The Role Physiotherapists Play in Neonatal Intensive Care Units in South Africa: A Pilot Study

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A Research Report submitted to the faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science in Physiotherapy.

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Declaration

I, Marelizé Gühring, declare that this Research Report is my own, unaided work. It is being submitted for the Master of Science in Physiotherapy at the university of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

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22nd of July 2024 in Yeppoon, Australia

Abstract

Background

There is uncertainty about the role physiotherapists play in neonatal intensive care units (NICUs) in South Africa. This is a result of a lack of literature together with a lack of competency frameworks and standardised undergraduate training. This led to the study aim to describe the role physiotherapists are playing in NICUs in South Africa.

Methodology

A quantitative, cross-sectional, self-administered survey was used to conduct the study. A strategically structured questionnaire collected information on the demographics, qualifications and clinical experience, multidisciplinary team (MDT) involvement, physiotherapy treatment and follow-up protocols of 40 qualified physiotherapists currently working in NICUs in South Africa. The questionnaire was distributed on the South African Society of Physiotherapy (SASP) email platform and social media groups on Facebook, LinkedIn and WhatsApp. The link to the questionnaire was available for two months on the SASP website and was distributed a second time on the relevant social media groups. It was unclear how many physiotherapists work in NICUs in South Africa and so a sample size could not be calculated. After two months of distributing the questionnaire, it was decided that 40 participants would supply sufficient data for the study to continue. The data was collected and managed using REDCap tools. The results of the study were analysed into percentages and frequencies and presented in graphs and tables.

Results

Data from 40 participants were analysed. More female physiotherapists (90%) participated in the study than male physiotherapists (10%). Most of the participants were between 31 and 40 years of age (50%). More than half of the participants were working in Gauteng (57%). The response rate was higher from physiotherapists working in private hospitals (60%) than public hospitals (40%). The participants had various years of experience and postgraduate training with most participants having trained in neurodevelopmental physiotherapy (79%) compared to respiratory physiotherapy (13%). Basic undergraduate education was predominantly the tertiary education (BSc=69%) with minimal specialised training in neonatal physiotherapy

(MSc=23%, PhD=8%). The participants worked in both respiratory (74.4%) and neurodevelopmental physiotherapy (71.8%). Treatment was initiated after doctor referral (47.4%) or both self-screening and doctor referral (47.4%).

The most used respiratory treatment modalities were vibrations (93.8%), suctioning (93.8%) and percussions (78.1%). Lung squeezing (18.8%), ventilatory weaning (21.9%) and participation in extubation (18.8%) had low responses. The most common respiratory conditions treated were consolidations (81.3%), atelectasis (71.9%), respiratory distress syndrome (RDS) (71.9%) with meconium aspiration (59.4%), the inability to wean off ventilators/during extubation (56.3%) and pulmonary interstitial emphysema (PIE) (18.8%) having lower frequencies. Respiratory physiotherapy was mostly performed once per day (42.4%) or twice per day (30.3%) with treatment performed over weekends and public holidays (64.7%).

The most common neurodevelopmental conditions treated were prematurity (83.8%), cerebral palsy (83.8%), developmental delay (75.7%) and hypotonia (73%). The most used neurodevelopmental treatment modalities were positioning (89.2%), prevention of secondary complications in musculoskeletal, neuromuscular systems and skin (86.5%) and gross motor development/developmental milestone facilitation (81.1%). Neurodevelopmental physiotherapy was mostly performed once per day (62.2%). Treatment over weekends and public holidays were either always or when necessary (40.5%). Treatment was mostly initiated when the patient was medically stable (80.6%).

Participation in a multidisciplinary team (54.3%) was higher compared to never participating in an multidisciplinary team (11.4%). Treatment was mostly performed as a combination of independent and combined sessions (62.9%). Dieticians (94.4%) and speech and language therapists (69.4%) were indicated to be working most often in the NICU with audiologists (48.6%) and occupational therapists (30.6%) less often. Referrals to other health professionals were higher (61.1%) than receiving referrals (41.6%).

Family and caregiver support and education was performed by 91.9% of the participants with most performed while the patient was in the unit (77.8%), compared

to before discharge (16.7%) or on request of the family (5.6%). The type of support and education given were physical demonstrations on the patients (88.9%), verbal education (86.1%), general brochures (27.8%), videos and pictures (27.8%) and personalised brochures (25%).

Twenty-four (63.2%) participants have follow-up protocols post-discharge with occasional attendance (58.3%), definite attendance (20.8%) or attendance after a reminder (20.8%). Most of the first follow-up sessions were one month after discharge (50%), two weeks after discharge (33.3%), one week after discharge (20.8%) or longer than a month after discharge (20.8%). Follow-up care at other practices were mostly uncertain (64.3%).

Discussion and Conclusion

Physiotherapists working in NICUs in South Africa have a role in respiratory and neurodevelopmental treatment as well as family and caregiver support and education. For the family members to be actively involved in the decision-making, family and caregiver support and education should always be included in the scope of practice of neonatal physiotherapists. There is also an important role in the multidisciplinary team as well as follow-up care, however, there is still a lack of implementation. Clearly defined roles of all health professionals within the NICU will improve the referral system and ultimately ensure holistic treatment is provided.

The lack of a competency framework, additional educational or experience-related requirements and unstandardised undergraduate training programs cause an inconsistency in physiotherapy treatment and results in evidence-based practice to be lacking. It is therefore recommended that in the absence of standardised undergraduate training, competency frameworks should be developed for physiotherapists working in NICUs.

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List of Abbreviations

ADHD	Attention deficit hyperactivity disorder
ADNP	Activity-dependent neuroprotective protein
ANS	Autonomic nervous system
ART	Antiretroviral treatment
ASD	Autism spectrum disorder
BPD	Bronchopulmonary dysplasia
BSc	Bachelor of Science
CLD	Chronic lung disease
CNT	Certification in Neonatal Therapy
CP	Cerebral palsy
DNA	Deoxyribonucleic acid
ECPE	Encephaloclastic porencephaly
ELBW	Extremely low birth weight
FINE	Family and Infant Neurodevelopmental Education programme
g	gram
HDP	Hypertensive disorders in pregnancy
HIC	High income country
HINE	Hammersmith Infant Neurological Examination
HIV	Human Immunodeficiency virus
HREC	Human Research Ethics Committee
ICU	Intensive care unit
IVH	Intraventricular haemorrhage
kg	kilogram
LBW	Low birth weight
LMIC	Low- to middle-income country
MAES	Movement Analysis Education Strategies Therapy
MSc	Master of Science
MDT	Multidisciplinary team
MHI	Manual hyperinflation
MV	Mechanical ventilation
NBO	Newborn Behavioural Observation
NDT	Neurodevelopmental Treatment

NEC	Necrotising enterocolitis
NICU	Neonatal intensive care unit
NIDCAP	Newborn Individualized Developmental Care and Assessment Program
NTMTC	Neonatal Touch and Massage Certification
PhD	Doctor of Philosophy
PIE	Pulmonary interstitial emphysema
PPD	Post-partum depression
PTSD	Posttraumatic stress disorder
PVL	Periventricular leukomalacia
PVHI	Periventricular haemorrhagic infarction
RDS	Respiratory distress syndrome
REDCap	Research Electronic Data Capture
ROP	Retinopathy of prematurity
SASP	South African Society of Physiotherapy
TIMP	Test of Infant Motor Performance
UK	United Kingdom
USA	United States of America
VAP	Ventilator-associated pneumonia
VILI	Ventilator-induced lung injury
VLBW	Very low birth weight
WHO	World Health Organization

Chapter 1 Background and Need

1.1 Introduction

Neonatal intensive care units (NICUs) are highly specialised hospital units where critically ill and unstable neonates (children younger than 28 days) and premature newborns get admitted if they require any medical care after birth (Chokshi, et al., 2013; Sharma et al., 2018).

Neonatal physiotherapy is a very specialised area within paediatric physiotherapy due to the neonates' extreme vulnerability (Sweeney, et al., 2009). Their vulnerability is due to their complex behavioural, physiological and medical conditions and low gestational age at birth (preterm neonates) (Sweeney, et al., 2009). As there has been an increase in the survival rate and admission of extremely premature neonates to the NICU, the need for neonatal physiotherapists in the NICU has also increased (Brady & Smith, 2015; Hudson & Box, 2003). The role played by neonatal physiotherapists, however, varies between NICUs (Hudson & Box, 2003).

Physiotherapy in NICUs can be divided into two significant areas, namely neurodevelopmental and respiratory physiotherapy.

Neurodevelopmental physiotherapy is seen by many as one of the main purposes of physiotherapy in NICUs as the understanding of the developing brain and the neurological morbidities has improved considerably (Smyser, et al., 2016). The NICU environment is very different to the uterine environment (Lee & Lee, 2018). This abnormal environment induces stress in the neonate, causing physiological instability and ultimately delaying normal growth and development (Lee & Lee, 2018). Early neurodevelopmental physiotherapy has an important role to play to enhance development and minimise long-term impairments (Anderson, et al., 2020; Hudson & Box, 2003; Smyser, et al., 2016). This is achieved by providing sensory stimulation, promoting movement appropriate for gestational age, promoting behavioural organisation and physiological stability (Chokshi, et al., 2013).

Respiratory physiotherapy is another main area of treatment in NICUs. Neonatal airways are very narrow which leads to increased airway resistance (Price & Ronan,

2014). Their airways also have less compliance when compared to adult, and even paediatric airways (Price & Ronan, 2014). This predisposes neonates to atelectasis, decreased ventilation and oxygenation, sputum retention and other pulmonary complications (Price & Ronan, 2014; Zanelat, et al., 2017). Respiratory physiotherapy has been shown to have immediate positive effects on neonatal lung mechanics by reducing airway resistance and improving lung compliance by removing secretions and improving gas exchange in the lungs (Price & Ronan, 2014).

Many physiotherapists believe that respiratory physiotherapy on neonates is damaging and dangerous, due to their physiological vulnerability (Price & Ronan, 2014). Other physiotherapists have experienced the beneficial role respiratory physiotherapy can have on ventilated, as well as non-ventilated patients. In certain countries respiratory physiotherapists are included in the weaning and extubation process of the neonates, whereas in South Africa this is not the norm (Bacci, et al., 2018).

The literature regarding the benefits of respiratory and neurodevelopmental physiotherapy in NICUs shows that there is a definite need for these specialised services, if done correctly, to ensure survival and to minimise long term impairments to the neonates (Anderson, et al., 2020; Hudson & Box, 2003). However, several opinions remain that neonates are very vulnerable and should only be treated when more stable (Blasco, et al., 2023; Dolgan, et al., 2022; Price & Ronan, 2014; Thacker & Patel, 2014).

Additional roles physiotherapists can perform in NICUs are support and education of family members and caregivers, positioning, and prevention of plagiocephaly (Brady & Smith, 2015; Lee & Lee, 2018).

Neonatal survival rates are directly impacted and affected by the quality of medical care in the country. In high-income countries (HIC) neonatal mortality is mostly caused by unpreventable causes. In low- to middle-income countries (LMIC), neonatal mortality is mostly caused by preventable conditions (Chow et al., 2015).

In the United Kingdom (UK) it is highly recommended for physiotherapists working in NICUs to have at least a Master's degree or appropriate professional experience at the level of a Master's degree (Brady & Smith, 2015). When looking at the United States of America (USA), physiotherapists need at least two- to six-month training, among other training requirements, in neonatology before being able to work in NICUs (Sweeney, et al., 2009). This highlights the level of speciality and training needed in NICUs.

Both the above-mentioned countries have developed and published competency frameworks to guide and ensure the competence of the neonatal physiotherapists. This ensures that treatments are done in a safe, standardised, competent and family-focused manner when working in this highly specialised area (Brady & Smith, 2015; Price & Ronan, 2014; Sweeney, et al., 2009; Sweeney, et al., 2010).

In private and public hospitals in South Africa, physiotherapy positions in intensive care units (ICU) are available to any qualified physiotherapist (van Aswegen, et al., 2017). It is the same for physiotherapy positions in NICUs. Physiotherapists do not require any additional education or experience to treat this critically ill and vulnerable population. The undergraduate training for ICU care for adults or children is also not standardised in South Africa and no competency frameworks exist to guide physiotherapists and outline their role (van Aswegen, et al., 2017). The lack of standardised guidelines results in dissimilarities in the skillset and expertise level among neonatal physiotherapists. This leads to inconsistencies in clinical decision making and having to rely on personal experiences during decision making of patient management, which has a negative impact on patient outcomes and results in variations in clinical practice both nationally and internationally.

1.2 Problem statement

The role of neonatal physiotherapy in NICUs is oftentimes unclear and not well defined. The vagueness is specific to the management of neonates, practice modalities, the role of physiotherapists in a multi-disciplinary team (MDT) and what a holistic approach entails in a NICU. Given that the role of physiotherapists in NICUs is

unclear, there are not, as yet, set guidelines for physiotherapists to follow when performing treatment in NICUs in South Africa.

The current lack of literature in South Africa, lack of consensus on the scope and the current role neonatal physiotherapists play in NICUs, has led to the research question this study will attempt to answer.

1.3 Research question

What role do physiotherapists play in NICUs in South Africa?

1.4 Aim of the study

To describe the role physiotherapists play in NICUs in South Africa.

1.5 Objectives of the study

The objectives of the study are to:

1. Identify common conditions treated by physiotherapists in NICUs in South Africa.
2. Determine whether respiratory physiotherapy is practiced in NICUs in South Africa and to what degree.
3. Determine whether neurodevelopmental physiotherapy is practiced in NICUs in South Africa and to what degree.
4. Explore which physiotherapy modalities are currently being used in NICUs in South Africa to treat neonates.
5. Evaluate if physiotherapists treat and work with an MDT approach in NICUs in South Africa.
6. Determine if there are follow-up protocols in place for physiotherapy treatment post-discharge from NICUs in South Africa.

1.6 Significance of the study

Neonatal physiotherapists are part of a highly skilled and specialised group treating very vulnerable neonates (Sweeney, et al., 2009). It is important for neonatal

physiotherapists to have a clear understanding of what their role is within the NICU to ensure treatment is safe, standardised and performed with a high degree of competency (Hudson & Box, 2003).

This study aims to identify what physiotherapists are currently doing and what their purpose is in neonatal care in order to address the lack of literature defining the role and scope of physiotherapy in NICUs in South Africa.

The study will provide an in-depth analysis of the treatment methods and procedures currently used by physiotherapists in NICUs. It will also focus on the qualifications, clinical experience and, follow-up protocols used by neonatal physiotherapists and whether or not they function in an MDT in a NICU.

1.7 Outline of the research report

Figure 1.1 provides an outline of the research report and how it will be presented.

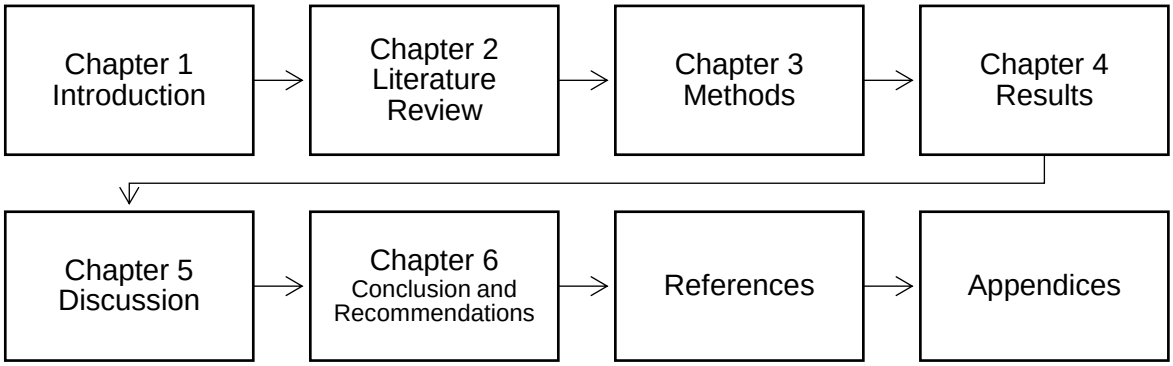

Figure 1.1: Outline of the research report

Relevant and recent literature on the topic was reviewed in order to inform this study. The reviewed literature is presented in Chapter 2.

Chapter 2 Literature Review

2.1 Introduction

Relevant and recent literature was reviewed on several topics related to NICU, in South Africa and globally. In this literature review the type and number of patients admitted to NICUs with their risk factors and complications are discussed with special focus on prematurity. The role and scope of physiotherapy were reviewed in a global and South African context. Literature on respiratory and neurodevelopmental physiotherapy was included as the two main areas of practice. The multidisciplinary team, family education and support, education and clinical experience of physiotherapists in NICUs are discussed. Follow-up protocols after NICU discharge are explained.

2.2 Search strategy

The following databases were used to obtain literature: CINAHL Ultimate, ClinicalKey, Cochrane Library, PEDro, PubMed, Google Scholar and SCOPUS. The keywords used in the searches included NICU, Prematurity, Respiratory physiotherapy, Developmental physiotherapy, Multidisciplinary Team, Follow-up, Family Support and South Africa. No articles published before 2011 were included to ensure only the most recent literature was included, with the exception of articles in which the USA's competency frameworks are discussed. All articles were in English. Articles were scanned by title and abstract for inclusion and full texts of relevant papers were read. The reference lists of retrieved papers were examined for additional papers of interest. Research conducted in South Africa was sought after however, little research has been conducted on this topic in South Africa. Research conducted in other countries were included if relevant to the topic. All study designs were considered to include various views of the topic.

2.3 Neonatal Intensive Care Unit

A NICU is a highly specialised hospital unit where critically ill and unstable neonates (<28 days old) receive treatment and life supporting care (Chokshi, et al., 2013; Coutts, et al., 2021). It is known to be a very stressful environment and is not suitable to adequately support neurodevelopment in premature infants (Coutts, et al., 2021). The

uterine environment is very different to the NICU environment as it provides appropriate visual, auditory, vestibular, tactile and sensory stimuli needed at this gestational age (Lee & Lee, 2018). The NICU has noxious sensory stimuli like light and noise, interrupted rest periods and multiple medical and nursing activities (Anderson, et al., 2020; Lee & Lee, 2018; Maree, et al., 2017). It is also characterised by limited physiological movement opportunities for the infants due to various medical connections and uncomfortable positioning which restrict normal developmental movements (Lee & Lee, 2018). This change in environment influences the physiological processes that can affect medical stability and development of the infant which can have adverse short-term and long-term effects (Altimier & Phillips, 2016; Coutts, et al., 2021).

2.4 Mortality in NICUs

2.4.1 Global

The World Health Organization (WHO) releases a report annually on the most recent available data on health and health-related indicators globally. According to the 2022 report, 2.4 million neonates died within the first month of life in 2020 and 2.3 million in 2022 (WHO, 2022). This is a significant improvement from five million neonates in 1990 (WHO, 2022). Among children under the age of five, 47% of all deaths were neonatal deaths with prematurity being the leading cause (WHO, 2022). These statistics show that the improvement of perinatal and neonatal care with advanced technology has increased neonatal survival rates and improved health of infants admitted to NICUs over the years (Bernstein, et al., 2021; Chow, et al., 2015; Price & Ronan, 2014).

The World Health Statistics Reports of neonatal mortality rates from 2000 and 2021 were compared. The African region had a decrease from 43/1000 to 27/1000 live births. The Eastern Mediterranean region had a decrease from 40/1000 to 25/1000, the South-East Asia region had a decrease from 38/1000 to 17/1000, the region of the Americas had a decrease from 12/1000 to 7/1000, the Western Pacific region had a decrease from 19/1000 to 6/1000 and the European region had a decrease from 11/1000 to 4/1000 live births. South Africa also had a decrease from 21/1000 live births in 2000 to 11/1000 live births in 2021 (WHO, 2005; WHO, 2023).

A country's neonatal mortality rates are largely dependent on its quality of health care, economy, environment, epidemiological profile and socioeconomic status (Chow, et al., 2015; WHO, 2023). Of all neonatal deaths, 98% occur in LMIC with 78% being in Sub-Saharan Africa and Asia (WHO, 2005; WHO, 2023).

The population and disease profile are vastly different in LMICs, like South Africa, compared to HICs (Saggers, et al., 2020; WHO, 2023). This is due to lack of infrastructure, services, specialised care, equipment and human resources (Saggers, et al., 2020). Lack of education, poor access to healthcare and sub-optimal quality of healthcare, poor maternal nutrition and adverse social conditions are other factors contributing to high neonatal mortality rates (Hoque, et al., 2015; WHO, 2023).

In LMICs, infants admitted to the NICU normally die from preventable conditions or complications like infections, whereas in HICs infants die from unpreventable conditions like congenital abnormalities (Chow, et al., 2015; Hoque, et al., 2015). Globally, the main causes of neonatal mortality are prematurity (28%), sepsis (26%) and asphyxia (23%) (Hoque, et al., 2015; Nieuwoudt, et al., 2022).

2.4.2 South Africa

In South Africa, the three major causes of neonatal mortality have stayed consistent over time and across literature which include spontaneous preterm births, intrapartum asphyxia and infections (which can lead to neonatal sepsis) (Hoque, et al., 2015; Nieuwoudt, et al., 2022; Rhonda, et al., 2018). A study identified the causes of mortality in three different weight classes in South Africa (Rhonda, et al., 2018). Infants weighing less than 500 grams (g) died predominantly from prematurity related complications (87.8%) and secondly from infections (6.7%) (Rhonda, et al., 2018). Infants weighing between 500g and one kilogram (kg) died predominantly from prematurity related complications (47.9%), intrapartum-related events (24.3%) and infections (11.6%) (Rhonda, et al., 2018). Infants weighing more than one kilogram died mostly from intrapartum-related events (34.9%), prematurity related complications (29.1%), infections (13.8%) and congenital abnormalities (12.3%) (Rhonda, et al., 2018). The incidence of neonatal sepsis in South Africa is between 8.5% and 10% with late-onset sepsis accounting for the majority of these infections

(Coetzee, et al., 2017). Early-onset sepsis has a mortality rate of 40% and late-onset sepsis has a mortality rate of 22.5% (Coetzee, et al., 2017).

The study also looked at avoidable healthcare-system-related factors causing neonatal mortality in South Africa. The biggest factor identified was inadequate facilities and equipment in NICUs. Nosocomial infections, fetal distress not detected intrapartum, delay in referring patients to secondary and tertiary hospitals and no access to NICU beds with ventilators were the following top causes of neonatal mortality (Rhonda, et al., 2018).

Two other studies also highlighted that, in South Africa, preterm birth is the biggest cause of neonatal mortality with prematurity related complications ranked as the second largest cause of mortality (Ballot, et al., 2015; Milford, et al., 2023).

2.5 Prematurity

2.5.1 Definition and categories of premature births

The WHO defines a preterm birth as a live birth (any signs of life within the first hour post-delivery) before 37 completed weeks of gestation or fewer than 259 days from the mother's last menstrual period. The lower age limit of survival varies depending on the availability of interventions for extremely preterm infants (<28 weeks of gestation or <one kilogram). In HICs the limit of viability has decreased to 24 or 25 weeks of gestation as survival rates have improved. In LMICs, specifically South Africa, the limit is still more than 27 weeks of gestation due to the lack of resources (Ramokolo, et al., 2019).

Premature infants can be categorised into one of four groups based on their gestational age (Purisch & Gyamfi-Bannerman, 2017). Extremely preterm is a gestational age less than 27 weeks, early preterm is a gestational age between 27 and 32 weeks, moderate preterm is a gestational age between 32 and 34 weeks and late preterm is between 34 and 37 weeks of gestation (Purisch & Gyamfi-Bannerman, 2017). According to the WHO, 85% of preterm births are between 32 and 37 weeks of gestation with 11.4 million infants in this age category being born in 2020 (WHO,

2023). In 2020, 1.4 million infants were born between 28 and 32 weeks of gestation and 0.6 million infants were born before 28 weeks of gestation (WHO, 2023).

Another classification system categorises premature infants into groups based on their weight (Cutland, et al., 2017). Extremely low birth weight (ELBW) is less than one kilogram, very low birth weight (VLBW) is between one kilogram and 1,5kg and low birth weight (LBW) is between 1,5kg and 2,5kg (Cutland, et al., 2017). In South Africa, the chance of survival is higher for in an infant with a birth weight of more than 0.9kg and is less than 60% for a birth weight of less than 0.8kg (Ramokolo, et al., 2019).

2.5.2 Epidemiology of preterm births

Medical and technological advances in neonatal care have improved the survival rate of premature infants and lowered the age of viability globally (Ramokolo, et al., 2019; WHO, 2023). However, the advances have not contributed to reducing preterm birth rates which is seen in the global increase from 9.8% to 9.9% from 2010 to 2020 (WHO, 2023). The absolute number of preterm births globally were 13.8 million in 2010 and 13.4 million in 2020 (Ramokolo, et al., 2019; WHO, 2023).

The WHO published another report, ‘Born too soon Decade of action on preterm birth’, in 2023 focusing on prematurity globally. This report clearly states that prematurity rates differ between regions, with the highest rates predominately in LMICs. According to the report, the five countries with the highest rates of preterm births in 2020 were Bangladesh (16.2%), Malawi (14.5%), Pakistan (14.4%), India (13.0%) and South Africa (13.0%) making Southern Asia the region with the highest rate and number of preterm births worldwide. In sub-Saharan Africa, the total number of preterm births increased slightly from 3 350 100 in 2010 to 3 913 200 in 2020 with no measurable change in the preterm birth rate of 10.1% in 2010 and 2020 (WHO, 2023). Some HICs like Greece and the USA also had high rates of 11.6% and 10% respectively. Eastern Asia, South-Eastern Asia, Australia, New Zealand, Northern America and Europe all had less than 8% of all births being premature (WHO, 2023).

Prematurity is the leading cause of child mortality and the fourth leading cause of mortality over all age ranges. In 2020, the rate of preterm births resulting in death were

3% in Northern America, Europe, Australia, New Zealand and Latin America. In Eastern Asia, South-Eastern Asia and Oceania the rate was 4%. In Western Asia and Northern Africa, it was 6%. The highest rates were in Southern Asia with a mortality rate of 8% and Sub-Saharan Africa with 11% (WHO, 2023). The South African neonatal mortality rate among infants weighing more than one kilogram have declined from 8.8/1 000 in 2002 to 8.5/1 000 in 2017 highlighting the improved intensive care for infants in this weight class (Ramokolo, et al., 2019). The ELBW infants constitute 60% of premature birth mortality in South Africa (Ramokolo, et al., 2019).

