NUTRITIONAL MANAGEMENT OF ADULT PATIENTS HOSPITALISED WITH COVID-19 BY DIETITIANS IN KWAZULU-NATAL

by

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ABSTRACT

Background: The outbreak of a novel coronavirus disease (COVID-19) in December 2019, led to a worldwide pandemic. Over the past three years, over 4 million people in South Africa (SA) have been infected with COVID-19, which mainly affects the respiratory system. The presence of existing co-morbidities influences the severity of the illness, and the long-term prognosis. Patients who require hospitalisation for respiratory support are often critically ill and, in most cases, cannot consume enough nutrients. Although dietitians have been involved in the nutritional management of patients hospitalised with COVID-19, there were no guidelines on the nutritional management of COVID-19 available for them to use and they were not trained on its management. There is no consensus on how dietitians managed COVID-19 and which nutritional management guidelines they consulted.

Aim: This study aimed to determine how dietitians managed adult patients hospitalised with COVID-19 in KwaZulu-Natal (KZN).

Objectives: (i) to determine which nutritional guidelines dietitians used in the management of adult COVID-19 patients; (ii) to identify the challenges that dietitians faced when nutritionally managing adult COVID-19 patients; (iii) to determine whether dietitians took or estimated anthropometric measurements in bed-bound and mobile adult COVID-19 patients; (iv) to determine whether dietitians assessed malnutrition risk in adult COVID-19 patients, and if so, which nutrition screening tools were used; (v) to determine if dietitians recommended unconventional mega-doses of micro- and immunonutrient supplements for the management of adult COVID-19 patients and the reasons for use.

Method: A cross-sectional descriptive study, which included dietitians employed in the public and private sectors in KZN was conducted. An electronic self-administered questionnaire was developed and used to collect data via the online platform Google Forms. Initially, the KZN Department of Health (DOH) and the Association for Dietetics in South Africa (ADSA) assisted with distributing the link to the study to dietitians in KZN. However, after an initial poor response, the data collection period was extended and the researcher was granted permission to directly contact and invite dietitians to participate, using publicly-available contact details. Data were collected between 14 August 2022 and 31 March 2023 and analysed using the Statistical Package for Social Sciences (SPSS) version 25.

Results: Of the forty-two dietitians who participated in this study, 52.4% (n=22) were KZN DOH-employed dietitians and 31% (n=13) were ADSA members. Seven-percent (n=3) of the dietitians were both KZN DOH-employed dietitians and ADSA members and approximately

10% (n=4) of the dietitians were neither KZN DOH-employed dietitians nor ADSA members. An equal number of dietitians worked in private hospitals (n=16; 38.1%) and in public district-level hospitals (n=16; 38.1%). A significant number of dietitians began treating COVID-19 patients from the start of the pandemic or during and/or after the first wave of infection (p=0.001). Just over half of the dietitians were no longer treating any COVID-19 patients at the time of data collection (n=22; 52.4%) (p<0.001). Sixty-nine percent (n=29) of dietitians consulted a nutrition society for recommendations on the nutritional management of COVID-19 patients. The European Society for Parenteral and Enteral Nutrition (ESPEN) expert statements and practical guidance for nutritional management of individuals with SARS-CoV-2 infection were most used in the current study. The most frequently used values for calculating macronutrient requirements were: 25-30 kCal/kg/day for energy, 1.2-1.5 g/kg/day for protein, 30% of the total energy requirement (TER) for fat and 50-60% of TER for carbohydrates. Dietitians also reported using actual body weight (ABW) (n=13; 31.0%) or estimated body weight (n=19; 45.2%) to calculate nutritional requirements (p=0.004). Individual challenges faced by the dietitians were similarly grouped. There was significant disagreement among the dietitians that a lack of support and resources (p<0.001) and nutrition-related external factors were challenges they experienced (p<0.001). Anthropometry was assessed in all patient groups, with the main methods used being estimated weight, height and body mass index (BMI) for patients who were bed-bound and unconscious (n=31; 73.8%) (p=0.003). Actual weight, height and BMI were assessed in patients who were fully mobile (n=35; 83.3%) (p<0.001). There was also a significant agreement amongst the dietitians that COVID-19 patients did not feel well enough to have their anthropometric measurements taken. Half of the dietitians reported using a nutrition screening tool to screen for malnutrition (n=21; 50%) and a significant number of dietitians (n=13; 61.9%) used the Nutrition Risk Screening 2002 (NRS-2002) tool (p<0.001). Only 12 dietitians (28.6%) recommended the use of mega-doses of micro- and immunonutrient supplements in their COVID-19 patients, with an overall significant agreement that mega-doses could benefit the patient (p=0.012). All 12 dietitians who recommended mega-doses of micro- and immunonutrient supplements did not report any adverse side-effects in their patients (p<0.001), and most (n=10; 83.3%) noticed an improvement in the condition of their COVID-19 patients (p=0.039).

Conclusion: This was one of the first studies in SA to investigate the nutritional management of adult patients hospitalised with COVID-19. Although dietitians were involved in treating COVID-19 patients from the onset of the pandemic, most were not treating any COVID-19 patients at the time of data collection. Most dietitians consulted the ESPEN practical

recommendations on the nutritional management of critically ill patients to manage their COVID-19 patients. There was no significant consensus amongst the dietitians that medical conditions and complications were challenges faced by the dietitians. Depending on the degree of mobility of the COVID-19 patient, anthropometry was assessed in COVID-19 patients, either by estimation or actual measurements. The most common malnutrition screening tools used by dietitians were the NRS-2002 and the Malnutrition Universal Screening Tool (MUST). Mega-dosing of micro- and immunonutrient supplements was not popular among the dietitians in the current study and further studies are needed in this area.

PREFACE

This dissertation was written between March 2021 and December 2023 using data collected from an online questionnaire in KwaZulu-Natal, under the supervision of Prof Kirthee Pillay.

Signed: [redacted] Date: 07 December 2023

Naseera Ebrahim (Candidate)

As the supervisor of this candidate, I agree to the submission of this dissertation.

Signed: [redacted] Date: 07 December 2023

Prof Kirthee Pillay

DECLARATION OF ORIGINALITY

I, Naseera Ebrahim declare that:

1. The research reported in this dissertation, except where otherwise indicated, is my original research.
2. This dissertation has not been submitted for any degree or examination at any other university.
3. This dissertation does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.
4. This dissertation does not contain another persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:
   a. Their words have been re-written but the general information attributed to them has been referenced.
   b. Where their exact words have been used, then their writing has been placed in italics and inside quotation marks, and referenced.
5. This dissertation does not contain text, graphics or tables copied and pasted from the internet, unless specifically acknowledged, and the source being detailed in the dissertation and in the References section.

Signed: [redacted] Date: 07 December 2023

Naseera Ebrahim (Candidate)

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AA	Arachidonic acid
ABW	Actual body weight
ACE2	Angiotensin-converting enzyme 2
Adj-BW	Adjusted body weight
ADSA	Association for Dietetics in South Africa
ARDS	Acute respiratory distress syndrome
ASPEN	American Society for Parenteral and Enteral Nutrition
BAPEN	British Association for Parenteral and Enteral Nutrition
BIA	Bioelectrical impedance analysers
BMI	Body mass index
BNT162	Pfizer & BioNTech vaccine
BREC	Biomedical Research Ethics Committee
CDC	Centers for Disease Control and Prevention
COVID-19	Coronavirus disease 2019
CPAP	Continuous positive airway pressure
CRP	C-reactive protein
CT	Computed tomography
DHA	Docosahexaenoic acid
DNA	Deoxyribose nucleic acid
DOH	Department of Health
EN	Enteral nutrition
EPA	Eicosapentaenoic acid
ESPEN	European Society for Parenteral and Enteral Nutrition
GIT	Gastrointestinal tract
GLIM	Global leadership Initiative on Malnutrition
GNRI	Geriatric Nutrition Risk Index
GRVs	Gastric residual volumes
HD	Haemodialysis
HIV	Human immunodeficiency virus
HPCSA	Health Professions Council of South Africa
IBW	Ideal body weight
ICU	Intensive care unit

IL	Interleukin
IU	International units
IV	Intravenous
KMO	Kaiser-Meyer-Olkin
KZN	KwaZulu-Natal
MAG	Malnutrition Advisory Group
MCT	Medium-chain triglyceride
MDT	Multidisciplinary team
MNA-SF	Mini Nutritional Assessment-Short Form
MUAC	Mid-upper arm circumference
MUST	Malnutrition Universal Screening Tool
NCDs	Non-communicable diseases
NGT	Nasogastric tube
NHRD	National Health Research Database
NICD	National Institute for Communicable Diseases
NIH	National Institutes of Health
NNIA	Nestlé Nutrition Institute Africa
NRS-2002	Nutrition Risk Screening 2002
NUTRIC	Nutrition Risk in the Critically Ill
ONS	Oral nutrition supplements
$PaCO_2$	Partial pressure of arterial carbon dioxide
PACS	Post-acute COVID-19 syndrome
PN	Parenteral nutrition
POPIA	Protection of Personal Information Act
PPE	Personal protective equipment
RNA	Ribose nucleic acid
RT-PCR	Reverse transcription polymerase chain reaction
SA	South Africa
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
SASPEN	South African Society for Parenteral and Enteral Nutrition
SGA	Subjective Global Assessment
SMOF	Soybean, MCT, olive and fish oils
SNAQ	Short Nutritional Assessment Questionnaire

SPSS	Statistical Package for Social Sciences
TER	Total energy requirements
TNF	Tumour necrosis factor
UK	United Kingdom
UKZN	University of KwaZulu-Natal
USA	United States of America
WHO	World Health Organization

CHAPTER 1
INTRODUCTION, THE PROBLEM AND ITS SETTING

This chapter introduces the study by discussing the importance of the study, the aim and objectives of the study, and the study hypotheses. This chapter also outlines the study parameters and presents the assumptions made. Lastly, key terms used in the dissertation are defined.

1.1 Importance of the study

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first identified in Wuhan, China in December 2019, and spread to most countries worldwide (Azkur *et al* 2020; Cervantes-Pérez *et al* 2020). The coronavirus disease 2019 (COVID-19), which is caused by infection with SARS-CoV-2, is an extremely infectious disease that is easily transmitted among the population (Awadasseid *et al* 2020; Handu *et al* 2020; Olaimat *et al* 2020). In January 2020, cases of COVID-19 were identified outside of China, leading to SARS-CoV-2 spreading rapidly between countries and continents. By 11 March 2020, the World Health Organization (WHO) declared the outbreak a global pandemic (Ciarambino *et al* 2021; Awadasseid *et al* 2020; Azkur *et al* 2020; Cucinotta & Vanelli 2020; Fernández-Quintela *et al* 2020). According to Ash (2020) in just a few short months, many countries were completely overwhelmed and current 21st century medicine was challenged, as health departments all over the world struggled to effectively manage and prevent further spread of SARS-CoV-2. As of 30 November 2023, the total number of confirmed infections globally was 772 052 752, with 6 985 278 COVID-19-related deaths (WHO 2023a). In terms of cases of COVID-19 by region, Europe has had the highest number of infections (36%), followed by the West Pacific (27%), the Americas (25%), South-East Asia (8%), the Eastern Mediterranean (3%) and lastly Africa (1%) (WHO 2023a).

The National Institute for Communicable Diseases (NICD), in collaboration with the Department of Health (DOH) in South Africa (SA) reported its very first case of COVID-19 on 05 March 2020, when a man from KwaZulu-Natal (KZN) presented with COVID-19 symptoms, upon returning from a trip to Italy with a group of 10 individuals. Since then, SA has reported 43% of all COVID-19 cases on the African continent (WHO 2023b). Between March 2020 and December 2021, SA has seen four 'waves' of infection, whereby there has been a substantial and persistent increase in the number of daily cases (SAcoronavirus 2022; NICD 2020).

A SARS-CoV-2 infection can be asymptomatic (Caccialanza *et al* 2020; Tsai *et al* 2020), or it may present with general flu-like symptoms (Donnelly & Keller 2021; Awadasseid *et al* 2020). Some of these include fever (83-98%), cough (50-82%), shortness of breath (19-55%), fatigue, muscle weakness (11-44%), anosmia (loss of or diminished sense of smell) and gastrointestinal disturbances (12-61%) (Awadasseid *et al* 2020; Handu *et al* 2020; Heidary *et al* 2020; Olaimat *et al* 2020; Tsai *et al* 2020). According to Caccialanza *et al* (2020), more serious symptoms include upper respiratory tract infection and severe pneumonia, ultimately causing respiratory failure. A small study in Iran, with 23 participants who had all tested positive for COVID-19, found that 83% reported anosmia as the first symptom they experienced, followed by myalgia and then fever, all of which can affect appetite (Heidary *et al* 2020).

From literature published since 2020, it is clear that SARS-CoV-2 not only affects the respiratory tract in humans, but also colonises the gastrointestinal tract (GIT), affects the kidneys and negatively impacts on neurological function (Thibault *et al* 2020a). This ultimately leads to pneumonia and multi-organ failure (Brugliera *et al* 2020). In some cases, up to 30% of infected patients present with acute respiratory distress syndrome (ARDS) and approximately 10% require urgent medical care for haemodynamic and respiratory support (Thibault *et al* 2020a). According to Behrens *et al* (2021), 85% of COVID-19 patients admitted to the intensive care unit (ICU) met the Berlin criteria for ARDS. According to Matthay *et al* (2021), the Berlin criteria for ARDS includes the following: the development of respiratory failure within one week of clinical insult, respiratory failure that cannot be explained by cardiac failure and lastly, chest imaging that shows unexplainable bilateral opacities.

Almost 5%-12% of patients hospitalised with COVID-19 require ICU admission for mechanical ventilation (Minnelli *et al* 2020). Mechanical ventilation reduces the ability to eat and drink, resulting in the need for a dietetic consultation as part of the multidisciplinary team (MDT) management (Haraj *et al* 2021). According to Handu *et al* (2020), a dietitian should include the following aspects when evaluating the nutritional status of a patient, regardless of the COVID-19 status: food and nutrition-related status, medical history, anthropometric measurements, biochemical and clinical assessments and lastly, the current medical management of the patient.

Since COVID-19 is mainly characterised by a highly acute inflammatory syndrome (Behrens *et al* 2021; Haraj *et al* 2021), the desire and often the ability to consume enough nutrients diminishes, depriving the body of much needed macro- and micronutrients (Donnelly & Keller 2021). The body is more susceptible to diseases and less likely to recover from them, due to the catabolic state that acute illness causes, highlighting the vital role of nutrition in the management of COVID-19 (Haraj *et al* 2021; Handu *et al* 2020; Thibault *et al* 2020a). Nutrition is a key factor in determining the length of recovery time, as many COVID-19 patients experience severe loss of muscle mass (Thibault *et al* 2020a).

According to Handu *et al* (2020), malnutrition is defined as a deficit (undernutrition) or surplus (overnutrition) of energy and/or protein intake over an extended period of time. Recent studies have shown that there is a strong link between malnutrition (specifically undernutrition) and poor disease outcome in COVID-19 patients (Thibault *et al* 2020a). Reber *et al* (2019a) mentions that about 50% of all patients admitted to hospital are malnourished or at risk of malnutrition. A Moroccan study by Haraj *et al* (2021), aimed to assess nutritional status in COVID-19 patients in the ICU, and to describe the prevalence and influencing factors of undernutrition in these patients. Of the 41 participants, 14.6% were undernourished and 65.9% were at risk of undernutrition. Additionally, 61% of the participants had experienced some weight loss, of which 24% had experienced weight loss of more than 10% of their admission body weight. The study also concluded that there was a positive correlation between poor nutritional status and length of ICU stay (Haraj *et al* 2021). According to the cross-sectional study by Li *et al* (2020), 27.5% of patients over the age of 65 years with COVID-19 were at risk of malnutrition and 52.7% were malnourished. The hypermetabolic and inflammatory state that COVID-19 causes, results in a loss of muscle mass and a weakening of the immune system, increasing the severity of the disease (Thibault *et al* 2020b). Additionally, with the lack of sufficient nutritional support during acute infection, the integrity of the GIT is compromised (Minnelli *et al* 2020). Thus, much of the emerging literature on COVID-19 patients highlights the importance of nutrition as an influential factor in disease outcome (Laviano *et al* 2020).

Thibault *et al* (2020a) states that by providing the COVID-19 patient with a sufficient amount of protein and amino acids, the body is able to produce immune cells called lymphocytes. In addition, certain antioxidants play a role in regulating the function as well as the number of lymphocytes that the body is able to produce (Thibault *et al* 2020a). Furthermore, Minnelli *et al* (2020) mentions that there is a need for enteral nutrition (EN) and/or parenteral nutrition (PN) in patients, with or without COVID-19, who are mechanically ventilated to ensure the preservation of the gut-barrier function, thus reducing nutrition-related complications. A recent meta-analysis indicated that early EN plays an important role in reducing the rate of complications, for example pneumonia (Thibault *et al* 2020b). Various bodily functions, enzymatic reactions and immune responses are controlled by micronutrients, which are obtained from the diet and supplements (Minnelli *et al* 2020). According to Cervantes-Pérez *et al* (2020), certain vitamins and minerals are especially important in individuals in a state of hypermetabolic disease, as they function as antioxidants and co-enzymes. Antioxidants reduce oxidative stress and inflammation in the body, as is evident in COVID-19 patients and co-enzymes enable certain chemical reactions to occur (Cervantes-Pérez *et al* 2020; Minnelli *et al* 2020).

Despite there being very limited information on the nutritional support of hospitalised patients infected with SARS-CoV-2, Fernández-Quintela *et al* (2020) states that medical nutritional therapy should be considered as first-line treatment in COVID-19 patients. Early EN and/or PN is recommended by many regulatory bodies worldwide, based on the fact that it maintains the integrity of the GIT, prevents sarcopenia (loss of muscle strength) and assists with immune response (Barazzoni *et al* 2020; Martindale *et al* 2020). Individualised nutrition care plans, developed by dietitians are considered to be central to the recovery of COVID-19 patients (Fernández-Quintela *et al* 2020).

According to Minnelli *et al* (2020), 41% of patients being treated for COVID-19 in certain New York hospitals, showed evidence of underlying co-morbidities. The presence of chronic and/or acute conditions in older COVID-19 patients increased the risk for a poor prognosis and mortality (Minnelli *et al* 2020). Currently, overnutrition (in the form of obesity) affects the treatment and outcome of patients with COVID-19, just as much as undernutrition (Cervantes-Pérez *et al* 2020). According to Fernández-Quintela *et al* (2020), the inflammatory response that is seen in COVID-19 patients is exacerbated by the presence of non-communicable diseases (NCDs), for example type 2 diabetes mellitus, obesity and hypertension. A systematic review by James *et al* (2021), including 22 published articles, 38 preprint articles, and 79 trials, found that obesity and diabetes in COVID-19 patients were associated with a higher risk of severe disease and poorer outcome, across all age groups. Maintaining a good nutritional status is vital in the fight against COVID-19, as adequate dietary practices and good nutrition habits minimise the risk of developing more serious symptoms and complications (Fernández-Quintela *et al* 2020).

The development of vaccines against COVID-19 began in 2020, and progressed rapidly as compared to other vaccines. The United Kingdom (UK) became the first country to approve a COVID-19 vaccine [Pfizer & BioNTech (BNT162)] on 02 December 2020. The WHO approved the use of BNT162 on 31 December 2020 via emergency use authorisation, allowing for global manufacture and distribution (Kashte *et al* 2021). According to the South African Coronavirus website, as of 04 December 2023, SA had administered a total of 39 256 137 doses of COVID-19 vaccines. Furthermore, as at 04 December 2023, the total number of individuals vaccinated in KZN (received either one dose of Johnson & Johnson vaccine, or two doses of the BNT162 vaccine) was 3 636 680. This also indicates that of the nine provinces in SA, KZN has the second highest number of vaccinated individuals (SAcoronavirus 2023a)

Despite the emphasis on nutritional care and management, there are currently no specific guidelines on the nutritional management of patients with COVID-19. However, the European Society for Parenteral and Enteral Nutrition (ESPEN) has published an article of existing guidelines for critically ill patients, which may be applicable to the nutritional management of COVID-19 patients (Barazzoni *et al* 2020). Despite it being almost four years since the initial outbreak of COVID-19, it is still relatively new to healthcare professionals and facilities, and there is much to be learned through clinical practice, expertise and research. With this in mind, many dietitians at the time of the pandemic, in both the public and private sectors treated COVID-19 patients without prior training or protocol on the nutritional management of COVID-19. In addition, there is no consensus on how COVID-19 should be nutritionally managed. This is because there are still many gaps in the literature with regards to specific nutrition guidelines, assessing nutritional status in the COVID-19 population and the challenges that dietitians have experienced when managing COVID-19 patients. This study may help to improve future dietetic practices related to the nutritional management of COVID-19 patients, by providing information on common-practices by dietitians during the COVID-19 pandemic. Whether this information is still relevant in 2024 is debatable, however, it may still prove to be valuable in certain circumstances. Additionally, this study was conducted in KZN because at the time of the study, it had the highest rates of COVID-19 infection after the Gauteng Province (SAcoronavirus 2023b). The aim of this study was to determine how dietitians managed adult patients hospitalised with COVID-19 in KZN.

1.2 Study aim

To determine how dietitians managed adult patients hospitalised with COVID-19 in KZN.

1.3 Study objectives

1.3.1 To determine which nutritional guidelines dietitians used in the management of adult COVID-19 patients.

1.3.2 To identify the challenges that dietitians faced when nutritionally managing adult COVID-19 patients.

1.3.3 To determine whether dietitians took or estimated anthropometric measurements in bed-bound and mobile adult COVID-19 patients.

1.3.4 To determine whether dietitians assessed malnutrition risk in adult COVID-19 patients, and if so, which nutrition screening tools were used.

1.3.5 To determine if dietitians recommended unconventional mega-doses of micro- and immunonutrient supplements for the management of adult COVID-19 patients and the reasons for use.

1.4 Study hypotheses

1.4.1 Dietitians in KZN followed the ESPEN recommendations for nutritional management of COVID-19 patients.

1.4.2 Dietitians faced many challenges when managing adult COVID-19 patients, the most common being GIT intolerances and haemodynamic instability.

1.4.3 Dietitians estimated anthropometric measurements in both bed-bound and mobile adult COVID-19 patients.

1.4.4 Dietitians frequently assessed malnutrition risk and the Malnutrition Universal Screening Tool (MUST) was most commonly used.

1.4.5 Dietitians recommended mega-doses of certain micro- and immunonutrients to manage adult COVID-19 patients, due to their perceived benefits on the immune system.

1.5 Study parameters

1.5.1 Inclusion criteria

1.5.1.1 Dietitians who had treated adult COVID-19 patients in KZN.

1.5.2 Exclusion criteria

1.5.2.1 Dietitians who had not treated adult COVID-19 patients.

1.5.2.2 Dietitians who had treated adult COVID-19 patients in a South African province other than KZN.

1.6 Assumptions

The following assumptions were made in this study:

1.6.1 Dietitians who participated in the study were registered with the Health Professions Council of South Africa (HPCSA) at the time of data collection.

1.6.2 Only the intended dietitian accessed and answered the questionnaire once.

1.6.3 The participants had uninterrupted access to a computer and the internet to complete the questionnaire.

1.6.4 Dietitians understood the language and questions used in the questionnaire.

1.6.5 The participants were honest and truthful when answering the questionnaire.

1.7 Definition of terms

Adult patients: Patients that are over the age of 18 years (SAcoronavirus 2023a).

Anthropometry: Anthropometry involves the assessment of body composition and development over the lifespan of an individual. It is used to assess health and response to nutritional treatment (Heymsfield *et al* 2018).

Close-ended question: These are questions that typically require a single worded answer, for example a 'yes' or 'no' answer to a question that is being asked. Close-ended questions can also require the respondent to select from pre-populated choices (Farrell 2016).

COVID-19: An extremely infectious viral disease caused by a coronavirus called SARS-CoV-2 (Awadasseid *et al* 2020).

Dietitian: According to the HPCSA (2023), a dietitian is defined as a professional who is an expert on diet and nutrition.

Enteral nutrition: A method of delivering nutrients to patients directly into the stomach or small intestine, when they are unable to consume sufficient amounts orally (Mayo Clinic 2021).

Haemodynamic: The measure of the functioning of the cardiovascular system, and the study of the hydrostatic flow of blood within this system (Secomb 2017).

Hospitalised: A patient who is admitted to a hospital for medical care and remains there for the duration of treatment (O'Leary *et al* 2019).

Hypermetabolic: A complex response, which releases catecholamines, glucagon, dopamine and glucocorticoids, which if not treated appropriately, causes intense catabolism, ultimately leading to multi-organ dysfunction (Jeschke 2016).

KwaZulu-Natal: One of the nine provinces in SA (SAcoronavirus 2023a).

Mechanical ventilation: Provision of assisted breathing by applying a positive pressure breath to patients who are unable to breathe sufficiently on their own due to illness or disease (Hickey & Giwa 2023).

Mega-dose: The consumption or administration of certain vitamins and/or minerals in quantities that go beyond ten or more times the recommended intake (Narvaez *et al* 2020).

Nutritional management: The continuous checking and monitoring of certain aspects in patient care. This includes the implementation of a validated nutritional screening tool to assess nutritional status, development of a comprehensive nutrition care plan, timeous delivery of individualised nutritional treatment and constant monitoring of tolerance to the treatment plan (Reber *et al* 2019a).

Open-ended question: A technique used when interviewing or collecting information on a specific topic where respondents are allowed to describe their thoughts or opinions in detail (Weller *et al* 2018).

Pandemic: A pandemic is an outbreak of a disease or infection over a large geographical area, which ultimately spreads globally, infecting a large number of people worldwide (Grennan 2019).

Parenteral nutrition: The intravenous (IV) administration of nutrition in patients who are unable to consume or absorb sufficient nutrients [American Society for Parenteral and Enteral Nutrition (ASPEN)] (ASPEN 2023).

Pilot study: A pilot study is used to test the feasibility of a study prior to conducting the main study. Furthermore, it assists researchers to alter or refine certain aspects of the study in order to streamline the data collection process, identify the time frame needed and find and allocate resources needed for the success of the main study (Ismail *et al* 2017).

Respiratory failure: A serious medical condition where there is insufficient oxygen in the blood, resulting in breathing difficulties (Summers *et al* 2022).

Vaccines: A vaccine is a preparation used to knowingly stimulate the immune system to initiate an immune response, using an inactive protein of a virus or bacteria [Centers for Disease Control and Prevention (CDC)] (CDC 2021).

1.8 Summary

A novel coronavirus emerged in 2019 and spread to almost all parts of the world. This virus primarily affects the respiratory system in humans, with a large number of adults requiring hospital admission. Like with any other illness, the ability of an infected patient to eat and drink is compromised, increasing their risk for malnutrition. Since COVID-19 is a new disease, dietitians have been challenged by how to nutritionally manage patients with the virus, in the absence of COVID-19-specific nutritional guidelines. Due to limited research and data on the nutritional management of COVID-19 patients, this study aimed to determine how dietitians managed adult patients hospitalised with COVID-19 in KZN. It is anticipated that this study will fill these knowledge gaps.

CHAPTER 2
REVIEW OF RELATED LITERATURE

This chapter reviews the most recent literature published on the nutritional management of patients with COVID-19. The pathophysiology of SARS-CoV-2, the impact of nutrition on the immune system, nutritional assessment, nutritional requirements, therapeutic feeding and factors that influence the feeding of COVID-19 patients are reviewed. This chapter also covers the management of COVID-19 patients in the general ward or at home and monitoring and re-assessment of COVID-19 patients.

