Improving Nursing Knowledge of Malnutrition Screening and Anthropometry Taking at Starship Child Health

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The development, delivery and evaluation of a malnutrition screening and anthropometry online training programme for nurses at Starship Child Health.

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Abstract

Adequate nursing knowledge of malnutrition screening and taking accurate anthropometry is essential in detecting infants and children at risk of malnutrition and its associated complications whilst in hospital. Currently, there is no standardised formal education for nurses at Starship Child Health, Auckland, New Zealand, on malnutrition screening and taking accurate anthropometry. The aim of this study was to develop, deliver, and evaluate the feasibility of an online learning module for nurses that describes the use of malnutrition screening tools and their role in the patient care continuum and standardised weighing and measuring techniques for inpatients at Starship.

This study was conducted in two parts. Part one involved developing and piloting two online learning modules on malnutrition screening and accurate anthropometry taking delivered using the Ko Awatea LEARN platform. Part two involved evaluating the learning modules using a prospective pre-post study design and an ad-hoc satisfaction questionnaire in fifty-one nurses over a two-week period.

There was a significant increase in knowledge after completing the learning modules, illustrated by the percentage of nurses who answered all questions correctly in the post-test (52.9%) compared to the pre-test (7.8%) (z = -4.6, p < .001). These results demonstrated that knowledge gain was achieved across malnutrition screening, its process and documentation, and standardised anthropometric protocols. A majority of nurses felt well informed about malnutrition screening and taking anthropometry on completion of the modules. Nurses had positive perceptions and attitudes on the learning modules. Embedding the modules within the already established Ko Awatea LEARN educational platform resulted in positive perceptions and attitudes to complete the learning tasks. There was a disconnect between the perception of confidence in taking accurate anthropometry, which was not reflected in the number of nurses who correctly answered questions relating to the standardised procedures when taking these measurements.

The findings from this study provide evidence that some form of mandated education on malnutrition screening and accurate anthropometry taking should be implemented at Starship Child Health. Overall, this will increase malnutrition screening rates at the ward level and allow earlier detection of malnutrition risk in infants and children.

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Table of contents

List of Figures

List of Tables

Abbreviations

ADHB	Auckland District Health Board
ASPEN	the American Society for Parenteral and Enteral Nutrition
BMI	Body Mass Index
BMIFA	Body Mass Index For Age
BSA	Body Surface Area
CED	Child Emergency Department
GP	General Practitioner
HC	Head Circumference
HFA	Height For Age
IBM SPSS	International Business Machines Statistical Package for the Social Sciences
LMS	Learning Management Systems
MCQ	Multiple-Choice Questionnaire
MNA-SF	Mini Nutritional Assessment-Short Form
MoH	Ministry of Health
MOS	Management Operating System
MST	Malnutrition Screening Tool
MUAC	Mid-Upper Arm Circumference
MUST	Malnutrition Universal Screening Tool
NHANES	National Health And Nutrition Examination Survey
PEM	Protein Energy Malnutrition
PICU	Paediatric Intensive Care Unit
PIS	Participant Information Sheet
PYMS	Paediatric York Malnutrition Score
RCPCH	Royal College of Paediatrics and Child Health
SCH	Starship Child Health
SD	Standard Deviation
SGA	Subjective Global Assessment
STAMP	Screening Tool for the Assessment of Malnutrition in Paediatrics

STRONGkids Screening Tool for Risk On Nutritional status and Growth

UK United Kingdom

USA United States of America

WFA Weight For Age

WFH Weight For Height

WFHL Weight For Height/Length

WHO World Health Organisation

Chapter 1. Introduction

Adequate nutrition during childhood plays an essential role in achieving good health and optimal growth. An imbalance of nutrients such as protein and energy can negatively affect growth; in excess, it can result in overweight and obesity. Conversely, inadequacy can result in malnutrition (underweight, wasting, and stunting) (de Onis & Blössner, 1997). Malnutrition in children may manifest due to poor diet quality, inadequate food intake, or chronic and frequent disease and illness. Often, a combination of all three factors may result in malnutrition (de Onis & Blössner, 1997). Malnutrition is, therefore, a vicious cycle in children that can make them more vulnerable and susceptible to disease. It can also decrease growth and development, all of which may result in more extended hospital stays and delayed recovery time (Philips & Browning, 2017).

To prevent malnutrition and its consequences while in hospital, hospitals must implement effective screening measures and interventions. Since 2016, Starship Child Health (SCH) has conducted malnutrition-focused research in Auckland, New Zealand (NZ). Using an implementation science methodology (Sarma et al., 2019), this body of work has examined the practice of weight and length/height (anthropometry) measurement, evaluated best practice guidelines for mitigating malnutrition risk, and piloted a validated paediatric malnutrition screening tool. **Figure 1.1** displays an overview and associated timelines of these projects and a broad summary of the outcomes and recommendations.

Beer (2017) and Ives (2016) conducted two projects at SCH. One project examined the prevalence and risk of malnutrition in paediatric patients on admission to SCH and the comparison of three validated malnutrition screening tools for use at SCH (Beer, 2017). Beer (2017) found, 10% of children had at least one anthropometric indicator of undernutrition (some with multiple indicators). Overweight was the most common form of malnutrition identified (13%), followed by stunting (6%) and underweight (6%). Three screening tools were used to measure the prevalence and risk of malnutrition (PYMS, STAMP, and STRONGkids). Depending on the screening tool used, Beer (2017) highlighted that 27.1% to 48.3% of children were at a high risk of developing malnutrition, suggesting a wide variation between the three screening tools. Although the STRONGkids tool was not as specific as the PYMS tool, it demonstrated good ability in determining children at risk of malnutrition (Beer, 2017). Ultimately, Beer (2017) concluded that the STRONGkids tool was the most practical tool for SCH. Beer's (2017) conclusion

was due to its unique consideration of other factors that impact nutrition outside of food intakes and its easy applicability (it does not require weight and height measurements and has a short completion time). Following agreement on the use of STRONGkids, an assessment of its application at SCH was necessary (Beer, 2017).

The second study in 2016 evaluated whether nurses were adhering to best practice protocols when taking anthropometry at SCH (Ives, 2016). While 100% of nurses agreed that an accurate weight measurement was important and 78% nurses agreed an accurate height or length was important, nurses were not meeting key performance criteria when obtaining these measurements. Despite 96.6% of the same cohort of nurses stating they were confident in taking height/length and weight measurements (Ives, 2016). This study also identified a lack of appropriate standardised equipment to complete these measurements on multiple wards across SCH, which led to the purchase of standardised, calibrated equipment for all wards. Ives (2016) highlighted that while most nurses agreed that accurately weighing and measuring children was important, meeting pre-defined performance criteria and competency did not match self-confidence in completing the task. Therefore, this suggested that additional support in the form of a training refresh should be developed to support nurses and ensure an ongoing standardised approach for taking anthropometric measurements (Ives, 2016).

In 2019, Lee (2019) evaluated the use of the STRONGkids malnutrition risk screening tool and the barriers to its successful implementation. This study identified a significant relationship between malnutrition risk and the following factors: gender, age, length of stay, and clinical business unit (Lee, 2019). It also identified the primary barriers nurses experienced using STRONGkids on admission, including busyness, lack of time, low priority, and the predominant barrier being insufficient knowledge about the tools used and their relation to nutrition, resulting in low screening rates (Lee, 2019). Lee (2019) further highlighted the need for additional training and education on malnutrition risk screening. Furthermore, it was suggested that creating an organisational structure around nutrition and the malnutrition screening tool could resolve knowledge gaps and increase nurse's motivation to use the tool (Lee, 2019).

As highlighted, low malnutrition screening rates and key performance criteria not being met in anthropometry taking of children at SCH, suggests that further training and education are required for these nurses. **Figure 1.2** provides a conceptual framework of the current project, its continuation of the

above research, and its overall role in preventing hospital-acquired childhood malnutrition. The aim of this pilot study is to develop, deliver, and evaluate the feasibility of an online learning module for nurses that describes the use of malnutrition screening tools and their role in the patient care continuum and standardised weighing and measuring techniques for inpatients at SCH.

It is hoped that a training tool developed to increase competency and confidence will increase nursing malnutrition screening rates and increase the accuracy of taking anthropometric measurements. If successful, this would result in the timely identification of malnutrition earlier on in the child's stay to implement preventative measures to slow the adverse consequences of malnutrition.

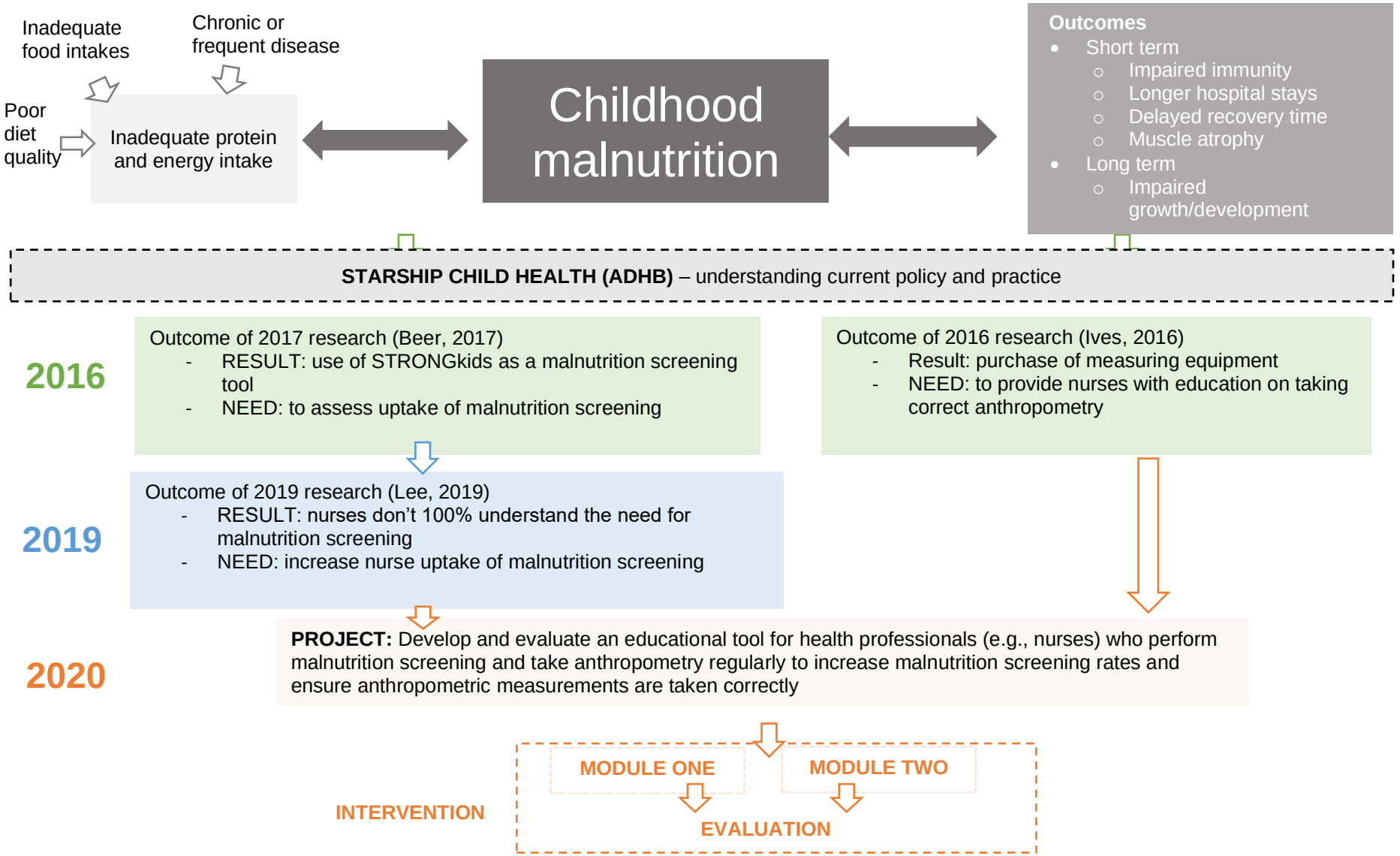

Figure 1.1. Conceptual framework depicting the projects conducted at Starship Child Health on Malnutrition Screening and Anthropometry.

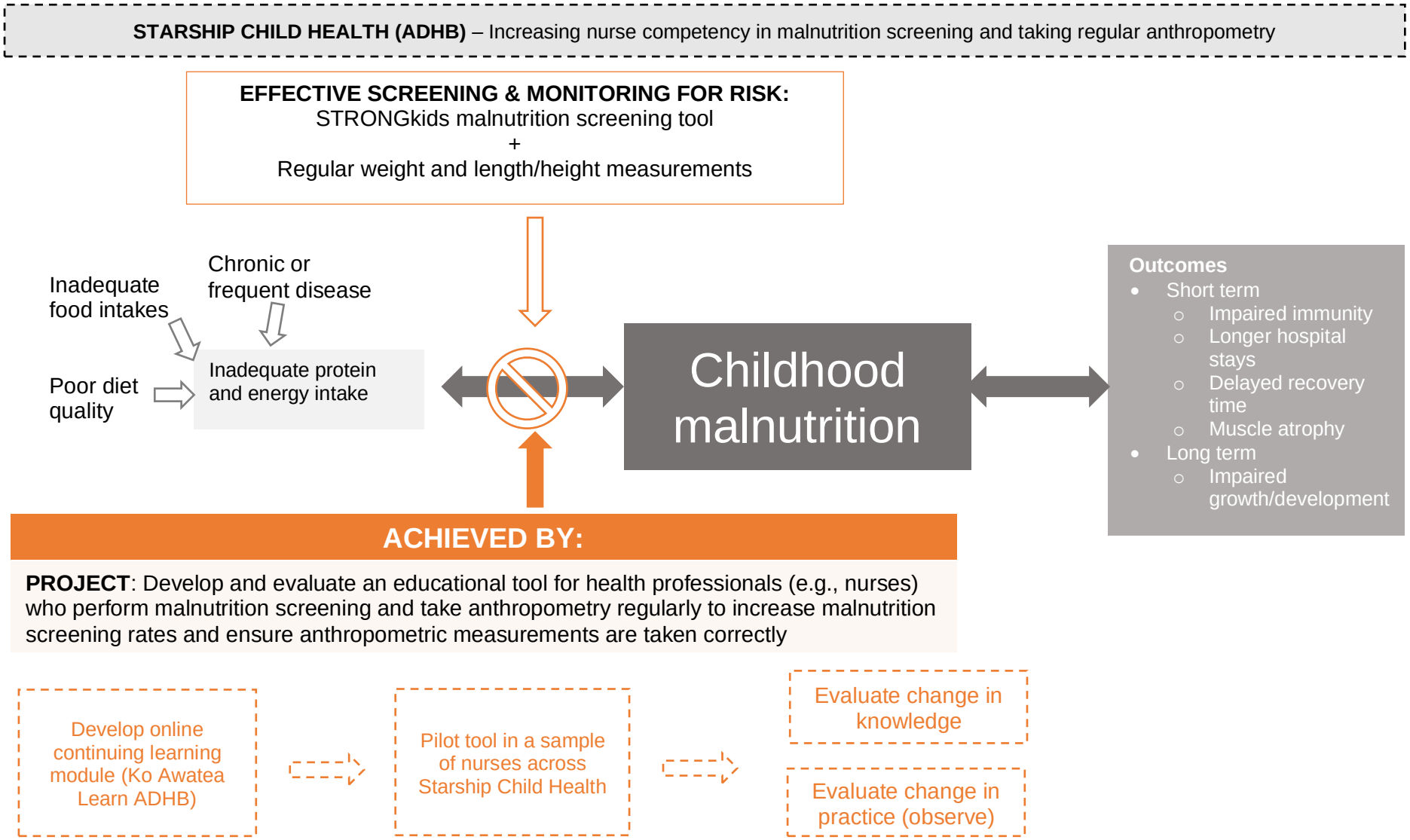

Figure 1.2. Conceptual framework depicting the sequence of events in childhood malnutrition and the role of the current project in preventing childhood malnutrition.

Chapter 2. Literature Review

This literature review aims to investigate;

- The current knowledge and evidence for developing practical educational training programmes for carrying out malnutrition screening and anthropometry for paediatric nurses.
- The literature on the barriers to carrying out malnutrition screening and anthropometry and if nurses' skills, knowledge, and attitudes can improve nursing competency.

Objectives of this literature review are;

- To define the term malnutrition and more specifically, paediatric malnutrition.
- To discuss anthropometry and its techniques to accurately measure anthropometry and the correct training needed for health professionals.
- To critically appraise the published literature on malnutrition screening tools and nurse perceptions and confidence in using these tools.
- To discuss the methods used for designing successful training programmes for adult learners and current education programmes that have successfully increased nursing skills, knowledge, or attitudes in malnutrition screening and anthropometry.

A literature search was conducted between April 2020 and August 2020 using the electronic databases of PubMed, Medline, SCOPUS, and Google Scholar. The following search terms were used to identify relevant articles; malnutrition screening, nutrition screening, nurse training, nurse education, health professional training, adult learning, anthropometry, weight and height measurements, and paediatric/children hospital. If the abstract contained topics such as paediatric malnutrition, the importance of malnutrition screening, anthropometry and its associated techniques, nursing understanding and perceptions of malnutrition screening and anthropometry, the development and evaluation of training programs for adults or successful nurse education programs - then the full text was obtained. The terms undernutrition and undernourished in this review refer to malnutrition and malnourishment.

2.1. Malnutrition

2.1.1. Definition

Malnutrition (under and overnutrition) is a broad term that refers to imbalanced, excessive, or deficient intakes of nutrients needed for a functioning human body that can result in endangered health (McCarthy, 2019). Historically, malnutrition was associated with developing countries. However, recent research has shown that malnutrition does not just affect one population type or group (Becker et al., 2014). It can present in different ways, such as under and overnutrition, poverty or famine, or in acute or chronic illness (Becker et al., 2014).

2.1.2. Malnutrition in developing countries

Malnutrition can encompass protein-energy malnutrition (PEM). PEM can commonly occur in developing countries due to an inadequate food supply and can severely affect infants and children (Grover & Looi, 2009). It can present in three forms: Kwashiorkor, Marasmus and Marasmus Kwashiorkor. Kwashiorkor is identified by a protein deficiency with a reasonably normal energy intake. Clinically, Kwashiorkor presents with a normal weight for age with oedema and distended abdomens. Marasmus is characterised by an overall energy and protein deficiency with clinical presentations of dry and wrinkled skin and depleted muscle and fat stores. Marasmus kwashiorkor clinically presents as a combination of the above two (Grover & Looi, 2009).

2.1.3. Malnutrition in developed countries

In developed countries, malnutrition is uncommon to present as PEM, as the food supply is not often inadequate. It is most likely to manifest in the hospital setting, acutely, or in chronic illness (Grover & Looi, 2009). It may also affect the homeless, victims of abuse, or areas where access to high-quality food may be difficult (Becker et al., 2014). In the past, malnutrition has been described in various ways in the literature due to not one universally accepted definition. As a result of this, the true prevalence of and consequences associated with malnutrition are not fully known (Phillips & Browning, 2017). Malnutrition rates in hospitals are not accurately measured and are estimated anywhere between 6-51% (Mehta et al., 2013). An absence of a standardised malnutrition definition, different nutrition

screening practices and nutrition not being prioritised as part of patient care are just some of the reasons that contribute to the varying reported prevalence of malnutrition in hospitals (Mehta et al., 2013).

2.1.4. Paediatric malnutrition

The Academy of Nutrition and Dietetics and the American Society for Enteral and Parenteral Nutrition (ASPEN) co-developed a consensus statement for the definition of paediatric malnutrition in 2014 as "an imbalance between nutrient requirement and intake, resulting in cumulative deficits of energy, protein or micronutrients that may negatively affect growth, development and other relevant outcomes" (Becker et al., 2014). While malnutrition is mainly perceived as undernourishment, it can also encompass overnutrition. Children who do not receive adequate energy and protein intakes for development and growth or are unable to utilise food and nutrients due to illness are said to be malnourished. Conversely, those who consume excess energy and nutrients are malnourished and over nourished (Becker et al., 2014).

Additionally, malnutrition can be further classified as acute or chronic. Weight is typically affected in acute malnutrition (wasting) with a low weight-for-height (WFH). In contrast, identification of chronic malnutrition (stunting) is a low height-for-age (HFA) (Becker et al., 2014).

2.1.5. Identifying paediatric malnutrition

When identifying paediatric malnutrition, classification criteria are used to identify and then treat with appropriate intervention. Assessment or evaluation of a child's nutritional status on admission can help identify malnutrition risk (Mehta et al., 2012). However, there is no universally accepted method of assessing nutritional status. Anthropometric measurements (such as weight, height, or length measurements explored further in section 2.2) are used in growth monitoring. They are still widely used to assess a child's nutritional status (Elia & Stratton, 2012). Other anthropometric measuring methods, such as bioelectrical impedance analysis, serum nutritional markers (for example, albumin), and dual-energy x-ray absorptiometry, are not recommended to evaluate children's nutritional status due to specialist training needed to use the complicated equipment (Ong, Han & Wong, 2014). Additionally, measurements such as albumin can be influenced by inflammation and fluid and electrolyte shifts. Hence, it is not a good measure of nutritional status in the hospital setting (Bharadwaj et al., 2016).

Anthropometric measurements are plotted on standardised percentile growth charts, which can track if optimal growth is occurring. Additionally, anthropometry is used to evaluate a child's nutritional status (Nogueira de Almeida, Ricco, Nogueira, Del Ciampo & Mucillo, 1999) by detecting acute or chronic protein/energy deficits that can affect growth. These measurements are simple, cheap, and are relatively quick to perform. On the other hand, anthropometry measurements have several limitations, including measurement errors such as intra- and inter-individual variation, which can be skewed when oedema is present (Ulijaszeck & Kerr, 1999). Weight and height/length measurements allow the calculation of the following indicators to be compared to a reference population (Gibson, 2005); weight-for-height or length (WFHL), height-for-age (HFA), weight-for-age (WFA), BMI-for-age (body mass index), and mid-upper arm circumference (MUAC). Head circumference (HC) is also commonly taken, which is used to indicate brain growth and volume in infants and young children (Irving et al., 2015). ASPEN and the Academy of Nutrition and Dietetics recommended the above indicators for diagnosing and documenting malnutrition in children aged one month to 18 years (Becker et al., 2014).

There is no standardised, universally accepted anthropometry evaluation method to classify paediatric malnutrition (Nogueira de Almeida et al., 1999). As a result of this, several methods have been evaluated. Currently, the Gomez, Galvan, Cravioto & Frenk (1955) and Waterlow (1972) methods are frequently used together. The Gomez et al. (1955) method is based on a single measure, where the child's weight is expressed as a percentage of the standard weight at that specific age (Seoane & Latham, 1971). If this deviates from below-accepted standards, the child is identified as malnourished. **Table 2.1** summarises the criteria Gomez et al. (1955) used to identify paediatric malnutrition. As weight alone is a single measurement and is unpredictable (weight can be rapidly gained or lost), it has been deemed as misleading or not likely to determine whether a child's diet was previously inadequate (Seoane & Latham, 1971). Due to these criticisms, the Gomez et al. (1955) method is not adequate to use on its own as a paediatric malnutrition evaluation method (Seoane & Latham, 1971).

The Waterlow (1972) method uses two measurements, weight and height, to calculate WFH and HFA percentiles in children under ten years of age. These percentiles below the median are then used to determine four degrees of wasting and stunting (Nogueira de Almeida et al., 1999). **Table 2.1** displays a summary of this criteria by Waterlow et al. (1972). WFH identifies a child's level of thinness in relation to their height and does not solely rely on weight alone (Seoane & Latham, 1971). The calculation of HFA can suggest the degree of chronicity of malnutrition in the child, because poor nutrient intake over

time can cause stunting (Seoane & Latham, 1971). This method is independent of age and has age-related external standards, which are further advantages to its use (Waterlow, 1972). Therefore, using multiple measurements in anthropometry assessment can provide a more accurate representation of nutritional status in children (such as combining WFA, WFH, and HFA used in the Gomez et al. (1955) and Waterlow (1972) methods), rather than using one of the above methods on their own.

For population-based assessments, the WHO Child Growth Standards and WHO reference 2007 growth charts (criterion) can be used due to their ability to be applied internationally. At the time of its initial development (1997), the WHO criterion's growth standards used the Global Database, representing 84% of children under five years of age from Asia, Africa, Latin America, and Oceania. These growth standards allowed nutritional data to be compared to international standards (de Onis & Blössner, 1997). If a child presented with a degree of impaired growth, their measurements could be compared to other children of the same sex and age (also known as a reference), which is clinically useful. The criterion uses a classification system based on z-scores or standard deviations (SD) to identify a child's nutritional status under five years. Z-scores are defined as a statistical measure that can indicate whether a single data point is above or below 'average' compared to normal data, i.e., how atypical the measurement is (Becker et al., 2014). As the criterion is linear (allowing comparisons across age groups and indicators) and expresses anthropometry measurements as a z-score below or above the reference mean, it is a widely used and recognised classification system for children's nutritional status (de Onis & Blössner, 1997).

The WHO charts have seven smoothed z-score lines (-3, -2, -1, 0, 1, 2, 3). Children that develop and grow normally, are between -1 and 1 z-score of any given indicator and will usually track parallel to one of the z-score lines (Becker et al., 2014). A z-score between < -2 SD and > -3 SD is used in the WHO criterion to classify low WFA, low HFA, and low WFH as moderate undernutrition. A < -3 SD classifies severe undernutrition (de Onis & Blössner, 1997). **Table 2.1** summarises the criteria the WHO (2006) uses to identify and classify paediatric malnutrition. After the initial release of the criterion in 1997, there were growing concerns that the international WHO criterion did not have growth references applicable for older children to assess the emerging childhood obesity issue (de Onis & Blössner, 2007). Additionally, it was highlighted that these standards had a gap across all centiles compared to other existing growth standards for older children (de Onis & Blössner, 2007). Consequently, the WHO developed new and improved growth references for growth charts (i.e., a single growth reference) for

children aged 5-19 years for the screening, surveillance, and monitoring of growth in 2007 (de Onis & Blössner, 2007). These described reference values are not limited to population-based applications. Health professionals can also use them in the individual application as a screening tool to detect risks of nutrition disorders. Nonetheless, when using the reference values in individual-based applications, they should not be viewed as a diagnostic tool on their own (de Onis & Blössner, 1997).

As stated, there is no universally accepted method of anthropometry evaluation for the classification of paediatric malnutrition. There are multiple methods and presentations which are described in the literature. Frequently, anthropometric evaluations that use a combination of methods such as by Gomez et al. (1955) and Waterlow (1972) are used together to produce an accurate representation of a child's nutritional status. Using just one anthropometry evaluation method when diagnosing paediatric malnutrition can be variable and may be misleading (Seoane & Latham, 1971). The WHO criterion is generally used for population-based applications, where the reference values can be used for comparisons and monitoring purposes but are also used in individuals. Still, caution must be followed to not use it as a single diagnostic tool (de Onis & Blössner, 1997).

Table 2.1. Summary of the methods of anthropometry evaluation to classify paediatric malnutrition.

