body from running which increases the risk of developing a nutrient deficiency and MSK condition. This is supported by Beermann *et al.* (2020) who noted that running stresses the body's metabolic pathways, resulting in an increased need for micronutrients. Furthermore, Wirnitzer *et al.* (2021b) noted that an insufficient nutrient intake may lead to clinical conditions. Some of the chiropractors only recommended supplements as a prevention precaution to runners who were at risk of developing a nutrient deficiency or MSK condition.

The literature has identified many risk factors for the development of nutrient deficiencies and MSK conditions in runners. In the case of menopausal runners, many chiropractors in this study recommended vitamin D and calcium to prevent bone pathology and stress fractures. This aligns with Beermann *et al.* (2020) who stated that female runners are at risk of stress fractures and should consume such supplements. Some chiropractors recommended supplements for preventative purposes based on the patient and is case dependent.

Sub-theme 2: Dispensing methods employed by chiropractors

The majority of the South African chiropractors in this study did not dispense nutritional supplements from their practice. The chiropractors advised the patients to either source the product from a health store, pharmacy or buy from another practitioner within the multidisciplinary practice. No previous literature has investigated the sale of nutritional supplements by South African chiropractors, thus the findings in this study cannot be compared in a South African context. However, Page *et al.* (2012) found to the contrary, as the majority of Canadian chiropractors did sell nutritional products from their practices. The minority of South African chiropractors who did sell health products emphasised a similar rationale as the Canadian chiropractors — that sales were completely at the patient's discretion and purchased voluntarily.

Sub-theme 3: Education provided with the supplement recommendation

Previous literature has not looked at the nutritional education provided by chiropractors to runners. This study found that South African chiropractors educate runners about the supplement that they have recommended, to improve patient compliance. Education included directions of use, benefits and side effects; the importance of training on the supplements; and to be aware of unwanted contaminants in products. The chiropractors occasionally provided the runners with literature to learn more about the supplements. Sanders (2020) also noted that South African chiropractors provided nutritional education to patients, such as articles, journals, brochures, general books and magazines.

Additionally, South African chiropractors advised runners on the continuation of supplements after an injury had healed. No previous literature has looked at the recommendation of supplements after a MSK condition or injury has healed, particularly in runners. This study found that the continuation of supplementation depended on the type of supplement recommended, dose, type of injury present, changes in the runner's clinical presentation and the type of runner.

THEME 2: COMMONALITY IN VITAMINS AND MINERALS UTILISED BY CHIROPRACTORS IN THE MANAGEMENT OF MSK CONDITIONS IN RUNNERS

This study noted the common nutritional supplements which are frequently recommended by South African chiropractors to manage both MSK and non-MSK conditions in runners. Previous literature has not investigated the type of supplements recommended by chiropractors to runners and, thus, the findings in this study have generated new information which cannot be compared to existing literature.

The nutritional supplements most frequently advised by chiropractors include magnesium, vitamin D, omega 3, glucosamine, chondroitin, electrolytes, vitamin B, collagen, iron and calcium, as well as "other" which included homeopathic remedies, herbal products, Traumeel, Arnica supplements, bone broth, alkalising powders, and proteolytic enzymes. Few chiropractors in this study recommend phosphorous, creatine, curcumin, probiotics, caffeine, carbohydrate supplements, vitamin C, a multivitamin, zinc, MSM, and whey protein to runners.

A limited amount of literature reports the supplement recommendations by chiropractors to patients of the general population. The findings of this study align with Sanders (2020) who also identified South African chiropractors to recommend probiotics, multivitamins, vitamins, minerals, essential fatty acids, protein, enzymes, and herbal remedies to patients. Furthermore, Stuber *et al.* (2013) and Lee *et al.* (2018) noted that Canadian and Australian chiropractors commonly recommended probiotics, fatty acids, vitamins, minerals, protein, fibre, herbal remedies, enzymes, and glucosamine. The recommended vitamins included vitamin D, vitamin C and multivitamins, while minerals included calcium. Chiropractors in this study did not report to advise fibre to runners. Furthermore, the supplements in this study reflect similar findings by Barrack *et al*. (2021) who found that runners commonly consume vitamin D, calcium, iron, multivitamin, vitamin B, zinc, vitamin C, magnesium, probiotics, creatine, protein supplements, and carbohydrate-electrolyte drinks

Sanders (2020) reported essential fatty acids (omega 3) to be the most recommended by chiropractors, which contrasts to the findings of this study which found magnesium to be the most commonly recommend supplement to runners by all of the chiropractors. This is supported by Wirnitzer *et al.* (2021a, 2021b), who found that magnesium was the most frequently consumed mineral supplement by runners. The recommendation of magnesium, vitamin D, and omega 3 to runners by chiropractors, is supported by the findings of Wardenaar and Hoogervorst (2022), who noted vitamin D, omega 3 and magnesium to be the most frequently recommended to athletes by sports dieticians and other health professionals.

The chiropractors in this study did not recommend vitamin A and E to runners. Grozenski and Kiel (2020) and Brancaccio *et al*. (2022) reported athletes and runners to be at a risk of developing anti-oxidant deficiencies. Thus, it is surprising that none of the chiropractors in this study recommended anti-oxidants (vitamin A and E) to runners to prevent the MSK side effects associated with oxidative stress.

Many chiropractors in this study recommended herbal products and homeopathic remedies to runners. It should be noted that the recommendation of such substances is not within the South African chiropractic scope of practice, which only allows for the prescription and dispensing of vitamins, minerals, nutritional supplements, and topical substances (2001 Regulations of Act 63 of 1982, as amended). Therefore, it must be noted that this study reports which herbal products were recommended for certain conditions, purely for research purposes. This study, in no way or form, promotes the use of herbal products and homeopathic remedies to runners.

This study reported the common MSK conditions in runners for which chiropractors frequently recommended supplements. The most frequently reported MSK conditions which chiropractors recommended supplements for included muscle cramping, joint pathology (pain, inflammation, arthritic changes), joint support, general inflammation, and bone support. Additional MSK conditions in runners for which South African chiropractors in this study recommended supplements to runners include muscle pain and stiffness, muscular tears or strain, ligament tears or sprain, osteoporosis and tendon issues (tendonitis, tendinopathy, tendon tear), stress fractures, ligament laxity, lower back pain, and muscle atrophy. Previous literature has not investigated the MSK conditions in runners for which South African chiropractors recommended supplements and, thus, the findings in this study generate new information which cannot be compared to existing literature.