2.1 Introduction

Since the emergence of SARS-CoV-2 in 2019, the number of individuals infected has increased exponentially. The total number of people in SA who have tested positive for COVID-19 as of 30 November 2023 was 4 072 575, while a total of 102 595 COVID-19-related deaths have been reported (WHO 2023b). According to the South African Coronavirus website last updated on 01 February 2023, in KZN alone, 728 670 cases of COVID-19 were identified (SAcoronavirus 2023b). Since COVID-19 is no longer considered a public health emergency, this may explain the infrequent updates of the statistics on the website. However, this data suggests that SARS-CoV-2 is easily transmitted with a relatively short incubation period of between 1-14 days (Bohn *et al* 2020; Cucinotta & Vanelli 2020; McAloon *et al* 2020; Olaimat *et al* 2020; Tsai *et al* 2020; Zaki & Mohamed 2020). The main route for the spread of SARS-CoV-2 is through human contact with an infected person, thus at the start of the pandemic the WHO advocated for frequent washing of hands, the use of an alcohol-based sanitiser, wearing of masks and other face coverings and most importantly the concept of 'social distancing' to reduce the spread of the virus (WHO 2020).

The progression and prognosis of COVID-19 are significantly influenced by the nutritional status of the individual (Coelho-Ravagnani *et al* 2020). This being said, limited studies have been conducted on the nutritional management of COVID-19, including SA (Barazzoni *et al* 2020). Thus, this literature review covers the pathophysiology of the SARS-CoV-2 virus and the link between the immune system and nutrition. In addition to this, nutritional assessment methods, nutritional requirements, therapeutic feeding and associated challenges relating to COVID-19 patients are reviewed.

2.2 Pathophysiology of SARS-CoV-2

2.2.1 Structure of SARS-CoV-2

After looking at SARS-CoV-2 under an electron microscope, scientists concluded that the virus is spherical in shape, ranging from 60-140 nm in diameter with spike-like protrusions approximately 9-12 nm in length (Mittal *et al* 2020). SARS-CoV-2 is similar in structure to other coronaviruses that have surfaced over the years and consists of a single positive strand of ribose nucleic acid (RNA) (Azkur *et al* 2020; Zhang & Liu 2020), protected by a nucleocapsid, which is surrounded by a lipid bilayer membrane, containing certain spike and membrane proteins (Tsai *et al* 2020). According to Mittal *et al* (2020), the RNA in SARS-CoV-2 contains a genome which codes for both structural and non-structural proteins. The combination of these proteins is responsible for the physical configuration of the virus, and how it functions to attach to the host and infect it (Yadav *et al* 2021).

Structural proteins are responsible for the infection of the host and attachment of the virus to the host cells (Bohn *et al* 2020). These proteins include the spike glycoprotein responsible for attaching to the host cell, the membrane protein, the envelope and the nucleocapsid, all of which control the manufacture and release of the virus (Wong & Saier Jr 2021; Yadav *et al* 2021; Azkur *et al* 2020; Bohn *et al* 2020; Parasher 2020). The basic structure of the SARS-CoV-2 virus is shown in Figure 2.1.

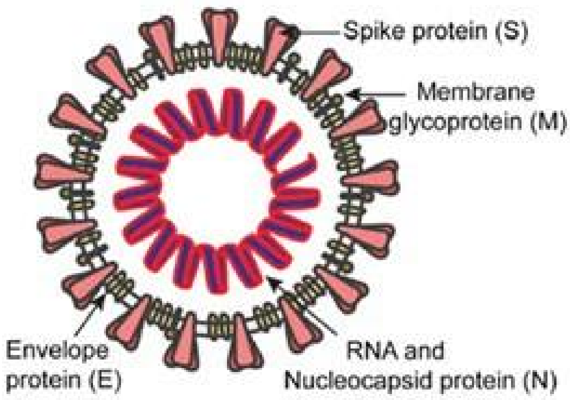

Figure 2.1: Basic structure of the SARS-CoV-2 virus (Mittal *et al* 2020)

SARS-CoV-2 contains approximately 15 non-structural proteins involved in replicating the virus and the transcription of RNA (Raj 2021; Wong & Saier Jr 2021; Mittal *et al* 2020). Other functions of the non-structural proteins include the suppression and disruption of the host's immune system, translation, transcription and enzyme activity. Some also act as co-factors in certain biochemical reactions in the body (Raj 2021).

2.2.2 Invasion of the host cells

It is a complex process for SARS-CoV-2 to enter any host cell. The spike protein has to undergo an intensive action of binding to receptor cells, as well as enzymatic processing to allow the fusion of the virus to the host cell (Walls *et al* 2020). Like other coronaviruses, SARS-CoV-2 also makes use of the angiotensin-converting enzyme 2 (ACE2) receptors in order to gain access to the host cell (Bohn *et al* 2020; Walls *et al* 2020; Wang *et al* 2020). It is known that ACE2 receptors are found in the lungs, heart, thyroid, kidneys, GIT (Thibault *et al* 2020b), and various other organs in the human body (Bohn *et al* 2020). Once the binding sites of the spike protein has successfully bonded with the ACE2 receptors, the membranes of the virus and the ACE2 fuse together (Bohn *et al* 2020). Once fused, the nucleocapsid is inserted into the host cell, and the RNA is then translated and encapsulated in vesicles within the host cell. These vesicles then bind with the plasma membrane of the host cell, and are then released to similarly infect other host cells (Bohn *et al* 2020), facilitating an immune response in the body (Fernández- Quintela *et al* 2020).

2.2.3 The immune response of the host cells

According to literature available on the COVID-19 pandemic, the first line of defense against SARS-CoV-2 is a strong immune system (Bohn *et al* 2020; Fernández-Quintela *et al* 2020; Thibault *et al* 2020a; Thibault *et al* 2020b). The human immune system includes innate and adaptive cells, certain tissue barriers and cell mediators, all of which are affected by SARS-CoV-2 (Azkur *et al* 2020). Certain immune pathways are inhibited and the body's natural antiviral immune response is negatively affected (Azkur *et al* 2020). Furthermore, impaired immune function leads to increased production of pro-inflammatory cytokines, which ultimately causes cellular death (Bohn *et al* 2020). According to Azkur *et al* (2020) and Thibault *et al* (2020b), when a host becomes infected with SARS-CoV-2, the immune system cannot control and coordinate its response, leading to hyper-inflammation and cytokine and chemokine storms. Some of the common cyto- and chemokines are interleukin (IL)-2, IL-7, IL-10, tumour necrosis factor (TNF), C-reactive protein (CRP), ferritin, and D-dimers (Hojyo *et al* 2020). T-cells and B-cells are responsible for the antibody response with SARS-CoV-2, however, these cells are still susceptible to being a host for the virus, causing an increased secretion of certain enzymes and reactive oxygen species. These increased secretions further exacerbate the hyper-inflammatory state (Bohn *et al* 2020).

2.2.4 COVID-19 prognosis

The prognosis with COVID-19 varies from one individual to another. Mortality from COVID-19 can be caused by many factors. One of the main factors is the presence of severe ARDS requiring mechanical ventilation (Mateu *et al* 2023; Heneka *et al* 2020). The African COVID-19 Critical Care Outcomes Study (ACCCOS) across 10 African countries, including SA, with nearly 4 000 patients reported that the in-hospital 30-day mortality from COVID-19 was 48% in patients who were admitted to the ICU or critical care unit (ACCCOS 2021). Another prospective observational study conducted in Cape Town, SA, with 402 COVID-19 patients admitted to the ICU at a tertiary-level hospital, showed an overall ICU-mortality rate of 62% (Nyasulu *et al* 2022). Globally, the mortality rate of COVID-19 patients is constantly changing, due to the presence of existing co-morbidities, access to specialised health care and the roll-out of COVID-19 vaccines (Heneka *et al* 2020).

There are other factors that influence mortality in COVID-19 patients (Heneka *et al* 2020). Age should be considered in the prognosis of COVID-19. Older age is a prognostic factor for a worse outcome, as patients 80 years and older are associated with an 11-fold increased mortality risk (Pascarella *et al* 2020). According to Heneka *et al* (2020), the presence of existing chronic diseases of lifestyle also influence mortality in COVID-19 patients. Laboratory values and inflammation markers, as well as the presence of organ dysfunction also impact the prognosis. It is important to note that the rapid progression of COVID-19 symptoms is not a predictor of poorer outcome, however, the presence of pyrexia (fever) may increase the odds of developing ARDS, but has a lower mortality risk. In the case of COVID-19-related ARDS, there is an increased length of mechanical ventilation and ICU stay, as patients continue to be intubated from between two weeks to a month. Due to prolonged mechanical ventilation, COVID-19 patients are susceptible to developing neurological problems, as studies have shown that one third of COVID-19 patients have some form of motor or cognitive deficit, upon discharge (Heneka *et al* 2020).

Post-acute COVID-19 syndrome (PACS) or long-COVID-19 are the terms used to describe the prolonged symptoms present during recovery from COVID-19 (Mateu *et al* 2023). There is increasing evidence that recovery from COVID-19 can take between several weeks to several months, and many complications may be experienced during recovery (Mateu *et al* 2023; James *et al* 2021). According to Mahase (2020), researchers in Italy, found that of 143 COVID-19 patients discharged from a hospital in Rome, 13% reported being completely symptom free, whilst 87% reported experiencing at least one COVID-19 symptom 60 days after testing positive for SARS-CoV-2. The main symptoms reported were fatigue (53%), dyspnoea (difficulty breathing) (43%), joint pain (27%) and chest pain (22%) (Mahase 2020). Quality of life is negatively affected by PACS (Heneka *et al* 2020; Mahase 2020), and it appears to affect women more than men (Al-Jahdhami *et al* 2021). A more recent prospective cohort study conducted in Spain, in which 548 COVID-19 patients were followed for almost two years, showed that 62% of the patients had some form of PACS, and only 38% fully recovered within that timeframe. The patients with PACS reported experiencing symptoms such as fatigue, dyspnoea, cough, diarrhoea, muscle pain and weakness and chest pain. Symptoms appeared to be more common in patients with pre-existing co-morbidities (Mateu *et al* 2023).

2.2.5 COVID-19 vaccinations

Vaccination against COVID-19 is a strategy to reduce the transmission of SARS-CoV-2 and to guard against clinical disease and death (Silva *et al* 2022). According to Roghani (2021) and Wang *et al* (2021), prioritisation according to age and risk is a valid initial approach and strategy in the distribution of COVID-19 vaccines. Vaccinated individuals may still contract COVID-19, but tend to have mild symptoms and recover better that those who are unvaccinated (Silva *et al* 2022). This is supported by data from numerous countries, showing that the distribution of COVID-19 vaccines has had a major positive impact in reducing COVID-19-associated infections, need for hospitalisation and death (Silva *et al* 2022).

Roghani (2021) aimed to understand the relationship between age-specific COVID-19 vaccinations and the number of daily cases, hospitalisation and mortality rate, among individuals living in Tennessee, United States of America (USA). It was found that COVID-19 vaccinations in the elderly population (≥ 71 years old) reduced the death and hospitalisation rates by 95% and 80%, respectively, with a significantly reduced number of daily cases among the whole adult population (Roghani 2021). Notarte *et al* (2022) conducted a systematic review including 17 studies on vaccination and long-COVID-19. Six of these studies agreed that COVID-19 vaccination prior to SARS-CoV-2 infection showed a reduced risk of developing long-COVID-19 in those with mild to moderate illness. Most studies focused on the short-term effects of the vaccines (1 week to 1-month post-vaccination) and only two studies considered patient follow-up in six-month periods. Unfortunately, no study included in this systematic review explored the outcome of booster vaccines on long-COVID-19. This review suggested two hypotheses to explain how vaccines may affect long-term side-effects of COVID-19. These hypotheses include reduced severity of the disease (less risk of developing systemic disorders, onset and duration) and an accelerated clearance of the virus from the body (reduced inflammation and immune response) (Notarte *et al* 2022).

2.3 Nutrition and the immune system

2.3.1 Dietary influences on the immune system

Although the immune system is impacted by various factors such as age, sex, lifestyle, environment and genetics, the most significant factor is nutrition (Aman & Masood 2020). A systematic review by Zhang & Liu (2020), which summarised therapeutic options for treating coronaviruses, found that inadequate nutrition may lead to a weakened immune system response. Approximately 80% of the immune system is found in the gut, therefore a healthier gut leads to a healthier immune system (Mishra & Patel 2020).

For the immune system to function effectively in the presence of SARS-CoV-2, an abundant supply of energy and macronutrients is essential (Aman & Masood 2020). During periods of acute inflammation and illness, the immune system is activated and requires an increased amount of energy to meet the increased basal energy expenditure that is evident (Childs *et al* 2019). Furthermore, protein requirements are also increased as certain amino acids become conditionally essential. For example, arginine is involved in the generation of nitric oxide from macrophages and glutamine is required for certain cell processes during acute illness (Childs *et al* 2019). The quality of protein consumed instead of the quantity plays a role in improving the functioning of the immune system (Fernández-Quintela *et al* 2020). According to Mishra & Patel (2020), reducing the intake of dietary fat enhances immune defenses in the body. This is supported by research showing that fats and oils could possibly affect the way white blood cells function in the body (Mishra & Patel 2020). Furthermore, certain fatty acids such as omega-3 polyunsaturated fatty acids play a significant role in controlling and resolving inflammation that is evident in COVID-19 patients (Calder *et al* 2020). Carbohydrates, specifically refined, may contribute to weight gain, obesity and chronic inflammation, causing more COVID-19 complications due to an altered body response to infection (Childs *et al* 2019).

Micronutrients, including vitamins and minerals are important co-factors for certain chemical reactions in the body and help to maintain immune system function. Available evidence indicates that the consumption of certain vitamins and minerals improves immune system function, thus allowing it to better fight off SARS-CoV-2 (Aman & Masood 2020; Brugliera *et al* 2020; Cervantes-Pérez *et al* 2020; Fernández-Quintela *et al* 2020; Mishra & Patel 2020; Childs *et al* 2019). Vitamins A, some B-complex, C, E, D and minerals including zinc, selenium, iron and copper, appear to benefit the immune system. Contrary to this, Aman & Masood (2020) believe that there is no current evidence to support the use of micronutrient supplements as an immune booster or to treat and prevent viral infections, with the exception of vitamin C.

2.3.2 Other influences on the immune system

According to Ciarambino *et al* (2021), there are many factors other than nutrition, which influence the immune system. Firstly, age is a powerful factor as increasing age increases susceptibility to infections, through the concept of immune aging. Immune aging is a chronic state of inflammation in which the response of the innate immune system to viral pathogens is inadequate. This inadequacy is characterised by raised serum levels of certain acute phase proteins and some pro-inflammatory cytokines, for example, CRP, TNF, IL-6 and IL-8. Furthermore, aging results in the release of antibodies that have a weaker response and a lower affinity for pathogens. In the case of older adults, this state predisposes the individual to severe COVID-19 by exacerbating the state of inflammation (Ciarambino *et al* 2021).

According to Ciarambino *et al* (2021), females have a higher innate immune response than males, as females produce much lower amounts of pro-inflammatory mediators compared to men; this increases their resistance to infections. Female hormones such as oestrogen, influence the regulation of the immune system by suppressing androgen receptors and immune cell activity. This activity may decrease the severity and mortality rates to a greater extent in female COVID-19 patients, compared to males (Ciarambino *et al* 2021; Zhang & Liu 2020).

An article by Fragkou *et al* (2021), which investigated nutrition in the early stages of life and the impact that it has on the immune system, indicates that the hypothesis of fetal and infant origin of disease underlines the relationship between early life malnutrition and the risk for developing NCDs such as type 2 diabetes mellitus, hypertension, obesity, cardiac malfunction, respiratory distress and kidney disease in later life. Furthermore, the authors highlight the link between gut microbiota, malnutrition, NCDs and the impact it has on the immune system in later life (Fragkou *et al* 2021).

2.4 Nutritional assessment of COVID-19 patients

2.4.1 The role of the dietitian

Since dietetics combines evidence-based nutrition with health and disease status, dietitians are best placed to offer nutritional support, advice and counselling to patients in a hospital setting and in private practice (Terblanche 2019; Endervelt & Gesser-Edelsburg 2014). In literature published on COVID-19, there is a consensus that all patients admitted to hospital (ICU and general ward), should have a consultation with a dietitian in order to assess nutritional status and for nutritional management (James *et al* 2021). Because dietitians are essential members of the MDT managing COVID-19, improvements in patient prognosis and outcome are more likely if dietitians are involved in management (Terblanche 2019).

2.4.2 The importance of nutritional assessment

A thorough nutritional assessment of the patient by a dietitian is the first step in any nutrition care plan (Van Tonder *et al* 2019). Many recent studies and guidelines (Barazzoni *et al* 2020; Caccialanza *et al* 2020; Li *et al* 2020; Thibault *et al* 2020a; Thibault *et al* 2020b), mention that COVID-19 patients are at high risk for poor nutritional status, thus, emphasising the importance of nutritional assessment. A cross-sectional study conducted on elderly COVID-19 patients over 65 years admitted to Wuhan Tongji Hospital in China during January and February 2020, found that 27.5% of the patients assessed were at risk for developing malnutrition, while 52.7% of the patients were malnourished (Li *et al* 2020). This suggests that elderly patients with COVID-19 appear to have a higher prevalence of malnutrition (Li *et al* 2020).

It should be noted that timeous nutritional care and intervention in COVID-19 patients is key to avoiding further complications in the future (Thibault *et al* 2020a). Some of these complications include a prompt decline in motor and respiratory muscle function, dyspnoea, dysgeusia, changes in blood parameters, wasting and even dysphagia (Thibault *et al* 2020b). Cervantes-Pérez *et al* (2020) also believe that assessing the nutritional status of COVID-19 patients, and the early treatment of malnutrition is the foundation for reducing the risk for complications and allowing for a successful recovery and improved quality of life. This is supported by Brugliera *et al* (2020), who mention that overall health is mainly determined by nutritional status in patients with or without COVID-19. According to Zhang & Liu (2020), the nutritional status of a COVID-19 patient should be assessed prior to treatment and factored into their management.

2.4.3 Tools used for nutritional screening

To date, most of the available literature indicates that nutritional screening tools should be used to quickly and efficiently assess hospitalised COVID-19 patients for risk of poor nutritional status (Cervantes-Pérez *et al* 2020). However, it is important to remember that there is no gold standard nutritional screening tool (Cervantes-Pérez *et al* 2020) and screening tools such as the MUST (Appendix A) and Nutrition Risk Screening 2002 (NRS-2002) (Appendix B) have been frequently used by healthcare professionals for many years prior to the COVID-19 pandemic. In addition to the MUST and NRS-2002, there are various other screening tools currently being used to assess patients at risk for poor nutritional status. Some of these tools are shown in Table 2.1.

Table 2.1: Various screening tools used to assess COVID-19 patients at risk for poor nutritional status

Screening tool	Acronym	Aim of screening tool
Mini Nutritional Assessment-Short Form	MNA-SF	To measure nutritional risk in older patients by assessing biochemical, clinical and dietetic factors.
Geriatric Nutrition Risk Index	GNRI	To measure nutritional risk in older patients.
Nutrition Risk Screening 2002	NRS-2002	To measure nutritional risk in hospitalised patients.
Malnutrition Universal Screening Tool	MUST	To measure nutritional risk in patients over the age of 65 years.
Short Nutritional Assessment Questionnaire	SNAQ	To predict weight loss and malnutrition in the early stages of hospitalisation.
Nutrition Risk in the Critically Ill	NUTRIC	Indicated for ICU patients at risk for developing adverse events, which may be modified by aggressive nutrition therapy.
Subjective Global Assessment	SGA	Used to predict outcomes in critically ill patients, by assessing biochemical, clinical and dietetic factors.
Global Leadership Initiative on Malnutrition	GLIM	A relatively new approach to diagnose malnutrition in adult patients, based on phenotypic and etiologic criteria.

2.4.3.1 Malnutrition universal screening tool

Patients who are infected with SARS-CoV-2 and at higher risk for worse outcomes and mortality should be screened using the MUST (Braun 2020). The MUST was developed in the UK in 2003 by the Malnutrition Advisory Group (MAG) to assess body mass index (BMI) status (regardless if accurate weight and height are available or not), the presence of unintentional loss of approximately 5-10% of body weight during the previous 3-6 months, and lastly, the presence of acute illness in patients who could not eat during the previous five consecutive days (Hormozi *et al* 2019). According to Reber *et al* (2019b), the MUST can be applied to all health care settings, including hospitals, clinics, care homes and nursing homes. The scoring system of the MUST is as follows: 0 points indicates that the patient has a low risk for malnutrition (requiring routine care), a score of 1 indicates that the patient has a medium risk for malnutrition (requiring observation), and lastly, a score of 3 indicates a high risk for malnutrition (requiring immediate intervention and treatment) (Reber *et al* 2019b).

According to Hormozi *et al* (2019), the MUST is preferred as it provides a more accurate approximation of the nutritional status of the patient, and requires less time to complete than other tools. The MAG, which is part of the British Association for Parenteral and Enteral Nutrition (BAPEN) mentions that the MUST is appropriate to screen all adults, regardless of whether they are hospitalised or not (BAPEN 2020). The BAPEN (2020) goes on to discuss recommendations for both ICU/critical care units and hospitalised patients in the general ward. In the ICU and/or critical care unit, patients are unlikely to consume anything orally for extended periods of time. In this case, the MUST will classify the patient as being at a high risk for malnutrition, and will require urgent nutritional intervention, and regular reassessments to monitor patient tolerance (BAPEN 2020).

2.4.3.2 Nutrition risk screening tool 2002

As stated by Reber *et al* (2019b), the NRS-2002 was developed with the purpose of being a general tool that can be used in hospitals to identify patients who may need nutrition intervention. This screening tool consists of four questions, each scoring from 0-3 points. If a patient scores 3 points or more, the patient is either at risk for malnutrition, or already malnourished. If a patient scores less than 3 points, then re-assessment should be done after a week. This screening tool consists of pre-screening questions, similar to that of the MUST questionnaire. If a patient answers 'yes' to any of the pre-screening questions, the healthcare worker will then need to move to the screening section of the tool. The screening section is made up of two sections: section A, which evaluates nutritional status and section B, which looks at the metabolic stress or severity of the disease. The last part of the questionnaire considers the age of the patient. Patients older than 70 years score 1 point, as they are at increased nutritional risk (Kroc *et al* 2021; Reber *et al* 2019b).

In a retrospective study conducted in Switzerland by Del Giorno *et al* (2020), the NRS-2002 tool was used to assess the nutritional status of 90 patients with COVID-19. Of these patients, 92% presented with nutritional risk. Various factors were measured against the NRS-2002 tool, including length of hospital stay, prolonged length of stay, loss of appetite, need for ICU and death. The findings of this study indicated that there was a significant relationship (p=0.030) between screening COVID-19 patients with the NRS-2002 and length of hospital stay, as the nutritional risk based on the NRS-2002 screening tool independently predicted length of hospital stay. Furthermore, it was found that the NRS-2002 had a 100% sensitivity for patient outcome, prolonged length of stay and loss of appetite, however, it had a low specificity (22%, 23% and 34%, respectively) (Del Giorno *et al* 2020).

2.4.4 Anthropometric assessment in COVID-19 patients

Although anthropometry is highlighted as one of the main tools for nutritional assessment (Bagni *et al* 2021), it is not always possible for dietitians to conduct a full anthropometric assessment on patients with COVID-19 (Thibault *et al* 2020a). Anthropometry involves the following measurements: weight, height, BMI, waist, hip, head and calf circumferences, and skinfold thickness (Casadei & Kiel 2021). Furthermore, anthropometric assessment is an easy to conduct, standardised method that is minimally invasive with low costs to the health professional and the patient (Bagni *et al* 2021; Casadei & Kiel 2021). Since the COVID-19 pandemic encouraged physical distancing, there were limited guidelines relating to anthropometric assessment in the COVID-19 population (Bagni *et al* 2021). However, according to Poros *et al* (2021), the majority of studies on COVID-19 patients used BMI to classify nutritional status. Globally, there has been a lack of equipment in many facilities treating COVID-19 patients (Thibault *et al* 2020b). In these cases, estimation of anthropometry and body composition by a dietitian was an alternative (Brugliera *et al* 2020). Unfortunately, there is limited data available on anthropometry in COVID-19 patients, as many initial studies neglected to include this aspect of patient care (Földi *et al* 2020).

A study in the Netherlands by Moonen *et al* (2021), aimed to measure body composition in

COVID-19 patients in the general ward and ICU, by means of bioelectrical impedance analysers (BIA), to reveal any relationship between body composition and course of the disease. This study found that there was no significant relationship between BMI, fat mass or fat-free mass distribution and the severity of illness in COVID-19 patients. However, a limitation that should be considered is that the study was relatively small, with only 54 participants (Moonen *et al* 2021). In another retrospective study on critically ill COVID-19 patients, computed tomography (CT) scans were used as an alternative method to measure skeletal muscle mass and visceral adipose tissue as indicators for length of hospital and ICU stay, duration of mechanical ventilation, and in-hospital death. The outcomes of this study concluded that higher visceral adipose tissue and lower skeletal muscle mass were associated with worse outcomes (Poros *et al* 2021). Földi *et al* (2020) conducted a systematic review and meta-analysis on obesity as a risk factor for critical illness in COVID-19. In this article, BMI was the anthropometric measurement of choice, and it was found that COVID-19 patients with a higher BMI had a higher risk of ICU admission and a greater need for invasive mechanical ventilation (Földi *et al* 2020).

2.5 Nutritional requirements for COVID-19 patients

2.5.1 Macronutrients

To date, there are currently no published studies on the nutritional management of COVID-19 patients. However, it is known that inadequate nutrition in critically ill patients increases the risk for mortality and patients may require more time in the ICU (Arkin *et al* 2020). Because SARS-CoV-2 causes hyper-inflammation, a major challenge for healthcare workers is to minimise the hyper-inflammatory state, without compromising the response of the immune system (Fernández-Quintela *et al* 2020). Furthermore, greater focus is placed on the medical management of COVID-19 patients compared to the nutritional management (Fernández-Quintela *et al* 2020). Most COVID-19 patients are supportively managed, but many healthcare workers do not understand that nutrition is a component of this supportive care (Fernández-Quintela *et al* 2020). Consistent with Barazzoni *et al* (2020) and Handu *et al* (2020), the guidelines that are recommended for the nutritional management and rehabilitation of adult COVID-19 patients are based on currently available evidence, knowledge and clinical experience of dietitians managing critically ill hospitalised patients, as recommended by ESPEN. There is still much to be learned about nutrition in COVID-19 patients and the long-term effects that nutrition may have on disease outcome (Barazzoni *et al* 2020).

2.5.1.1 Energy

The South African Society for Parenteral and Enteral Nutrition (SASPEN), released a document that refers to the ESPEN recommendations for energy requirements in adult patients with COVID-19. The energy requirements suggested in the SASPEN document is primarily based on the ESPEN requirements for polymorbid and geriatric patients. This is due to the fact that polymorbid and geriatric patients make up the majority of the COVID-19 patients in hospital and are at increased risk for malnutrition (SASPEN 2020). Indirect calorimetry can be used to determine the energy requirements of patients, however, in the case of the COVID-19 pandemic, this should only be done if the necessary disinfection and sanitising procedures are observed (Thibault *et al* 2020b). Alternatively, weight-based or predictive equations may be used (Barazzoni *et al* 2020).

Most recommendations and guidelines use actual body weight (ABW) to calculate energy requirements for patients. However, to account for differences in body type and composition (in the case of obesity or severe undernutrition), ideal body weight (IBW) or adjusted body weight (Adj-BW) are preferred (Barazzoni *et al* 2020; Martindale *et al* 2020). According to Lahner (2019), IBW is considered the weight at which nutritional requirements are adequately met for both under- and overweight patients. Ideal body weight can be calculated as follows: IBW = BMI x height (metres)^2. Depending on whether the patient is under- or overweight, the lower limit or upper limit, respectively, of the normal BMI range (18.5 – 24.9 kg/m^2) should be used in the IBW calculation. In addition, Adj-BW is used in patients with amputations, oedema and kidney disease, to account for missing limbs or extra fluid. Adjusted body weight is calculated as follows: IBW + (ABW – IBW) x 0.33 (Lahner 2019).