There is a stagnation in the reduction of prematurity related infant deaths with almost one million infant deaths caused by direct complications of preterm births in 2021. In the same year, 0.9 million children died from prematurity-related complications which accounted for a third of all neonatal deaths (2.3 million) worldwide (WHO, 2023).

2.5.3 Risk factors associated with premature births

2.5.3.1 Global

There are two groups of risk factors associated with preterm birth with the first being spontaneous preterm birth. Short inter-pregnancy intervals and the age of the mother during pregnancy (adolescent pregnancy and advanced maternal age), increase the risk for premature births. According to the WHO, the adolescent fertility rate in LMIC has been reducing since 2012 but Sub-Saharan Africa still has the least modern contraceptive prevalence for example, male and female sterilisation, implants and pills. In some higher-income countries it was found that multi-embryo transfers for in-vitro fertilisation is increasing which is related to advanced maternal age and multiple pregnancies. Multiple pregnancies and assisted reproduction pregnancies are also at higher risk of preterm birth. On average, more than 45% of twins and more than 90% of triplets will have LBW and have premature birth (WHO, 2023).

Infections during pregnancy like urinary tract infections, asymptomatic bacteriuria, malaria, Human Immunodeficiency virus (HIV), syphilis, bacterial vaginosis and chorioamnionitis increase the risk for premature births. Underlying chronic medical conditions of the mother like diabetes mellitus, hypertension, anaemia, asthma and thyroid disease also place the pregnancy at higher risk (WHO, 2023).

The nutritional status of the mother including undernutrition and micronutrient deficiencies and lifestyle factors like smoking, alcohol consumption, drug use and excess physical activity are all increasing the risk for preterm birth (Hoque, et al., 2015) (WHO, 2023). Genetic factors that may predispose to preterm birth include cervical incompetence, intrauterine growth restriction and congenital abnormalities (WHO, 2023).

These risk factors can be monitored and some even treated during high-quality antenatal care (Hoque, et al., 2015; WHO, 2023). During antenatal care visits, interventions aim to screen for risk factors and prevent premature births across a continuum of care including nutritional and maternal health, prevention and treatment of infections and medical conditions (WHO, 2023). There is however, large inequalities in both coverage and quality of health-care services resulting in significant discrepancies between countries and even within countries (WHO, 2023). The coverage of antenatal care (four visits) in North America and Europe were 98% in 2022 whereas sub-Saharan Africa had 54% coverage (WHO, 2023). In cases where women are attending antenatal visits, the visits may begin too late in the pregnancy or appropriate screening and care may be lacking (WHO, 2023). Intersectoral interventions targeting whole populations can aim at reducing some of these risk factors such as reducing smoking and improving air quality (WHO, 2023).

The second group of risk factors is known as provider-initiated preterm birth which results in an induction or caesarean birth due to maternal indication, fetal indication or without medical indication. Maternal indications can include pre-eclampsia, placental abnormalities and pre-existing maternal conditions like diabetes mellitus and hypertension. Fetal indications can include severe fetal growth restriction. Non-medical indications are inductions or caesarean births due to physician or patient preferences. Maternal and fetal indications are unpreventable but can be managed and monitored if appropriate and timely antenatal screening was performed (WHO, 2023).

2.5.3.2 South Africa

South Africa has multiple cultural groups which allows for the identification of preterm birth risk factors being impacted by traditional practices, pregnancy knowledge and cultural beliefs. Some cultural beliefs may result in hidden pregnancies, poor pregnancy knowledge and inadequate antenatal care. A study done on cultural beliefs surrounding preterm births in South Africa stated that there is poor education especially among adolescents. Late antenatal care was associated with unplanned pregnancies and cultural beliefs in certain cultures (Milford, et al., 2023).

Poor education and low socio-economic status of mothers were associated with previous miscarriages, higher risk for unplanned pregnancies, adolescent pregnancies and poor antenatal care resulting in increased risk for preterm births (Jeena, et al., 2020). A study done in 2020, found that premature births and LBW infants were strongly associated with maternal smoking during pregnancy and advanced maternal age (Jeena, et al., 2020; WHO, 2022). Poor maternal nutritional status and undernutrition were also associated with premature births and LBW infants (Jeena, et al., 2020).

Infections, especially HIV, are a common cause of preterm births in South Africa (Ramokolo, et al., 2019). Two thirds of the people living with HIV globally (37.7 million), are living in the African region with adolescent girls and young women accounting for 25% of all HIV infections (WHO, 2022). Approximately 30.8% of live births in South Africa annually are HIV-exposed, increasing the risk of premature births in mothers with HIV (Jeena, et al., 2020; Ramokolo, et al., 2019). The availability and usage of antiretroviral treatment (ART) has increased significantly since 2000 to 2020 with approximately 73% of people living with HIV receiving ART (WHO, 2022). HIV-positive mothers on ART have a higher risk for hypertensive disorders in pregnancy (HDP) which is also strongly associated with premature births (Jeena, et al., 2020; Ramokolo, et al., 2019). With this said, mothers not receiving ART are at an increased risk for premature birth due to the degree of immunosuppression (Short & Taylor, 2014).

The African region also had the highest incidence of malaria and tuberculosis in 2020 (WHO, 2022). Malaria can cause maternal anaemia and placental infection which affect fetal growth. Similar birth outcomes are seen in mothers who were previously

diagnosed with tuberculosis and other sexually transmitted infections like Chlamydia trachomatis, Neisseria gonorrhoea, Trichomonas vaginalis and syphilis (Jeena, et al., 2020).

Africa bears approximately 25% of the world's disease burden with only 3% of the world's health care workers (WHO, 2022). This contributes to the large impact prematurity has on South Africa, together with its low resourced healthcare, poor funding and lack of human resources (Milford, et al., 2023).

2.5.4 Causes of prematurity related complications

As a consequence of the improvement in prematurity survival rates, prematurity-related complications have risen which can be very severe or lead to death (Armanian, et al., 2019; Caesar, et al., 2016). Surviving preterm birth has been shown to have effects on many facets of development and long-term complications in respiratory, cardiovascular and neurodevelopmental systems (WHO, 2023).

Gestational age and birth weight are predictors of risk of mortality and long-term impairments (Purisch & Gyamfi-Bannerman, 2017; WHO, 2023). The severity of disability and risk of mortality being inversely proportionate to the gestational age and birth weight (WHO, 2023). This led to shifting the efforts from only keeping premature infants alive to also managing disorders related to prematurity (Armanian, et al., 2019).

The NICU environment exposes the infants to excessive and prolonged exposure to stress which exceed their natural regulatory capacity threatening the allostatic balance of the infant. Inadequate management and treatment of stressors have been associated with short- and long-term alterations in cognitive, language, sensory, motor and behavioural development (Lammertink, et al., 2021).

In an expert review on the mechanisms of resilience and vulnerability in preterm infants, Lammertink, et al. (2021), classified postnatal stresses into three groups namely, physical, maternal and environmental stresses. The infants might already be predisposed to prenatal factors responsible for preterm birth like infections or vascular diseases and so a combination of prenatal and postnatal stresses increase the risk of

morbidity and mortality. Physical stress includes repetitive painful procedures and medical conditions causing pain. As preterm infants are underdeveloped in pain transmission and modulation, they have an increased physiological and behavioural sensitivity to pain (Lammertink, et al., 2021).

Environmental stresses include routine nursing interventions (tactile sensation) and sensory overstimulation, including sound levels and light exposure in the NICU. Sensory overstimulation has been associated with negative physiological effects like decreased oxygen saturation, increased blood pressure and heart rate. It also alters their sleep-wake states. As sleep is crucial for brain maturation and development, inappropriate sensory stimulation negatively affects brain development (Lammertink, et al., 2021).

Maternal behaviour and care toward a preterm infant play a crucial role in early regulation of stress responses. The parent-infant attachment and relationship are obstructed both physically and emotionally during the NICU admission. This has been shown to negatively affect the parent's mental and the infant's medical well-being (Lammertink, et al., 2021).

2.5.5 Neurodevelopmental complications associated with prematurity

Prematurity is strongly associated with altered brain development and has become the major cause of behavioural, cognitive and neurodevelopmental delay and impairments (Boardman, et al., 2020; Caesar, et al., 2016). Of the 13 million infants born prematurely globally each year, 2.7% have moderate to severe impairments and 4.4% have mild neurodevelopmental impairments later in life (WHO, 2023).

Depending on the gestational age, the third trimester of pregnancy is either partially or completely missed by premature infants (Lammertink, et al., 2021). The third trimester of pregnancy is vital for infant brain plasticity, growth and development with several developmental events taking place between 24 and 40 weeks of gestation (Lammertink, et al., 2021). The interruption of these maturational processes by preterm birth results in the infant having a neurobiological immature system and

predisposing the fragile brain to extrauterine stresses (Caesar, et al., 2016; Lammertink, et al., 2021).

The autonomic nervous system (ANS) is responsible for immediate responses to stresses, which plays an important role in maintaining physiological, and essentially respiratory and cardiovascular homeostasis. The development of the ANS undergoes important maturational milestones during the transition of the second to third trimester. The exposure of stresses during this crucial period of ANS development, increases the possibility of detrimental effects and complications in ANS functioning and stress-regulation in preterm infants (Lammertink, et al., 2021).

The immature nervous system is also at risk of various neural insults caused by extrauterine stressors as the premature brain has minimal myelinated white matter predisposing the neurons to injury (Lammertink, et al., 2021). Neural insults include inflammation, ischaemia, hypoxic brain injury, excitotoxicity and free radical attack (Caesar, et al., 2016; Tsimis, et al., 2016).

Periventricular leukomalacia (PVL) is a brain injury predisposing LBW and premature infants to developmental impairments and cerebral palsy (CP) in 60-100% of survivors and has been said to be the most common cause of CP in premature infants (Tsimis, et al., 2016). PVL is a result of an inflammatory response caused by free radical generation, increased presence of excitatory neurotransmitters and cytokine toxicity (Caesar, et al., 2016; Tsimis, et al., 2016). This results in a disruption in the myelination process which affect the motor skill development of the infant (Tsimis, et al., 2016). The regulation of the cardiovascular system is disrupted by the endotoxin release, resulting in reduced cerebral blood circulation which leads to ischaemic lesions (Caesar, et al., 2016; Tsimis, et al., 2016). PVL has been associated with both perinatal infections and intrapartum hypoxia-ischemia (Caesar, et al., 2016; Tsimis, et al., 2016). Other causes of PVL also include infections, ventilation mode and cerebral ischemia (Tsimis, et al., 2016).

Intraventricular haemorrhage (IVH) is a major complication which predominantly occurs within the first 48 hours of life (Ozek & Kersin, 2020). IVH usually starts in the germinal matrix which is a highly vascularised collection of neuronal-glial precursor

cells. It is believed that risk factors cause a disturbance in the cerebral blood flow to the immature germinal matrix blood vessels and result in platelet and coagulation disorders. This can lead to a haemorrhage in the germinal matrix which may rupture into the ventricular system of the brain. The density of vasculature increases with gestational age in the regions of the germinal matrix, cerebral cortex and white matter. Even a small haemorrhage can have an impact on future functioning of the germinal matrix and ventricular system which has a role in memory and language. Risk factors include a low Apgar score, severe respiratory distress syndrome (RDS), vaginal delivery, hypoxia, hypercapnia, pneumothorax, seizures, patent ductus arteriosus and infection. IVH occurs in approximately 10-20% of preterm infants born before 30 weeks of gestation and 35-45% of infants born weighing less than 750g have a chance of developing grade three or four IVH (Ozek & Kersin, 2020). Signs and symptoms of IVH include small abnormalities in movement, tone, eye movement, level of consciousness and respiration. A study concluded that premature infants with grade three or four IVH, have a 50% chance of developing CP, have cognitive delay or posthemorrhagic hydrocephalus. Infants with a grade one and two IVH, are at risk for developmental delay and complications (Ozek & Kersin, 2020).

Periventricular haemorrhagic infarction (PVHI) is another serious brain lesion diagnosed in preterm infants. It usually develops between 24 and 96 hours post birth and is a higher risk in infants born before 32 weeks of gestation. PVHI occurs due to impaired drainage of the medullary veins in the periventricular white matter and is associated with ischaemia of this area. As the vasculature density is lower in premature infants, blood vessels in this area easily rupture due to fluctuations in cerebral blood flow. PVHI has been linked to cardiovascular instability and has an increased risk of causing CP and neurological complications with both motor and cognitive neurological fallouts. Risk factors include pneumothorax, respiratory resuscitation, low APGAR scores and pulmonary haemorrhage (Soltirovska Salamon, et al., 2014).

The extensive primary and secondary injuries to the brain result in impaired white matter development and a decrease in total brain volumes persisting throughout life (Caesar, et al., 2016).

2.5.5.1 Complications in motor and cognitive development

Injuries and insults to the developing motor portion and periventricular axons can result in motor development deficits. Periventricular axons are responsible for transmitting sensory and motor impulses and are often damaged as a result of a combination of mechanical, metabolic and ischaemic disturbances in the brain. It has been shown that preterm infants are prone to injury of the thalamus and cerebellum and has been associated with decreased growth of the basal ganglia and thalamus. The basal ganglia is responsible for motor control and learning and so damage to this area will result in movement disorders. Injury to the thalamus will result in problems with motor signaling (Caesar, et al., 2016).

The thalamus and cerebellum play crucial roles in perceptual, cognitive and motor skills which can lead to developmental deficits in motor development and cognitive abilities to learn and organise new, unpredictable or difficult tasks (Caesar, et al., 2016). Other impairments in cognitive developmental can include difficulties in reading, spelling, language skills and cognitive function including a lower IQ, poor visuomotor coordination and decreased processing speed (Altimier & Phillips, 2016; Caesar, et al., 2016). Injury to the thalamus can also impact awareness, visually guided actions, attention and perceptual matching. It also affects memory and cognition including cognitive aspects of motor control (Caesar, et al., 2016).

2.5.5.2 Complications in sensory development

As the sensory and neurological systems develop interdependently and not separately, all sensory stimuli elicit a behavioural response in the brain, which then leads to another sensory response. When infants experience inappropriate and excessive sensory stimuli in the NICU environment, their neurodevelopment is affected negatively (Altimier & Phillips, 2016).

The immature brain also has a lack of inhibitory control which selects, controls and processes sensory stimuli. This sensory processing impairment reflects the inability to transform sensory information used to regulate different responses into appropriate behaviour (Kara, et al., 2020; Madlinger-Lewis, et al., 2014). The sensory overstimulation and pain caused in the NICU, during this critical period of brain

development have negative effects on their short- and long-term motor, sensory and neurologic development that can cause sensory and motor dysfunction and lead to learning difficulties. As the processing of sensory stimuli is critical for normal development, processing impairments from the tactile, proprioceptive and vestibular systems may lead to impairments in adaptive behaviour, motor development and movement coordination. Impairments in sensory processing affects 39-52% of premature infants with a higher risk in infants born before 32 weeks of gestation (Kara, et al., 2020; Madlinger-Lewis, et al., 2014). Sensory abnormalities including problems with vestibular balance, pain processing, deafness and CP have been associated with prematurity. Premature infants can also exhibit neurobehavioural impairments like a lack of self-regulation and state control, poor reflex development, poor muscle tone, and poor movement (Kara, et al., 2020; Madlinger-Lewis, et al., 2014).

2.5.5.3 Complications in language development

Language difficulties associated with prematurity include using less complex expressive language, slower receptive language skills, poorer vocabularies and having longer atypical language organisation compared to full term infants (Altimier & Phillips, 2016). These language deficits are caused by damage to the thalamus and basal ganglia which act as central monitor for language activities (Caesar, et al., 2016). The delays are not only associated with early gestational age and LBW but also various prematurity related brain injuries like IVH and PVL (Altimier & Phillips, 2016).

2.5.5.4 Complications in behavioural development

Changes in central autonomic regulation alters the capacity of developing infants to respond to environmental changes and have been associated with a wide spectrum of psychiatric disorders and symptoms (Lammertink, et al., 2021). The most common being autism spectrum disorder (ASD), attention deficits, emotional symptoms, attention deficit hyperactivity disorder (ADHD), anxiety, depression and executive functioning (Altimier & Phillips, 2016; Chung, et al., 2019; Lammertink, et al., 2021).

Physical and motor disorders are more noticeable in premature infants but there is also a great risk of social-emotional, mental, speech and language, cognitive and behavioural difficulties (Altimier & Phillips, 2016). Infants rarely only present with motor

deficits and are likely to perform below average in two or more developmental domains (Caesar, et al., 2016). Adequate treatment and management of stressors and facilitation of normal development are crucial to prevent or minimise the short- and long-term alterations in preterm infants' brain and development (Lammertink, et al., 2021).

2.5.6 Respiratory complications associated with prematurity

Premature infants have physiological and anatomical immature respiratory systems as the respiratory system undergoes significant growth and development during the third trimester (Blasco, et al., 2023). An underdeveloped respiratory system and lack of pulmonary surfactant increase the risk for respiratory complications (Blasco, et al., 2023). Surfactant is a complex mixture of proteins and phospholipids responsible for alveolar stability, reducing alveolar surface tension and prevents alveolar collapse on expiration (Hermansen & Mahajan, 2015). During the development of the respiratory system, surfactant is produced during 30-32 weeks of gestation (Hermansen & Mahajan, 2015). Premature infants born before that time will have a deficiency of pulmonary surfactant at birth (Hermansen & Mahajan, 2015).

Respiratory distress syndrome (RDS) develops as a result of a lack of surfactant causing a decrease in lung compliance, resulting in atelectasis (Hermansen & Mahajan, 2015). This causes pulmonary vascular constriction, hypoperfusion and lung tissue ischaemia (Hermansen & Mahajan, 2015). Full term infants rarely develop RDS as they have sufficient surfactant production (Hermansen & Mahajan, 2015). Symptoms include cyanosis, grunting, nasal flaring, inspiratory stridor, poor feeding, tachypnoea and apnoea (Hermansen & Mahajan, 2015). It is usually treated with oxygen supplementation, mechanical ventilation (MV), steroid therapy and surfactant supplementation (Blasco, et al., 2023). These interventions can produce additional lung injury and further delay lung development (Blasco, et al., 2023). Preterm infants who suffered from RDS have an increased risk for decreased lung function in the future and has also been linked to poorer developmental outcomes (Hermansen & Mahajan, 2015).

Bronchopulmonary dysplasia (BPD) is a long-term complication of RDS. It is defined as a chronic inflammatory lung disease with incomplete lung development and supplemental oxygen requirement (Rivera, et al., 2016). Bronchopulmonary dysplasia is characterised by persistent decreases in alveolar counts and enlarged alveoli causing an overall reduction in the surface area available for gas exchange (Rivera, et al., 2016). Prenatal risk factors include surfactant deficiency, prenatal infection, genetic susceptibility and placental insufficiency (Rivera, et al., 2016). Post-birth risk factors include small gestational age, postnatal sepsis, long period of MV, long period of oxygen therapy and severity of RDS (Rivera, et al., 2016). Long-term complications of BPD include altered pulmonary function, increased susceptibility to infections, airway hyper-reactivity and increased risk of inflammatory lung disease (Rivera, et al., 2016). It has also been associated with severe complications like pulmonary hypertension, poor growth, neurodevelopmental disability and long-term pulmonary morbidity (Hansen, et al., 2021).

In addition to surfactant deficiency, preterm infants have reduced number of alveoli and underdeveloped collateral ventilation also predisposing them to decreased lung compliance. These characteristics predispose premature infants to atelectasis which occurs as a result of alveolar unit collapse. Atelectasis is the reduction in lung volume which destabilises the relationship between perfusion and ventilation and causes pulmonary shunting. According to Santos, et al. (2019), there are various factors predisposing infants to atelectasis which include mucous plugs, MV, elective and accidental extubation, poor endotracheal tube placement, gastroesophageal reflux, meconium aspiration, pneumothorax, pleural effusion, BPD, bacterial pneumonia and RDS (Santos, et al., 2019).

Santos, et al. (2019), found that the most frequent respiratory changes on chest X-rays of preterm infants are atelectasis, opacities, hyperlucency and pulmonary infiltrates. Opacities occur from pulmonary infiltrates attributable to the accumulation of fluid in the interstitial spaces from inflammation. Hyperlucency occurs as a result of haemorrhage, atelectasis, pulmonary oedema or consolidations (Santos, et al., 2019).

In mechanically ventilated infants, the most common radiological change is pulmonary infiltrates (Santos, et al., 2019). It is described that in pulmonary diseases like

bronchiolitis, pneumonia, RDS and meconium aspiration, pulmonary infiltrates occur as a result of inflammatory processes which leads to alveolar collapse and reduction in lung volumes (Santos, et al., 2019). There is also an increased risk of infection associated with the use of MV and as the time on ventilator support prolongs, the risk increases (Ahmed, et al., 2023; Santos, et al., 2019). Nosocomial infections are very common in NICU settings with ventilator-associated pneumonia (VAP) among the most common types of infections (Ahmed, et al., 2023).

Pneumothoraces occur in 1-2% of term infants but more often in premature infants. It occurs when pulmonary space pressure exceeds extrapleural pressure. It can either occur spontaneously or secondary to ventilatory barotrauma, lung deformity, aspiration or infection (Hermansen & Mahajan, 2015).

According to Lategan, et al. (2022), there are inequalities in the availability of resources geographically and between private and public sectors in South Africa. These inequalities are also present in neonatal care impacting the availability of interventions that can improve outcomes for preterm infants. Interventions needed for respiratory care for preterm infants may include intubation and MV equipment, adequate oxygen and exogenous surfactant replacement. The absence of resources and appropriate treatment may lead to respiratory failure as a result of surfactant deficiency, infection and apnoea (Lategan, et al., 2022).

2.5.7 Other complications associated with prematurity

Premature infants are immunologically compromised as they have immature innate and adaptive immune systems together with immaturity of their organs and other mechanisms involved in first-line defense. This leads to less functional defense mechanisms which leads to a delayed immune response and the inability to localise infections which increases their risk for infections and sepsis. Moore, et al. (2014), explains that complications of prematurity are associated with exaggerated inflammatory responses coupled with inadequate anti-inflammatory mechanisms. Complications related to inflammation include BPD, IVH, necrotising enterocolitis (NEC) and retinopathy of prematurity (ROP) (Moore, et al., 2014).

Necrotising enterocolitis is defined as a gastrointestinal disease accompanied by signs and symptoms of shock. It is associated with an imbalance between beneficial bacteria and pathogenic bacteria, colonisation of intestinal bacteria, oxidative stress and exaggerated inflammatory responses. Even though NEC has a lower incidence than BPD, it is a leading cause of long-term morbidity and mortality in preterm infants. The severity and incidence significantly increases as gestational age decreases. There is also a great risk for liver and bowel transplantation and significant neurodevelopmental delay associated with NEC. Risk factors include formula feeding, hypoxia-ischaemia and prematurity (Moore, et al., 2014).

Retinopathy of prematurity is a vasoproliferative disorder affecting the immature retinal neural structures of premature infants with a higher risk in LBW and younger gestational ages, mainly younger than 28 weeks of gestation. Other risk factors include MV, oxygen supplementation, surfactant administration and late-onset sepsis. This is a two-step disorder starting with retinal vessel arrest due to exposure to high oxygen levels at birth. This hypoxia stimulates angiogenic growth factor upregulation and the risk of neovascularisation. Severe ROP has been associated with poorer motor and cognitive development as ROP causes maturational delay in the external capsule and posterior white matter. By reducing risk factors affecting retinal development postnatally, brain development may positively be affected and developmental complications reduced (Ramirez, et al., 2022).

A study done in South Africa looked at hospitalisation of HIV-exposed premature infants. Among hospitalised infants, the HIV-exposed infants had twice the risk of NICU admission compared to unexposed infants. Preterm birth, especially very preterm birth, VLBW and NICU admission are more likely in HIV-exposed infants and are related to worse morbidity as they are prone to complications (Anderson, et al., 2021).

Prematurity is associated with various other complications in the respiratory, gastrointestinal, musculoskeletal, cardiovascular, central nervous and other systems (Dogan, et al., 2022). Only a few common complications, relevant to physiotherapy were explained above.

2.6 Other causes for NICU admission

A descriptive and retrospective study, with a large sample size, described the need for NICU care for full term infants. The study found that the most common cause for NICU admission of full-term infants is respiratory dysfunction (Lucas, et al., 2022). Respiratory dysfunction can be caused by different pathologies or can be as a result of the rapid adaptation of the infant to the extrauterine environment (Lucas, et al., 2022). The study indicated that half of the infants with respiratory dysfunction required MV (Lucas, et al., 2022). The second most common causes were jaundice and sepsis. Asphyxia and malformations requiring surgical procedures were also frequent causes for admission (Lucas, et al., 2022). Birth asphyxias may be caused by poor care of the mother during labour and resuscitation of the neonate (Hoque, et al., 2015). This can be as a result of limited resources and inadequate training of medical staff (Hoque, et al., 2015).

Saggers, et al. (2020), reviewed a large number of neonates with surgical conditions admitted to NICUs in South Africa over two years. The retrospective, descriptive study found that of all neonatal deaths in sub-Saharan Africa and South Asia, 10% are due to congenital malformations requiring surgical interventions. Congenital malformations account for more than 25% of paediatric surgical admissions and 50% of emergency procedures in Africa. Common surgical conditions include NEC, anorectal malformations, congenital diaphragmatic hernia, Hirschsprung's disease, omphalocele, oesophageal atresia, gastroschisis, tracheo-oesophageal fistula, intestinal atresia and intestinal perforation. Resources available for neonatal surgery vary widely between low- and high-income countries. This is one of many challenges in LMIC which leads to the high mortality and morbidity rates in this patient population (Saggers, et al., 2020).

Neonatal infections are also a common cause of NICU admission. Risk factors for infections include poor obstetric care, un-sterile delivery, and care practices in LMIC (Hoque, et al., 2015). Sepsis is also a common postoperative complication seen in NICUs (Saggers, et al., 2020). Infections can lead to septicaemia which is related to medical interventions like VAP, urinary tract infections, central line-associated sepsis and localised infection at the surgical site (Saggers, et al., 2020).