However, the type of MSK conditions mentioned by the chiropractors in this study align to studies that noted MSK conditions in runners as lower back pain, bone pathology (such as

osteoporosis), stress fractures, inflammation, muscle stiffness, muscle damage, and muscle cramping in runners (Istvan *et al.* 2019; Beermann *et al*. 2020, Maselli *et al*. 2020; Barrack *et al*. 2021; Hunt *et al*. 2021; Bykowska-Derda *et al.* 2022).

Although a discrepancy in the literature exists regarding arthritic changes in runners, the chiropractors in this study recommended supplements for joint pathology and joint prevention. Joint pathology and support are the second and third most common MSK condition for which the chiropractors recommended supplements. Hespanhol *et al.* (2017) and Viljoen *et al.* (2021) found that muscle was the most commonly injured tissue in South African trail runners and Dutch runners respectively. It is not surprising that the chiropractors in this study recommended supplements most commonly for muscular complaints, such as cramping. This aligns with the findings of Malliaropoulos *et al*. (2015) and Vernillo *et al.* (2016) which noted muscle cramping in Greek and Italian runners. However, muscular pain, stiffness, tears or strains were not as frequently addressed by the chiropractors in this study.

The chiropractors reported to provide different supplement recommendations for acute and chronic injuries. Acute injuries required supplements to assist with inflammation, pain and healing, whereas chronic injuries required supplement recommendations to address certain deficiencies and prevent the re-occurrence of the injury. No previous study has looked at the nutritional recommendations by chiropractors to manage acute injuries versus chronic conditions in runners.

Furthermore, the chiropractors in this study reported which supplements were recommended for which MSK conditions, as detailed in the results. This study has generated new information regarding the chiropractic utilisation of vitamins, minerals and nutritional supplements when managing MSK conditions in runners. Previous literature has not investigated this topic before and, thus, the information will be compared to literature where possible.

South African chiropractors recommend magnesium most commonly for cramping. This aligns with the findings of Hunt *et al.* (2021) that magnesium is commonly utilised to reduce muscle cramping, which commonly occurs in runners. Furthermore, Wirnitzer *et al.* (2021a, 2021b) found magnesium to be the most commonly consumed mineral amongst runners. Thus, the popularity of this supplement is not surprising.

South African chiropractors recommend whey protein for muscle aches, stiffness, muscle tears and strains in runners. This aligns with the findings of Close *et al.* (2019) and Tiller *et al.* (2019), who emphasised the importance of increased protein intake in runners to promote the healing of injured tissues, prevent muscle atrophy, aid muscle recovery, and growth. However, chiropractors in this study did not recommend protein for muscle atrophy

in runners. South African chiropractors recommended other supplements to assist with muscular tears or strains, such as creatine. This reflects the same findings of Close *et al.* (2019) regarding the consumption of creatine to assist with muscular injury. Close *et al.* (2019) further noted the use of omega-3 to reduce inflammation during muscle damage or injury and to aid the healing of the muscle tissue. However, South African chiropractors do not utilise omega-3 or anti-inflammatory supplements to assist with muscular damage or injuries.

This study found that South African chiropractors recommended supplements to runners for generalised muscle aches, pains and stiffness, which include magnesium, phosphorous, calcium, electrolytes, water, whey protein, vitamin B, vitamin K, multivitamin, omega 3, and zinc. The recommendation of phosphorous for muscle aches and stiffness is supported by Heffernan *et al.* (2019), who noted reduced lactate levels in endurance athletes after supplementation. Magnesium will aid muscle recovery (Hunt *et al.* 2021) and, thus, the recommendation of magnesium by chiropractors will improve muscular aches and stiffness in runners. The recommendation of vitamin B, magnesium and calcium by chiropractors is supported by Lalchhuanawma (2019), who noted that deficiencies in such supplements may aggravate MPS and the development of trigger points. The study also noted the use of iron, folic acid, vitamin C and vitamin D to reduce muscle aches and MPS. However, the South African chiropractors in this study did not recommend these supplements to the runners to reduce muscle pains. Similarly, Brancaccio *et al.* (2022) and Grozenski and Kiel (2020) reported that athletes with muscle pain, weakness, stiffness or muscular damage, may benefit from supplementation with vitamin D and anti-oxidants (vitamin A and vitamin E). Anti-oxidants are thought to aid muscle healing and prevent exercise-induced damage but the chiropractors did not recommend vitamin D for muscular complaints in runners, and none of the chiropractors in this study recommended anti-oxidants for any MSK condition.

In this study, the South African chiropractors recommended similar supplements for both tendon and ligament injuries, as well as general health of these tissues. The supplements recommended in this study reflect the findings of Close *et al.* (2019), which included protein, collagen and anti-inflammatory supplements. These supplements are believed to aid tendon and ligament recovery after injury, and to support general tendon or ligament health for the prevention of injuries (Close *et al.* 2019). However, Akram *et al*. (2020), Awuchi *et al.* (2020) and Close *et al.* (2019) noted that vitamin C promotes collagen synthesis, which will positively impact tendon and ligament health. The chiropractors in this study did not include vitamin C in their supplement recommendations for tendinous or ligamentous conditions in runners.

Close *et al.* (2019) noted that collagen can be used for prophylactic and therapeutic effects in tendon and ligament health, yet few chiropractors recommend collagen for tendon and ligament health in runners. Tendon injuries are common amongst elite runners (Close *et al.* (2019), with ankle sprains commonly reported in trail runners (Matos et al. 2021). Thus, it would be expected that more chiropractors would recommend collagen and vitamin C to runners to support these soft tissue structures and prevent injuries.

Close *et al.* (2019) reported the benefits of anti-inflammatory supplements to assist in tendon recovery, which supports the recommendation of such supplements by the chiropractors in this study. The chiropractors emphasised the importance of anti-inflammatory supplements during the acute phase of a tendon or ligament injury, to decrease inflammation, pain and promote healing of the tissues. Although ligament laxity has been identified as a risk factor for the development of MSK conditions in runners (Dempster *et al.* 2021), very few chiropractors recommended supplements for ligament laxity, which was collagen. South African chiropractors should perhaps identify and recommend supplements more often for ligament laxity in runners, to reduce the risk of future MSK conditions.

South African chiropractors recommend vitamin D, calcium and vitamin K for general bone support, osteoporosis and stress fractures in runners. These supplements were similarly reported by Beermann *et al.* (2020) and Close *et al.* (2019) to maintain BMD and prevent stress fractures. Runners are at a high risk of decreased BMD and stress fractures, especially in females (Johnston *et al*. 2020 and Bykowska-Derda *et al*. 2022). Thus, the South African chiropractors in this study recommend supplements for bone support as one of the top five MSK conditions requiring nutritional advise.