ESPEN makes the following recommendations for energy intake in COVID-19 patients (Barazzoni *et al* 2020):

- Individuals over the age of 65 years, with polymorbid conditions should aim to consume 27 kCal/kg/day.
- For severely underweight patients with polymorbid conditions, the recommendation is 30 kCal/kg/day. It is essential to monitor for refeeding syndrome in these patients, and a gradual increase in energy should be implemented.
- In the case of older individuals, the recommendation is 30 kCal/kg/day. However, this may be individually adjusted to compensate for physical activity, nutritional and disease status, and dietary tolerance.

2.5.1.2 Protein

Dietary protein is essential to prevent loss of muscle mass. According to Fernández-Quintela *et al* (2020), the functioning of the immune system is dependent on the amount and quality of protein it receives, as a deficiency decreases the quantity of immunoglobulins and gut-associated lymphoid tissue available in the body. Furthermore, amino acids such as glutamine and arginine are known to support the immune system and its functioning (Fernández-Quintela *et al* 2020; Childs *et al* 2019). The ESPEN recommendation for protein intake in COVID-19 patients is based on current guidelines for critically ill patients, as follows (Barazzoni *et al* 2020):

- In older individuals, the protein requirement is 1 g/kg/day. This amount can be adjusted to accommodate for factors such as nutritional status, disease condition, activity level and dietary tolerance.
- In patients with polymorbidity, protein intake should be 1-1.3 g/kg/day. This is to prevent further weight loss and risk of complications.
- Critically ill patients can be given 1.3 g/kg/day of dietary protein, given that Adj-BW is used to calculate requirements (Barazzoni *et al* 2020).

According to a statement by Braun (2020), there is a time-dependent association between protein intake and mortality in critically ill patients. With regards to ventilated patients, there appears to be a relationship between gradually increasing protein over five days and lower mortality rates. On the first two days, a lower intake is recommended (<0.8 g/kg/day). Between days three and five, an intermediate amount of protein should be used (0.8-1.2 g/kg/day) and after day five, protein requirements are >1.2 g/kg/day. On the contrary, Handu *et al* (2020) and Minnelli *et al* (2020) both mention that a patient should receive between 1.2-2 g/kg/day of protein. However, giving a critically ill patient a lower amount of protein, without slowly increasing the amount, may result in a lower survival rate (Braun 2020).

2.5.1.3 Fat

The ESPEN-endorsed article regarding nutrition in COVID-19 patients, suggests a fat intake of 30% of the total energy requirement (TER) in patients who are non-ventilated or who do not have respiratory deficiency (Barazzoni *et al* 2020). However, if the patient is ventilated or requires respiratory support, 50% of the total energy intake should come from fat (Barazzoni *et al* 2020). Polyunsaturated fatty acids such as α-linolenic acid (omega-3) and linoleic acid (omega-6) are considered essential as the body lacks the enzymes needed to produce these compounds. Thus, they need to be obtained from the diet and other sources (Darwesh *et al* 2021). In the body, α-linolenic acid undergoes a series of reactions and is metabolised into eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are important for inhibiting cytokine secretion, limiting inflammation and antioxidant action (Darwesh *et al* 2021; Di Renzo *et al* 2020).

It has been proposed that fish oil emulsions administered parenterally, containing 4-6 g/day of EPA and DHA, may benefit patients with severe COVID-19 (Bistrian 2020; Zhang & Liu 2020). Additionally, the immunomodulatory properties evident in polyunsaturated fatty acids could improve the outcome of COVID-19 patients with severe underlying conditions such as obesity, diabetes, hypertension and in the elderly with COVID-19 (Fernández-Quintela *et al* 2020). On the contrary, linoleic acid can be metabolised into arachidonic acid (AA), which can compete for the same metabolic pathways as α-linolenic acid, in addition to linoleic acid being considered pro-inflammatory. Nowadays, diets are high in omega-6 fatty acids, which may cause a rise in AA, leading to increased production of cytokines, thromboxanes, leukotrienes and CRP, thus increasing susceptibility to COVID-19. With this in mind, a balanced omega-3 to omega-6 ratio is important for good health (Simopoulos 2021).

2.5.1.4 Carbohydrates

Fernández-Quintela *et al* (2020) states that the functioning of the immune system is also related to dietary carbohydrates, including dietary fibre. The type of carbohydrates consumed plays an important role in how the body processes it. For example, carbohydrates with a higher glycaemic index place a higher burden on the mitochondrion in the cells of the body. This results in the body producing more inflammatory cytokines, which exacerbates the disease condition. Many studies have shown that by consuming an adequate amount of fibre per day (25-35 g/day), there is a reduction in both GIT and systemic inflammation, which may be helpful in the management of COVID-19 patients. Furthermore, there is an increase in the production of short chain fatty acids (butyrate, propionate and acetate), which appears to have a direct anti-inflammatory affect as it impedes the release of pro-inflammatory cytokines, which have a beneficial effect on the microbiota in the GIT and the respiratory tract. Since COVID-19 mainly affects the respiratory and GIT systems, it seems plausible that by enhancing the functioning of these systems, a better outcome may be possible (Fernández-Quintela *et al* 2020). In critically ill patients without any respiratory complications, ESPEN recommends that 70% of TER should come from carbohydrates, whereas in patients who are ventilated or have some form of respiratory issue, the recommendation is to provide 50% of TER from carbohydrates (Barazzoni *et al* 2020).

2.5.2 Micronutrients

To date, there has been much speculation on the role of certain vitamins and minerals in the prevention and/or treatment of COVID-19. According to Handu *et al* (2020), there is a lack of scientific evidence to support the administration of vitamins and minerals in COVID-19 patients, be it through oral supplements or IV. However, there is no data to suggest that micronutrient supplements are harmful in COVID-19 patients (Philipp *et al* 2021). There is a substantial link between micronutrients and the optimal functioning of the immune system (Khaled 2020). Some patients, such as polymorbid adults, may utilise certain micronutrients faster without consuming adequate amounts, thus putting them at increased risk for developing deficiencies (Gomes *et al* 2018). In all cases, dietitians should base their decision on whether or not to recommend supplemental micronutrients on scientific evidence and clinical experience (Handu *et al* 2020). An underlying micronutrient deficiency may negatively impact the immune system, impairing resistance to infections (Fernández-Quintela *et al* 2020). Arkin *et al* (2020) agrees with this and adds that micronutrient deficiencies at the time of ICU admission, creates more complications with regards to nutritional management. During periods of viral infection, micronutrient supplementation should be part of the standard nutrition approach for patients so as to limit the severity of illness and improve recovery from the infection (Barazzoni *et al* 2020).

Zhang & Liu (2020) conducted a systematic review on the potential interventions for COVID-19 in China. The interventions included certain vitamins, minerals and other compounds that may have the potential to benefit an individual infected with SARS-CoV-2. It was found that nutrient-specific interventions and the use of antiviral treatments were very useful in the management of COVID-19. Furthermore, Barazzoni *et al* (2020) refers to certain micronutrients (vitamins and minerals) that are important for the functioning of the immune system, especially in COVID-19 patients. Both SASPEN and ESPEN recommend that the daily requirements for vitamins and minerals be met in COVID-19 patients so that the patient's immune system is not compromised. However, ASPEN does not mention the use of micronutrient supplements in COVID-19 patients (Martindale *et al* 2020). If micronutrient supplements are given to a patient with or without COVID-19, the supplement should contain a complete range of both vitamins and trace elements and should be in the recommended daily quantities (Gomes *et al* 2018). Some researchers recommend supplementing COVID-19 patients with micronutrients in doses beyond the recommended amounts (mega-dosing) (Barazzoni *et al* 2020; Fernández-Quintela *et al* 2020). It is important to note that current guidelines oppose routine mega-dosing of micronutrients in the management of COVID-19, as there is insufficient evidence that it prevents or improves the clinical outcome of COVID-19 (SASPEN 2020).

A study by Voelkle *et al* (2022) investigated the prevalence of micronutrient deficiencies for eight different micronutrients (vitamins A, B_9, B_{12}, D, E, zinc, selenium and copper) in 57 hospitalised COVID-19 patients. It was found that deficiencies of vitamin A (39%), vitamin D (40%), zinc (39%) and selenium (51%) were the most prevalent in this population. Furthermore, this study found that COVID-19 patients with multiple micronutrient deficiencies were at a higher risk for more severe COVID-19 infection, however, further research is needed in this area (Voelkle *et al* 2022).

2.5.2.1 Vitamins

Several recent articles have highlighted the use and importance of certain vitamins in COVID-19 patients (James *et al* 2021; Barazzoni *et al* 2020; Calder *et al* 2020; Cervantes-Pérez *et al* 2020; Dehghani-Samani *et al* 2020; Di Renzo *et al* 2020; Fernández-Quintela *et al* 2020; Olaimat *et al* 2020; Zhang & Liu 2020). One of the most commonly discussed vitamins is vitamin A. According to James *et al* (2021), Barazzoni *et al* (2020) and Zhang & Liu (2020), vitamin A is referred to as the anti-infective vitamin as many of the defense systems in the body depend on an adequate supply of vitamin A for optimal functioning. Vitamin A, in the form of retinoic acid and carotenoids, increase T-cell proliferation and differentiation, which decreases oxidative stress and improves the antibody response in the body, all of which decrease the risk of developing ARDS (Jovic *et al* 2020). Additionally, vitamin A regulates natural killer cells and maintains tissue integrity in the body, which is thought to have a protective effect against the complications of some diseases, including lung disease, diarrhoea, malaria, measles and human immunodeficiency virus (HIV) (James *et al* 2021; Barazzoni *et al* 2020; Calder 2020; Di Renzo *et al* 2020; Zhang & Liu 2020). Vitamin A should be supplemented in COVID-19 patients who present with some form of malnutrition, in order to improve clinical outcome (Braun 2020).

According to Cervantes-Pérez *et al* (2020), Di Renzo *et al* 2020, Jovic *et al* (2020) and Zhang & Liu (2020), the vitamin B-complex act as coenzymes for energy and protein metabolism in the body. Despite a lack of information on vitamin B-complex and COVID-19, a systematic review by Dehghani-Samani *et al* (2020) mentions that there is evidence to suggest these vitamins have an important role in the functioning of the immune system, which is vital in the case of COVID-19. Vitamin B-complex can suppress oxidative stress in cells, decrease the production of pre- and pro-inflammatory cytokines, maintain epithelial barriers and differentiate and proliferate lymphocytes (Dehghani-Samani *et al* 2020; Jovic *et al* 2020). There is some evidence that vitamins B_3 (niacin), B_9 (folate) and B_{12} (cobalamin) may have potential binding affinity for the SARS-CoV-2 protease, by reducing IL levels in alveolar tissue, acting as precursors for deoxyribose nucleic acid (DNA) synthesis, and preventing the binding of the spike protein to the ACE2 receptors (Kumar *et al* 2021; Jovic *et al* 2020). Furthermore, Kumar *et al* (2021) mentions that vitamin B_1 (thiamine) plays a crucial role in the reduction of SARS-CoV-2 by prompting cell-mediated immunity, thus, sufficient levels can assist in building immunity to the virus. Additionally, vitamin B_6 (pyridoxine) supplements assist in relieving the symptoms associated with COVID-19, by reducing pro-inflammatory cytokines, maintaining endothelial barriers and preventing hypercoagulability (Kumar *et al* 2021).

Vitamin C is an antioxidant that is needed for collagen synthesis and a healthy immune system. Adequate amounts of vitamin C maintains many aspects of immune function, improving innate and adaptive immune cell function, reinforcing epithelial tissue barriers, encouraging cell movement to infection sites, certain macrophage activities (James *et al* 2021; Di Renzo *et al* 2020), and regulating the genes responsible for the generation of B-cells and T-cells (Dehghani-Samani *et al* 2020). Over the years, there has been numerous studies on the use of vitamin C as a cold remedy (Kumar *et al* 2021; Fernández-Quintela *et al* 2020). According to Kumar *et al* (2021), Dehghani-Samani *et al* (2020), Jovic *et al* (2020) and Zhang & Liu (2020), vitamin C may function as an antihistamine, which could provide relief from flu-like symptoms and lower respiratory tract infections, both of which are evident in COVID-19. However, there is inadequate evidence available to recommend its supplementation in COVID-19 patients (Fernández-Quintela *et al* 2020). A Cochrane review, which considered 24 trials with a total of 10 708 participants, found that regular consumption of vitamin C in quantities greater than 200 mg/day, was ineffective in reducing the incidence of colds and flu, however, it shortened the duration of symptoms in adults by 8% (James *et al* 2021).

Since vitamin D is considered a hormone in addition to a nutrient, it can be synthesised in the body when an individual is exposed to adequate sunlight. However, many individuals are deficient in vitamin D due to limited sun exposure, age, medical conditions and the environment. Vitamin D is vital for immune cells as it functions as an immunomodulator for monocytes, macrophages, dendritic cells, B-cells and T-cells. Thus, a deficiency could lead to an impaired immune system, which could exacerbate symptoms associated with COVID-19 (Cervantes-Pérez *et al* 2020; Dehghani-Samani *et al* 2020; Di Renzo *et al* 2020; Zhang & Liu 2020). Vitamin D plays a role in maintaining the innate and adaptive immune responses, preserving barrier defenses and producing antimicrobial peptides found in macrophages in the epithelial cells of the respiratory tract and decreasing the production of pro-inflammatory cytokines that are evident in COVID-19 patients (Kumar *et al* 2021). Meta-analyses have found a relationship between a low vitamin D status and risk and severity of acute respiratory tract infections (James *et al* 2021), renal failure, sepsis and mortality (Jovic *et al* 2020). According to Philipp *et al* (2021), vitamin D is effective in the prevention of respiratory tract infections in patients who are deficient in vitamin D when receiving daily or weekly doses of vitamin D. However, it is still unknown if this remains true for COVID-19 patients (Fernández-Quintela *et al* 2020).

One of the main roles of vitamin E is to reduce oxidative stress in the body by binding to free radicals (James *et al* 2021; Kumar *et al* 2021; Dehghani-Samani *et al* 2020; Zhang & Liu 2020). Oxidative stress and inflammation are the foundation of the pathological mechanism of COVID-19-associated ARDS (Jovic *et al* 2020). Vitamin E is involved in the activation of T-cells and the suppression of prostaglandins, both of which contribute to the COVID-19 immune response (Dehghani-Samani *et al* 2020; Di Renzo *et al* 2020). Vitamin E increases prostacyclin levels by preventing AA metabolism, leading to blood vessel dilation and the inhibition of platelet aggregation, which are seen in COVID-19 patients (Kumar *et al* 2021). To date, there is a limited amount of research available on the status and supplementation of vitamin E in viral infections, and the resultant effect it may have in COVID-19 patients (Fernández-Quintela *et al* 2020).

2.5.2.2 Minerals

Minerals and trace elements are essential for the correct functioning of the body, however, to date there are no specific recommendations with regards to supplementation in COVID-19 patients (Cervantes-Pérez *et al* 2020). Several recently published articles discuss the use and importance of certain minerals in the management of COVID-19, some of which include zinc, selenium iron, copper and magnesium (Barazzoni *et al* 2020; Calder *et al* 2020; Cervantes-Pérez *et al* 2020; Di Renzo *et al* 2020; Fernández-Quintela *et al* 2020; Olaimat *et al* 2020;

Zhang & Liu 2020). Zinc is an essential mineral that is required for various body functions. Some of these functions include cell metabolism and division, protein and DNA synthesis, wound healing, maintaining an optimal sense of smell and taste and being a catalyst for a large number of enzymatic reactions in the body [National Institutes of Health (NIH) 2021]. Furthermore, James *et al* (2021) and Zhang & Liu (2020) mention that zinc plays an important role in anti-inflammatory pathways in the body and a deficiency is more common in the elderly, which increases susceptibility to infectious diseases. In a systematic review and meta-analysis conducted in 2021, it was found that zinc supplementation with 45 mg to 300 mg daily in the form of lozenges, appeared to reduce symptoms of community-acquired viral respiratory tract infections by two days (NIH 2021). Selenium is another trace mineral that exerts anti-inflammatory properties and works together with vitamin E to reduce oxidative stress in the body. Oxidative stress can alter the virus genome, resulting in the virus becoming highly virulent (James *et al* 2021; Jayawardena *et al* 2020; Zhang & Liu 2020).

According to Zhang & Liu (2020), typical manifestations in hospitalised COVID-19 patients include anaemia and hyperferritinaemia due to interrupted iron metabolism. Furthermore, recurrent respiratory tract infections are linked to iron deficiency, due to the role iron plays in maintaining the immune system. However, it must be noted that an iron overload can cause additional oxidative stress, which proliferates mutations of viruses and bacteria (Zhang & Liu 2020). Copper and magnesium both influence development and differentiation of immune system cells and exhibits antiviral properties in-vitro (Jayawardena *et al* 2020). A cohort study in Singapore reported that a combination of magnesium, and vitamins B_{12} and D, reduced the progression rate of COVID-19 in older patients. Specifically, 150 mg/day of oral magnesium, 500 µg/day of oral vitamin B_{12} and 1000 international units (IU)/day of oral vitamin D_3 were protective against respiratory tract infections. However, more studies need to be conducted in order to confirm this (Tan *et al* 2020). Additionally, copper has the potential to deactivate infectious viruses and improve immunity, thus more studies should be conducted on the supplementation of copper in COVID-19 patients (Kumar *et al* 2021).

2.5.2.3 Immunonutrients

Immunonutrients, also known as pharmaconutrients, are substrates that stimulate immune-favouring mediators and inhibit proinflammatory mediators, such as cytokines (Gianotti *et al* 2022). The concept of immunonutrients is based on the fact that the functioning of the immune system, and hence the immune response to infection and inflammation, is dependent on the nutritional status of an individual (Di Renzo *et al* 2020). Certain vitamins (vitamins A, C and E), omega-3 polyunsaturated fatty acids and amino acids are also considered immunonutrients. The amino acids glutamine and arginine are well-known amongst dietitians for having a beneficial effect on gut barrier function (Haraj *et al* 2021). Thus, the immunomodulatory effects of glutamine and arginine are discussed with relevance to COVID-19.

Glutamine is an amino acid that becomes conditionally essential in the body under certain circumstances such as in critical care, trauma, burns and sepsis (Haraj *et al* 2021). Glutamine has the ability to repair damaged tissue and acts as an energy substrate for immune system and GIT cells (Obayan 2021; Haraj *et al* 2021). Since COVID-19 is associated with severe oxidative stress and inflammation, it is natural that the glutamine stores in the body may become depleted and oral and/or IV therapy of glutamine could be beneficial. It is proposed that 0.3-0.75 g/kg of oral or IV glutamine is beneficial and improves clinical outcome in surgical and ICU patients, and can be implemented in COVID-19 patients. Additionally, the use of glutamine as a prophylactic treatment in certain COVID-19 patients may be advantageous, however, more research is required (Obayan 2021; Di Renzo *et al* 2020).

In addition to glutamine, arginine is also a conditionally essential amino acid involved in cell metabolism, wound healing, catabolism and immune functioning. Furthermore, arginine supplementation has been reported to increase the response of T-cells and maintain epithelial cells, highlighting the role of arginine in prolonged infection (Adebayo *et al* 2021; Di Renzo *et al* 2020). A recent study found that plasma levels of arginine in both adults and children infected with SARS-CoV-2, were significantly lower compared to the healthy control group. This suggests that arginine may play a significant role in many biological processes within the immune system (Adebayo *et al* 2021). A decrease in plasma arginine levels, in addition to greater arginase activity has been reported in COVID-19 patients (Fiorentino *et al* 2021).

A single-center double-blind randomised, placebo-controlled trial including 101 participants in Italy was designed to test the hypothesis that the addition of arginine to standard hospital therapy is an effective treatment for hospitalised adult patients with severe COVID-19. This study found that supplementation with 1.66 g of arginine significantly decreased the need for respiratory support and the length of hospital stay was reduced ($p<0.0001$). However, there was no effect on the time to obtain a negative reverse transcription polymerase chain reaction (RT-PCR) for SARS-CoV-2, nor the time to normalise lymphophenia in these patients (Fiorentino *et al* 2021).

2.6 Therapeutic feeding of COVID-19 patients

Arkin *et al* (2020) emphasises that most COVID-19 patients who are in the ICU have been ill for days at home. As with most illnesses, COVID-19 also causes a decrease in appetite, increasing the risk of malnutrition. Malnutrition is further worsened as enteral or parenteral feeding is frequently delayed because the treatment of shock, hypoxemia, acidosis or hypercapnoea is prioritised. Furthermore, delayed enteral feeding creates the additional stress of developing refeeding syndrome and electrolyte abnormalities, which can lead to haemodynamic instability and cardiac arrhythmia (Arkin *et al* 2020; Martindale *et al* 2020). Furthermore, Martindale *et al* (2020), writing on behalf of ASPEN on COVID-19 patients, recommends that early EN should be started within 24-36 hours of ICU admission or within 12 hours after intubation, as is the current practice with most critically ill patients.

2.6.1 Meeting patient requirements

In both COVID-19 and non-COVID-19 patients, a prolonged stay in ICU is likely if a patient requires mechanical ventilation. In this case, oral feeding may be unsuccessful, and alternate routes should be considered (Arkin *et al* 2020). Furthermore, the patient's energy requirements are determined by their energy expenditure. When available, the use of direct calorimetry is preferred (Arkin *et al* 2020). However, many facilities do not have access to this and rely on the volume of oxygen used by the patient from a pulmonary artery catheter or the volume of carbon dioxide that the patient produces (obtained from the ventilator) to determine energy expenditure. Either of these methods is preferred to predictive energy equations. Moreover, much of the literature available advocates for hypocaloric feeding in all critically ill patients, when initiating feeding (Arkin *et al* 2020; Barazzoni *et al* 2020; Braun 2020; Martindale *et al* 2020). This means that during the acute phase of illness (day 1-2), not more than 70% of the patient's energy requirements should be administered. By day 3-5, the dietitian may opt to increase energy intake to 80-100% of the patient's requirements (Braun 2020).

Patients who have an extended stay in the ICU are more likely to experience an increase in muscle breakdown, thus increasing protein requirements (Handu *et al* 2020). Due to prolonged ICU stay and extended periods of immobilisation, patients lose muscle mass and function (Brugliera *et al* 2020). During the acute phase of illness, protein requirements increase, and should be adjusted based on patient tolerance (Braun 2020). The importance of meeting macroand micronutrient requirements cannot be stressed enough, as studies have shown significant improvements in 6-month mortality when more that 80% of requirements are met, as compared to patients receiving only 50-80% of their requirements (Arkin *et al* 2020). It is important for a dietitian to consider the medications that the patient is receiving and to adjust the nutritional prescription accordingly, as some medications such as dextrose, propofol and/or inotropes affect blood glucose and triglyceride levels (Handu *et al* 2020; Minnelli *et al* 2020).

2.6.2 Feeding routes

2.6.2.1 Oral nutrition supplements

A practical approach to nutrition in hospitalised COVID-19 patients is to provide the patient with oral nutrition supplements (ONS) (Arkin *et al* 2020; Caccialanza *et al* 2020), which ensures that the patient receives sufficient energy, protein and micronutrients. According to ESPEN, ONS is suitable in COVID-19 patients when food fortification and nutrition counselling are insufficient to meet nutritional requirements. Oral nutrition supplements providing a minimum of 400 kCal and at least 30 g of protein per day, should be given in COVID-19 patients when required (Barazzoni *et al* 2020).

According to James *et al* (2021), a simple screening process should be undertaken to assess nutritional risk in COVID-19 patients. Since many COVID-19 patients are unable to meet their nutrient requirements, they should be given supplemental whey protein at 20 g/day, and a mixture of multivitamins and minerals. Should a patient be at risk for malnutrition, the patient should receive approximately 2-3 bottles of a liquid ONS per day, providing 600-900 kCal and 35-55 g of protein per day, in addition to a normal diet (James *et al* 2021; Caccialanza *et al* 2020). However, patient compliance is an issue, and frequent assessment and modification are needed. Once a patient has been discharged, routine follow-up is needed (Caccialanza *et al* 2020). Oral nutritional supplements should continue for a minimum of one month after discharge, or more if the patient is severely malnourished or presents with other limiting factors such as constant breathlessness, fatigue, use of a nebuliser, or difficulty in swallowing (Latif *et al* 2021).

A prospective observational study conducted in India by Chada *et al* (2021), included 1 083 patients with mild, moderate and severe COVID-19. Nutritional support was initiated in 98% of the patients. Of these patients, 10% received EN and 90% received an oral diet. One hundred and eighty-three patients were admitted to the ICU, of which 112 (61%) received EN, and 71

(39%) received an oral diet. Of the total patients on an oral diet, 65% were recommended for ONS in addition to the ward diet. A significant correlation between energy and protein intake and mortality ($p<0.001$) was reported, thus, associating nutritional adequacy with reduced disease progression (Chada *et al* 2021). Moreover, the UK implemented a concept of 'every contact counts' in which COVID-19 patients are offered something to eat or drink every time the dietitian or health professional is in contact with the patient, so as to encourage sufficient dietary intake (James *et al* 2021).

2.6.2.2 Enteral nutrition

Enteral nutrition should be started in all patients, with or without COVID-19, who have a well-functioning GIT, but are unable to consume adequate energy and protein from an oral diet and ONS over a three-day period (Ojo *et al* 2022). This is to maintain the GIT and prevent muscle loss (Brugliera *et al* 2020). Both Barazzoni *et al* (2020) and Braun (2020) agree that early EN support by means of a nasogastric tube (NGT) should be prioritised in COVID-19 patients admitted to hospital, who are unlikely or unable to consume food orally. In addition, Minnelli *et al* (2020) mentions that trophic feeding (10-20 ml/h) should be given at first and tolerance assessed. Enteral nutrition is less invasive than PN, with far fewer complications, but must be tailored to meet individual needs (Braun 2020).

There are many ways of delivering EN such as continuous feeding, intermittent feeding and bolus feeding, each with its own advantages and disadvantages (Ojo *et al* 2022). Continuous feeding is defined as providing a lower volume of feed, uninterruptedly over 24 hours. Intermittent feeding involves providing EN within a certain period of time and bolus feeding involves the administration of a specific volume of feed, given over 15-40 minutes, multiple times a day (Hrdy *et al* 2020). A clinical trial initiated in 2018 in an academic hospital in the Czech Republic, which compared continuous feeding and intermittent or bolus feeding, found no significant differences in the prevalence of abdominal distention, vomiting or diarrhoea in critically ill patients (Hrdy *et al* 2020). For COVID-19 patients, continuous feeding is preferred to intermittent or bolus feeding (Martindale *et al* 2020). The results of the systematic review and meta-analysis by Ojo *et al* (2022) showed that early EN lowered the mortality risk in critically ill COVID-19 patients ($p<0.05$), but did not affect the length of ICU stay and mechanical ventilation in these patients ($p>0.05$). It must be noted that due to the unpredictable availability of resources in certain areas during the COVID-19 pandemic, there could have been shortages of commercially-available EN feeds and feeding pumps, which could have further affected the method of enteral feeding and ultimately COVID-19 patient care (Minnelli *et al* 2020).