According to Coetzee, et al, (2017), neonatal sepsis is a clinical condition occurring within the first 28 days of life with nonspecific signs and symptoms which may include lethargy, irritability, unstable temperatures, poor feeding, glucose instability, brady- or tachycardia, poor perfusion, apnoea, bleeding tendencies and bacteraemia. Early-onset sepsis starts within 72 hours of life and is the result of intrapartum vertical transmission of bacteria from the mother to the fetus either transplacentally or from the genital tract. Late-onset sepsis starts after 72 hours of life and is caused by the transmission of bacteria from healthcare providers or the environment. Risk factors for early-onset sepsis include maternal intrapartum pyrexia (temperature >38 ˚C), LBW, prematurity, low Apgar scores, prolonged rupture of membranes before delivery and assisted instrumental delivery. Risk factors for late-onset sepsis include prematurity, repeated invasive procedures, deep intravenous lines, prolonged hospital admission, prolonged antimicrobial administration and MV (Coetzee, et al., 2017).

Meconium aspiration is defined as respiratory failure present in infants born through meconium-stained amniotic fluid who then aspirated on the fluid. Meconium appears in the intestines around 12 weeks of gestation but meconium aspiration is unusual in premature infants as they have ineffective peristalsis and poor anal sphincter tone (Monfredini, et al., 2021). Meconium aspiration is uncommon before 34 weeks of gestation and is more commonly seen in near-term, term and post-term infants. Risk factors associated with meconium-stained amniotic fluid include pre-eclampsia, maternal hypertension, infections, maternal substance abuse and placental insufficiency. Risk factors associated with meconium aspiration include fetal acidosis, caesarean section, thick meconium, low APGAR scores and the need for intubation at birth. Respiratory findings can include mild to moderate respiratory distress and severe refractory hypoxaemia secondary to persistent pulmonary hypertension which requires advanced respiratory support (Monfredini, et al., 2021).

2.7 The role of physiotherapy in NICUs

2.7.1 Global

Neonatal physiotherapy is seen as an advanced sub-specialised area within paediatric physiotherapy (Price & Ronan, 2014; Sweeney, et al., 2009). It has a unique and important role in improving functional outcomes and health-related quality of life in

neonatal patients with critical illness (Brady & Smith, 2015). The role of neonatal physiotherapy, however, varies across countries due to the differences in resources available, the scope of patient referrals and the level of professional autonomy (Lee, et al., 2022; Liberali, et al., 2014).

A competency framework was developed and published by the Association of Paediatric Chartered Physiotherapists in the UK for neonatal physiotherapists to guide and ensure competence and evidence-based practice. This guide explains the role of neonatal physiotherapy as specialised care in movement and postural control within familial, behavioural and environmental contexts. It is responsible to shape the musculoskeletal system and motor organisation of infants receiving intensive care. It also includes supporting caregivers in optimising brain development based on principles of movement science. They address functional and structural integrity of all body systems, promotes age-appropriate movement and postural activities and facilitate appropriate interaction between the infant, caregivers, parents and health professionals. Respiratory physiotherapy and management of orthopaedic conditions within the NICU also form part of the scope (Brady & Smith, 2015; Price & Ronan, 2014).

The American Physical Therapy Association has explained the role of neonatal physical therapy in the USA as minimising complications of prematurity, screening to determine referral needs, examination of infants, interpretation of findings, intervention plan development and implementation, collaboration with families and health professionals to assess treatment efficacy and development of discharge plans (Kotecha & Desai, 2022; Sweeney, et al., 2009; Sweeney, et al., 2010). The USA also developed clinical competencies and training models to ensure that treatments are done in a safe, standardised, competent and family-focused manner when working in this highly specialised area (Kotecha & Desai, 2022; Sweeney, et al., 2009; Sweeney, et al., 2010).

In Canada, a joint statement was published on the guidelines for institutional implementation of developmental care in NICUs (Martel, et al., 2017; Milette, et al., 2017). The guidelines provide a framework to facilitate the implementation process of developmental care, ensure consistency of care across settings, sustainability of

developmental care and accountability for best practice (Milette, et al., 2017). This framework is developed for a group of health professionals, including physical therapists (Martel, et al., 2017; Milette, et al., 2017). Another article states that the role of physical therapists as rehabilitation specialists in Canada is to provide complementary assessment and intervention strategies (Nery, et al., 2019). These strategies are designed to minimise neurobehavioural and sensory deficits, prevent musculoskeletal complications and promote self-regulation (Nery, et al., 2019). Strategies also include clinical monitoring, referral, education, health promotion and collaboration in research (Nery, et al., 2019).

A survey looking at paediatric competencies of entry-level physiotherapists in Australia explained the role of paediatric physiotherapy as optimising physical function, quality of life and participation of children with a range of abilities and diagnoses. This study defined the paediatric population as children from birth to 22 years of age. Entry-level physiotherapists in Australia should have the ability to manage a caseload of patients with paediatric patients included as they are first contact practitioners (Baque, et al., 2020).

Two studies looking at the role of neonatal physiotherapy in India highlighted the role in neurodevelopment, respiratory care and family-centered care. In some hospitals, the physiotherapists are responsible for extubating the infants (Kotecha & Desai, 2022; Sharma, et al., 2018). Kumar, et al. (2013), also states ‘In some institutions around the world, extubations are also performed by physiotherapists in accordance with the neonatal unit protocol’ (Kumar, et al., 2013: 141). The studies also mentioned hydrotherapy for pain and sleep management (Kotecha & Desai, 2022; Sharma, et al., 2018). A survey done on professionally qualified physiotherapists working in neonatal and paediatric ICUs in India, explained the role of neonatal physiotherapists as being associated with the care of the neonates’ lungs (Kumar, et al., 2013). However, they are also responsible for the management of neurological and musculoskeletal disorders (Kumar, et al., 2013).

Katucka, et al., (2022), conducted a study with the aim to determine the importance of physiotherapy and its role in the therapeutic process in premature infants in Poland. They stated that the aim of neonatal physiotherapy is to prevent complications,

achieve the best possible functional state of the infant and eliminate pathological reflexes. The cooperation of the parents is crucial as the progress of therapy depends on it (Katucka, et al., 2022).

2.7.2 South Africa

Van Aswegen, et al. (2017) conducted a study on minimum clinical standards for physiotherapists working in intensive care units (ICU) in South Africa. This study was based on ICUs in general and is not specific to NICUs however, they explain the role of physiotherapists in ICUs, which is relevant to neonatal physiotherapists. They explain that physiotherapists play a crucial role as a member of the MDT in the management and rehabilitation of patients in ICUs. They also play a role in terms of improving health-related quality of life and functional outcomes in critically ill patients. As physiotherapy in NICUs forms part of acute care, it differs from other fields of physiotherapy. This is due to the short-term acute physiological and anatomical complications and instability, particular focus on respiratory health and the increased risk of significant morbidity, which are dependent on the decision-making and interventions performed in the NICUs (van Aswegen, et al., 2017).

It is difficult to know what role physiotherapists are currently playing in NICUs in South Africa where there are no minimum standards of practice or competency frameworks to reflect and clarify the role. There is also a lack of literature on the role physiotherapists are playing specifically in NICUs in South Africa.

2.7.3 Evidence-based physiotherapy

The USA's practice frameworks and evidence-based practice guidelines explain that a crucial aspect of providing care in any physical therapy setting is critical appraisal of relevant literature and application of evidence-based practice (Sweeney, et al., 2010).

The Academy of Pediatric Physical Therapy explains that practice guidelines are developed to provide graded recommendations based on systemic reviews of literature using internationally acceptable methods. Guidelines are developed to inform practice, with the goals of standardising measures, providing clinicians and

researchers with an understanding of the best current practice and gaps in the literature and reduce unwarranted variations in practice (Rapport, et al., 2014).

A detailed understanding of the available, highest quality and most recent literature with clinical expertise is required to treat patients, specifically this very vulnerable population, in a safe, appropriate and the most effective manner (Price & Ronan, 2014). Knowledge on complications, risks and potential adverse outcomes is crucial to minimise risks associated with physiotherapy treatment (Price & Ronan, 2014). By implementing both research and clinical findings into treatment can enhance clinical practice and prevent the misuse, overuse and underuse of physiotherapy services (Price & Ronan, 2014). Evidence-based practice in neonatal physiotherapy is therefore, essential to further establish and strengthen the role physiotherapists play in NICUs.

2.8 Education and clinical experience of physiotherapists working in NICUs

2.8.1 Global

The NICU, which is seen as a very specialised unit, requires competent and experienced health professionals with extensive knowledge and skills (Barbosa, 2013). To keep up with the specialist neonatologists and neonatal nurses, who have specialty neonatal training, it should be assumed that neonatal physiotherapists also require comprehensive knowledge and clinical experience in neonatal and intensive care in order to work in NICUs (Barbosa, 2013; Price & Ronan, 2014; Sweeney, et al., 2009).

In the USA, qualified physical therapists need at least two- to six-months of additional training, among other training requirements, in neonatology before being able to work in NICUs. The physical therapists have to participate in continuing education, mentorship and supervised experience before providing treatment independently in NICUs (Sweeney, et al., 2009; Sweeney, et al., 2010).

According to the clinical competencies guidelines, neonatal physical therapists in the USA require comprehensive training in infant and brain development, physiological

evaluation and monitoring, infant neurobehavioural functioning, family systems, NICU environment and MDT work in NICUs (Sweeney, et al., 2009). As many of these infants admitted to NICUs are physiologically and metabolically unstable, have underdeveloped musculoskeletal, neuromuscular, cardiovascular and integumental systems, even everyday caregiving can pose possible risks (Barbosa, 2013; Sweeney, et al., 2009). NICUs are, therefore, not appropriate for physical therapy assistants, generalists or students as the potential to do harm is high in this vulnerable population (Price & Ronan, 2014; Sweeney, et al., 2009).

In the UK it is highly recommended for physiotherapists working in NICUs to have at least a Master's degree or appropriate professional experience on the level of a Master's degree (Brady & Smith, 2015). According to Price and Ronan (2014), neonatal physiotherapists also require a highly complex set of skills including advanced clinical training to appropriately manage the infants' instability, minimise complications and reduce NICU stay (Kotecha & Desai, 2022; Price & Ronan, 2014).

The Physiotherapy Board of Australia and the Physiotherapy Board of New Zealand require entry-level physiotherapists to have the necessary knowledge and skills to treat a general population of patients ranging from birth to geriatrics. Baque, et al. (2020), described the curricula of Australian entry-level physiotherapy programmes. They found that graduating from an accredited institution allow physiotherapists to work in any area including paediatrics, and so, neonatal care. It is also not compulsory for students to gain paediatric experience during their education due to limited paediatric placements and the small proportion of physiotherapists working in this area. In Australia and New Zealand, essential competencies for paediatric physiotherapy are therefore included in the entry-level curricula and no additional training or education is required to treat infants admitted to NICUs. Baque, et al. (2020) explained however, that the type and depth of content and experience related to paediatric physiotherapy are not standardised across different Australian physiotherapy programmes. A consensus were reported on content areas, however, the extent to which the areas were covered varied between universities and level of tertiary education. This study recommended the development of minimum standards for entry-level paediatric education and assessment (Baque, et al., 2020).

2.8.2 South Africa

Physiotherapy positions available within NICUs in public and private hospitals in South Africa are available to any qualified physiotherapist (van Aswegen, et al., 2017). There are no additional educational or experience-related requirements to providing care to this critically ill and vulnerable population (van Aswegen, et al., 2017).

A retrospective review was done with the aim to establish whether the most relevant medical conditions treated by physiotherapists in South Africa align with the curriculum of the University of the Witwatersrand physiotherapy department (Ntsiea, et al., 2017). As there are no additional requirements to working in a NICU in South Africa, the undergraduate curriculum is instrumental to equip entry-level physiotherapists with the ability to confidently and effectively assess and treat the majority of conditions seen (Ntsiea, et al., 2017). The curriculum should focus on current clinical skills and cover a wide variety of medical conditions seen in practice (Ntsiea, et al., 2017). There is however, no clear or accepted model for curriculum development in and should therefore focus on evidence-based research (Ntsiea, et al., 2017). An undergraduate curriculum is also developed based on the patient statistics of the province which differs between provinces (Ntsiea, et al., 2017). Undergraduate physiotherapy training is therefore not standardised and no competencies related to NICU physiotherapy exist (Ntsiea, et al., 2017).

Even though physiotherapists are allowed to practice in NICUs without additional education or experience, they have access to postgraduate developmental care programmes (Rheeder, et al., 2017). These training programmes are internationally recognised and are not specific to physiotherapists but rather available to most NICU MDT members (Rheeder, et al., 2017). Postgraduate developmental care programmes include, the Family and Infant Neurodevelopmental Education (FINE) programme, the Newborn Individualized Developmental Care and Assessment Program (NIDCAP), the European Foundation for the Care of Newborn Infants, the Wee Care Neuroprotective NICU programme (Wee Care), Prechtl General Movement Assessment, the Hammersmith Infant Neurological Examination (HINE) and Neurodevelopmental Treatment (NDT) programmes.

The programmes are not freely available in South Africa and most of the programmes are not easily accessible as their training centres are based overseas. As a result, developmental care is still not fully implemented in South Africa as standard practice of care (Rheeder, et al., 2017). This causes dissimilarities in the skillset and expertise level among neonatal physiotherapists in South Africa, leading to inconsistencies in clinical decision making or having to rely on personal experiences during decision making of patient management, which has a negative impact on patient outcomes (Lee, et al., 2022; van Aswegen, et al., 2017). This results in variations in clinical practice both nationally and internationally (van Aswegen, et al., 2017).

In order to ensure safe and effective clinical practice from physiotherapists, it is crucial to clarify competencies required to work in ICUs, including NICUs (Lee, et al., 2022; Skinner, et al., 2016; van Aswegen, et al., 2017).

2.9 Respiratory physiotherapy in NICUs

2.9.1 Indications and goals for respiratory treatment

Infants admitted to the NICU are characterised as being at risk of respiratory complications and may require respiratory physiotherapy (Blasco, et al., 2023). Premature infants have respiratory vulnerability as a result of underdeveloped respiratory systems whereas term infants may have respiratory pathologies or require MV which predisposes their respiratory systems (Blasco, et al., 2023; Price & Ronan, 2014).

A systematic review, with good methodological quality, aimed to summarise the evidence on the effects of respiratory physiotherapy on preterm infants and determine the most appropriate techniques. The study states that the objectives of respiratory physiotherapy in the NICU include treating and preventing pulmonary collapse, reduce reintubations, eliminate excess secretions and improve pulmonary ventilation (Blasco, et al., 2023).

Neonatal airways are very narrow, increasing the effect secretions have on airway resistance. Premature infants also have poor pulmonary compliance as a result of surfactant deficiency which predisposes them to atelectasis and ventilatory mismatch.

Respiratory physiotherapy is shown to have an immediate improvement on lung mechanics when techniques are focused on improving ventilation distribution and removing airway secretions (Price & Ronan, 2014).

Mechanical ventilation is a treatment modality used when critical neonatal patients have insufficient spontaneous ventilation (Sangsari, et al., 2022). Mechanical ventilation facilitates oxygenation, carbon dioxide removal and gas exchange and is commonly used in NICUs (Sangsari, et al., 2022). In a study done by Sangsari, et al. (2022), it was found that in a group of ELBW neonates, 89% were on MV. In this ventilated group, 95% of the neonates survived (Sangsari, et al., 2022). Another study reported that in a group of neonates born before 28 weeks of gestation, 74% were on MV (Sangsari, et al., 2022). Mechanical ventilation has many advantages but can also cause complications like VAP, tracheal injuries (especially with re-intubation), ventilator-induced lung injury (VILI) and neurodevelopmental impairments (Price & Ronan, 2014; Sangsari, et al., 2022). It is therefore recommended that infants are weaned from MV as soon as possible (Sangsari, et al., 2022).

Respiratory physiotherapy has been proven to assist in the weaning of MV and to minimise ventilator-associated complications (Chokshi, et al., 2013; Price & Ronan, 2014). Ventilator-associated complications include increased risk for morbidity and mortality, prolonged ICU length of stay, reduced health related quality of life, diaphragm dysfunction, dyspnoea and hypercapnia (Morar & van Aswegen, 2016). When physiotherapy is performed after extubation the likelihood of re-intubation is reduced (Chokshi, et al., 2013; Price & Ronan, 2014). Respiratory physiotherapy pre- and post-extubation improves pulmonary function and facilitates the removal of pulmonary secretions caused by the MV (Dogan, et al., 2022; Sangsari, et al., 2022). By removing secretions, resistance in the airways is reduced, lung mechanics and ventilation distribution are improved and pulmonary compliance is improved (Dogan, et al., 2022; Price & Ronan, 2014).

Respiratory physiotherapy is also performed to maintain adequate levels of oxygenation and re-expand collapsed lung segments (Chokshi, et al., 2013; Dogan, et al., 2022). Blasco, et al. also found positive effects on physiological parameters,

duration of oxygen therapy, radiological findings, length of hospitalisation and pulmonary compliance (Blasco, et al., 2023).

The effects of routine respiratory physiotherapy has been shown to be ineffective and may result in complications. Price and Ronan (2014), have stated that clinical practice should be based on objective signs of deterioration like worsening ventilatory parameters, radiological changes, superadded infections and secretion load. Physiotherapy should therefore, not be performed routinely, if not indicated, and is not required in infants with uncomplicated disorders like RDS and BPD with an absence of objective indicators (Price & Ronan, 2014).

2.9.2 Respiratory physiotherapy techniques

Respiratory physiotherapy treatment usually consists of a combination of techniques including positioning, percussions, vibrations, saline installation and airway suctioning (Blasco, et al., 2023; Dolgan, et al., 2022; Kotecha & Desai, 2022). Other techniques may also include lung squeezing, manual hyperinflation (MHI) and shaking. In some countries, like India and Brazil, physiotherapists are also responsible for adjusting ventilator settings and extubating the infants (Blasco, et al., 2023; Kotecha & Desai, 2022). In South Africa, physiotherapists working in ICUs have little involvement in weaning patients from MV (Morar & van Aswegen, 2016). There is, however, a lack of literature on physiotherapists' involvement in ventilator weaning in NICUs in South Africa.

Percussions are effective in mobilising secretions in the lungs by mechanically dislodging them from the airways (Kotecha & Desai, 2022). Vibrations assist in mobilising secretions from the small airways to the larger airways (Kotecha & Desai, 2022). Suctioning performed independently has shown to reduce airway resistance (Price & Ronan, 2014). Percussions and vibrations performed with suctioning have shown significant results in secretion removal and improved oxygenation (Price & Ronan, 2014).

Treatment techniques aimed at improving ventilation distribution include lung squeezing and manual expiratory chest compressions. Lung squeezing has also

shown to correct atelectasis more effectively than manual techniques (Price & Ronan, 2014; Thacker & Patel, 2014). Lung squeezing also places the infant under less physiological stress (Thacker & Patel, 2014).

Postural drainage used for secretion mobilisation and its effectiveness is poorly researched. A study done by Chokshi, et al. (2013), however, found that 67.3% of neonatal physiotherapists in India still use postural drainage for mobilising secretions. By placing the infants in specific positions can have positive effects on ventilation distribution (Dogan, et al., 2022). Prone positioning has been found to improve respiratory function and improve oxygenation (Dogan, et al., 2022). Positioning can also assist optimal positioning of the infants, limit uncontrolled movements and encourage more stable vital signs and physiological stability (Chokshi, et al., 2013). Correct and regular position changes also prevent postural plagiocephaly (Dogan, et al., 2022).

Manual hyperinflation and postural drainage positions with a head-down tilt have been associated with severe complications (Price & Ronan, 2014).

Santos, et al. (2019), stated that the recognition of the characteristics of respiratory alterations in infants lead to the most effective and appropriate physiotherapy treatment which may prevent progression of more severe pulmonary complications (Santos, et al., 2019).

2.9.3 Complications associated with respiratory physiotherapy

Respiratory physiotherapy has many advantages but can also cause harm if not performed correctly (Thacker & Patel, 2014). It has been associated with neurological complications including encephaloclastic porencephaly (ECPE), concussion and IVH (Dogan, et al., 2022; Price & Ronan, 2014). These complications can result in severe neurological sequalae and disability (Price & Ronan, 2014).

The incorrect performance of manual techniques also predisposes the infants to metabolic bone diseases and rib fractures. Cardiovascular instability is associated with suctioning, with open suctioning causing more instability and longer recovery times

compared to closed suctioning. Infants weighing less than 1000g have shown to be affected the most. Signs of instability following suctioning include transient desaturations, bradycardias and hypoxia (Price & Ronan, 2014; Thacker & Patel, 2014).

Price & Ronan (2014), states that MHI is now considered a contraindication for premature infants as it poses a risk of barotrauma and pneumothoraces and have detrimental effects on cerebral blood flow. Premature infants have little protection against over-extension due to their high chest wall compliance and low elastic and collagen content in their lungs. Premature infants with RDS have an increased risk of chronic lung disease (CLD) due to surfactant deficiency and infants with more compliant lungs have an increased risk of pneumothoraces when MHI is performed (Price & Ronan, 2014).

Postural drainage positions with a head-down tilt is also considered unsafe in this population as the infants are unable to regulate cerebral blood flow which results to their intracranial pressure increasing which can lead to IVH (Price & Ronan, 2014).

These complications have been associated with poor technique including vigorous percussions, long durations of treatment sessions, physiological fluctuations during the treatment sessions and treatment performed within the first 24 hours of life (Blasco, et al., 2023; Dolgan, et al., 2022; Price & Ronan, 2014). Adequate training of physiotherapists and knowledge of the potential consequences is crucial to minimise these risks (Price & Ronan, 2014). Routine respiratory physiotherapy has no positive effect on long term clinical outcomes and might only result in complications (Price & Ronan, 2014). Neonatal physiotherapists have to determine if and when which treatment will be appropriate for each infant (Price & Ronan, 2014).

2.10 Neurodevelopmental physiotherapy in NICUs

2.10.1 Indications and goals for neurodevelopmental treatment

The Canadian competency framework for physical therapists, states that neurodevelopmental physiotherapy should aim at preventing long-term consequences associated with the NICU environment, promoting the optimal organisation and

neurological development of infants and integrating parents and caregivers as team members (Milette, et al., 2017).

The neurodevelopment of infants need to be well understood in order to perform appropriate interventions to optimise development (Altimier & Phillips, 2016). The development that occurs in the third trimester of gestation will be impacted the most as the premature infant will now spend this time in a NICU instead of a protective womb (Altimier & Phillips, 2016; Griffiths, et al., 2019). As the NICU environment predisposes the infants to an excessive amount of stress, neurodevelopmental interventions should aim to recognise, reduce and manage stress triggers (Anderson, et al., 2020). When infant stress is reduced, medical stability and optimal neurodevelopment will be achieved (Anderson, et al., 2020).

Interventions should also aim to enhance general development with specific focus on sensory stimulation and motor development (Anderson, et al., 2020). Neurodevelopmental treatment focuses on promoting infant organisation and homeostasis between behavioural and physiological systems (Barbosa, 2013). Early interventions are therefore critical to enhance neurodevelopmental outcomes in preterm infants (Anderson, et al., 2020; Griffiths, et al., 2019).

2.10.2 Neurodevelopmental physiotherapy techniques

Neurodevelopmental interventions used in the NICU include massage, enhancing infant self-regulation, parent/caregiver education, kangaroo care, therapeutic handling, mobilisation exercises, orofacial stimulation and soft tissue mobilisation (Anderson, et al., 2020; Chokshi, et al., 2013; Kotecha & Desai, 2022). The WHO also includes pain management, skin protection and sleep safeguarding as interventions to optimise infant development (WHO, 2023).

In a recent review on physiotherapy and rehabilitation approaches in NICUs, positioning was found to facilitate the organisation of posture and movement by supporting musculoskeletal alignment (Dogan, et al., 2022). Through positioning, the quality of the infant's movements and spontaneous movements are facilitated (Dogan, et al., 2022). Prolonged atypical positioning is associated with torticollis, positional

plagiocephaly and reduced movement quality (Chokshi, et al., 2013). Safe and comfortable positioning of infants will promote physiological stability and neuromotor and neurosensory development (Kahraman, et al., 2018). Positioning can also be used for skin protection, to minimise painful and stressful events and to facilitate sleep (Dogan, et al., 2022; Kahraman, et al., 2018).

Dogan, et al. (2022) states in their review that massage is an effective modality for weight gain, growth and development in infants admitted to the NICU. This modality can be performed by doing passive joint movements and gentle, regular and rhythmic strokes over the skin. It was found that massage and joint mobilisation contributes to neural activity maturation processes by reducing the mismatch between uterine and extrauterine environment. Passive joint movements allowing normal range of movement are beneficial for bone development and supports bone mineral density (Dogan, et al., 2022).

Kangaroo care is also called skin-to-skin contact and is a very popular treatment approach in the NICU for parent-infant bonding and neuroprotection (Dogan, et al., 2022). It was found to be the optimal position and environment for infant DNA, epigenesis, neural networks and physiological regulations (Dogan, et al., 2022). It also supports brain plasticity and accelerates brain maturation (Dogan, et al., 2022). The oxytocin levels of the infant and parent increase during kangaroo care which results in reduced stress and effective development of infant self-regulation (Dogan, et al., 2022). Self-regulation has positive effects on oxygen saturation, respiratory rate and temperature regulation (Chokshi, et al., 2013).

Chokshi, et al. (2013), found that hydrotherapy is useful for facilitating self-regulation in a swaddled infant but is rarely used. Taping can be used to stabilise joints and prevent abnormal movements but is also only used by a small percentage of physiotherapists and little evidence is available on the effectiveness (Chokshi, et al., 2013).

All infants born preterm benefit from preventative developmental intervention. However, some infants are at higher risk and will benefit more from it. Risk factors

include, younger gestational age, high social risk families, brain injuries and lower birth weight (Anderson, et al., 2020).

2.11 Family-centred care in NICUs

2.11.1 Parental stress

Parents (including caregivers) of premature infants admitted to the NICU are likely to experience a great amount of stress, anxiety and potentially depression (Altimier & Phillips, 2016; Sharma, et al., 2018; Treyvaud, et al., 2019). The admission of an infant to the NICU can be a very traumatising experience and period for parents (Coutts, et al., 2021; Treyvaud, et al., 2019; Govindaswamy, et al., 2019). This period can be filled with guilt, anxiety, fear and uncertainty (Coutts, et al., 2021). The parents have also lost the normal experiences of childbirth as several natural processes are disrupted like the immediate bonding with their infant post birth (Govindaswamy, et al., 2019; Maree, et al., 2017; Williams, et al., 2018).