The South African chiropractors recommended electrolytes to runners to prevent dehydration and for various MSK conditions, such as muscle cramping, muscular pains, stiffness and atrophy. The recommendation of electrolytes by South African chiropractors to runners is supported by Tiller *et al.* (2019) who emphasised the importance of adequate hydration (both water and electrolytes) to prevent dehydration and injuries during an ultramarathon.

In addition to MSK conditions, the chiropractors recommended electrolytes to enhance recovery, prevent fatigue and maintain performance. This is supported by Tiller *et al.* (2019), who stated that inadequate hydration is noted in runners who do not finish a marathon. Although dehydration and hyponatraemia may result in serious and fatal consequences (Tiller *et al.* 2019), the chiropractors in this study did not mention such consequences when

recommending electrolytes to runners. This may possibly be as a result of the study investigating the use of supplements for MSK conditions and not medical emergencies.

Many South African chiropractors in this study recommended supplements to runners for joint support and joint pathology, which included any pain, inflammation or arthritic changes relating to the joints. The supplements recommended for these MSK conditions were very similar, and included glucosamine, chondroitin, Boswellia, MSM, omega 3, proteolytic enzymes, Traumeel, vitamin D, bone broth, collagen, hyaluronic acid and magnesium. However, recommendations for joint pathology included more "anti-inflammatory" supplements compared to supplements advised for general joint support. This may be explained by the need for decreased inflammation and pain control after arthritic changes have occurred.

Although the chiropractors recommended supplements for joint pathology and joint support as the second and third most common MSK conditions in runners, a discrepancy in the literature exists regarding the development of joint pathology in runners. Gessel and Harrast (2019) noted an increased risk of arthritis in long distance runners, which aligns with the chiropractors in this study recommending joint supplements more to long distance and elite runners due to the increased loading on the joints. Common "joint supplements" include chondroitin, glucosamine, collagen, MSM and omega 3, which literature has reported on the beneficial effects of these supplements to reduce joint pain, inflammation and maintain articular cartilage integrity.

When looking at the benefits of these supplements, which have been outlined in Table 2.2, Chapter 2, it is understandable why chiropractors would recommend such supplements to runners who experience increased loads at the joints. Furthermore, many of the chiropractors recommend "joint supplements" to runners, young or older, if they have experienced a previous joint injury or trauma. This may be explained by the protective mechanisms of the supplements to promote good function of the articular cartilage and surrounding joint tissues.

Hyaluronic acid was recommended by very few chiropractors for joint support in runners. Guo *et al.* (2020) reported that hyaluronic acid is commonly found in articular cartilage and is thought to maintain the elastoviscosity of connective tissues, joint lubrication and act as a shock absorber to protect articular cartilage from mechanical loading. Therefore, given that most of the chiropractors recommended supplements for joint support and health, as well as joint pain and arthritic changes, it would be expected that more chiropractors would recommend hyaluronic acid for joint support. Grozenski and Kiel (2020) reported that athletes suffering from joint injuries may benefit from vitamin D supplementation, which

supports the recommendation of vitamin D by chiropractors in this study for joint support in runners.

One MSK condition which runners may experience is inflammation (Beermann *et al.* 2020), which supports the recommendation of supplements by South African chiropractors for inflammation in runners. Stuber *et al.* (2013) and Lee *et al.* (2018) reported that Australian and Canadian chiropractors recommended supplements for inflammation in patients, which further supports the findings in this study. The chiropractors recommended anti-inflammatory supplements to runners to reduce inflammation in the body and assist with the resultant pain, poor recovery rates and performance. The anti-inflammatory supplements consisted of omega 3, proteolytic enzymes, curcumin, homeopathic remedies, herbal products (such as Traumeel and Septogard), MSM, and alkalising powders.

Close *et al.* (2019) noted the powerful anti-inflammatory properties of omega 3, which is believed to assist in the prevention of MSK injuries and promote healing of injured tissues. Furthermore, Sanders (2020) found that omega 3 was the most commonly advised supplement by South African chiropractors for inflammation in the general population. Grozenski and Kiel (2020) reported the use of anti-oxidants to reduce inflammation, but no chiropractors in this study recommend anti-oxidants for inflammation in runners.

In this study, very few South African chiropractors recommended supplements for lower back pain in runners. The low frequency rate of chiropractors recommending supplements for this condition is supported by Maselli *et al.* (2020), who reported a reduced prevalence of lower back pain in runners compared to the general population. Furthermore, studies which investigated MSK conditions in runners did note lower back pain in this population but it was not within the top three most commonly occurring MSK conditions in runners (Desai *et al*. 2020; Hsu *et al.* 2020).

Although this study aimed to explore which MSK conditions chiropractors recommend supplements for in runners, additional information emerged regarding supplementation to assist non-MSK conditions in runners. The most common non-MSK conditions which South African chiropractors recommend supplements to runners included energy, immune support and iron deficiency anaemia.

Akram *et al.* (2020) and Awuchi *et al*. (2020) noted in the literature the role of vitamin B in energy production and metabolism, which supports chiropractors in this study advising vitamin B to runners for energy and fatigue. Wardenaar and Hoogervorst (2022) identified caffeine as one of the top three ergogenic supplements most commonly recommended by sports dieticians and health professionals to athletes. South African chiropractors in this study recommended caffeine to runners for energy before runs and to maintain energy

during the runs. Thus, a link may be made with the findings of Wardenaar and Hoogervorst (2022) and this study, that caffeine may be recommend to athletes, being runners in this case, as an ergogenic supplement as energy maintenance will have a positive impact on performance. However, previous studies have not reported on the utilisation of supplements by chiropractors for issues of energy or fatigue in runners. Thus, this study has generated new information which cannot be compared to previous literature.

Beermann *et al.* (2020) reported that running decreases immune function and Beck *et al*. (2021) noted that runners are prone to the developments of REDS which can affect immunity in runners. Thus, these studies support the notion of South African chiropractors recommending immune support supplements to runners. These supplements include vitamin C, a multivitamin, vitamin B, zinc and selenium. Akram *et al.* (2020) and Awuchi *et al.* (2020) enforces the recommendation of vitamin C and zinc as the studies noted these micronutrients to promote adequate functioning of the immune system. Furthermore, Barrack *et al*. (2021) reported runners to consume vitamin C, multivitamins and zinc. Grozenski and Kiel (2020) noted antioxidants to protect immune function but no chiropractors in this study recommended vitamins A or E for immune support in runners.

South African chiropractors recommended supplements to female runners who experience menstrual irregularities and to provide menstrual support. This is supported by Beck *et al*. (2021), who noted that female runners with REDS may experience impaired menstrual function. As runners are at a high risk of REDS, it is important that female runners require additional advice to protect their menstrual function and prevent irregularities. Thus, South African chiropractors recommended iron, calcium, vitamin B and folic acid to female runners requiring menstrual support.