2.6.2.3 Parenteral nutrition

If EN does not meet a patient's nutritional requirements or is not tolerated, PN should be considered. There should be no restrictions on EN or PN based on a patient's diagnosis or age, however, refeeding syndrome is most likely in patients on PN, and they should be carefully monitored (Thibault *et al* 2020b). According to Martindale *et al* (2020) and Minnelli *et al* (2020), the following are considerations for providing PN in COVID-19 patients:

- A COVID-19 patient on multiple vasopressors.
- A COVID-19 patient on high pressure respiratory support, such as continuous positive airway pressure (CPAP) or high positive end-expiratory pressure.
- Bowel ischaemia in COVID-19 patients.
- Gastrointestinal tract bleeding and intolerance.

In a letter to the editor of the journal, Clinical Nutrition, Salazar & Cheah (2020) mentioned that between February and April 2020, PN was initiated in 52 COVID-19 patients at a Singapore hospital. Within five days, 82.9% of the patients achieved their energy intake targets, 36.5% experienced hyperglycaemia, 7.6% experienced fluid overload, and 3.8% had hypoglycaemia. This highlights the importance of careful administration of PN and the need to monitor tolerance in the COVID-19 patient (Salazar & Cheah 2020). Further research is still required regarding the use of PN in COVID-19 patients (Barazzoni *et al* 2020).

2.7 Factors that influence the feeding of COVID-19 patients

2.7.1 Gastrointestinal concerns

At the time of admission to the ICU, various regimes are applied to the COVID-19 patient, yet one of the main problems noted is the impaired functioning of the GIT and its associated dysmotility (Arkin *et al* 2020). Many COVID-19 patients in the ICU receive one or more agents that act on the GIT to preserve and encourage motility and almost half of COVID-19 patients experience some form of intolerance (Martindale *et al* 2020). Many patients have an indication of either an ileus or some form of pseudo-obstruction or ischemia in the small and/or large intestine (Barazzoni *et al* 2020). Many believe that this is due to the administration of certain vasopressors, which constrict the blood vessels in the body. However, the doses of vasopressors given to COVID-19 patients are reasonably lower than the doses given to other ICU or critical care patients. Furthermore, COVID-19 patients who need mechanical ventilation require high doses of opioids and sedatives. The use of these medications further contributes to dysmotility in the GIT. It should be noted that even in the absence of dysmotility, low gastric residual volumes (GRVs) and steady stool output, insufficient GIT absorption has been noted due to the use of acetaminophen (Arkin *et al* 2020). As recommended by ESPEN for critically ill patients, GRVs should be monitored closely. If it exceeds the 500 ml cut-off value, the insertion of a post-pyloric feeding tube as opposed to an NGT, is recommended (Barazzoni *et al* 2020).

2.7.2 Proning

There is a risk of aspiration in all patients with enteral feeding tubes (Behrens *et al* 2021). In COVID-19 patients, there is a higher risk of the feeding tube being dislodged (causing aspiration) as many patients undergo proning. Proning has been used to treat ARDS since the 1970s (Behrens *et al* 2021). It is defined as the process of turning a patient from their back onto their abdomen, with specific movements (McCabe 2020). When a patient is transitioned from the supine to prone position (or vice versa), aspiration and/or vomiting are often observed (Behrens *et al* 2021; Minnelli *et al* 2020). It is proposed that feeding should be stopped one hour prior to changing positions, and GRVs carefully monitored for signs of intolerance (Minnelli *et al* 2020). If possible, the bed should be elevated to 10-25 degrees whilst proning (Behrens *et al* 2021; Handu *et al* 2020). Furthermore, ESPEN mentions that the prone position should not be considered as a limitation to providing EN. Despite the many benefits of bolus feeding, continuous feeding via a feeding pump may prove to be beneficial in this population as a smaller volume of feed may reduce the threat of aspiration (Martindale *et al* 2020). According to Handu *et al* (2020), healthcare practitioners should ensure that the head of the patient's bed is elevated to 30-45 degrees, regardless of whether the patient is receiving EN or not.

2.7.3 Respiratory distress

Many COVID-19 patients experience some form of lung injury and respiratory distress; therefore, any small setback may affect their recovery time (Arkin *et al* 2020). In line with Azkur *et al* (2020), COVID-19 patients with ARDS are progressively more challenged to meet oxygen requirements. This is due to the fluid and cell-free haemoglobin that builds up in the lungs. This combination results in pink-coloured secretions in the patient due to the breakdown of red blood cells, as a result of the cytokine storm (Azkur *et al* 2020). Some COVID-19 patients with ARDS may need assistance in maintaining oxygen saturation by mechanical ventilation. Non-invasive ventilation is an alternative to normal ventilation because it does not require an endotracheal tube to be inserted into the patient's airway and makes use of a face and nose mask that is connected to a ventilator (Osadnik *et al* 2017). There is often evidence of insufficient energy and protein consumption as different types of oxygen support inhibits caloric intake in the patient (Handu *et al* 2020).

2.7.4 Contraindications with feeding

As with all types of patients, there are certain instances where EN is contraindicated. This includes when a patient is haemodynamically unstable, the presence of shock, poor tissue perfusion and when there is evidence of life-threatening hypoxaemia, hypercapnoea or acidosis (Barazzoni *et al* 2020; Martindale *et al* 2020). Furthermore, Barazzoni *et al* (2020), Martindale *et al* (2020) and Minnelli *et al* (2020) all agree that a dietitian should consider withholding EN in the following cases:

- Mean arterial pressure is less than 65 mmHg.
- The need for vasopressors is increasing in both frequency and dose.
- Lactate levels are escalating.
- Nausea, vomiting, diarrhoea and abdominal distention are present (James *et al* 2021).
- Circulatory shock is present with evidence of EN intolerance (Minnelli *et al* 2020).

2.7.5 Challenges dietitians face in the management of COVID-19

Although SARS-CoV-2 was identified in 2019, it is still a relatively new disease to healthcare professionals, who still face many ongoing challenges with its management (Ash 2020). However, the current dynamics of prognosis and progression of COVID-19 has changed and healthcare facilities have seen a decline in COVID-19 cases. Fewer individuals are being infected, fewer COVID-19-related deaths are being reported and COVID-19 is no longer a major topic of discussion (WHO 2024). Dietitians face multiple unprecedented challenges in assessing and providing sufficient nutrition to COVID-19 patients, because SARS-CoV-2 causes GIT intolerance (Arkin *et al* 2020). When feeding tubes are placed, there is a need to confirm placement, prior to the onset of feeding. This further delays the delivery of nutrients and requires additional personnel to be available, thus increasing the healthcare worker's risk of exposure to COVID-19 (Arkin *et al* 2020). With this rationale in mind, dietetic and other allied healthcare worker consultations are also limited, as dietitians are not considered indispensable (Thibault *et al* 2020b).

Donnelly & Keller (2021) explains that one of the main barriers to conducting nutritional assessment in COVID-19 patients is the lack of face-to-face communication and consultation, with a greater reliance on 'patient-reported' anthropometry, which may be subjective. Furthermore, once patients have been weaned off mechanical ventilation, a plan for oral nutrition should be in place (Barazzoni *et al* 2020). However, many patients report that they have some degree of dysphagia and are unable to meet their nutritional requirements. This is where the speech therapist and dietitian should work hand-in-hand. Texture-modified foods can be given if it is safe to do so, otherwise, EN should continue. Ventilator-associated dysphagia can last up to 21 days, especially in elderly patients, and is associated with other complications such as pneumonia, the need for reintubation and even mortality (Arkin *et al* 2020; Handu *et al* 2020).

2.8 Managing COVID-19 patients in the general ward or at home

In many countries worldwide, the majority of individuals infected with SARS-CoV-2 experience mild to moderate symptoms, which can be managed at home (Handu *et al* 2020). It is imperative that those who are self-managing at home consult a dietitian to optimise their nutritional status to prevent further complications (Arkin *et al* 2020). Dietitians know the value and benefits of oral feeding, which is the most preferred route for patients to meet their daily nutrient needs (Arkin *et al* 2020). In terms of stable COVID-19 patients, a dietitian should consult with the patient on a monthly basis to assess their nutritional progress and compliance. It must be noted that when patients are discharged from the hospital, nutritional counselling and personalised meal plans should be arranged, when possible. The patient should be informed about food fortification and how to go about enriching meals so as to prevent or reduce the risk of malnutrition (Arkin *et al* 2020).

Additionally, in the early stages of the pandemic, ESPEN recommended quarantine of COVID-19 patients at home. It was recommended that in the absence of limiting factors, physical activity should continue, provided that certain COVID-19 precautions were maintained. A daily routine should include a minimum of 30 minutes of physical activity or more than one hour of physical activity every alternate day. Moreover, a lengthy stay at home may predispose the individual to a sedentary lifestyle, exacerbating chronic conditions. Some of these behaviours include prolonged periods of sitting, sleeping, lounging, using mobile devices and watching television. A decreased energy expenditure together with an increased energy intake leads primarily to weight gain, muscle loss, malnutrition and may negatively affect the immune system

(Barazzoni *et al* 2020).

2.9 Monitoring and re-assessment of COVID-19 patients

Dietitians should reassess and monitor critically ill COVID-19 patient dietary tolerance on a daily basis, whereas stable COVID-19 patients can be reassessed every 2-3 days (Handu *et al* 2020). A clinical assessment along with laboratory values should be monitored for signs of feeding intolerance in COVID-19 patients (Minnelli *et al* 2020). Furthermore, dietitians should monitor for electrolyte (sodium, phosphorus, potassium, calcium and magnesium) abnormalities associated with the refeeding syndrome as rapid changes in electrolytes can affect feeding and illness outcome (Handu *et al* 2020).

2.10 Conclusion

It can be concluded that due to the novelty of SARS-CoV-2 and the rapid spread of the virus between countries, health organisations all over the world were forced to rapidly establish recommendations and guidelines to assist with the management of infected patients. Initially, very little was known about the virus and how it affects the different systems in the body. Nevertheless, studies have been conducted and more accurate information has become available. One of the most important, yet overlooked aspects of COVID-19 is nutritional management. The nutritional status of a patient can influence the progression and severity of COVID-19, as a large percentage of the human immune system can be found in the GIT. The state of the GIT is directly linked to macro- and micronutrients and the quality and quantity of food consumed. Throughout the pandemic, dietitians were required to treat COVID-19 patients, despite the lack of specific guidelines on the nutritional management of COVID-19. To date, there are limited studies on how dietitians managed COVID-19 patients, even though it has been almost four years since the start of the pandemic. Thus, this study aimed to determine how dietitians managed adult patients hospitalised with COVID-19 in KZN.

CHAPTER 3
METHODOLOGY

This chapter presents the study methodology. An outline of the study design, study population and sample selection, study methods and materials and the data collection process is presented. In addition, reduction of bias, statistical analysis, quality control, and ethical considerations are described.

3.1 Study design

This was a cross-sectional descriptive study. A cross-sectional study is defined as a type of research study which involves the collection and comparison of data from a specific population, at a particular point in time. The data collected are used to draw conclusions on a topic (Kesmodel 2018; Alexander *et al* 2015). A descriptive study is used to define the features and characteristics of a specific phenomenon that is being observed. Additionally, descriptive studies are used to describe why or how something has occurred by making use of surveys and other observational tools (Nassaji 2015).

According to Aggarwal & Ranganathan (2019) and Kesmodel (2018), a cross-sectional descriptive study design is relevant when studying the knowledge, attitudes and prevalence among patients and health professionals, and ultimately assessing disease burden and healthcare needs. Therefore, the current study design was appropriate as it collected responses to questions in a survey from health professionals. Additionally, a cross-sectional descriptive study design is an economical way of collecting data as there is little or no cost to the participants and researcher (Spector 2019).

3.2 Study population and sample selection

The study population was selected using purposive sampling. Purposive sampling is defined as a careful selection of participants, specifically due to the abilities and experience that the population may possess. Furthermore, this type of sampling is used in research studies that are mainly qualitative, but also quantitative in nature (Etikan *et al* 2016), as was the case in the current study.

Dietitians registered with the HPCSA, and who were employed in both the public and private sectors in KZN were included in the current study. The province of KZN was selected because at the time of the study it had the second highest number of COVID-19 cases in SA, accounting for 18% of the total infections, 16% of the total deaths and 13% of all active cases in the country (SAcoronavirus 2023b). The researcher contacted the KZN DOH and the Association for Dietetics in South Africa (ADSA) KZN branch for assistance with contacting dietitians to inform them about the study and inviting them to participate. The HPCSA was initially contacted for assistance with recruiting participants for the study. However, due to the Protection of Personal Information Act (POPIA) (SA Government Gazette No. 37067) in place in SA at the time of the study, the HPCSA was unable to provide any personal information, such as names and contact details of dietitians. Because professional registration numbers (DT numbers) can also be used to identify individual practitioners, this information was excluded from the questionnaire. Consequently, the KZN DOH and ADSA were contacted for assistance in contacting dietitians as it was hoped that this would cover the majority of dietitians in KZN, who met the study inclusion criteria. No advertisement of the study was distributed, however, there was an email or WhatsApp message that accompanied the link that was sent out to all the dietitians on their respective mailing lists (KZN DOH and ADSA).

A total number of 295 dietitians (151 DOH-employed dietitians and 144 ADSA members) were identified at the start of the study. Assuming a margin of error of 0.05 and an alpha value of 0.05, the minimum sample required from a population of 295 individuals was calculated to be 167 individuals. It should be noted that the initially identified sample size was not mutually exclusive, and there may have been an overlap between dietitians in the KZN DOH sector who were also ADSA members and vice versa. Due to the POPIA (SA Government Gazette No. 37067) in place in SA at the time of the study, it was not possible to identify individuals from each group. This meant that some dietitians may have been invited to participate in the study more than once. To address this issue, dietitians were asked to answer the questionnaire once only, regardless of how many times they were invited to participate.

3.3 Study methods and materials

3.3.1 Electronic self-administered questionnaire

With the restrictions in place due to the COVID-19 pandemic, the concept of 'work from-home' had been established and promoted. With this shift, it became necessary to move communication to the online space and to make use of web-based tools to satisfy the demands of remote working. Collecting data via online platforms was safe and appropriate during the COVID-19 pandemic, as it limited contact between the researcher and participants, effectively reducing the transmission of COVID-19 (Divala *et al* 2020). A larger number of eligible participants may be reached with online platforms as they are more accessible and data can be collected over a shorter period of time (Ali *et al* 2020; Divala *et al* 2020). Further advantages of online surveys include a shorter and more pleasant experience for the participant, anonymity and confidentiality of responses, lower costs for the researcher and participants, varying types of questions and controlled progression of the questionnaire, less errors and blank questions and user ease of access (Nayak & Narayan 2019). Disadvantages of on-line surveys include incompatible software, unfamiliarity with computers and online productivity tools, time constraints and a lack of social presence and interaction during the survey (Ali *et al* 2020).

3.3.2 Development of the questionnaire

According to Taherdoost (2021), a questionnaire is one of the main methods for collecting primary data for a research study. Questionnaires are intended to measure variables, be it in the form of open-ended questions or closed-ended questions. Open-ended questions are considered to be qualitative questions, where a respondent is required to give or formulate an idea or opinion. On the other hand, closed-ended questions involve a set of pre-populated options for the respondent to select from. These include: dichotomous scales (having only two options to choose from), nominal-polychromous scales (having more than two options to choose from) and continuous or bounded scales (such as frequency or agreement scales). Furthermore, when creating a questionnaire, short and simple questions should be prioritised over long and complex ones, while words and statements should be clear so that it can be understood by respondents from varying backgrounds. The concept of 'double-barreling' which means that only a single item is asked per question, and making assumptions or directing respondents by arranging options in a biased way, should also be avoided (Taherdoost 2021).

The electronic self-administered questionnaire used in the current study (Appendix C) was divided into four different sections, with different types of questions, to allow for a systematic and logical flow when answering the questionnaire. Table 3.1 shows the different sections of the questionnaire and the types of questions in each section.

Table 3.1: Different sections and types of questions in the electronic self-administered questionnaire developed for the current study

Section	Content	Type of questions
A	Treatment of COVID-19 patients	Multiple-choice
B	Demographic information	Multiple-choice
C	COVID-19 patient nutritional assessment	Multiple-choice, checkbox grids, Likert scale
D	Therapeutic nutrition in COVID-19 patients	Multiple-choice, multiple-choice grids, Likert scale and open-ended questions

For multiple-choice questions, participants could select only one of the listed options, whereas with the checkbox grids, participants could select more than one option per row. A total of five questions in the questionnaire made use of a Likert scale. Likert scales were included in the questionnaire because they are effective in measuring unobservable data such as individual perceptions or agreement (Jebb *et al* 2019).

The first question in the electronic self-administered questionnaire used in the current study aimed to exclude any participants that did not meet the study inclusion criteria of dietitians who had treated or were treating COVID-19 patients at the time of the study. At the time of developing the questionnaire for the current study, there was a limited number of clinical studies offering guidelines for the nutritional management of COVID-19 patients. Therefore, many of the questions or topics in the questionnaire were developed from a medical perspective and from the meta-analyses that were available at the time. In March 2020, ESPEN published already existing practical guidelines on nutrition in critically ill patients (Barazzoni *et al* 2020), while ASPEN (Martindale *et al* 2020) and SASPEN (2020) published recommendations on nutrition in critically ill patients in April 2020, based on the ESPEN publication. All of these recommendations considered COVID-19 patients, and focused on the use of screening tools, methods for measuring anthropometry, and nutritional intervention. Furthermore, these papers provided an indication of macronutrient requirements, and micronutrient supplementation. Lastly, a common thread amongst most papers related to nutrition and COVID-19 was the clinical management of these patients, the challenges encountered and how they related to the nutritional management of these patients (Arkin *et al* 2020; Handu *et al* 2020; Minnelli *et al* 2020; Thibault *et al* 2020b).

Google Forms was the online platform used in this study. Google Forms was selected as it has many useful features. Some of these include: unlimited survey questions and responses, automatic collection of survey data into Google Spreadsheets, multiple customisation options, ability to insert images and videos into the survey and allowance for page branching and skip question logic. It also allows multiple collaborators to work on the development of the survey (Vasantha-Raju & Harinarayana 2016).

Since COVID-19 was a relatively new infectious disease at the time of development and review of the questionnaire for the current study, there were not many experts on it. However, the following individuals were invited to be part of the expert review panel: an ICU physician, an internal medicine physician, an academic in the dietetics field and two clinical dietitians. The physicians and academic were based in KZN, while the dietitians were from the Western Cape Province in SA. The expert review panel was asked to review and evaluate the questionnaire, in terms of it meeting the objectives of the study, content suitability and comprehensiveness of questions. The researcher revised the questionnaire in line with the comments received from the expert review panel.

3.3.3 Pilot study

A pilot study was conducted between 18 May 2022 and 11 June 2022. Dietitians in the Gauteng Province of SA were invited to participate in the pilot study as they would not meet the inclusion criteria to participate in the main study. A total of 15 dietitians participated in the pilot study. According to Tseng & Sim (2021) and In (2017), the minimum number of participants recommended for a pilot study is between 12 and 30, depending on the type of study. Participants were provided with a template, on which they could record their feedback while answering the questionnaire. This allowed for comments to be made on each section of the questionnaire systematically. Table 3.2 shows the amendments that were made to the questionnaire and reasons for the amendments, in response to the feedback from the dietitians who participated in the pilot study.

Table 3.2: Amendments made to the questionnaire and reasons for the amendments

Question	Amendments	Reasons for amendments
Title	The original title of the study was: 'Nutritional management of adult patients with COVID-19 by dietitians in KwaZulu-Natal.' This was revised to: 'Nutritional management of adult patients hospitalised with COVID-19 by dietitians in KwaZulu-Natal.'	Lacks clarity on whether the study is limited to hospitalised patients, outpatients and/or both.
3	Removed the word 'outpatients.'	Due to title change, the word 'outpatients' became irrelevant.
3	Added the option of 'none.'	To accommodate those participants who were not treating COVID-19 patients at the time of the study.
3	Changed '10+ patients' to '≥10 patients.'	To prevent confusion on whether the option included the number 10 or not.
7	Inserted 'ulna length' and 'knee height' as options in the grid.	These are commonly used anthropometric measurements in hospitalised patients.
12	Inserted question regarding the weight used by dietitians when calculating nutritional requirements for their COVID-19 patients.	To clarify which weight was used to calculate nutritional requirements in COVID-19 patients.
13	A definition for the term 'mega-dose' was inserted as follows: 'a mega-dose is a dose many times higher than the recommended amount (Narvaez *et al* 2020).'	To provide a clear, concise understanding of the term.

3.4 Data collection

Data was collected with assistance from the KZN DOH and ADSA, as separate entities.

3.4.1 KwaZulu-Natal Department of Health dietitians

3.4.1.1 Initial data collection

On 14 August 2022, the Nutrition Directorate distributed the link to the study, along with the information document, via email to the dietetics departments of all DOH hospitals in KZN. The Nutrition Directorate did not provide follow-up communication after the initial distribution of the study link. The study closed on 30 September 2022, allowing dietitians just over one month to participate in the study.

3.4.1.2 Extended data collection

At the end of the initial data collection period, which closed on 30 September 2022, there was a poor response to the study, as less than 12% of the minimum sample of dietitians had participated. It was then decided to extend the closing date to improve the response rate. It was assumed that the email containing the link to the study may have been overlooked or misplaced among other emails. In response, the Nutrition Directorate and the office of the National Health Research Database (NHRD) gave the researcher permission to contact the dietitians directly to inform them of the study and invite them to participate. Only publicly available contact details were allowed to be used to contact the dietitians. This was made possible by the fact that the KZN DOH website has publicly available lists of all the health facilities in the province (hospitals, clinics and community health centres) with contact details.

The list containing the contact details of public hospitals in KZN was used as the study considered adult patients hospitalised with COVID-19. The researcher called the hospitals alphabetically (as per the list on the website) and asked the switchboard operator to transfer the call to the dietitian or to the dietetics department. Once the intended person or department was reached, the researcher informed the dietitian of the study and invited them to participate. Those interested to participate in the study were also asked to share the study link with other dietitians in the department. Seventy hospitals were contacted in total and a summary of the response outcomes are presented in Table 3.3. The extended data collection period concluded on 31 March 2023.

Table 3.3: Summary of the response outcomes and the corresponding number of hospitals contacted

Response outcome	**Hospitals (%)***
Dietitian/s interested and requested the link to the study.	43 (61.4)
Dietitian/s not interested to participate in the study.	2 (2.9)
Dietitian/s had already participated in the study.	1 (1.4)
Dietitian/s not eligible to participate in the study.	9 (12.9)
No dietitian/s working at the hospital.	5 (7.1)
Unable to contact the dietitian/ dietetics department after five attempts.	8 (11.4)
Dietitian working at more than one hospital, but still interested to participate.	2 (2.9)

* Percentage of total hospitals contacted (n=70)

3.4.2 Association for Dietetics in South Africa members

3.4.2.1 Initial data collection

The Association for Dietetics in South Africa sent out the link to the study on the ADSA KZN WhatsApp group, and according to ADSA, at the time of commencement of data collection, there were 144 ADSA members, of which, 60 members were part of the WhatsApp group. The link to the study was distributed on 16 August 2022 with the concluding date for data collection given as 30 September 2022. Once again, due to a poor initial response, the data collection period was extended to improve the response rate.

3.4.2.2 Extended data collection

The link to the study was redistributed on the ADSA WhatsApp group on 06 February 2023. This was done to remind dietitians to participate and to accommodate any new members on the WhatsApp group. In addition, the 'Find a Dietitian' webpage on the ADSA website was accessed in order to contact dietitians directly. The webpage allows an individual to search for dietitians in one of the following ways: by area, by name and/or by area of interest. For the purposes of the current study, dietitians were identified by searching 'KwaZulu-Natal' in the area search bar. A summary of the dietitians identified within different areas of KZN is shown in Table 3.4.

Table 3.4: Number of dietitians identified within different areas of KZN using the ADSA website

Area in KZN	Number of dietitians identified
Ballito	1
Durban	19
Empangeni	4
Estcourt	3
Gillitts	3
Hillcrest	1
Hilton	1
Howick	2
Ixopo	1
Kloof	1
Newcastle	1
Pietermaritzburg	13
Stanger	1
Ulundi	1
Umhlanga	5
Vryheid	1

The dietitians listed on the 'Find a Dietitian' webpage was contacted via email or telephone depending on which details were available. A standard email containing information on the study, the informed consent document and the link were sent out individually to the dietitians, inviting them to participate in the study. Of the 58 dietitians identified and contacted, five dietitians responded by email stating that they were not eligible to participate in the study as they did not meet the study inclusion criteria. The remaining 53 dietitians did not respond to the email. Once again, the extended data collection period concluded on 31 March 2023.

3.5 Reduction of bias

Various methods were employed to reduce bias by both the researcher and participants. To reduce bias by the researcher, an alphabetical approach was used when contacting the KZN DOH hospitals. Additionally, those hospitals which were initially unreachable, were contacted again (up to a maximum of five attempts). When directly contacting ADSA members on the 'Find a Dietitian' webpage, the terms 'KwaZulu-Natal' and 'KZN' were used to identify dietitians in the area search bar, and they were contacted based on the order in which they were listed on the webpage. To reduce bias by the participants, the electronic self-administered questionnaire would not have allowed participants to move on to the next section if any of the questions in that particular section were incomplete. This feature of making all questions compulsory prevented unanswered questions, thus preventing participants from not answering certain questions. The exception to this was the last question, where participants were allowed to leave a comment if they wished to do so. In addition, dietitians were requested not to discuss the questions in the questionnaire with other dietitians while answering the questionnaire.

3.6 Content and face validity

Steps were taken to ensure content and face validity in the current study. Content validity represents the degree to which the results from a certain tool is representative of the variable it is intended to measure (Price *et al* 2020). Due to COVID-19 being a novel disease, the researcher extensively reviewed available information on nutrition in critically ill adults and medical and clinical management of COVID-19 patients, to ensure content validity of the questionnaire. The subjective evaluation of appropriateness of a research questionnaire by experts is called face validity (Allen *et al* 2023). In the current study, face validity was ensured by asking an expert review panel to review and evaluate the questionnaire, in terms of it meeting the objectives of the study, content suitability and comprehensiveness of questions. In addition, the qualitative feedback received from the dietitians who participated in the pilot study contributed to both content and face validity of the questionnaire.

3.7 Data quality control

Since data were collected via an online platform (Google Forms), the data were collected, stored and collated automatically onto Google Sheets (online software equivalent to Microsoft Excel). There was no need for the data to be cross-checked as it was submitted to the statistician as primary data. This ensures quality control, accuracy and minimises human error (Vasantha-Raju & Harinarayana 2016).

3.8 Statistical analysis

Data were analysed using the Statistical Package for Social Sciences (SPSS) version 25. The statistical tests used to analyse the data were as follows: descriptive statistics, chi-squared goodness-of-fit test, binomial test, one sample t-test and factor analysis. A detailed description of each method is shown in Table 3.5. A p-value of <0.05 was considered statistically significant.

Table 3.5: Detailed description of each statistical test used

Statistical tests	**Description**
Descriptive statistics	Included mean and standard deviations (where applicable). It also included frequency tables and graphs that contains the number of participants who selected a particular response.
Chi-square goodness of fit test	A univariate test was used on categorical variables to test whether any of the response options were selected significantly more or less often than the others. It was assumed that under the null hypothesis all responses were equally selected.
Binomial test	This was used to identify whether a significant proportion of respondents selected one of a possible two responses. In the study, this test was used to analyse the proportions of participants who selected either 'yes' or 'no' to a particular question or option given.
One sample t-test	This tested whether a mean score was significantly different from a scalar value, by means of a five-point scale ranging from 'strongly disagree' to 'strongly agree.'
Factor analysis	This was used to determine groupings where multiple items measured a single construct. In the study, the challenges faced by dietitians were broad and overlapped, thus making this test ideal to analyse the data. During the process, some items were excluded either because they did not load strongly enough onto any factor or because they cross-loaded onto multiple factors. The reliability of combining the items into a single latent variable was tested using Cronbach's alpha. An alpha value of at least 0.7 was considered adequate. If items did not correlate strongly enough with the other items in the construct and negatively affected the reliability, they were excluded. The factor extraction was deemed to be successful if the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) exceeded 0.6 and Bartlett's test of sphericity was significant.