Williams, et al. (2018), reported that 15% of mothers and 8% of fathers with NICU admitted infants, experience postpartum posttraumatic stress disorder (PTSD). In addition to this, 39-63% of NICU mothers experience post-partum depression (PPD) compared to 13-19% of mothers whose infants are not admitted to NICU (Williams, et al., 2018).

The most common factors causing parental stress include the loss of the parenting role in the NICU, anxiety about their infant's medical well-being, pressure of parenting other children at home, transportation barriers, limited visiting times, financial stress and periods of separation from their infant (Treyvaud, et al., 2019; Williams, et al., 2018). This can cause the parents to feel like outsiders to their infant's healing process and influence the parent-infant relationship which could lead to attachment disorders (Govindaswamy, et al., 2019; Treyvaud, et al., 2019). Factors like maternal anxiety and depression are linked to poorer decision-making capabilities and infant care as well as poor psychological and physiological outcomes for the infant (Williams, et al., 2018).

2.11.2 Family support

According to the WHO (2023), family-centred care in NICUs result in improved health and developmental outcomes, improved family and patient experience, higher health professional satisfaction and better resource allocation (WHO, 2023). Health professionals can play an important role in reducing parental stress and improving the mental health of the parents by identifying and meeting the needs of parents in NICUs (Maree, et al., 2017; Govindaswamy, et al., 2019). It is believed that when parents are actively involved in the developmental, social, and emotional support of the infant, optimal health outcomes are achieved (Griffiths, et al., 2019; Williams, et al., 2018). Permanent parent presence in the NICU allows them to fully participate in the care of their infant, build parent confidence and be present during all procedures and therapy (Williams, et al., 2018).

Maree, et al., (2017) developed and implemented a quality improvement initiative to foster family-centred care in a NICU in South Africa. The intervention plan included various activities like early introduction of parents to their infants, involvement in caring activities and open visitation policies (Maree, et al., 2017). The study concluded that these activities benefited the infants, parents, neonatal staff and the institution (Maree, et al., 2017). It is evident that interventions that include parental participation are associated with improved parent and infant outcomes (Anderson, et al., 2020; Maree, et al., 2017).

When parents are engaged in good communication with health professionals and their cultural and ethical beliefs and traditions are considered, they can be very effective contributors to the medical decision-making and healing processes of the infant (Chokshi, et al., 2013; Treyvaud, et al., 2019). A review done by Nyaloko, et al., (2023) looked at cultural determinants in South Africa that need to be integrated into preterm infant care in NICUs. The results emphasised that parental cultural beliefs and practices significantly influence parental experiences and stress (Nyaloko, et al., 2023). It is therefore, crucial to integrate cultural practices when providing neonatal healthcare services (Nyaloko, et al., 2023). Nyaloko, et al., (2023), recommend that health professionals understand various cultural determinants to provide culturally sensitive care and provide sufficient support to parents in NICUs, especially in a culturally diverse country like South Africa (Nyaloko, et al., 2023).

Another study also emphasised the importance of staff education and respect for diversity regarding educational, geographical, cultural, racial, ethnical and spiritual backgrounds in family-centred care (Hall, et al., 2015).

Peer-to-peer support groups among NICU parents is another strategy used for parental support. As the parents are going through similar difficulties, it is easy to ask advice or talk about experiences (Treyvaud, et al., 2019). Individual psychosocial support can also be given through referral to psychologists or social workers (Chokshi, et al., 2013; Treyvaud, et al., 2019).

2.11.3 Family education

A review done by Treyvaud, et al. (2019) investigated current published guidelines on family support and family-centred care in NICUs. The review states that health professionals should encourage and allow the parents to participate in their infant's care as much as possible. This will allow them to become increasingly prepared, give them confidence when discharged from the hospital and improve the parent-infant relationship. This will help prepare them for further hands-on caregiving at home as NICU infants are more likely to have long lasting medical complications (Treyvaud, et al., 2019).

The study also found that when educating parents on relevant information such as their infant's condition, therapy and interventions used, infant development, NICU conditions and transition to home they form part of the team which will reduce their stress and increase their confidence. Parent education can be done in various ways including group discussions, general brochures, personalised brochures, verbal education, physical demonstration on the infant or videos and pictures (Treyvaud, et al., 2019).

It is evident from the large amount of literature on the topic, that family support and education in the NICU is crucial for parental mental health, improving developmental outcomes of the infant, improving the wellbeing of the infant and improving the parent-infant relationship (Chokshi, et al., 2013; Treyvaud, et al., 2019).

2.12 Multidisciplinary team in NICUs

2.12.1 Team members

The medical and technological advancements responsible for the reduction in the neonatal mortality rates have shifted the focus from only prioritising neonatal survival to reducing and treating complications associated with the NICU and prematurity (Dawood, et al., 2023). Most of the infants admitted to NICUs have more than one health or developmental impairment and require a team of health professionals to ensure holistic treatment is provided (WHO, 2023).

Barbosa (2013) highlighted the unique contribution of each MDT member in the NICU and explained the interrelationship among the members. The study splits the NICU health professionals into a medical and a developmental, also called allied health, group. The medical group consists of doctors, nurses and dieticians who are present in all NICUs and are mainly responsible for the infants' primary healthcare (Barbosa, 2013).

The allied health group consists of physiotherapists, occupational therapists, psychologists, speech and language therapists, social workers and lactation consultants (Barbosa, 2013). Availability of allied health members may be dependent on financial constraints and the hospital culture and values (Barbosa, 2013). The delivery of the required interventions are once again also dependent on adequate infrastructure, financial and human resources, effective referral and follow-up systems (WHO, 2023). Therefore, the type and availability of allied health members usually differ between NICUs and countries (Barbosa, 2013).

The allied health members require advanced skills to optimise outcomes for these vulnerable infants, while also understanding and adapting to medical procedures and challenges (Chokshi, et al., 2013; Ross, et al., 2017). However, poorly skilled MDT members can also contribute to the high neonatal mortality and morbidity rates (Dawood, et al., 2023). Dawood, et al., (2023) states that there is a paucity in the literature focusing on the quality of NICU care and the treatment performed by MDT members in South Africa.

The roles of the allied health members are to support other health professionals and family members while providing appropriate developmental and medical treatment (Barbosa, 2013). The role assignment vary between hospitals and countries based on professional training, policies and individual backgrounds (Barbosa, 2013). Professional roles may be shared by team members and may overlap at times due to cross-training among the health professions (Barbosa, 2013). Collaboration, consultation and communication between the members are required for role assignment to clarify each profession's role, prevent treatment duplication and excessive costs (Barbosa, 2013; Brady & Smith, 2015; Ross, et al., 2017).

Barbosa (2013) highlights that parents should be active team members and should always remain at the centre of decision-making and treatment processes. Ross, et al., (2017) and Barbosa, (2013), state that a collaborative MDT with shared responsibility, effective communication, appropriate referral systems and adequate skills and knowledge can significantly improve parent satisfaction and promote the best possible outcomes for infants and families.

2.12.2 Occupational therapists

Neurodevelopmental disorders and complications associated with infants admitted to NICUs form part of the occupational therapy scope of practice (Dawood, et al., 2023). Occupational therapists are therefore, seen as valuable members of the MDT (Hardy, et al., 2021). Orton, et al. (2018), states that occupational therapists have a unique role in offering support to the development of sensory processing, upper limb function and fine motor function. Ross, et al. (2017) explains that occupational therapists are the only professionals addressing components of development aimed at optimising occupational participation for premature infants. This includes upper limb functioning, head control, non-nutritive sucking and visual development (Ross, et al., 2017).

Barbosa (2013) states however, that in many hospitals, physical therapists and occupational therapists are seen as interchangeable rehabilitation professionals and that the team is often dependent on the discipline who initiated rehabilitation services in a specific unit. Some NICUs will predominantly be served by physical therapists and others will have occupational therapists as the primary rehabilitation professional. The

study outlined the potential roles of physical therapists and occupational therapists in NICUs in the USA. Most roles were the same for both professions except for two differences namely, occupational therapists do not perform chest therapy and physical therapists are not involved in parental role-occupation. The scope of occupational therapy includes providing developmental care, facilitating behavioural organisation, promoting optimal positioning, providing therapeutic interventions, facilitating oral motor skills, supporting family-centred care and being an active team member (Barbosa, 2013).

Hardy, et al., (2021) discussed the role of occupational therapy in NICUs in South Africa as infant-orientated, family-orientated and therapist-orientated. Infant-orientated treatment includes splinting, environmental modulation and positioning. Family-orientated treatment focuses on family-centred care, parent education and parental role fulfillment. The therapist-orientated role focuses on the therapist's well-being like preventing burnout. Other roles include discharge planning, neonatal assessments, and matching the infants' capabilities with their surrounding environment. The study found that many occupational therapists feel incompetent in delivering this specialised treatment, which may be due to a lack of training or lack of experience. Newly qualified occupational therapists are required to treat in high-care settings, like NICUs, in public sectors, despite having limited NICU training. The study also found that there might be a lack of undergraduate training on NICU care and a lack of literature on the specific role and scope of occupational therapy in NICUs in South Africa (Hardy, et al., 2021).

2.12.3 Speech and language therapists

Infants admitted to the NICU often have oral motor difficulties due to neurological vulnerability, medical interventions, comorbidities and anatomical anomalies. Speech and language therapists therefore form part of the MDT to detect and treat possible complications.

Barbosa (2013) outlined the roles of speech and language therapists as providing developmental care, facilitating behavioural organisation, promoting optimal positioning, sensory intervention and handling, facilitating oral motor skills, supporting family-centred care and being an active team member. They are primarily responsible

for ensuring safe feeding practices which includes evaluating the readiness for oral feeds, assessing oral reflexes and movements, and assessing oral abilities (Orton, et al., 2018; Ross, et al., 2017). They should also determine whether oral feeding will be safe and sustainable after discharge from the NICU (South African Speech-Hearing-Language Association, 2011).

The South African Speech-Hearing-Language Association (2011), states that speech and language therapists require specialised skills to appropriately evaluate infants' swallowing, feeding and communication. This is needed for educating other team members and counselling of the family (South African Speech-Hearing-Language Association, 2011).

2.12.4 Psychologists and social workers

It is evident in the literature that parental stress, anxiety and depression are very common in NICUs (Williams, et al., 2018). Parents with NICU admitted infants experience a range of emotions and have changing needs during the NICU period (Barbosa, 2013). These psychological factors have severe influences on how the parents cope with the events which are different to their expectations (Barbosa, 2013). It also affects how they adapt to changing parental roles and how they establish a bond with their infant (Barbosa, 2013). This emphasises the importance of psychologists in the MDT in NICUs and the unique role they have in providing psycho-emotional support to parents (Barbosa, 2013).

Psychologists are qualified to work with families in crisis times and can provide very valuable non-medical support to parents during this stressful and uncertain time (Barbosa, 2013). The assist parents in recognising their strengths and weaknesses in establishing a parent-infant bond. They can also provide individual and group counselling to assist parents in adjusting to their new parental role and facilitate the transition to home (Barbosa, 2013).

Social workers have an important role in coordinating multiple systems to aid the needs of the family and infant. They accomplish this through evaluating the strengths and weaknesses of the family, understanding family dynamics and providing emotional

and psychological support to the family. Other roles include assisting families in accessing material resources and aiding in administrative tasks. These tasks can include applying for social grants and liaising with health insurance companies or follow-up clinics (Barbosa, 2013).

It is possible that some of the roles of psychologists and social workers overlap in NICUs and so role assignment is crucial in each unit.

2.12.5 Doctors, nurses and dieticians

The doctors' role in the NICU is defined as being responsible for the infants' main medical care plan (Barbosa, 2013). It is also their responsibility to coordinate the services provided by the other team members. The referral of infants to other health professionals is based on laws and practice acts within each country (Khurana, et al., 2020). In South Africa, the allied health members are dependent on the doctors' referrals and are not allowed to assess or treat infants without the proper referral from the doctors (Dawood, et al., 2023). Inhibitors to appropriate referrals in South African NICUs include a lack of knowledge on the roles of allied health members and not prioritising rehabilitation in this high-risk population (Dawood, et al., 2023).

Nurses have the role of improving and maintaining neonatal and family health by assessing, planning and coordinating interventions developmentally appropriate for the infants and parents (Barbosa, 2013). They monitor the infants' medical status, assist in medicine provision and coordinate services and treatment provided from other team members (Barbosa, 2013).

In South Africa, there is a significant shortage of professionally trained intensive care nurses. As a result, some NICUs have to rely on registered nurses, experienced nurses or newly qualified nurses to provide advanced nursing care. The critical need for skilled and trained neonatal nurses in South Africa was highlighted in a review conducted by Hillermann (2022). The study explained that the leading cause of neonatal mortality is preventable and a contributing factor is the shortage of trained intensive care nurses. Improved quality of care is critical for re-establishing patient and

staff confidence and enriching healthcare in private and public hospitals (Hillermann, 2022).

Dieticians work closely with the doctors and nurses to meet the infants' growth and nutritional needs. They determine the type and volume of feeds needed by the infants for appropriate growth and development (Barbosa, 2013).

2.13 Follow-up protocol

The increased survival rates of term and preterm infants have led to an emerging need to manage complications after NICU discharge (Brachio, et al., 2020; Kang & Cho, 2021). As prematurity is associated with various developmental complications and an increased risk of developmental delay, follow-up care is essential for appropriate growth, development and management of complications (Kang & Cho, 2021). Follow-up treatment include family support, referral to other health professionals and patient advocacy (Brachio, et al., 2020; Mendelski, et al., 2022; WHO, 2023). It also allows the opportunity for early detection and treatment of developmental delay and disabilities to ensure all infants can reach their full potential (Brachio, et al., 2020; Kang & Cho, 2021; WHO, 2023).

Follow-up care should consist of an MDT to identify both medical and neurodevelopmental problems (Brachio, et al., 2020; Mendelski, et al., 2022). Motor function is the main focus of physiotherapy follow-up; however, the whole team is needed to assess and integrate all facets of development (Brachio, et al., 2020).

Orton, et al., (2018), conducted a review to discuss the role of MDT members in follow-up care of high-risk infants. The review states that physiotherapists are predominantly responsible for assessing spontaneous movement, gross motor development, muscle tone and reflexes. They are also responsible for guiding the diagnosis and management of motor impairments. Occupational therapists are responsible for supporting development and participation in activities of daily living, including play and self-care. They also focus on upper limb and fine motor functioning, sensory processing and play. The speech therapists are responsible for the development of feeding, swallowing and communication. They also advise on food transitioning and

language development. Regular assessments are needed to gain an accurate picture of an infant's complications, delay and progress (Orton, et al., 2018).

A scoping review done by Kang & Cho (2021), emphasised the importance of follow-up care for parental support. They found that parents raising infants born prematurely, have difficulties with handling and raising them and often have feelings of incompetence, anxiety and concern post discharge from the NICU. With this they experience higher parenting stress and have less parental role acquisition. Parental behaviour can affect infant growth and development and therefore follow-up care for the parents is just as essential as for the infant. Follow-up care also give support to parents who face various challenges when caring for their child after discharge from NICU. This intervention can include general care techniques as well as specific developmental or medical care for the infant (Kang & Cho, 2021).

According to the WHO (2023), there is a lack of follow-up care for high-risk infants as the follow-up systems have gaps in care and lack information and education on short- and long-term complications related to prematurity (WHO, 2023).

Poor referral and follow-up with few services available can lead to delayed diagnosis of health needs in infants after NICU discharge (Hardy, et al., 2021). In South Africa families might experience challenges to attend follow-up treatment sessions like the cost of health care, extensive travelling to clinics, inappropriateness of services, waiting periods to receive services and delayed diagnosis of complications and delays (Hardy, et al., 2021).

There is a scarcity of literature on follow-up protocols in South Africa. Sabanathan, et al. (2015), however states that LMICs have high rates of infants not reaching their developmental milestones as these countries have many factors influencing neurodevelopment (Sabanathan, et al., 2015). These factors include poverty, inadequate cognitive stimulation, malnutrition and chronic infections (Sabanathan, et al., 2015). Low maternal education and parental stress associated with low socio-economic status have also been associated with a lack of cognitive stimulation of infants (Sabanathan, et al., 2015). As parents of NICU admitted infants are likely to experience PTSD and PPD there might be reduced maternal involvement in the

infant's development and follow-up treatment (Williams, et al., 2018). It has also been shown that the prolonged parent-infant separation in the NICU can result in poor parent-infant interactions post-discharge (Sabanathan, et al., 2015). High-risk infants in LMICs like South Africa, are therefore further predisposed to developmental complications as a result of these factors (Sabanathan, et al., 2015). This highlights the importance of follow-up protocols and care for infants discharged from NICUs in South Africa.

2.14 Conclusion

A NICU is a highly specialised hospital unit where extremely fragile and ill infants receive life supporting and rehabilitative care. The medical and technological advances have improved with time which have positively affected the mortality rates of NICU admitted infants but also increased the number and severity of complications and long-term impairments associated with NICU admission and prematurity.

It is evident in the literature that physiotherapy has an important role in NICUs with the two main areas being respiratory physiotherapy and neurodevelopmental physiotherapy. There is also an important role in family and caregiver education and support with a large amount of literature supporting this.

There is currently a lack of literature on follow-up protocols for NICU graduates in South Africa. It is evident, however, that a lack of follow-up care can lead to high rates of developmental delay and neurodevelopmental complications, currently seen in LMICs like South Africa.

The role physiotherapists are currently playing in NICUs differ between countries and is dependent on the presence of competency frameworks or clinical standards developed in a country. The absence of a competency framework in South Africa and lack of literature, specific to South Africa, makes it difficult to define the role neonatal physiotherapists are currently playing in South Africa.

Chapter 3 Methodology

This chapter gives an in-depth explanation of how the study was conducted and the data analysed.

3.1 Study design

The study design was a quantitative, cross-sectional, self-administered survey.

3.2 Participants

3.2.1 Source of participants

The participants in this study were qualified physiotherapists currently working in NICUs in South Africa. The questionnaire (Appendix B) was distributed on the South African Society of Physiotherapy (SASP) email platform and social media groups on Facebook, LinkedIn and WhatsApp. Distributing the questionnaire on these specific platforms ensured that the invitation to participate reached a large number of paediatric physiotherapists. A reminder was sent out one month later.

3.2.2 Sample selection

3.2.2.1 Inclusion criteria

The inclusion criteria for participation in this study was physiotherapists currently working in NICUs in South Africa.

3.2.2.2 Exclusion criteria

Physiotherapists who previously worked in NICUs but are not currently working in NICUs.

Physiotherapists who previously worked in South Africa but are currently working in another country.

3.3 Questionnaire

A strategically structured questionnaire (Appendix B) was developed based on current evidence with input from academics in this field. The questionnaire (Appendix B) was divided into demographics, qualifications and clinical experience, MDT involvement,

physiotherapy treatment and follow-up protocol. The physiotherapy treatment was further divided into respiratory physiotherapy, neurodevelopmental physiotherapy and a collective group including support and education of family members and caregivers. The questions were formulated using relevant articles and resources. The competency framework models used in the UK and USA were used as primary references (Brady & Smith, 2015; Price & Ronan, 2014; Sweeney, et al., 2009; Sweeney, et al., 2010).

The data was collected and managed using REDCap (Research Electronic Data Capture) tools hosted at the University of the Witwatersrand. It is a secure website used for formulating and managing surveys (Harris, et al., 2009). The tool develops and deploys electronically captured data (Harris, et al., 2009).

3.4 Procedure

3.4.1 Pilot study

The pilot study examined the content validity of the questionnaire (Appendix B) and allowed the opportunity to identify technological problems before distributing the questionnaire for the main study. The questionnaire (Appendix B) was emailed to five paediatric physiotherapists who knew the objectives and aims of the study.

Three participants have clinical experience in neonatal physiotherapy. Two of the participants were in the process of completing their master's degree in paediatric physiotherapy. The other two participants were senior lecturers, one having a Doctor of Philosophy (PhD) in physiotherapy and the other being a professor in physiotherapy, with vast clinical and academic experience in neonatal physiotherapy. All five participants had experience in both respiratory and neurodevelopmental physiotherapy. The variety of experience, postgraduate education and areas of speciality allowed a variety of input into all areas of the questionnaire. It also gave an indication of how long it took to complete, as this had to be mentioned in the participation information sheet (Appendix A).

Minimal changes were made to the questionnaire based on the feedback received from the participants in the pilot study. A question asking when patients come for follow-up treatment had an option stating 'more than two weeks'. This option was

changed to ‘more than one month’. It was advised to add an introduction paragraph explaining the study and providing the ethics number at the beginning of the questionnaire. There was also a technical error present on the questionnaire link which was corrected.

3.4.2 Main study

The input from the pilot study led to a strategically structured questionnaire (Appendix B) consisting of 37 questions which took 10 minutes to complete. This questionnaire (Appendix B) was distributed on the SASP email platform and relevant social media groups. The questionnaire was distributed on the 12th of April 2023 on the SASP email platform and was available on their website until 31 May 2023. The questionnaire was distributed on the relevant social media groups on the 14th March 2023 and was redistributed again in May 2023. The study was not advertised prior to distributing the questionnaire.

There are between 180 and 220 physiotherapists registered with the SASP Paediatric Special Interest Group. It was unclear how many of these registered physiotherapists work in NICUs and how many physiotherapists are not registered to this special interest group but do work in NICUs. A sample size for the study could therefore not be accurately calculated. After two months of distributing the questionnaire, it was decided that 40 participants would supply sufficient data for the study to continue.

Data collection and analysis were done via REDCap. The results of the surveys were analysed into percentages and frequencies and presented in graphs and tables. Conclusions were formulated from the results and trends in the data were identified. These conclusions show what physiotherapists are currently doing in NICUs in South Africa and what role they are playing. Recommendations were made according to the result findings and relevant literature. The results of the study will also be published and presented at local conferences.

3.5 Ethical considerations

An application was made for ethical clearance from the Human Research Ethics Committee (Medical)(HREC) at the University of the Witwatersrand before starting the

study. An ethical clearance certificate (Appendix C) was received from the HREC giving unconditional ethical clearance (Human Research Ethics Committee (Medical) Clearance certificate number: M220814).

Full confidentiality and anonymity of the participants was maintained throughout the study. As the participants stayed anonymous, multiple participation could not be monitored. The information was only used for the purpose of the study. The information sheet stated that participation was voluntary and that by clicking on the link, the participants gave consent to participate in the study.

3.6 Data reduction

The questionnaire was developed on REDCap which allowed the data from the answered surveys to automatically be stored and saved in REDCap. The survey answers could be viewed which led to the exclusion of two surveys due to incompletion. As REDCap already presents the data of the surveys into frequencies and percentages, the data were not exported to another programme and data analysis were done from REDCap.

3.7 Statistical analyses

This study was a quantitative, cross-sectional study using descriptive statistics. Quantitative research collects and analyses data in a numerical order which allows for statistical analysis (Goertzen, 2017). It gave insight into the trends and behaviours of physiotherapists working in NICUs (Goertzen, 2017). The data was analysed using frequencies and percentages based on the results.

Table 3.1: Data analysis

Objective	Type of data collected	Analysis
Determine the demographics, qualifications and clinical experience of neonatal physiotherapists in SA.	Categorical data - Nominal data	Frequencies Percentages
Identify common conditions treated by physiotherapists in NICUs in SA.	Categorical data - Nominal data	Frequencies Percentages
Determine whether respiratory physiotherapy is practiced in NICUs in SA and to what degree.	Categorical data - Nominal data	Frequencies Percentages
Determine whether neurodevelopmental physiotherapy is practiced in NICUs in SA and to what degree.	Categorical data - Nominal data	Frequencies Percentages
Explore which physiotherapy modalities are currently being used in NICUs in SA to treat neonates.	Categorical data - Nominal data	Frequencies Percentages
Evaluate if physiotherapists treat and work with an MDT approach in NICUs in SA.	Categorical data - Nominal data	Frequencies Percentages
Determine if there are follow-up protocols in place for physiotherapy	Categorical data - Nominal data	Frequencies Percentages

treatment post-discharge from NICUs in SA.		

3.8 Data management plan

Anonymised data will be stored on an external hard drive for two years if published and six years if unpublished. Only the researcher will have access to this information which will then be destroyed.

The results of the study is presented as percentages and frequencies in the next chapter. The data is presented in graphs and tables with a descriptive paragraph above each.

Chapter 4 Results

The results of the study is presented in this chapter. The data of each question was analysed and trends were identified. This data is presented in graphs and tables.

4.1 Participation

A total of 42 participants submitted the questionnaire after two months of distribution. Of all of these, two questionnaires were not completed after indicating that the participant works in a NICU. No further questions were answered which led to the two questionnaires to be excluded from the study. The absence of further participation led to the decision that 40 participants would supply sufficient data for the study. Once data from 40 participants was obtained, data collection was discontinued. The data from the 40 completed questionnaires were analysed. Not all the questions were answered by all 40 participants as it was dependent on the type of treatment they perform in the NICU.

4.2 Demographics

The demographic data of the participants is described in this section.

4.2.1 Gender of participants (n=40)

The gender of the participants is shown in figure 4.1. Of the 40 participants, 36 were female and four were male.