Method	Variable	Grade of malnutrition	Criteria
Gomez[a]	WFA (% of median)	Mild	75-90%
		Moderate	60-74%
		Severe	<60%
Waterlow[b]	WFH (% of median)	Mild	80-90%
		Moderate	70-80%
		Severe	<70%
	HFA (% of median)	Mild	90-95%
	Stunting	Moderate	85-90%
		Severe	<85%
WHO[c]	WFH (z-score)	Moderate	-2 to -3 SD
	Wasting	Severe	< -3 SD
	HFA (z-score)	Moderate	-2 to -3 SD
	Stunting	Severe	< -3 SD
	WFA (z-score)	Moderate	-2 to -3 SD
		Severe	< -3 SD

WFA = Weight for Age; WFH = Weight for Height; HFA = Height for Age; SD = Standard Deviation. [a](Gomez et al., 1955); [b](Waterlow, 1972) [c](WHO, 2006).

2.2. Anthropometry

Anthropometry can be defined as 'the measurement of man,' which can include any physiological, psychological, or anatomical trait. In the clinical setting, anthropometry refers to the morphological characteristics measured externally, such as weight, height, length, HC, or MUAC (Ulijaszeck & Kerr, 1999). Anthropometry plays a significant role in the nutritional assessment of children through nutritional screening, surveillance, and monitoring. It is also valuable in growth monitoring. Children can often have these measurements taken at general practitioner (GP) appointments, where they can then be plotted on growth charts to track optimal growth (Lipman, Euler, Markowitz & Ratcliffe, 2009). Anthropometry measurements are generally regarded as quick, simple and cheap, which require minimal training (Voss, 1995). However, anthropometry measurements can have several limitations,

such as diurnal variations, inaccurate equipment and human measurement errors (intra- and inter-individual), resulting in incorrect interpretations (Lipman et al., 2009). Human measurement errors may occur due to the child's behaviour, posture, movement and co-operation when being measured, which can increase the likelihood of a measurement error (Foote, 2014; Lampl, Birch, Picciano, Johnson & Frongillo, 2001; and Voss, Bailey, Cumming, Wilkin & Bretts, 1990). Obtaining repeatable measures is a method of counteracting this error and is additionally best practice, but it can be very time-consuming for already busy health professionals (Ulijaszeck & Kerr, 1999).

Anthropometry measurements are not routinely taken in all health care settings. In various UK hospitals, 86% of children had a recorded weight measurement, but none had a recorded height measurement (Stoner & Walker, 2006). In a multi-centre randomised controlled trial of primary care providers in eight cities in the United States of America (USA), only 30% of children had accurate measurements taken when observed (Lipman et al., 2004). When anthropometry measurements are missed or not measured accurately, children at risk of malnutrition or growth failure may be missed entirely (Lipman et al., 2009). For these reasons, there are standardised techniques that health professionals should use to increase accuracy, which may require additional training. The methods and the ideal training of health professionals are outlined below.

2.2.1. Taking anthropometric measurements

Anthropometry is an essential component in the assessment of an individual's nutritional status and monitoring growth. When taking accurate weight, height or length, and HC measurements, there are three essential components: using a standardised measurement technique, use of high-quality equipment that is regularly calibrated, and health professionals who are trained in taking consistent and precise measurements (Canadian Paediatric Society, Dietitians of Canada, The College of Family Physicians of Canada, & Community Health Nurses of Canada, 2010). The WHO *Training Course on Child Growth Assessment* is one example of a training tool on applying the WHO Child Growth Standards. It is intended primarily for health professionals who measure and assess children's growth or who supervise these activities (WHO, 2008).

Table 2.2 displays a summary of several best practice guidelines for measuring weight, length, height, and HC in infants and children developed by organisations such as the WHO, National Health And

Nutrition Examination Survey (NHANES), and the Ministry of Health, NZ (MoH). There are two different methods for both weight and height (for < two-year-olds and > two-year-olds) due to the child's age and ability to stand. The two methods allow the best possible measurement to be obtained with varying needs and ages.

While there are many similarities between the three guidelines for measuring infants and children, some critical differences are noted, including NHANES (2016), which recommend HC be measured on children from birth to six months of age. In contrast, the WHO guidelines recommend measuring HC from birth up to two years. The MoH (2010) is the only set of guidelines that recommend the use of clinical electronic scales in both infants under two years and children over two years, whereas NHANES (2016) and the WHO (2008) suggest using the tared weighing method for infants under two years of age. The MoH (2010) guidelines emphasise that the best practice involves taking three measurements and using the average, compared to the other organisations who do not. Additionally, the WHO (2008) guidelines emphasise that the mother assists in measuring weight, length, height, and HC in infants and children. These guidelines are followed by many hospitals and health professionals around the world. In NZ, the hospital guidelines used are based on the WHO's protocols (seen in **Table 2.2**), but the MoH (2010) includes additional advice on cultural safety, such as the appropriateness of touching heads.

Table 2.2. Summary of best practice guidelines for measuring anthropometry in infants and children by various organisations.

Guidelines	Weight	Length	Height	Head circumference
WHO[a, b]	Under two years • Use tared weighing. • Ensure scale reads 0.0 before weighing. • Mother stands on scale with feet slightly apart (no shoes), remaining still for weight to display. • Tare scale with mother on the scale and pass the naked baby to her. • The baby's weight will be displayed. Record to the nearest 0.1kg. Two years and older • Weigh child alone. • Tare scale to 0.0. • The child stands in the middle of the scale, feet apart and still. • Weight will be displayed. Record to the nearest 0.1kg.	Under two years • Cover board with a thin cloth. • Mother places the child on their back, head against the fixed headboard (nappy removed). • Position so that a vertical line from the ear canal to the lower border of the eye socket is perpendicular to the board (child's eyes are looking straight up). The mother holds head in this position. • Ensure the child is straight along the board. • Hold down the child's legs with one hand and move the footboard with the other. Soles of the feet are flat against the footboard, toes upwards. • Record to the last completed 0.1cm.	Two years and older. Ask the mother to be involved. • The child stands on the baseboard, feet slightly apart with the back of the head, shoulder blades, buttocks, calves, and heels touching the vertical board. • Head is positioned so that a horizontal line from the ear canal to the lower border of the eye socket runs parallel to the baseboard. • Keep the head in position. The other hand pulls down the headboard to rest on top of the head and compress the hair. • Record to the last completed 0.1cm.	• Remove hairpins, headbands, or braids. • An infant or child less than two years of age is held on the mother's lap, and older children stand/sit unassisted. • Stand/sit to the left side of the child and pass tape around the head. Anchor it just above the eyebrows over the fullest protuberance of the skull at the back of the head. • An assistant will sit/stand in front of the child and help position the tape. • When positioned, pull the tape tight to compress the hair and skin. • Record the to the last completed 1mm.

NHANES[c]	Under two years • Use tared weighing. • The parent stands alone on the scale, where weight will display. • Tare scale with the parent still standing. • Hand the child to the parent on the scale, where the scale will read only the child's weight. Two years and older • The child stands still in the centre of the scales, feet slightly apart, facing the recorder, hands at sides, and looking straight ahead. • The scale will read the child's weight.	Under two years • Two people required, one to hold the child's head and the other to position the feet. • The head is in contact with the headpiece and is in the Frankfort plane. • Secure the child's head in the proper alignment by lightly cupping the palms of hands over the ears. • Align the child's legs with one hand over the knees. The other hand slides the foot piece to rest firmly at the child's heels. Toes point directly upward, soles of the feet flexed flat against the foot piece.	Aged 2 years or older. • Remove hair ornaments, buns, or braids. • The child stands straight with heels together, toes apart. • Back of the head, shoulder blades, buttocks, and heels need to contact the backboard. • Align the head in the Frankfort horizontal plane. • Lower the stadiometer headpiece till it is firmly on top of the child's head. • The child stands as tall as possible, taking a deep breath and holding this position.	Children from birth to 6 months old. • The infant is seated on the parent's lap. • Head circumference tape is placed around the child's head: across the frontal bones of the skull; above the eyebrows; perpendicular to the long axis of the face; above ears, and over the occipital prominence at the back of the head. • Move tape up and down over the back of the head to locate maximum circumference. • Tighten the tape for a snug fit around the head, compressing the hair • Record to the nearest 0.1cm.
MOH, NZ[d]	• Only clinical electronic scales in the metric setting to be used. • Babies weighed without clothes or a nappy. • Children older than two years can be weighed in vest and pants but without footwear.	• Always remove shoes or other footwear. • Under two years of age, measure length without a nappy using a length board or mat. • Good practice to take three measurements and use the average.	• Always remove shoes or other footwear. • Over two years, measure height using a rigid upright measure with a T piece or a stadiometer. • Good practice to take three measurements and use the average.	• Head circumference should be measured using a thin plastic or disposable paper tape. Measurements should be taken where the head circumference is widest. • Good practice to take the average of three measurements. • Hats or bonnets should be removed. Be aware of cultural issues around touching heads.

[a](WHO, 2008). [b](de Onis et al., 2004). [C](National Health and Nutrition Examination Survey (NHANES), 2016). [d](Ministry of Health, New Zealand, (MOH) 2010).

2.2.2. Training healthcare workers in taking anthropometry

Nurses, dietitians, paediatricians, health care assistants and other health care workers who may measure weight, height, length and HC as part of routine patient care should be trained using best practice processes. This would ensure accurate anthropometry measurements being taken by all health care workers (Royal College of Nursing, 2017). Nurses need to keep their knowledge and skills up to date with requirements for continuing professional development. Charge nurses, nurse specialists/educators and dietitians are in ideal positions to educate staff on weighing and measuring children correctly. Increasing competence at a senior level would provide the necessary skills to assess ward nurses and health care assistants (Royal College of Nursing, 2017). Several training approaches are used to upskill health professionals, including the *Training Course on Child Growth Assessment* developed by the WHO (2008). The training module includes three modules: B) Measuring a Child's Growth, C) Interpreting Growth Indicators, and D) Counselling on Growth and Feeding, with exercises to complete following each module (WHO, 2008).

Additionally, there are two supplementary modules (A and E) that contain resources such as photos to supplement module learning (WHO, 2008). The WHO has developed other complementary resources such as the *Anthropometry Training Video*, which can be downloaded for free from the WHO website, supporting further teaching in this space (WHO, 2020).

2.2.3. Other important uses of weight and height in the clinical setting

Health care staff may take weight, height, and length measurements for reasons other than malnutrition screening. On admission to the hospital, these measurements are taken as part of a formal nutrition assessment, usually by health care assistants or nurses (Royal College of Nursing, 2017). Clinically, body weight can be used to calculate drug doses, chemotherapy doses, and resuscitation, especially in critical care. It is also used for growth monitoring, assessing fluid balance in children who suffer renal or cardiac issues (Selewski et al., 2011). Furthermore, it is used in calculating enteral and parenteral feeding requirements and monitoring changes in body composition and hydration (British Association for Parenteral and Enteral Nutrition, 2016). Erroneous or absent anthropometric measurements can

lead to therapies not being tailored to the individual patient, which may negatively affect clinical outcomes, including the amount of time ventilated, length of critical care admission and patient survival (Bloomfield, Steel, MacLennan & Noble, 2006).

2.2.3.1. Resuscitation

In emergency resuscitation, body weight is needed to determine drug doses in children as it is determined on a per kilogram basis. Weight is also required for estimating the amount of fluid therapy, size of airway equipment required, and the number of joules needed for defibrillation (Chavez, Peterson, Lo & Arel, 2015).

2.2.3.2. Chemotherapy and medication dosages

Chemotherapy doses for children use weight and height to calculate the body surface area (BSA, measured in m^2) via using a monogram. Once the BSA is calculated, the dosage can be determined by a formula. Because chemotherapy doses are calculated using BSA, there is a high potential of reaching a level of toxicity in the presence of measurement error. Other medications such as anaesthetics, diuretics, and opioids also require body weight (kg) to calculate dosage. An accurate weight and height measurement is crucial for administering the correct drug dosage to ensure the child's smaller and immature body system does not receive an overdose that may be lethal (Aschenbrenner & Venable, 2009).

2.3. Malnutrition screening

ASPEN defines malnutrition screening (also referred to as nutrition screening) as "a process to identify an individual who is malnourished or who is at risk for malnutrition to determine if a detailed nutrition assessment is indicated" (Mueller, Compher & Ellen 2011). By performing malnutrition screening poor nutritional status can be detected earlier, preventing the potential negative consequences of malnutrition in children. Studies have shown that both acute and chronic malnutrition can impair children's growth and development but also the cognitive development of school-aged children (Emond, Blair, Emmett & Drewett, 2007; and Kar, Rao & Chandrammouli, 2008).

Children admitted to the hospital are at a high risk of developing malnutrition, specifically when an underlying disease or illness is present (Joosten & Hulst, 2008). The prevalence of children developing malnutrition in hospitals appears to be variable and has been reported in the literature worldwide (Sermet-Gaudelus et al., 2000; Aurangzeb et al., 2012; Cooper et al., 1981; Hendricks et al., 1995; Moeeni, Walls & Day, 2014 and Lee, 2019). In a French hospital, the authors found that 62% of children lost weight during their hospital stay (Sermet-Gaudelus et al., 2000). While in an Australian tertiary paediatric hospital, 52.6% of children aged 0-2 years were reported to be undernourished, followed by 26.3% and 21.1% in the 2-5 years and 5-10 years age groups respectively (Aurangzeb et al., 2012). In cross-sectional studies of children's hospitals in North America and the United Kingdom (UK), under-nutrition prevalence varied between 20-40% (Cooper et al., 1981 and Hendricks et al., 1995). These international findings can be compared to results found in NZ. Moeeni, Walls & Day (2014) indicated that up to 10% of NZ children that are hospitalised, are also undernourished. Lee (2019) at SCH in Auckland identified that 53.4% of children are at a medium risk of malnourishment. These studies highlight the varying degrees of malnutrition and extensive variation in the prevalence of children reported to be undernourished in hospital (which could be attributed to the exclusion or inclusion of the intensive care wards (O'Connor, Youde, Allen & Baur, 2004)). Despite this large variation of malnutrition prevalence being reported, these rates show that malnutrition in children not only occurs in New Zealand, but also worldwide.

Standard assessment of a patient’s current nutritional status can identify whether they are currently malnourished but cannot identify those at risk of malnutrition (White, 1994). Likewise, through anthropometry and its evaluation through growth tracking, malnutrition can be detected; however, it cannot diagnose those at risk of malnutrition (Maciel, Nakano, Carvalho & Dutra, 2020). In order to prevent malnutrition and hospital-acquired malnutrition (with its associated complications) from occurring, early detection of nutritional inadequacy through screening is vital to identify those at risk of malnutrition and those who are malnourished on admission (Hulst, Zwart, Hop & Joosten, 2009). When screening is performed on admission to the hospital, it can result in the early implementation of nutritional interventions with the hopes of preventing the complications associated with malnutrition.

2.3.1. Available screening tools

Numerous nutrition risk screening tools are used in the hospital to identify malnutrition early in adult populations, none of which are appropriate for use in children (Hartman, Shamir, Hecht & Koletzko, 2012). Since then, few paediatric-specific malnutrition screening tools have been developed, including the Screening Tool Risk On Nutritional status and Growth (STRONGkids), currently being used at SCH (Lee, 2019).

In 2009, Hulst, Zwart, Hop and Joosten conducted a study in Dutch hospitals over three consecutive days intending to investigate the feasibility and value of a new nutritional risk screening tool, called STRONGkids, for nationwide implementation in the Netherlands. It is a tool with a comprehensive summary of frequently asked questions that target nutrition-related issues combined with a clinical view of the child's nutritional status (Hulst et al., 2009).

The screening tool consists of four items with points allocated to each item if it is present: subjective clinical assessment (1 point) whether diminished subcutaneous fat or muscle mass or a hollow face is present; high-risk disease(s) being present (2 points); nutritional intake and losses that may be occurring (1 point), and weight loss or poor weight gain (1 point) (Hulst et al., 2009). Anthropometric measurements such as weight, height, or supine lengths were used. These were then compared to Dutch reference standards and translated into SD scores for WFH and HFA. An SD score of < -2 for WFH indicated acute malnutrition, and an SD score of < -2 for HFA indicated chronic malnutrition (Hulst et al., 2009). Hulst et al. (2009) successfully applied the tool to 98% of the n=424 children (aged from 31 days to 17 years old) included in the study. Using this tool, they found a significant correlation between having a "high risk" score, a negative SD score in WFH and a prolonged hospital stay (Joosten & Hulst, 2011). Joosten and Hulst (2011) concluded that using the STRONGkids tool helped raise the clinician's awareness of the importance of the nutritional status in children and enabled the clinician to refer children earlier on for dietary interventions. Additionally, in an NZ study of the STRONGkids tool being used in a Christchurch hospital, they found it useful and reproducible while identifying 100% of undernourished children at the time of the study (Moeeni, Walls & Day, 2013).

Furthermore, a follow-up study found the STRONGkids tool proved to be a feasible tool for identifying hospitalised children in NZ who were at risk of malnutrition when applied by nursing staff and paediatricians (Moeeni, Walls & Day, 2014). Findings from the 2017 study by Beer at SCH in Auckland,

NZ, were consistent with Moeeni, Walls & Day (2013) in Christchurch, NZ. Concluding that out of three malnutrition screening tools, the STRONGkids tool was found to be the most practicable for the SCH setting due to its advantages of being able to identify children at risk of malnutrition and earlier referral for dietary interventions (Beer, 2017). These studies highlight that the STRONGkids screening tool is accurate, suitable, and can be easily applied on admission by nurses to allow early identification of nutritional risk in children.

2.3.2. Application of screening tools

Malnutrition screening tools such as STRONGkids have been designed for various healthcare workers (Elia & Stratton, 2012). Nurses, however, are in the best position to perform malnutrition screening due to the close contact they have with new admissions (McLaren & Green, 1998). As a result, detailed malnutrition screening can occur early and subsequent monitoring throughout their hospital stay, allowing effective planning and individualised nutritional care (Davies, 2005). Moreover, due to nurses being on-hand and having direct contact with patients daily, this enables them to identify when changes to a patient's food intake or general wellbeing may occur. These changes include screening for malnutrition risk factors such as recent weight loss or factors contributing to decreased food intakes such as nausea, vomiting, and pain (Davies, 2005). With early identification of patients at a high risk of malnutrition, nurses can refer to the appropriate expert (dietitians, doctors, or clinical nurse specialists) earlier on (Davies, 2005).

2.3.3. Current barriers to the use of STRONGkids

While STRONGkids has advantages to its use, it also has some drawbacks. The tool was initially designed to be applied by a physician rather than by nursing staff due to the first question involving a subjective clinical assessment (Mooeni, Walls & Day, 2014). This poses a problem because physicians are not always the first health professional in contact with patients on admission. Therefore, the tool needs to be able to be used effectively by nurses as well. In recent semi-structured interviews at SCH (Lee, 2019), nurses' most frequently cited barrier to using the STRONGkids tool effectively was identifying the (pre-defined) underlying illness list, which was often found in a separate location to the screening tool. Therefore, this made it particularly difficult to remember which diseases were classified under each illness category without consulting the separate document. Several nurses also felt that

conditions were missing from the list. These barriers consequently decreased the tool's applicability for the nurses (Lee, 2019).

2.4. Nurse perceptions and understanding of malnutrition screening and anthropometry

While nurses are in the best position to perform malnutrition screening (McLaren & Green, 1998) and appear to place importance on helping patients receive appropriate care (Lee, 2019), this does not mean malnutrition screening is always carried out (Ferguson et al., 2010; Holst, Rasmussen & Unosson, 2009; Irving et al., 2015; Lee 2019; Porter, Raja, Cant & Aroni, 2009; and Raja et al., 2008). Nurses have reported several barriers they experience, which are outlined below. A further summary of the barriers, groups of nurses have reported can be seen in **Table 2.3.** It is important to note; the discussed barriers are predominantly in the adult patient population due to limited studies evaluating the barriers of nurses specifically using paediatric malnutrition screening tools.

Green and Kreuter in 1991 highlighted that the behaviour of health care staff (such as nurses) could have an impact on a variety of patient outcomes. An individual's behaviour can be influenced by numerous factors, which are summarised in **Figure 2.1**; understanding, competence, and perception can affect an individual's confidence in performing an action. In order to promote positive behaviour change in nurses, which can result in improving malnutrition screening rates and accurate anthropometry taking, the training programme must focus on strategies to change nursing behaviours (Bjerrum, Tewes & Pedersen, 2012). For this aspect to be included in training programs for nurses, all of the factors that can influence nursing behaviour must be explored (Bjerrum et al., 2012).

Table 2.3. Summary of study characteristics of nursing barriers to the correct use of malnutrition screening.

Reference	Country	Setting	Participants	Method of screening	Barriers
Ferguson[a]	Australia	Hospitals and nursing homes	Nurses and dietitians	MST (67%), SGA (14%). MNA-SF (9%), MUST (5%), Other (26%)*	Lack of time, insufficient staff, limited awareness regarding the importance of nutrition screening, incorrect use of screening tools, high patient turnover, and social barriers.
Raja[b]	Australia	Hospitals	Nurses	MST, MUST	Lack of time, lack of knowledge, and communication issues with patients regarding weight history.
Irving[c]	United States of America	Hospital (Paediatric Intensive Care Unit)	Nurses, dietitians, paediatric clinicians	Anthropometry measuring	Nursing workload, not perceived as important, lack of correct equipment, unsure of correct technique, patient/family do not want to be disturbed and presence of medical devices.
Holst[d]	Denmark, Sweden, Norway	Hospitals	Nurses	Not stated	Lack of knowledge, lack of technique, lack of education.
Porter[e]	Australia	Hospitals	Nurses	MUST	Lack of time, the uncertainty of protocols and skills, and lack of recognition of evidence-based skills.
Lee[f]	New Zealand	Hospital (SCH)	Nurses	STRONGkids	Busyness, lack of time, not a top priority, forgetting to complete it, the screening tool's position in the Admission to Discharge (A to D) planner, missing resources, and late admissions.

MST: Malnutrition Screening Tool, SGA: Subjective Global Assessment, MNA-SF: Mini Nutritional Assessment-Short Form, MUST: Malnutrition Universal Screening Tool, STRONGkids: Screening Tool Risk On Nutritional status and Growth. [a](Ferguson et al., 2010), [b](Raja et al., 2008), [c](Irving et al., 2015), [d](Holst et al., 2009), [e](Porter et al., 2009) and [f](Lee, 2019).

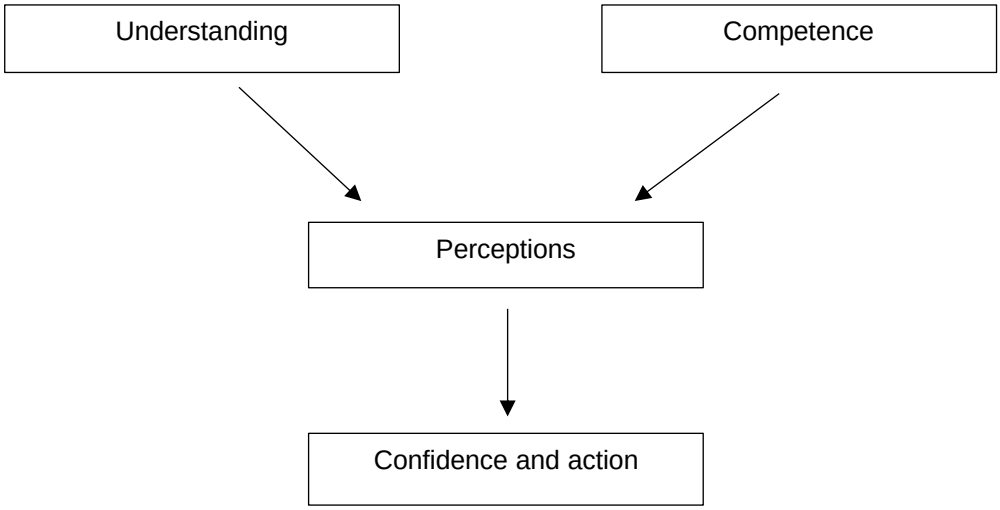

Figure 2.1. Summary of the factors that influence nursing behaviour

2.4.1. Understanding

Understanding can imply "abilities and dispositions with respect to an object of knowledge that is sufficient to support intelligent behaviour" (Bereiter, 2002). Understanding is essential in nursing practice. Nurses need to understand why they need to perform specific tasks, such as why malnutrition screening is necessary and why accurate anthropometry is needed.

Several studies have explored nursing understanding with regards to malnutrition screening. A review of the barriers and facilitators of malnutrition screening in community nurses reported that some staff had difficulty using the malnutrition screening tool correctly due to not receiving adequate training (Green & James, 2013). Some nurses further stated that completing the screening tool was a justifiable reason to refer to GPs and dietitians to receive nutritional supplements. These findings highlight that inadequate understanding of why malnutrition screening is used can act as significant barriers for screening to even occur (Green & James, 2013).

Perry, in 1997, used a survey that explored nursing nutritional attitudes and knowledge. He found that 71% of nurses in a UK hospital disagreed or strongly disagreed with the statement of 'it is important to assess the nutritional status of every patient admitted to the ward,' indicating that a large proportion of nurses did not think nutrition assessment was a priority. Conversely, in a Korean hospital, Kim and Choue (2009) used the same survey in the Perry (1997) study. They showed that only 31% of nurses disagreed or strongly disagreed with the same above statement (Kim & Choue, 2009). Despite a decrease in nurses disagreeing with the same statement between these two studies, Perry (1997) and Kim and Choue (2009) displayed that nurses still did not understand the nutrition assessment criteria and did not perform these assessments appropriately when put into practice. This lack of awareness and understanding of nursing' evidence-based practice has been reported across the literature (Baker et al., 2010; and Raja et al., 2008). Alarmingly, Raja et al. (2008) reported weight bias in screening, as obese patients were not considered "at-risk" and were therefore not screened by nurses compared to more consistent screening in patients who appeared underweight.

Furthermore, Raja et al. (2008) reported a relationship between nurses who demonstrated a lack of knowledge and decreased malnutrition screening rates. In two wards where nurses appeared to have a lack of knowledge the screening tool was completed in only 4% of patients (Raja et al., 2008). At SCH, there is some belief that malnutrition screening is not important (Lee, 2019). Some reasons behind

this belief included: the tool is a repetition of routine assessments; that screening is an extra task for nurses to complete in addition to referring for a dietitian; no evidence of patient improvement had been observed since the tool's implementation and uncertainty of what happened once obtaining their patient's malnutrition score (Lee, 2019). Additionally, nurses suggested they would like an explanation of why the tool was being used and wanted more knowledge about the tool's background. These statements indicate a degree of a lack of understanding of the benefits to using the STRONGkids tool and its importance in clinical and nutrition care plans (Lee, 2019).

These studies highlight the presence of a disconnect between nurses' understanding of malnutrition screening and its importance. Lack of awareness and understanding may have a negative impact on the perceptions and the application of malnutrition screening (this is explored further in section 2.4.3).

2.4.2. Competence and knowledge

Competence (also known as the ‘know-how’) is “a measurable human capability that is required for effective performance” (Marrelli, Tondora & Hoge, 2005). The WHO further defines it as "the successful demonstration of essential knowledge, skills, a personal characteristic (attitudes) and professional behaviour on a specific task, action or function in the work setting" (WHO, 2011). Competence comprise*s knowledge*, s*kill*, and a*ttitude* or a cluster of two or more of these attributes.

Knowledge can be described as awareness, information, or understanding about facts, rules, principles, guidelines, or concepts needed to perform a task successfully (Marrelli, 1998). Knowledge is acquired through learning and experience (Marrelli et al., 2005). A *skill* is the ability to perform mental or physical tasks with a specified outcome (Marrelli, 1998). *Attitudes* are essential in competence, as they may be needed for effective workplace performance. Attitudes can include work habits, interactions with others, or the management of oneself that can contribute to effective work performance (Marrelli et al., 2005).

