Non-pharmacological Pain Management in Pediatric Nursing (1-10 years)

JULIA RONO

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Author:	JULIA RONO
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Supervisor (Arcada):	GUN-BRIT LEJONQVIST ,PAULEEN MANNEVAARA
Commissioned by:	ANNIKA SKOGSTER

Abstract:

Pain is recognized as a global health problem and its alleviation is considered a human right by the IASP and WHO. In the pediatric population, research indicates that pain is under-treated a situation that negatively affects normal child development and causes a deterioration in their quality of life. Non-pharmacological methods have been touted as effective and safe in pain management in this population. However, knowledge on the subject among nurses have been found to be wanting and their use in pain management has been minimal.

This study's purpose was to explore and present the different non-pharmacological methods whose pain alleviation abilities in children (1-10 years) have been described in clinical care by nurses. This was with an aim of equipping pediatric nurses with up-to-date knowledge on the efficient non-pharmacological methods to tackle a variety of pain types in the pediatric population.

The study employed an exploratory systematic literature review which involved conducting a rigorous data search and selection procedure of publications retrieved from PubMed, PsycINFO, CINAHL, Elsevier and Google Scholar. This resulted in 36 publications which forms the core of this thesis. 11 non-pharmacological pain alleviation methods were identified.

The results of this study will provide recent literature on the available non-pharmacological pain alleviation methods in pre-school and school going children (1-10 years) whose efficacy has been determined in clinical settings.

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CONTENTS

1 INTRODUCTION

Pain is recognized as a global health problem. According to Brennan, Lohman, & Gwyther (2019), its relief and management is a recognized human right, an aspect that is recognized by world health bodies such as the International Association for the Study of Pain (IASP) and the World Health Organization (WHO). In pediatrics, pain is a particularly stressful experience that often negatively impacts normal child development and causes a deterioration in quality of life. Despite increased research in the study of pain in recent years, under-treatment of pain is commonplace. This is especially true for the pediatric population (Linhares *et al.*, 2012). The nursing management of pediatric pain is often an arduous task. There are several factors that make pain management in pediatrics difficult. First, pain is multidimensional and subjective and its experience is influenced by a host of factors that include sensory, physiological, cognitive, emotional, and behavioral components (Fillingim *et al.*, 2016). Inexistence of holistic pain assessment tools for pediatrics and the cognitive hindrances for subjective assessment in this population makes pain management difficult. Further, there is still the niggling belief that the pain experience of children is not similar to that of adults (Twycross and Collis, 2013).

There exist several ways of managing pain in the pediatric population. The use of these management techniques is dependent on a host of factors that include; the pain type (whether acute, chronic or recurrent), the pain context (whether post-operative, procedural or clinical), and the pain dimension (the pain location, duration, affective quality and intensity).

The first pain management strategy in pediatrics involves the use of pharmacological interventions. Here, pain symptoms are managed by providing a set of analgesics that include opioids and sedatives. Their use in the pediatric population however is shrouded with controversy with some of them being associated with adverse neurodevelopmental outcomes (Kesavan, 2015).Another pediatric pain alleviation strategy includes the use non-pharmacological interventions. Several non-pharmacological interventions have been described in the past. They include psychological techniques such as distraction techniques, techniques based on cognitive behavioral therapy and physical techniques (Koller and Goldman, 2012).

Despite the pharmacological analgesia being the more widely used pain alleviation method in children, the effectiveness of non-pharmacological pain management strategies have been confirmed in pre-school and school going children (Koller and Goldman, 2012; Wente, 2013; Oliveira and Linhares, 2015). Despite this evidential support, pain alleviation using non-pharmacological techniques in children is minimally implemented in care settings by nurses (Chotolli and Luize, 2015). Lack of sufficient knowledge on their existence has been highlighted as one of the factors that hinder their utilization in care (Yildirim, Cicek and Uyar, 2008; Mwanza, Gwisai and Munemo, 2019).