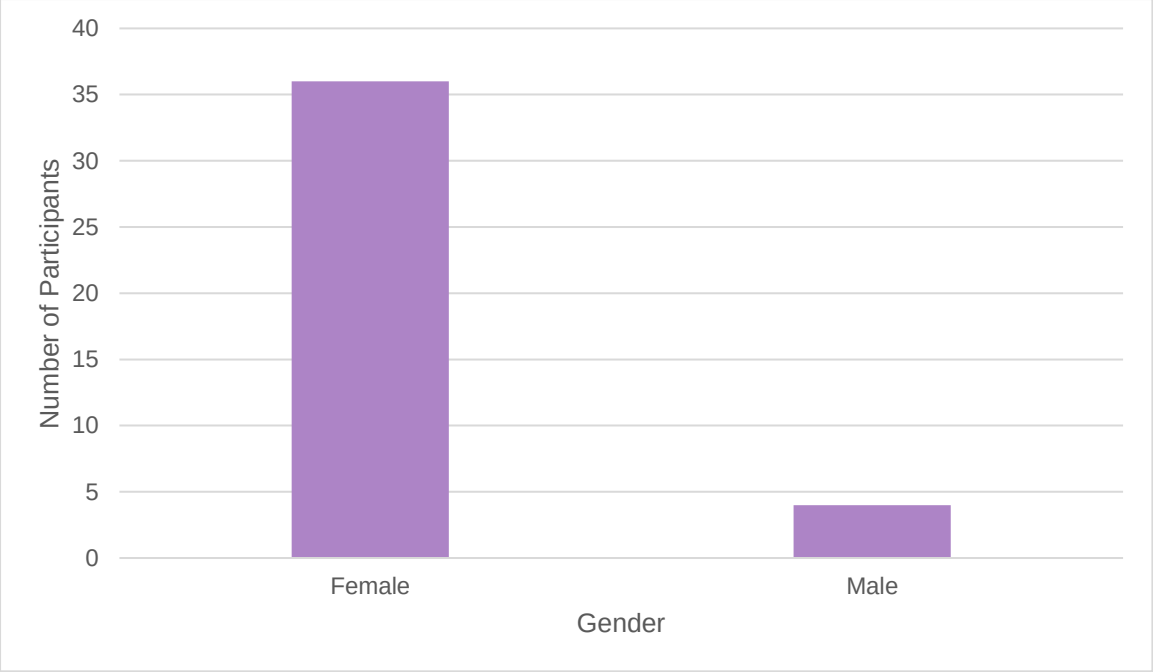

Figure 4.1: Gender of participants (n=40)

4.2.2 Age of participants (n=40)

The ages of the participants are presented in categories in figure 4.2. Half of the participants were between 31 and 40 years of age. Eleven participants were between 22 and 30 years, four participants were between 51 and 60 years, three participants were between 41 and 50 years and two participants were between 61 and 70 years.

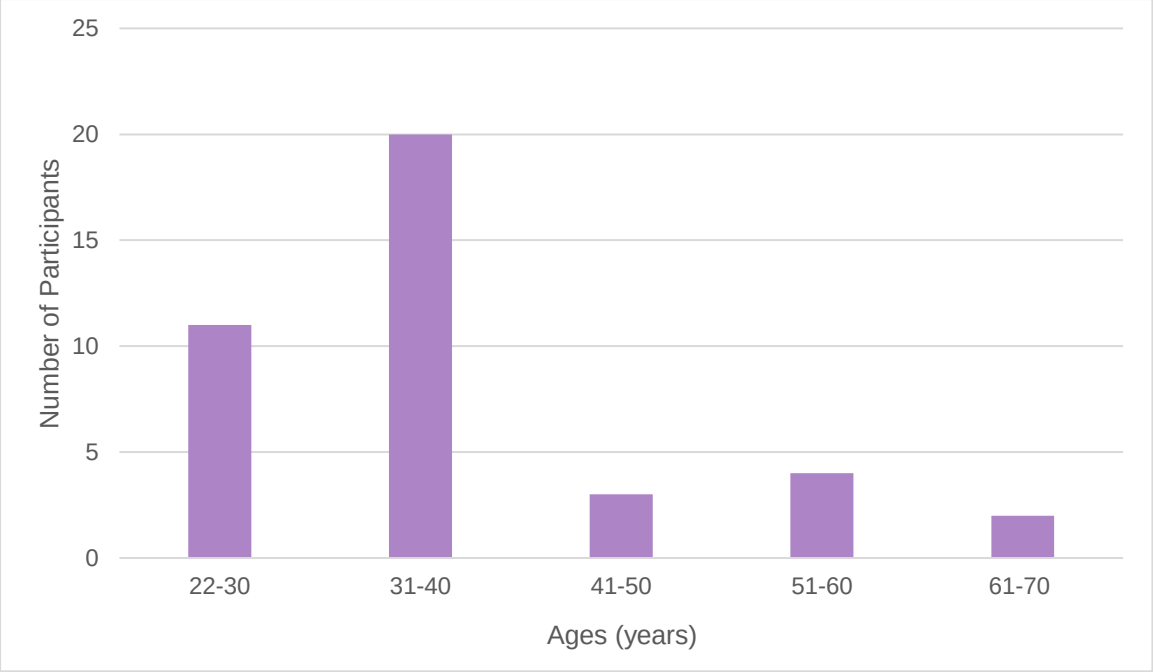

Figure 4.2: Ages of participants (n=40)

4.2.3 Geographical location of participants (n=32)

Figure 4.3 represents the geographical location of the participants. More than half of the participants were from Gauteng (n=18), seven were from the Eastern Cape, two were from the Western Cape, KwaZulu-Natal and Mpumalanga and one was from the Free State. There were no participants from Limpopo, the Northern Cape and the North West provinces.

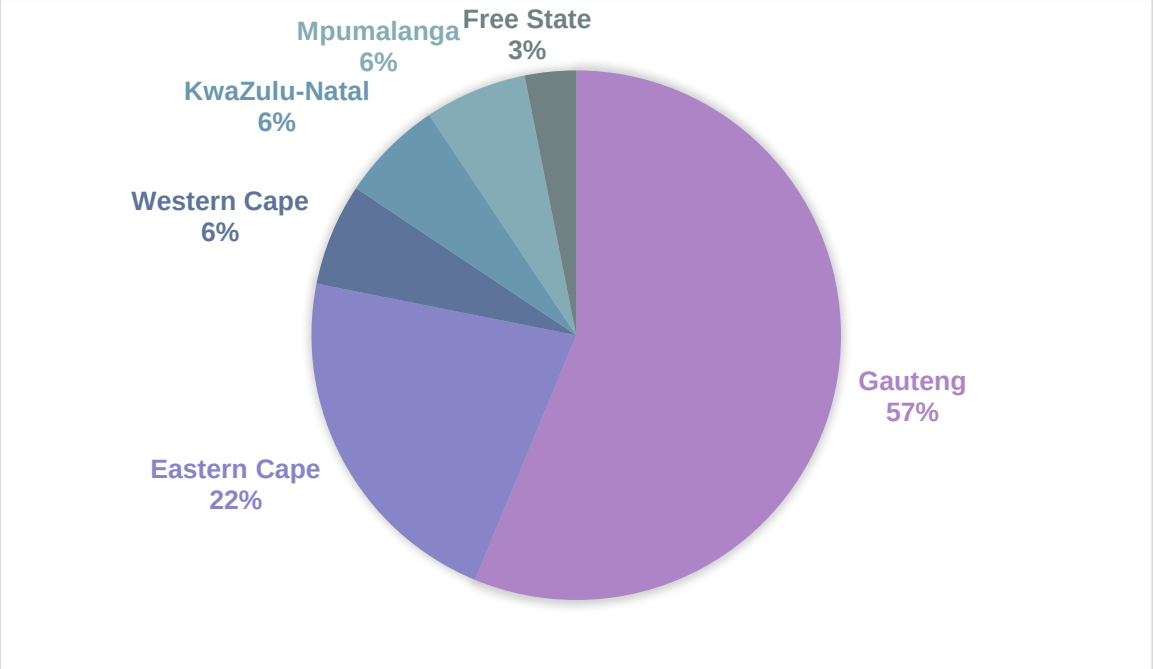

Figure 4.3: Geographical location of participants (n=32)

4.2.4 Type of hospital the participants work in (n=40)

Table 4.1 presents how many participants work in private hospitals only, public hospitals only or both in all the provinces. The data is presented as frequencies and percentages. Of all the participants, 60% work in private hospitals only with half located in Gauteng.

Table 4.1: Type of hospitals in each province (n=40)

	Private Hospital		**Public Hospital**		**Both**	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Gauteng	12	30%	1	2.5%	5	12.5%
Western Cape	2	5%	0	0%	0	0%
Eastern Cape	0	0%	5	12.5%	2	5%
Free State	0	0%	1	2.5%	0	0%
KwaZulu-Natal	2	5%	0	0%	0	0%
Mpumalanga	2	5%	0	0%	0	0%
Province not indicated	6	15%	1	2.5%	1	2.5%
TOTAL	**24**	**60%**	**8**	**20%**	**8**	**20%**

4.2.5 Level of tertiary education (n=39)

In figure 4.4 it is evidenced that most of the participants' highest level of education is a Bachelor of Science (BSc) in Physiotherapy (n=27). Nine participants have a Master of Science (MSc) in Physiotherapy and three have a PhD in Physiotherapy.

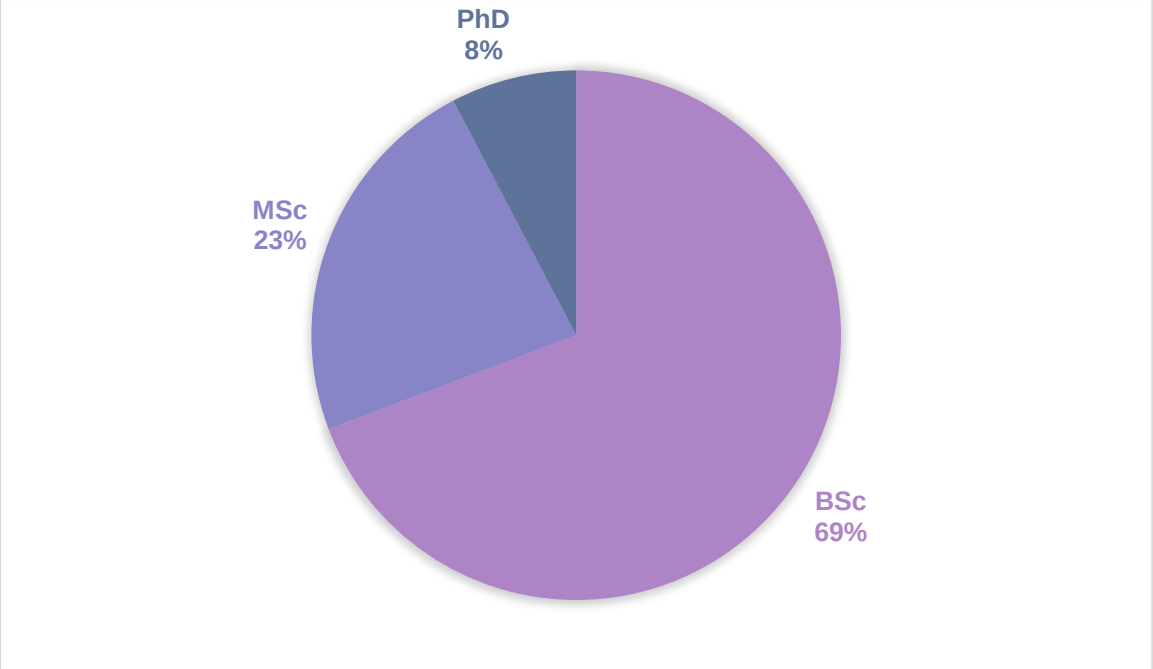

Figure 4.4: Tertiary education of participants (n=39)

4.2.6 Postgraduate education specific to neonates (n=39)

The participants' postgraduate education in terms of neonates are outlined in table 4.2. The data is presented as frequencies and percentages. In-service training with experienced physiotherapists had the highest frequency. In terms of post-graduate courses, it is evident that neurodevelopmental courses are preferred over respiratory courses. The eight participants who have not received in-service training have all attended postgraduate courses.

Table 4.2: Postgraduate education specific to neonates (n=39)

Postgraduate Courses/Education	Frequency (n)	Percentage (%)
In-service Training with Experienced Physiotherapists	31	79.5%
Prechtl General Movement Assessment Basic	17	43.6%
Prechtl General Movement Assessment Advanced	7	17.9%
Hammersmith Infant Neurological Examination (HINE)	9	23.1%
Neurodevelopmental Treatment (NDT) Introduction	15	38.5%
Neurodevelopmental Treatment (NDT) Basic	15	38.5%
Neurodevelopmental Treatment (NDT) Advanced	7	17.9%
Respiratory Neonatal Postgraduate Courses	11	18.2%
Other	11	28.2%
MAES	5	12.8%
Neonatal Touch and Massage Certification (NTMTC)	2	5.1%
Certification in Neonatal Therapy (CNT)	1	2.6%
Ithemba Neonatal Therapy Course	2	5.1%
Newborn Behavioural Observation (NBO)	1	2.6%
Certified Neonatal Therapist Qualification	1	2.6%
Bayley	1	2.6%
Test of Infant Motor Performance (TIMP)	1	2.6%

4.2.7 Years of experience (n=38)

Figure 4.5 illustrates how many years of experience the participants have in working with neonates admitted to NICUs. The majority of participants have between six and ten years or less than two years' experience. None of the participants have more than 30 years of experience.

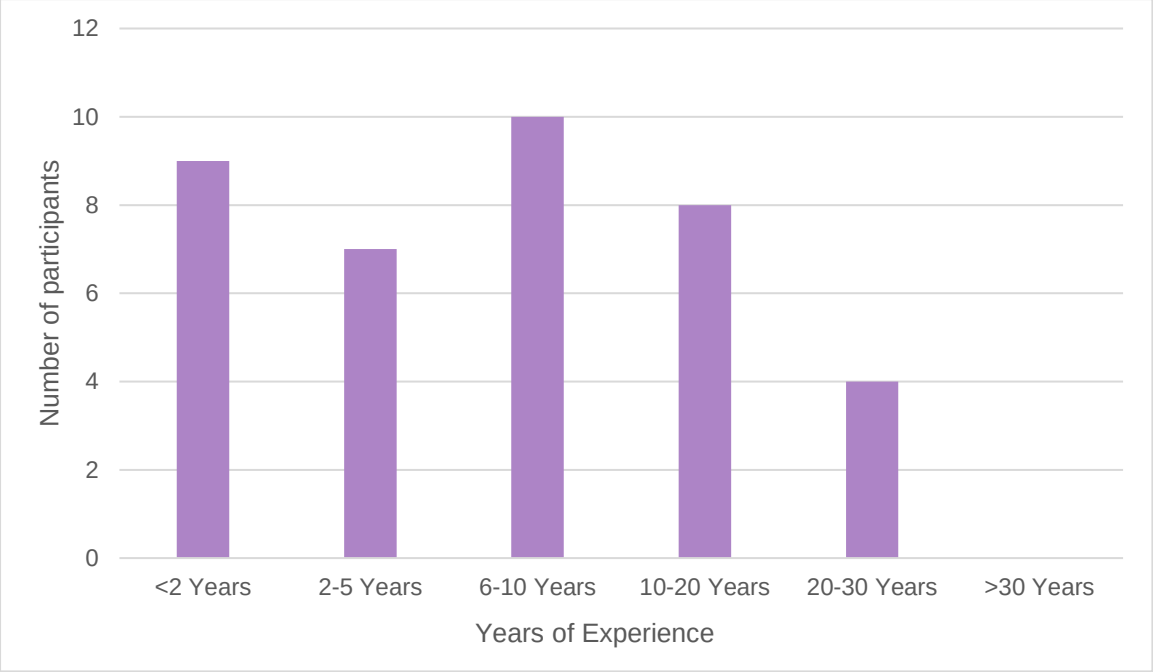

Figure 4.5: Years of experience in a NICU (n=38)

4.2.8 Areas of work (n=39)

Physiotherapy treatment in the NICU is holistic and has various areas of treatment. Table 4.3 describes how many participants work in one or more of these areas. Respiratory physiotherapy had the highest frequency. Of the 29 participants performing respiratory physiotherapy, 17 (58.6%) have not attended postgraduate training in neonatal respiratory physiotherapy. Neurodevelopmental physiotherapy had the second highest frequency with four of the 28 (14.3%) participants not having attended neonatal postgraduate training in neurodevelopmental physiotherapy. Family and caregiver education and support are only performed by half of the participants. Positioning is included in 64.1% of the participants' treatment and only 25.6% of the participants include prevention of plagiocephaly in their treatment.

Table 4.3: Areas of work (n=39)

	Frequency (n)	Percentage (%)
Respiratory	29	74.4%
Neurodevelopmental	28	71.8%
Positioning	25	64.1%
Family and caregiver education and support	20	51.3%
Prevention of plagiocephaly	10	25.6%
Do not treat but screen for post-discharge treatment	1	2.6%

4.2.9 Start of treatment (n=38)

When asked when treatment is started, 18 participants answered after doctor referral with 16 working in private hospitals and 2 working in both private and public. Eighteen participants indicated that treatment is started after doctor referral and self-screening of the patients. These participants are distributed between private hospitals (n=5), public hospitals (n=7) and both (n=6). Only 5.3% of the participants start treatment after self-screening. These results are presented in figure 4.6 as frequencies.

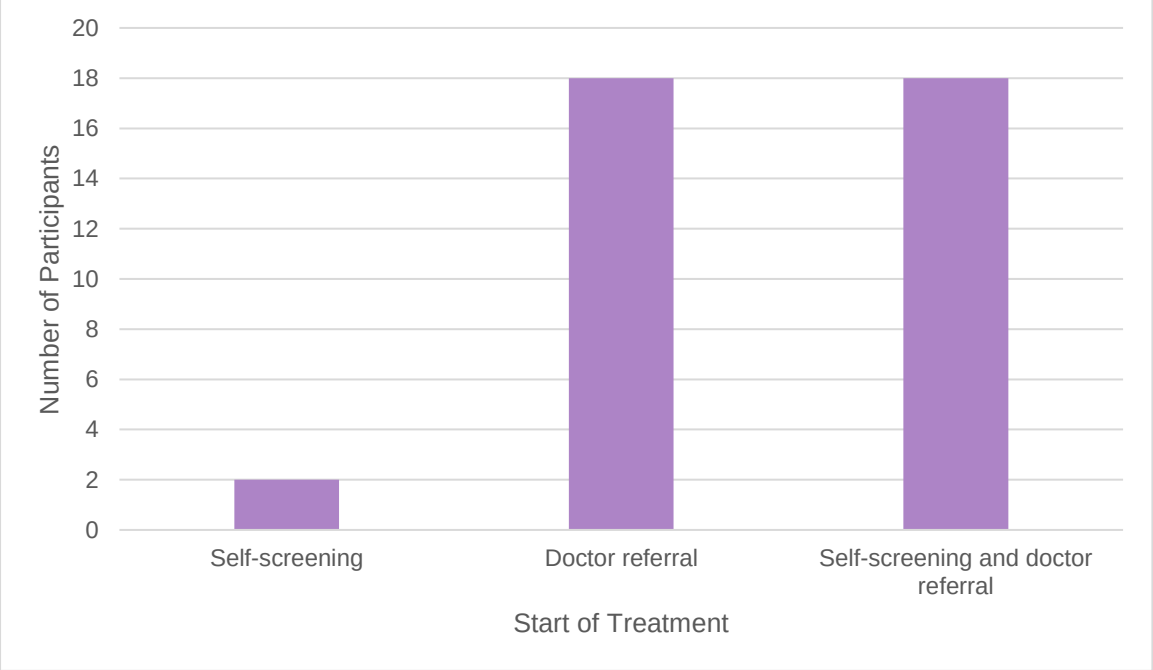

Figure 4.6: Start of treatment (n=38)

4.3 Respiratory Physiotherapy

The participants performing respiratory physiotherapy in NICUs participated in the questions in this section. Thirty-two participants answered this section on respiratory physiotherapy which differs from the 29 participants indicated in ‘4.2.8 Areas of work’.

4.3.1 Modalities used during respiratory physiotherapy (n=32)

The treatment modalities used during respiratory physiotherapy are presented in table 4.4 as frequencies and percentages. The participants use one or more modalities during treatment. Vibrations and suctioning are performed by almost all the participants. Percussions are performed by slightly fewer participants but are still used frequently. Positioning prior to treatment, pre- and post-extubation suctioning and treatment, and postural drainage without a tilt are all performed by more than half of the participants. The other treatment modalities are performed by less than half of the participants. The six participants who are involved in the extubation process are all working in public hospitals.

Table 4.4: Modalities used during respiratory physiotherapy (n=32)

	Frequency (n)	Percentage (%)
Vibrations	30	93.8%
Suctioning	30	93.8%
Percussions	25	78.1%
Positioning prior to treatment	19	59.4%
Pre-extubation suctioning and treatment	18	56.3%
Post-extubation suctioning and treatment	17	53.1%
Postural drainage without tilt	17	53.1%
Non-specific positioning to alter ventilation	16	50%
Shaking	12	37.5%
Saline installation (prior to suctioning or another time)	12	37.5%
Postural drainage with tilt	7	21.9%
Ventilator weaning	7	21.9%
Lung squeezing	6	18.8%
Participate in extubation process	6	18.8%
Manual hyperinflation	5	15.6%

4.3.2 Respiratory conditions treated (n=32)

Figure 4.7 presents the respiratory conditions most often treated in NICUs. The most common condition is consolidations (81.3%). Atelectasis and Respiratory Distress Syndrome of Prematurity (RDS) had the second highest frequency (71.9%). Meconium aspiration (59.4%) and the inability to wean off ventilators/during extubation (56.3%) are slightly less common. Pulmonary Interstitial Emphysema (PIE) (18.8%) is not commonly treated. Six other conditions were mentioned including surgical conditions leading to septic shock requiring ventilation (n=1), viruses and other infections (n=1), oxygen dependency (n=1), bronchopneumonia and bronchiolitis (n=1), post-surgery/heart surgery (n=1) and prematurity (n=1).

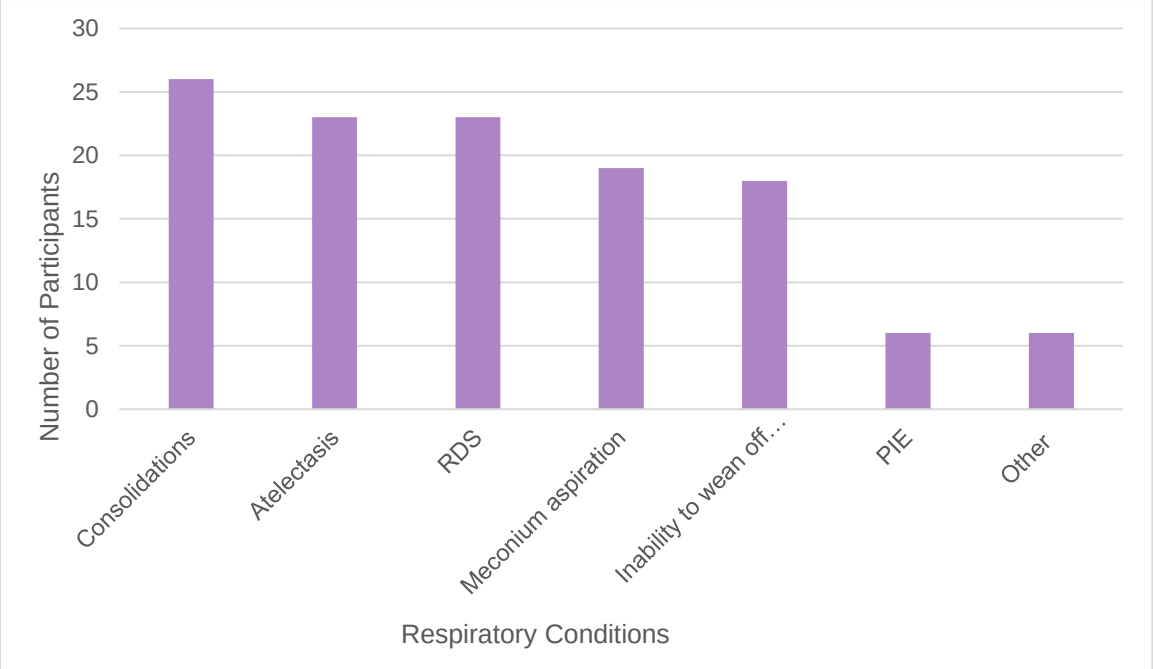

Figure 4.7: Respiratory conditions treated (n=32)

4.3.3 Tasks performed by nurses on behalf of the physiotherapist (n=32)

Nurses often perform physiotherapy duties. Figure 4.8 summarises that mostly only positioning neonates for ventilatory purposes (50%) are performed by nurses. Manual techniques performed by nurses were only indicated by 18.8% of the participants. The other 37.5% of participants indicated that the nurses do not perform any duties on their behalf.

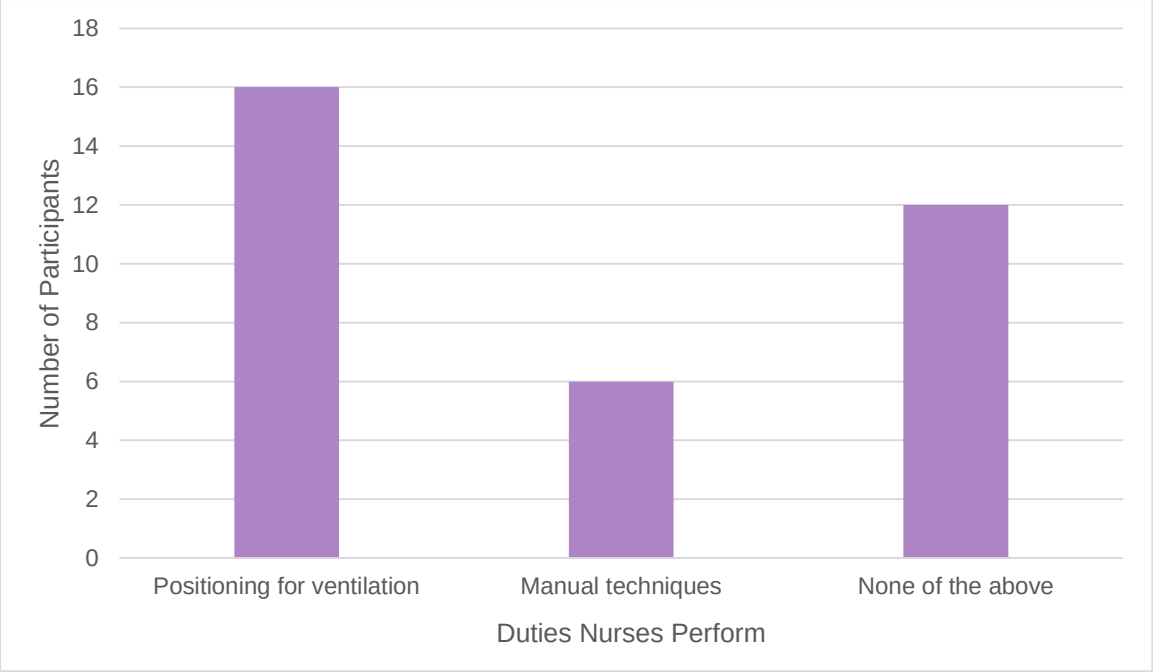

Figure 4.8: Tasks performed by nurses on behalf of physiotherapists (n=32)

4.3.4 Treatment Frequency (n=33)

The frequency of treatment is illustrated in figure 4.9. Most participants treat patients once (42.4%) or twice daily (30.3%). One participant indicated that treatment frequency is specified by the referring doctor. The remaining participants (21.2%) only treat when needed.