Competence plays a role in professional practice, as both competence and understanding have a pivotal role in influencing an individual’s perception of a specific task. Nursing competence, specifically, is yet to have one universal definition due to the need for more research and development in this area (Fukada, 2018). A competent nurse must possess the above attributes (adequate knowledge, skills, and attitudes) (Fukuda, 2018). Still, they must also have the motivation and ability to use them to provide safe, effective, and professional nursing care to his/her patient (Fukada, 2018).

In a study of the implementation of the Malnutrition Universal Screening Tool (MUST) in two wards in Melbourne Hospitals, they reported low screening rates (17% and 62%) (Porter et al., 2009). When investigating these low screening rates, one of the themes that emerged from the focus group discussions with nurses was that a sense of competence was a barrier in the successful use of the screening tool (Porter et al., 2009). Furthermore, a decreased sense of competence was also highlighted as a key barrier in a systematic review of barriers to implementing change in health professional's practice (Baker et al., 2010). Low levels of competence meant these nurses felt either a lack of knowledge and skills or a negative attitude to implementing this screening tool, resulting in low screening rates (Porter et al., 2009). These findings highlight that if competence is thought to be low, this can result in another significant barrier to malnutrition screening and anthropometry taking occurring.

2.4.3. Perception

Perception can be defined as the "organisation, identification and interpretation of sensory information to represent and understand the presented information or environment" (Schacter, Gilbert & Wegner, 2011). Perception plays a crucial role in increasing nursing competency. An individual's understanding and competence (the know-how) to perform a specific task can determine one's perception of the task.

In a study of the perceived barriers of obtaining anthropometric measurements in critically ill children in Philadelphia, USA, 84% of nurses agreed that it was important to obtain these measurements. However, only 3% knew if these measurements were obtained during admission (Irving et al., 2015). Although nurses perceived anthropometry to be important, only 3% were actioning this perception. This finding was likely due to anthropometry being regarded as a low priority by nurses (Irving et al., 2005). Anthropometry being perceived as a low priority was also found in an audit of anthropometry practices in a children's hospital unit in England, where 86% of children had a weight recorded. However, none had a recorded height (Stoner & Walker, 2006).

In the previously mentioned study of the MUST tool's introduction into Melbourne hospitals, nurses stated they tended to rely on their own judgements and perceptions of patient need rather than screening universally (Porter et al., 2009). Overall, resistance to performing the screening was reported when the perceived benefit to the process was small (Porter et al., 2009). Raja et al. (2008) also found

a consistent finding that nurses perceived their professional judgement to be just as helpful in identifying patients at risk compared to the screening tools. Others also perceived there were specific skills required to complete the screening form, which had flow-on effects of being detrimental in confidence levels in performing malnutrition screening (Porter et al., 2009). Conversely, the same study found positive perceptions on the value of malnutrition screening were enablers in increasing screening rates by nurses (Porter et al., 2009).

These studies highlight that negative perceptions can limit nurses' abilities to apply evidence-based practice skills and knowledge to malnutrition screening and taking anthropometry. Nurses appeared to have low self-perception resulting in decreased self-confidence in performing screening, overall translating into lower malnutrition screening rates. On the other hand, those with more positive perceptions about the importance of screening had higher screening rates. These findings are consistent with the social learning theory, which will be discussed further in section 2.5.3.2.

2.4.4. Confidence and action

As eluded in sections 2.4.1 to 2.4.3 and in **Figure 2.1**, understanding, competence, and perception all play an essential role in an individual's confidence and, therefore, action for a given task. It should be noted that confidence and competence are often related together; however, they do not always co-exist. A nurse can be competent and can have the proper knowledge, skills, and attitudes to perform specific tasks, but confidence is said to increase over time with more exposure and experience (Chapman, 2018). In this section confidence and action will refer to nurses and their confidence in themselves in performing malnutrition screening and in taking anthropometry.

The previously mentioned Porter et al. (2009) study identified a lack of knowledge in the correct use of a newly implemented screening tool within the hospital setting. This adversely affected confidence in performing screening altogether, resulting in lower total screening rates (Porter et al., 2009). In the study of barriers and facilitators affecting community nurses performing malnutrition screening, Green and James (2013) identified that approximately a third of nurses agreed that they either lacked techniques in using the tool or found it difficult to identify malnourished patients. Both these examples of low confidence in using malnutrition screening tools showcase the potential for negative consequences on patient care.

In the 2016 study at SCH, 96% of nurses reported they felt confident in taking weight and height measurements in children (Ives, 2016). However, despite this level of nursing confidence, observation of taking anthropometry identified a lack of standardised equipment and, more importantly, key performance criteria not being met, resulting in increased measurement error. This indicated that while there may have been a level of understanding of how these measurements need to be taken, nurses did not have the competence (the know-how) to perform these measurements correctly, resulting in performance and action such as the key performance criteria not being met. Nurses also expressed confidence in taking these anthropometric measurements; however, this was not apparent on observation. These findings are consistent with a cognitive bias, referred to as the overconfidence effect (Ives, 2016). Where an individual's subjective confidence in their ability to perform a task is more significant than their actual ability to perform the task (Moore & Healy, 2008). Nursing overconfidence has been shown to negatively affect clinical judgement and decision-making (Baumann, Deber & Thompson, 1991).

2.4.5. Conclusion

Many barriers exist in nursing practice that may affect the ability to perform universal malnutrition screening and taking accurate anthropometry measurements. Although most of the above studies were not specific to paediatrics, they provide valuable insights into the barriers that affect nursing clinical competency for the particular tasks of malnutrition screening and taking anthropometry. These barriers imply that ongoing education, training and support are needed to increase understanding, competence, perceptions, confidence, and therefore action. By having education programs that target these factors, a greater awareness of the importance of malnutrition screening and accurate anthropometry taking in children will follow.

2.5. Training programmes

2.5.1. Development and assessment of an educational training program

When developing an educational training programme for adults, important considerations must be made such as understanding the perceived barriers or enablers being experienced. In the present study, this refers to nurses using the malnutrition screening tool and taking accurate anthropometry measurements. When developing an effective training programme, there are three essential phases involved such as (Goldstein, 2002).

1. Assessment phase.
2. Training design.
3. Evaluation.

2.5.2. Assessment phase

The assessment phase is usually measured through a needs assessment which consists of three steps (Goldstein, 2002). *Organisational analysis*, where the goals of the organisation are understood and how training could potentially contribute to these goals. *Task analysis*, where the tasks, knowledge, skills, and attitudes of an individual's needs to fulfil their job role are assessed. Finally, *person analysis*, where the current knowledge, skill level, and attitudes of an individual are determined and then compared to the performance criteria needed on the job (Goldstein, 2002).

2.5.3. Training design phase

For a training programme to be effective, it needs to be tailored to a specific audience (Goldstein, 2002). In the present study, the specific audience is paediatric nurses. It is crucial to understand how different individuals learn and how they process information. These different learning styles can be explained as learning theories, some of which are briefly described below.

2.5.3.1. Adult learning theory

According to Driscoll (1959) and Knowles (1984), adults learn differently from children, despite sharing many common characteristics. They are motivated to learn in order to respond to problems and changes while having more life and work experiences to draw on. They are continuous learners, have responsibilities beyond the training situation, expect that the learning to be meaningful, and prefer to manage their own learning (Driscoll, 1959).

2.5.3.2. Social learning theory

This theory acknowledges that behaviour, cognition, other personal factors, and environmental events can influence each other and vice versa (Bandura, 1986). People process information concerning their perceived self-efficacy (an individual's belief in their ability to perform a specific task) (Badura, 1977). It is hypothesised that despite an individual having the correct knowledge and skills, there is a correlation between an individual's perceived self-efficacy and their performance on the job (Bandura, 1982). In a real-life example, if there is a perceived low self-efficacy, this may prevent individuals from using their knowledge and skills and will likely negatively impact job performance (Bandura, 1982). Low self-efficacy affecting on-the-job performance can be related to the concept of competence vs confidence. Competence and confidence do not always co-exist (as discussed in section 2.4.4); however, a lack of confidence can negatively impair an individual's attitude toward a specific task and doubt their ability to perform this task, despite having the competence (know-how) to do so. These findings were identified in the 2019 study at SCH (Lee, 2019), where nurses stated they lacked confidence in using the current screening tool. A lack of confidence indicates that the perceived low self-efficacy impaired the nurses' ability to use their knowledge and skills when performing malnutrition screening, which could have ultimately led to low malnutrition screening rates.

2.5.3.3. Learning space theory

Learning space theory describes learning as being influenced by the relationship between the learner and the environment. The learner's environment is divided into four domains: *microsystem* (the learners immediate setting, e.g., the training facilitator/educator)*; mesosystem* (the learner's concurrent settings in their lives, e.g., colleagues, friends, family); the *ecosystem* (the social structures that influence the individual's immediate environment, e.g., the culture of the training organisation) and the *macrosystem*

(the broader institutional values of the widespread culture) (Kolb & Kolb, 2005). Learning space theory was demonstrated at SCH, where a nurse stated: "…they were less likely to perform malnutrition screening because they saw no one else doing it" (Lee, 2019). In this example, the mesosystem (i.e., colleagues) significantly influenced an individual's learning and behaviour when performing the malnutrition screening task (Lee, 2019).

2.5.3.4. Experiential learning theory

Experiential learning theory describes learning as a result of knowledge created through the change of experience. Moreover, knowledge can result from the combination of grasping experience (including concrete and abstract experiences) and transforming it (includes reflective observation and active experimentation) (Kolb, 1984). Therefore, experiential learning creates knowledge that involves a creative tension among the four learning processes mentioned above (Kolb & Kolb, 2005).

2.5.4. Evaluation

Evaluating a training tool is defined as a measurement technique that analyses whether the training program has met the intended goals. Evaluation measures can include evaluating the learners' training content and design, organisational payoffs, and changes to learners' on-the-job performance (Alvarez, Salas & Garofano, 2004). Evaluation measures can also include assessing competence, therefore assessing health professionals' ability to provide effective patient care (Greiner et al., 2003).

In 1998, Kirkpatrick and Kirkpatrick created an evaluation model that included four levels representing a sequence of steps for evaluating training programs (Kirkpatrick & Kirkpatrick, 2006). Each level is necessary and interacts with the next level and becomes progressively more time-consuming. However, no level should be skipped (Kirkpatrick & Kirkpatrick, 2006). The four levels are as follows.

- Level 1 – Reaction. How those who participate in the program react to it.
- Level 2 – Learning. In which the training program changes participants' attitudes, improves knowledge, and increases skills.
- Level 3 – Behaviour. In which the training program changes the participants' behaviour.
- Level 4 - Results. The final results obtained after the participants partake in the training program, which includes on-the-job performance (Kirkpatrick & Kirkpatrick, 2006).

While Kirkpatrick and Kirkpatrick's method (2006) are widely used (Reio, Rocco, Smith & Chang, 2017), Bushnell (1990) claimed that it only evaluates what happens straight after training has occurred. Bushnell (1990) proposed an alternative model that explores inputs, processes, and outputs of evaluating training programs summarised in **Figure 2.2.**

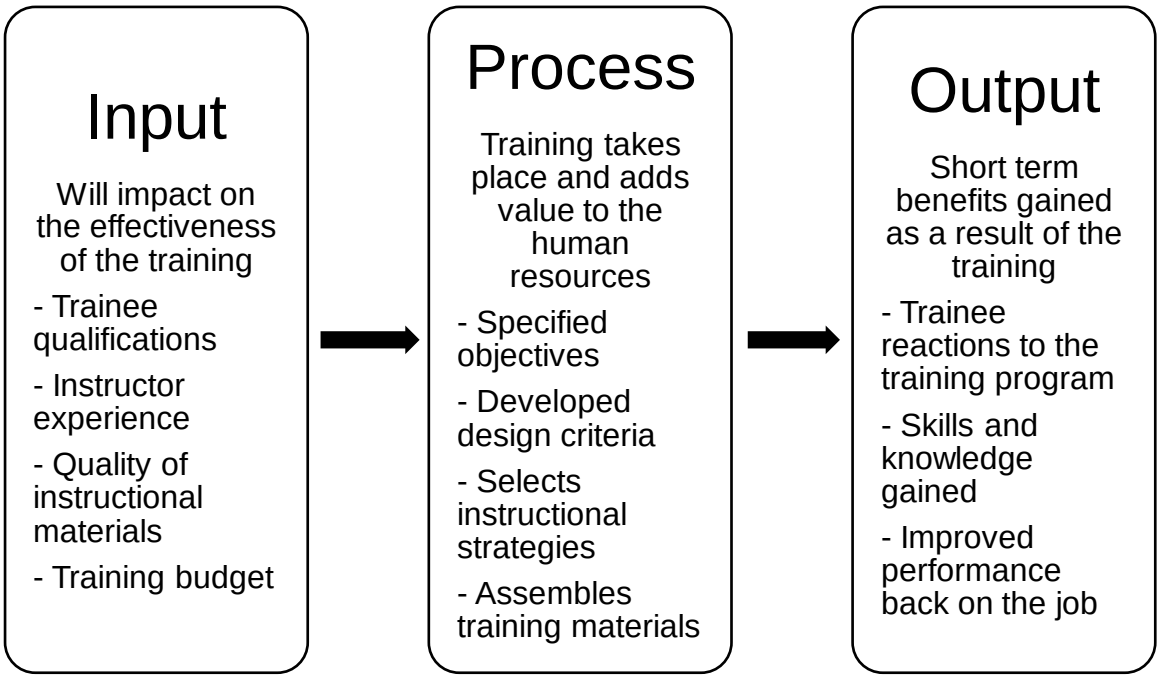

Figure 2.2. Input, Process and Output (IPO): A Model for Evaluating Training (Bushnell, 1990).

2.5.4.1. Competency-based assessment

Assessing competency can be included in training evaluations as it considers on-the-job performance (Bushnell, 1990; and Kirkpatrick & Kirkpatrick, 2006). Competency is essential for health professionals, as competency-based approaches to assessment, staff development, and training are viewed as a central strategy for improving patient-centred care that is deemed effective (Greiner et al., 2003). Competency-based assessment includes the “process or tools used to measure the ability of trainees to apply their education to practice” (Palermo, Gibson, Dart, Whelan & Hay, 2017). Miller in 1990, proposed a framework for assessing clinical competency in medical education. He realised that while gaining knowledge is the first step in the framework, it is not enough to show competence. When

developing training programs with competency-based assessments, it is crucial to consider that the assessment methods encompass all four stages, which include:

1. Knows (knowledge) – the participant understands what is required to carry out the task successfully.
2. Knows how (competence) – the participant knows how to apply the knowledge in given situations.
3. Shows how (performance) - the participant shows how to apply the knowledge in given situations.
4. Does (action) – the participant applies the knowledge in action independently (Miller, 1990).

When developing a training tool for education purposes, it is essential to remember that the needs must be assessed. Tool design is a significant consideration and must reflect the different learning environments that adults may learn. Finally, the evaluation phase is just as important as the design phase. Competency is often used as an evaluation technique to assess a health professional's ability to provide appropriate care for patients. Competency can be used to evaluate whether a training tool has effectively influenced knowledge, skills, and attitudes.

2.5.5. Nurse education and training programmes

Many of the barriers highlighted in section 2.4 can be overcome by designing and implementing appropriate training and education tools, which have been developed to increase overall competency (Green & James, 2013). Currently, there is limited literature on the successful implementation of educational tools for nurses in various healthcare settings in malnutrition screening and anthropometry taking in paediatric populations (Gance-Cleveland, Sidora-Arcoleo, Keesing, Gottesman & Brady, 2009; Sungaya et al., 2013; and Valla et al., 2015). However, some hospitals have trialled introducing aspects of malnutrition screening or anthropometry education to increase nurses' confidence and competency (Valla et al., 2015; and Westergren et al., 2016).

Raja et al. (2008) reported that the level of support and type of education offered to nurse staff (instead of sole characteristics of individual screening tools) were essential aspects in tool completion rates. This finding highlights the importance of induction programs for new staff, continuing education, and increased feedback to nurses regarding screening practices to ensure all patients at risk of malnutrition

are identified correctly (Raja et al., 2008). Additionally, nurses reported being more receptive to screening when ongoing training and support were provided (Porter et al., 2009; and Green & James, 2013).

2.5.6. Current training programmes

Current training programs aimed at nurses have been reported in the literature (Bjerrum, Tewes & Pedersen, 2012; Gance-Cleveland et al., 2009; Valla et al., 2015; and Westergren et al., 2016) and are summarised in **Table 2.4**. A study in adult nursing homes found that a study circle intervention of training precision in nutritional treatment effectively increased nursing knowledge and care for nutritional assessments/treatments. However, the training was time-consuming (9-10 hours/staff member) and required intense facilitation and organisation. Being short of time is a barrier that has been reported by SCH nurses (Lee, 2019). In addition to Westergren et al. (2016) findings, this highlighted the importance of education programs needing to be quick, easy to understand, and flexible. Westergren et al. (2016) then created a computer-based training module for nursing staff in nutrition and eating (including education on screening for malnutrition risk), which could influence nutritional treatment and care precision. The results showed that the computer-based training appeared to increase staff's precision in nutritional treatment and resulted in the increased probability of patients at risk of undernutrition being identified and then receive treatment (Westergren et al., 2016). Limitations to this study included the inclusion of different hospital sizes, which resulted in different case mixes. This limitation was a known weakness to the authors, as prevalence figures and nutritional treatment/care regimens were not the same between the hospitals used in the study (Westergren et al., 2009). Another limitation was that several people were involved in the data collection, which could have introduced bias. Still, this was needed to obtain a large sample size representative of routine clinical care (Westergren et al., 2016). The Westergren et al. study (2016) is summarised further in **Table 2.4.**

Specifically, in the paediatric population, Valla et al. (2015) explored whether a targeted nutritional assessment teaching program for anthropometric measurements would improve critically ill children's nutritional status assessment in France (Valla et al., 2015). The study included a baseline evaluation of nutritional assessment, knowledge, anthropometric measurements (weight, height, HC, and MUAC), and nutritional index calculations in patient files. Following this was a training program to implement redeveloped nutritional assessment guidelines, including anthropometrical measurements and their

interpretation through one-on-one teaching. After the intervention, the knowledge questionnaire that was delivered before the training was repeated again. The impacts of the teaching program were reviewed annually, two years post-implementation (Valla et al., 2015). Before the intervention, 54% and 67% of staff were aware of malnutrition's role in the immune system and morbidity/mortality, respectively. Additionally, only 47% felt confident in nutritional assessment.

Over the two years, results showed that the percentage of children with completed nutritional anthropometric measurements on record increased from 20% to 99%. Thus, 70% had a written nutritional plan as a result in their medical records. Height, HC, and MUAC measurements had the greatest increase in being completed. Due to the training program, the authors improved the general knowledge about malnutrition consequences significantly and the nurses' confidence to adequately perform nutritional assessments (Valla et al., 2015). The Valla et al. (2015) study confirmed that a specialised training program increased nursing confidence in malnutrition screening and in taking anthropometry, which was reflected in improved percentages of completion. Nursing competency also improved through the training which addressed factors such as knowledge, skills, and attitudes. Although this study was only conducted in the PICU setting and therefore is not a reflection of a hospital-wide implementation, it can guide the development of new training programmes for nurses in other paediatric hospitals and wards. Over time this could improve nursing competency in malnutrition screening and taking anthropometry in children.

Table 2.4. Summary of training programs used to educate nurses in nutrition screening and anthropometry taking.

Study	Setting	Study design	N= participants	Intervention	Length of training	Results
Westergren[a]	Adult inpatient hospitals, Sweden	Pre-post intervention study, cross-sectional design	354 registered nurses and nurse assistants	Interactive computer-based training in eating and nutrition (including malnutrition screening, nutrition interventions, and monitoring, additional case studies and quizzes to support learning).	50-60 min	• Increased precision in nutritional treatment. • Increased probability of patients at risk of undernutrition to be identified and receive nutritional treatment. • Inclusion of varying hospital sizes resulting in different case-mixes. • Potential bias due to several people involved in the data collection.
Valla[b]	PICU, France	Single-centre prospective study	145 PICU nursing staff	Individual teaching of the newly developed nutrition assessment guidelines (including anthropometry measurements and their interpretation).	Not stated, completed during daily work.	• Improvement in nutritional awareness and confidence about nutritional assessment. • Improvement in knowledge about undernutrition and its consequences. • Increase in anthropometric measurements recorded. • Only performed in one specific hospital ward.
Bjerrum[c]	University hospital, Denmark	Intervention study with focus groups	16 registered nurses	Based on experimental learning theories with five learning modules (including risk assessment and consequences of malnutrition).	3-4 days	• Change in knowledge of nutrition. • Nurses felt more secure and strengthened in their ability to take responsibility for more nutrition management. • Short duration training was not enough to achieve the nurses' full understanding of their responsibility for nutrition care.
Lipman[d]	Primary care providers, USA	Multi-centred randomised controlled intervention	112 registered nurses and nurse aids/medical assistants	Training session including presentation and handouts of growth disorders and growth monitoring techniques, demonstration of correct length/height measurements. Pre- and post-test to evaluate change in knowledge.	Not stated	• Significantly improved accuracy of linear measurements (30% measurements accurate at baseline compared to 55% post-intervention). • Incorrect technique was found to be a major factor (70% of children) contributing to inaccurate measurements. • Failure to use correct techniques was found to be a lack of knowledge.

PICU = Paediatric Intensive Care Unit. [a](Westergren et al., 2016); [b](Valla et al., 2015); [c](Bjerrum, Tewes & Pedersen, 2012); [d](Lipman et al., 2004)

2.5.7. Current malnutrition and anthropometry training for nurses at SCH

During the implementation of the STRONGkids tool in 2018 (in wards 26B (Medical Specialities), 26A (Neuroservices) and 25 (General Paediatrics)), and the remainder of SCH in 2019, training was provided daily for a period of 1-2 weeks by ward dietitians during nurse meetings (Lee, 2019). Training sessions were approximately 10 minutes long, where there was a brief explanation by the ward dietitian on how to use the tool. If nurses missed out on this training, they received training from the ward's nurse educator or senior nurse. Newly employed nurses were provided training for using the tool by the ward's nurse educator or senior nurse when receiving their nurse package (Lee, 2019). In semi-structured interviews, nurses stated that if they had missed out on training altogether, they learnt on the ward from other nurses (Lee, 2019). When Ives (2016) conducted anthropometry research, 96% of nurses responded that they were confident in taking weight and height measurements at SCH. Yet only 12% had received formal training from a clinical nurse educator and 4% from a dietitian, with the majority of nurses (59%) receiving training from other nurses on the ward (Ives, 2016).

Currently, there is no formal initial or ongoing training for malnutrition screening and taking anthropometry for new nurses or continuing support for current nurses. Having a training module that is widely available to nurses via existing online learning platforms would ensure standardised procedures for taking weight and height/length. A training programme would also provide ongoing support and education on the importance of malnutrition screening (Ives, 2016).

2.6. Conclusion

In conclusion, there are limited nursing education programs specifically aimed at increasing knowledge, confidence, skills, and attitudes in malnutrition screening and taking anthropometry in paediatric populations. Nurses have reported targeted education programs on specific nutritional assessment aspects in adult populations to be very time-consuming for staff, which resulted in computer-based education being a more useful tool in terms of time efficiency (Westergren et al., 1977). Studies on nursing perceptions on using screening tools have also highlighted the need for malnutrition screening training to be part of staff induction programs and ongoing education and training to enable nurses to

be more receptive to the use of malnutrition screening tools (Porter et al., 2009; and Raja et al., 2008). In the paediatric population, a training tool that taught standardised methods of measuring anthropometry improved general knowledge of malnutrition, its consequences and improved nursing confidence and competency in performing nutritional assessment (Valla et al., 2015). Overall, the training tool showed an increase in the completion of malnutrition screening and correct anthropometry taking (Valla et al., 2015).

2.7. Aim and objectives

The aim of this pilot study was to develop, deliver, and evaluate the feasibility of an online learning module for nurses that describes the use of malnutrition screening tools and their role in the patient care continuum and standardised weighing and measuring techniques for inpatients at SCH.

This study has four main objectives:

1. To develop an online education tool suitable for nurses to use efficiently and effectively;
2. To measure a change in nurse knowledge on the importance of malnutrition screening in the hospital setting and the relationship between the screening tool and accurate anthropometric measurements;
3. To measure a change in nurses' knowledge, confidence, and ability in performing anthropometric measurements on children and infants;
4. To evaluate whether the online education tool is feasible for use in the long term.

Chapter 3. Methodology

3.1. Setting

Starship Child Health (SCH) is a paediatric hospital located in Auckland, New Zealand. It provides a range of health services for children throughout NZ and the South Pacific. SCH provides inpatient, outpatient services (through various clinics across Auckland), day stay, and community settings. There are eight wards, which include: 23B (cardiology), 24A (orthopaedics), 24B (general surgery), 25 (general paediatrics), 26A (neurology, neurosurgery, endocrinology, and metabolic), 26B (medical specialities), 27A (haematology and oncology day stay and clinic), 27B (haematology/oncology), Paediatric Intensive Care Unit (PICU), Children's Emergency Department (CED) and a Day Stay Unit. As well as being a paediatric hospital, it is also a major teaching centre and aims to lead the nation in paediatric training and research (Starship, 2019).

3.2. Recruitment

Nurses for the project were recruited through liaising with the ward charge nurses or nurse educators. The student researcher then introduced the research project to the ward nurses by attending each ward's Management Operating Systems (MOS) meetings 2-3 times per week. Following the meetings, hard copies of the participant information sheet (PIS) (see Appendix A), a flow diagram of the project's process (see **Figure 3.1**) and a recruitment poster (see Appendix B) were left at the ward's reception. These recruitment posters were displayed in common nursing spaces for increased visibility and participation. A participant koha was included to increase participation.

Further recruitment was conducted through the student researcher's personal contacts at SCH, which helped increase nurse participation. If nurses indicated they wanted to participate, they were directed to a Qualtrics® (Qualtrics, 2021) link to provide e-consent and then complete the pre-test. Participants also had the option of downloading the consent form as a PDF file (see Appendix C). Failure to provide consent meant no further participation was necessary.

3.2.1. Participants

Nurses were recruited from wards 23B, 24B, 25, 26A and 26B. These wards were previously reported to complete malnutrition screening in 34%, 41%, 88%, 65% and 67% of patients on admission, respectively and regularly measure anthropometry throughout patient admissions. This data was obtained from the 2019 audit of SCH malnutrition screening practices (Lee, 2019).

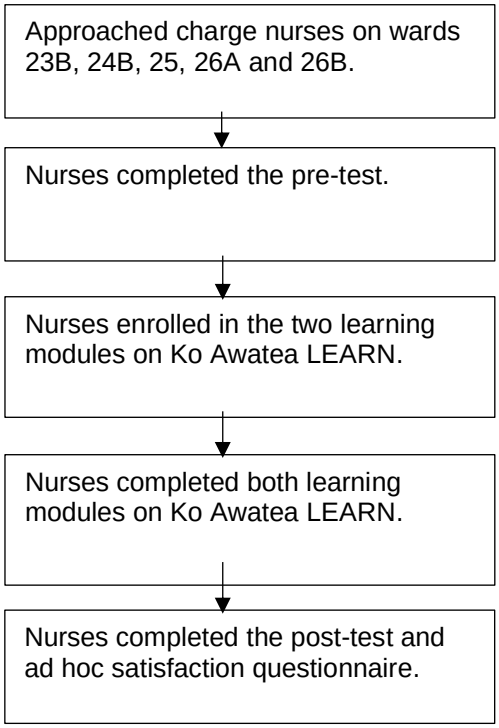

Figure 3.1. Process of implementing the learning modules at SCH.