Beermann *et al.* (2020) noted that females who experience menstrual irregularities should supplement with calcium and vitamin D to maintain bone health and prevent the development of the female athlete triad. This is supported by the findings of Johnston *et al.* (2020) that females with menstrual irregularities are at greater risk of stress fractures and, thus, the findings in this study align with the literature, that South African chiropractors recommend calcium to females experiencing menstrual irregularities, including pre-menopausal and post-menopausal runners. The chiropractors did not advise vitamin D to female runners with menstrual irregularities, which should be considered in order to enhance the absorption of calcium in this population who are at risk of stress fractures (Akram *et al.* 2020; Awuchi *et al.* 2020 and Johnston *et al.* 2020). Previous literature has not investigated the utilisation of supplements by chiropractors to manage female runners requiring menstrual support and, therefore, this study has generated new information which cannot be compared to previous literature.

Pre-menopausal and post-menopausal runners are at a high risk of developing MSK conditions, such as stress fractures in particular (Johnston *et al.* 2020). Thus, the chiropractors recommended supplements to menopausal runners. Supplements included magnesium, calcium, vitamin D, iron, anti-inflammatory supplements and homeopathic remedies. The recommendation of calcium and vitamin D to support bone health in this population is supported by various literature. Furthermore, Bykowska-Derda *et al.* (2022) further identified that long distance running may increase the risk of bone pathology. Thus, the study supports the notion of menopausal long-distance runners requiring adequate bone support supplementation. Previous literature has not reported on the utilisation of iron, magnesium, anti-inflammatory supplements or homeopathic remedies in menopausal runners. A chiropractor elaborated the need for anti-inflammatory supplements or homeopathic remedies due to increased inflammation in the body during menopause. A study by Shieh *et al.* (2020) supported the reasoning provided by the South African chiropractor as the study further noted increased inflammation in menopausal females.

Numerous literature has elaborated on the increased risk of anaemia in runners due to foot-strike haemolysis, vegan and vegetarian diets, menstrual blood loss, and training at high altitudes (Beermann *et al.* 2020). Beermann *et al.* (2020) found that the majority of female runners and all of the male runners consume less than the recommended daily allowance of iron. Thus, the literature supports the findings that South African chiropractors recommend supplements for iron deficiency anaemia in runners. This aligns with Lee *et al.* (2018), who found chiropractors to recommend supplements for anaemia in patients. The chiropractors in this study recommended iron and vitamin B to manage anaemia in runners, especially in menstruating females and long distance runners. The chiropractors did not elaborate on iron supplementation to assist runners' performance. However, literature exists to support improved race times in runners who supplement with iron, as well as prolonged lactic acid onset, a higher lactate threshold, quicker recovery times post-exercise, fatigue resistance and greater strength (Heffernan *et al.* 2019). Thus, it still remains unknown if iron utilisation by South African chiropractors may improve runners' recovery and performance.

Mellinger and Neurohr (2019) emphasised the importance of addressing additional factors when treating a running injury, which included runners' sleep patterns. Chiropractors in this study recommended magnesium and vitamin B supplements to assist runners with their sleep, which indirectly improved their energy and running performance. No other literature exists to support the utilisation of supplements for sleep in runners.

THEME 3: THE POSITIVE INFLUENCE OF SUPPLEMENT UTILISATION BY CHIROPRACTORS IN THE MANAGEMENT OF MSK CONDITIONS IN RUNNERS

This study noted that the utilisation of nutritional supplements by South African chiropractors has a positive influence on runners. Previous literature has not investigated the influence of supplement utilisation by chiropractors when managing MSK conditions in runners and, thus, the findings in this study have generated new information. Comparisons between the findings of this study will be made to literature where possible.

Sub-theme 1: Treatment outcomes after supplement utilisation

South African chiropractors perceived improved treatment outcomes in runners after utilising vitamins, minerals and nutritional supplements in the management of MSK conditions. Objective and subjective improvements in the runners were noted, such as reduced pain, less stiffness, decreased muscle soreness, faster recovery rates, improved performance, less cramping, more energy, faster healing and faster return to running. The findings in this study are supported by Wirnitzer *et al.* (2021a, 2021b) who noted that the use of supplements in runners enhance performance, speed up recovery post-runs, and enhance healing and rehabilitation of injuries.

South African chiropractors utilised nutritional advice and supplement recommendations in adjunct to other management protocols for runners. The chiropractors in this study owed the positive treatment outcomes to the combination of management protocols, rather than just the use of supplements. This reflects the findings of Nelson *et al.* (2021), who identified a multimodal approach of chiropractors when managing athletes, and van Niekerk (2014), who identified the utilisation of various modalities to treat runners after a marathon. However, previous studies have not investigated the impact of chiropractic on the treatment outcomes in runners, nor the impact of nutritional supplementation in runners. The findings in this study have generated new information regarding the treatment outcomes in runners, after the utilisation of supplements by chiropractors when managing MSK conditions in runners.

Sub-theme 2: Running performance after supplementation

The participants in this study reported an improvement in runners' performance after utilising supplements. South African chiropractors received feedback from the runners which included faster running times, faster recovery to train and perform at their optimum, and a stronger immune system to continue training. The chiropractors noted the improved performance to be linked with the feedback of less joint pain, reduced cramping, and feeling

less tired and sore. Thus, reduced MSK conditions and improved recovery in the runners allowed them to push harder during runs to improve their performance. The chiropractors in this study did not identify any specific supplements to improve runners' performances and, thus, a comparison cannot be made to literature supporting the benefits of a particular supplement to enhance performance.

Sub-theme 3: Injury rate in runners after supplementation

The South African chiropractors in this study reported a decreased injury rate in runners after utilising supplements. The chiropractors emphasised the importance of runners adhering to the supplement protocol, as well as taking the supplement for a certain time for it to have beneficial effects. Previous literature exists to support a reduction in the injury rate in runners after supplementation. As an example, Tiller *et al.* (2019) noted adequate hydration to decrease the risk of injuries in marathon runners, and Close *et al.* (2019) reported the consumption of certain supplements to prevent injuries in tendons and ligaments. Close *et al.* (2019) reported the efficiency of nutrition to reduce the risk of injuries.

Thus, the literature supports the findings of this study that runners experience less injuries after the recommendation of supplements by chiropractors. The chiropractors noticed less muscle cramping in runners after supplementation with magnesium. This aligns with the findings of Hunt *et al.* (2021), that runners are prone to a magnesium deficiency that results in muscle cramping and consumption of magnesium and, therefore, alleviates the cramping. The chiropractors in this study did not mention other specific injuries which responded to supplementation and, thus, further comparisons cannot be made with the literature.