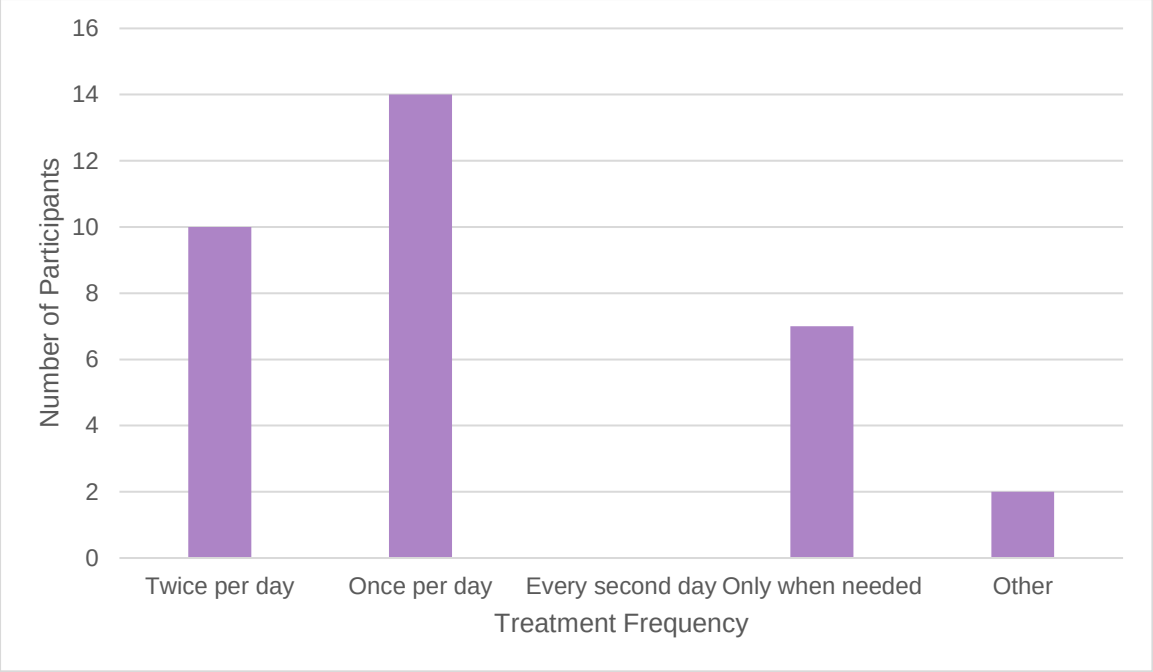

Figure 4.9: Treatment frequency of respiratory physiotherapy (n=33)

4.3.5 Treatment over weekends and public holidays (n=34)

Figure 4.10 shows that the majority of the participants perform treatment over weekends and public holidays. Of these 22 participants, 86.4% are working in private hospitals. Eight participants (23.5%) perform treatment only if necessary, and four participants (11.8%) do not perform treatment over weekends and public holidays.

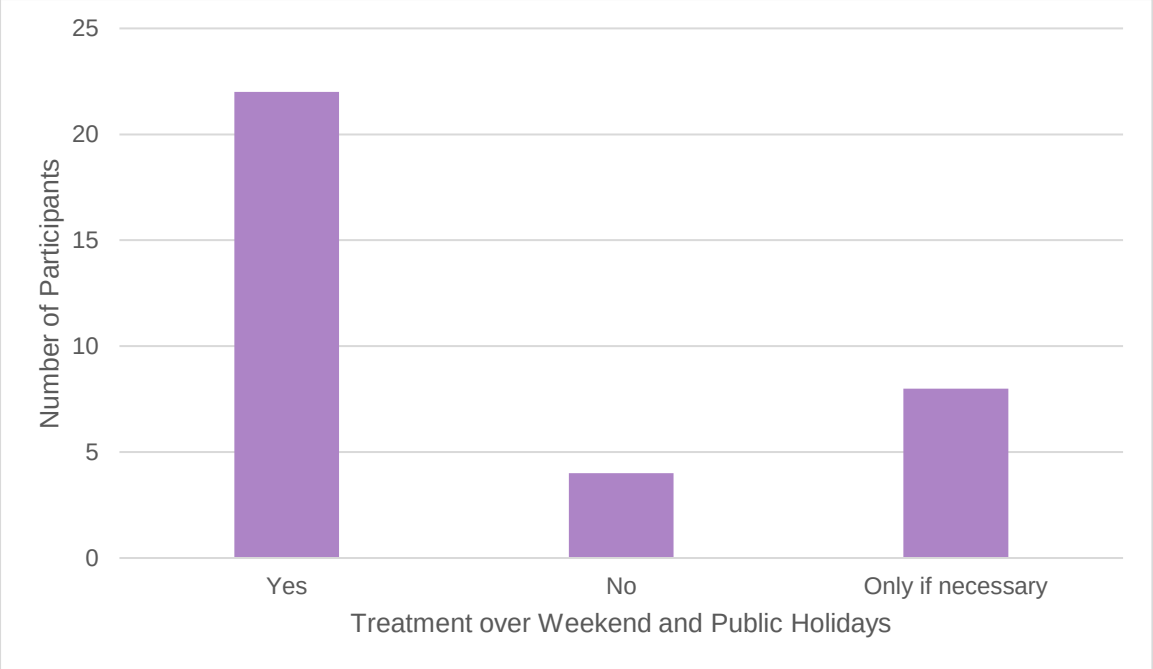

Figure 4.10: Respiratory physiotherapy over weekends and public holidays (n=34)

4.4 Neurodevelopmental Physiotherapy

The participants performing neurodevelopmental physiotherapy in the NICU participated in the questions in this section. Thirty-seven participants answered this section on neurodevelopmental physiotherapy which differs from the 28 participants indicated in '4.2.8 Areas of work'.

4.4.1 Neurodevelopmental conditions treated (n=37)

Figure 4.11 presents the neurodevelopmental conditions most often treated in the NICU. The most common conditions are prematurity (83.8%), cerebral palsy (83.8%), developmental delay (75.7%) and hypotonia (73%). Other (43.2%) conditions mentioned by the participants include 'anything' (n=1), HIE (n=2), hydrocephalus and other syndromes (n=1), genetic disorders (n=5), syndromes (n=1), abstinence syndrome (n=1), Angleman syndrome (n=1), Activity-dependent neuroprotective protein (ADNP) syndrome (n=1), vast neuromuscular conditions (n=1), congenital abnormalities like trisomy 21 (n=3), seizures (n=1) and meningitis (n=1).

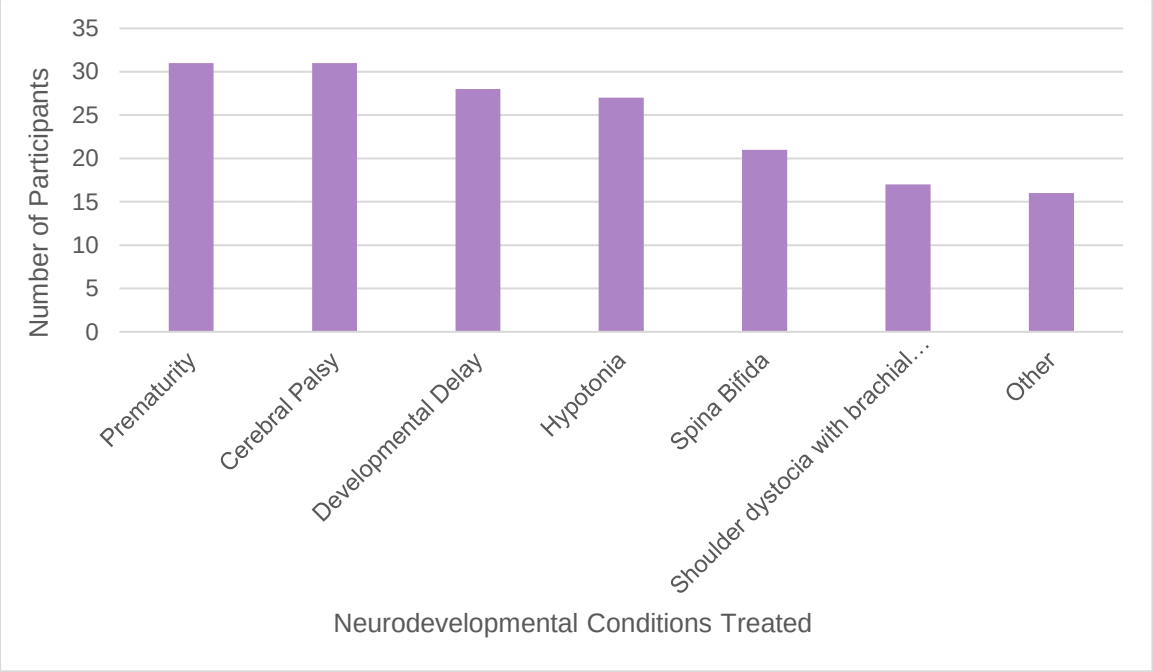

Figure 4.11: Neurodevelopmental conditions (n=37)

4.4.2 Neurodevelopmental treatment modalities (n=37)

Neurodevelopmental modalities used during treatment are presented in table 4.5 as frequencies and percentages. The most commonly performed modalities are positioning, prevention of secondary complications in musculoskeletal, neuromuscular systems and skin, gross motor development/developmental milestone facilitation, supportive care such as kangaroo care, massage and environmental alterations such as noise and light.

Table 4.5: Modalities used during neurodevelopmental physiotherapy (n=37)

	Frequency (n)	Percentage (%)
Positioning	33	89.2%
Prevention of secondary complications in musculoskeletal, neuromuscular systems and skin	32	86.5%
Gross motor development/ Developmental milestone facilitation	30	81.1%
Supportive care such as kangaroo care	23	62.2%
Massage	22	59.5%
Environmental alterations such as noise and light	20	54.1%
Interaction activities	18	48.6%
Behavioural organisation and self-regulation	17	45.9%
Sensory and perceptual development	13	35.1%
Splints and taping	12	32.4%
Assist coordination of sucking and swallowing	8	21.6%

4.4.3 Treatment frequency (n=37)

The frequency of treatment is shown in figure 4.12. Neurodevelopmental physiotherapy is mostly performed once per day (62.2%). Treatment performed only when needed (13.5%), twice daily (10.8%) or every second day (5.4%) had low frequencies. Three participants answered ‘other’ (8.1%) which were specified as once to twice per week (n=2), once per week (n=1) and per doctor request (n=1).

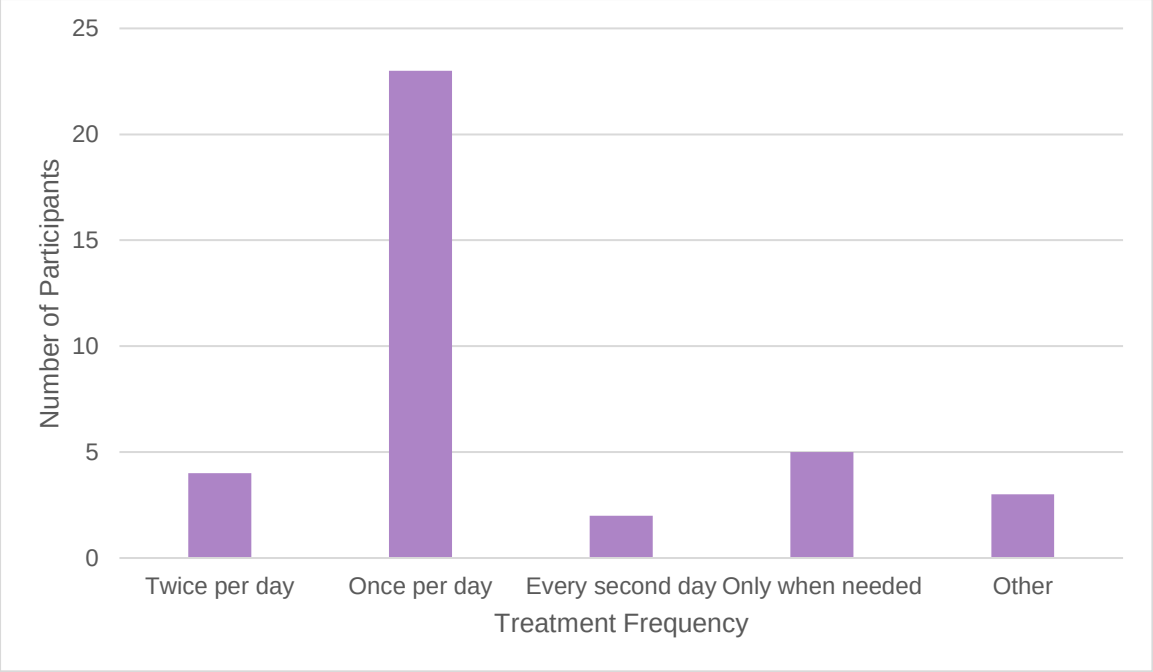

Figure 4.12: Treatment frequency of neurodevelopmental physiotherapy (n=37)

4.4.4 Treatment over weekends and public holidays (n=37)

Figure 4.13 presents treatment performance over weekends and public holidays. Fifteen participants indicated that they perform treatment over weekends and public holidays with 80% of them working in private hospitals. Fifteen participants also indicated that they perform treatment over weekends and public holidays only when needed with 60% of them working in private hospitals.

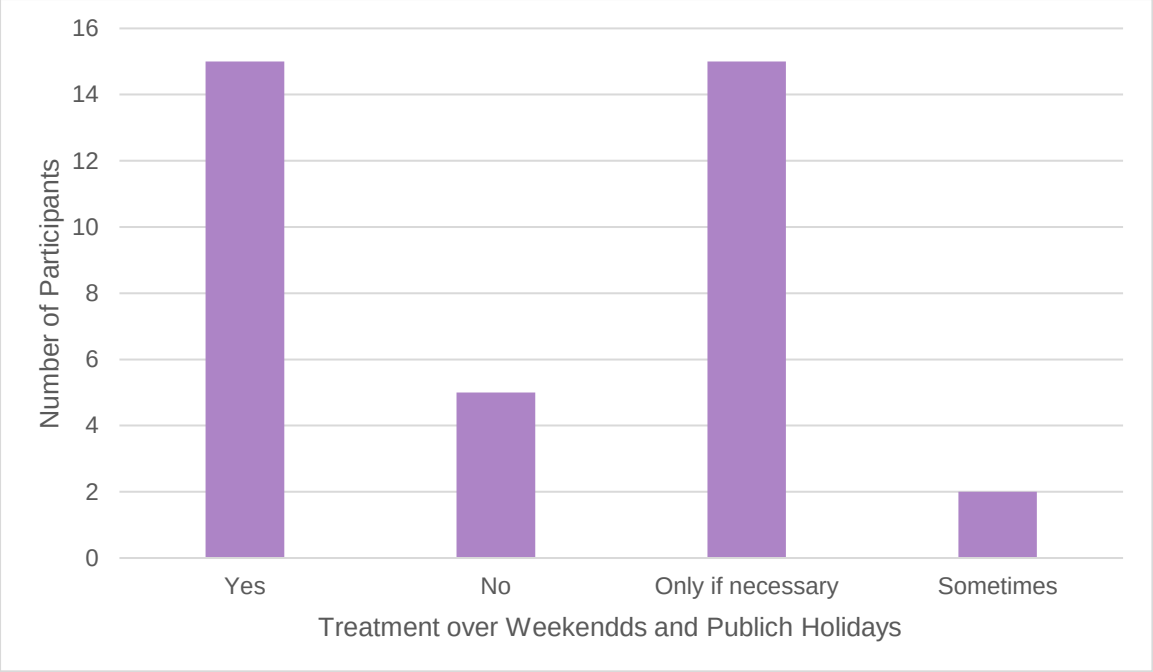

Figure 4.13: Neurodevelopmental physiotherapy done over weekends and public holidays (n=37)

4.4.5 Start of Treatment (n=36)

Physiotherapy is most often started when the patient is medically stable (80.6%) or after admission (19.4%).

4.5 Multidisciplinary team

This section outlines the presence of and participation in an MDT in NICUs.

4.5.1 Participation in an MDT (n=35)

More than half of the participants work in an MDT (54.3%) with a very small percentage (11.4%) of participants not working in an MDT. Of the 19 participants working in an MDT, 12 work in private hospitals, three work in both private and public hospitals and four work in public hospitals. The four participants who do not work in and MDT are also working in private hospitals. This is illustrated in figure 4.14.

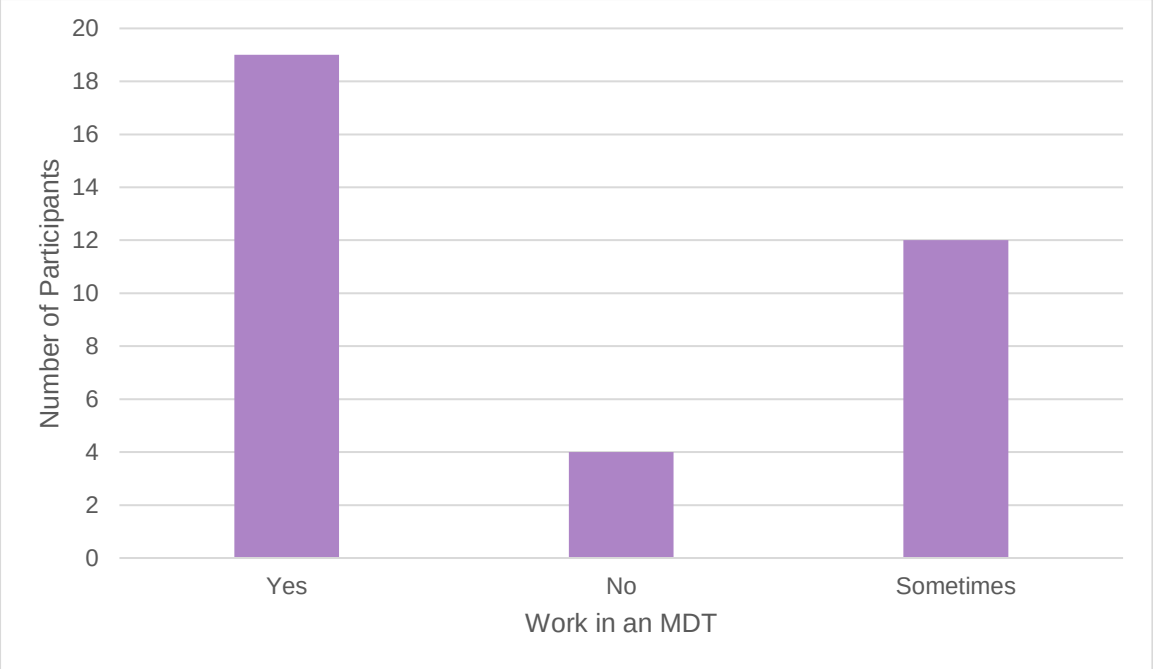

Figure 4.14: Working in an MDT (n=35)

4.5.2 Treatment performed in a team (n=35)

Most participants perform treatment as a combination of independent and combined sessions (62.9%). The other participants either perform treatment independently (34.3%) or are always part of a team (2.9%).

4.5.3 MDT members working in the NICU (n=36)

The MDT members working in the NICU are illustrated in figure 4.15. Dieticians (94.4%) have the highest frequency and Speech and Language therapists (69.4%) the second highest for working in NICUs. Audiologists (48.6%) and occupational therapists (30.6%) are less frequently working in NICUs.

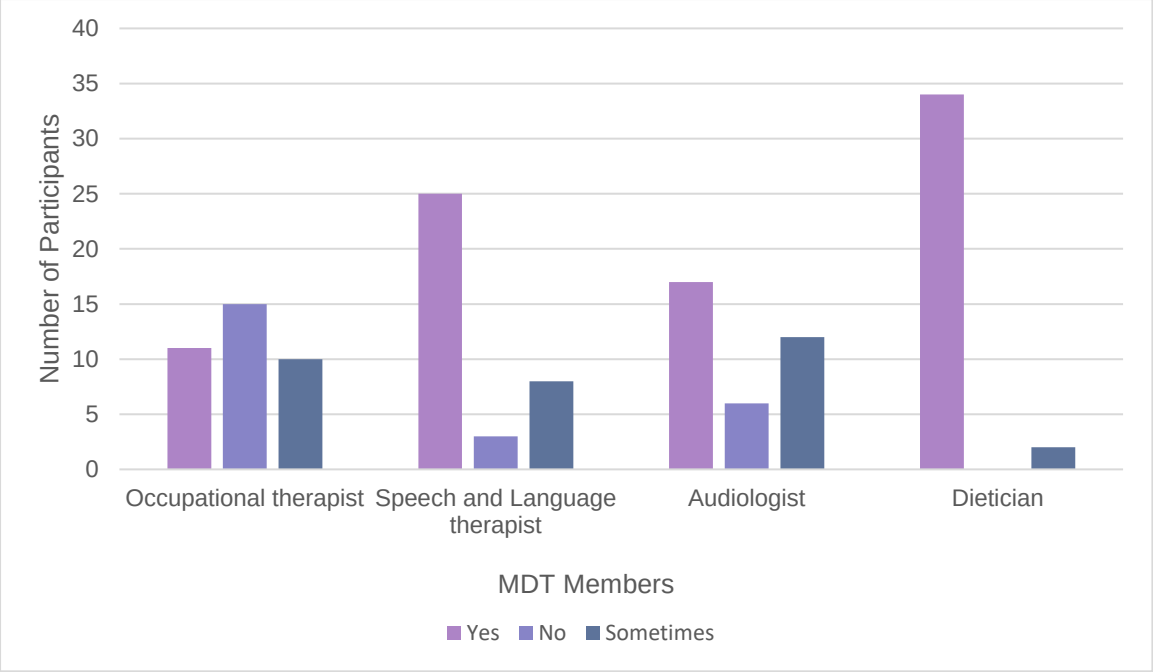

Figure 4.15: Members of the MDT (n=36)

4.5.4 Referrals to other health professionals (n=36)

Twenty-two participants refer patients. Fourteen of the 22 (63.6%) perform respiratory and neurodevelopmental physiotherapy, seven (31.8%) only perform neurodevelopmental physiotherapy and one (4.5%) only performs respiratory physiotherapy. Ten participants occasionally refer and four participants do not refer patients to other health professionals. Of the four participants not referring, three (75%) only performs respiratory physiotherapy.

4.5.5 Receiving referrals from other health professionals (n=36)

Sixteen participants receive referrals occasionally and 15 participants frequently receive referrals. Of the 15 participants, nine (60%) perform both respiratory and neurodevelopmental physiotherapy and five (33.3%) only perform neurodevelopmental physiotherapy. Five participants do not receive referrals with four (80%) of them only performing respiratory physiotherapy.

4.5.6 Treatment performed with nurses (n=36)

Most of the participants occasionally treat patients with nurses. Sixteen participants always treat with nurses with 10 (62.5%) of them working in private hospitals.

4.5.7 Support and education to family members and caregivers (n=37)

Figure 4.16 illustrates that support and education to family members and caregivers are performed by most of the participants (91.9%).

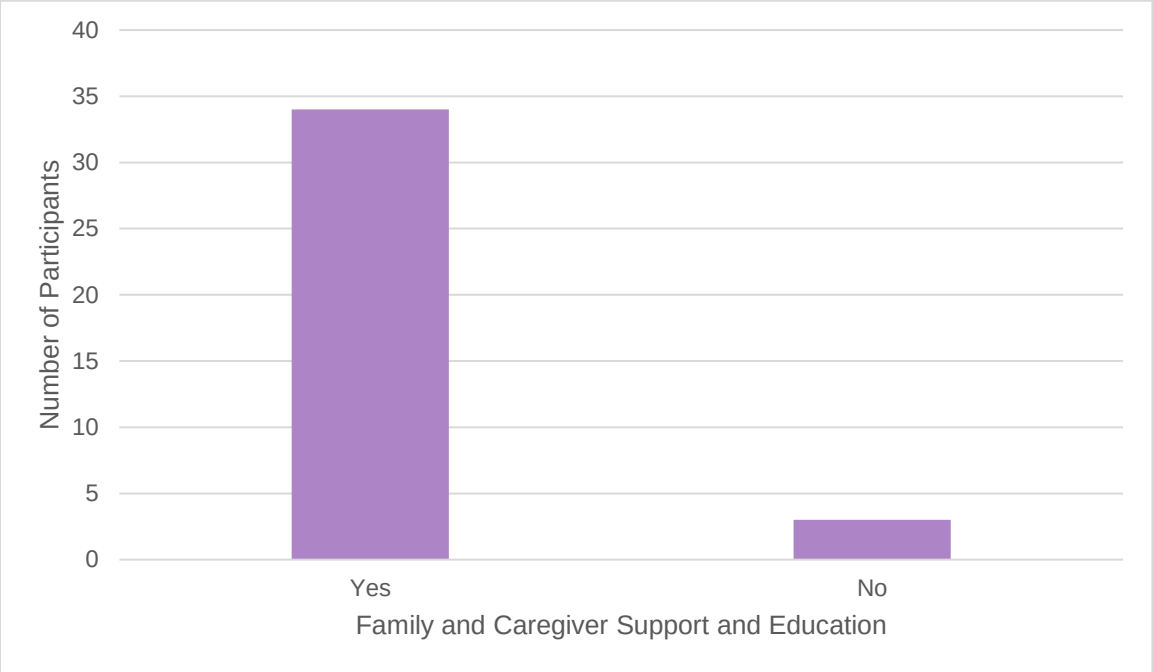

Figure 4.16: Family and caregiver support and eduction (n=37)

4.5.8 Time of family and caregiver support and education (n=36)

Support and education to family members and caregivers are most frequently performed when the patient is in the unit (77.8%). It is seldom performed as preparation for discharge (16.7%) or only on request from the family or caregivers (5.6%). These results are presented in figure 4.17.