3.2.2. Eligibility

All nurses who worked at SCH and were involved in malnutrition screening on patient admission and regularly took and recorded patient anthropometry on the ward were eligible for this study. Additionally, participants had to be willing and able to complete the online learning modules, the associated pre/post-tests, and the ad hoc satisfaction questionnaire. Participants were not eligible if they decided not to participate or had a hearing or visual deficit that would make using a computer to complete the learning modules and associated tests difficult.

3.3. Study design

This study consisted of two parts. Part one involved developing and piloting two online learning modules delivered to nurses in wards 23B, 24B, 25, 26A and 26B using the Ko Awatea LEARN platform at SCH over two weeks in February 2021. Part two involved evaluating the learning modules using a prospective pre-post study design and an ad-hoc satisfaction questionnaire.

3.4. Part one. Developing online learning modules

The online learning modules were developed over an eight-week time frame. The modules were developed for use by nurses who completed malnutrition screening on patient admission and regularly took anthropometric measurements of inpatients. The learning modules consisted of two modules which aimed to provide:

a) Succinct information on the role of malnutrition screening tools in patient care; and
b) Instructions on taking accurate anthropometry in infants and children using instructional videos of standardised measuring techniques.

The learning modules were web-based and developed on the Auckland District Health Board's (ADHB) learning platform Ko Awatea LEARN. Storyboards were created as a basis for designing each of the learning modules (see Appendix D) alongside a script. From there, the development of the modules began on Ko Awatea LEARN with initial help from ADHB's Instructional Designer and LMS Administrator. Each learning module was presented in the course presentation format and included interactive videos and questionnaires after key sections to assist with learning. An instructional video on how to use the STRONGkids screening tool and its documentation process was created on Adobe© Premiere Pro – Video Editing Software (Adobe, 2021). The video helped ensure that information on how to use the STRONGkids screening tool and its correct documentation was conveyed in an easy-to-understand video. The development and link to this video are found in Appendix E. The learning modules were designed to take nurses 30-40 minutes to complete, with the ability to complete one module and the other at a later date. The minimal time was to ensure that these modules would not create any additional burden or time pressures within the busy ward environment.

The modules were developed with regular input from clinical paediatric dietitian's Stella Friedlander and Kim Herbison at SCH. This input ensured that the information on malnutrition screening and standardised procedures for taking anthropometry were correct and applicable. The final result was two modules; 1: Malnutrition Screening and 2: Weighing & Measuring Infants and Children (see Appendix F). The anthropometry module was named 'Weighing & Measuring Infants and Children' to avoid confusion if some nurses were not familiar with the term anthropometry.

Before implementing the pilot for general ward nurses, the learning modules were sent to several nurse educators on wards 24B, 25 and 26A for final feedback. This feedback ensured that the information delivered was practical and applicable to nurses in the ward setting. It was hoped that these learning modules delivered via Ko Awatea LEARN would allow easy integration into regular continued professional development for the current nursing staff and be included as an onboarding activity for new nursing staff. A summary of the learning modules' development process over the eight-week time frame is displayed in **Figure 3.2.**

3.4.1. Module learning outcomes

Research on the use of training programmes for adult learners (Driscoll, 1959 and Knowles, 1984) was used to inform and guide the module learning outcomes. In order to incorporate the malnutrition screening and anthropometry modules into the yearly continued professional development schedule for nurses, two sets of intended learning outcomes were developed.

Module 1 Learning Outcomes:

By completing the online learning modules on malnutrition screening, nurses should be able to:

1. Discuss the importance of malnutrition screening;
2. Apply the process of malnutrition screening using the STRONGkids screening tool;
3. Discuss the use of weighing and measuring as a means of monitoring patients assessed to be at high risk of malnutrition following the screening.

Module 2 Learning Outcomes:

By completing the online anthropometry training module, nurses should be able to:

1. Measure an infant or child's weight;
2. Measure an infant and child's length or height.

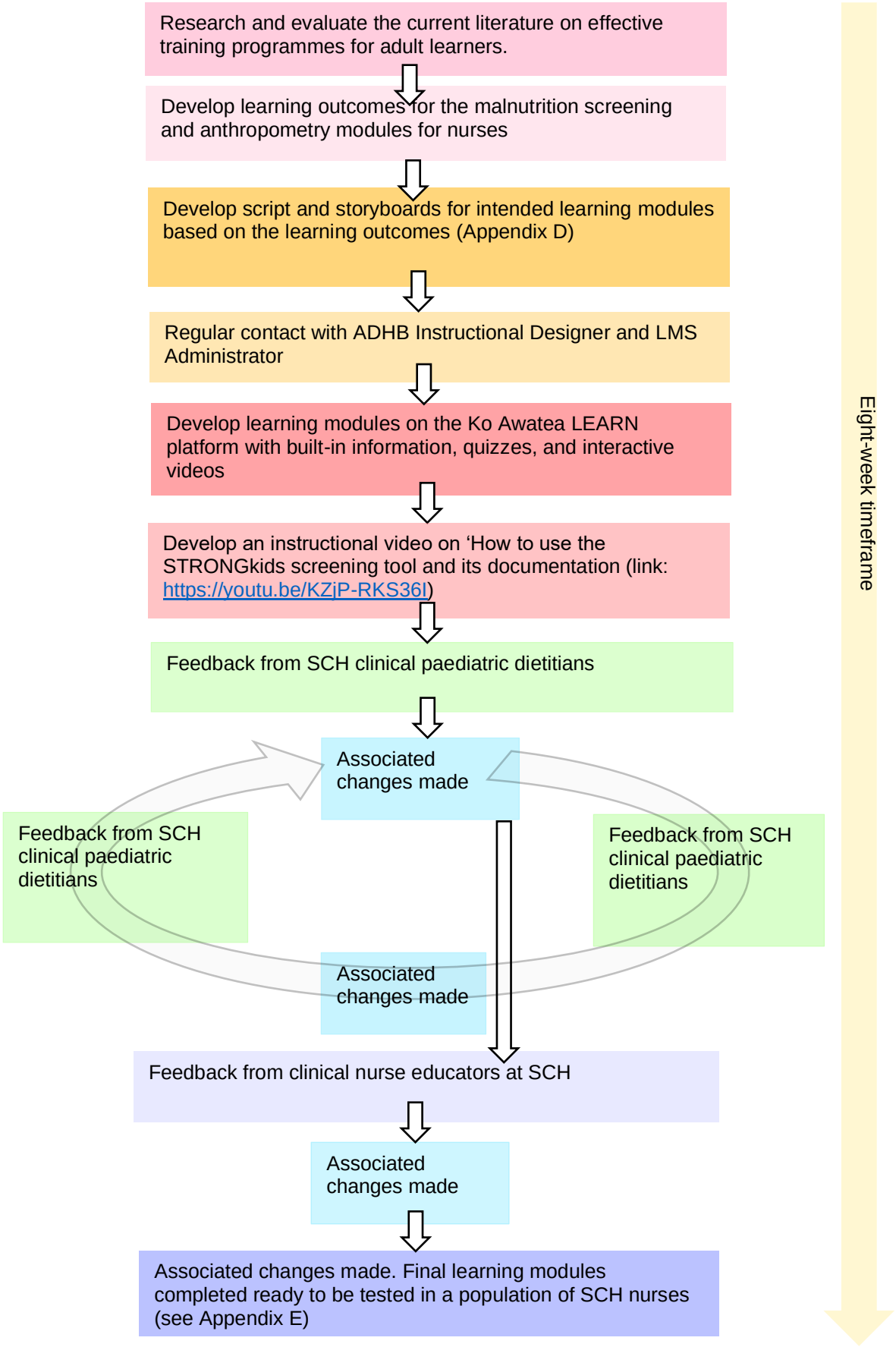

Figure 3.2. The process of developing the online learning modules for nurses at SCH.

3.4.2. Testing the online learning module in a convenience sample of nurses

The online learning modules were tested using a convenience sample of nurses at SCH (N=51). Ward distribution included wards 23B, 24B, 25, 26A and 26B. The study's recruitment and promotion were conducted by attending the daily MOS meetings for each ward 2-3 times per week. Attendance at these meetings ensured that most nurses working in each ward were introduced to the current project and given the opportunity to participate. Firstly, a short introduction of the implementation of malnutrition screening and standardised anthropometry protocols which began in 2016 at SCH and was used to bring the current project into a broader context for the nurses. Secondly, a brief explanation of how the pre-test, learning modules, and how the post-test would operate then followed. Invitation emails (see Appendix G) were sent to the ward's charge nurses, along with the PIS and flow diagram (see **Figure 3.3**). During the second week of testing, further emails were sent to nurses through nurse educators or charge nurses to remind the ward nurses of the research (see Appendix G). Recruitment was enhanced further through the student researcher's affiliation with nurses on wards 23B and 25, increasing recruitment uptake and consent to participate. The testing phase occurred over two weeks with regular contact with charge nurses or nurse educators through email or face-to-face conversations.

3.5. Part two. Evaluating the effectiveness of the online learning module

Evaluation of the online learning modules was divided into two phases:

A) Prospective pre-post testing, where nurses were required to take the same test before and after completing the learning modules
B) An ad hoc satisfaction questionnaire completed at the end of the learning modules.

3.5.1. Prospective pre-post test

The online learning modules' effectiveness was evaluated using a prospective pre-post study design. This involved the nurses taking the pre-test to evaluate baseline knowledge, completing the learning modules on Ko Awatea LEARN, then completing post-test to evaluate a change in knowledge. Nurses

also had to complete an ad hoc satisfaction questionnaire after completing the learning modules. This evaluation allowed the determination of the level of knowledge attained through completing the modules and change in critical thinking skills associated with malnutrition screening and taking accurate anthropometry.

The test included six questions developed on the Qualtrics® software (Qualtrics, 2021) (see Appendix H). All questions were based on the module's learning objectives (Section 3.4.1.). A summary of the questions used with the rationale behind each question in the pre-/post-test is displayed in **Table 3.1.** The first question used a 5-point Likert scale (strongly disagree to strongly agree) on whether nurses agreed or disagreed with the statement. The remaining questions (question two to question six) were multiple-choice questions.

Table 3.1 Summary of the rationale behind each question in the pre-/post-test.

Question	Rationale
1. Malnutrition screening for patients admitted to Starship Hospital is important.	Allowed insights into whether the learning modules had influenced nurse perceptions of malnutrition screening.
2. Malnutrition screening should (choose 2).	Allowed insights into the nurses' general understanding of malnutrition screening.
3. Where would you document the result of the malnutrition screen for a patient (choose 1).	Designed to find out the nurses' understanding of the documentation processes following malnutrition screening.
4. Why is it important to accurately weigh and measure infant and children? (choose 3).	Designed to assess nursing understanding of why accurate anthropometry in infants and children is important.
5. When weighing a child over 2 years of age (choose 1).	Designed to assess nursing knowledge and understanding of important standardised procedures when weighing children based on the WHO's *Training Course on Child Growth Assessment*[a].
6. When measuring a child's length or height (choose 3).	Designed to assess nursing knowledge and understanding of important standardised procedures when measuring a child's length or height based on the WHO's *Training Course on Child Growth Assessment*[a].

[a](WHO, 2008).

3.5.2. Ad hoc satisfaction questionnaire

An ad hoc satisfaction questionnaire (Appendix F) was administered through Qualtrics® (Qualtrics, 2021) after completing the online learning modules to determine the overall acceptability and feasibility of a wider implementation of the modules. All six questions asked nurses to rate on a 5-point Likert scale (strongly disagree to strongly agree) to rate the level at which they agreed or disagreed with each statement. A summary of the statements used with the rationale behind each statement in the ad hoc satisfaction questionnaire is displayed in **Table 3.2.**

The questionnaire helped establish the nurses' perceptions of how effective the modules were in improving understanding and knowledge of using the malnutrition screening tools and providing practical skills in taking anthropometry. Additionally, the questionnaire determined whether the learning modules improved nurses' confidence in implementing these skills into taking anthropometry. Furthermore, findings from the ad hoc satisfaction questionnaire were used to provide evidence for the inclusion of these modules as mandatory training on Ko Awatea LEARN, either as 'Clinical Mandatory Training One Time Completion' or as a 'Clinical Mandatory Training Refresher'. These findings also informed if the learning modules should be stand-alone modules or whether they should be incorporated into pre-existing modules for nurses to avoid Ko Awatea module fatigue.

Table 3.2. Summary of the rationale behind each statement in the ad hoc satisfaction questionnaire.

Statement	Rationale
1. I found the malnutrition module useful for my practice.	To determine whether nurses perceived the malnutrition screening module to be useful for their practice.
2. I feel well informed about the malnutrition screening process and its importance.	To ascertain whether nurses felt informed about the malnutrition screening process and its importance.
3. I found the weighing and measuring module useful for my practice.	To determine if nurses found the weighing and measuring module (anthropometry) useful for their practice.
4. I am confident in taking height/length and weight measurements in infants and children.	To evaluate nursing confidence levels in taking height/length and weight measurements in practice.
5. I feel that nurses should repeat the weighing and measuring module regularly.	To determine whether nurses felt repeating the weighing and measuring module regularly would be helpful for their practice.
6. The format for both modules was clear and useful.	To determine whether nurses felt that the learning modules were user friendly.

3.6. Data collection

3.6.1. Prospective pre-post testing

The prospective pre-post-tests (see Appendix H) were generated using Qualtrics® software (Qualtrics, 2021). The link to these tests was provided via email, on the hard copies of the flow diagram (**Figure 3.2**) left on the ward, or the link provided on the home page of the learning modules on Ko Awatea LEARN. Nurses had to complete this test before undergoing the learning modules. Upon completion of these modules, nurses took the same test. Both tests contained the same six multiple-choice questions (MCQs), which covered malnutrition screening and standardised methods for taking anthropometry. Test results were returned directly to the student researcher through the Qualtrics® software (Qualtrics, 2021).

3.6.2. Ad hoc satisfaction questionnaire

The ad hoc satisfaction questionnaire was also generated using Qualtrics® software (Qualtrics, 2021) and was included at the end of the post-test. Nurses completed this questionnaire upon completion of the learning modules. Questionnaire results were returned directly to the student researcher through the Qualtrics® software (Qualtrics, 2021).

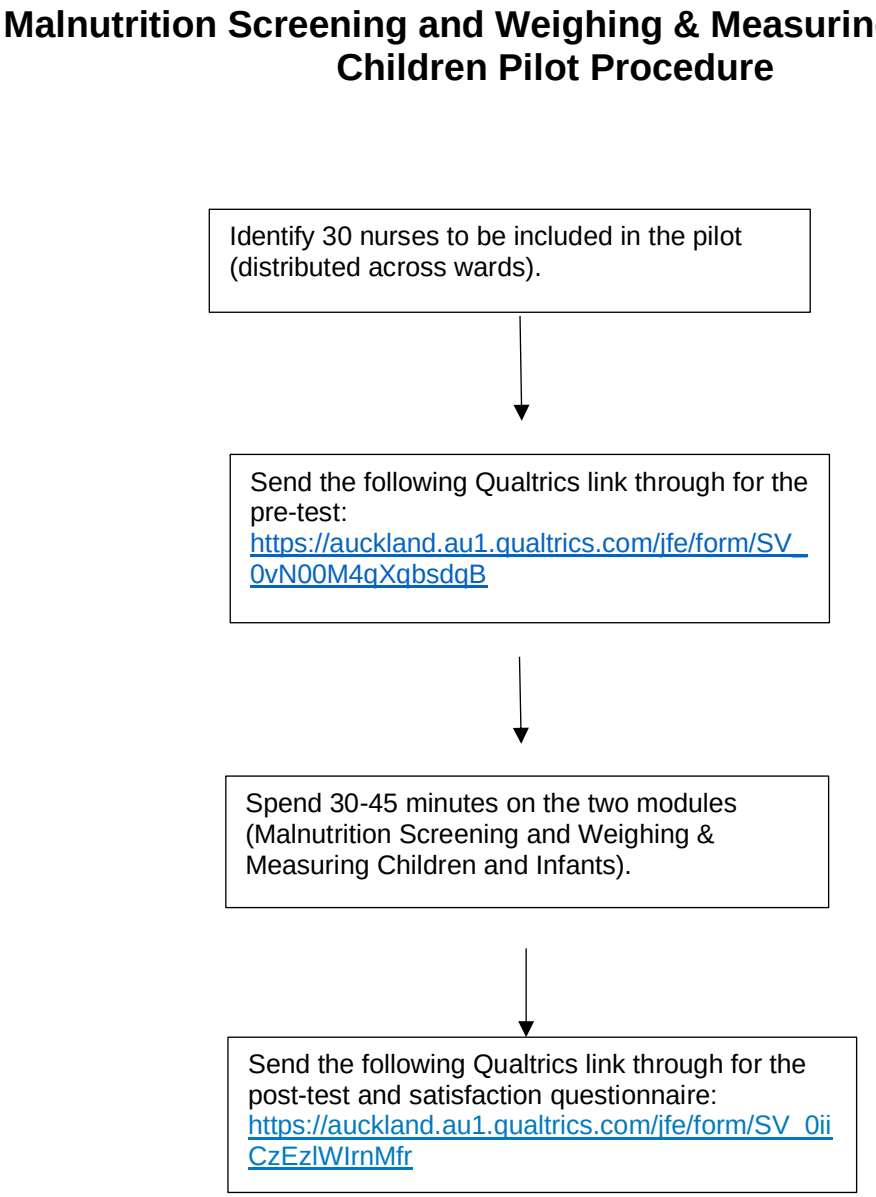

Figure 3.3. Flow diagram of the pilot procedure given to nurses at Starship Child Health, Auckland District Health Board.

3.7. Data analysis

Statistical analysis was conducted using Microsoft® Office Excel® software version 16.44 (Microsoft, 2020) and IBM® SPSS® Statistic Data Editor version 26 (IBM, 2021). A descriptive assessment of the test outcomes at pre-test and post-test was completed, including the average test scores and responses from the nurses. Additionally, the ad hoc satisfaction questionnaire's data analysis was also a descriptive assessment.

The data were checked for normality, and due to the spread of answers not being normally distributed, it was decided that non-parametric statistical testing was to be used. A Wilcoxon signed-rank test (the non-parametric counterpart of the paired *t*-test) was performed to determine whether there were differences in the participant's pre-test scores compared to their post-test scores after completing the learning modules. The Wilcoxon signed-rank test was used as the data met all of the assumptions, including only one group of participants being used in the study that were related, i.e., nurses at SCH. Pearson's product-moment correlation was used to measure the correlation between the SCH nurses' post-test scores and the difference in their pre-and post-test scores.

Further comparisons of the pre-test and post-test scores were carried out to assess individual knowledge before and after completing the online learning modules. Each correct MCQ answer was worth 16.7% (a maximum score for six correct MCQs was 100%). A higher score or improvement in scored indicated a better level of knowledge gained.

3.8. Ethical considerations

The study was approved by the University of Auckland Health Research Ethics Committee on 23/07/2020 (AH1390).

Chapter 4. Results

4.1. Participants

A total of n=51 nurses completed the pre-test, the two learning modules on Ko Awatea LEARN, the post-test and the ad hoc satisfaction questionnaire over two weeks in February 2021 (**Figure 4.1**). The following nurses were excluded from the study; one nurse (2%) completed only the pre-test and did not complete the modules and post-test. Four nurses (7%) either enrolled in the learning modules or completed only one module and not the other on Ko Awatea LEARN.

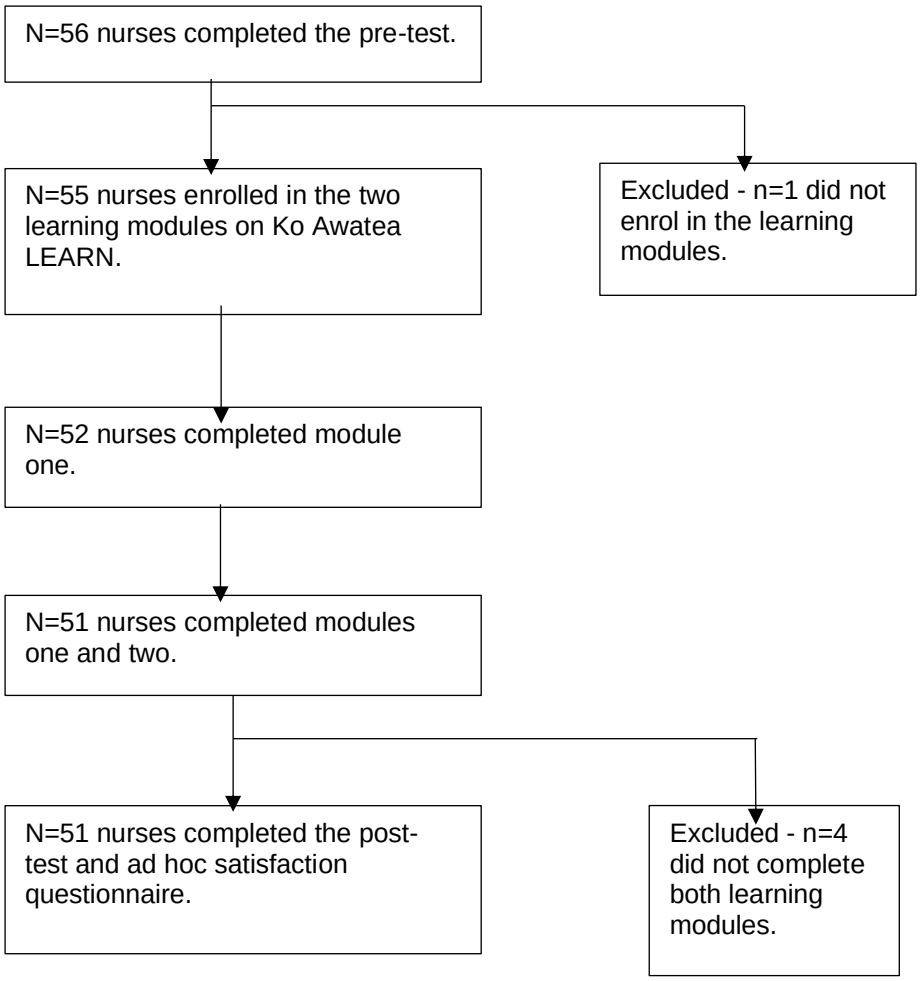

Figure 4.1. Flow diagram explaining the final sample of nurses that took part in the current study.

4.2. Prospective pre-and post-test results

Table 4.1 displays a summary of the pre-and post-test questions with the corresponding options to answer each question. The response rate for each answer option was calculated rather than the total number of nurses answering correctly, as some questions required more than one answer to be completed (questions two, four, and six). Additionally, five nurses (10%) had partially completed tests where nurses did not provide answers to a question at all or where the correct choice of answers was not made, i.e., only choosing two answer options when asked to choose three.

Table 4.1. Summary of the questions, answer options, the number of responses and response rates to the pre-and post-test in a cohort of nurses working at Starship Child Health, Auckland District Health Board SCH (N=51).

		Pre-test responses	Post-test responses
Question	**Answers**	**N (response rate,%)****	**N (response rate,%)**
Malnutrition screening for patients admitted to Starship Hospital is important;	*A. Strongly agree* *B. Agree* *C. Neutral* *D. Disagree* E. *Strongly disagree*	A. 28 (55%) B. 20 (39%) C. 0 (0%) D. 0 (0%) E. 3 (6%)	A. 37 (73%) B. 12 (24%) C. 0 (0%) D. 0 (0%) E. 0 (0%)
Malnutrition screening should (choose 2);	*A. Be a quick and simple generalised screen** *B. Be a guide for prescribing nutritional supplements* *C. Be a comprehensive, in depth evaluation of nutritional status* D. *Identify individuals at risk of malnutrition who require further assessment*	A. 42 (82%) B. 6 (12%) C. 6 (12%) D. 47 (92%)	A. 44 (86%) B. 4 (8%) C. 5 (10%) D. 47 (92%)
Where would you document the result of the malnutrition screen for a patient (choose 1);	*A. In the A to D planner* *B. In the case notes* *C. In the food and drink intake record* *D. There is no need for documentation*	A. 33 (65%) B. 11 (22%) C. 6 (12%) D. 0 (0%)	A. 51 (100%) B. 0 (0%) C. 0 (0%) D. 0 (0%)
Why is it important to accurately weigh and measure infant and children? (choose 3);	*A. To assess if the child is ready for discharge;* *B. So it can be plotted on growth charts and growth assessed;* *C. So it can be used as part of a nutrition assessment;* *D. To calculate medication dosage.*	A. 5 (10%) B. 47 (92%) C. 48 (94%) D. 46 (90%)	A. 4 (8%) B. 46 (90%) C. 50 (98%) D. 47 (92%)
When weighing a child over 2 years of age (choose 1);	*A. Remove outer clothing and shoes before weighing;* *B. Weigh naked;* *C. Weigh fully clothed;* *D. Remove outer clothing, standing with mother using a tared weight.*	A. 45 (88%) B. 2 (4%) C. 3 (6%) D. 1 (2%)	A. 50 (98%) B. 0 (0%) C. 0 (0%) D. 1 (2%)

When measuring a child's length or height (choose 3);	*A. It does not matter what measurement is chosen, only that it is documented* *B. If a child is under 2 years of age, measure recumbent length;* *C. If a child is over 2 years of age and able to stand, measure standing height;* *D. A child needs to have all clothes removed for a length or height measurement;* *E. In best practice, length or height should be taken before a weight measurement;* *F. Length can be measured using a length mat in a cot or bed;* *G. Two people are required to measure length in infants.*	A. 2 (4%) B. 37 (73%) C. 48 (94%) D. 1 (2%) E. 5 (10%) F. 27 (53%) G. 25 (49%)	A. 0 (0%) B. 39 (76%) C. 50 (98%) D. 1 (2%) E. 4 (8%) F. 15 (29%) G. 40 (78%)

*red denotes the correct answers to the questionnaire.
**response rate calculated by (n=number of participants who chose the particular answer)/(n=total number of study participants).