This study's aim was to systematically review available and recent literature on the effective non-pharmacological pain alleviation interventions for the pediatric population (1-10 years). This study did not limit itself to a particular type of pain but rather included studies that showed the use and efficacy of non-pharmacological pain intervention for procedural, post-operative, acute, chronic pain relief in pediatric patients (1-10 years). The study will act as a good resource for nurses on the available non-pharmacological pain intervention for pediatric pain amelioration, their efficacy and their use case scenario. This will stimulate the use of best practices of pediatric pain alleviation by nurses in clinical settings.

2 BACKGROUND

2.1 Concept of Pain

According to the International Association for the study of pain (IASP), pain can be defined as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in term of such damage" (IASP, 2012). However, pain is itself a complex phenomenon that is very subjective, an aspect that continues to pose a challenge in correctly defining it. For example, Williams and Craig contend that the IASP definition leaves out the cognitive and social components of pain and trivializes the severity of pain (by just calling it unpleasant) (Williams and Craig, 2016).

Normally, pain is itself a conscious experience which stems from the peripheral and central nervous system activity as a response to a noxious stimulus. Pain perception normally involving the trinity of the brain's emotional, sensory, and cognitive processes. Resolution of pain is mostly achieved by healing and/or the removal of the noxious stimuli. Most often however, pain perception may persist despite the noxious stimuli removal and healing, sometimes occurring even without any apparent tissue damage, disease or any notable noxious stimuli (Raj, 2007).

In pediatric care, pain is a contender of one of the main causes of distress and suffering in children receiving care. When unrelieved it may result into undesirable physical and psychological consequences and may negatively influence a child's future pain response (Noel *et al.*, 2012). It is therefore essential that pediatric pain be well managed.

2.2 Classification of Pain

To guide assessment and proper management of pediatric pain, it's essential to decipher the accepted classification of pain. Some major aspect that can be used to classify pain are 1) intensity, where it can be classified as mild, moderate or severe, 2) the pain's pathophysiology (nociceptive, neuropathic or mixed), and 3) the pain's duration (acute or chronic), (Raj, 2007). On the pain duration category, acute pain is characterized by a sudden onset and a short duration of perception. It is the most common pain complaint in pediatric settings and results from either injury, illnesses or common medical procedures

such as venipuncture. Some features that characterize this type of pain are anxiety, evasion, elevated parent distress and a host of other somatic symptoms. Being the most prevalent pain type in pediatric nursing, it is essential that it be properly managed. Chronic pain on the other hand, is also a significant pain type in pediatric settings. Unlike acute pain, it persists for 3-6 months after healing manifesting itself either recurrently or in a persistent form and affecting one or several of the body organs. Early and effective management of this type of pain in pediatrics is essential if disability and full amelioration from the pain is to be achieved (Cupples, 2013). Pain may also be described as nociceptive or neuropathic. In the former, the pain perception transduction starts when a damaged tissue activates sensory neurons which sends signals to the brain ultimately triggering the pain sensation perceived by an individual. This pain type can also be identified either as somatic or visceral, with somatic pain manifesting in soft tissues, bones and the skin as throbbing, easily localizable pain. Visceral pain on the other hand is difficult to locate and manifests as a dull or cramping sensation. Finally, neuropathic pain, is usually due to pathological changes experienced in the peripheral or central nervous system (Raj, 2007).

2.3 Pain Management

Pain management is a branch of patient care that utilizes interdisciplinary approaches to ease the suffering, improve the quality of life and avert undesirable physical and psychological consequences of those experiencing pain (Jungquist *et al.*, 2017). Pain management involves, a host of practices that include pain assessment, planning, implementation of a suitable pain alleviation strategy and evaluation of the efficacy of the technique used in amelioration of pain. Unlike in adults, pain in children is difficult to effectively manage (assess, treat and evaluate), due to a variety of factors such as myths of pain inexistence in children and difficulty in sufficiently assessing pain in this population (Mak *et al.*, 2011). However, the deleterious effects of pain both physically and psychological in the long-term (Grunau, Holsti and Peters, 2006; Noel *et al.*, 2012), as well as the high prevalence of pain in this population (King *et al.*, 2011), points to the need of efficient management of pain in this population.