Sub-theme 4: Runners' perceptions and attitudes of supplementation

In this study, the South African chiropractors reported a positive perception of runners regarding the recommendation and consumption of supplements to manage their MSK conditions. The chiropractors noticed greater patient outcomes with runners who were happy to comply with the supplement advice provided, which included directions of use and the time period for which they should consume the supplement. Additionally, the chiropractors reported that when runners noticed improved outcomes after supplement recommendations, the runners developed a more positive, broader outlook of the chiropractic profession.

The chiropractors noticed that runners increased their trust of chiropractic, and increased their utilisation of the profession. Runners presented with a multitude of concerns due to a greater understanding of the profession, that chiropractors do not only "click … spines" (Participant J) and can holistically manage a variety of neuromusculoskeletal concerns. These findings cannot be compared to previous literature, as no study has investigated

runners' perceptions and attitudes regarding supplementation recommended by chiropractors to manage MSK conditions.

THEME 4: HOLISTIC MANAGEMENT OF RUNNERS BY CHIROPRACTORS

This study found that South African chiropractors employ a holistic management of runners when addressing MSK concerns in these patients. The South African chiropractors in this study utilised nutritional advice and supplement recommendations in adjunct to other management protocols for runners. These included adjustments, mobilisations, shockwave, laser, strengthening exercises, stretching, rest, shoe corrections, and advice to alternate the side of the road on which they run. The study did not aim to identify all of the chiropractic management protocols for MSK conditions in runners and, consequently, only a few additional management protocols were noted.

The chiropractors reported to use a combination of treatment options to provide a holistic management of the runner. This is supported by Sanders (2020) who noted the holistic nature of chiropractic when managing a patient. The holistic management of a patient addresses all aspects of the person to ensure adequate management of a given concern (Rasweswe *et al.* 2021). Therefore, South African chiropractors provided dietary advice to the runners in addition to supplement recommendations and referred runners to other practitioners when necessary.

Sub-theme 1: Dietary advice

Previous literature has not explored the use of dietary advice by chiropractors when managing runners. Nelson *et al.* (2021) noted that chiropractors included nutritional education alongside supplement recommendations when managing athletes but the study did not mention a particular group of athletes. Therefore, the findings in this study have generated new information that cannot be compared to previous literature. Comparisons of dietary advice by chiropractors to available literature will be made where possible.

Most of the South African chiropractors did not attempt to first correct the runners' diets before prescribing supplements. The chiropractors reported that patients prefer to take a tablet than make dietary changes. Although the South African chiropractic curriculum includes clinical nutrition as a subject (Chiropractic Handbook 2021), chiropractors feel that they do not have adequate nutritional knowledge to provide major dietary changes to runners or create a diet plan. The chiropractors would provide minor nutritional advice to runners when necessary. This aligns with the statement by Sanders (2020) that, if a patient requires, chiropractors will incorporate nutrition as part of the holistic management of the

patient. Sanders (2020) noted that South African chiropractors provided nutritional guidance to patients, such as portion sizes, calorie intake, and healthier food and drink options.

This study was concerned with the recommendation of nutritional supplements more than the type of dietary advice given to runners. Thus, the chiropractors did not elaborate on the dietary advice provided. Some of the advice mentioned included a banana for potassium, energy and to help with muscle cramps. If runners required further specialised dietary advice, the chiropractors referred to nutritional experts. Similarly, Sanders (2020) also noted that chiropractors referred to nutritional experts when they felt a lack of nutritional knowledge to make certain recommendations. Furthermore, Page *et al.* (2012) reported that chiropractors may not have enough knowledge on nutritional supplements and products.

Some chiropractors educated patients on macronutrients (protein, carbohydrates and fats) to replenish lost nutrients from running. The chiropractors advised replenishment prior, during and after runs with both macronutrients and micronutrients for energy, recovery, performance and injury prevention. This is supported by Wirnitzer *et al.* (2021b), who noted increased macronutrients and micronutrients requirements in runners, along with Beermann *et al.* (2020), who emphasised the importance of consuming such nutrients to prevent illness and injuries.

Many of the chiropractors advised the runners to consume water during the day, during runs and after runs. The chiropractors further recommend electrolytes in addition to plain water, to ensure adequate hydration. This recommendation is supported by Tiller *et al.* (2019), who emphasised the importance of electrolytes for hydration strategies, as over consumption of water can dilute electrolytes in the body leading to dehydration and hyponatraemia.

The chiropractors provided differing dietary advice to runners of contrasting socioeconomic backgrounds. Previous literature has not investigated the variation in nutritional advice for runners of various socioeconomic backgrounds, especially the chiropractic management of such runners. Thus, the results generated by the study of Tiller et al. (2019) have provided new information regarding the nutritional management of runners based on their economic level.

For the lower socioeconomic runners, the chiropractors first attempted dietary recommendations within runners' budget. If the dietary changes did not adequately assist the runners, only then would the chiropractors advise supplements. One chiropractor noted a cheaper method for a recovery drink post-runs, using a *"Steri Stumpie"*, a local flavoured milk. These recommendations varied drastically compared to the higher socioeconomic

runners. Chiropractors could recommend any supplement for the higher socioeconomic runner to buy, as their budget could afford to try different supplements, such as vitamins and minerals, sports recovery aids or referral to a dietician.

Sub-theme 2: Interdisciplinary management of runners

South African chiropractors engaged in interdisciplinary care to manage runners. The chiropractors in this study commonly work with dieticians, functional medical practitioners, homeopaths and general practitioners. This aligns with the findings of Nelson *et al.* (2021), who noted that chiropractors embrace interdisciplinary management of patients and refer to external specialists when necessary. Furthermore, van Niekerk (2014) found chiropractors to refer runners to other practitioners but the type of practitioners was not described.

Although the chiropractors provided nutritional advice to runners, mainly supplement recommendations, specialised cases were referred to nutritional experts. The chiropractors referred elite runners who require an in-depth nutritional consult and diet plan; runners who are not responding to general nutritional advice and chiropractic treatment; or runners wanting a comprehensive nutritional plan. The chiropractors were happy to refer runners as they felt that nutritional practitioners are more specialised to provide the runner with a greater standard of nutritional care. The findings of this study align with those of De Gouveia (2009) and Sanders (2020), who noted that chiropractors refer patients to nutritionists, homeopaths, naturopaths and other health professionals who are more trained in the field.

Some chiropractors in this study reported to work with general practitioners (GP). The chiropractors would refer runners to their GP when a condition fell out of the chiropractic scope of practice, or would work with the GP to ensure that supplementation did not interact with the runner's chronic medication. Furthermore, chiropractors advised runners to consult with their GP or gynaecologist if the runner was experiencing hormonal imbalances, required hormonal therapy or for general check-ups. The chiropractors emphasised the importance of female runners, especially menopausal and post-menopausal, to receive regular check-ups with their gynaecologist to ensure adequate bone health. The chiropractors further referred runners to orthopaedic surgeons when an injury required surgical intervention.