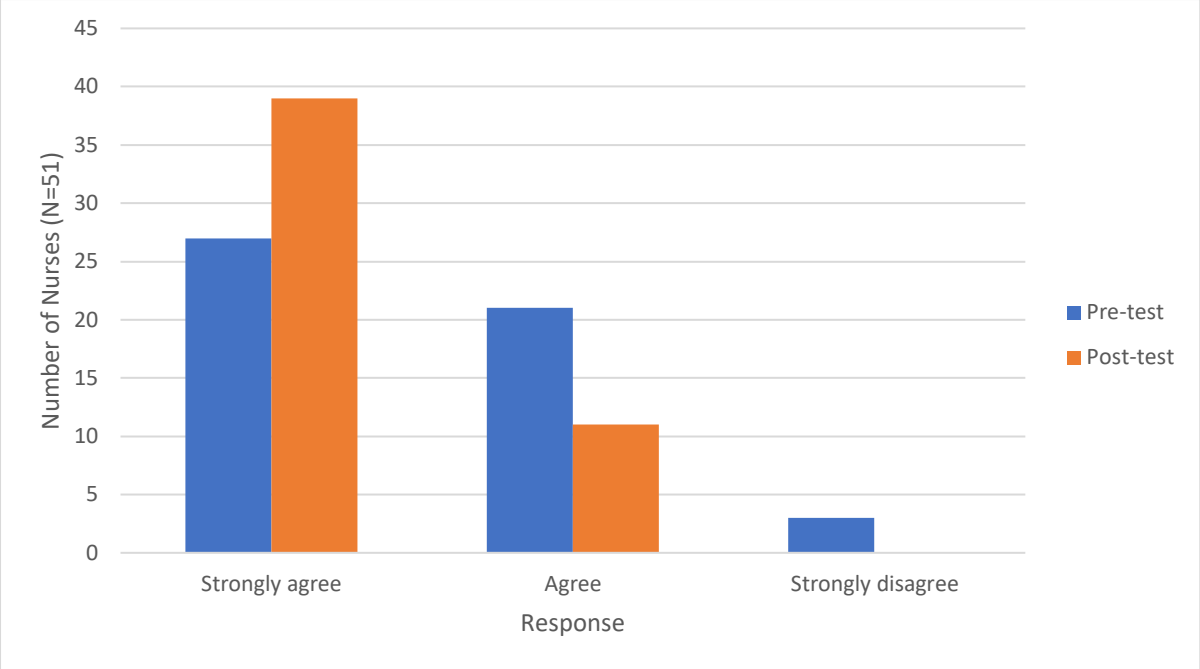

Figure 4.2. Responses to question one; "Malnutrition screening for patients admitted to Starship hospital is important" in a cohort of nurses working at Starship Child Health, Auckland District Health Board (N=51).

The results of question one is displayed in **Figure 4.2.** There were no neutral or disagreed responses from the nurses. Thus, these response categories were not included in **Figure 4.2.** Thirty-nine (76%) nurses in the post-test strongly agreed with the statement of malnutrition screening being important at SCH compared to twenty-seven (53%) nurses in the pre-test. No nurses strongly disagreed with the statement of malnutrition screening being important at SCH in the post-test, compared to three nurses (6%) who strongly disagreed with the statement in the pre-test (**Figure 4.2**).

A Wilcoxon signed-rank test was conducted to determine the impact of the malnutrition screening and anthropometry learning modules on improving nursing knowledge at SCH. An improvement in knowledge is defined by an increase in awareness or understanding of the facts or guidelines needed to perform a task (Marrelli, 1998). Nurses illustrated this improvement by exhibiting an increase in the total post-test scores in questions two-six compared to their pre-test scores. The difference in scores was approximately symmetrically distributed for most of the questions (questions two, four, five and six). It was visually assessed by a histogram with a superimposed normal curve (Appendix I). The difference in scores for question three was not symmetrically distributed, and the difference in total test scores was slightly negatively skewed (Appendix I). It was decided to proceed with the Wilcoxon signed-rank test as transforming the data could have altered its ranking, resulting in interpretational issues. Or

conversely, using an alternative analysis such as the Sign test could have resulted in less powerful data.

Completing the learning modules resulted in an increase in overall post-test scores in thirty-two (63%) nurses compared to the pre-test. There was no increase in overall post-test scores for sixteen nurses (31%), and three nurses (6%) did not have an increase in overall post-test scores when compared to the overall pre-test scores (see **Table 4.2**). There was a significant increase in the percentage of post-test questions answered correctly overall (45.1% overall), with 52.9% of nurses scoring 100% in the post-test compared to 7.8% of nurses scoring 100% in the pre-test, $z = -4.600$, $p < .001$ (**Table 4.3**).

Table 4.2. Summary of the difference in the pre-and post-test scores (Wilcoxon signed-rank test) in a cohort of nurses working at Starship Child Health, Auckland District Health Board (N=51).

Difference in scores		N	Mean rank	Sum of ranks
Q2 post-test score – Q2 pre-test score	Negative Ranks	7[a]	9.50	66.50
	Positive Ranks	12[b]	10.29	123.50
	Ties	32[c]		
	Total	51		
Q3 post-test score – Q3 pre-test score	Negative Ranks	0[d]	.00	.00
	Positive Ranks	18[e]	9.50	171.00
	Ties	33[f]		
	Total	51		
Q4 post-test score – Q4 pre-test score	Negative Ranks	3[g]	3.50	10.50
	Positive Ranks	7[h]	6.36	44.50
	Ties	41[i]		
	Total	51		
Q5 post-test score – Q5 pre-test score	Negative Ranks	1[j]	3.50	3.50
	Positive Ranks	5[k]	3.50	17.50
	Ties	45[l]		
	Total	51		
Q6 post-test score – Q6 pre-test score	Negative Ranks	6[m]	13.00	78.00
	Positive Ranks	26[n]	17.31	450.00
	Ties	19[o]		
	Total	51		
Overall post-test score – overall pre-test score	Negative Ranks	3[p]	12.67	38.00
	Positive Ranks	32[q]	18.50	592.00
	Ties	16[r]		
	Total	51		

* Wilcoxon signed-rank test.
a. Q2 post-test score < Q2 pre-test score; b. Q2 post-test score > Q2 pre-test score; c. Q2 post-test score = Q2 pre-test score; d. Q3 post-test score < Q3 pre-test score; e. Q3post-test score > Q3 pre-test score; f. Q3 post-test score = Q3 pre-test score; g. Q4 post-test score < Q4 pre-test score; h. Q4 post-test score > Q4 pre-test score; i. Q4 post-test score = Q4 pre-test score; j. Q5 post-test score < Q5 pre-test score; k. Q5 post-test score > Q5 pre-test score; l. Q5 post-test score = Q5 pre-test score; m. Q6 post-test score < Q6 pre-test score; n. Q6 post-test score > Q6 pre-test score; o. Q6 post-test score = Q6 pre-test score; p. overall post-test score < overall pre-test score; q. overall post-test score > overall pre-test score; r. overall post-test score = overall pre-test score.

Furthermore, there was a significant increase in the percentage of question options answered correctly for questions six (an increase of 33.3%) and three (an increase of 31.4%) in the post-test when compared to the pre-test z = -3.696 and -4.243 (respectively), p < .001 (**Table 4.3)**. There was no significant increase in the percentage of questions answered correctly in questions two, four, and five z = -1.279, -1.778, and -1.633, respectively and p = 0.201, 0.075, and 0.102, respectively (**Table 4.3**).

Table 4.3. The percentage of questions answered correctly in the pre-test and post-test by a cohort of nurses working at Starship Child Health, Auckland District Health Board SCH (N=51).

	% of SCH nurses answered questions correctly				
Questions	**Pre-test**	**Post-test**	**Difference**	**Wilcoxon signed-rank test**	
				z	*p*
2. Malnutrition screening should (choose 2)	70.6	80.4	9.8	-1.279	.201
3. Where would you document the result of the malnutrition screen for a patient (choose 1)	68.6	100	31.4	-4.243	<.001
4. Why is it important to accurately weigh and measure infant and children? (choose 3)	84.3	92.2	7.9	-1.778	.075
5. When weighing a child over 2 years of age (choose 1)	90.2	98.0	7.8	-1.633	.102
6. When measuring a child's length or height (choose 3)	29.4	62.7	33.3	-3.696	<.001
Overall scores (those who correctly answered 100%)	7.8	52.9	45.1	-4.600	<.001

A Pearson's correlation was performed to assess the relationship between the post-test scores and the difference between the pre-and post-test scores (difference = post – pre) in SCH nurses who completed the two learning modules. Preliminary analyses showed the relationship to be linear with both variables normally distributed, as assessed by visual inspection of Normal Q-Q Plots (Appendix I). An outlier was identified, which was not a data entry error or measurement error. It was decided that the outlier would not be transformed or removed from the analysis. The outlier can be seen in Appendix I in the Normal Q-Q Plot for TOTALSCOREPOST. There was a significant positive correlation between the post-test scores and the difference between the pre-and post-test scores $r(49) = .37$, $p < 0.008$ (**Table 4.4)**.

Table 4.4. Correlations between post-test scores and difference in scores (Pearson's correlation coefficients) in a cohort of nurses working at Starship Child Health, Auckland District Health Board (N=51).

		Post-test scores	**Difference between pre-and post-test scores**
Post-test scores	Pearson correlation	1	.369*
	Sig. (2-tailed)		.008
	N	51	51
Difference between pre-and post-test score	Pearson correlation	.369*	1
	Sig. (2-tailed)	.008	
	N	51	51

*Correlation is significant at the 0.01 level (2-tailed).

4.3. Ad hoc satisfaction questionnaire results

Fifty-one nurses completed the ad hoc satisfaction questionnaire upon completing the Ko Awatea LEARN learning modules and the post-test. A summary of the questionnaire with n=number of nurses who responded to each statement can be seen in **Table 4.5.** The response rate is presented, as one nurse (2%) did not provide any responses to one statement.

Table 4.5. Summary of the questions, answers, number of responses and response rates in the ad hoc satisfaction questionnaire from a cohort of nursing working at Starship Child Health, Auckland District Health Board (N=51).

Statement	Answers	N=participants/51 (*response rate)
I found the malnutrition module useful for my practice.	*A. Strongly agree*	A. 13 (25%)
	B. Agree	B. 32 (63%)
	C. Neutral	C. 6 (12%)
	D. Disagree	D. 0 (0%)
	E. *Strongly disagree*	E. 0 (0%)
I feel well informed about the malnutrition screening process and its importance	*A. Strongly agree*	A. 21 (41%)
	B. Agree	B. 28 (55%)
	C. Neutral	C. 1 (2%)
	D. Disagree	D. 0 (0%)
	E. *Strongly disagree*	E. 0 (0%)
I found the weighing and measuring module useful for my practice	*A. Strongly agree*	A. 20 (39%)
	B. Agree	B. 24 (47%)
	C. Neutral	C. 7 (14%)
	D. Disagree	D. 0 (0%)
	E. *Strongly disagree*	E. 0 (0%)
I am confident in taking height/length and weight measurements in infants and children.	*A. Strongly agree*	A. 25 (49%)
	B. Agree	B. 26 (51%)
	C. Neutral	C. 0 (0%)
	D. Disagree	D. 0 (0%)
	E. *Strongly disagree*	E. 0 (0%)
I feel that nurses should repeat the weighing and measuring module regularly.	*A. Strongly agree*	A. 6 (12%)
	B. Agree	B. 24 (47%)
	C. Neutral	C. 11 (22%)
	D. Disagree	D. 8 (16%)
	E. *Strongly disagree*	E. 2 (4%)
The format for both modules was clear and useful.	*A. Strongly agree*	A. 23 (45%)
	B. Agree	B. 27 (53%)
	C. Neutral	C. 1 (2%)
	D. Disagree	D. 0 (0%)
	E. *Strongly disagree*	E. 0 (0%)

*response rate calculated by (n=number of participants who chose the particular answer)/(n=total number of study participants).

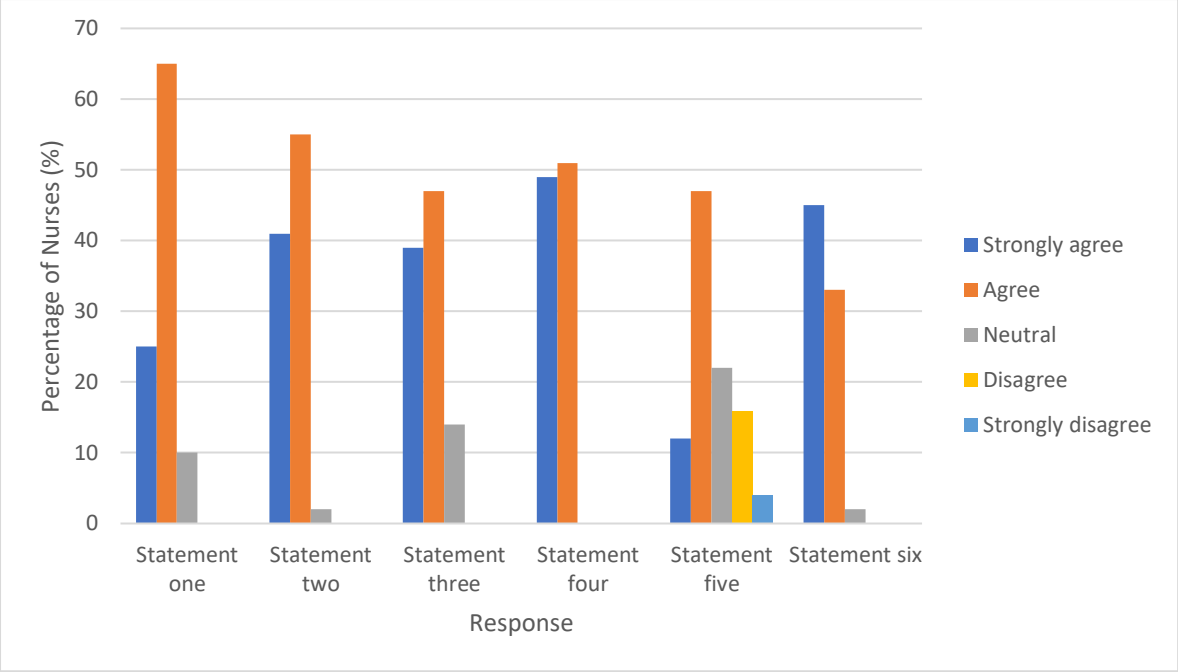

Figure 4.3. Responses to the ad hoc satisfaction questionnaire from a cohort of nurses working at Starship Child Health, Auckland District Health Board (N=51).

Statement one: *I found the malnutrition module useful for my practice*.
Statement two: *I feel well informed about the malnutrition screening process and its importance*.
Statement three: *I found the weighing and measuring module useful for my practice*.
Statement four: *I am confident in taking height/length and weight measurements in infants and children.*
Statement five: *I feel that nurses should repeat the weighing and measuring module regularly.*
Statement six: *The format for both modules was clear and useful*.

A visual summary of the response's nurses provided to each statement is shown in **Figure 4.3**. Ninety percent (n=46) of nurses strongly agreed or agreed that they found the malnutrition screening module useful for their nursing practice (statement one). Ninety-six percent (n=49) of nurses strongly agreed/agreed with feeling well informed about the screening process and its importance (statement 2). Eighty-six percent (n=44) of nurses reported they strongly agreed/agreed that they felt the anthropometry module was useful for their practice (statement 3). All nurses (100%, n=51) strongly agreed/agreed that they felt confident in taking height/length and weight measurements in both infants and children (statement 4). Thirty-eight percent (n=10) of nurses strongly disagreed/disagreed that nurses should repeat the weighing and measuring module often, compared to 59% (n=30) who strongly agreed/agreed with the same statement (statement 5). Ninety-eight percent (n=50) of nurses strongly agreed/agreed that the learning modules were user friendly and useful for their nursing practice.

4.4. Verbal feedback from SCH nurses in relation to the research pilot

Verbal feedback was received from several SCH nurses involved in this pilot project. The majority of the feedback was related to the number of learning modules on Ko Awatea LEARN, which the nurses had to complete. Many were suffering from 'Ko Awatea LEARN fatigue', with several outstanding learning modules in their continuing competency and recency to practice. The numerous learning modules resulted in very little time left to complete the learning modules for the current pilot in the workday. Additionally, several nurses stated that the hospital was extremely busy over the two-week pilot period, creating even further time pressures on staff to complete the modules.

A nurse educator on 24B who tested the learning modules before it was distributed to the general ward nurses provided feedback on the modules, highlighting that there were plans to change the A-D planners in the near future and the STRONGkids malnutrition screening tool sticker would no longer be placed here, but in the MDT form. She explained further:

> "I think that nurses are asked to do a lot in terms of screening and assessments, and we definitely should be doing the malnutrition screening where able, but actually any member of the MDT who assesses and works with these children must be able to do this." – *Nurse educator on 24B*.

The nurse educator also stated that the weighing and measuring module would be very beneficial to new nurses in SCH, and overall, both modules were good, relevant, to the point and easy to follow.

Another nurse educator on ward 26A questioned where nurses could find the food diet form (i.e., the food and drink intake record) and had provided further feedback on the inclusion of appropriate hand hygiene practices when weighing or measuring an infant. This addition was made to the learning modules. The nurse educator further added that the modules were well done and were easy to use.

General ward nurse feedback included that the learning modules were very helpful for their nursing practice (ward 23B). That new things were learnt, such as standard procedures for measuring an infant's length (ward 25). That the learning modules were a good refresher for malnutrition screening and improving knowledge in taking anthropometry (ward 24B). Further comments included nurses enjoyed how the modules did not take too much time to complete (ward 24B) and that the modules were easy to use and follow (ward 23B).

Chapter 5. Discussion

5.1. Introduction

This study aimed to develop, deliver, and evaluate the feasibility of an online learning module for nurses on the use of malnutrition screening and standardised weighing and measuring techniques for inpatients at SCH and assess whether completing these learning modules resulted in improvements in knowledge. The pilot study design was in two parts: 1) to develop and pilot online the learning modules and 2) evaluate the learning modules in a convenience sample of nurses using a prospective pre-post study design and ad hoc satisfaction questionnaire. The two learning modules covered 1) malnutrition screening and 2) standardised weighing and measuring techniques for infants and children. These learning modules were piloted in five wards at SCH, with fifty-one nurses participating in the research. The pre-post-test evaluated the utility of the learning modules, including determining the baseline level of knowledge and any change in knowledge on malnutrition screening and taking accurate anthropometry. The evaluation was achieved by assessing the change in knowledge and understanding (through improvements in test scores), perceptions and confidence regarding malnutrition screening, and taking anthropometry.

Overall, the study found that the malnutrition screening and anthropometry learning modules resulted in nurses scoring higher in the post-test when compared to the pre-test, indicating that a level of knowledge gain had occurred. Findings from the ad hoc satisfaction questionnaire highlighted that nurses felt well informed on the importance of malnutrition screening and taking anthropometry and appeared to have positive perceptions of the content's learning modules. Nurses felt confident in taking weight, height and length measurements, with some agreement in completing the anthropometry module annually as a knowledge and skill refresher. Some nurses reported that the learning modules did not take too long to complete, and they were able to do this during the downtime of their shifts. Conversely, several nurses stated that many nurses were already suffering from 'Ko Awatea LEARN fatigue', indicating that having another learning module to complete on Ko Awatea LEARN could be perceived by nurses as an extra burden to workload. However, overall, both learning modules were reported to be easy to follow and complete.

5.2. Pre-and post-test

There was a significant increase in total post-test scores, where nurses answered 52.9% of questions correctly compared to 7.8% in the pre-test scores. These results indicate that the malnutrition screening and anthropometry modules may have increased the overall level of nurse knowledge in these two topic areas. An increase in knowledge is defined by an increase in awareness or understanding of the facts or guidelines needed to perform a task (Marrelli, 1998), illustrated here through an increase in the total test scores. This finding is consistent with other studies that have used online learning modules to increase knowledge in various health care workers (Choi et al., 2018 and Westergren et al., 2016).

A two-year prospective, longitudinal, cross-country, interrupted time-series study developed an eLearning course on severe acute malnutrition (SAM) management in children (Choi et al., 2018). The authors looked at whether the course improved the knowledge and skills on SAM management of various healthcare workers in hospitals and community settings (Choi et al., 2018). Assessment of knowledge gained was through a pre-, post- and six-month post-assessment. N=606 health care workers participated (with n=236 nurses included). The course content included three learning modules on malnutrition, identification through malnutrition screening and taking anthropometry, and the management of children with malnutrition. Each module took 2-3 hours to complete. The authors saw a mean score gain in knowledge which was 11.8 (calculated from the post – pre difference mean) – a 41.5% relative increase in the test scores. Of the health care workers who worked in hospitals, 85.9% reported applying their knowledge by changing their clinical practice in malnutrition screening, assessment, diagnosis and management. Six months after the intervention, healthcare workers demonstrated significantly increased retained knowledge of malnutrition, identification, and management. There was also improved confidence in malnutrition screening and anthropometry taking in these health care workers (Choi et al., 2018). There were several differences between the Choi et al. study (2018) and the current study. These included the learning modules being more time-intensive (2-3 hours per module), a larger sample size used, including healthcare workers other than nurses across several countries and a longer follow-up time. However, both the Choi et al. study (2018) and the current study successfully showed that online learning modules in malnutrition screening and anthropometry taking could increase healthcare workers' knowledge in these topic areas.

Another study looked at the short-term effects of a computer-based nutritional training program for hospital-based nurses in Sweden (Westergren et al., 2016). The computer-based training module included education on screening for malnutrition risk to increase the precision in nutritional treatment and care. The program took nurses 50-60 minutes to complete. The results showed that the short computer-based training appeared to increase staff's precision in nutritional treatment and resulted in the increased probability of patients at risk of undernutrition being identified correctly and then receiving nutritional treatment (Westergren et al., 2016). The Westergren et al. (2016) study has similar findings to the current study, despite not explicitly evaluating knowledge change. The authors demonstrated that the computer-based training, which took minimal time to complete, provided adequate information to the nurses resulting in some knowledge gain, allowing an increase in their precision of nutritional care (Westergren et al., 2016). The above outcome is similar to the current study where the online learning modules took SCH nurses only 30-45 minutes to complete, which also saw an increased knowledge of malnutrition screening and anthropometry taking in these nurses. The Choi et al. (2018), Westergren et al. (2016) and the current study highlight that online training programmes that involve education on aspects of malnutrition screening and anthropometry taking can play a role in influencing nursing knowledge.

Question one results suggested that after completing the learning modules, nursing perceptions of malnutrition screening and its importance had increased slightly. The positive perceptions reported in the ad hoc satisfaction questionnaire could be attributed to the malnutrition screening module informing new knowledge or a refresher for nurses on why malnutrition screening is vital in patient care. This finding can be likened to a study where the authors explored whether a malnutrition eLearning course improved knowledge and skills in health care workers in both the hospital and community health settings (Choi et al., 2018). The authors found that when asked if there was any change in how they viewed malnutrition and its management after completing the malnutrition eLearning course, n=304 health care workers responded yes there had been a change. The study's outcome showed that the perception of malnutrition had changed in these health care workers (Choi et al., 2018). While this question did not evaluate perceptions of malnutrition screening specifically, it did evaluate whether the eLearning course facilitated a change in their perceptions of malnutrition (Choi et al., 2018). The Choi et al. study (2018) and the current study both displayed that online learning modules can influence healthcare workers' perceptions of malnutrition and its screening.

Question three saw a significant increase in the nurses' post-test scores when compared to their pre-test scores. Additionally, question three identified a lack of knowledge about the location of appropriate documentation required to complete malnutrition screening (i.e., the placement of the STRONGkids screening tool scoring sticker in the A to D planner) in this cohort of nurses. Nurses not knowing where to document nutrition information has also been reported elsewhere (Hakonsen, Pedersen, Bygholm, Thisted & Bjerrum, 2019). In focus groups of n=14 health professionals held in Danish adult nursing homes, only 61 – 71% of health professionals knew the location of and how to document nutrition care plans, including nutrition screening outcomes (Hakonsen et al., 2019). These results highlighted variations and inconsistencies within nutrition documentation. A lack of knowledge in nutrition care, screening, treatment, and documentation can negatively influence patient outcomes (Hakonsen et al., 2019).

Nurses also demonstrated a significant increase in their post-test scores compared to their pre-test scores in question six. Baseline knowledge of standardised techniques for taking weight, height or length in children was low (29% correctly responded) and then increased post learning modules (62.7%). Despite registered nurses being found to be twice as likely to measure children's length or height accurately when compared to nurse aides (Lipman et al., 2004), there is still evidence of inadequate nursing knowledge of standardised techniques for anthropometry taking amongst all types of nurses in the literature (Foote et al., 2011; Irving et al., 2015; and Lipman et al., 2004). In a study where health care providers (including nurses) were asked what the main barriers were to obtain anthropometric measurements in children, 30%, 64%, and 39% of health care providers responded that they were unsure of the appropriate techniques required for measuring weight, height and head circumference, respectively (Irving et al., 2015). Furthermore, in a multicentre randomised controlled trial in primary care providers in the USA, incorrect measurement techniques for obtaining length/height in children were a major contributing factor to inaccurate measurements by nurses and nurse aides (Lipman et al., 2004). A lack of knowledge was the primary determinant for incorrect measuring techniques, which was determined by observing nurses and nurse aides performing incorrect techniques such as the child wearing shoes, to feet being splayed during a measurement being taken (Lipman et al., 2004). Foote et al. (2011) found that upon implementing clinical practice guidelines on linear growth measurement in children, health professionals reported numerous barriers to implementing the anthropometry guidelines. Some of the barriers included a lack of awareness of the

guideline itself alongside the scientific evidence supporting the recommendations, unfamiliarity with the terms and forgetting or neglecting essential steps of the measurement procedures (Foote et al., 2011). These findings highlight the substantial impact that a lack of knowledge can have. The misunderstanding of the scientific evidence supporting the correct techniques used for anthropometry can also impact the accuracy of the measurements. A lack of awareness or the forgetting of the standardised techniques used can also affect accurate anthropometry taking. A lack of awareness or forgetting the techniques could have been why several nurses in the current study were not able to correctly identify height and length standardised measuring techniques, in addition to a potential lack of knowledge in this particular area of anthropometry.

Whilst not all increases in the pre-and post-test scores were significant, questions two, four and five still saw post-test scores increase compared to the baseline scores. When nurses were questioned about malnutrition screening processes (question two), a 9.8% increase in nurses responding with the correct answers was observed. This result could be attributed to the information conveyed in the malnutrition screening module, which resulted in a slight increase in knowledge of the malnutrition screening process. A 7.9% increase in nurses achieving a correct answer was observed when responding to the importance of accurate anthropometric measurements (question four). This increase could be due to the information learnt or remembered by the nurses in the weighing and measuring module. A 7.8% increase was seen in nurses achieving the correct answer for standardised techniques for weighing children (question five). The 7.8% increase suggested that nurses had relatively good knowledge of the weighing procedures for children over the age of two years, before and after completing the learning modules. These non-significant findings have been found in studies looking at education programmes and knowledge attained, such as in a study that used a similar study design but looked at junior doctors instead of nurses (Aeberhard et al., 2016). The prospective pre-post intervention study at a university hospital in Bern, Switzerland, found an online education programme intervention on malnutrition awareness did not significantly increase basic knowledge in junior doctors (Aeberhard et al., 2016). Participants took part in a sixteen MCQ before and after completing the education program. The education programme was based on the information in the MCQ test. It included information on malnutrition and its consequences, screening for malnutrition and adequate nutritional therapies to implement and monitor in adult patients. The programme took 20-30 minutes to complete. Like the current study, Aeberhard et al. (2016) found that despite no significant change between the pre-and

post-intervention test scores (the mean percentage of correct answers was 55.6% and 59.43%, respectively) post-intervention scores were still higher than baseline scores. These results indicated a level of knowledge gain still occurred after the education programme despite these results not being significant (Aeberhard et al., 2016).

There was a significant positive correlation between the post-test scores and the difference between the pre-and post-test scores found through Pearson's correlation test. The significant correlation implies that an improvement in post-test scores is related to a positive change in score, and therefore a gain in knowledge. A study that used Pearson's correlation to look at whether a relationship existed between two variables (like the current study was in elementary schools in the USA (Sorrells, 2009). The author looked at whether there was a relationship between using power videos in the classroom and increased student performance on maths, reading and science tests at elementary schools (Sorrells, 2009). The author concluded through Pearson's correlation that there were relationships between the use of power videos in the classroom and increased student achievement in specific subject areas (Sorrells, 2009). From this analysis, the author provided some evidence for key stakeholders that power videos may positively benefit student achievement in the classroom through using Pearson's correlation (Sorrells, 2009). Likewise, Pearson's correlation test in the current study identified a significant correlation between improved post-test scores and a positive change in score, providing evidence that the learning modules may benefit nursing knowledge.