2.4 Pain assessment

Pain, as earlier intimated is multifactorial, having physiological, emotional, cognitive, sociocultural and behavioral components. Its therefore essential that any assessment technique employed in assessing pain consider this. In pediatric unlike in adults, pain symptom assessment is not easy and the ability to correctly assess the pain in a pediatric patient is influenced by a host of factors. Nurses should consider the child's age, cognitive and communicative ability, pain type, and the situation if they are to accurately determine the level of pain a child is in (Verghese and Hannallah, 2010; Chiaretti *et al.*, 2013).

Based on the unique needs of the pediatric population, several methods of pain assessment whose reliability has been proved have been described. They fall into three main categories namely biological/physiological measures, observational and behavioral measures, and self-report measures.

Physiological assessment techniques are usually concerned with assessing a child's physiological parameters that have been known to be affected by pain perception and are thus considered important pain markers (Cowen *et al.*, 2015). Some physiological markers of interest in pain assessment include 1) Heart rate variability (Changes in time, frequency and intervals between heartbeats may provide a good picture of reactivity to noxious stimuli (Appelhans and Luecken, 2008)), 2) Changes in heart rate and blood pressure, 3) Skin conductance (as noxious stimuli may stimulate sweating affecting skin conductance (Storm, 2008)), 4) respiratory rates and, 5) concentration of biomarkers such as stress hormones, biochemical analytes and inflammatory mediators among others (Cowen *et al.*, 2015).

Observational and behavioral measures are also used in the assessment of pain in the pediatric population. These measures utilize several behavioral indices that can be used to assess pain. These include pediatrics' motor responses, facial expressions, crying level and duration, sleep-wake patterns and vocalization. Observational and behavioral pain assessment measures are mainly used in neonates and infants and most of the time assessed in association with physiological parameters previously described (Chiaretti *et al.*, 2013). Some commonly used behavioral pain assessment tools are the Children's Hospital of Eastern Ontario Pain Scale (CHEOPS) scale, the Objective Pain Scale, the

Comfort Scale, and the FLACC scale (Crellin *et al.*, 2007; Verghese and Hannallah, 2010; Chiaretti *et al.*, 2013).

Self-report measures are also used in assessment of pain in pediatrics and are considered as gold standard in children who are well developed cognitively and can easily communicate, usually 3 years and above (Chiaretti *et al.*, 2013). These methods utilize a host of strategies to effectively evaluate one's pain level. This includes direct questioning, and use of self-rating scales. Some common tools and scales that employ the self-report underpinnings include the visual Analogue Scale (VAS), the Wong-Baker Faces Pain Rating Scale, the pain ladder among a host of others (Verghese and Hannallah, 2010; Chiaretti *et al.*, 2013).

3 THEORETICAL FRAMEWORK

3.1 Abdellah's 21 Nursing Problems Theory

Abdellah's 21 nursing problems theory incorporates the interrelated concepts of human health, nursing problems and problem solving. In her view, Abdellah considers the nursing practice to be an art and science which shapes a nurse's attitude, intellectual values, and technical skills into a natural desire and competence to help those who need health care to cope with their health needs (Abdellah, Levine and Levine, 1986). In her 1960 seminar paper, Abdellah described nursing as the utilization of a problem-solving approach to solve nursing problems that are related to people's health needs. She views nursing as a helping profession. In nursing according to her, nurses are obligated to provide holistic care to patients that is patient-centered (Abdellah, 1960). She emphasizes the need to move away from care that is disease focused to one that focuses on treating the whole person. With this view, Abdellah developed a theory that seeks to unravel the 21 areas nursing should focus on. These problem areas are what Abdellah believes should guide nursing care and ensure patients receive care that helps them fulfill their health needs.