Table 3.6 shows the objectives of the study and which statistical tests was used to address each objective.

Table 3.6: Objectives of the study and the corresponding statistical tests that were applied

Objective		Statistical tests that were applied
(i)	To determine which nutritional guidelines dietitians used in the management of adult COVID-19 patients.	• Chi-square goodness of fit test • One sample t-test • Descriptive statistics
(ii)	To identify the challenges that dietitians faced when nutritionally managing adult COVID-19 patients.	• One sample t-test • Factor analysis • Descriptive statistics
(iii)	To determine whether dietitians took or estimated anthropometric measurements in bed-bound and mobile adult COVID-19 patients.	• Binomial test • One sample t-test • Descriptive statistics
(iv)	To determine whether dietitians assessed malnutrition risk in adult COVID-19 patients, and if so, which nutrition screening tools were used.	• Chi-square goodness of fit test • Descriptive statistics
(v)	To determine if dietitians recommended unconventional mega-doses of micro- and immunonutrient supplements for the management of adult COVID-19 patients and the reasons for use.	• Chi-square goodness of fit test • One sample t-test • Binomial test • Descriptive statistics

3.9 Ethical considerations

Ethical approval was obtained from the University of KwaZulu-Natal (UKZN) Biomedical Research Ethics Committee (BREC) (reference number: BREC/00003865/2022) (Appendix D). In addition, the Nutrition Directorate of the KZN DOH issued a letter of support for the study (Appendix E). Ethics approval was obtained from the NHRD (Appendix F). A letter of support for the study from ADSA KZN (Appendix G) allowed the researcher to contact dietitians in the private sector. In order to comply with ethical standards, an information document and consent form (Appendix H) was developed and distributed with the link to the study. In addition to this, when a participant opened the link to the study, they saw a summary of the content included in the information document and consent form, and were informed that by clicking on the button labelled 'next', they were consenting to participate in this study, and were then allowed to continue to the questionnaire. Participants were free to withdraw from the study at any time without penalty. Participant contact details were stored separately from the data so as not to link the two in any way. The electronic data collected in this study will be stored with the supervisor in the Department of Dietetics and Human Nutrition at UKZN. Only the researcher and the supervisor will have access to the password-protected data. The electronic data will be deleted after a period of five years.

CHAPTER 4
RESULTS

This chapter presents the results of the study.

4.1 Study participants

Forty-eight dietitians started answering the questionnaire, however, six were excluded at the start of the questionnaire as they had not treated any COVID-19 patients, and thus were not allowed to proceed further. This resulted in a sample of 42 dietitians.

4.2 Affiliations and primary work locations

The affiliations and primary work locations of the dietitians who participated in the study are presented in Table 4.1.

Table 4.1: Affiliations and primary work locations of the dietitians (n=42)

Affiliations	**n**	**%***	**p-value#**
KZN DOH employee	22	52.4	**<0.001**
ADSA member	13	31.0	
Both KZN DOH employee and ADSA member	3	7.1	
Neither KZN DOH employee nor ADSA member	4	9.5	
Primary work locations			
Private Hospital	16	38.1	**<0.001**
Tertiary-level Hospital	4	9.5	
Regional-level Hospital	3	7.1	
District-level Hospital	16	38.1	
Community Health Centre	0	0	
Clinic	0	0	
Private Practice	1	2.4	
Other	2	4.8	

* Percentage of sample (n=42)
\# Chi-square goodness of fit test; p-values in bold are statistically significant
KZN DOH = KwaZulu-Natal Department of Health; ADSA = Association for Dietetics in South Africa

A significant proportion of the dietitians were either KZN DOH dietitians or ADSA members ($p<0.001$), and a significant proportion of the dietitians worked primarily in a private hospital (n=16; 38.1%) or at a district-level hospital (n=16; 38.1%) ($p<0.001$). Two dietitians (4.8%) selected the option of 'other' for primary work location and when prompted to specify, one dietitian (2.4%) indicated working in both regional and private hospitals during the pandemic, while the other dietitian (n=1; 2.4%) indicated working in a specialised hospital (Table 4.1).

4.3 Treating COVID-19 patients

Table 4.2 shows the timeline of when dietitians began treating COVID-19 patients and how many patients they treated in a typical week.

Table 4.2: Treatment of patients with COVID-19 by dietitians (n=42)

Timeline of when dietitians began treating COVID-19 patients	**n**	**%***	**p-value#**
Since the start of the pandemic (March 2020)	17	40.5	**0.001**
During and/or after the first wave of infection (June-July 2020)	13	31.0	
During and/or after the second wave of infection (December 2020-January 2021)	4	9.5	
During and/or after the third wave of infection (June-July 2021)	5	11.9	
During and/or after the fourth wave of infection (December 2021)	3	7.1	
Average number of patients treated in a typical week			
None	22	52.4	**<0.001**
1-3 patients	10	23.8	
4-6 patients	5	11.9	
7-9 patients	0	0	
≥10 patients	5	11.9	

* Percentage of sample (n=42)
# Chi-square goodness of fit test; p-values in bold are statistically significant

A significant proportion of the sample (n=30; 71.5%) started treating COVID-19 patients either from the start of the pandemic or during and/or after the first wave of infection (p=0.001). It was also found that a significant percentage of the dietitians (n=22; 52.4%) were not treating any hospitalised COVID-19 patients weekly at the time of data collection (p<0.001) (Table 4.2).

4.4 Nutritional assessment in patients with COVID-19

4.4.1 Use of nutrition screening tools

Table 4.3 shows the different nutrition screening tools that were used by the dietitians to screen for malnutrition in COVID-19 patients. Half of the dietitians reported using a nutrition screening tool (n=21; 50%). Of these dietitians, a significant proportion (n=13; 61.9%) used the NRS-2002 tool ($p<0.001$) (Table 4.3).

Table 4.3: Nutrition screening tools used by dietitians (n=21)

Screening tool used	**n**	**%***	**p-value#**
Geriatric Nutrition Risk Index (GNRI)	0	0	**<0.001**
Global leadership Initiative on Malnutrition (GLIM)	1	4.8	
Malnutrition Universal Screening Tool (MUST)	4	19.0	
Mini Nutritional Assessment-Short Form (MNA-SF)	1	4.8	
Nutrition Risk in the Critically Ill (NUTRIC)	1	4.8	
Nutrition Risk Screening 2002 (NRS-2002)	13	61.9	
Short Nutritional Assessment Questionnaire (SNAQ)	0	0	
Subjective Global Assessment (SGA)	1	4.8	
Other	0	0	

*Percentage of sample (n=21)
Chi-square goodness of fit test; p-values in bold are statistically significant

4.4.2 Measurement of anthropometry

Table 4.4 shows methods used by dietitians to assess anthropometry in COVID-19 patients based on their degree of mobility.

Table 4.4: Methods used to assess anthropometry in COVID-19 patients based on their degree of mobility (n=42)

Degree of mobility	n (%)		p-value#
	Yes	No	
Bed-bound, cannot move, unconscious			
Assessed anthropometry	32 (76.2)	10 (23.8)	**0.001**
Measured actual weight, height and BMI	2 (4.8)	40 (95.2)	**<0.001**
Estimated weight, height and BMI	31 (73.8)	11 (26.2)	**0.003**
MUAC	17 (40.5)	25 (59.5)	0.280
Ulna length	1 (2.4)	41 (97.6)	**<0.001**
Knee height	2 (4.8)	40 (95.2)	**<0.001**
Other	0 (0)	42 (100.0)	**<0.001**
Bed-bound, but can sit up			
Assessed anthropometry	33 (78.6)	9 (21.4)	**<0.001**
Measured actual weight, height and BMI	7 (16.7)	35 (83.3)	**<0.001**
Estimated weight, height and BMI	27 (64.3)	15 (35.7)	0.088
MUAC	18 (42.9)	24 (57.1)	0.441
Ulna length	1 (2.4)	41 (97.6)	**<0.001**
Knee height	4 (9.5)	38 (90.5)	**<0.001**
Other	1 (2.4)	41 (97.6)	**<0.001**
Fully mobile			
Assessed anthropometry	38 (90.5)	4 (9.5)	**<0.001**
Measured actual weight, height and BMI	35 (83.3)	7 (16.7)	**<0.001**
Estimated weight, height and BMI	4 (9.5)	38 (90.5)	**<0.001**
MUAC	13 (31.0)	29 (69.0)	**0.020**
Ulna length	0 (0)	42 (100.0)	**<0.001**
Knee height	0 (0)	42 (100.0)	**<0.001**
Other	1 (2.4)	41 (97.6)	**<0.001**

# Binomial test; p-values in bold are statistically significant
BMI = body mass index; MUAC = mid-upper arm circumference

For bed-bound patients who could not move and/or were unconscious, 76.2% (n=32) of the dietitians assessed anthropometry (p=0.001), and 73.8% (n=31) specifically used estimated weight, height and BMI (p=0.003) For patients who were bed-bound but could sit up, 78.6% (n=33) of the dietitians assessed anthropometry (p<0.001), however, no specific technique/method was used by a significant proportion of the sample. Lastly, in patients who were fully mobile, 90.5% (n=38) of the dietitians assessed anthropometry (p<0.001), and 83.3% (n=35) used actual weight, height and BMI (p<0.001) (Table 4.4).

Figure 4.1 shows the different methods used to assess anthropometry in COVID-19 patients with varying degrees of mobility.

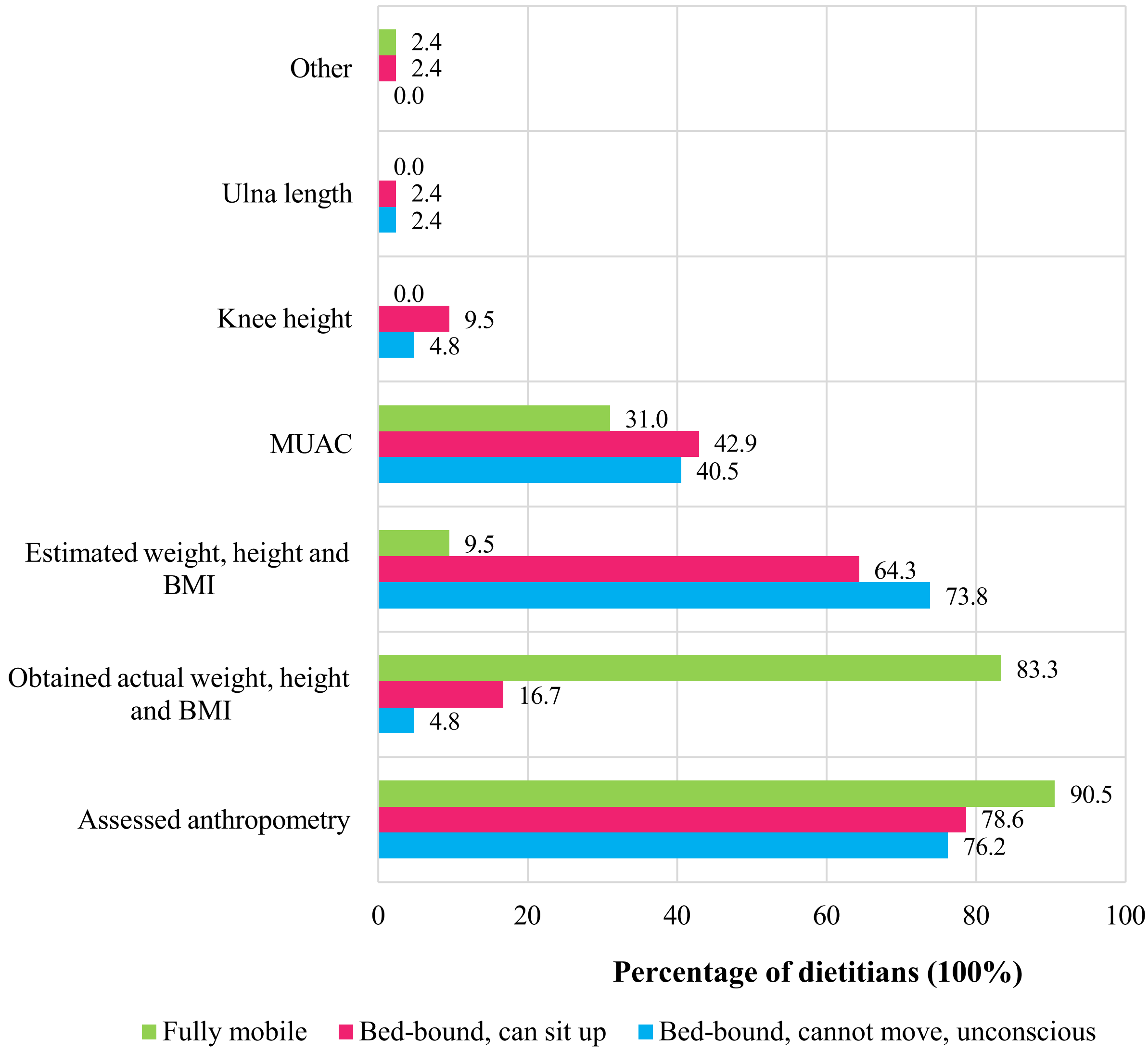

Figure 4.1: Methods used to assess anthropometry in patients with varying degrees of mobility

Dietitians were also asked about challenges and/or barriers that they may have experienced when assessing anthropometry in COVID-19 patients. For this question, a Likert scale (where 1 = strongly disagree and 5 = strongly agree) was used to indicate agreement/disagreement and a one-sample t-test was used to determine if there was a significant agreement/disagreement with each statement. The mean agreement score was tested against the central score of 3, to determine if it was different from 3, and therefore significant. Table 4.5 shows challenges and/or barriers that dietitians experienced when assessing anthropometry in COVID-19 patients.

Table 4.5: Challenges and/or barriers experienced by dietitians when assessing anthropometry in COVID-19 patients (n=42)

Challenges and/or barriers	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean agreement score (SD)	p-value#
	n (%)						
The protocol in my place of work did not allow some healthcare workers to be in direct contact with COVID-19 patients.	7 (16.7)	16 (38.1)	5 (11.9)	10 (23.8)	4 (9.5)	2.71 (1.27)	0.154
There was a shortage of PPE, thus I was unable to directly assess anthropometry in these patients.	6 (14.3)	19 (45.2)	5 (11.9)	7 (16.7)	5 (11.9)	2.67 (1.26)	0.095
I did not have access to certain equipment (e.g. scale, stadiometer) to assess my COVID-19 patient.	9 (21.4)	12 (28.6)	4 (9.5)	15 (35.7)	2 (4.8)	2.74 (1.29)	0.195
My patient did not feel well enough to allow me to take anthropometric measurements.	2 (4.8)	5 (11.9)	11 (26.2)	18 (42.9)	6 (14.3)	3.5 (1.04)	**0.003**
I was not consulted by the managing physician.	12 (28.6)	12 (28.6)	9 (21.4)	8 (19.0)	1 (2.4)	2.38 (1.17)	**0.001**

# One-sample t-test; p-values in bold are statistically significant
PPE = personal protective equipment

There was a significant agreement that patients did not feel well enough to allow dietitians to take anthropometric measurements (p=0.003). It was also found that there was a significant disagreement that the dietitians were not consulted by the managing physician (p=0.001) (Table 4.5).

4.5 Therapeutic nutrition in patients with COVID-19

4.5.1 Nutrition intervention or support

Figure 4.2 shows the proportion of dietitians who advocated for nutrition intervention or support in their COVID-19 patients.

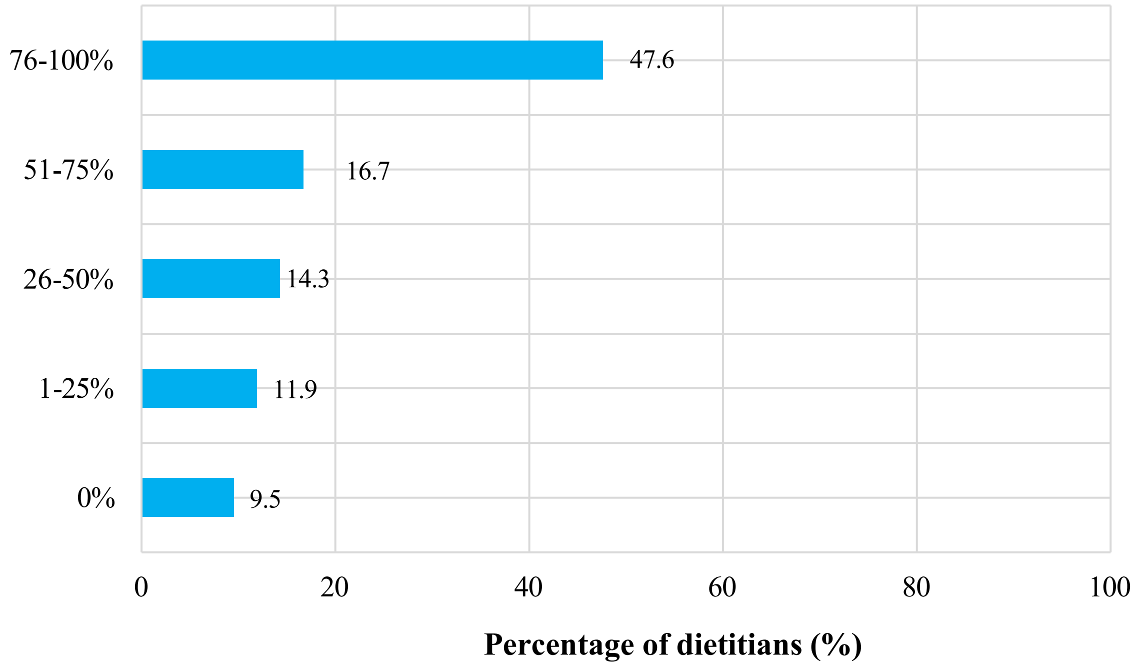

Figure 4.2: Dietitians who advocated for nutrition intervention or support in their COVID-19 patients

A significant majority of the dietitians advocated for nutrition intervention or support in more than 75% of their COVID-19 patients (n=20; 47.6%) (p<0.001), while only 9.5% (n=4) did not advocate for nutrition intervention or support at all (Figure 4.2).

Of the four dietitians who did not advocate for nutrition intervention or support, one strongly agreed that there was insufficient scientific evidence to support the need for nutrition intervention or support in COVID-19 patients. Another disagreed and two remained neutral.

With regards to the statement on there being insufficient guidelines or recommendations on nutrition intervention or support in COVID-19 patients, the responses included: strongly agree (n=1; 25%), agree (n=1; 25%), strongly disagree (n=1; 25%) and neutral (n=1; 25%). Fifty percent (n=2) of the dietitians disagreed that there was a lack of resources available to provide COVID-19 patients with nutrition intervention or support, and the other 50% (n=2) remained neutral. Lastly, 25% (n=1) of the dietitians disagreed with the statement that there may be unknown side-effects of nutrition intervention or support that may pose a risk in COVID-19 patients, whereas the majority (n=3; 75%) remained neutral.

Table 4.6 shows the nutrition societies that dietitians consulted for guidelines or nutrition recommendations for the management of patients with COVID-19.

Table 4.6: Nutrition societies that dietitians consulted for guidelines or nutrition recommendations on how to manage COVID-19 patients (n=42)

Nutrition society	**n**	**%***	**p-value#**
American Society for Parenteral and Enteral Nutrition (ASPEN)	7	16.7	0.133
European Society for Parenteral and Enteral Nutrition (ESPEN)	12	28.6	
South African Society for Parenteral and Enteral Nutrition (SASPEN)	5	11.9	
I did not consult a nutrition society	13	31.0	
Other	5	11.9	

*Percentage of sample (n=42)
Chi-square goodness of fit test; p-values in bold are statistically significant

Thirteen dietitians (31.0%) reported that they did not consult a nutrition society for guidelines or nutrition recommendations on how to manage COVID-19 patients, while 28.6% (n=12) consulted ESPEN. A chi-square goodness-of-fit test showed that no response option was selected significantly more than others (p=0.133). The five dietitians (11.9%) who selected the option of ‘other’ were further broken down as follows: two dietitians (4.8%) consulted the first three options being ASPEN, ESPEN and SASPEN; one dietitian (2.4%) consulted online platforms such as WHO, Nestlé Nutrition Institute Africa (NNIA) and De Nova Medica; one dietitian (2.4%) consulted studies published during the COVID-19 pandemic by Paul Wischmeyer (a critical care, perioperative and nutrition physician-researcher, specialising in surgical recovery, critical care and COVID-19). Lastly, one dietitian (2.4%) reported attending three webinars, which provided information from various nutrition societies and organisations (Table 4.6).

4.5.2 Macronutrient requirements

An open-ended question was used to determine the values/ranges most frequently used by dietitians when calculating dietary prescriptions for patients with COVID-19. For each macronutrient (energy, protein, fat and carbohydrate), similar responses were grouped together. Table 4.7 shows the values/ranges that dietitians used when calculating energy requirements for COVID-19 patients.

Table 4.7: Energy values/ranges used by dietitians for calculating energy requirements in COVID-19 patients (n=42)

Energy values/ranges (kCal/kg/day)	n	%*
14	1	2.4
20-23	1	2.4
20-25	1	2.4
25	3	7.1
25-30	12	28.6
25-35	6	14.3
28-35	1	2.4
30	2	4.8
30-35	3	7.1
30-50	1	2.4
35	1	2.4
35-45	1	2.4
Other	6	14.3
Did not calculate	3	7.1

*Percentage of sample (n=42)

Twelve dietitians (28.6%) reported using a range of 25-30 kCal/kg/day when calculating energy requirements for COVID-19 patients. This was followed by six dietitians (14.3%) who reported using a range of 25-35 kCal/kg/day. Six dietitians (14.3%) were categorised into ‘other’ as they provided more detailed explanations, which included:

- “150-200” (kJ/kg/day).
- “20-25 kCal initially in unstable (patients), or 10 kCal/kg with refeeding (syndrome) and 25-30 kCal/kg in stable (patients).”
- “Day 1: 10 kCal/kg; day 2: 15 kCal/kg; day 3: 20 kCal/kg; day 4: 25 kCal/kg.”

- “It depended on nutritional status and underlying medical conditions.”
- “Schofield equation with adjusted stress factors.”
- “Ventilated patients (on) day 0-4: 15 kCal/kg/day energy (and) day 4 onwards: 25-35 kCal/kg/day.”

Three dietitians (7.1%) stated that they did not calculate energy requirements for COVID-19 patients (Table 4.7).

Table 4.8 shows the values/ranges dietitians used when calculating protein requirements for COVID-19 patients.

Table 4.8: Protein values/ranges used by dietitians for calculating protein requirements in COVID-19 patients (n=42)

Protein values/ranges (g/kg/day)	n	%*
0.8-1.1	1	2.4
0.8-1.5	1	2.4
0.8-2	1	2.4
1-1.2	1	2.4
1-1.3	1	2.4
1-1.5	3	7.1
1-2	2	4.8
1.2	2	4.8
1.2-1.5	6	14.3
1.2-1.6	2	4.8
1.2-2	4	9.5
1.3	2	4.8
1.3-1.5	1	2.4
1.3-2	2	4.8
1.5	3	7.1
1.5-1.8	1	2.4
1.5-2	3	7.1
Other	3	7.1
Did not calculate	3	7.1

*Percentage of sample (n=42)

Six dietitians (14.3%) reported using a range of 1.2-1.5 g/kg/day when calculating protein requirements for COVID-19 patients. This was followed by four dietitians (9.5%) who reported using a range of 1.2-2 g/kg/day. Three dietitians (7.1%) used a range of 1-1.5 g/kg/day, whereas another three dietitians (7.1%) used a range of 1.5-2 g/kg/day. Only three dietitians (7.1%)

indicated that they used a value of 1.5 g/kg/day to calculate protein requirements. About 7% (n=3) of the dietitians were categorised into ‘other’ as they provided more detailed explanations, which included:

- “>2 g/kg due to majority being obese.”
- “1.2/1.3- 2.0 g/kg or 0.8-1.0 g/kg in (patients with) renal failure not on HD (haemodialysis).”
- “It depended on nutritional status, and other underlying medical conditions.”

Three dietitians (7.1%) stated that they did not calculate protein requirements for COVID-19 patients (Table 4.8).

Table 4.9 shows the values/ranges dietitians used when calculating fat requirements for COVID-19 patients.

Table 4.9: Fat values/ranges used by dietitians for calculating fat requirements in COVID-19 patients (n=42)

Fat values/ranges (% TER)	n	%*
15-20	1	2.4
15-25	1	2.4
15-40	1	2.4
20	1	2.4
20-25	1	2.4
20-30	3	7.1
25	2	4.8
25-30	4	9.5
30	15	35.7
30-35	1	2.4
30-40	2	4.8
40	1	2.4
Other	4	9.5
Did not calculate	5	11.9

*Percentage of sample (n=42)
TER = total energy requirements

Fifteen dietitians (35.7%) reported using 30% of TER when calculating fat requirements for COVID-19 patients. This was followed by four dietitians (9.5%) who indicated using a range of 25-30% of TER, and three dietitians (7.1%) who reported using a range of 20-30% of TER. About 10% (n=4) of the dietitians were categorised into ‘other’ as they provided more detailed explanations, which included:

- “<30%.”
- “30% fat if not in respiratory distress and 50% for ventilated patients.”
- “It depended on nutritional status, and other underlying medical conditions.”
- “In theory, 0.7-1.5 g/kg per day. Not applicable in clinical practice, most critically ill were on TPN (total PN) due to CPAP masks - SMOF (soybean, MCT, olive and fish oils) lipids were of preference.”

Five dietitians (11.9%) stated that they did not calculate fat requirements for COVID-19 patients (Table 4.9).

Table 4.10 shows the values/ranges dietitians used for calculating carbohydrate requirements in COVID-19 patients.

Table 4.10: Carbohydrate values/ranges used by dietitians for calculating carbohydrate requirements in COVID-19 patients (n=42)

Carbohydrate values/ranges (% TER)	n	%*
15	1	2.4
40-45	1	2.4
40-50	3	7.1
40-60	1	2.4
45-50	1	2.4
45-55	1	2.4
45-60	1	2.4
50	2	4.8
50-55	2	4.8
50-60	8	19.0
55	6	14.3
55-60	4	9.5
60	4	9.5
Other	3	7.1
Did not calculate	4	9.5

*Percentage of sample (n=42)
TER = total energy requirements

Nineteen percent (n=8) of the dietitians reported using a range of 50-60% of TER when calculating carbohydrate requirements for COVID-19 patients. This was followed by 14.3% (n=6) who indicated using 55% of TER. Four dietitians (9.5%) reported using 55-60% of TER and another four dietitians (9.5%) indicated that they used 60% of TER. Three dietitians (7.1%) were categorised into ‘other’ as they provided more detailed explanations, which included:

- “50-70% dependent on whether patient is in distress or not.”
- “It depended on nutritional status, and other underlying medical conditions.”
- “In theory max 4-5mg/kg/min. In practice, not possible. Again, most critically ill were on TPN (total PN). Volumes were limited or dictated by physician, blood sugars were usually uncontrolled.”

Four dietitians (9.5%) indicated that they did not calculate carbohydrate requirements for COVID-19 patients (Table 4.10).

Table 4.11 shows the different weight parameters that dietitians used to calculate nutritional requirements for COVID-19 patients.