5.3. Ad hoc satisfaction questionnaire

The ad hoc satisfaction questionnaire provided insight into the user experience and feasibility of the learning modules as an addition to continuing and upskilling nursing competency. These findings will be used to develop a more refined learning tool for future use that is practical for application in the busy ward environment at SCH. Research that has used various satisfaction questionnaires to evaluate the feasibility of applying education programmes in a real-life setting have been reported elsewhere (Foote et al., 2011). In this study, the authors assessed whether education on a developed evidence-based clinical practice guideline in measuring linear growth in children, improved ease of the implementation of these guidelines for health professionals (Foote et al., 2011). Additionally, the authors also collected data about the anthropometry guideline's clarity, applicability and feasibility through a 4-point Likert scale survey. The authors concluded from the survey that the health professionals found the guideline

to be understandable and the recommendations to be logical and reasonable. Furthermore, the anthropometry guideline gave the health professionals more confidence in the accuracy of their measurements and recommended using the guideline to other health professionals (Foote et al., 2011). The satisfaction survey in the Foote et al. (2011) study allowed the authors to improve the anthropometry guideline and tailor its implementation tools to allow the efficient introduction of the developed clinical practice guideline. The efficient implementation would have resulted in an increased uptake of the anthropometry guidelines by the health professionals in the hospital and other hospitals in the future (Foote et al., 2011).

A majority (90%) of nurses responded that they found the malnutrition screening module useful for their practice. Most nurses (96%) reported that they felt well informed about the malnutrition screening process and its importance in clinical practice. The high percentage was achieved through previous malnutrition quality improvement research at SCH (Lee, 2019), nurse-to-nurse training on the wards and reinforcement via the current learning modules. Most nurses (86%) responded they found the weighing and measuring module useful for their practice. Currently, there are no malnutrition screening or standardised weighing and measuring learning modules available for nurses via Ko Awatea LEARN as a refresher for current nurses, or as an onboarding task for new nurses. Upon implementing the STRONGkids screening tool based on Beer's (2017) research, a dietitian initially delivered training during daily MOS meetings for some wards. If nurses missed this training, they either received training from the nurse educator, from other nurses on the ward or taught themselves (Lee, 2019). Lee (2019) also found that nurses from wards 23B, 26A and 26B felt their training was insufficient. As these wards had the STRONGkids tool implemented last at SCH, this may have negatively affected wards 23B, 26A and 26B as they had the lowest malnutrition screening rates at the time of the Lee (2019) study.

Likewise, in the Ives (2016) study, nurses responded they received training in taking length/height and weight measurements from other nurses on the ward (59%), from university training (56%), from a clinical nurse educator (21%) and others, including job training and learning through experience (12%). These studies (Lee, 2019 and Ives, 2016) highlight the different avenues through which nurses may have learnt the malnutrition screening processes and anthropometry taking techniques. Many SCH nurses explained they did not know why they were using the STRONGkids screening tool (Lee, 2019). In addition, several SCH nurses were not meeting key performance criteria when observed weighing and measuring children (Ives, 2016). These studies (Ives, 2016 and Lee, 2019) suggest why the SCH

nurses may have found the current learning modules useful for their practice. It informed on aspects of malnutrition screening that nurses were previously unsure on (Lee, 2019). Those nurses who may not have been aware of or previously forgotten may have also been informed on standardised weighing and measuring techniques for accurate anthropometry taking (Ives, 2016).

All (100%) of the nurses responded they were confident in taking height/length and weight measurements in children. In contrast, most (98%) nurses identified the correct weighing procedures, whereas fewer nurses (62.7%) were able to identify the correct procedures for measuring height or length in children. These results suggest that there appears to be a disconnect between nurse perception of confidence in taking length and height measurements and awareness of the standardised methodologies. This finding remains consistent with the 2016 SCH study by Ives (2016), where most (96.6%) felt confident in taking length/height or weight measurements. However, when observed, nurses achieved 33% of the length criteria, and no single height criterion was met (Ives, 2016). These findings demonstrated that nurses were not competent in taking these measurements (Ives, 2016). Awareness of the role of taking length/height as a measure for nutritional assessment was also lacking. Where in the same cohort of SCH nurse's, length/height measurements were commonly cited as important for monitoring growth, baseline measurement, medication/treatment dosage, and routine clinic visits (Ives, 2016). Although observation of nurses taking anthropometry measurements was not completed as part of the current study, nurses need adequate knowledge and competence to perform the task correctly (overall competency) (Miller, 1990). A lack of knowledge and the subsequent impact on overall nursing competency in performing these height or length measurements can have considerable implications on accurate anthropometry taking.

A majority (59%) of nurses felt they should repeat the weighing and measuring module regularly. Conversely, there was some (40%) consensus held by nurses that repeating the anthropometry module would not be helpful. This finding may be because of the perceived confidence in applying the anthropometric methodology in a standardised manner. However, at baseline, a large (70.6%) proportion of nurses could not correctly identify the techniques for measuring height and length in children. Post learning module, some (37.7%) of the nurses were still unable to identify the techniques correctly. As displayed, some nurses were still unaware of the standardised techniques used for measuring height and length after the learning modules. Height and length measurements are prone to human measurement error when compared to weight measurement (Ulijaszeck & Kerr, 1999). Human

measurement error can be attributed to the child's behaviour, posture, movement and cooperation when measured (Foote, 2014; Lampl et al., 2001; and Voss et al., 1990). Due to these measurements being prone to human measurement error and the results of the current study, there is a need for education on anthropometry (including how to minimise human measurement error), taken through a yearly refresh of this knowledge.

Furthermore, nurses are busy with constant multi-tasking and interruptions occurring during shifts (Yen et al., 2018). It may be fair to assume that due to the many tasks, interruptions and difficulties when measuring children nurses may face, they may forget or neglect necessary steps of anthropometric measuring procedures and not even realise. For these reasons, it is advised that nurses should repeat annual ongoing education in anthropometry taking to allow refreshers in knowledge. Ongoing education would remind nurses of the correct techniques in taking anthropometry so that they are less likely to forget when they are busy (Foote, 2014 and Foote et al., 2011).

There was a strong consensus that both learning modules were easy to use and useful for their nursing practice, which could be attributed to the learning modules being designed and integrated into the established learning system, Ko Awatea LEARN, at ADHB. The strong consensus indicated that the format chosen for the learning modules was applicable to SCH nurses and could be used as a basis for a more refined set of learning modules in the future. The format and ease of use of online learning modules in nurses has been evaluated in the literature (Ortega-Moran et al., 2020; and Wilkinson, Forbes, Bloomfield & Fincham, 2004). In a quantitative research study by Ortega-Moran et al. (2020), they evaluated the validity of an online theoretical module of a minimally invasive surgery blended learning course for nurses. Perceptions and satisfaction of the online modules was one of the study's objectives. The module contained seven sections, and like the current study, the modules were developed and integrated on Moodle (Moodle, 2019), an e-learning web platform. Using a 5-point Likert scale, the authors found that the n=24 nurses had a high level of satisfaction with the e-learning platform. In particular, valuing the design and functionality of the web environment, considered it easy to use, attractive, well organised and allowed the progress of learning to be seen (Ortega-Moran et al., 2020). Although this study did not look at online learning modules in malnutrition screening or anthropometry taking in children, it did show that using an online learning platform can be beneficial for nurse learning.

In one pre-post-test study design using questionnaires and group interviews, they explored how four e-learning modules would affect nursing students' perceptions of web-based learning (Wilkinson, Forbes, Bloomfield & Fincham, 2004). The overall learning experience was perceived positively, attributed to the nursing students enjoying the flexibility, having control over when and where they learnt and the quality of the learning within the modules. One downside that the student nurses reported was that the learning could be isolating. Because SCH nurses must complete Ko Awatea LEARN modules during work time, it is unlikely these nurses would feel isolated in learning, they would not be completing the learning in an isolated environment like being at home. Despite these studies (Ortega-Moran et al., 2020 and Wilkinson, Forbes, Bloomfield & Fincham, 2004) not specifically exploring learning modules on malnutrition screening and anthropometry taking in children. They demonstrated that online learning modules could be highly beneficial for nurses' learning when integrated into current learning platforms. It gives them the flexibility to learn when and where they want to, while also being easy to navigate (Ortega-Moran et al., 2020 and Wilkinson, Forbes, Bloomfield & Fincham, 2004).

5.4. The learning modules

Previous malnutrition and anthropometry-focused research at SCH reported a lack of knowledge of malnutrition screening, including its processes, outcomes, and importance (Lee, 2019) and a lack of standardisation in anthropometric measurement techniques and nursing competency in this area (Beer, 2017 and Ives, 2016). These findings provided evidence for a gap in knowledge and skills in these two nutrition-related clinical areas. Therefore, these findings highlight the need for further education on malnutrition screening and taking anthropometry to increase hospital-wide screening rates and the accuracy of anthropometry measurements long term.

This study used implementation science to inform the development of these learning modules and was a crucial strength. Implementation science is defined as "the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices into routine practice, hence improving the quality and effectiveness of health services" (Bauer, Damschroder, Hagedorn, Smith & Kilbourne, 2015). It is based on a series of aims outlined below, relevant to previous projects held at SCH. The first aim involves the innovations or processes that need to be well defined and include specified standards for implementation via establishing the current practice and the associated best practice guidelines (Meyers et al., 2012). This aim was exhibited through the projects of both Beer

(2017) and Ives (2016). Beer (2017) established that no current malnutrition screening tools were being used at SCH at the time and consequently, found that the STRONGkids screening tool was the most practicable for use at SCH. Following this, a recommendation was to assess uptake of the STRONGkids screening tool in the future. Ives (2016) established that nurses were not adhering to standardised procedures when taking anthropometry measurements. Furthermore, Ives (2016) found multiple pieces of measuring equipment not being 100% accurate. This resulted in the recommendations of purchasing new equipment and the need to provide nurses with education on taking correct anthropometry at SCH.

The second aim involves monitoring and evaluating activities to allow the development of new innovations or processes to implement based on the first aim (Meyers et al., 2012). The third aim involves evaluating further the new processes at a patient, ward and organisational level and acknowledging that these may need to be adapted or modified to be sustainable and fit the current setting (Meyers et al., 2012). Both of these aims were exhibited in the current study and Lee's (2019) study. Lee (2019) established that nurses felt they were unsure why they needed to perform malnutrition screening when assessing the uptake of the STRONGkids screening tool at SCH, following Beer's (2017) recommendations. This resulted in evidence for an education programme to increase nursing uptake of malnutrition screening at SCH (Lee, 2019). The current study, therefore, has used evidence from Beer (2017), Ives (2016) and Lee (2019) to inform the development of the learning modules to ensure they were useful to SCH nurses. The learning modules included ongoing input from SCH clinical paediatric dietitians to guarantee the content used best practice information to educate the nurses.

Furthermore, the development of the learning modules had key stakeholder involvement from nurse educators. These nurse educators also piloted the learning modules before general ward nurses did to confirm the learning modules were relevant, applicable and easy to use for SCH nurses in their working environment. Evaluation of the learning modules was conducted through the pre-post-tests and the ad hoc satisfaction questionnaire, which helped inform the feasibility of the learning modules long term. The potential sustainability of the learning modules at SCH will be evaluated in section 5.6.

As mentioned, the learning modules themselves used research from Lee (2019) and Ives (2016) to provide the foundation for their development, with input from SCH paediatric dietitians and nurse educators. Input from these experts in these nutrition-related areas allowed further refinement of the module format and information delivery. For the malnutrition screening module, conclusions were drawn

by Lee (2019) on areas to address. These included: explaining the decision to use the STRONGkids screening tool and its background, use of the malnutrition score by the SCH paediatric dietitians in their assessment of patient nutritional status, and the need for intervention and information on the appropriate use of the underlying illness list. These issues were addressed in developing the module-based video titled 'how to use the STRONGkids screening tool' (Appendix E). The video included information on the STRONGkids screening tool, how to use it to produce a risk score, where to document the score, and what happens after the score has been recorded. Additional details about each section of the screening tool, including the importance of the underlying illness list, were also included. The increase in post-test scores regarding the questions on malnutrition screening, particularly the significant increase in scores for questions relating to the correct documentation of the risk score, could be attributed to knowledge gained from this video. Most found the malnutrition screening module to be a valuable addition to their practice, presumably due to no existing ongoing training on malnutrition screening and an increase in knowledge on the screening process and its importance for inclusion in patient care.

Likewise, research from Ives (2016) provided the foundation for developing the weighing and measuring module. Ives (2016) concluded areas to improve on at SCH were: a training programme for SCH to educate on standardised procedures for taking length/height and weight measurements and incorporating this into the existing ADHB Moodle. Further suggestions included the online modules having text, videos and quizzes to ensure nurses have understood the material presented (Ives, 2016).

The learning modules included text to provide information on anthropometry, its relevance in the clinical setting, and its use in nutritional assessment. Videos were chosen as the primary source of conveying information for the weighing and measuring module and aspects of the malnutrition screening module. In the selected videos, a defined standard is being educated, and images are known to enhance learning as they are easier to remember (Stahl, 2011). A study that evaluated the use of online instructional videos for teaching clinical nursing skills found that n=7 students viewed the flexibility and self-management aspects of this learning positively (Kelly, Lyng, McGrath & Cannon, 2009). Despite no change in learning outcomes between the group that was taught by a lecturer (n=7) and the video group (n=7), the instructional videos ensured a defined standard, helping minimise procedural and methodological inconsistencies that may occur in nursing skills teaching (Kelly et al., 2009). The weighing and measuring videos chosen in the current study were embedded from YouTube version

16.14.2 (2021) into the module, with pointers added to emphasise certain aspects of anthropometry taking. These videos were created by the Royal College of Paediatrics and Child Health (RCPCH), Allergy Care Pathways Project (Allergy Care Pathways, 2011). As is standard practice within Ko Awatea LEARN, questions to assess understanding were added after critical pieces of information or the videos to consolidate the material. Most nurses had positive perceptions and found the weighing and measuring module useful for their practice, presumably attributed to no current ongoing training and increased knowledge on standardised techniques for taking anthropometry.

This increase in knowledge and positive perceptions of both learning modules can be likened to the Choi et al. (2018) study on the effectiveness of a malnutrition eLearning course. The content of the online courses was developed by researchers who were members of the International Malnutrition Task Force, resulting in the content being relevant and applicable for the health care workers in the study (Choi et al., 2018). As with the current study, the previous SCH research, highly experienced SCH clinical paediatric dietitians and nurse educators helped develop the content in the current learning modules. Like the current study, Choi et al. (2018) demonstrated a gain in knowledge and saw positive perceptions on the learning course being valuable in the health care worker's practice (Choi et al., 2018). Therefore, when developing education programs intended to educate health professionals such as nurses, it is crucial to establish the needs wanted by the health professionals and have input from experts in the area of interest to have successful education programs.

Choosing Ko Awatea LEARN as a platform for the learning modules was another strength. It is the primary education platform used by District Health Boards (DHBs) across New Zealand and was chosen to develop the online learning modules in the present research. It allowed nurses to enrol in the course and then complete them during their workday downtime. As the learning modules were designed only to take 30-45 minutes, nurses could complete the modules either all together or split into two whilst not creating any additional burdens. It is becoming increasingly difficult for nurses to attend more traditional types of training (such as face-to-face learning) due to staff shortages, lack of support, lack of time and lack of money (Young, 2003). Online learning allows reduced training costs, provides flexibility on when to complete the training, enhances learning results without time constraints (Chang, Liu & Hwang, 2011) and appears to be just as effective as traditional teaching in skills and knowledge learning (Sinclair, Kable, Levett-Jones & Booth, 2016 and Voutilainen, Saaranen & Sormunen, 2017).

From the 2019 audit, data was used to recruit nurses from wards known to have lower malnutrition screening rates on admission, such as wards 23B and 24B, who performed malnutrition screening on 34% and 41% of patients, respectively (Lee, 2019). Wards with higher malnutrition screening rates were also included, such as wards 25, 26A and 26B, who performed malnutrition screening on 88%, 65% and 67% of patients on admission, respectively (Lee, 2019). It was thought that by including a mix of historic ward-specific malnutrition screening rates that the impact of an improvement in knowledge would become evident.

5.5. Limitations

The current study had both limitations and strengths. The strengths included: a combination of text and instructional videos used in the learning modules, the learning modules being developed based on evidence from previous SCH research, paediatric dietitians and nurse educators through implementation science, and the delivery of the learning modules being integrated on a learning platform known to SCH nurses. One limitation was the sample size of nurses (n=51) piloting the learning modules were from only five wards at SCH. This sample size may not represent the nursing population of SCH as a further five wards (wards 24A, 27A, 27B, PICU and CED) and the Day Stay Unit was not included. Consequently, this could mean the results do not accurately reflect the knowledge base and perceptions of malnutrition screening and anthropometry of all nurses at SCH. Not all nurses were included in the study.

Attempts were made to recruit nurses from across the five wards at SCH. However, no data on nurse ward location was collected, reducing the ability to identify the number of nurses that completed the modules within each ward location. Due to this, it cannot confidently be stated whether the learning modules alone increased knowledge of malnutrition screening or whether a greater proportion of nurses from wards with high malnutrition screening rates completed the modules. This limitation may have positively skewed the results, as higher malnutrition screening rates may imply a greater understanding of the malnutrition screening process. These findings have been reported elsewhere. In three hospital wards in the USA, health professionals had relatively high malnutrition screening rates (64%) yet saw an increase in knowledge in malnutrition screening and management in their health professionals after receiving education and training (Silver et al., 2018). In the six-month prospective pilot, n=45 received three months of training and education on the screening, diagnosis, documentation and timeliness of

malnutrition care (Silver et al., 2018). Despite malnutrition screening rates remaining relatively high but unchanged between pre- (64.2%) and post-intervention (64.3%), malnutrition knowledge increased by 14.0% evaluated through a questionnaire (Silver et al., 2018). Despite this, the learning modules would have either created new knowledge gain in nurses who were not as familiar with malnutrition screening and its process or was a refresher for those who were more familiar with the malnutrition screening process, having an overall positive effect.

Non-compliance with response instructions with some nurses not providing the required number of answers in the pre-/post-tests and the ad hoc satisfaction questionnaire was another limitation. Some nurses did not provide the required number of responses needed for questions that had more than one answer. On the other hand, some nurses did not respond to questions at all. The inconsistency of nurses' responses could have affected the results by slightly underestimating test scores, as scores were not adjusted for responses not having enough answers or no answers at all. This meant that some nurses who may have had partial knowledge of a particular question but did not provide enough answers would have been marked down. Subsequently, these nurses would have received test scores that did not accurately reflect their existing knowledge base. It is suggested in future evaluations to consider awarding half marks for partially correct questions to avoid this limitation.

The short duration may have impacted the test-retest reliability between completing the pre-test, the learning modules and the post-test as exhibited by the average time between nurses taking the pre-test (4/03/21) and the post-test (5/03/21) was approximately one day. Information is more likely to be accurately remembered when testing occurs straight after learning (Kornell & Bjork, 2009). Therefore, because the link to the post-test was provided on the home page of the learning modules on Ko Awatea LEARN, most nurses would have taken the post-test immediately after completing the learning modules. This limitation may have increased the likelihood of participants remembering the answers from the pre-test, which could have resulted in an over-estimation of total scores (and difference in scores). Likewise, due to the same questions being asked in the pre-test and the post-test, the reactive effect may have occurred (Cranmer, 2017). The reactive effect is where the testing phase may have influenced nurses who achieved higher scores in the post-test. Nurses could have been exposed to the correct answers in the pre-test when completing the post-test, which may have resulted in the higher post-test scores being achieved instead of the learning modules on their own (Cranmer, 2017).

5.6. Future implications

The current study evaluated knowledge, understanding, competence (the know-how), perception and confidence, but could not assess overall nursing competency, particularly in taking anthropometry. Due to time constraints for the student researcher, observation of practice was not completed. An observation of practice would have allowed assessment of whether the learning modules increased the nurses' ability to correctly and accurately perform weight, height, length, and HC measurements. Therefore, in future evaluations of the learning modules following further content development, observations should be performed to assess nursing competency. Future work could include this component through using observation checklists developed by Ives (2016). A larger sample size, including all wards at SCH utilising some form of participant identification is advised to provide more statistical strength to the study. Across the literature, various sample sizes have been reported (Bjerrum et al., 2012; Choi et al., 2018; Silver et al., 2018; and Westergren et al., 2016). In the study looking at whether a malnutrition eLearning course improves knowledge and skills in health care workers in the hospital and community health settings, the authors had an initial sample size of n=1059 of health professionals and students, with n=606 completing the study in its entirety (Choi et al., 2018). The large sample size was attributed to this study being a global study across three different countries. Another study evaluating a malnutrition education and training program in the USA piloted this programme in n=45 health professionals from one hospital (Silver et al., 2018). In a training program for nurses to increase nutrition knowledge in Denmark, the authors used n=16 nurses from one hospital ward (Bjerrum et al., 2012). In a study where the authors evaluated the effectiveness of a computer-based nutrition training program for nurses, a total of n=297 nurses and nurse aides from one hospital were used (Westergren et al., 2016). From these studies, there is a variation of sample sizes used, and it is clear that when other health professionals are included, the ability to recruit more participants increases. However, in the Westergren et al. (2016) study, the authors showed that it is possible to recruit a large group of just nurses from one hospital. Thus, a future study should recruit as many nurses from SCH as possible from a range of all wards. Recruiting nurses from all wards would allow a better reflection of knowledge and perceptions of malnutrition screening and anthropometry by nurses at SCH.

Choosing Ko Awatea LEARN as the platform allowed the development of the learning modules into a learning environment familiar to nurses across the DHBs and can be accessed quickly at any time

during a shift. However, one consideration was the 'Ko Awatea LEARN fatigue' reported by nurses (Section 4.4) due to the numerous modules' nurses have to complete annually. This will need to be considered in the future for adequate uptake of the modules. Some ways to avoid this include incorporating the module's content into existing Ko Awatea LEARN training modules or making it an annual course completed only once a year. Additionally, the learning modules could be mandatory for newly recruited nurses as part of their onboarding protocols and procedures. These considerations may increase the likelihood of the learning modules being completed consistently by nurses, resulting in standardised education on malnutrition screening and taking accurate anthropometry.

As there was a positive response to the learning modules, material covered, and ease of use, this provides evidence of the feasibility of incorporating these learning modules into standard practice. Whilst there is scope to refine the content of the modules themselves further, any changes to malnutrition screening practices at SCH or the screening tool used will need to be considered concerning the sustainability of the current learning modules. Changes such as those proposed to be made to the A-D planner (section 4.4) will affect the physical placement of the STRONGkids screening tool scoring sticker and its resulting documentation. If these changes occur, the video embedded into the malnutrition module that explains how to use the STRONGkids screening tool and its documentation process will need to be updated. Likewise, if the screening tool used at SCH were to change (i.e., from STRONGkids to an alternative such as the PNST (White et al., 2014)), the module will need to be updated to reflect the protocol of a new screening tool. It is unlikely that the anthropometry module will need to be altered in the near future as this used standardised procedures defined by the WHO (2008) that are unlikely to change.

Finally, the current study, alongside the previous research conducted at SCH (Beer, 2017; Ives, 2016 and Lee, 2019), has used implementation science. The current study's results provide evidence for mandating malnutrition screening and ongoing refresher education for anthropometry techniques in nurse education calendars at SCH. Furthermore, SCH should regulate education and support on malnutrition screening and procedures for taking accurate anthropometry. This would achieve higher malnutrition screening rates, earlier detection of malnutrition risk, and effective monitoring of anthropometric measures in nutrition assessment. The increase in post-test scores suggests an improvement in knowledge and knowledge gaps in key areas relating to malnutrition screening and procedures for taking anthropometry at SCH. The increase in knowledge and positive perceptions

established in the ad hoc satisfaction questionnaire/verbal feedback from the nurses demonstrated that they felt the learning modules were useful, especially in those from wards that do not perform malnutrition screening as often as they should. While there was a gain in knowledge in these nurses, there still appears to be nearly half (47.1%) of the nurses who did not achieve a 100% score. The test's malnutrition screening and anthropometry questions were based on evidence-based practices with input from SCH clinical paediatric dietitians. The information in the learning modules and tests is knowledge that these nurses need to be educated on (Eglseer et al., 2018 and Royal College of Nursing, 2017).

Moreover, it appears there is still a gap in nurses' knowledge and understanding of the correct standardised procedures for accurately weighing and measuring children, particularly in measuring height and length. Despite a general consensus that the anthropometry modules should not be completed regularly, there is evidence to support ongoing education in these clinical areas as an onboarding task for new nurses and as ongoing training for current nurses (Green et al., 2013; Porter et al., 2009; Raja et al., 2008; Valla et al., 2015 and Westergren et al., 2016;). In focus groups with nurses in varying stages of their careers, the importance of ongoing education was highlighted across all stages of nurses' careers (Price & Reichert, 2017). Students and early career nurses reported that improved training and orientation were perceived as valuable resources to prepare them for the realities of nursing practices. Whilst mid- to late-career nurses stated continuing education was an investment in their expertise that would improve their care provided to patients (Price & Reichert, 2017). Therefore, the previously mentioned research and the current study have demonstrated that despite an increase in nurses' knowledge of malnutrition screening and anthropometry, there are still existing knowledge gaps that can be improved with annual education. It has also provided more evidence for malnutrition screening to be made mandatory at SCH, with ongoing education for current nurses and as part of onboarding for new nurses. These initiatives will support nurses in all stages of their careers and result in increased malnutrition screening rates and earlier detection in malnutrition, alongside accurate anthropometric measurements being taken by nurses in the long term.

5.7. Conclusion

This pilot study demonstrated that through completing short learning modules on malnutrition screening and anthropometry taking, nurses achieved a significant increase in knowledge in areas such as

understanding the importance of malnutrition screening, correct processes and documentation of screening results, and standardised anthropometric protocols. A majority of nurses felt well informed about malnutrition screening and taking anthropometry on completion of the modules. Embedding the modules within the already established Ko Awatea LEARN educational platform resulted in positive perceptions and attitudes to complete the learning tasks. There was a disconnect between the perception of confidence in taking accurate anthropometry, which was not reflected in the number of nurses who correctly answered questions relating to the standardised procedures when taking these measurements. Therefore, future projects should consider piloting a more refined version of the current learning modules on a larger nursing sample size, emphasising measuring height and length in infants and children to decrease this knowledge gap. Observation of practice is recommended to evaluate whether completing the modules translates to an increase in overall nursing competency in taking accurate anthropometry. Although this was a pilot study, these findings provide further evidence for some form of mandated education and implementation on these two areas of clinical practice at SCH. Mandated education would have the power to increase malnutrition screening rates at the ward level and allow earlier detection of malnutrition risk in infants and children. Future projects should take care to avoid 'Ko Awatea LEARN fatigue'. The subsequent failure of the implementation objectives and considerations for any future changes to the malnutrition screening processes or tool used should be made.