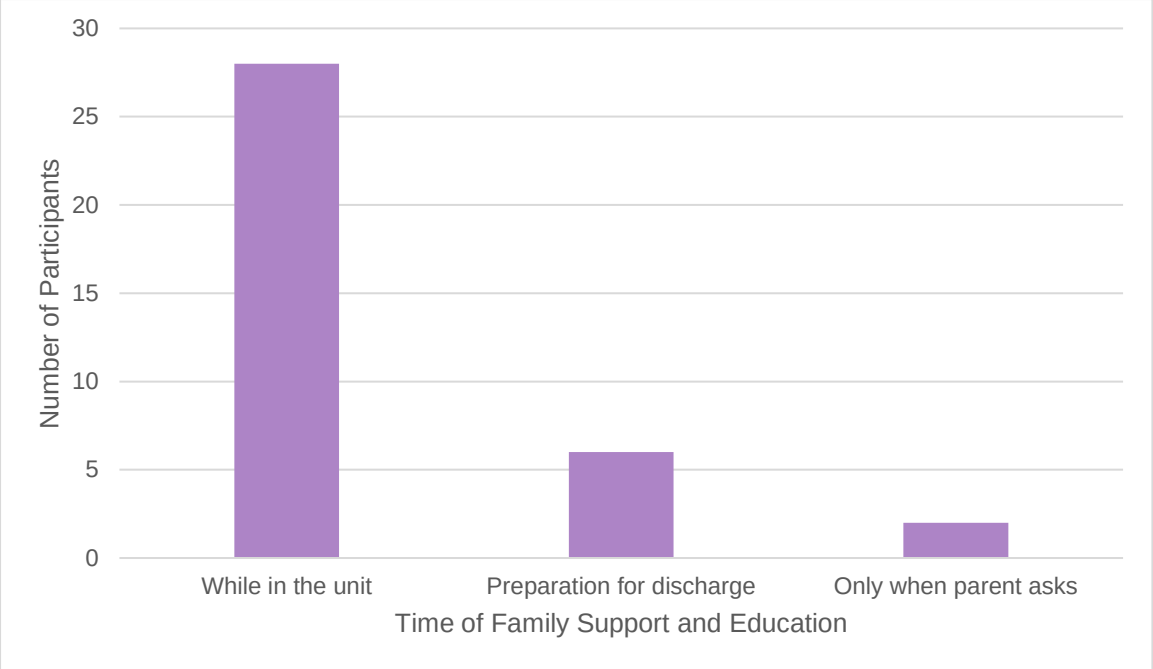

Figure 4.17: Time of family and caregiver support and eduction (n=36)

4.5.9 Type of support and education given (n=36)

Figure 4.18 compares the type of support and education given to family members and caregivers. It includes physical demonstration on the patient (88.9%), verbal communication (86.1%), videos and pictures (27.8%), general brochures (27.8%) and personalised brochures (25%).

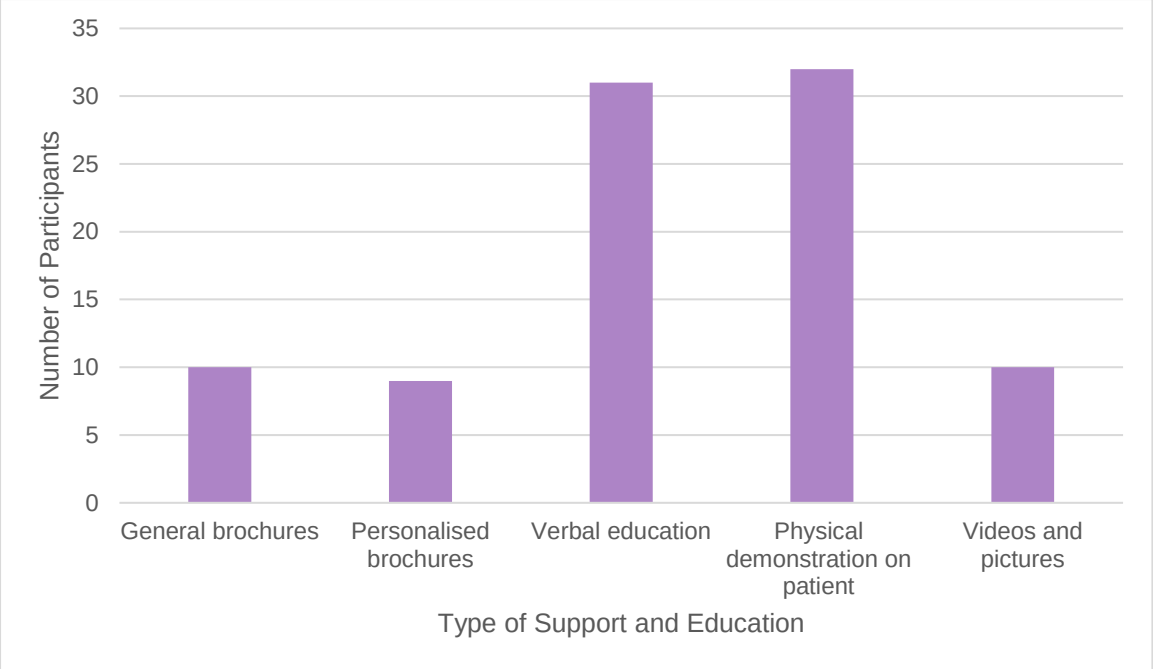

Figure 4.18: Type of support and education given to family and caregivers (n=36)

4.6 Follow-up protocols

Follow-up treatment of neonates post-discharge is essential to optimise long-term outcomes (Kang & Cho, 2021). This section reports on the follow-up protocols.

4.6.1 Follow-up protocol post-discharge from NICU (n=38)

Figure 4.19 shows that 24 of the participants have a follow-up protocol in place. Fourteen (58.3%) performs respiratory and neurodevelopmental physiotherapy, eight (33.3%) only perform neurodevelopmental physiotherapy and two (8.3%) participants perform respiratory physiotherapy only. Of the 24 participants with follow-up protocols, 13 (54.2%) are working in private hospitals, seven (29.2%) are working in both private and public hospitals and only four (16.7%) are working in public hospitals.

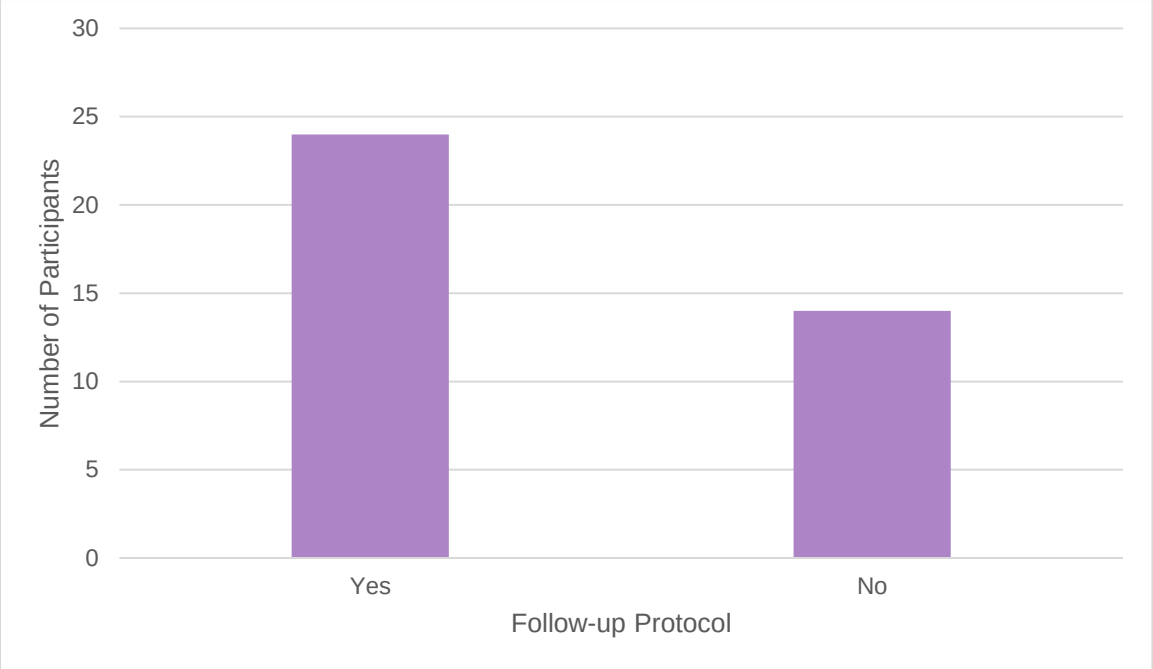

Figure 4.19: A follow-up protocol (n=38)

4.6.2 Attendance of follow-up sessions (n=24)

The attendance of patients to follow-up sessions is illustrated in figure 4.20. Occasional attendance has the highest frequency (58.3%). Definite attendance and attendance after a reminder are equal (20.8%).

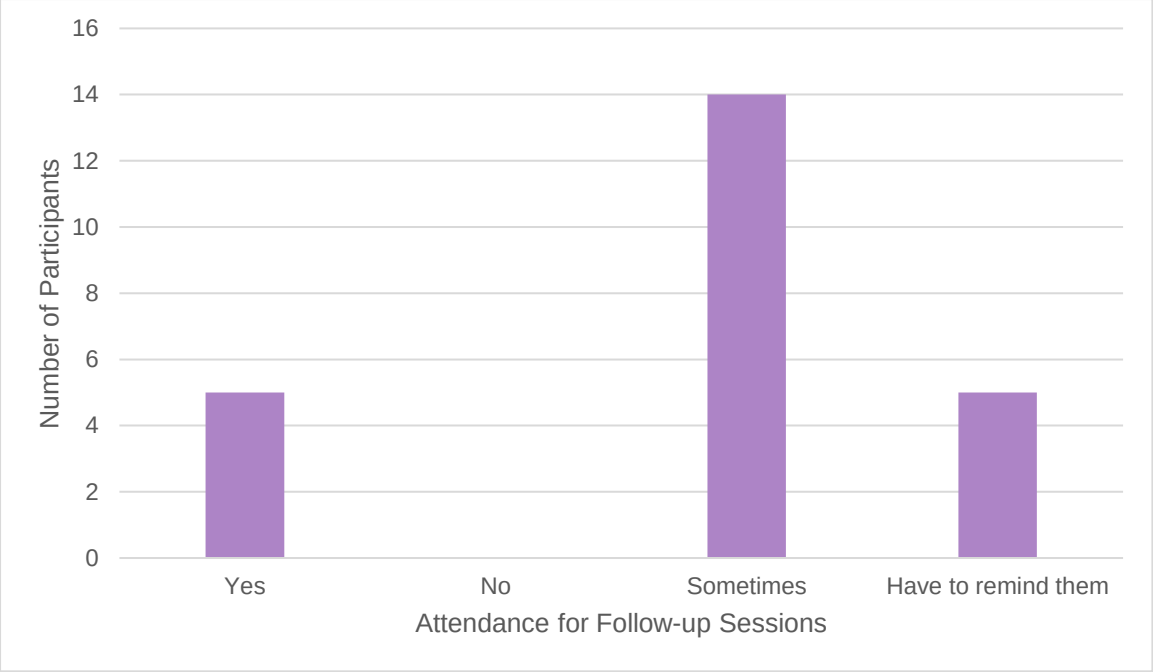

Figure 4.20: Patient attendance to follow-up sessions (n=24)

4.6.3 First follow-up session (n=24)

The first follow-up session is most frequently booked for a month after discharge (50%) or two weeks after discharge (33.3%). Appointments booked for more than a month later (20.8%) or a week after discharge (20.8%) are less frequent. Figure 4.21 compares when the first follow-up sessions are booked.

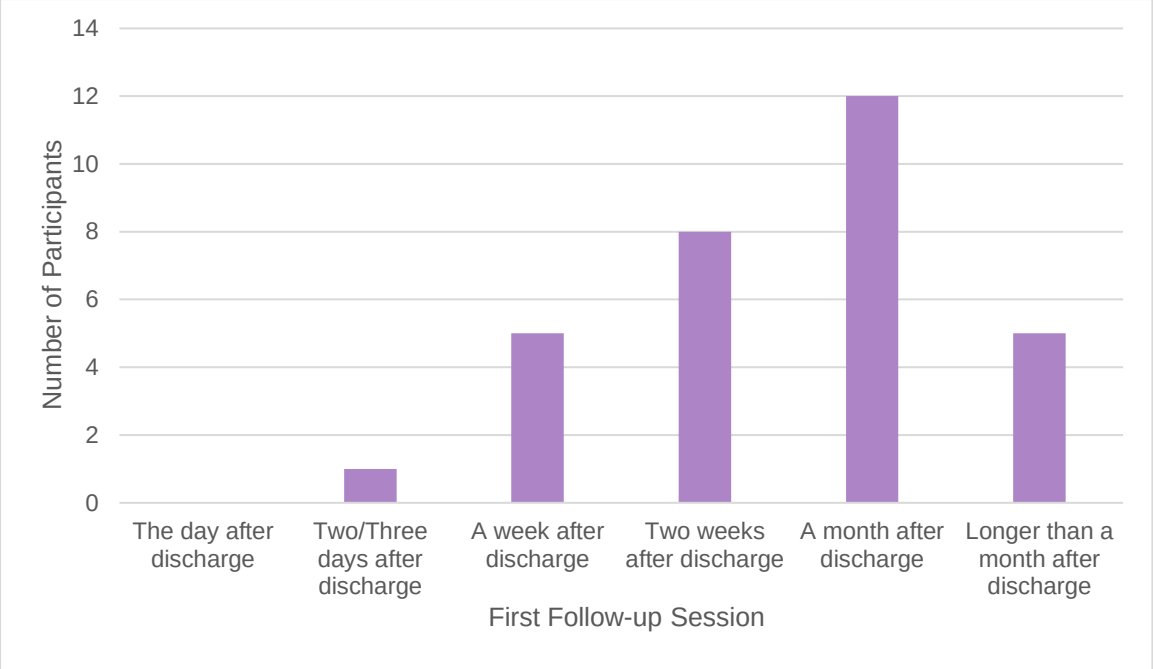

Figure 4.21: First follow-up session booked (n=24)

4.6.4 Follow-up at other practices (n=14)

Whether the patients prefer to follow-up at other practices is uncertain (64.3%). Patient follow-up at other practices is illustrated in figure 4.22.

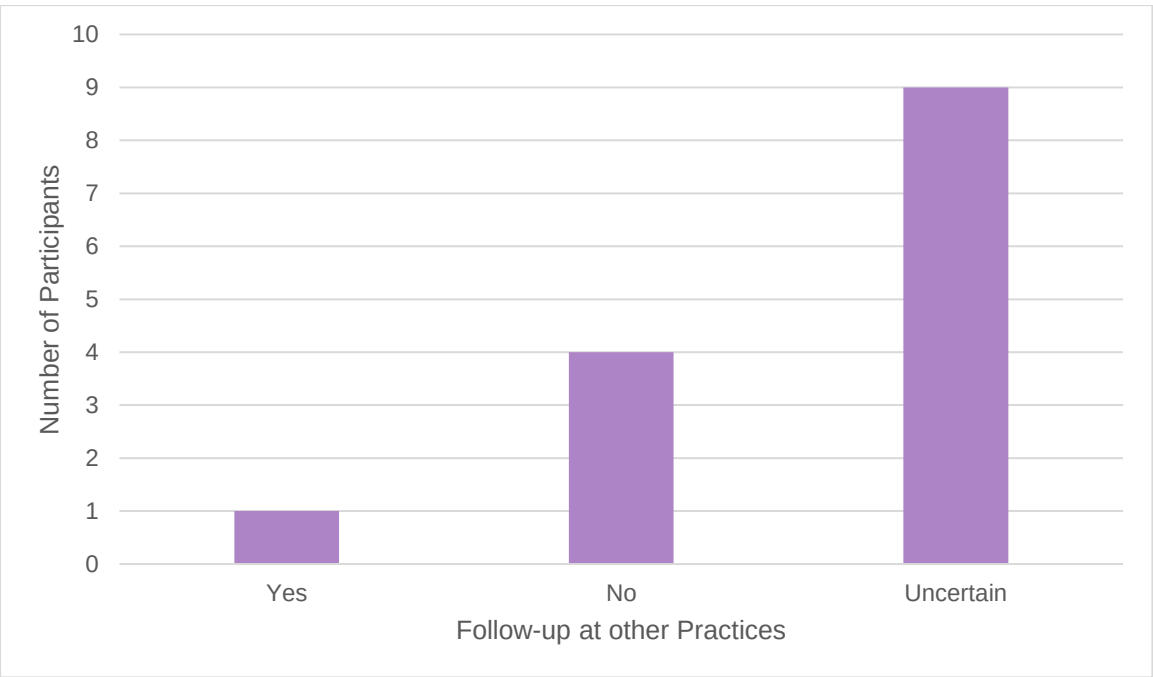

Figure 4.22: Follow-up at other practices (n=14)

This chapter described the results of the study. The results were analysed into five main groups namely, demographics including qualifications and clinical experience, respiratory physiotherapy, neurodevelopmental physiotherapy, MDT involvement including family and caregiver support and education and lastly follow-up protocols. The following chapter will critically analyse and discuss the results in an integrated discussion referring to relevant and recent literature. The implications of the study results on the understanding of the role physiotherapists are playing in NICUs in South Africa will also be discussed.

Chapter 5 Discussion

This chapter integrates the results of the study with relevant and recent evidence on the topic. The aim and objectives of the study are also discussed in terms of the study results.

5.1 Demographics

There were significantly more female participants compared to male participants (10%). World Physiotherapy, 2021 stated in their last global report that 63% of the global physiotherapy workforce are female and 60% of South Africa's physiotherapists are female. The study results were supported by the published statistics indicating more female physiotherapists compared to male physiotherapists. The slight discrepancy between the percentages of female physiotherapists does however, indicate more female preference for neonatal physiotherapy. The ages of the participants were spread across the age categories; with more than half of the participants between the ages of 31 and 40 years of age. The years of experience was relatively evenly spread among the participants. A large percentage of participants had less than two years' experience. This adds to the concern of inexperienced physiotherapists working with this fragile population and the lack of postgraduate requirements to independently work in a NICU. More than half of the participants were working in Gauteng and in private hospitals. The big discrepancy between participants working in private and public hospitals led to the inability to compare results between the two sectors.

The participants' level of tertiary education was predominantly BSc in physiotherapy. A study done by van Aswegen, et al., (2017) supports these findings and states that physiotherapy positions in ICUs, including NICUs, in South Africa are available to any qualified physiotherapist with no additional educational or experience-related requirements (van Aswegen, et al., 2017). This emphasises the importance of the undergraduate curriculum to equip physiotherapists with sufficient knowledge and skills to treat this population. Ntsiea, et al., (2017) reviewed the undergraduate curriculum of the physiotherapy department of the University of the Witwatersrand and stated that there is currently no clear or accepted model for curriculum development,

resulting in unstandardised training in South Africa (Ntsiea, et al., 2017). Similarly, in Australia and New Zealand, the necessary requirements to practice in a NICU are included in the undergraduate training, however, as a result of the content and experience-related differences between universities, their undergraduate training also remains unstandardised (Baque, et al., 2020). In contrast to this, physical therapists in the USA require two- to six-months additional training with educational, mentoring and supervised experience prior to independently practice in a NICU (Sweeney, et al., 2009; Sweeney, et al., 2010). In the UK physiotherapists require an MSc degree or appropriate experience equal to an MSc degree to work in a NICU (Brady & Smith, 2015). In addition to this, both the USA and UK have developed competency frameworks to guide and ensure competence and evidence-based practice (Brady & Smith, 2015; Price & Ronan, 2014; Sweeney, et al., 2009; Sweeney, et al., 2010). It is therefore, recommended that in the absence of standardised undergraduate training, competency frameworks should be developed for physiotherapists working in NICUs (Baque, et al., 2020; Lee, et al., 2022; Skinner, et al., 2016; van Aswegen, et al., 2017).

The results indicated that both respiratory physiotherapy and neurodevelopmental physiotherapy are practiced in NICUs. Comparing this to the postgraduate education of the participants, there is a discrepancy between the two areas. Respiratory physiotherapy is practiced by 74.4% of the participants but only 13% of the postgraduate courses were indicated to focus on neonatal respiratory physiotherapy. This could be as a result of a lack of neonatal respiratory courses available. Neurodevelopmental physiotherapy is practiced by 71.8% of the participants which is supported by the 79% neurodevelopmental postgraduate courses. South African physiotherapists have access to postgraduate developmental care programmes which is predominantly focused on neurodevelopment (Rheeder, et al., 2017). In-service training with experienced physiotherapists was however, included in 79.5% of the participants' postgraduate education.

5.2 Respiratory physiotherapy

The results indicated that the most commonly treated condition is lung consolidation. The literature explains that the narrow airways of the underdeveloped respiratory system are easily affected by airway secretions which increases the airway resistance

and negatively affect lung mechanics, ventilation distribution and pulmonary compliance (Blasco, et al., 2023; Dogan, et al., 2022; Price & Ronan, 2014). This can lead to atelectasis which, together with RDS, were the second most commonly treated conditions. Atelectasis can be a result of mucous plugs caused by pulmonary infiltrates, or surfactant deficiency commonly seen in premature infants (Santos, et al., 2019). The literature explains that when respiratory physiotherapy is focused on removing airway secretions and treating consolidation, immediate improvements can be seen on lung mechanics, ventilation distribution, pulmonary compliance and airway resistance (Dogan, et al., 2022; Price & Ronan, 2014). Respiratory physiotherapy also assists in maintaining adequate oxygenation and re-expanding collapsed lung segments, effectively treating atelectasis (Chokshi, et al., 2013; Dogan, et al., 2022).

Respiratory distress syndrome is described in the literature as a common complication in premature infants as a result of surfactant deficiency (Blasco, et al., 2023; Hermansen & Mahajan, 2015). Price & Ronan (2014) explains that physiotherapy treatment should be based on clear objective measures indicating deterioration, like increased secretion load, worsening ventilatory parameters or radiological changes (Price & Ronan, 2014). Uncomplicated RDS, therefore, does not require respiratory physiotherapy treatment. The questionnaire did however, not give the option to choose between complicated and uncomplicated RDS. It is uncertain how many of the 71.9% of the participants, who indicated that they treat RDS, were actually treating complicated RDS.

Meconium aspiration was treated by 59.4% of respondents and the inability to wean infants off MV was reported by 56.3% of the participants. This is supported by current literature explaining that consolidations, RDS and meconium aspiration can result in the need to mechanically ventilate infants (Santos, et al., 2019). Treating these conditions early could therefore prevent the need for MV.

The literature explains that MV increases the risk for secondary infections which can delay the weaning process (Ahmed, et al., 2023; Santos, et al., 2019). Performing respiratory physiotherapy on mechanically ventilated infants is therefore essential to improve pulmonary function and facilitate the removal of pulmonary secretions caused

by the MV to facilitate the weaning process (Dogan, et al., 2022; Sangsari, et al., 2022).

Respiratory treatment has been described by the literature to consist of a combination of treatment modalities which should be individualised based on appropriateness (Blasco, et al., 2023; Dolgan, et al., 2022; Kotecha & Desai, 2022; Price & Ronan, 2014). The most popular techniques used by the participants were vibrations, suctioning and percussions. These techniques are effective in loosening, mobilising and clearing secretions in the airways and improving oxygenation (Kotecha & Desai, 2022).

Mechanical ventilation should be weaned as early as possible as it is associated with several complications (Price & Ronan, 2014; Sangsari, et al., 2022). The literature states that physiotherapy performed before and after extubation, improves pulmonary function and facilitates the removal of secretions caused by the MV (Dogan, et al., 2022; Sangsari, et al., 2022). The results showed that more than half of the participants perform suctioning and treatment before and after extubation, supporting the evidence.

Postural drainage is poorly researched for its effectiveness in secretion mobilisation and is considered unsafe when performed with a head-down tilt (Price & Ronan, 2014). The results were in accordance with the literature as very few participants use postural drainage with a head-down tilt. Postural drainage without a tilt, however, was reported by 53.1% of the participants. The literature states that, even though it is not considered effective in secretion mobilisation, it has positive effects on ventilation distribution which will be effective in the management of atelectasis (Chokshi, et al., 2013; Dogan, et al., 2022).

Very few participants are involved in the extubation process and responsible for ventilator weaning, which was also supported in the literature. Morar & van Aswegen (2016), state that physiotherapists working in ICUs in South Africa have little involvement in weaning ventilator settings and extubating infants (Morar & van Aswegen, 2016). This contrasts with other countries like Brazil and India where

extubations are performed by physiotherapists in accordance with the NICU protocol (Blasco, et al., 2023; Kotecha & Desai, 2022; Sharma, et al., 2018).

Lung squeezing was reported by only 18.8% of the participants. This finding contrasts with the evidence in the literature, as lung squeezing has been reported to be very effective in improving ventilation distribution in infants and was found to be less physiologically disrupting than manual techniques (Blasco, et al., 2023; Price & Ronan, 2014; Thacker & Patel, 2014).

Manual hyperinflation was reported by a minority of the participants. The competency framework developed in the UK states that MHI is considered as a contraindication in the neonatal population and is associated with severe complications like pneumothoraces and barotrauma (Price & Ronan, 2014).

There was a discrepancy between the results and the literature on treatment frequency of respiratory physiotherapy. The results indicated that most participants treat patients once or twice per day, indicating routine treatment is performed. Only a few participants treat patients ‘only when needed’. The literature states that routine physiotherapy has no positive effect on long term clinical outcomes and can lead to complications (Price & Ronan, 2014). Therefore, clinical practice should be based on objective parameters rather than routine (Price & Ronan, 2014). Routine treatment can be a result of the referral system used in South Africa. Allied health members are dependent on a doctor’s referral to treat infants in some NICUs, especially in private facilities (Dawood, et al., 2023). An equal number of participants indicated that they start treatment after referral from a doctor or after a doctor referral and self-screening. Physiotherapy treatment initiation and oftentimes, treatment frequency, is therefore dependent on the doctor’s referral and can to a great extend be influenced by a lack of knowledge on the role physiotherapists play in NICUs. Price & Ronan (2014) explain that neonatal physiotherapists should determine if and when which treatment will be appropriate for each infant, emphasising the importance of clinical reasoning in neonatal physiotherapy (Price & Ronan, 2014).

The results showed that 64.7% of the participants treat infants over weekends and public holidays and 11.8% do not. The remaining 23.5% of the participants only treat over weekends and public holidays when it is necessary.

It is evident that respiratory physiotherapy is practiced in NICUs in South Africa. There are however, a few discrepancies between the results and literature on the conditions treated and modalities used in the NICU. This highlights the importance of appropriate training and education on respiratory physiotherapy, which is currently lacking in South Africa.