Table 4.11: Weight parameters used by dietitians to calculate nutritional requirements for COVID-19 patients (n=42)

Parameter	n	%*	p-value#
Actual body weight	13	31.0	**0.004**
Estimated body weight	19	45.2	
Ideal body weight	4	9.5	
Adjusted body weight	6	14.3	

* Percentage of sample (n=42)
# Chi-square goodness of fit test; p-values in bold are statistically significant

A significant proportion of dietitians used actual body weight (n=13; 31.0%) or estimated body weight (n=19; 45.2%) to calculate nutritional requirements for COVID-19 patients (p=0.004) (Table 4.11).

4.5.3 Micro- and immunonutrient supplementation

Of the 42 dietitians, a significant number (n=30; 71.4%) (p=0.008) reported that they had not recommended any micro- and immunonutrient supplementation to COVID-19 patients in mega-doses. The 12 dietitians (28.6%) who recommended micro- and immunonutrient supplements to COVID-19 patients were asked to indicate in which situation they would supplement each of the vitamins, minerals and immunonutrients listed. Table 4.12 shows the micro- and immunonutrient supplements used by dietitians in COVID-19 patients.

Table 4.12: Supplementation of micro- and immunonutrients in COVID-19 patients (n=12)

	Did not supplement		**Supplemented in mega-doses in all COVID-19 patients**		**Supplemented in mega-doses in some COVID-19 patients when there was evidence of deficiency or when there was a perceived benefit**		**p-value#**
	n	**%***	**n**	**%***	**n**	**%***	
General vitamin and mineral supplement	3	25	2	16.7	7	58.3	0.174
Vitamin A	9	75	1	8.3	2	16.7	**0.009**
Vitamin B complex	8	66.7	3	25	1	8.3	**0.039**
Vitamin C	2	16.7	4	33.3	6	50	0.368
Vitamin D	3	25	5	41.7	4	33.3	0.779
Vitamin E	9	75	1	8.3	2	16.7	**0.009**
Vitamin K	10	83.3	1	8.3	1	8.3	**0.001**
Iron	7	58.3	1	8.3	4	33.3	0.105
Zinc	6	50	4	33.3	2	16.7	0.368
Magnesium	9	75	1	8.3	2	16.7	**0.009**
Copper	10	83.3	0	0.0	2	16.7	**0.021**
Selenium	9	75	2	16.7	1	8.3	**0.009**
Calcium	7	58.3	2	16.7	3	25	0.174
Glutamine	4	33.3	4	33.3	4	33.3	1.000
Arginine	10	83.3	0	0.0	2	16.7	**0.021**
Omega-3 fatty acids	7	58.3	2	16.7	3	25	0.174
Medium-chain triglyceride (MCT) oil	10	83.3	0	0.0	2	16.7	**0.021**

* Percentage of sample (n=12)

Chi-square goodness of fit test; p-values in bold are statistically significant

The following vitamins, minerals and immunonutrients were not supplemented by a significant number of dietitians in COVID-19 patients: vitamin A (n=9; 75%) (p=0.009), vitamin B-complex (n=8; 66.7%) (p=0.039), vitamin E (n=9; 75%) (p=0.009) vitamin K (n=10; 83.8%) (p=0.001), magnesium (n=9; 75%) (p=0.009), copper (n=10; 83.3%) (p=0.021), selenium (n=9; 75%) (p=0.009), arginine (n=10; 83.3%) (p=0.021) and medium-chain triglyceride (MCT) oil (n=10; 83.3%) (p=0.021) (Table 4.12).

Table 4.13 shows the dietitians' agreement/disagreement with statements provided in the questionnaire regarding the reasons why they recommended/would recommend mega-doses of micro- and immunonutrient supplements to COVID-19 patients.

Table 4.13: Reasons for choosing to give mega-doses of a micro- and immunonutrient supplements to COVID-19 patients (n=12)

Reason	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	**Mean agreement score (SD)**	**p-value#**
	n (%)						
There is scientific evidence to support mega-dosing.	0 (0)	2 (16.7)	6 (50.0)	3 (25.0)	1 (8.3)	3.25 (0.87)	0.339
There is no evidence of any potential harmful side effects of mega-dosing.	0 (0)	3 (25.0)	8 (66.7)	1 (8.3)	0 (0)	2.83 (0.58)	0.339
Mega-dosing can benefit patients with COVID-19.	0 (0)	0 (0)	6 (50)	5 (41.7)	1 (8.3)	3.58 (0.67)	**0.012**
Mega-dosing is promoted by the media/individuals.	2 (16.7)	1 (8.3)	3 (25.0)	4 (33.3)	2 (16.7)	3.25 (1.36)	0.536
I have had success with mega-dosing in COVID-19 patients.	1 (8.3)	0 (0)	7 (58.3)	3 (25.0)	1 (8.3)	3.25 (0.96)	0.389

One-sample t-test; p-values in bold are statistically significant

There was a significant agreement that mega-dosing of micro- and immunonutrient supplements benefited patients with COVID-19 ($p=0.012$) (Table 4.13).

In addition to this, the 12 dietitians were asked about improvements and side-effects associated with mega-dosing of micro- and immunonutrient supplements in COVID-19 patients. Their responses are presented in Table 4.14.

Table 4.14: Improvements and side-effects associated with mega-dosing of micro- and immunonutrient supplements in COVID-19 patients (n=12)

	n (%)		p-value#
	Yes	**No**	
Noticed an improvement in the recovery of COVID-19 patients who were given mega-doses of micro- and immunonutrient supplements.	10 (83.3)	2 (16.7)	**0.039**
Experienced any adverse side-effects related to mega-dosing of micro- and immunonutrient supplements.	0 (0)	12 (100)	**<0.001**

\# Binomial test; p-values in bold are statistically significant

A significant 83.3% (n=10) of dietitians noticed an improvement in the recovery of COVID-19 patients who were given mega-doses of micro- and immunonutrient supplements ($p=0.039$). All 12 dietitians (100%) reported no adverse side-effects in their COVID-19 patients who were given mega-doses of micro- and immunonutrient supplements ($p<0.001$) (Table 4.14).

4.5.4 Provision of nutritional support

Table 4.15 indicates the frequency with which dietitians provided selected nutritional support to COVID-19 patients.

Table 4.15: Frequency with which dietitians provided selected nutritional support to COVID-19 patients (n=42)

Type of nutritional support	**Never**	**Rarely**	**Sometimes**	**Often**	**Always/ Nearly always**	**p-value#**
	n (%)					
Provided ONS to COVID-19 patients.	0 (0)	0 (0)	9 (21.4)	18 (42.9)	15 (35.7)	0.223
Provided early EN within 24-36 hours of admission.	5 (11.9)	11 (26.2)	10 (23.8)	12 (28.6)	4 (9.5)	0.176
Provided PN to COVID-19 patients.	20 (47.6)	4 (9.5)	12 (28.6)	4 (9.5)	2 (4.8)	**<0.001**
Provided trophic feeding for COVID-19 patients.	19 (45.2)	9 (21.4)	8 (19.0)	5 (11.9)	1 (2.4)	**<0.001**
Provided hypocaloric nutrition in critically ill COVID-19 patients, and gradually increased until 100% of requirements were met.	12 (28.6)	6 (14.3)	13 (31.0)	6 (14.3)	5 (11.9)	0.146
Adjusted the nutrition prescription accordingly for COVID-19 patients on certain medications (e.g. propofol, dextrose and inotropes).	14 (33.3)	3 (7.1)	9 (21.4)	10 (23.8)	6 (14.3)	0.083
Routinely checked GRVs and blood parameters of COVID-19 patients, and adjusted the nutrition prescription accordingly.	15 (35.7)	2 (4.8)	6 (14.3)	7 (16.7)	12 (28.6)	**0.014**

Chi-square goodness of fit test; p-values in bold are statistically significant

ONS = oral nutrition supplements; EN = enteral nutrition; PN = parenteral nutrition; GRVs = gastric residual volumes

A five-point ordinal scale (from never to always/nearly always) was used to determine how often dietitians provided nutritional support to COVID-19 patients. It was found that a significant proportion of the dietitians never (n=20; 47.6%) or sometimes (n=12; 28.6%) provided PN to COVID-19 patients ($p<0.001$). Additionally, a significant 45.2% (n=19) reported never having provided trophic feeding to their COVID-19 patients ($p<0.001$). Lastly, it was found that 35.7% (n=15) and 28.6% (n=12) never and always/nearly always, respectively, routinely checked the GRVs and blood parameters of COVID-19 patients and then adjusted the nutrition prescription accordingly ($p=0.014$) (Table 4.15).

4.5.5 Nutrition-related challenges encountered

Table 4.16 shows the dietitians' responses to challenges related to the management of COVID-19 patients.

Table 4.16: Dietitians' responses to challenges related to the management of COVID-19 patients (n=42)

Challenges	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	**Mean agreement score (SD)**	**p-value#**
	n (%)						
I was limited to select from a few enteral and/or parenteral feeds for my COVID-19 patients.	8 (19.0)	10 (23.8)	8 (19.0)	12 (28.6)	4 (9.5)	2.86 (1.30)	0.480
The managing physician in my place of work had limited or no knowledge on nutrition.	11 (26.2)	10 (23.8)	14 (33.3)	4 (9.5)	3 (7.1)	2.48 (1.19)	**0.007**
Healthcare staff were inexperienced with handling and changing enteral and/or parenteral feeding bags.	18 (42.9)	12 (28.6)	7 (16.7)	5 (11.9)	0 (0)	1.98 (1.05)	**<0.001**
It was difficult to get the healthcare team on board regarding supplementary nutrition.	14 (33.3)	17 (40.5)	4 (9.5)	6 (14.3)	1 (2.4)	2.12 (1.11)	**<0.001**
The facility in which I work does not have the resources to provide enteral and/or parenteral nutrition to COVID-19 patients.	19 (45.2)	12 (28.6)	2 (4.8)	4 (9.5)	5 (11.9)	2.14 (1.41)	**<0.001**
Feeding my COVID-19 patients was delayed due to high dose vasopressors and/or inotropes.	4 (9.5)	11 (26.2)	12 (28.6)	11 (26.2)	4 (9.5)	3.00 (1.15)	1.000
Most of my COVID-19 patients were haemodynamically unstable, or presented with evidence of shock, hypoxaemia, hypercapnoea and/or acidosis, which delayed feeding.	4 (9.5)	12 (28.6)	12 (28.6)	10 (23.8)	4 (9.5)	2.95 (1.15)	0.789
My patients frequently experienced GIT disturbances (vomiting, diarrhoea, abdominal pain, constipation), which affected feeding.	3 (7.1)	10 (23.8)	11 (26.2)	14 (33.3)	4 (9.5)	3.14 (1.12)	0.412

Table 4.16: Dietitians' responses to challenges related to the management of COVID-19 patients (n=42) continued

Challenges	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	**Mean agreement score (SD)**	**p-value#**
	n (%)						
I frequently observed metabolic complications (hyperglycaemia, hypertriglyceridaemia and/or refeeding syndrome), in COVID-19 patients whilst on supplementary nutrition.	6 (14.3)	16 (38.1)	8 (19.0)	6 (14.3)	6 (14.3)	2.76 (1.28)	0.236
My COVID-19 patient's nasogastric feeding tube was frequently dislodged/ removed.	4 (9.5)	16 (38.1)	16 (38.1)	4 (9.5)	2 (4.8)	2.62 (0.96)	**0.014**
My patient was frequently in the prone position, which affected or limited feeding.	8 (19.0)	12 (28.6)	12 (28.6)	6 (14.3)	4 (9.5)	2.67 (1.22)	0.085
There was difficulty maintaining a central line for PN in COVID-19 patients.	14 (33.3)	8 (19.0)	18 (42.9)	1 (2.4)	1 (2.4)	2.21 (1.02)	**<0.001**
My COVID-19 patients experienced aspiration or some degree of dysphagia, and I was unable to consult a speech therapist.	13 (31.0)	14 (33.3)	7 (16.7)	7 (16.7)	1 (2.4)	2.26 (1.15)	**<0.001**
I am unfamiliar with selecting enteral and/or parenteral nutrition bags.	27 (64.3)	13 (31.0)	1 (2.4)	0 (0)	1 (2.4)	1.45 (0.77)	**<0.001**

# One-sample t-test; p-values in bold are statistically significant
GIT = gastrointestinal tract; PN = parenteral nutrition

There was a significant disagreement that the managing physician at the facility had limited or no knowledge on nutrition ($p=0.007$). Additionally, dietitians disagreed or strongly disagreed that it was difficult to get the healthcare team on board regarding supplementary nutrition ($p<0.001$), and that healthcare staff were inexperienced with handling and changing enteral and/or parenteral feeding bags ($p<0.001$). It was also found that a significant number of dietitians disagreed or strongly disagreed that they did not have the resources to provide enteral and/or parenteral nutrition to COVID-19 patients ($p<0.001$). Dietitians disagreed/strongly disagreed or remained neutral that the dislodgement of the patient's NGT ($p=0.014$) and difficulty in maintaining a central line ($p<0.001$) were challenges faced. Furthermore, dietitians disagreed or strongly disagreed that COVID-19 patients experienced aspiration or some degree of dysphagia, and they were unable to consult a speech therapist ($p<0.001$). Lastly, dietitians strongly disagreed that they were unfamiliar with selecting enteral and/or parenteral nutrition bags ($p<0.001$) (Table 4.16).

Factor analysis with promax rotation was applied to the 14 items measuring challenges encountered. Of the 14 items, only one item, 'I am unfamiliar with selecting enteral and/or parenteral nutrition bags', did not load strongly enough onto any factor and was removed. Three factors were extracted, which accounted for 48.16% of the variance in the data. A Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) of 0.651 and a significant Bartlett's test indicated that the data were adequate for successful and reliable extraction. Rotation converged in five iterations. The factor loadings of these items are summarised in Table 4.17.

Table 4.17: Factor loadings for factor analysis of challenges encountered

Challenge	Factor		
	1	2	3
I was limited to select from a few enteral and/or parenteral feeds for my COVID-19 patients.	0.763		
The managing physician in my place of work had limited or no knowledge on nutrition.	0.749		
Healthcare staff were inexperienced with handling and changing enteral and/or parenteral feeding bags.	0.627		
It was difficult to get the healthcare team on board regarding supplementary nutrition.	0.614		
The facility in which I work does not have the resources to provide enteral and/or parenteral nutrition to COVID-19 patients.	0.601		
Feeding my COVID-19 patients was delayed due to high dose vasopressors and/or inotropes.		0.834	
Most of my COVID-19 patients were haemodynamically unstable, or presented with evidence of shock, hypoxaemia, hypercapnoea and/or acidosis, which delayed feeding.		0.712	
My patients frequently experienced GIT disturbances (vomiting, diarrhoea, abdominal pain, constipation), which affected feeding.		0.641	
I frequently observed metabolic complications (hyperglycaemia, hypertriglyceridaemia and/or refeeding syndrome), in COVID-19 patients whilst on supplementary nutrition.		0.361	
My COVID-19 patient's nasogastric feeding tube was frequently dislodged/ removed.			0.706
My patient was frequently in the prone position, which affected or limited feeding.			0.655
There was difficulty maintaining a central line for PN in COVID-19 patients.			0.601
My COVID-19 patients experienced aspiration or some degree of dysphagia, and I was unable to consult a speech therapist.			0.598

GIT = gastrointestinal tract; PN = parenteral nutrition

Composite variables were formed by calculating the mean of the agreement scores for all items included in a variable. Table 4.18 shows a summary of the composite variables that were all reliable factors, as determined by Cronbach's alpha > 0.7, and could be used in further analysis.

Table 4.18: Composite variables for factor analysis

Factor	Construct	Variance extracted	Cronbach's alpha
1	Lack of support and resources	24.87	0.793
2	Medical conditions and complications	15.25	0.749
3	Nutrition-related external factors	8.04	0.724

Table 4.19 shows the level of agreement with each of the constructs related to challenges faced by dietitians.

Table 4.19: Level of agreement that these were challenges faced by dietitians

Construct	Mean (SD)	t	df	p-value#
Lack of support and resources	2.31 (0.90)	-4.932	41	**<0.001**
Medical conditions and complications	2.96 (0.89)	-0.261	41	0.796
Nutrition-related external factors	2.44 (0.81)	-4.481	41	**<0.001**

One-sample t-test; p-values in bold are statistically significant

From these constructs it was found that there was significant disagreement that there was a lack of support and resources ($p<0.001$) and that nutrition-related external factors presented a challenge ($p<0.001$) (Table 4.19).

4.5.6 Further comments or challenges regarding nutritional management

Dietitians were given the opportunity to leave a comment regarding the nutritional management of adult COVID-19 patients. The most common responses were grouped as follows:

- Nutritional feeds were not given to patients as prescribed/recommended by the dietitian.
- Gastric residual volumes in patients who received enteral nutrition were not monitored according to the dietitian's recommendation.
- Dietitians shared experiences on managing COVID-19 patients in terms of practicality.
- The presence of other more urgent chronic co-morbidities (diabetes, hypertension and cancer) influenced the nutritional management of COVID-19 patients.
- Some dietitians were inexperienced in a clinical setting.
- Mild cases of COVID-19 were referred to the dietitian upon discharge from the hospital.
- There were limited resources in some facilities.
- There was no clear indication of the amount of contact dietitians should have had with COVID-19 patients during the early stages of the pandemic.
- Dietitians recommended an individualised approach for COVID-19 patients.

CHAPTER 5
DISCUSSION

This chapter discusses the results presented in Chapter 4. Due to the novelty of COVID-19, there were very limited studies on the nutritional management of COVID-19 to compare the current study results to.

5.1 Study participants

Forty-two dietitians participated in the current study. More KZN DOH-employed dietitians than ADSA members participated in the current study (52.4% and 31%, respectively). This is feasible as there were slightly more KZN DOH- employed dietitians (151) than ADSA members (144) initially identified. Since about half of the dietitians in the current study were KZN DOH-employed dietitians, it is feasible that a similar number of them would be working at KZN DOH facilities (54.7%). Additionally, ADSA members mainly represented dietitians in the private sector, which was similar to the number of dietitians working at a private hospital or in private practice (40.5%). Although three dietitians were both KZN DOH-employees and ADSA members, it is unlikely that they would have participated in the current study twice, due to time constraints.

5.2 Treatment of COVID-19

Many of the dietitians in the current study reported that they began treating COVID-19 patients in the early stages of the pandemic (March-July 2020), when the number of adult COVID-19 patients admitted to hospital was high. According to the NICD, KZN had 78 448 (17.1%) of the total COVID-19 hospital admissions in SA between 05 March 2020 and 26 February 2022 (SAcoronavirus 2022). This can also be seen with the average number of COVID-19 patients that dietitians reported treating. As the pandemic proceeded, more than half of the dietitians in the current study reported no longer treating COVID-19 patients, and some reported treating only a few patients per week. This is feasible as the current study was conducted two years after the WHO declared the COVID-19 outbreak a pandemic on 11 March 2020. Additionally, COVID-19 vaccines became available in 2021, which reduced the number of patients with COVID-19 and the severity of COVID-19 among the population, resulting in a decrease in hospitalised cases (Notarte *et al* 2022; Silva *et al* 2022; Roghani 2021).

A retrospective cohort study conducted in Saudi Arabia between January and May 2021, which included 1058 COVID-19 patients, of which 25% (n=265) were vaccinated and 75% (n=793) were unvaccinated, showed a significantly lower hospitalisation rate in the vaccinated group (2.3%), compared to the unvaccinated group (16.5%) (Alnemari *et al* 2023). Furthermore, according to a retrospective observational study by Jassat *et al* (2022), fewer patients were admitted to hospital during the latter stages of the COVID-19 pandemic (January 2022), which could be due to the increase in the number of vaccinated individuals and a decrease in the severity of the disease. Supporting this, Dyer (2021) mentions that for newly diagnosed COVID-19 patients, the risk of hospitalisation was 29% lower than in the early stages of the pandemic (July 2020).

5.3 Nutritional guidelines used by dietitians

Given that malnutrition risk was assessed and nutrition screening tools were used by some dietitians in the current study, it seems prudent that dietitians would support and advocate for nutrition intervention or support in these patients. Dietitians are experts in diet and nutrition and have extensively studied the role that adequate nutrient intake plays in the progression, prognosis and prevention of diseases (Endervelt & Gesser-Edelsburg 2014). Since COVID-19 is no exception, dietitians should be considered an essential part of the healthcare team (Haraj *et al* 2021; Handu *et al* 2020). In the current study, the majority of dietitians advocated for nutrition intervention or support in their COVID-19 patients, albeit in various proportions of their patients. This could be due to differences in malnutrition risk among the patients and their need for dietetic intervention. Other reasons why dietitians may have had to advocate for dietetic intervention in a high proportion of COVID-19 patients, could possibly be due to a lack of knowledge, appreciation and support for the dietetics sector. This was one of the conclusions from a study conducted in the United Arab Emirates by Naja *et al* (2021), on the practice-related characteristics of dietitians treating COVID-19 patients. Only a few dietitians in the current study did not advocate for nutrition intervention or support in COVID-19 patients, and there was no strong consensus on agreement or disagreement with any of the statements given in the questionnaire as possible reasons for this.

It is common for dietitians to consult nutrition societies for recommendations or guidelines on the nutritional management of various nutrition-related diseases. Despite this, it is interesting to note that in the current study, many dietitians reported that they did not consult a nutrition society for guidelines on the nutritional management of COVID-19. This was unexpected, seeing that at the time of the current study, COVID-19 was a new disease without any published medical or nutritional management guidelines. The novelty of COVID-19 and the swiftness at which it spread (Tsai *et al* 2020), should have been an indication for dietitians to consult colleagues, nutrition organisations, and other reliable sources for information on the nutritional management of COVID-19. In the current study, of the dietitians who did consult a nutrition society, most dietitians consulted ESPEN for guidelines on the nutritional management of COVID-19, followed by ASPEN and SASPEN, all of which are reliable nutritional sources. Most of the published articles available referred to the ESPEN guidelines and recommendations on the management of critically ill patients, as most COVID-19 patients worldwide, were critically ill or of an advanced age.

A few dietitians in the current study referred to other sources for information on the nutritional management of COVID-19 patients. These sources included reputable organisations such as the WHO and NNIA. The WHO has created a special hub for COVID-19 and includes COVID- 19-related publications for easy access. The NNIA website is a nutrition-related website that healthcare professionals can access for publications, webinars and other valuable information. According to Minnelli *et al* (2020), webinars and early published literature on 'best practices' were popular, which is consistent with what some dietitians reported in the current study.

Energy values, in various increments, ranging between 20 and 35 kCal/kg/day were typically used by dietitians in the current study. This is in line with the recommended ESPEN energy values for critically ill patients of 27 kCal/kg/day to 30 kCal/kg/day, which may be adjusted to account for physical activity, metabolic stress and GIT tolerance in the patient (Barazzoni *et al* 2020). Interestingly, only one dietitian reported using predictive equations, such as the Schofield equation with adjustments made for stress factors, to calculate energy requirements. Both ESPEN and ASPEN mention this as an acceptable practice in the management of COVID-19 (Barazzoni *et al* 2020; Martindale *et al* 2020).

The American Society for Parenteral and Enteral Nutrition (ASPEN) recommends a more cautious approach to meeting energy requirements in COVID-19 patients, beginning with 15-20 kCal/kg/day and gradually increasing this until the full energy requirements are met (Martindale *et al* 2020). In the current study, some dietitians adopted this method of cautious feeding, especially in unstable or ventilated patients. A few dietitians reported not calculating energy requirements in the current study, which is not unexpected since there were limited studies and guidelines on the nutritional management of COVID-19 in the early stages of the pandemic, resulting in uncertainty among dietitians. Since COVID-19 presented differently in different patients and the degree of illness and/or symptoms varied, it may not have been necessary for dietitians to calculate energy requirements. It is possible that some COVID-19 patients were not on EN or were just given ready to drink ONS in addition to the ward diet (Arkin *et al* 2020; Caccialanza *et al* 2020).

Dietitians reported meeting the protein requirements of COVID-19 patients, but also considered pre-existing medical conditions, such as obesity and renal failure when calculating protein requirements. Since many COVID-19 patients presented with such co-morbidities, an individualised approach was prudent. In obese patients, ESPEN recommends 1.3 g/kg/day Adj-BW to preserve muscle mass (Barazzoni *et al* 2020), however, in the current study, dietitians reported providing > 2 g/kg/day to obese patients with COVID-19. Furthermore, COVID-19 patients with renal failure were reported to have been given less than 1 g/kg/day of protein, which is in line with ESPEN recommendations. Most dietitians in the current study frequently used protein values in increments ranging between 1 to 2 g/kg/day. This is consistent with both ESPEN and ASPEN guidelines, as ESPEN recommends using 1-1.3 g/kg/day of protein, while ASPEN recommends using 1.2-2 g/kg/day (Barazzoni *et al* 2020; Martindale *et al* 2020).

When aiming to provide an optimal amount of protein to safely meet their patient's increased requirements, dietitians should always consider the nutritional and medical status of their patient on an individualised basis (Barazzoni *et al* 2020). An international, multi-centre, randomised clinical trial including data from 16 countries by Heyland *et al* (2023), compared the use of high-dose protein (≥ 2.2 g/kg/day) to usual dose protein (≤ 1.2 g/kg/day) in 1301 mechanically ventilated ICU patients. The abstract from the study reported that the 60-day mortality rate was 34.6% in the high-dose protein group and 32.1% in the usual-dose protein group. Furthermore, the discharge rate was 46.1% and 50.2% in the high-dose protein group and the usual-dose protein group, respectively. These findings indicate that a higher dose of protein in mechanically ventilated ICU patients did not appear to improve mortality and discharge rates (Heyland *et al* 2023).

The percentage of TER for fat and carbohydrate may differ in COVID-19 patients, particularly in those on mechanical ventilation or with ARDS. According to ESPEN recommendations, for TER, a fat to carbohydrate ratio of 30:70 is suitable in non-ventilated patients without ARDS, and a ratio of 50:50 is appropriate in ventilated patients with ARDS (Barazzoni *et al* 2020). The reason for a lower recommendation of carbohydrate in ventilated patients or those with ARDS, is that there is reduced body stores of carbon dioxide, thereby reducing the ratio of partial pressure of arterial carbon dioxide ($PaCO_2$) levels, and decreasing the amount of time spent on the ventilator (Gangitano *et al* 2021). In the current study, the dietitians reported using lower values for fat (less than 40% of TER), and slightly higher values for carbohydrates (ranging between 50 to 60% of TER), which could suggest that many of the COVID-19 patients seen were not receiving mechanical ventilation and were more stable. Dietitians should also adjust these values based on other factors such as increasing blood glucose levels, fluid restrictions (common in patients receiving IV dextrose), blood parameters and patients on total PN (Martindale *et al* 2020; Salazar & Cheah 2020).

The current study showed that estimated weight, height and BMI were most often used in bed-bound patients. Thus, it is feasible that most dietitians would have used estimated weight to calculate nutritional requirements. Actual body weight was the second most frequently used weight parameter to calculate nutritional requirements, and was mostly measured in mobile patients. Less than a quarter of the dietitians in the current study stated that they used IBW or Adj-BW when calculating nutritional requirements. This is interesting because ESPEN mentions that IBW and Adj-BW should be used in certain energy and protein calculations, for example, in polymorbid obese adults (Barazzoni *et al* 2020), as was frequently observed in the COVID-19 pandemic. Additionally, IBW and Adj-BW should also be considered for patients who are severely malnourished, or who have existing amputations or ascites (Lahner 2019).