Sub-theme 3: Monitoring supplement utilisation in runners

Supplement monitoring determines if a runner should continue the supplementation, lower a supplement dose or cease supplementation completely. South African chiropractors have a varied approach to monitoring supplementation in runners. Previous literature has not investigated the monitoring of supplementation in runners, especially by chiropractors.

Some chiropractors monitored supplementation based on runners' improvement and reduced clinical features, while some used investigations such as blood tests and x-rays. The chiropractors used these indicators to then determine if the runners should continue the supplementation at the same dose or lower the dosage. The chiropractors felt that if a supplement has assisted runners' conditions, then they should remain on the supplement as before. Some chiropractors felt that once runners' condition had improved, a lowered dose would be sufficient enough to prevent the reoccurrence the condition. Alternatively, some chiropractors felt that runners should completely stop supplementation once a condition had resolved, as the body no longer requires the additional assistance.

Some chiropractors did not monitor supplementation in runners. When supplementation was prescribed for long term use to prevent conditions, chiropractors did not feel it was necessary to monitor. Furthermore, when chiropractors recommended supplements for a certain time period, such as during training and racing or an acute injury phase, then the runners would stop supplementation or lower the dose as instructed by the chiropractor. Thus, chiropractors did not feel the need to monitor supplementation as instructions as to how long to take the supplement had already been provided. Chiropractors further reported difficulty in monitoring patient compliance with supplementation.

The chiropractors were asked how they determined if supplementation has been insufficient and the need to refer a runner to another practitioner for more invasive treatment, such as surgery. Chiropractors referred patients to orthopaedic surgeons if the runner did not display an improvement after chiropractic treatment, if investigations warranted further treatment, and for conditions outside of the chiropractic scope of practice.

6.3 CONCLUSION

This chapter discussed the themes and sub-themes of this study at large. The next and final chapter provides a summary of the study, strengths, limitations and recommendations.

CHAPTER 7

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS OF THIS STUDY

7.1 INTRODUCTION

This chapter discusses a summary of the study findings. Additionally, the study's strengths, limitations and recommendations are addressed.

7.2 SUMMARY OF THE STUDY

The aim of this study was to explore the utilisation of vitamins and minerals by chiropractors in the management of musculoskeletal (MSK) conditions in runners. The participants' responses to the interview questions were included in Chapter 5.

7.2.1 Research Objective 1

The participants were asked numerous questions regarding nutritional advice and supplement recommendations to runners. These questions aimed to answer the first research objective, which was to understand how chiropractors utilise vitamins and minerals to manage MSK conditions in runners. Utilisation include the selection, prescription, dispensing, education and recommendation of supplements. The data revealed a mixed variation in the utilisation of nutritional supplements by South African chiropractors when managing runners. The data noted various factors surrounding the selection and prescription of nutritional supplements by chiropractors to runners, which filled the gap in the literature. Furthermore, the data revealed the dispensing methods of chiropractors and the education provided to runners, alongside the supplement recommendation.

7.2.2 Research Objective 2

The participants were asked throughout the interviews to elaborate on the type of supplements which they recommend to runners and for which conditions. The data revealed a wide range of supplement recommendations which included vitamins, minerals, nutritional supplements, herbal products and homeopathic remedies. The data found that participants recommended supplements for both MSK and non-MSK conditions in runners. The types of conditions were described by the chiropractors, as well as the type of supplement that they frequently recommended for such a condition.

7.2.3 Research Objective 3

The participants were asked if they had personally witnessed or if they were told by runners, whether the supplements had an influence on the management of MSK conditions. The participants reported a positive influence of supplementation when managing runners. The participants objectively noticed improvements and the runners subjectively reported that supplementation had beneficial effects. The supplements lead to a decrease in the clinical presentation of a condition; improvement in signs and symptoms; faster healing of an injury; decreased injury rates; improved post-run recovery; and improvement in performance. The runners further reported improvements in energy and overall feeling. The chiropractors additionally noticed the positive influence of supplementation on the profession as a whole, as runners were likely to return after improved outcomes and the runners gained a better understanding of the profession.

7.2.4 Additional Findings

In addition to the research objectives, the data revealed information regarding the holistic management of runners by chiropractors. The study noted that chiropractors utilise a wide range of treatment protocols when managing a runner. The chiropractors addressed all aspects of the runner to reduce any risk factors associated with MSK conditions, and managed the runner as a whole. This included the use of basic dietary advice in addition to recommending supplements, monitoring supplement use in runners, and referring the runners to other practitioners when necessary. The chiropractors engaged in interdisciplinary management of the runner in order to provide the best possible care.

7.3 STRENGTHS OF THE STUDY

There was a paucity in the literature regarding the utilisation of vitamins and minerals by chiropractors when managing MSK conditions in runners. This study has generated new information to fill such a gap, and has provided new information regarding the active utilisation of supplements by chiropractors when managing runners; the type of supplements commonly advised; the positive influence of supplementation in runners; and the holistic management of runners by chiropractors.

The exploratory qualitative nature of this study allowed the researcher to gain a better understanding of such a topic, allowing the data to be analysed and recorded. This study has generated information which can be utilised by chiropractors in practice when a runner presents with a MSK or non-MSK conditions. This study will aid chiropractors to improve treatment outcomes in runners and, ultimately, contribute to the growth of the profession.

7.4 LIMITATIONS OF THE STUDY

Due to the qualitative nature of the study, the participants provided examples from their memory regarding supplements and conditions during the interviews. Thus, participants could have forgotten to mention certain supplements or conditions. Furthermore, the small sample size of this study limits the data and themes generated.

7.5 RECOMMENDATIONS

It is recommended that a quantitative research be done in order to generate a more detailed outline of all the supplements and conditions which chiropractors recommend to runners. Furthermore, a study of similar nature could be conducted in a different athletic population to grow the data base surrounding this topic.

It is recommended that South African chiropractors, who wish to further their nutritional education in athletes, enrol in nutritional courses or webinars on such topics.
Additionally, chiropractors may further their education with post-graduate studies focused on MSK nutrition in athletes. These courses should elaborate on how nutrition can be used to manage conditions in athletes, and the role that nutrition may have in an athlete's recovery and performance. Further education on supplements should be provided, to enhance healing of injuries in athletes and prevent the development of conditions.