5.3 Neurodevelopmental physiotherapy

The results indicated that prematurity (83.8%) is the most common condition treated, which is strongly supported by the statistics published by the WHO. The global preterm birth rates have not reduced in the last ten years and South Africa is currently rated as the country with the fourth highest prematurity rate in the world (WHO, 2023). The literature explains the strong association between prematurity and altered brain development, neurodevelopmental delay and neurological impairments (Boardman, et al., 2020; Caesar, et al., 2016). Premature birth predisposes the fragile brain and affects vital maturational processes which can result in complications in motor, cognitive, sensory, language and behavioural development (Caesar, et al., 2016; Lammertink, et al., 2021). This was evident in the results as CP, developmental delay and hypotonia were the most common neurodevelopmental conditions treated.

Positioning (89.2%) and prevention of secondary complications in the musculoskeletal system, neuromuscular system and skin (86.5%) were indicated as common neurodevelopmental treatment modalities. Evidence suggests that the immature musculoskeletal system of premature infants are influenced by their positioning (Chokshi, et al., 2013). Musculoskeletal alignment facilitates the organisation of posture and the quality of movement (Dogan, et al., 2022). Comfortable and optimal positioning of infants are explained to promote physiological stability and development, and also prevent complications like positional plagiocephaly, torticollis and reduced movement quality (Chokshi, et al., 2013; Kahraman, et al., 2018). Correct positioning

is also beneficial to facilitate sleep, minimise pain and stress during procedures and for skin protection (Dogan, et al., 2022; Kahraman, et al., 2018).

Gross motor development and facilitation of developmental milestones were also indicated by 81.1% of the participants. Anderson, et al., (2020), state that all premature infants benefit from preventative developmental intervention, however, some infants will benefit more (Anderson, et al., 2020).
The popular use of kangaroo care (62.2%) by the participants is supported by the literature as it is explained to be an effective treatment approach used for parent-infant bonding and neuroprotection (Dogan, et al., 2022). Kangaroo care is also associated with reduced stress, accelerated brain maturation and effective development of self-regulation which positively affect the physiological stability of the infant (Chokshi, et al., 2013; Dogan, et al., 2022).

Massage was indicated by only 59.5% of the participants. The results did not reflect the evidence in the literature as massage has been associated with weight gain, development and growth in NICU admitted infants (Dogan, et al., 2022). It reduces the mismatch between extrauterine and uterine environments which facilitates neural activity maturation processes (Dogan, et al., 2022).

The literature states that only a small percentage of physiotherapists use taping to stabilise joints and facilitate normal movements. There is also little evidence supporting the effectiveness of taping (Chokshi, et al., 2013). The results supported the literature as only 32.4% of the participants indicated that they use taping and splinting as treatment modalities.

Only 21.6% of the participants indicated that they assist in the coordination of sucking and swallowing. This low percentage is supported by the South African Speech-Hearing-Language Association stating that speech and language therapists are responsible for infant swallowing, feeding and communication (South African Speech-Hearing-Language Association, 2011). This is however an area that lends itself to combined multidisciplinary treatments involving physiotherapists and speech and language therapists working together as sucking and swallowing are strongly associated with postural control.

The results showed that neurodevelopmental physiotherapy is most commonly performed once per day. Neurodevelopmental treatment is therefore, like respiratory physiotherapy, performed as routine treatment as only 13.5% of the participants perform neurodevelopmental treatment 'only when needed'. The aims of neurodevelopmental treatment are, however, defined as preventing long-term consequences associated with the NICU, promoting neurological development, promoting optimal organisation and reducing infant stress (Altimier & Phillips, 2016; Anderson, et al., 2020; Griffiths, et al., 2019; Milette, et al., 2017). In order to achieve these aims, consistent and regular treatment sessions are required, supporting the study results.

The results showed that 40.5% of the participants always treat infants over weekends and public holidays. Another 40.5% only treat over weekends and public holidays when necessary. The remaining participants answered never or 'sometimes'. Given the unstable clinical picture of these neonates it is important that physiotherapy services are available at all times and not only during working hours on week days.

Neurodevelopmental treatment is initiated by 80.6% of the participants when the infants are medically stable and 19.4% of the participants when the infants are admitted to the NICU. Each infant needs to be constantly monitored and physiotherapy intervention started as soon as it is appropriate for each individual child.

The study results showed that neurodevelopmental physiotherapy is being practiced in NICUs in South Africa and it aligns with the literature on which conditions are treated and which modalities are used. As the prematurity rate in South Africa is extremely high, the complications associated with premature birth should be prevented and managed early-on, emphasising the importance of neurodevelopmental physiotherapy in NICUs in South Africa.

5.4 Multidisciplinary team

The focus of neonatal care has shifted from only prioritising the survival of the infants to also reducing and treating complications associated with the NICU and premature birth (Dawood, et al., 2023). To ensure infants admitted to NICUs receive holistic

treatment, the literature emphasises the importance of an MDT in the NICU (Barbosa, 2013; WHO, 2023). The study results, however, did not reflect this. Only half of the participants (54.3%) always work in an MDT with the remaining participants either never (11.4%) or occasionally (34.3%) participating in an MDT. Very few participants always treat patients with other team members. A combination of independent and group treatment (62.9%) was the most popular answer.

The literature states that the type and availability of MDT members vary between NICUs and countries, and are dependent on professional training, competency frameworks, policies and individual backgrounds (Barbosa, 2013). There is a lack of literature on the treatment performed by each MDT member and the quality thereof in South Africa. This can be a reason for professional roles being shared by team members and the overlapping of treatment among health professionals (Barbosa, 2013; Dawood, et al., 2023). The study results indicated that occupational therapists are the least commonly working in NICUs which is supported by the literature. Occupational therapists and physiotherapists are seen as interchangeable rehabilitation professionals and often only one of the disciplines is present in a NICU (Barbosa, 2013). Barbosa (2013) explains that the two disciplines share most of the neurodevelopmental care roles in the NICU. There are two main differences between the disciplines namely, physiotherapists are not involved in parental role-occupation and occupational therapists do not perform respiratory treatment (Barbosa, 2013). As the two disciplines have overlapping roles, communication and collaboration between the disciplines are crucial to prevent treatment duplication (Barbosa, 2013; Brady & Smith, 2015; Ross, et al., 2017).

The participants were asked to identify which MDT members are present in their NICU. Dieticians were reported by 94.4% of the participants and speech and language therapists were reported by 69.4% of the participants. Audiologists are not commonly present in NICUs. The literature supports the need and unique contribution of each MDT member in the NICU (Barbosa, 2013). The availability and type of health professionals in a NICU is, however, dependent on several factors including the effectiveness of the referral systems (Barbosa, 2013; WHO, 2023).

The study results indicated that most participants refer patients to other health professionals. Physiotherapists performing respiratory physiotherapy refer less frequently compared to physiotherapists performing neurodevelopmental treatment. The literature explains the roles of other health professionals as offering developmental support and care within the NICU (Barbosa, 2013; Orton, et al., 2018). This can explain that physiotherapists performing neurodevelopmental treatment refer more frequently to other developmental disciplines. Referrals received from other health professionals were almost equal for regular and occasional referrals. The literature explains that the development of appropriate and effective referral systems in NICUs, is dependent on effective communication between team members and knowledge of each member's roles (Barbosa, 2013; Brady & Smith, 2015; Ross, et al., 2017). There is however, a lack of literature in South Africa on the specific treatment performed by each MDT member (Dawood, et al., 2023).

Barbosa (2013) states that family members are a crucial part of the MDT and should be included in the decision-making and management of their infants. The literature also emphasises the importance of family and caregiver support and education within NICUs (Coutts, et al., 2021; Govindaswamy, et al., 2019; Treyvaud, et al., 2019). Receiving support and education in the NICU have benefits for both the parents and the infant and have been shown to improve the well-being of the infant, improve developmental outcomes of the infant and positively affect parental mental health (Chokshi, et al., 2013; Treyvaud, et al., 2019; WHO, 2023). The results reflected that family and caregiver support and education, are performed by 91.9% of the participants with most of the support and education performed during NICU admission (77.8%). As South Africa is a culturally diverse country, it is suggested that NICU care is performed in a culturally sensitive manner to provide sufficient support and effectively educate all families and caregivers (Nyaloko, et al., 2023; Treyvaud, et al., 2019). Another study emphasised the importance of knowledge and respect for geographical, educational, cultural, racial, ethnical and spiritual diversity between families (Hall, et al., 2015).

The results showed that physical demonstrations (88.9%) and verbal education (86.1%) are the most frequently used methods to support and educate families and caregivers. These methods encourage more active involvement and participation of

the parents and caregivers compared to general brochures, personalised brochures and videos and pictures. These results are supported by current published guidelines stating that parental participation should be encouraged during the NICU admission as it prepares the parents and caregivers for the transition to home and also improves parent-infant relationships (Treyvaud, et al., 2019). Family and caregiver support and education should therefore always be included in the scope of practice of neonatal physiotherapists in South Africa.

Various MDT members are present in the NICU but treatment is still mainly performed independently. Role descriptions of team members are essential for appropriate referrals and effective and holistic treatment of infants without duplication. Family and caregiver support and education are successfully performed in NICUs aligning with the literature.

5.5 Follow-up protocol

Follow-up treatment post-discharge from NICU has various benefits and has been described in the literature as an essential component of neonatal physiotherapy (Brachio, et al., 2020; Mendelski, et al., 2022; WHO, 2023). Follow-up treatment allows the early detection and treatment of various developmental complications associated with prematurity and NICU admission (Brachio, et al., 2020; Kang & Cho, 2021; WHO, 2023). The results showed that 63.2% of the participants have follow-up protocols, however, the number of participants without follow-up protocols (36.4%) is still of concern. Of the participants who have follow-up protocols, more perform neurodevelopmental physiotherapy (57.9%) compared to respiratory physiotherapy (42%). This could be caused by the idea that follow-up physiotherapy treatment should mainly focus on the diagnosis and treatment of motor function and development (Brachio, et al., 2020; Orton, et al., 2018). Brachio, et al. (2020) and Mendelski, et al. (2022), however, state that follow-up care should consist of neurodevelopmental and medical treatment, with particular focus on respiratory health. Subtle developmental issues may only become apparent post-discharge and evidence has shown that all children who have had an admission to NICU may be at risk (Mendelski, et al., 2022; Orton, et al., 2018).

The attendance of patients to follow-up sessions was significantly low (20.8%) with majority of the participants indicating that their patients occasionally (58.3%) attend the sessions. The remaining participants (20.8%) have to remind the patients of the sessions ahead of time. Evidence suggests that the lack of follow-up treatment in South Africa is a result of the poor education and lack of information on short- and long-term complications (WHO, 2023). It is believed that South African families also have significant barriers to overcome in order to attend follow-up treatment (Hardy, et al., 2021).

The results show that the infants who attend follow-up treatment predominantly attend sessions a month after discharge. Two weeks post-discharge was the second highest answer indicating a slight delay in follow-up care. The lack of, and delay in follow-up treatment received by NICU graduates predisposes the infants to developmental complications and developmental delay, which is evident in the high rates of developmental complications seen in South Africa (Sabanathan, et al., 2015; Williams, et al., 2018). There is a lack of literature on follow-up protocols in South Africa, however, the WHO recently published a report stating that there is a lack of follow-up care globally, supporting the study results.

The objective to determine if there are follow-up protocols in place for physiotherapy treatment post-discharge from NICUs in South Africa, was successfully met. It is evident that there is a lack of follow-up care and attendance of NICU graduates to physiotherapy treatment, contributing to the high rates of developmental complications in South Africa.

This chapter discussed the study results and compared them to current and relevant literature on the topic. The main conclusions that can be drawn from this study as well as the study limitations and recommendations for future practice will be presented in chapter six.

Chapter 6 Conclusion and Recommendations

This chapter concludes the findings of the study and explains what role physiotherapists are currently playing in NICUs in South Africa. Additionally, practical recommendations are made, recommendations for future research are discussed and the strengths and limitations of the study are mentioned.

6.1 Conclusion

Neonates admitted to NICUs are extremely vulnerable as a result of their physiological instability, complex conditions and/or low gestational age. The quality of medical care within a NICU directly affect the outcome of these infants. Neonatal physiotherapy falls within this specialised area of care with two main areas of treatment namely, respiratory and neurodevelopmental treatment. The lack of literature on the role physiotherapists are playing in NICUs, together with the lack of a competency framework to explain the role, resulted in the uncertainty about what role physiotherapists are currently playing. This led to the study aim to describe the role physiotherapists are playing in NICUs in South Africa.

The study found that physiotherapists working in NICUs in South Africa have a role in respiratory and neurodevelopmental treatment as well as family and caregiver support and education. There is also an important role for physiotherapists in the MDT as well as follow-up care, however, there is still a lack of implementation among the physiotherapists in South Africa.

The lack of a competency framework, additional educational or experience-related requirements and unstandardised undergraduate training programs resulted in an inconsistency in physiotherapy treatment in NICUs across South Africa. It also resulted in evidence-based practice to be lacking in certain areas among neonatal physiotherapists. This is in contrast to other countries like the USA and UK where competency frameworks and additional postgraduate requirements are needed. It is however, similar to the practice in Australia and New Zealand.

Another similarity between practice in Australia, New Zealand and South Africa is the necessary requirements to practice in a NICU are included in the undergraduate training, however, as a result of the content and experience-related differences between universities, the undergraduate training also remains unstandardised.

6.2 Clinical Recommendations

Respiratory physiotherapy and neurodevelopmental physiotherapy are equally performed in NICUs. As physiotherapists are dependent on postgraduate education and training, more respiratory physiotherapy courses should be made available.

Physiotherapy should not be performed routinely and should be based on objective parameters specific to each infant. This is particularly relevant to respiratory physiotherapy as respiratory treatment can cause significantly complications.

With the use of a competency framework and a defined scope of practice, MDT members would have a better understanding of the role physiotherapists play in NICUs. This will improve the participation of physiotherapists in an MDT which will ensure holistic treatment and prevent treatment duplication. A clear distinction should be made between the roles of occupational therapists and physiotherapists as they are often described as interchangeable rehabilitation professionals in NICUs.

Clearly defined roles of all health professionals within the NICU will also improve the referral system as it will allow a better understanding of each discipline's role, which will ultimately ensure the necessary treatment is provided.

The literature emphasises the importance of family members as a part of the MDT and the importance of family and caregiver support and education. For the family members to be actively involved in the decision-making, family and caregiver support and education should always be included in the scope of practice of neonatal physiotherapists.

It is recommended that in the absence of standardised undergraduate training, competency frameworks should be developed for physiotherapists working in NICUs to ensure competency, adequate knowledge and evidence-based practice.

6.3 Recommendation for Future Research

It could be beneficial to use this baseline study to develop a competency framework for physiotherapists working in NICUs, in order to guide and ensure evidence-based practice across South Africa. In order to appropriately treat infants in NICUs, physiotherapists need standardised practices.

A larger in-depth study comparing the practice patterns of physiotherapists in NICUs in private and public hospitals would be beneficial to distinguish the differences between the sectors.

Intervention studies to determine the effectiveness of physiotherapy for neonates in NICU would help inform practice guidelines.

This study may serve as a guide to lecturers and universities of what physiotherapists are currently doing in NICUs and so add the necessary topics to the curriculum.

Qualitative research can be conducted to explore the physiotherapy scope of practice in NICUs in South Africa.

6.4 Strengths and Limitations

A possible limitation to this study is the big discrepancy between the participants working in public and private hospitals. The lack of participants working in the public sector could have skewed some of the results.

There is no way of knowing what proportion of physiotherapists who work in NICU actually participated in this study. Many physiotherapists may only occasionally work in NICU as a locum and may not have completed the questionnaire.

The results of this study do however provide a baseline from which further studies and interventions can be planned.

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Appendices

Appendix A: Information sheet

The Role Physiotherapists Currently Play in Neonatal Intensive Care Units in South Africa.

Dear Colleagues,

I, Marelizé Gühring, am doing research on the role physiotherapists are currently playing in neonatal intensive care units (NICUs) in South Africa (SA). This study aims to identify what physiotherapists are currently doing and what their purpose is in neonatal care to make up for the lack of literature defining the role and scope of physiotherapy in NICUs in SA.

The study consists of a strategically structured questionnaire that is distributed on the South African Society of Physiotherapy (SASP) email platform as well as the Paediatric Physiotherapy Interest Group and social media groups on Facebook, LinkedIn and WhatsApp. Qualified physiotherapists currently working in NICUs in SA are invited to complete the questionnaire. The data will be collected and managed by REDCap (Research Electronic Data Capture) tools hosted at the University of the Witwatersrand.

The study will provide an in-depth analysis of the treatment methods and procedures currently used by physiotherapists in NICUs. It will also focus on the qualifications, clinical experience, follow-up protocols used by neonatal physiotherapists and how they function in an MDT in a NICU.

If you are working with neonates in NICUs, I would like to invite you to take part in this study. It requires filling out an online questionnaire that comprises of 37 questions and

should only take about 10 minutes of your time. There are no benefits or risks associated with participating in the study. Participation is voluntary and by clicking on the link, you give consent to participate in the study.

All the information obtained will be used for research purposes only and will remain confidential and anonymous. You will not be required to provide your name or contact details. If you have any questions regarding the study, please feel free to contact me.

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg ("Committee"). A principal function of this Committee is to safeguard the rights and dignity of all human subjects who agree to participate in a research project and the integrity of the research.
If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Thank you for reading this Participation Information Sheet.
Please also share the link with your colleagues.
LINK

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Appendix B: Questionnaire

DEMOGRAPHICS

1. Gender:
    - Male
    - Female
    - Other
2. Age category:
    - 22-30
    - 31-40
    - 41-50
    - 51-60
    - 61-70
3. Geographical location:
    - Western cape
    - Gauteng
    - Limpopo
    - Eastern cape
    - Northern cape
    - North west
    - Free state
    - KwaZulu-Natal
    - Mpumalanga
4. In what type of hospitals have you worked in NICUs?
    - Private hospital
    - Public hospital
    - Both

QUALIFICATIONS AND CLINICAL EXPERINCE

5. What is your level of tertiary education?
    - Bachelor of Science (BSc) in Physiotherapy
    - Master of Science (MSc) in Physiotherapy
    - Doctor of Philosophy (PhD) in Physiotherapy
6. What is your postgraduate education in terms of neonates?

- In-service training with experienced physiotherapists

  Postgraduate courses:
- Prechtl General Movement Assessment Basic
- Prechtl General Movement Assessment Advanced
- Hammersmith Infant Neurological Examination (HINE)
- Neurodevelopmental Treatment (NDT) Introduction
- Neurodevelopmental Treatment (NDT) Basic
- Neurodevelopmental Treatment (NDT) Advanced
- Respiratory Neonatal postgraduate courses
- Other (e.g. Movement Analysis Education Strategies Therapy (MAES), Bayley)

7. How many years of experience do you have working with neonates?
   - <2
   - 2-5
   - 6-10
   - 10-20
   - 20-30
   - >30

PHYSIOTHERAPY TREATMENT

8. In which of the following areas do you work?
   - Respiratory
   - Neuro developmental
   - Family and caregiver education and support
   - Head formation
   - Positioning
   - Do not treat but screen patients for post-discharge treatment
9. When do you start treatment?
   - After self-screening of patients
   - After doctor referral only
   - After screening and after referral

RESPIRATORY PHYSIOTHERAPY

10. Which treatment modalities do you use?

- Postural drainage with tilt
- Postural drainage without tilt
- Non-specific positioning to alter ventilation
- Vibrations
- Shaking
- Percussions
- Positioning prior to treatment
- Suctioning
- Saline installation (prior to suctioning or another time)
- Pre-extubation suctioning and treatment
- Post-extubation suctioning and treatment
- Participate in extubation process
- Ventilator weaning
- Lung squeezing
- Manual hyperinflation

11. Which conditions do you normally treat?
    - Meconium aspiration
    - Atelectasis
    - Consolidations
    - Inability to wean off ventilator/extubate
    - Respiratory Distress Syndrome of Prematurity (RDS)
    - Pulmonary Interstitial Emphysema (PIE)
    - Other
12. If your answer to question 9. was “After self-screening of patients”.

    When do you start treating a patient? If there are:
    - Prophylactic
    - Radiological changes
    - Thick secretions present
    - Copious secretions present
    - Increasing oxygen requirement
    - Worsening of ventilatory parameters
    - Added sounds on auscultation findings
    - Chronic lung disease present

- Combination of factors
- Other

13. What do the nurses do on behalf of the physiotherapist?
    - Positioning for ventilation
    - Manual techniques
    - None of the above
14. How regular do you treat patients?
    - Twice per day
    - Once per day
    - Every second day
    - Only when needed
    - Other
15. Do you treat patients over weekends and public holidays?
    - Yes
    - No
    - Saturdays only
    - Only if necessary
    - Sometimes

NEURODEVELOPMENTAL PHYSIOTHERAPY

16. Which conditions do you normally treat?
    - Prematurity
    - Hypotonia
    - Cerebral palsy
    - Developmental delay
    - Spina bifida
    - Shoulder dystocia with brachial plexus injury
    - Other conditions e.g. syndromes
17. Which treatment modalities do you use?
    - Environmental alterations such as noise and light
    - Supportive caregiving such as kangaroo care
    - Behavioural organisation and self-regulation
    - Gross motor development/ Developmental milestone facilitation
    - Sensory and perceptual development

- Interaction activities
- Assist coordination of sucking and swallowing
- Prevention of secondary complications in musculoskeletal, neuromuscular systems and skin
- Splints and taping
- Massage
- Positioning

18. How regular do you treat patients?
    - Twice per day
    - Once per day
    - Every second day
    - Only when needed
    - Other
19. Do you treat patients over weekends and public holidays?
    - Yes
    - No
    - Only on Saturdays
    - Only if necessary
    - Sometimes
20. When do you start with treatment?
    - When admitted
    - When patient is medically stable
    - Just before discharge

FAMILY AND CAREGIVER SUPPORT AND EDUCATION

21. Do you give support and education to family members and caregivers?
    - Yes
    - No
22. When do you give support and education?
    - While in the unit
    - Preparation for discharge
    - Only when parent asks
23. What type of support and education do you give?
    - A general brochure

- A personalized brochure
- Verbal education
- Physical demonstration on patient
- Videos and pictures

FOLLOW-UP

24. Do you have a follow-up protocol in place for post-discharge?
    - Yes
    - No
25. If your answer to 24. was “yes”:

    Do patients come for their follow-up sessions?
    - Yes
    - No
    - Sometimes
    - Have to remind them
26. If your answer to 24. was “yes”:

    When is the first follow-up sessions booked?
    - The day after discharge
    - Two/three days after discharge
    - A week after discharge
    - Two weeks after discharge
    - A month after discharge
    - Longer than two weeks after discharge
27. If your answer to 24. was “no”:

    Do the patients follow-up at another practice?
    - Yes
    - No
    - Not sure

MULTI-DISCIPLINARY TEAM (MDT)

28. Do you work in an MDT in the NICU?
    - Yes
    - No
    - Sometimes

29. When you treat patients, it is:
    - Together with other health professionals
    - Separately on your own
    - Combination of the above
30. Is there an occupational therapist working in the NICU?
    - Yes
    - No
    - Sometimes
31. Is there a speech and language therapist working in the NICU?
    - Yes
    - No
    - Sometimes
32. Is there an audiologist working in the NICU?
    - Yes
    - No
    - Sometimes
33. Is there a dietician working in the NICU?
    - Yes
    - No
    - Sometimes
34. Do you regularly refer patients to other health professionals?
    - Yes
    - No
    - Sometimes
35. Do other health professionals regularly refer patients to you?
    - Yes
    - No
    - Sometimes
36. Do you treat patients with nurses?
    - Yes
    - No
    - Sometimes

Appendix C: Ethical clearance certificate

Appendix D: Turnitin report

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG	HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

Office of the Deputy Vice-Chancellor (Research and Innovation)

TO: Ms M Guhring
School of Therapeutic Sciences
Department of Physiotherapy
Medical School
University

E-mail: guhringm@gmail.com

CC: Supervisor: Professor J Potterton
<Joanne.Potterton@wits.ac.za>
and <HREC-Medical Research Office@wits.ac.za>

FROM: Mr Iain Burns
Human Research Ethics Committee (Medical)
Tel: 011 717 1252

E-mail: Iain.Burns@wits.ac.za

DATE: 2022/12/09

REF: R14/49

PROTOCOL NO: **M220814** (This is your ethics application reference number. Please quote it in all enquiries, oral or written, relating to this study.)

PROJECT TITLE: *The role physiotherapists play in neonatal intensive care units in South Africa*

Please find attached the Clearance Certificate for the above project. I hope it goes well and that an article in a recognized publication comes out of it. This will reflect well on your professional standing and contribute to Government funding of the University.

MSWorks2000/Iain0007/Clearscan.wps

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

R49 Ms M Guhring

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M220814

NAME: (Principal Investigator) — Ms M Guhring

DEPARTMENT: — School of Therapeutic Sciences
Department of Physiotherapy
Medical School
University

PROJECT TITLE: — *The role physiotherapists play in neonatal intensive care units in South Africa*

DATE CONSIDERED: — 2022/08/26

DECISION: — Approved unconditionally

CONDITIONS:

NOTE: — If contact information regarding student study participants is required, please contact the Registrar's office - <Nicoleen.Potgieter@wits.ac.za>

SUPERVISOR: — Professor J Potterton

APPROVED BY: — CB Penny
Dr CB Penny, Chairperson, HREC (Medical)

DATE OF APPROVAL: — 2022/12/09

This Clearance Certificate is valid for 5 years from the date of approval. An extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office secretariat on the 3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **August** and therefore reports and re-certification will be due in the month of **August** each year. Unreported changes to the study may invalidate the clearance given by the HREC (Medical).

Signature of Principal Investigator _____ Date _____

Final

ORIGINALITY REPORT

8%	4%	5%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	apps.who.int Internet Source	1%
2	Vanessa Maziero Barbosa. "Teamwork in the Neonatal Intensive Care Unit", Physical & Occupational Therapy In Pediatrics, 2013 Publication	<1%
3	Moore, Tiffa. "Relationships between stress biomarkers and feeding intolerance in preterm infants over time", Proquest, 2014. Publication	<1%
4	www.scielo.org.za Internet Source	<1%
5	repository.up.ac.za Internet Source	<1%
6	wiredspace.wits.ac.za Internet Source	<1%
7	Anne Karoline Santos, Jaqueline Silveira, Valéria Cabral Neves, Talita Gianello Gnoato Zotz et al. "Atelectasis and lung changes in preterm neonates in the neonatal period: a	<1%