Nutrition societies commonly provide guidelines for dietitians on the administration of nutrition feeds for patients. Since there is consensus among dietitians that if the GIT is working, it should be used, the oral route should be considered first when providing supplemental nutrition (Arkin *et al* 2020; Barazzoni *et al* 2020; Caccialanza *et al* 2020; Martindale *et al* 2020). Dietitians in the current study often or nearly always provided their COVID-19 patients with ONS, which is in line with existing guidelines for supplementary nutrition. However, the current study did not consider volumes and compositions of ONS given by the dietitians, nor did it consider patient compliance. The next best route, according to ESPEN, for supplementary nutrition is the enteral route (Barazzoni *et al* 2020). Early enteral feeding is indicated in patients where adequate oral intake is not possible (Ojo *et al* 2022). However, the results from the current study varied between dietitians rarely initiating early EN to them often initiating early EN. This may suggest that COVID-19 patients seen by the dietitians in the current study were able to consume food orally. Additionally, most of the dietitians in the current study did not use trophic feeding, which may indicate that the GIT was functioning and patients were able to tolerate adequate amounts of EN. Furthermore, the current study did not compare continuous and bolus feeding.

Total PN is considered as a last resort for patients as there are many associated complications if it is incorrectly administered. Additionally, PN is usually expensive and may not be easily available in all healthcare facilities. Different hospitals offer different levels of care, and since the results from the current study indicate that a significant number of dietitians worked at a private or district hospital, it is likely that the provision of PN in COVID-19 patients may have varied. The nutrition prescription should be adjusted to account for macronutrients that come from different medications. The medicine, propofol, is commonly used as a sedative in ventilated patients and contributes to fat intake in the patient (Minnelli *et al* 2020). Similarly, dextrose found in some IV solutions, contributes to carbohydrate intake in the patient (Martindale *et al* 2020; Minnelli *et al* 2020). Therefore, it is imperative that the dietitian be involved in adjusting the macronutrient requirements and intake accordingly. In the current study, there was no statistically significant response on the frequency of dietitians adjusting macronutrient requirements. Patients on EN should have their levels of blood glucose, triglycerides and electrolytes (magnesium, potassium and phosphorous) and GRVs monitored for signs of intolerance to EN (Barazzoni *et al* 2020). High GRVs (greater than 500 ml in a 24-hour period) should warrant the use of a post-pyloric feeding tube to maximise the delivery of nutrients (Barazzoni *et al* 2020), or an alternative, such as PN should be considered. There are still limited clinical trial data on nutrition in COVID-19 patients to provide definite guidelines for nutritional management in the COVID-19 patient population (James *et al* 2021).

5.4 Challenges encountered by dietitians

Since COVID-19 is a novel disease, all healthcare workers, including dietitians, experienced challenges managing the disease. Due to limited nutrition-related research in hospitalised COVID-19 patients to date, there are only a few studies to compare the results of the current study to. In the Chapter 4 (Results), the challenges that dietitians encountered were similarly grouped and are discussed below.

The first group of challenges was entitled 'lack of support and resources' and listed five challenges in the questionnaire. In the current study, there was consensus among the dietitians that a lack of support and resources was not an issue nor a challenge that they faced with their COVID-19 patients. There was a strong and significant disagreement that there were insufficient resources to provide enteral or parenteral nutrition to COVID-19 patients. However, some dietitians both agreed and disagreed that they were able to access a variety of enteral and parenteral nutrition feeds. This could be due to differences in employment sectors. For example, dietitians in the private sector or working at private hospitals may have had access to a wider range of feeds, as compared to dietitians working in the public sector, where they would have been limited to feeds that were on the Government tender at the time of the current study.

Dietitians in the current study disagreed with not having received support from other healthcare workers. A possible influential factor is the nutritional knowledge and perceptions of physicians and other healthcare workers, such as nurses and support staff. Healthcare workers who frequently consulted and worked with dietitians as part of the MDT, for example nurses, may have understood the importance of nutrition and may have been more inclined to support its intervention, and may have been more willing to assist with this in the absence of the dietitians. For example, changing the rate on the feeding pump based on the dietitian's plan, or replacing an empty feeding bag during the night. Additionally, healthcare workers are required to continuously develop their professional knowledge, so, it is possible that they may have been exposed to some nutrition-related material. Some may have even attended further nutrition courses as part of their continuous professional development.

The second group of challenges was entitled 'medical conditions and complications' and four challenges were listed in the questionnaire. In most COVID-19 patients, urgent medical intervention was prioritised during the initial stages of the pandemic, as not much was known about the virus. Certain medical interventions or therapies influenced the nutritional management of COVID-19 patients. According to Arkin *et al* (2020) and Handu *et al* (2020), for COVID-19 patients receiving vasopressor or inotropic support, aggressive nutritional intervention is contraindicated. However, in the current study, there was no consensus on this being considered a challenge among the dietitians. A possible reason for this not being considered a challenge among the dietitians in the current study may be that dietitians managed a wide range of COVID-19 patients, with varying severities of illness. The same can be said for patients who were initially haemodynamically unstable, in shock, or had other complications. One of the most common nutrition-related challenges that all dietitians face is the presence of GIT intolerance (Arkin *et al* 2020), and in the current study dietitians agreed that this was a challenge in feeding their COVID-19 patients. Gastrointestinal tract intolerance may be due to large volumes of feed being given too fast, antibiotic-associated diarrhoea, insufficient fluid intake resulting in constipation, nutritional composition of the feeds and other medications that the patients were receiving (Arkin *et al* 2020; Martindale *et al* 2020).

Because many COVID-19 patients were hospitalised for severe illness, many of them already had existing co-morbidities, such as obesity, diabetes, kidney disease and even malnutrition. With this is mind, it was not uncommon for patients to have had elevated blood glucose levels, high cholesterol levels, or other such elevated blood parameters. Despite this, it is interesting to note that many dietitians in the current study did not consider this as a common challenge with patients being on supplementary nutrition. A likely reason for this may be that blood parameters were not checked often enough to be able to detect any abnormalities in these patients, however, this is only speculation and further research is needed. Despite medical challenges being evident in most literature published during the pandemic, it is interesting to note that the results from the current study do not support medical conditions and complications as being challenges faced by dietitians. Due to the small sample size in the current study, additional studies on dietitian-encountered challenges would be useful.

The last group of challenges was entitled 'nutrition-related external factors' and listed four challenges in the questionnaire. Overall, there was a statistically significant disagreement that this group of challenges presented a problem for the dietitians in the current study. According to the dietitians in the current study, dislodgement of the NGT, maintaining a central line, proning, aspiration or difficulty swallowing were not often observed in COVID-19 patients, despite these being mentioned as common challenges in the literature (Behrens *et al* 2021; Arkin *et al* 2020; Handu *et al* 2020; Minnelli *et al* 2020). This could suggest that patients were cautiously managed by the MDT to avoid unnecessary complications or infections.

Some dietitians in the current study shared other challenges that they faced. Non-compliance by patients and/or healthcare staff regarding nutritional intake and GRVs not being monitored according to the dietitian's recommendations, were mentioned as challenges in the current study. It was also mentioned that COVID-19 patients were only referred to the dietitian upon discharge, and not while the patients were hospitalised. Furthermore, COVID-19 was highly prevalent in SA in early 2020. This suggests that some newly-qualified dietitians in SA, who had just begun their internship or community service in 2020, would not have been experienced in a clinical setting, and would have been at a disadvantage with regards to nutritional management of COVID-19.

5.5 Assessment of anthropometry in COVID-19 patients

Measuring actual weight, height and BMI in a patient is the best way to assess their anthropometric status (Bagni *et al* 2021; Casadei & Kiel 2021). However, this requires more contact and effort from both the dietitian and the patient, which may have been a limiting factor during the COVID-19 pandemic. To measure the actual weight of a patient, the patient must be able to stand on a scale, upright and without support. The same applies when measuring the height of a patient using a stadiometer (Lahner 2019). Despite the COVID-19 pandemic requiring isolation of infected patients, a statistically significant number of dietitians in the current study obtained actual anthropometric measurements in ambulatory patients. According to Brugliera *et al* (2020), by obtaining actual measurements for weight, height and BMI, dietitians are able to accurately assess anthropometric status and the type of nutritional intervention required, in a low-cost and minimally invasive way (Bagni *et al* 2021).

The main approaches used to assess anthropometric status in non-ambulatory COVID-19 patients in the current study were the estimation of weight, height and BMI. Estimated weight, height and BMI are frequently used in clinical practice and are an alternative when actual weight, height and BMI cannot be obtained for various reasons (Lahner 2019). Furthermore, there are many different predictive equations that use other body measurements to estimate weight. Predictive equations for estimating weight include the use of calf circumference, mid-upper arm circumference (MUAC) and knee height, amongst others (Lahner 2019). However, this has not been confirmed for use in a South African setting (Lahner 2019). During the COVID-19 pandemic, many patients were bed-bound due to severe illness (Caccialanza *et al* 2020). Thus, estimating height may have been more difficult as immobile patients would not always have been lying in a supine position and it may not have been conducive to move the patient. Although predictive equations and measurements such as ulna length, knee height and arm span are available to estimate height (Bagni *et al* 2021), these parameters were seldom used by dietitians in the current study.

Dietitians can estimate BMI by using other body parameters such as MUAC (Brito *et al* 2016). A retrospective study by Brito *et al* (2016) between 2004 and 2013, including 1373 patients in Spain, found a significant and positive correlation between MUAC and BMI. This indicates that MUAC can be used as an alternative to assessing BMI, when the weight and height of a patient cannot be easily obtained. This is similar to the results of a meta-analysis by Földi *et al* (2020), which considered BMI and obesity as risk factors for developing severe COVID-19.

The current study supports this as MUAC was the second most common method used to assess anthropometry in COVID-19 patients. This may be because MUAC is relatively easy to assess, does not require expensive equipment (Földi *et al* 2020; Brito *et al* 2016) and would have required very little physical contact and effort from both the dietitian and the COVID-19 patient.

In the current study, dietitians agreed that patients with COVID-19 did not feel well enough to have their actual anthropometric measurements taken. This seems reasonable as most patients hospitalised with COVID-19 during the early period of the pandemic were ill with severe complications (Caccialanza *et al* 2020; Thibault *et al* 2020a). During the pandemic, many COVID-19 patients were mechanically ventilated, due to some form of ARDS, which made it difficult for dietitians to conduct routine anthropometric assessments (Azkur *et al* 2020). Additionally, during the early stages of the pandemic, not all healthcare workers were allowed to be in direct contact with COVID-19 patients, due to uncertainty of protocol and the initial shortage of personal protective equipment (PPE) (Coto *et al* 2020). This was restricted to frontline physicians, nurses and a few support staff only (Handu *et al* 2020; Thibault *et al* 2020b). Contrary to this, most dietitians in the current study disagreed that they were restricted from being in direct contact with COVID-19 patients, and a significant number of dietitians disagreed that they were not consulted by the managing physician. This suggests that dietitians were consulted by the managing physician, and were directly involved with COVID-19 patients, which is similar to the findings of Coto *et al* (2020). Despite the initial shortage of PPE in SA during the COVID-19 pandemic, the dietitians in the current study disagreed that this was an influencing factor for not assessing anthropometry in COVID-19 patients.

Although not statistically significant, most of the dietitians in the current study agreed that they did not have access to certain equipment in order to assess anthropometry. Since COVID-19 is easily spread through contact with patients and surfaces, any equipment used would have been sanitised and disinfected between patients (Thibault *et al* 2020a). Although advanced equipment such as bed-scales, chair-scales, BIA, CT scans and indirect calorimetry are valuable tools to assess anthropometric status, they may not be easily available or accessible to dietitians and other healthcare staff due to the high cost associated with procuring and maintaining such advanced equipment (Bagni *et al* 2021; Poros *et al* 2021; Barazzoni *et al* 2020; Thibault *et al* 2020b).

5.6 Assessment of malnutrition risk and nutrition screening tools

Malnutrition screening tools were used by half of the dietitians in the current study and the NRS-2002 was the screening tool of choice for approximately 62% of these dietitians. Studies by Chada *et al* (2021), Kroc *et al* (2021), Barazzoni *et al* (2020), Del Giorno *et al* (2020) and Reber *et al* (2019b), all supported the use of the NRS-2002 for older hospitalised patients as a prognostic tool for determining length of hospital stay and mortality in patients with or without COVID-19. A cross-sectional study by Ahmadi *et al* (2022), which included 100 COVID-19 patients admitted to a hospital in Iran, found that for an increase in one unit of the NRS-2002 score, the mortality odds rose by 354%. This shows that the NRS-2002 is highly sensitive in predicting disease outcome in COVID-19 patients based on nutritional status and malnutrition risk. Despite there being no gold-standard nutrition screening tool (Reber *et al* 2019b), the NRS-2002 is considered well-validated and is widely used in hospital settings (Cervantes-Pérez *et al* 2020). The NRS-2002 appears to be appropriate for COVID-19 patients as it considers different aspects such as nutritional status, medical conditions and age, yet it is relatively quick to use (Ahmadi *et al* 2022). Dietitians can train nurses and other healthcare workers on how to use nutrition screening tools to quickly and accurately assess if a patient is at risk of malnutrition, and then refer them to the dietitian for a thorough nutritional assessment. By identifying malnutrition early, dietitians are in a better position to provide aggressive nutrition intervention, which can improve both the short- and long-term prognosis of patients with or without COVID-19 (Cervantes-Pérez *et al* 2020).

After the NRS-2002, the MUST was the nutrition screening tool most frequently used by dietitians in the current study. The MUST assesses BMI, acute illness and considers any recent weight loss in the patient (Kroc *et al* 2021). As mentioned earlier, this screening tool is easy to understand and simple enough for nurses and other healthcare workers to use and especially when the dietitian may be unavailable to assess the patient upon admission. Clinical indications such as loose- fitting clothing, visible wasting and poor dietary intake can all be used to score a patient on the MUST as it does not solely rely on anthropometric values to complete the screening tool. The MUST can be used in all healthcare settings such as hospitals, clinics and in private practice. A few studies and reviews of COVID-19 patients have demonstrated the use of the MUST as an appropriate tool for predicting malnutrition risk, and subsequent disease prognosis (Kroc *et al* 2021; BAPEN 2020; Barazzoni *et al* 2020; Hormozi *et al* 2019).

Other nutrition screening tools were used very seldom, if at all, by the dietitians in the current study. Nutrition screening tools such as the Mini Nutritional Assessment-Short Form (MNA-SF) and the Subjective Global Assessment (SGA) have not been widely studied in different patient populations, thus they have not been well-validated in terms of sensitivity and precision (Reber *et al* 2019b). Since only half of the dietitians used nutrition screening tools in COVID-19 patients in the current study, there is a need to increase awareness of the benefits of using nutrition screening tools in COVID-19 patients. Dietitians should be involved in the early stages of admission of COVID-19 patients, other healthcare workers should be trained on using nutrition screening tools and further prospective studies on the use of nutrition screening tools should be conducted, especially in a South African setting.

5.7 Mega-dosing with micro- and immunonutrient supplements

Less than one-third of the dietitians in the current study recommended mega-doses of micro- and immunonutrient supplements in COVID-19 patients. It is possible that this may be due to a lack of guidelines regarding the use of mega-doses of micro- and immunonutrient supplements in the management of COVID-19 patients. Literature has been published on micronutrient supplementation in both COVID-19 and non-COVID-19 critically ill patients, specifically the potential benefits and dosage recommendations (Philipp *et al* 2021; Barazzoni *et al* 2020; Fernández-Quintela *et al* 2020; Zhang & Liu 2020). However, it is interesting to note that dietitians who participated in the current study remained neutral on the statements provided in the questionnaire related to there being scientific evidence to support mega-dosing, and having had success with it.

The media and some individuals have in recent years, 'glamourised' the use of large doses of some vitamins, minerals and immunonutrients in the general population, as a way to boost the immune system and to prevent illness during the COVID-19 pandemic (Gillespie 2023). There is a belief that there is no harm in taking large amounts of these micronutrients on a daily basis, despite not displaying a clinical deficiency, which is why this remains a controversial topic that requires further research (Wells *et al* 2020). This may explain why there was no consensus by the dietitians in the current study as to whether mega-dosing was harmful or not, as it depends on the specific micronutrient and the disease being treated.

The South African Society for Parenteral and Enteral Nutrition (SASPEN) (2020) states that current guidelines from nutrition societies oppose mega-dosing with micro- and immunonutrient supplements in COVID-19 patients as there is not enough research to conclude if it is beneficial or improves COVID-19 recovery. However, there was a statistically significant agreement by the dietitians in the current study that mega-dosing with micro- and immunonutrient supplements could benefit COVID-19 patients. In line with this, it was found that dietitians in the current study believed that there was a noticeable improvement in their patients who received mega-doses of micro- and immunonutrient supplements, and patients did not experience any harmful side-effects. However, it is important to note that the current study did not investigate actual doses of micro- and immunonutrients given to COVID-19 patients and the initiation and duration of supplementation.

In the current study, over half of the dietitians supplemented with mega-doses of a general vitamin and mineral supplement in some COVID-19 patients when there was evidence of deficiency or when there was a perceived benefit. According to Gomes *et al* (2018), multivitamin supplements should be given in the recommended daily amounts, and not in excess. However, the composition of multivitamin and mineral supplements varies by manufacturer, therefore in the current study, COVID-19 patients may have received different combinations of vitamins and minerals.

Vitamin A was not supplemented by many dietitians in the current study, even though it may improve clinical outcome in patients with COVID-19 (Braun 2020). A pilot randomised controlled trial in Iran that included 30 hospitalised COVID-19 patients, each receiving 50 000 IU per day of vitamin A intramuscularly, for a maximum of two weeks, showed that there was no benefit from receiving supplemental vitamin A compared to the control group. However, further studies on a larger population are required (Somi *et al* 2022). Vitamin B is needed for energy metabolism in the body, and with the hypermetabolic state associated with COVID-19, body stores of vitamin B may be rapidly depleted (Cervantes-Pérez *et al* 2020). Despite this information, vitamin B was not often supplemented by dietitians in the current study. Some dietitians in the current study supplemented with vitamin C in some COVID-19 patients due to a perceived benefit. Some of the perceived benefits in hospitalised patients included reduced length of hospital stay, reduced need for mechanical ventilation and decreased mortality. However, a meta-analysis by Beran *et al* (2022), on nine studies in 1488 COVID-19 patients, found that vitamin C supplementation had no significant effect on length of hospital stay, need for mechanical ventilation and mortality (p=1.000). Thus, further studies are needed to assess its effectiveness in COVID-19 patients.

Some dietitians in the current study had supplemented with vitamin D in COVID-19 patients. Vitamin D had gained popularity during the COVID-19 pandemic, based on its potential anti-inflammatory action and potential to reduce respiratory distress, common in COVID-19 patients. Studies conducted in COVID-19 patients found that supplementation with vitamin D reduced intubation rates (p=0.04) and length of hospital stay (p=0.01), but not mortality rates (p=0.210) (Beran *et al* 2022). Supplementation with vitamins E and K was not popular among the dietitians in the current study. This may be due to a lack of evidence regarding their ability to improve disease outcome in COVID-19 patients. Additionally, these vitamins are fat-soluble, which means that they are not easily removed by the body when given in excess. This can easily lead to toxicity, which can further complicate the progression and prognosis of COVID-19 (Fernández-Quintela *et al* 2020).

Although minerals are required in small amounts in the body, this need may increase during times of stress, which may rapidly deplete body stores. A decrease in dietary intake during illness may also contribute to reduced mineral levels in the blood. In the current study, dietitians reported that they rarely recommended mega-doses of minerals for COVID-19 patients. Although recent literature has reported that magnesium, copper, selenium and calcium may be beneficial to COVID-19 patients (Barazzoni *et al* 2020; Calder *et al* 2020; Cervantes-Pérez *et al* 2020; Di Renzo *et al* 2020; Fernández-Quintela *et al* 2020; Olaimat *et al* 2020; Zhang & Liu 2020), dietitians in the current study rarely recommended these for their COVID-19 patients. In the current study, there was no clear consensus regarding supplementation with iron and zinc in COVID-19 patients, despite literature showing that low serum iron levels were common in COVID-19 patients and were associated with higher rates of inflammation (Suriawinata & Mehta 2022). Another controversy in the literature is the relationship between supplemental iron and an increase in SARS-CoV-2 pathogenicity, however, more research is required in this area (Suriawinata & Mehta 2022). A meta-analysis of five studies, including 738 patients, showed that zinc was not associated with a decreased mortality rate in COVID-19 patients (Beran *et al* 2022), thus questioning its role in COVID-19 patients.

The use of immunomodulation supplements appears to have a positive impact on the immune system in critically ill patients (Di Renzo *et al* 2020), yet dietitians in the current study did not recommend these for COVID-19 patients. This may be due to uncertainty regarding the associated side-effects in COVID-19 patients, lack of resources and limited studies on how immunonutrients impact COVID-19 patients (Obayan 2021; Di Renzo *et al* 2020; Haraj *et al*

2021). Glutamine is well known to benefit patients in a hypermetabolic state, as is the case in COVID-19 patients, yet results from the current study regarding its supplementation were not unanimous. Adebayo *et al* (2021) reported low arginine levels in COVID-19 patients, which may have negatively affected their clinical prognosis. Nevertheless, it was rarely supplemented by the dietitians in the current study. Anti-inflammatory nutrients such as omega-3 fatty acids and MCT oils exhibit numerous benefits in individuals with chronic diseases and those in states of chronic inflammation (Darwesh *et al* 2021; Fernández-Quintela *et al* 2020; Di Renzo *et al* 2020). However, caution should be taken when supplementing in patients with impaired liver function, as this could cause further liver damage (Fernández-Quintela *et al* 2020). As mentioned earlier, further research is required to determine if immunonutrients are beneficial in COVID-19 patients.

5.8 Responses to hypotheses

After analysing and discussing the results of this study, the study hypotheses are listed below and are either accepted or rejected.

- Dietitians in KZN followed the ESPEN recommendations when managing COVID-19 patients. This hypothesis is accepted, as results from this study support the practical recommendations from ESPEN regarding the nutritional guidelines for managing critically ill patients, as was common in the COVID-19 patient population.
- Dietitians faced many challenges when managing adult COVID-19 patients, the most common being GIT intolerance and haemodynamic instability. This hypothesis is rejected as there was no consensus among the dietitians that GIT intolerance and haemodynamic instability were the main challenges faced.
- Dietitians estimated anthropometric measurements in both bed-bound and mobile adult COVID-19 patients. This hypothesis is rejected, as although dietitians estimated anthropometry in bed-bound COVID-19 patients, dietitians measured actual anthropometry in mobile COVID-19 patients.
- Dietitians frequently assessed malnutrition risk and the MUST was most commonly used. This hypothesis is rejected as the NRS-2002 was the most commonly used nutrition screening tool.
- Dietitians recommended mega-doses of certain micro- and immunonutrients to manage adult COVID-19 patients, due to their perceived benefits on the immune system. This hypothesis is accepted as although only a small percentage of dietitians recommended mega-doses in COVID-19 patients, there was a significant agreement that mega-dosing

could benefit COVID-19 patients.

CHAPTER 6

CONCLUSIONS, STUDY LIMITATIONS AND RECOMMENDATIONS

This study aimed to determine how dietitians managed adult patients hospitalised with COVID-19 in KZN. The study objectives were as follows: (i) to determine which nutritional guidelines dietitians used in the management of adult COVID-19 patients; (ii) to identify the challenges that dietitians faced when nutritionally managing adult COVID-19 patients; (iii) to determine whether dietitians took or estimated anthropometric measurements in bed-bound and mobile adult COVID-19 patients; (iv) to determine whether dietitians assessed malnutrition risk in adult COVID-19 patients, and if so, which nutrition screening tools were used; (v) to determine if dietitians recommended unconventional mega-doses of micro- and immunonutrient supplements for the management of adult COVID-19 patients and the reasons for use. This chapter presents the conclusions and limitations of this study as well as recommendations for future studies.

6.1 Conclusions

Although the current sample size was small and limited to dietitians in KZN, to the best of the researcher's knowledge, it was one of the first to investigate the nutritional management of COVID-19 patients by dietitians in SA. Most of the dietitians who participated in the current study were KZN DOH-employed or ADSA members, who worked primarily in district-level or private hospitals in KZN. Although most of the dietitians who participated in the study started treating COVID-19 patients early in the pandemic, many were not treating hospitalised COVID-19 patients at the time of the study. Dietitians reported having to advocate for nutrition intervention or support in their COVID-19 patients, and most of them referred to ESPEN for practical nutritional recommendations on how to manage COVID-19. Values or ranges for energy, protein, fat and carbohydrate requirements used by the dietitians in the current study were similar to those recommended by ESPEN for critically ill patients. Parenteral nutrition, trophic feeding and monitoring GRVs were not commonly used by dietitians in the current study. Dietitians assessed anthropometry in hospitalised COVID-19 patients mainly through estimation of weight, height and BMI. When possible, actual weight, height and BMI were assessed. Despite many challenges related to measuring anthropometry, dietitians agreed that COVID-19 patients did not feel well enough for actual measurements to be taken. About half of the dietitians used a nutrition screening tool to screen for malnutrition, with the NRS-2002 being the most popular screening tool, followed by the MUST. Mega-dosing of micro- and immunonutrient supplements in COVID-19 patients was not common among the dietitians in the current study, and most micro- and immunonutrients listed in the questionnaire were not significantly supplemented, despite some dietitians agreeing that it may be beneficial. Some of the dietitians noticed an improvement in their COVID-19 patients, while none reported any adverse side-effects in patients who were given mega-doses of micro- and immunonutrient supplements. The three groups of challenges most identified by dietitians in this study included a lack of support and resources, medical conditions and complications and nutrition-related external factors.

6.2 Study limitations

6.2.1 The sample size was small even though numerous attempts was made to contact and invite dietitians to participate in the study. The small sample size did not allow for any generalised conclusions regarding the nutritional management of adult patients hospitalised with COVID-19 by dietitians in KZN to be drawn.

6.2.2 The questionnaire was also self-administered without guidance; therefore, accurate reporting by the participants is questionable.

6.2.3 Some KZN DOH facilities did not have reliable access to the internet, and some did not have a dietitian working at the facility, which would have reduced the response rate.

6.2.4 Due to the healthcare workers strike between February and March 2023, some dietitians could not reach their workplace and could not be contacted and invited to participate in the study.

6.2.5 Distribution of the study link on the ADSA WhatsApp group limited the number of ADSA members who were invited to participate, as it was not obligatory for an ADSA member to be part of the WhatsApp group.

6.2.6 It is likely that some dietitians may have searched the internet for answers to some questions, before or while participating in the study.

6.2.7 Data were collected late in the pandemic (between August 2022 and March 2023), which may have influenced the number of dietitians who were eligible to participate in the study.

6.2.8 There is a possibility that some dietitians may have moved out of KZN before or during the time of data collection, which would have reduced the study response rate.

6.2.9 This study focused on hospitalised adult COVID-19 patients only, and did not consider outpatient care and follow-up management as at the time of conceptualising the study, most patients with COVID-19 were admitted to hospitals, and not treated as outpatients.

6.2.10 Due to a lack of research on the nutritional management of COVID-19 by dietitians in

SA, there were no studies to compare the results of the current study to, which limited the discussion of results.

6.2.11 In the original and electronic self-administered questionnaire, the question on methods used to assess anthropometry included an option of 'skinfold thickness', however, for technical reasons, this was not included in the statistical analysis. Hence, data could not be captured and reported for this option.

6.2.12 It is possible that another healthcare professional, other than a dietitian, may have answered the questionnaire.

6.3 Recommendations

6.3.1 Government and other health organisations should inform dietitians of the availability of open-access literature on practical recommendations and reviews related to nutrition in COVID-19 patients.

6.3.2 A nutrition protocol, specific to COVID-19 patients, should be compiled by government and other health organisations in SA, so that dietitians have a standard operating procedure when treating COVID-19 patients.

6.3.3 The use of nutrition screening tools in healthcare facilities should be encouraged and integrated into admission protocol.

6.3.4 Dietitians should carefully consider the dosage and frequency of micro- and immunonutrient supplements they recommend, as this could influence the presence or absence of related side-effects and the detection of any beneficial effects in COVID-19 patients.