Appendix A: Participant Information Sheet

THE UNIVERSITY OF AUCKLAND
FACULTY OF MEDICAL AND HEALTH SCIENCES

PARTICIPANT INFORMATION SHEET

Research Title: Improving nursing knowledge of malnutrition screening and anthropometry at Starship Child Health

Researcher introduction:
My name is Vanessa Tregoning. I am a student at the University of Auckland in the Nutrition and Dietetics department. I am studying towards a Master of Health Sciences in Nutrition and Dietetics. My supervisors are Professor Clare Wall and Dr Amy Lovell (University of Auckland), Stella Friedlander and Kim Herbison (Starship Clinical Paediatric Dietitians).

What is the purpose of this study?
Malnutrition is a prevalent issue that occurs in hospitalised children. Malnutrition screening is essential in the early detection of malnutrition risk to avoid adverse health outcomes such as (insert here). The STRONGkids malnutrition screening tool was implemented at Starship Child Health (SCH) in 2019, however, there is still much confusion around the implementation and importance of using a malnutrition screening tool and standardised methods for taking length/height and weight measurements (anthropometry) amongst nursing staff. At present, no formal nurse education has been developed to train newly employed nurses or as part of nurse continued professional development. Therefore, this study aims to develop, deliver and evaluate an online education tool that educates nurses on how to measure and weigh children and infants at SCH, providing standardises protocols aimed to improve accuracy of these measures for use in conjunction with the STRONGkids malnutrition screening tool.

Why have I been invited to participate in this study?
You have been invited to participate in this study because you are a nurse at Starship Child Health who performs malnutrition screening on infants and children admitted to Starship and regularly takes weight and length/height measures are part of your daily duties.

What does this study involve?
If you decide to participate, you will be required to take part in an online training module, with pre- and post-tests designed to evaluate any changes in your knowledge related to taking anthropometry and malnutrition screening in infants and children. Post your involvement in the education package, accuracy in taking these measurements have improved. Additionally, you will be asked to complete a satisfaction questionnaire,

which will help us determine whether this training tool is effective in delivering education and a feasible addition to your continued training.

What if I don't want to participate in this study, or if I want to withdraw later?
Your participation in this study is voluntary. Participation/non-participation will have no effect on your employment or relationship with the DHB or the University of Auckland. You have the right to withdraw from the study at any stage without penalty.

How will my data be stored and destroyed?
Signed consent forms will be kept in a locked filing cabinet in the Discipline of Nutrition at the University of Auckland, Faculty of Medical and Health Sciences. Collected data, including test answers, questionnaires and statistical analyses will be stored on a password protected computer. When the study is complete, the consent forms will be stored for a minimum of six years after which they will be destroyed by paper shredding and confidential destruction. The test answers, questionnaires and statistical analysis will be kept for six years, after which they will be deleted.

Will I benefit from this study?
Taking part in this study will help us develop a refined online education tool for nurses that will improve malnutrition screening in the future. You may also find that participating in this study will increase your confidence in taking accurate anthropometric measurements such as weight and length/height and give you a greater understanding of why the malnutrition screening tool has been implemented at SCH. We hope that this study will, improve malnutrition screening rates at SCH and prevent any unnecessary outcomes associated with malnutrition.

How will my confidentiality be protected?
The protection of your confidentiality is paramount. Please be assured that any comments made whilst participating in this research will not be fed back to your supervising managers or the hospital. Any data collected from the tests and questionnaires will be anonymous and will be used to refine the online education tool for use by the wider hospital, with an aim to improve malnutrition screening and monitor changes in anthropometry during admissions.

Your contribution may be published in a report if it helps to convey a concept. If your contribution is published this will be done in a way that does not identify you as its source.

A copy of the research findings will be made available to you, if you wish.

Contact details
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Ethical Approval
The study was approved by the University of Auckland Health Research Ethics Committee on 23/07/2020 (AH1390).

If you require Māori cultural support talk to your whānau in the first instance. Alternatively, you may contact the administrator for He Kamaka Waiora (Māori Health Team) by telephoning 09 486 8324 ext. 2324. If you have any questions or complaints about the study, you may contact the Auckland and Waitematā District Health Boards Maori Research Committee or Maori Research Advisor by phoning 09 4868920 ext. 3204.

Appendix B: Recruitment Poster

Appendix C: Consent Form (Qualtrics® version)

Malnutrition Screening and Weighing & Measuring Children and Infants Pre-Test

Research Title: Improving nursing knowledge of malnutrition screening and anthropometry at Starship Child Health

I have read the Participation Information Sheet, and I have understood the nature of the research and why I have been selected. I have had the opportunity to ask questions and have them answered to my satisfaction. I have had the opportunity to use whānau support or a friend to help me ask questions and understand the study.

I have had the opportunity to use whānau support or a friend to help me ask questions and understand the study.

I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time and this will in no way affect my future health care.

I understand I will be participating in the use of an online education tool.

I understand that I will be asked to complete a pre- and post-test to assess the effectiveness of the online education tool and an observation of practice to further assess the effectiveness of the education.

I understand that my participation in this study is confidential and that no material which could identify me will be used in any reports on this study.

I have had time to consider whether to take part in the study.

I understand that the researcher and their supervisors will have access to my data.

Consent form

- ○ I consent
- ○ I do not consent

Malnutrition Screening and Weighing & Measuring Children and Infants Pre-Test

Signing here indicates your knowledge of and consent to the terms outlined in the preceding disclaimer. You will not be able to continue unless a signature is provided

SIGN HERE

clear

Appendix C: Consent Form (PDF version)

THE UNIVERSITY OF AUCKLAND
FACULTY OF MEDICAL AND HEALTH SCIENCES

Discipline of Nutrition and Dietetics
85 Park Road, Grafton
T: +64 9 923 9875
c.wall@auckland.ac.nz
The University of Auckland
Private Bag 92019
Auckland, New Zealand

Consent Form

Research Title: Improving nursing knowledge of malnutrition screening and anthropometry at Starship Child Health

I have read the Participation Information Sheet, and I have understood the nature of the research and why I have been selected. I have had the opportunity to ask questions and have them answered to my satisfaction. I have had the opportunity to use whānau support or a friend to help me ask questions and understand the study.

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I understand that my participation in this study is confidential and that no material which could identify me will be used in any reports on this study.

I have had time to consider whether to take part in the study.

I understand that the researcher and their supervisors will have access to my data.

I wish to receive a summary of the research findings: Yes ☐ No ☐

If yes, please indicate at which postal or email address you would like to receive this: -
_____

I _____ (full name) hereby consent to take part in this study.

Signed _____Date _____

If you require Māori cultural support talk to your whānau in the first instance. Alternatively, you may contact the administrator for He Kamaka Waiora (Māori Health Team) by telephoning 09 486 8324 ext. 2324. If you have any questions or complaints about the study, you may contact the Auckland and Waitematā District Health Boards Maori Research Committee or Maori Research Advisor by phoning 09 4868920 ext. 3204.

Appendix D: Story Boards – Malnutrition Screening Module

Malnutrition screening and anthropometry taking

Starship Child Health

1. INTRODUCTION
- Introduction to the overall learning tool

This online learning tool will be separated into two sections:

1. The role of malnutrition screening tools in patient care

And

2. Accurate anthropometry taking in infants and children

2. INTRODUCTION
- Explanation of the modules being split into two sections

Module 1: The role of malnutrition screening tools in patient care

3. TITLE
- Introduction to module 1: malnutrition screening

Upon completion of this malnutrition screening module, you should be able to:

1. Discuss the importance of malnutrition screening
2. Describe the process of malnutrition screening
3. Know how and where to document malnutrition screening outcomes
4. Discuss the use of anthropometry as a means of monitoring patients assessed to be at high risk of malnutrition following screening

4. LEARNING OBJECTIVES
- For malnutrition screening module

Malnutrition

In all its forms is a broad term which can refer to imbalanced, excessive or deficient intakes of nutrients needed for a functioning human body, which can result in endangered health – McCarthy, 2019.

5. DEFINITION
- Of malnutrition

Paediatric Malnutrition

However, paediatric malnutrition can be further defined as "an imbalance imbalance between nutrient requirement and intake, resulting in cumulative deficits of energy, protein or micronutrients that may negatively affect growth, development and other relevant outcomes" ASPEN and AND.

6. DEFINITION
- Of how paediatric malnutrition slightly differs

Malnutrition in the developed world

In the past, malnutrition has been best known with it's association with developing countries. Where children appear sad and emaciated with depleted muscle and fat stores. However malnutrition in the developed world mainly occurs within the context of undernutrition

7. MALNUTRITION IN DEVELOPED WORLD
- "Therefore the term malnutrition in this course will mean undernutrition"
- Allows to inform context

What are the causes of malnutrition in children?

- Long term health conditions that lead to a lack of appetite, disrupt digestion or increase the body's demand for energy e.g. congenital heart disease, cystic fibrosis, cerebral palsy and childhood cancers
- Malnutrition in children can also occur to eating disorders of behavioural or psychological conditions that can result in avoiding or refusing food/

8. CAUSES

What are the causes of malnutrition in children?

- Although rare, malnutrition in children can be caused by a poor diet if the child is neglected, living in poverty or being abused
- When the body receives inadequate food or has increased requirements, the body will use fat reserves or muscle mass to continue to fuel the body. This will result in weight loss and over a period of time - malnutrition

9. CAUSES

The effect of malnutrition in children

Over time, undernutrition can begin to affect growth and in the long term result in stunting, where the child may not reach their full height potential

(image of stunted height)

10. EFFECTS

The effect of malnutrition in children

In the clinical setting, physiological changes that can occur include impaired immunity, muscle atrophy and increased susceptibility to infection. As a result this may affect wound healing, which can delay recovery and increase the length of stay (Beer, 2017).

11. EFFECTS

Nutritional Screening

Screening is the process of assessing numerous people, which identifies those at risk, who may need further assessment in an efficient timeframe

Those screened to be at risk of being nutritionally compromised early on can then receive early nutrition support and then prevent the consequences of developing malnutrition.

12. NUTR SCREENING

Importance of screening on admission

It is recommended that a child is malnutrition screened on admission due to various reasons such as

- Provides the opportunity for early nutrition intervention if required and prevents the complications associated with undernutrition and malnutrition

13. IMPORTANCE OF SCREENING ON ADM

How to use STRONGkids?

The screening tool is used to score the risk of malnutrition occurring

It consists of 4 items and each item is allocated a score of 1-2 points with a maximum total score of 5 points

14. HOW TO USE STRONGkids - video

How to use STRONGkids?

1. Subjective clinical assessment (1 point)

- Is the patient in a poor nutritional status judged by subjective clinical assessment (diminished subcutaneous fat and/or muscle mass and/or hollow face)?

15. HOW TO USE STRONGkids - video

How to use STRONGkids?

2. High risk disease (2 points)

- Is there an underlying illness with a risk of malnutrition or expected major surgery?
- (insert table of high risk diseases)

16. HOW TO USE STRONGkids - video

Appendix D: Story Boards – Malnutrition Screening and Weighing & Measuring Modules

How to use STRONGkids?

3. Nutritional intake and losses (1 point)

Are one of the following items present?
- Excessive diarrhoea (>5 per day) and/or vomiting (>3 times/day) the last few days?
- Reduced food intake during the last few days before admission (not inc fasting for an elective procedure or surgery)?
- Pre existing dietetically advised nutritional intervention (see script)

17. HOW TO USE STRONGkids? - video

How to use STRONGkids?

4. Weight loss or poor weight gain (1 point)

- Is there weight loss or no weight gain (infants <1 year) during the last few weeks/months?

18. HOW TO USE STRONGkids? - video

Where do I document this?

A-D planner – maln screening sticker + update score on white board

Do not pick the pink colour. Choose colours that are representative of the score (red = 4-5 points – high risk. Orange = 1-3 – med risk. Green = 0 - low risk).

19. WHERE DO I DOCUMENT THIS? - video

Where do I document this?

20. WHERE DO I DOCUMENT THIS? - video

Where does anthropometry fit into all of this?
- As discussed, screening raises awareness of nutritional risks, but it cannot determine whether a child is malnourished or not
- Anthropometric (also known as weight, height or length) measurements are used to determine a child's current nutritional status, can screen for prolonged chronic undernutrition and provide a diagnosis for malnutrition. We will discuss anthropometry in more depth in the next module

21. WHERE DOES ANTHRO FIT INTO ALL OF THIS

Where does anthropometry fit into all of this?

- Conversely, anthropometry cannot identify the early stages of malnutrition
- Hence why malnutrition screening is very important to identify children at high risk of malnutrition early on, so that nutrition interventions can start promptly

22. WHERE DOES ANTHRO FIT INTO ALL OF IT

Conclusion

That's the end of this module, thank you for completing it! Now you know how important malnutrition screening is and it's role in patient care

23. CONCLUSION

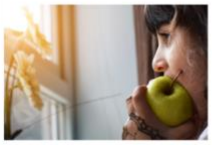
Anthropometry Guide

A how to on measuring weight, height and/or length

3. INTRODUCTION TO ANTHRO
- What anthropometry is

4. IMPORTANCE
- Assessing and monitoring fluid balance in children

5. IMPORTANCE
- Calculating enteral and parenteral feeding requirements



6. IMPORTANCE
- Monitoring the nutritional status of children who are nutritionally unstable and receiving active nutrition interventions e.g. enteral feeding

7. IMPORTANCE
- Monitoring growth

In this video though, we will be mainly discussing the importance of anthropometry in relation to nutritional assessment

Malnutrition screening form

8. ANTHRO + NUTR ASSESSMENT
- Once malnutrition screening has been conducted we have identified those at risk of malnutrition

9. ANTHRO + NUTR ASSESSMENT
- In those children at risk body weights, heights or lengths are needed for an effective nutrition assessment

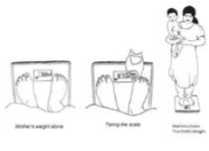
10. ANTHRO + NUTR ASSESSMENT
- Nutr assessment allows the timely identification ...(refer to script).
- This allows effective preventative.. (see script)

Malnutrition –
- Higher complication rates
- Longer recovery times
- Longer hospital stays

= this shows early identification is important

11. ANTHRO + NUTR ASSESSMENT
- Malnutrition in hospitalized children can result in higher complication rates, longer recovery and longer hospital stays
- This shows early identification is important

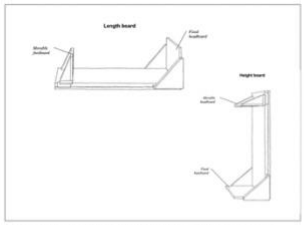
12. HOW TO VIDS START
- Now we will discuss how to take these measurements
- 2 methods of weighing dependent on age/needs. We will start with tared weighing



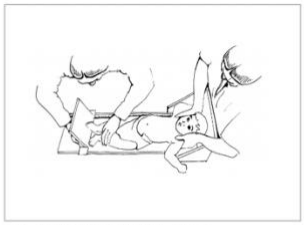
13. TARED WEIGHING - video
- When child is less than 2. Mother + baby can stand on scales together
- Ensure scales are on and zeroed
- Place mum on middle of scale.. (see script)

14. WEIGHING ALONE - video
- Older than 2, this method can be used
- Procedure explained in a non-frightening manner... (see script)

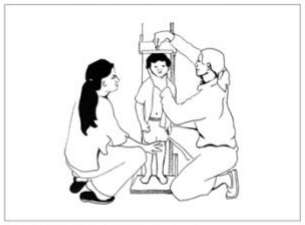
Appendix D: Story Boards – Weighing & Measuring Module



15. MEASURING HEIGHT OR LENGTH - video
- Choosing to measure height or length will depend on the child's age and ability to stand (see scipt)



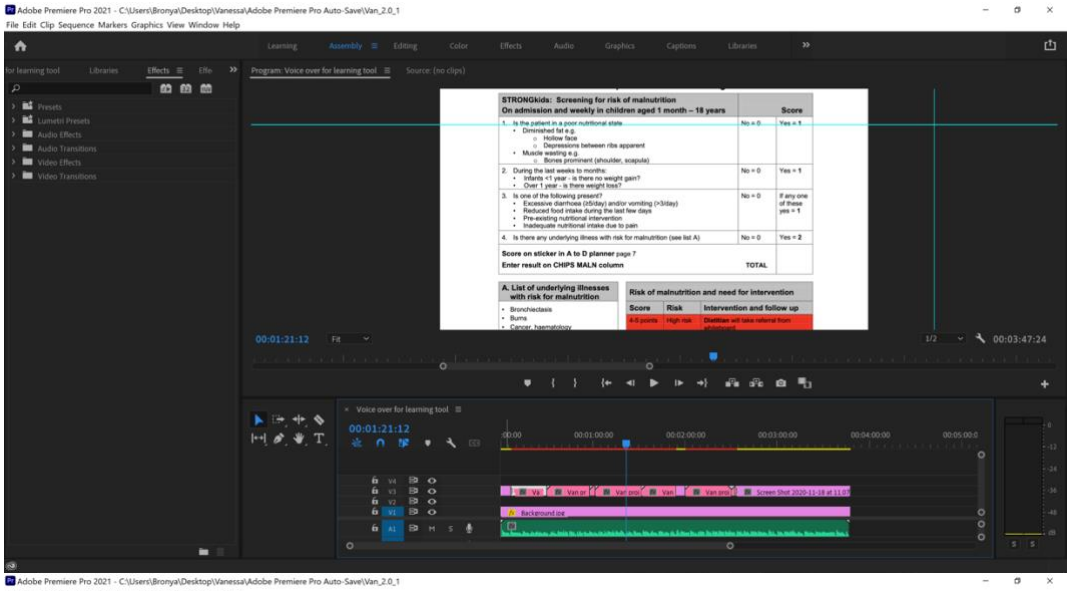
16. MEASURING LENGTH - video
- You should be prepared to measure length immediately after weighing the child, while the child is still naked (see script)

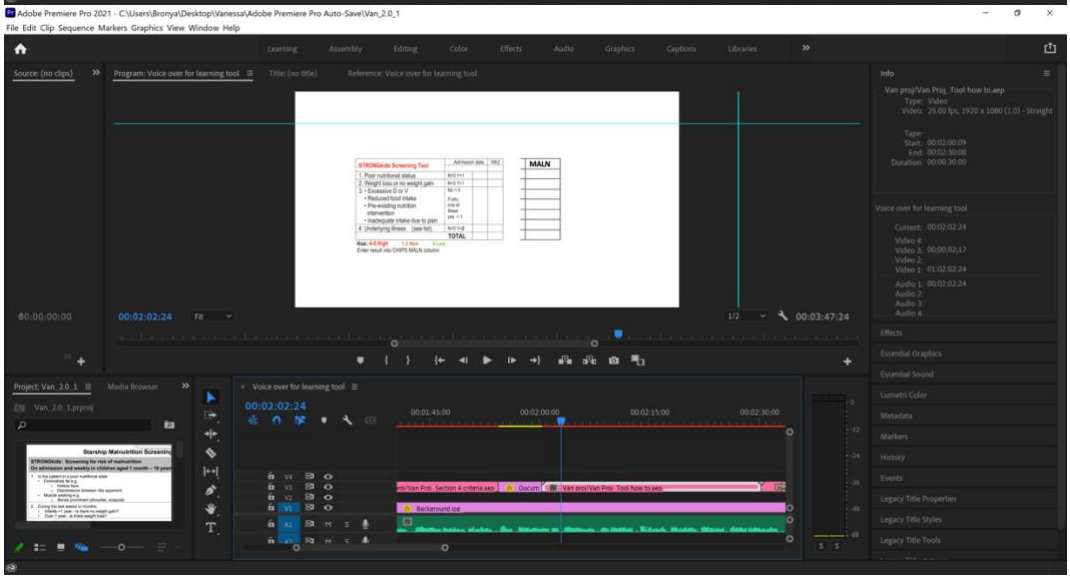


17. MEASURING HEIGHT - video
- If a child is over 2 years old and can stand – standing height can be used
- The height board must be mounted at a right angle … (see script)

18. CONCLUSION
- There you have it! We have now covered the uses of anthropometry in children in the clinical setting … (see script)

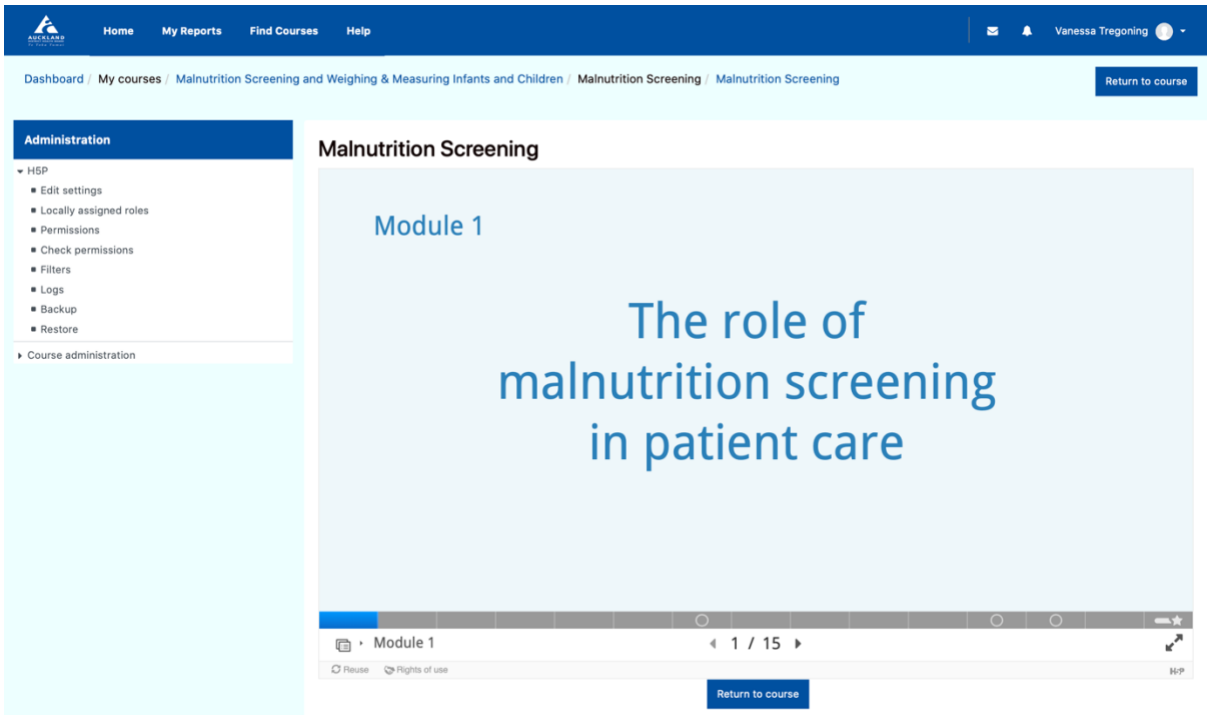
Appendix E: The development of the how to use the STRONGkids screening tool video and the link to the video

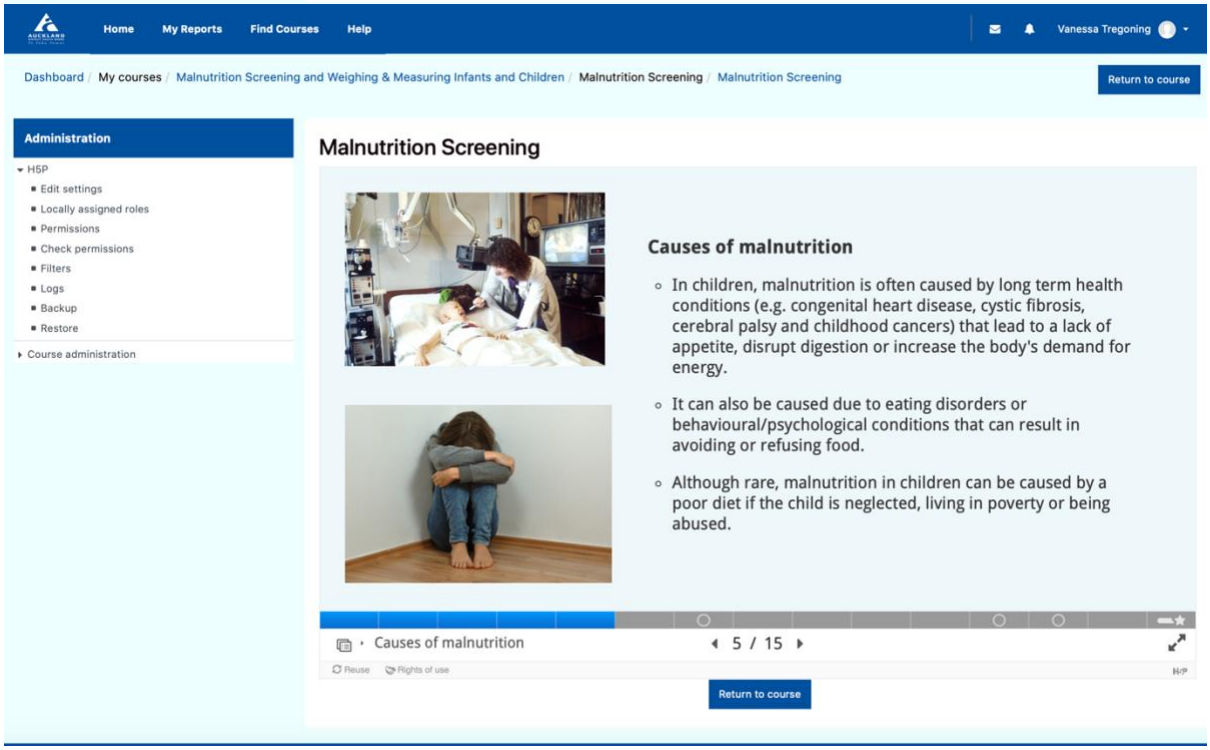




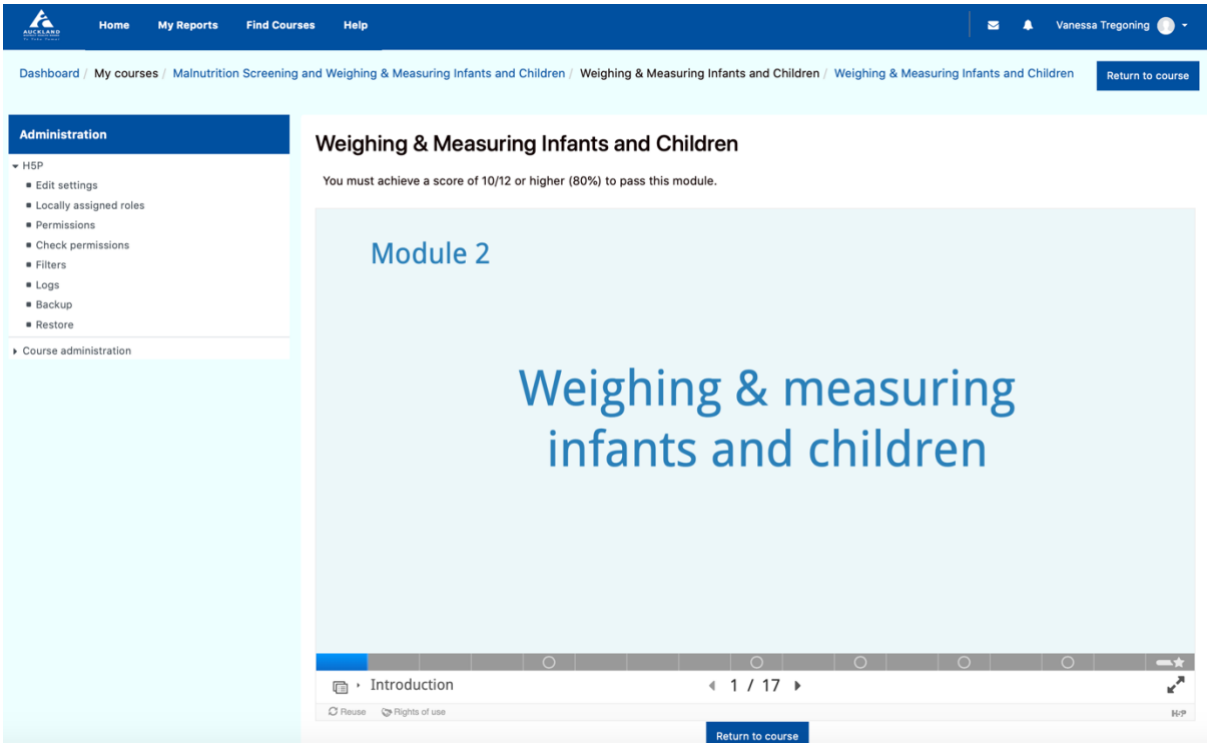
Link to the video: https://youtu.be/KZjP-RKS36I