7.6 CONCLUSION

This was an exploratory qualitative study which explored the utilisation of vitamins and minerals by chiropractors when managing MSK conditions in runners. Although some studies have investigated the use of nutritional supplements by chiropractors, no literature exists to support the recommendation of supplements by chiropractors to runners. This study generated new information to fill the gap in the literature. The study described how chiropractors select, prescribe and dispense nutritional supplements to runners. Furthermore, this study revealed which nutritional supplements the chiropractors recommended to runners, and for which MSK and non-MSK conditions these were recommended. The positive influence of supplementation in runners was also described. The study noted a perceived lack of nutritional knowledge by the chiropractors when managing runners.

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APPENDICES

Appendix A: Data Collection Tool

Participant number: ____

Demographic Data:

Age _____

Race _____

Institute of chiropractic qualification_____

Number of years in practice _____

Province of chiropractic practice _____

Research Questions:

1. Describe your methods of utilization of nutritional supplements as part of your management protocols for MSK conditions in runners.
    - As a practitioner, what leads you to prescribe and utilize vitamins and minerals as part of your management protocols for runners?
    - How often do you advise nutritional supplements to runners?
    - What vitamins and minerals do you most commonly advise to runners?
    - What type of conditions do you frequently recommend supplements for?
    - Do you have a supplement protocol for certain types of injuries?
    - What education and advise do you provide when utilizing nutritional supplements as part of your management of a runner?
    - Do you dispense nutritional supplements from your practice or prescribe for the patient to source elsewhere?
    - When you utilize nutritional supplementation in your management protocols, is it supported by investigation? If yes, explain what investigations you use (such as x-rays, blood work etc.).
    - Does your advice regarding supplements differ for the types of runners, such as recreational versus Comrades runners or trail versus road, or female runners versus male?

2. Elaborate on the role nutritional supplementation plays during your management of MSK conditions in runners.
    - Do you advise nutritional supplements only for the treatment of an injury, or do you also recommend supplements for preventative purposes?
    - If you recommend supplementation for prevention purposes, is it for all runners or only runners you feel are at risk of developing a certain deficiency?
    - Do you utilize vitamins and minerals in adjunct to other treatments?
    - Do you recommend the runner keeps using the supplements after the injury has healed?
    - How do you monitor if the patient no longer needs to take the supplementation?
    - Do you recommend supplements to runners as a conservative method for injury healing? If so, when do you decide to cease supplementation for a less conservative approach, example surgery.
    - Do you advise supplements from the very first appointment with the runner when they present with an injury?
3. Discuss the influence and impact of nutritional supplementation in your management of MSK conditions in runners.
    - Do you see improved treatment outcomes in the runner's pain, function and movement after supplementation?
    - Have you observed an overall decreased incidence of injuries in runners?
    - What effect does supplement recommendation have on the runner's perception and attitude?
    - Do athletes report an improvement in performance after utilization of supplements?
4. Describe any additional aspects of nutritional supplementation and education that you include in your management of runners.
    - Do you advise runners on any other nutritional supplements in addition to vitamins and minerals?
    - Do you work with practitioners who specialize in nutrition when advising nutritional supplements to runners?
    - Do you try to correct the runner's diet first before prescribing supplements?
    - Do you advise your patients are how and when different supplements should be taken, and if there are any interaction between supplements?

Appendix B: Letter of Information

LETTER OF INFORMATION

Dear participant,

Thank you for your co-operation. The following information pertains to my study.

Title of the Research Study: An exploration into the utilization of vitamins and minerals by chiropractors in the management of MSK conditions in runners.

Principal Investigator/s/researcher: Lori Louise Niemand (BHSC Chiropractic)
Co-Investigator/s/supervisor/s: Dr Ashura Abdul-Rasheed (M. Tech: Chiropractic; PHD Health Sciences) and Dr Yasmeen Thandar (PHD Pharmacology).

Brief Introduction and Purpose of the Study: The chiropractic scope of practice includes nutritional education and recommendations, such as vitamin and mineral supplementation. Chiropractors are neuromusculoskeletal specialists, who treat a variety of patients. Many MSK conditions may present to the chiropractor as a result of a nutrient deficiency. Previous studies have investigated the use of supplement recommendation by chiropractors, but no study has looked at this topic in relation to the management protocols of MSK conditions in a specific population. This study will look at the use of supplement recommendation and education for runners. This population is prone to nutrient deficiencies as a result of numerous factors. Some being high energy expenditure versus inadequate nutritional intake, and running in extreme environments. Therefore, runners commonly experience a number of MSK injuries as a result of nutrient deficiencies. As it stands, it is unknown what the role of chiropractic supplement recommendation and advise may have on Running-Related Musculoskeletal Injuries and how the runner athlete is managed in terms of nutritional supplements. This study will explore which conditions runners commonly present to the chiropractor with as a result of a vitamin and mineral deficiency, and the effect of supplement recommendation when utilized as part of prevention, treatment and management protocols. This study will highlight what specific supplements are recommended and for what conditions. As well as the impact on healing time and injury prevention in the runner.

Outline of the Procedures: Participants are kindly requested to take part in an interview of approximately 45 minutes. The interview will consist of pre-determined questions and will be conducted either by using an online meeting platform or in person, at the participant's practice. The interviews will be recorded for data capturing purposes.

Risks or Discomforts to the Participant: None have been identified in this study.

Benefits: There is minimal research available on supplement recommendation by chiropractors as part of their management protocols, especially for athletes. Although the study looks at MSK conditions in runners, the outcomes of the study may be beneficial for management protocols for a variety of athletes. This will benefit chiropractors as it may improve their patient outcomes, and in turn benefit athletes as injury prevention, faster healing time and performance are of high importance to this population.

Reason/s why the Participant May Be Withdrawn from the Study: If you wish, you may withdraw at any time with no consequences.

Remuneration: There is no remuneration for participating in this study.

Cost of the Study: There is no cost involved to participate in the study.

Confidentiality: All the information given will be kept confidential and only used for research purposes. Participants' names will be excluded from the study, by using a participant number.

Data: Once the data study has been concluded, all electronic data from the audio recorder will be transferred onto a password protected storage drive belonging to the researcher. The audio recorder will be wiped clean. Only the researcher and supervisors will have access to the drive. After five years, the data will be permanently deleted off the storage drive, including audio recordings and transcripts. All physical documents will be destroyed with a shredder.

Research-related Injury: No injuries should occur due to the interview nature of this study.

Persons to Contact in the Event of Any Problems or Queries:
Researcher: Lori Louise Niemand | 073 720 2095 | loriniemand@gmail.com
Supervisor: Dr Ashura Abdul-Rasheed | ashuraar@gmail.com
Co-supervisor: Dr Yasmeen Thandar | yasmeent@dut.ac.za
Acting Director Research and Postgraduate Support Directorate: Dr Vaneshree Govender | researchdirector@dut.ac.za

Appendix C: Letter of Informed Consent

LETTER OF INFORMED CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, _____ (name of researcher), about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____.
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared
  to participate in the study.
- I understand that significant new findings developed during the course of this research which may
  relate to my participation will be made available to me.