6.3.5 Other methods of nutritional assessment, such as biochemistry, clinical and dietary assessment should be included as part of the holistic management of COVID-19 patients.

6.3.6 An alternative method of data collection such as face-to-face interviews may be more suitable for recruiting a larger number of participants.

6.4 Recommendations for further research

6.4.1 Expanding this study to other provinces in SA may provide a better consensus on how all dietitians in SA managed COVID-19 patients during the pandemic.

6.4.2 Dietitian's perceptions and experiences with nutritional management of COVID-19 patients during the pandemic should be researched in future.

6.4.3 Longitudinal studies including both adult and paediatric patients, should be considered to investigate the long-term effects of nutritional intervention in COVID-19 patients.

6.4.4 Future studies should assess the ability and preparedness of dietitians to respond to public health emergencies.

6.4.5 Future studies using dietitians should consider alternative methods for data collection, as it could improve the study response rate.

6.4.6 Clinical trial studies can be conducted to gain a better understanding of the cause and effect of different nutrition interventions or protocols in COVID-19 patients.

6.4.7 Studies targeting caregivers of COVID-19 patients can provide insight into challenges faced by COVID-19 patients who self-managed their illness at home and the effect it had on clinical outcome of the disease.

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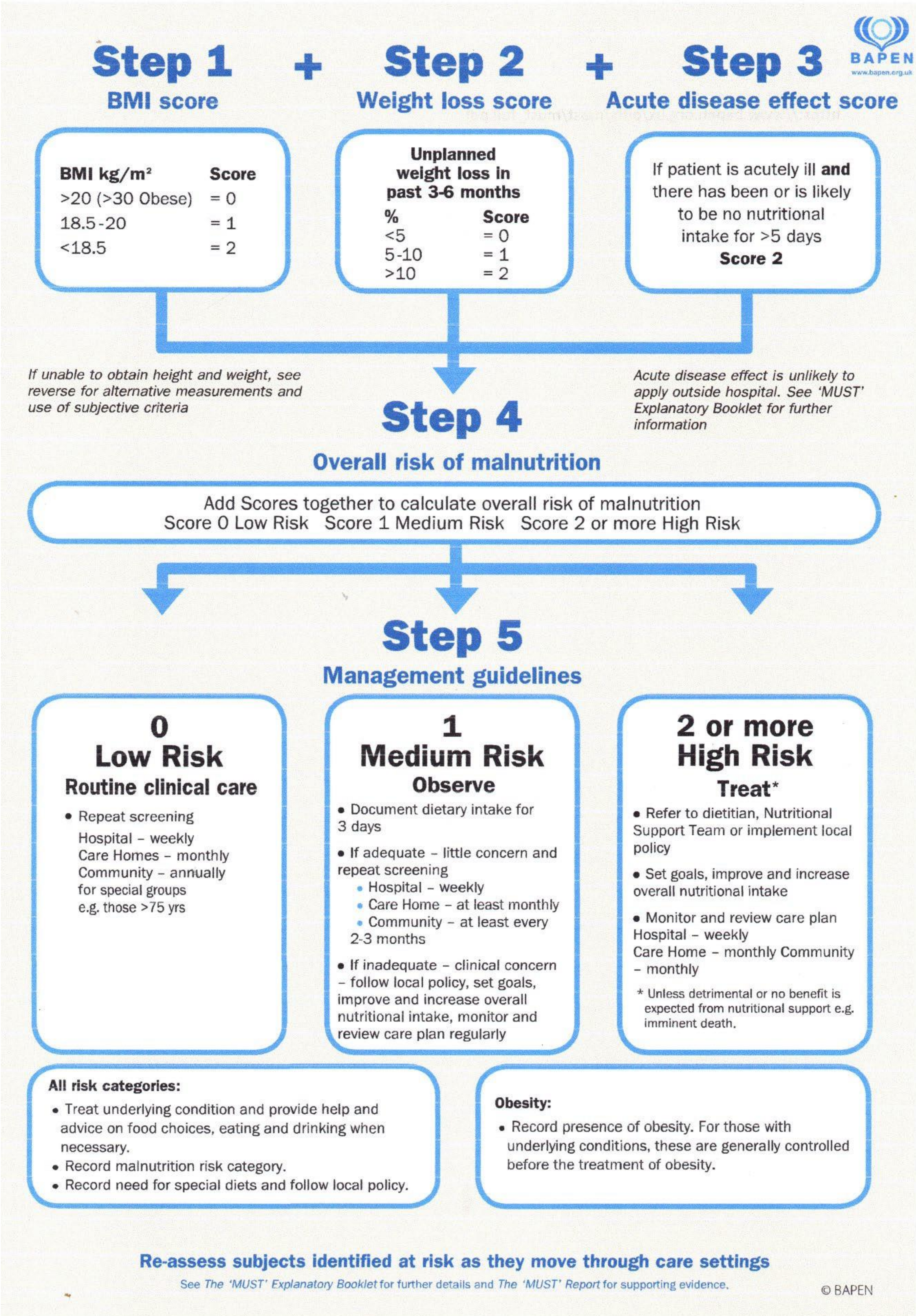
APPENDIX A: MALNUTRITION UNIVERSAL SCREENING TOOL (MUST) (BAPEN 2020)



APPENDIX B: NUTRITIONAL RISK SCREENING 2002 (NRS-2002) (NUTRITIONAL ACADEMY 2022)

NUTRITIONAL RISK SCREENING (NRS 2002)

Table 1 Initial screening

		YES	NO
1	Is BMI < 20.5?		
2	Has the patient lost weight within the last 3 months?		
3	Has the patient had a reduced dietary intake in the last week?		
4	Is the patient severely ill? (e.g in intensive therapy)		

Yes: If the answer is 'Yes' to any question, the screening in Table 2 is performed.

No: If the answer is 'No' to all questions, the patient is re-screened at weekly intervals. If the patient e.g is scheduled for a major operation, a preventive nutritional care plan is considered to avoid the associated risk status.

Table 2 Final screening

Impaired nutritional status		Severity of disease (increase in requirements)	
Absent **Score = 0**	Normal nutritional status	**Absent** **Score = 0**	Normal nutritional requirements
Mild **Score = 1**	Wt loss > 5% in 3 mths or Food intake below 50–75% of normal requirement in preceding week.	**Mild** **Score = 1**	Hip fracture, Chronic patients, in particular with acute complications: cirrhosis, COPD, Chronic hemodialysis, diabetes, oncology.
Moderate **Score = 2**	Wt loss > 5% in 2 mths or BMI 18.5 – 20.5 + impaired general condition or food intake 25–60% of normal requirement in preceding week.	**Moderate** **Score 2**	Major abdominal surgery, Stroke, Severe pneumonia, hematologic malignancy.
Severe **Score = 3**	Wt loss > 5% in 1 mth (415% in 3 mths) or BMI < 18.5 + impaired general condition or Food intake 0-25% of normal requirement in preceding week in preceding week.	**Severe** **Score = 3**	Head injury* Bone marrow transplantation* Intensive care patients (APACHE410).

Score (nutritional Status) = + Score (disease severity) = Total score =

Age = if ≥70 years: add 1 to total score above → Age-adjusted total score =

Score ≥3: the patient is nutritionally at risk and a nutritional care plan is initiated

Score <3: weekly rescreening of the patient. If the patient e.g is scheduled for a major operation, a preventive nutritional care plan is considered to avoid the associated risk status.

APPENDIX C: ELECTRONIC SELF-ADMINISTERED QUESTIONNAIRE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

NUTRITIONAL MANAGEMENT OF ADULT PATIENTS HOSPITALISED WITH COVID-19 BY DIETITIANS IN KWAZULU-NATAL

This questionnaire is part of a research project for the degree of Master of Science in Dietetics. The objectives of this research study are:

1. To determine which nutritional guidelines dietitians have used in the management of adult COVID-19 patients.
2. To identify the challenges that dietitians have faced when nutritionally managing adult COVID-19 patients.
3. To determine whether dietitians have taken or estimated anthropometric measurements in bed-bound and mobile adult COVID-19 patients.
4. To determine whether dietitians assessed malnutrition risk in adult COVID-19 patients, and if so, which nutrition screening tools were used.
5. To determine if dietitians recommended unconventional mega-doses of micro- and immunonutrient supplements for the management of adult COVID-19 patients and the reasons for use.

Please answer all questions honestly and without consulting other dietitians.

SECTION A: TREATMENT OF COVID-19 PATIENTS

You may refer to your patient notes/case files if needed.

1. Have you treated, or are you currently treating any COVID-19 patients?

Yes		
No		*Automatic exit of the study*

2. When did you start treating COVID-19 patients?

Since the start of the pandemic (March 2020)	
During and/or after the first wave of infection (June-July 2020)	
During and/or after the second wave of infection (December 2020- January 2021)	
During and/or after the third wave of infection (June-July 2021)	
During and/or after the fourth wave of infection (December 2021)	

3. On average, how many COVID-19 patients do you currently treat in a **<u>typical</u>** week? [Inclusive of general ward and intensive care unit (ICU) COVID-19 patients].

None	
1-3 patients	
4-6 patients	
7-9 patients	
≥10 patients	

SECTION B: DEMOGRAPHIC INFORMATION

4. Indicate into which group you belong:

KwaZulu-Natal Department of Health (KZN DOH) dietitian	
Association for Dietetics in South Africa (ADSA) member	
Both KZN DOH dietitian and ADSA member	
None of the above	

5. Where do you **<u>primarily</u>** work?

Private Hospital		
Tertiary-level Hospital		
Regional-level Hospital		
District-level Hospital		
Community Health Centre		
Clinic		
Private Practice		
Other		Specify:

SECTION C: COVID-19 PATIENT NUTRITIONAL ASSESSMENT

6. Did you make use of a nutrition screening tool to screen for malnutrition in COVID-19 patients?

Yes	
No	

6.1 ***<u>If you answered yes to question 6</u>***, indicate which nutrition screening tool you use **<u>most often.</u>**

Geriatric Nutrition Risk Index (GNRI)	
Global leadership Initiative on Malnutrition (GLIM)	
Malnutrition Universal Screening Tool (MUST)	
Mini Nutritional Assessment-Short Form (MNA-SF)	
Nutrition Risk in the Critically Ill (NUTRIC)	
Nutrition Risk Screening 2002 (NRS-2002)	
Short Nutritional Assessment Questionnaire (SNAQ)	
Subjective Global Assessment (SGA)	
Other. Specify:	

7. How do you assess basic anthropometry in your COVID-19 patients, based on their degree of mobility? (You may select MORE THAN ONE option in each row).

Degree of mobility	**I did not assess anthropometry**	**Actual weight/ height/ BMI**	**Estimated weight/ height/ BMI**	**Mid-upper arm circumference (MUAC)**	**Skinfold thickness**	**Ulna length**	**Knee height**	**Other**
7.1 Bed-bound, cannot move, unconscious.								
7.2 Bed-bound, but can sit up.								
7.3 Fully mobile.								

8. Indicate your agreement that you experienced the following challenges and/or barriers when assessing anthropometry in COVID-19 patients.

Barriers/ Challenges		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
8.1	The protocol in my place of work did not allow non-essential healthcare workers to be in direct contact with COVID-19 patients.					
8.2	There was a shortage of personal protective equipment (PPE), thus I was unable to directly assess anthropometry in these patients.					
8.3	I did not have access to certain equipment (e.g. scale, stadiometer) to assess my COVID-19 patient.					
8.4	My patient did not feel well enough to allow me to take anthropometric measurements.					
8.5	I was not consulted by the managing physician.					

SECTION D: THERAPEUTIC NUTRITION IN COVID-19 PATIENTS

9. What proportion of your COVID-19 patients did you advocate for nutrition intervention or support?

None of them	
1 – 25%	
26-50%	
51-75%	
>75%	

9.1 ***If you answered none to question 9,*** indicate your agreement that the following are reasons that you did not advocate for nutrition intervention in COVID-19 patients.

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
9.1.1 There is insufficient scientific evidence to support the need for nutrition intervention or support in COVID-19 patients.					
9.1.2 There are insufficient guidelines or recommendations on nutrition intervention or support in COVID-19 patients					
9.1.3 There is a lack of resources available to provide COVID-19 patients with nutrition intervention or support.					
9.1.4 There may be unknown side effects of nutrition intervention or support that pose a risk in COVID-19 patients.					

10. Which of the following nutrition societies did you consult for guidelines or nutritional recommendations on the nutritional management of patients with COVID-19?

10.1 American Society for Enteral and Parenteral Nutrition (ASPEN).	
10.2 European Society for Enteral and Parenteral Nutrition (ESPEN).	
10.3 South African Society for Enteral and Parenteral Nutrition (SASPEN).	
10.4 I did not consult a nutrition society.	
10.5 Other. Specify:	

11. Indicate the macronutrient values and/or ranges that you **most frequently** used when planning dietary prescriptions for patients with COVID-19.

11.1 Energy (kCal/kg/day)	
11.2 Protein (g/kg/day)	
11.3 Fat (% of total energy requirement)	
11.4 Carbohydrates (% of total energy requirement)	

12. Which of the following did you use **most often** when calculating nutritional requirements for COVID-19 patients?

Actual body weight	
Estimated body weight	
Ideal body weight	
Adjusted body weight	

13. Have you recommended any micro- and/or immunonutrient supplement to COVID-19 patients in mega-doses? (A mega-doses is a dose many times higher than the recommended amount).

Yes	
No	

13.1 ***If you answered yes to question 13,*** select ONE option in each row that most frequently applies to supplementing micro- and immunonutrients in mega-doses to COVID-19 patients.

Micro- and immunonutrient supplement	**Did not supplement**	**Supplemented in mega-doses in ALL my COVID-19 patients**	**Supplemented in mega-doses in SOME of my COVID-19 patients when there was evidence of deficiency or when there was a perceived benefit**
13.1.1 General vitamin and mineral supplement			
13.1.2 Vitamin A			
13.1.3 Vitamin B complex			
13.1.4 Vitamin C			
13.1.5 Vitamin D			
13.1.6 Vitamin E			
13.1.7 Vitamin K			
13.1.8 Iron			
13.1.9 Zinc			
13.1.10 Magnesium			
13.1.11 Copper			
13.1.12 Selenium			
13.1.13 Calcium			
13.1.14 Glutamine			
13.1.15 Arginine			
13.1.16 Omega-3 Fatty Acids			
13.1.17 Medium Chain Triglyceride (MCT) Oil			

13.2 Indicate your agreement that the following are reasons why you choose/would choose to give mega-doses of a micronutrient and/or immunonutrient supplement to COVID-19 patients.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
13.2.1 There is scientific evidence to support mega-dosing.					
13.2.2 There is no evidence of any potential harmful side effects of mega-dosing.					
13.2.3 Mega-dosing can benefit patients with COVID-19.					
13.2.4 Mega-dosing is promoted by the media/individuals.					
13.2.5 I have had success with mega-dosing in COVID-19 patients.					

13.3 In general, have you noticed any improvement in the recovery of the COVID-19 patients who were given a micronutrient and/or immunonutrient supplement/s?

Yes	
No	

13.4 Have any of your COVID-19 patients experienced any adverse side-effects related to the micronutrient and/or immunonutrient supplement/s that were given?

Yes	
No	

14 Indicate how often you offered the following nutritional support in COVID-19 patients:

Nutritional support offered		Never	Rarely	Sometimes	Often	Always/Nearly always
14.1	Provided oral nutritional supplements (ONS) to COVID-19 patients					
14.2	Provided early enteral nutrition within 24-36 hours of admission					
14.3	Provided parenteral nutrition to COVID-19 patients					
14.4	Provided trophic feeding for COVID-19 patients					
14.5	Provided hypocaloric nutrition in critically ill COVID-19 patients, and gradually increased until 100% of requirements were met.					
14.6	Adjusted the nutrition prescription accordingly, for COVID-19 patients on certain medications (e.g. propofol, dextrose and inotropes).					
14.7	Routinely checked the gastric residual volumes (GRVs) and blood parameters of COVID-19 patients, and adjusted the nutrition prescription accordingly.					

15 Indicate your agreement that you experienced the following challenges when nutritionally managing COVID-19 patients.

	Challenges	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
15.1	The facility in which I work does not have the resources to provide enteral and/or parenteral nutrition to COVID-19 patients.					
15.2	I was limited to select from a few enteral and/or parenteral feeds for my COVID-19 patients.					
15.3	It was difficult to get the healthcare team on board regarding supplementary nutrition.					
15.4	The managing physician in my place of work had limited or no knowledge on nutrition.					
15.5	Healthcare staff were inexperienced with handling and changing enteral and/or parenteral feeding bags.					
15.6	I am unfamiliar with selecting enteral and/or parenteral nutrition bags.					
15.7	I frequently observed metabolic complications (hyperglycaemia, hypertriglyceridaemia and/or refeeding syndrome), in COVID-19 patients whilst on supplementary nutrition.					
15.8	My patients frequently experienced GIT disturbances (vomiting, diarrhoea, abdominal pain, constipation), which affected feeding.					
15.9	Most of my COVID-19 patients were haemodynamically unstable, or presented with evidence of shock, hypoxaemia, hypercapnoea and/or acidosis, which delayed feeding.					
15.10	Feeding my COVID-19 patients was delayed due to high dose vasopressors and/or inotropes.					
15.11	My COVID-19 patient's nasogastric feeding tube was frequently dislodged/ removed.					
15.12	There was difficulty maintaining a central line for parenteral nutrition in COVID-19 patients.					
15.13	My COVID-19 patients experienced aspiration or some degree of dysphagia, and I was unable to consult a speech therapist.					
15.14	My patient was frequently in the prone position, which affected or limited feeding.					

16 Do you have any further comments or challenges to add regarding the nutritional management of adult COVID-19 patients?

____

APPENDIX D: BIOMEDICAL RESEARCH ETHICS COMMITTEE (BREC) ETHICS APPROVAL

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

07 May 2022

Ms Naseera Ebrahim (214547541)
School of Agri Earth & Env Sc
Pietermaritzburg

Dear Ms Ebrahim,

Protocol reference number: BREC/00003865/2022
Project title: Nutritional management of adult patients with COVID-19 by dietitians in KwaZulu-Natal.
Degree: MSc

EXPEDITED APPLICATION: APPROVAL LETTER

A sub-committee of the Biomedical Research Ethics Committee has considered and noted your application.

The conditions have been met and the study is given full ethics approval and may begin as from 07 May 2022. Please ensure that any outstanding site permissions are obtained and forwarded to BREC for approval before commencing research at a site.

This approval is subject to national and UKZN lockdown regulations, see (http://research.ukzn.ac.za/Libraries/BREC/BREC_Amended_Lockdown_Level_1_Guidelines.sflb.ashx). Based on feedback from some sites, we urge PIs to show sensitivity and exercise appropriate consideration at sites where personnel and service users appear stressed or overloaded.

This approval is valid for one year from 07 May 2022. To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2015), South African National Good Clinical Practice Guidelines (2020) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

The sub-committee's decision will be noted by a full Committee at its next meeting taking place on 14 June 2022.

Yours sincerely,

[redacted]

Prof D Wassenaar
Chair: Biomedical Research Ethics Committee

Biomedical Research Ethics Committee
Chair: Professor D R Wassenaar
UKZN Research Ethics Office Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Email: BREC@ukzn.ac.za
Website: http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx

APPENDIX E: NUTRITION DIRECTORATE LETTER OF SUPPORT

KWAZULU-NATAL PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

Private Bag X9051, Pietermaritzburg
Natalia, 330 Langalibalele Street, Pietermaritzburg, 3200
Private Bag X 9051, Pietermaritzburg, 3200
Tel: 033 395 2726 Fax: 033 395 3053 Email sthandiwe.njokwe@kznhealth.gov.za
www.kznhealth.gov.za

DIRECTORATE
MCWH &NUTRITION

Enquiries: Ms S Monegi
Telephone: (033) 395 2079
16 February 2022

Ms Naseera Ebrahim

University of Kwazulu Natal

RE: Request for letter of support for Masters study on "Nutritional management of adult patients with COVID-19 by dietitians in KwaZulu-Natal.

Reference is made to your communication on the above dated 14 February 2022.

The KZN Department of Health supports your study proposal as described above. The proposal and consent forms have been reviewed and we thank you for considering the comments from the Nutrition unit and making the necessary changes to the proposal.

The Nutrition unit supports the study with the concession that the following items are adhered to:-

- All legislation, policies, procedures, protocols and guidelines of the Department of Health are adhered to.
- This study will commence once this office has received confirmation from the Provincial Health Research Committee in the KZN Department of Health.
- The District Office / facilities will not provide any resources for this research.
- You will be expected to provide feedback on your findings to the KZN Department of Health on completion of the study.

Please feel free to contact me on the details provided above should you require any clarity or further information.

Kind regards,

[redacted]

Ms\PP Phungula
Acting Director: MCWH & Nutrition

Fighting Disease, Fighting Poverty, Giving Hope

APPENDIX F: NATIONAL HEALTH RESEARCH DATABASE (NHRD) ETHICS APPROVAL

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

Physical Address: 330 Langalibalele Street, Pietermaritzburg
Postal Address: Private Bag X9051
Tel: 033 395 2805/ 3189/ 3123 Fax: 033 394 3782
Email:
www.kznhealth.gov.za

DIRECTORATE:
Health Research & Knowledge Management

NHRD Ref: KZ_202204_013

Dear Ms N. Ebrahim
(UKZN)

Approval of research

1. The research proposal titled **'National management of adult patients with COVID-19 by Dietitians in KwaZulu Natal'** was reviewed by the KwaZulu-Natal Department of Health (KZN-DoH).

   The proposal is hereby **approved** for research to be undertaken at all hospitals.

2. You are requested to take note of the following:
   a. *All research conducted in KwaZulu-Natal must comply with government regulations relating to Covid-19. These include but are not limited to: regulations concerning social distancing, the wearing of personal protective equipment, and limitations on meetings and social gatherings.*
   b. *Kindly liaise with the facility manager BEFORE your research begins in order to ensure that conditions in the facility are conducive to the conduct of your research. These include, but are not limited to, an assurance that the numbers of patients attending the facility are sufficient to support your sample size requirements, and that the space and physical infrastructure of the facility can accommodate the research team and any additional equipment required for the research.*
   c. *Please ensure that you provide your letter of ethics re-certification to this unit, when the current approval expires.*
   d. *Provide an interim progress report and final report (electronic and hard copies) when your research is complete to* ***HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200*** *and e-mail an electronic copy to hrkm@kznhealth.gov.za*
   e. *Please note that the Department of Health shall not be held liable for any injury that occurs as a result of this study.*

For any additional information please contact Mr X. Xaba on 033-395 2805.

Yours Sincerely

ELutge

Dr E Lutge
Chairperson, Health Research Committee
Date: 26/04/2022.

Fighting Disease, Fighting Poverty, Giving Hope

APPENDIX G: A LETTER OF SUPPORT FROM THE ASSOCIATION FOR DIETETICS IN SOUTH AFRICA (ADSA)

ADSA
ASSOCIATION FOR DIETETICS
IN SOUTH AFRICA

04 March 2022

Ms Naseera Ebrahim
Dietetics and Human Nutrition
University of KwaZulu-Natal

Dear Ms Naseera Ebrahim

RE: Request permission to conduct a research study on "nutritional management of adult patients with COVID-19 by dietitians in KwaZulu-Natal".

Your request to conduct the above-mentioned study is supported by the ADSA KZN branch, subjected to Ethics approval obtained from the University of KwaZulu Natal.

You are requested to take note of the following:

- You need to send the ADSA KZN branch your ethics approval letter.
- Your survey link will be shared with ADSA KZN branch members via the Whatsapp Group only.

Yours sincerely,

Dr L. Govender, RD (SA)
ADSA KZN Chairperson 2021-2023
www.adsa.org.za

APPENDIX H: INFORMATION DOCUMENT AND CONSENT FORM

UNIVERSITY OF KWAZULU-NATAL™
INYUVESI YAKWAZULU-NATALI

<u>INFORMATION SHEET AND CONSENT FORM TO PARTICIPATE IN RESEARCH</u>

Date:______________________

Dear fellow dietitians,

My name is Naseera Ebrahim and I am currently doing my MSc in Dietetics through the University of KwaZulu-Natal (UKZN) in Pietermaritzburg. My academic supervisor is Prof. Kirthee Pillay.

You are being invited to consider participating in a study, titled ***Nutritional management of adult patients hospitalised with COVID-19 by dietitians in KwaZulu-Natal***. The aim of the study is to determine how dietitians have managed adult patients with COVID-19 in KwaZulu-Natal (KZN).

The study is being conducted via an online data-collection platform called Google Forms. Should you decide to participate, you will be required to complete a self-administered questionnaire consisting of both open- and closed-ended questions, on the nutritional management of adult COVID-19 patients. The survey should take a maximum of 10 minutes to complete. It is expected that approximately 167 dietitians from both the public and private sectors in KZN will participate. This study is self-funded by the researcher.

Data collected in this study will remain anonymous and confidential, and will only be used for research purposes. The original electronic copies of the completed questionnaires will be stored in the Department of Dietetics at the University of KwaZulu-Natal in Pietermaritzburg for a period of five (5) years. Only the researcher and the supervisor will be able to access the data, which will be password protected. On completion of this study, a written report will be forwarded to the KZN Department of Health (DOH) as well as the KZN branch of the Association for Dietetics in South Africa (ADSA). Should you wish to access the results, please email the researcher to request a copy of this report. Prospective participants should be aware that participation in this study is entirely voluntary and should you wish to withdraw from the study at any point, you may do so without any consequences. There are no risks associated with participation in this study, neither are there any monetary benefits to participants. There is no cost to participate in this study, with the exception of the data costs that might be incurred by the participant during the completion of the online questionnaire; none of which will be reimbursed by the researcher nor the academic institution. One of the benefits of this study is that the findings may provide insight into the common practices of dietitians in KZN, when nutritionally managing adult patients with COVID-19.

In the event of any questions/concerns or problems, you may contact the researcher via email (naseera.eb17@gmail.com) or telephonically (+27 72 172 3588). The research supervisor may be contacted by emailing pillayk@ukzn.ac.za or phoning +27 33 260 5674 during office hours. This study has been ethically reviewed and approved by the UKZN Biomedical Research Ethics Committee (BREC) (approval number BREC/00003865/2022). The BIOMEDICAL RESEARCH ETHICS ADMINISTRATION contact details are as follows:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: +27 31 260 2486 - Fax: +27 31 260 4609
Email: BREC@ukzn.ac.za

DECLARATION OF CONSENT

I hereby acknowledge that I have been informed about the study entitled ***Nutritional management of adult patients hospitalised with COVID-19 by dietitians in KwaZulu-Natal***, by the researcher, Naseera Ebrahim.

I understand the purpose and procedures of the study. I have been given an opportunity to answer questions about the study and have had answers to my satisfaction. I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without any consequences. Furthermore, I understand that all data collected in this study will remain anonymous and will not be shared with any third parties, without prior consent. I have been informed of any risk, benefit and/or compensation that may/may not arise out of me participating in this study.

I understand that by clicking on the link to the survey, I:

- Give my explicit consent to participate in this study.
- Understand that I am able to exit this study at any point in time, without any negative consequences.
- Acknowledge that I am not entitled to any monetary compensation for participating in this study.
- Will only answer the survey once, regardless of how many times I may be invited to participate in the survey.

If I have any further questions/concerns or queries related to this study, I understand that I may contact the researcher by email at naseera.eb17@gmail.com or by telephone on +27 72 172 3588.

If I have any questions or concerns about my rights as a study participant, or if I am concerned about any aspect of this study or the researcher then I may contact:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: +27 31 260 2486 - Fax: +27 31 260 4609
Email: BREC@ukzn.ac.za