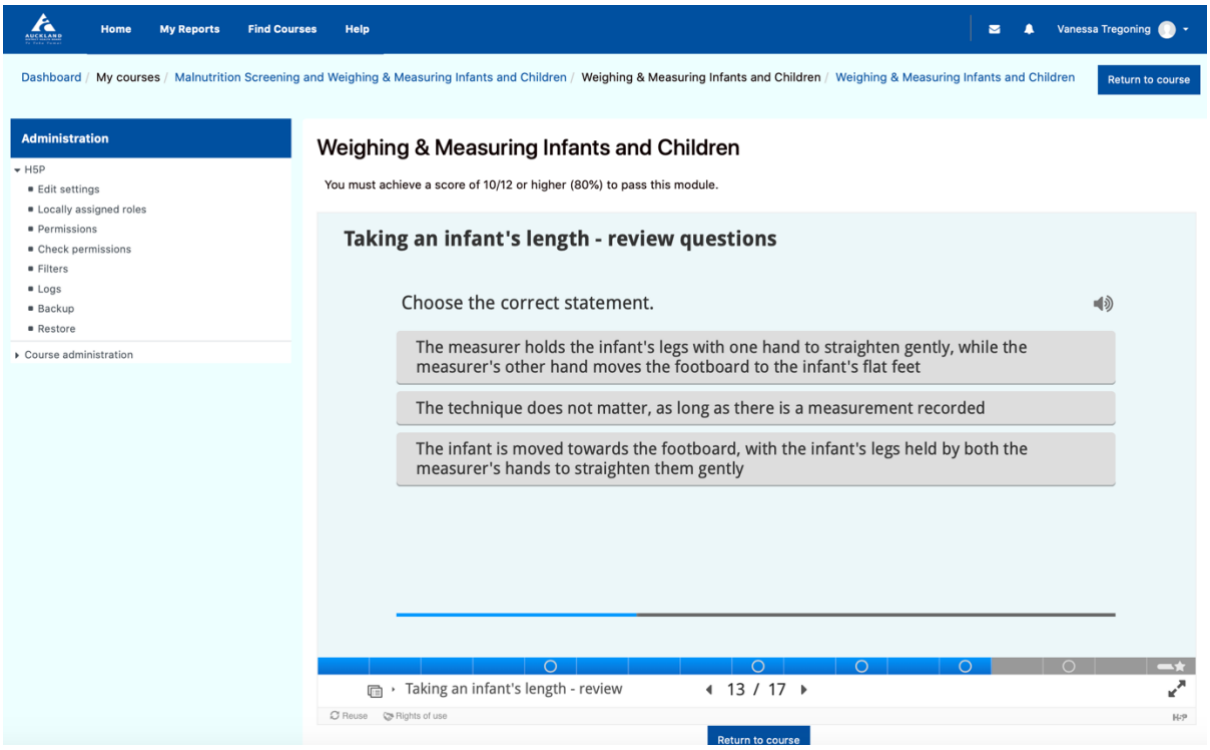
Appendix F: Ko Awatea LEARN Learning Modules





Appendix


Home
My Reports
Find Courses
Help
Vanessa Tregoning
Dashboard / My courses / Malnutrition Screening and Weighing & Measuring Infants and Children / Weighing & Measuring Infants and Children / Weighing & Measuring Infants and Children
Return to course
Administration
H5P
Edit settings
Locally assigned roles
Permissions
Check permissions
Filters
Logs
Backup
Restore
Course administration
Weighing & Measuring Infants and Children
You must achieve a score of 10/12 or higher (80%) to pass this module.
Module 2
Weighing & measuring infants and children
Introduction
1 / 17
Reuse
Rights of use
Return to course


Home
My Reports
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Vanessa Tregoning
Dashboard / My courses / Malnutrition Screening and Weighing & Measuring Infants and Children / Weighing & Measuring Infants and Children / Weighing & Measuring Infants and Children
Return to course
Administration
H5P
Edit settings
Locally assigned roles
Permissions
Check permissions
Filters
Logs
Backup
Restore
Course administration
Weighing & Measuring Infants and Children
You must achieve a score of 10/12 or higher (80%) to pass this module.
Taking an infant's length - review questions
Choose the correct statement.
The measurer holds the infant's legs with one hand to straighten gently, while the measurer's other hand moves the footboard to the infant's flat feet
The technique does not matter, as long as there is a measurement recorded
The infant is moved towards the footboard, with the infant's legs held by both the measurer's hands to straighten them gently
Taking an infant's length - review
13 / 17
Reuse
Rights of use
Return to course

Appendix G: Invitation Email

Kia Ora,

My name is Vanessa Tregoning and I am a Masters of Health Science student majoring in Nutrition and Dietetics. As part of my Masters fulfillment, I am carrying out a project with Paediatric Dietitians at Starship City Hospital. The project is a continuation of the malnutrition screening initiative that has been conducted at Starship since 2016.

The project this year, is an online learning module for nurses, consisting of two modules 1) informing on the role and importance of malnutrition screening in patient care and 2) instructions on taking accurate weighing and measuring in infants and children using instructional videos of standardized measuring techniques. We will evaluate the effectiveness of this educational tool and changes to the knowledge of malnutrition screening and taking anthropometry with a pre- and post-test consisting of 6 questions. Following this, observation of practice will take place in a small number of nurses. Nurses will also be asked to complete a satisfaction questionnaire on how effective the training was and whether it will be a feasible addition to continued training.

To complete the two modules and its associated questions, it should take approximately 30 minutes. Test answers and feedback will be kept completely anonymous; therefore, it will not affect nurse employment or duties on the wards. It is hoped these learning modules will be integrated into regular continued professional development for current nurses and as part of on-boarding activities for new nurses.

Below are contact details for myself (the student researcher) and my project supervisors. Please reach out if this is something you feel you would be interested in participating or any other queries.

Kind regards,

Vanessa Tregoning (Student Researcher), vtre034@aucklanduni.ac.nz

ADHB
- Stella Friedlander, StellaF@adhb.govt.nz
- Kim Herbison, KHerbison@adhb.govt.nz

University of Auckland
- Clare Wall, c.wall@auckland.ac.nz
- Amy Lovell, a.lovell@auckland.ac.nz

Appendix G: Follow up email sent to nurses on behalf from Sarah Little (SCH Nurse Director)

Starship Paediatric Dietitians and The University of Auckland need your help!

As part of the continued improvements in malnutrition screening and taking accurate height/length and weight measurements for patients admitted to Starship, the paediatric dietitians and a student researcher at the University of Auckland have created a **one-time online training module** for nurses.

To understand whether this would be a helpful addition to training new ward nurses on malnutrition screening and taking accurate height/length and weight measurements, we are asking current nurses to **provide us with feedback by completing the module on Ko Awatea Learn**. Without your valuable feedback we won't be able to provide a relevant resource for the hospital!

As an acknowledgment of the time taken to complete this research during your busy day, all participating nurses will go in the draw to win one of three $75 Countdown vouchers on completing the module.

Your input is so valuable. Please take the time to read the attached information sheet and follow these steps:

1. **Consent to taking part in the research and complete a pre-module quiz**: https://auckland.au1.qualtrics.com/jfe/form/SV_0vN00M4qXqbsdqB

2. **Complete the module via Ko Awatea Learn module** (Malnutrition Screening and Weighing & Measuring Infants and Children): https://koawatealearn.co.nz/enrol/index.php?id=5986

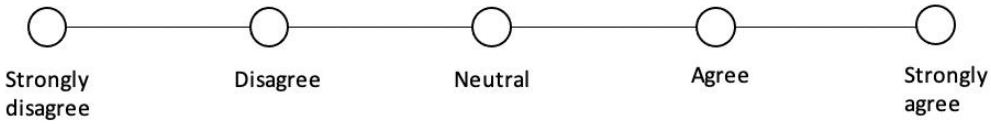
3. **Complete the post-module quiz**: https://auckland.au1.qualtrics.com/jfe/form/SV_0iiCzEzlWIrnMfr

Ngā mihi,
Vanessa Tregoning (student), Stella Friedlander and Kim Herbison (paediatric dietitians)

Appendix H: Pre-Post Test and Ad Hoc Satisfaction Questionnaire

A: Pre and post online training module questionnaire

1. Malnutrition screening for patients admitted to Starship Hospital is important;



2. Malnutrition screening should (choose 2):
   a. Be a quick, simple and generalised screen;
   b. Be a guide for prescribing nutritional supplements;
   c. Be a comprehensive, in depth evaluation of nutritional status
   d. Identify individuals at risk of malnutrition who require further assessment.

3. Where would you document the result of the malnutrition screen for a patient (choose 1):
   a. In the A to D planner;
   b. In the case notes;
   c. In the food and drink intake record;
   d. There is no need for documentation.

4. Why is it important to accurately weight and measure infants and children? (choose 3);
   a. To assess if the child is ready for discharge;
   b. So it can be plotted on growth charts and growth assessed;
   c. So it can be used as part of a nutrition assessment;
   d. To calculate medication dosage.

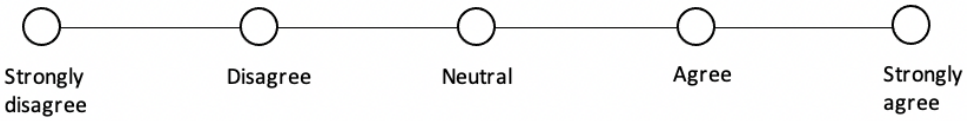
5. When weighing a child over 2 years of age (choose 1);
   a. Remove outer clothing and shoes before weighing;
   b. Weigh naked;
   c. Weigh fully clothed;
   d. Remove outer clothing, standing with mother using a tared weight.

6. When measuring a child's length or height (choose 3);
   a. It does not matter what measurement is chosen, only that it is documented
   b. If a child is under 2 years of age, measure recumbent length;
   c. If a child is over 2 years of age and able to stand, measure standing height;
   d. A child needs to have all clothes removed for a length or height measurement;
   e. In best practice, length or height should be taken before a weight measurement;
   f. Length can be measured using a length mat in a cot or bed;
   g. Two people are required to measure length in infants.

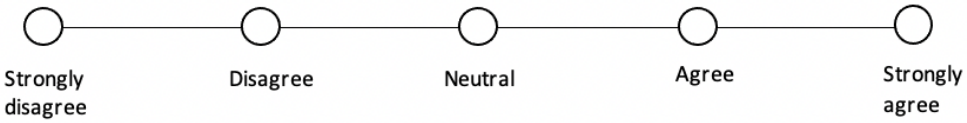
Appendix H: Pre-Post Test and Ad Hoc Satisfaction Questionnaire

B: Ad hoc satisfaction questionnaire

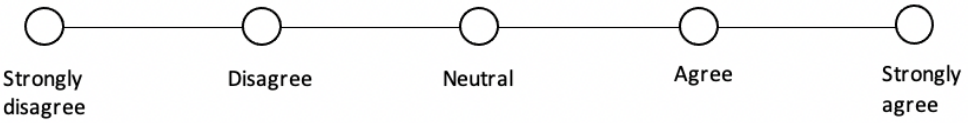
1. I found the malnutrition screening module useful for my practice.



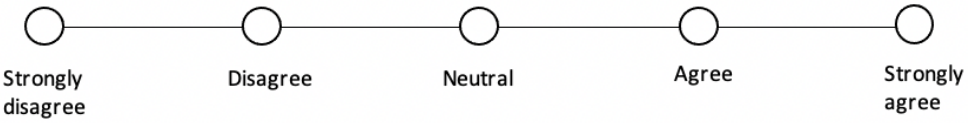
2. I feel well informed about the malnutrition screening process and its importance.



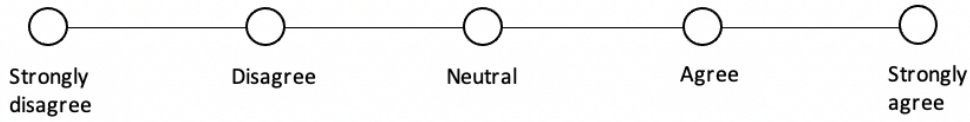
3. I found the weighing and measuring module useful for my practice.



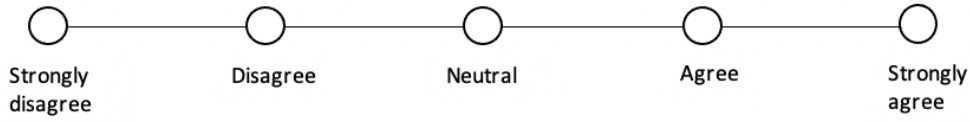
4. I am confident in taking height/length and weight measurements in infants and children.



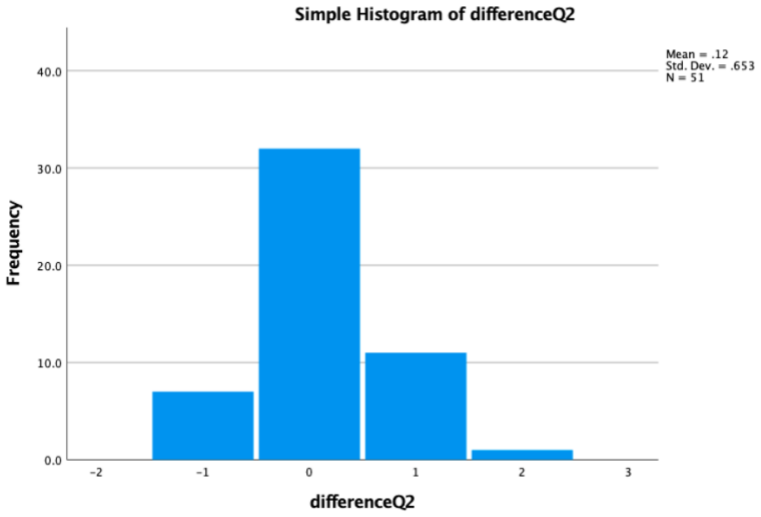
5. I feel that nurses should repeat the weighing and measuring module regularly.

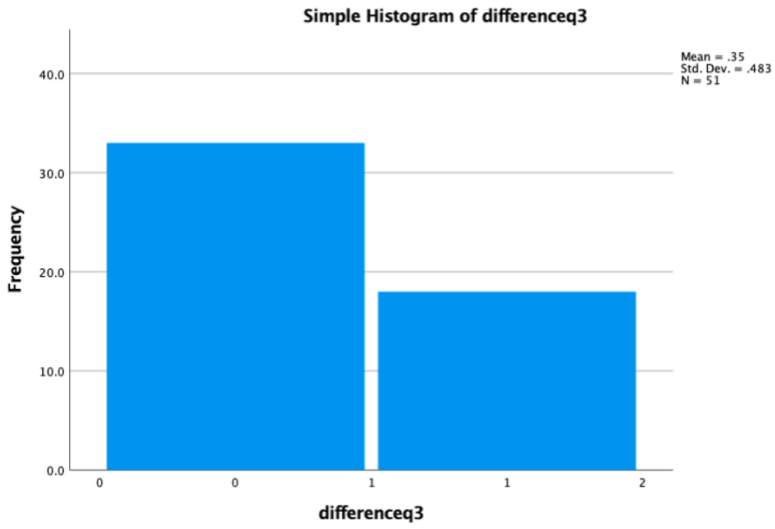


6. The format for both modules was clear and useful.

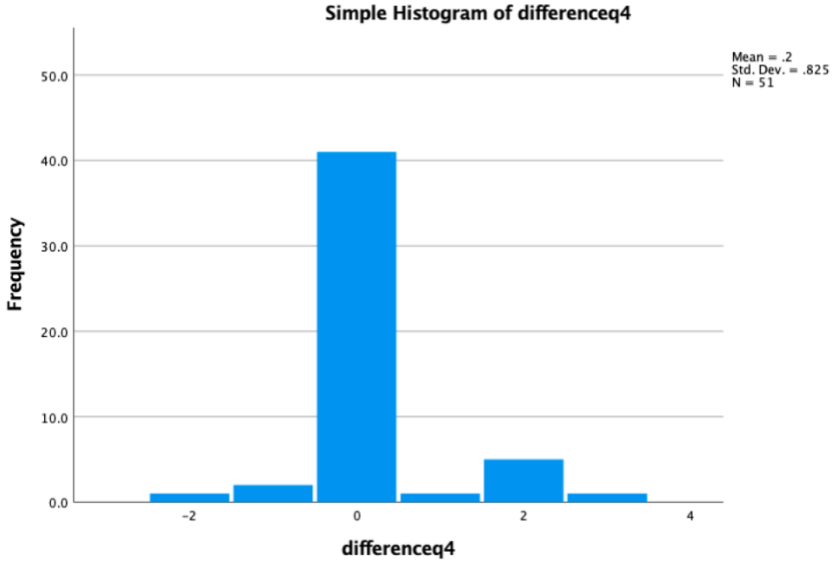


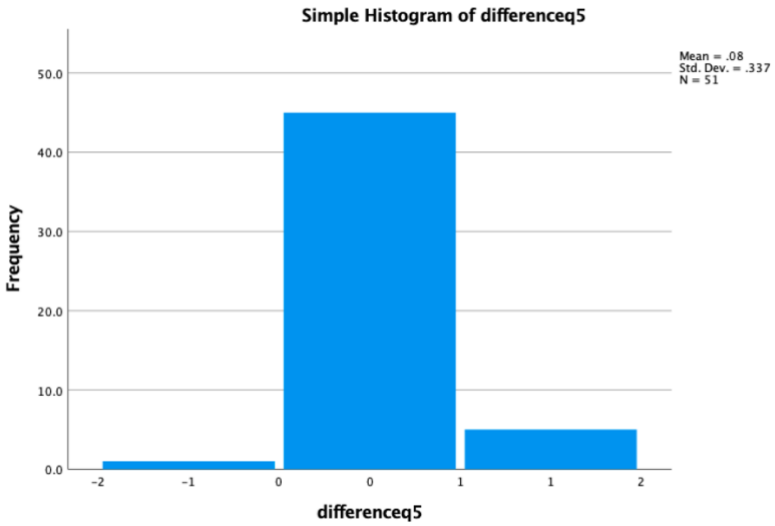
Appendix I: Histogram and Normal Q-Q Plots for Data



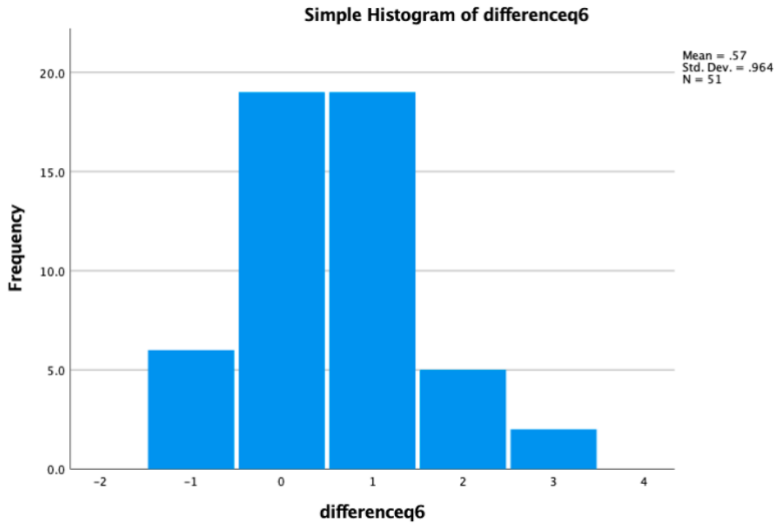


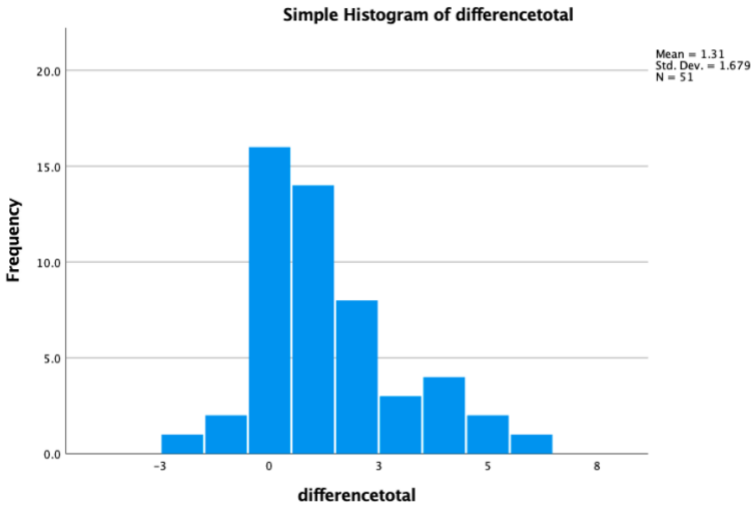
Appendix


Simple Histogram of differenceq4
Mean = .2
Std. Dev. = .825
N = 51
Frequency
50.0
40.0
30.0
20.0
10.0
0.0
−2
0
2
4
differenceq4

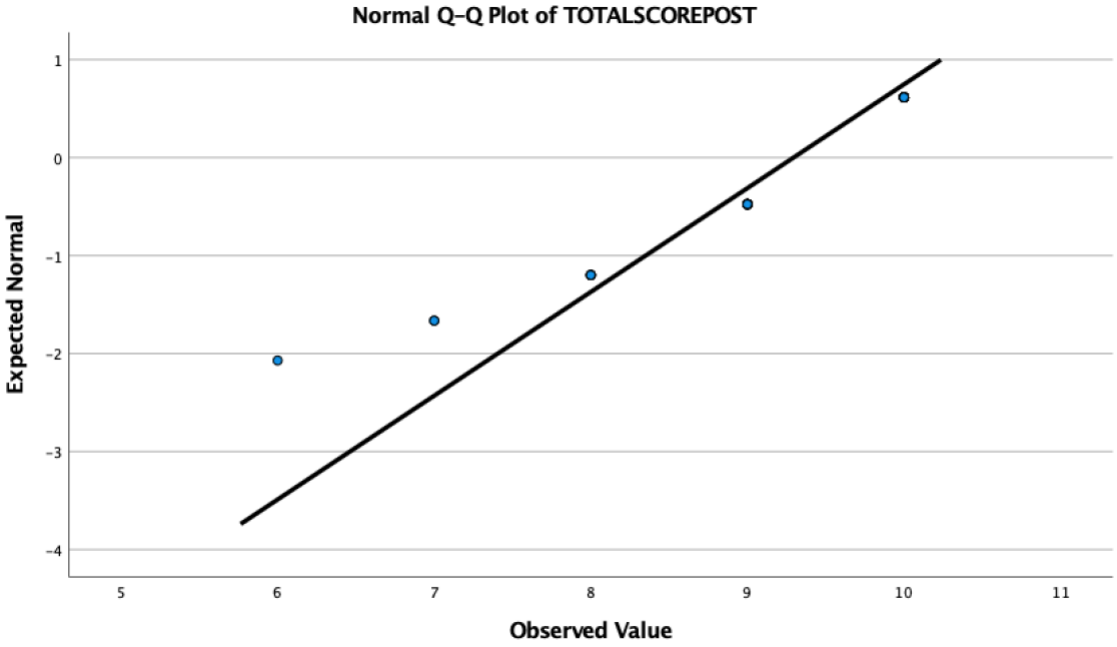

Simple Histogram of differenceq5
Mean = .08
Std. Dev. = .337
N = 51
Frequency
50.0
40.0
30.0
20.0
10.0
0.0
−2
−1
0
0
1
1
2
differenceq5

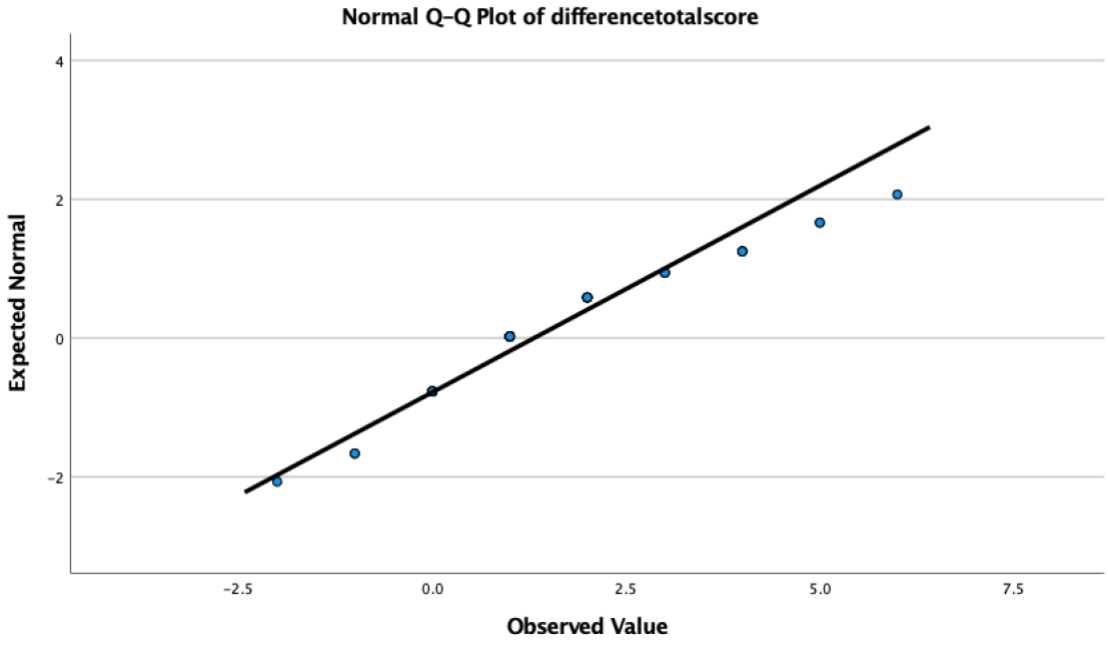
Appendix


Simple Histogram of differenceq6
Mean = .57
Std. Dev. = .964
N = 51
Frequency
20.0
15.0
10.0
5.0
0.0
-2
-1
0
1
2
3
4
differenceq6


Simple Histogram of differencetotal
Mean = 1.31
Std. Dev. = 1.679
N = 51
Frequency
20.0
15.0
10.0
5.0
0.0
-3
0
3
5
8
differencetotal

Appendix


Normal Q–Q Plot of TOTALSCOREPOST
Expected Normal
Observed Value
1
0
−1
−2
−3
−4
5
6
7
8
9
10
11


Normal Q–Q Plot of differencetotalscore
Expected Normal
Observed Value
4
2
0
−2
−2.5
0.0
2.5
5.0
7.5

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