_____	_____	_____	_____
Full Name of Participant	**Date**	**Time**	**Signature**

I, _____ (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____	_____	_____
Full Name of Researcher	**Date**	**Signature**

_____	_____	_____
Full Name of Witness (if applicable)	**Date**	**Signature**

_____	_____	_____
Full Name of Legal Guardian (if applicable)	**Date**	**Signature**

Appendix D: DUT IREC Ethical Clearance

Institutional Research Ethics Committee
Research and Postgraduate Support Directorate
2nd Floor, Berwyn Court
Gate 1, Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

20 July 2023

Ms L L Niemand
15 Northumberland Place
Durban North
4051

Dear Ms Niemand

An exploration into the utilization of vitamins and minerals by chiropractors in the management of musckuloskeletal conditions in runners
Ethics Clearance Number: IREC 091/23

The DUT-Institutional Research Ethics Committee acknowledges receipt of your notification regarding the piloting of your data collection tool.

Kindly ensure that participants used for the pilot study are not part of the main study.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the DUT-IREC according to the DUT-IREC SOP's.

Please note that any deviations from the approved proposal require the approval of the DUT-IREC as outlined in the DUT-IREC SOP's.

It is compulsory for a student or researcher to apply for recertification on an annual basis. The failure to do so will result in withdrawal of ethics clearance. It is the responsibility of the researcher and the supervisor to apply for recertification.

Please note that you are required to submit a Notification of Completion of Study form together with an abstract to the DUT-IREC office on completion of your study.

Yours Sincerely

Prof J K Adam
Chairperson: DUT-IREC

Appendix E: AHPCSA Gatekeeper Permission

Dear Ms Niemand

Thank you for your communication.

If you can forward all relevant information in text only, I will gladly circulate the information, unfortunately our system cannot forward attachments or images.

With kind regards

LEGAL NOTICE | PRIVACY POLICY | AHPCSA WEBSITE

DR LOUIS MULLINDER

ALLIED HEALTH PROFESSIONS COUNCIL OF SOUTH AFRICA

6 Castelli, Il Villaggio,
5 De Havilland Crescent South,
Persequor Technopark, Pretoria 0184

Private Bag X28
Lynnwood Ridge, Pretoria 0040

012 349 2331/2332/2333
registrar@ahpcsa.co.za

See More from Lori Niemand

Appendix F: Advertisement

Do you recommend supplements to runners?

You are invited to participate in my research study!

This study will explore the utilization of
vitamins and minerals
in the management of musculoskeletal conditions in runners.

Here is how you can participate:

If you have been in practice for a minimum of 3 years and regularly see patients, please contact me at:
loriniemand@gmail.com

You will be required to take part in a 45 minute interview, either online or in-person.

Please note the following:

- You will be allowed to withdraw from the study at any point
- No risks or costs are involved for your participation
- Information will be kept confidential and for research purposes only

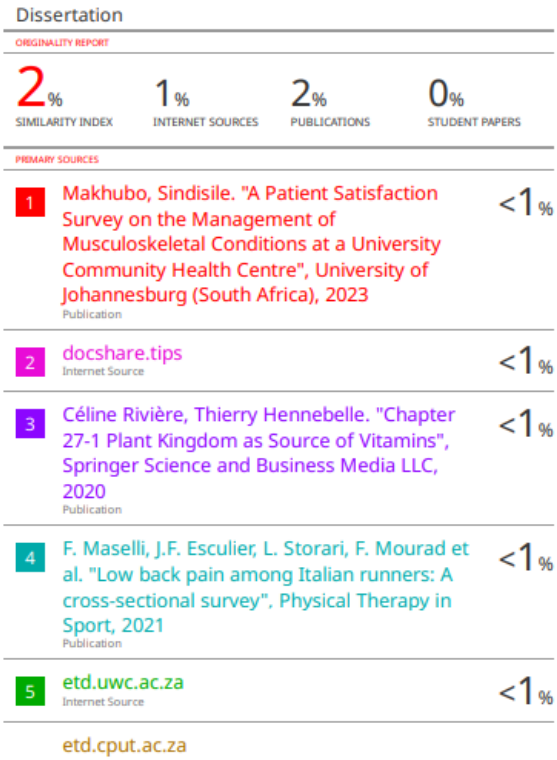
Person to contact for queries:
Researcher: Lori Louise Niemand | 073 720 2095 | loriniemand@gmail.com
Supervisor: Dr.Ashura Abdul-Rasheed | ashuraar@gmail.com
Co-supervisor: Dr.Yasmeen Thandar | yasmeent@dut.ac.za

Appendix G: Plagiarism Report

Dissertation

by Lori Niemand

Submission date: 28-Nov-2023 06:47PM (UTC+0200)
Submission ID: 2239651136
File name: turnitin_submission.docx (132.93K)
Word count: 37287
Character count: 212539



Dissertation

ORIGINALITY REPORT

2%	1%	2%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Makhubo, Sindisile. "A Patient Satisfaction Survey on the Management of Musculoskeletal Conditions at a University Community Health Centre", University of Johannesburg (South Africa), 2023 Publication	<1%
2	docshare.tips Internet Source	<1%
3	Céline Rivière, Thierry Hennebelle. "Chapter 27-1 Plant Kingdom as Source of Vitamins", Springer Science and Business Media LLC, 2020 Publication	<1%
4	F. Maselli, J.F. Esculier, L. Storari, F. Mourad et al. "Low back pain among Italian runners: A cross-sectional survey", Physical Therapy in Sport, 2021 Publication	<1%
5	etd.uwc.ac.za Internet Source	<1%

etd.cput.ac.za

Appendix H: Editor's Certificate

Helen Bond
IMPELA EDITING SERVICES
impelaediting@gmail.com
079 395 5873

28 November 2023

CERIFICATE

Lori Niemand

Dear Lori

Thank you for using Impela Editing Services to proofread your Master's dissertation entitled "*AN EXPLORATION INTO THE UTILIZATION OF VITAMINS AND MINERALS BY CHIROPRACTORS IN THE MANAGEMENT OF MUSCULOSKELETAL CONDITIONS IN RUNNERS*".

I have proofread for errors of grammar, punctuation, spelling, syntax and typing mistakes. I have formatted your work and checked the references (this means checking the formatting), according to the DUT guidelines. I believe your work to be error free.

Kind regards

Helen Bond (Bachelor of Arts, HDE)