Before getting into the 21 problems that nursing care should seek to solve, it is important to identify the various components that make up the 21 nursing problems theory. These components include individual, nursing, health, society, nursing problems, and provision of solution to nursing problems. According to Faye Abdellah, nursing is key in alleviating the impairment or meeting the health needs of individuals who have an impaired health condition. She emphasizes that nurses need to employ a patient-centered approach in their quest of meeting patients care needs. In the significant role of caring they play as members of healthcare personnel, they must possess the right attitude and utilize the nursing competencies learnt through education and practice to provide holistic, quality, effective and patient-centered care (Abdellah and Levine, 1994).

The second component of Faye's theory is the individual. This is the person seeking care or one who has an unmet health need. It is the responsibility of the nurse to meet their needs, help restore their self-help ability and alleviate either their physical, psychological or social impairments.

The third aspect of Faye's theory is health. Faye claims that the sole reason the nursing profession exists is health, or the achievement of it. Faye does not exhaustively describe what health and a healthy person is like according to her beliefs but notes that health is when both the mind and body are in a state of complete wellbeing (Wayne, 2014).

Society is another aspect that Faye was cognizant of during the development of his theory. She notes that social enterprises and social problems are interconnected and their impact on social issues such as poverty, racism, pollution, etc. have an effect on the health of the individuals and how care is delivered. As such, nursing should not only focus on the restoration of physical health but also encompass the consideration of social issues during care provision.

Having identified the other key aspects of nursing care provision, Faye noted that there are various health needs that individuals seeking care have. These are what Faye refers to as nursing problems in her Twenty-One Nursing Problems Theory. Because nursing care has the role of ensuring that individuals' health needs are met, Faye seeks to identify these unmet needs with an aim of giving nurses a direction as they attend to their care duties. Faye notes that unmet health needs may either be overt and covert and it's the nurse's role to identify all these needs and take the opportunity to meet them (Abdellah, Levine and Levine, 1986; Wayne, 2014).

The last component of Faye's Nursing Problems Theory is problem solving on the side of nurses. After needs identification, Faye envisions the important role of nurses as problem solvers. Both overt and covert health needs of individuals need to be met and it is the role of the nurse to borrow from their past experiences, nursing expertise and competencies and basic problem-solving skills to meet these needs.

3.2 Typology of the 21 Nursing Problems

Abdellah Faye nursing problems were either physical, emotional, sociological involved patient care elements or were about nurse-patient interpersonal relationships. Additionally, Faye utilized Virginia Henderson's 14 basic human needs to develop a classification of the 21 nursing problems that her theory proposed (Abdellah, 1960). Henderson theory talks about the existence of basic need as components of an individual's health and the fact that achievement of health may require external assistance. Faye

placed the nursing problems she proposes in her theory into distinct categories. based on how important they are to restoring a patient's health, her 21 problems can be divided into other four categories which include basic, sustenal, remedial and restorative care needs. The table below highlights the major categorization of Faye's patients' needs

Basic Care Needs

Faye identified 5 needs that are basic to all patients. Nurses therefore are expected to keep up with individuals' good hygiene and physical comfort, enhance optimal health through activities such as sleep, rest and exercise, encourage safety by preventing instances of injury, accidents, or spread of infection and uphold an individual's good body mechanics by preventing and correcting deformity.

Sustenal Care Needs

Faye also identified needs that are key to the sustenance of an individual's health that nurses need to facilitate: Nurses need to facilitate whole-body nutrition, effortless elimination, maintenance of an optimal fluid and electrolyte balance, identification of the body's physiological responses to disease, the maintenance of f regulatory functions and mechanisms, as well as the preservation of an individual's sensory function.

Remedial Care Needs

Faye also identified remedial needs of patients that nurses should seek to fulfill. Nurse should facilitate the maintenance of good nurse-individual interrelationships, enhance a patient's therapeutic environment, help individuals attain personal spiritual goals, and maintain effective communication with patients. Additionally, nurses are expected to recognize and accept emotion-relationship interrelatedness and individuals' positive and negative feelings, expressions and reactions.

Restorative Needs

The last type of needs that Faye identified to need facilitation by nurses are restorative needs. Faye noted that nurses have a role in recognizing the importance of social factors as disease influencers, using community resources to develop solutions to help individuals who are unwell and setting of care goals despite the existence of physical and emotional limitations.

3.3 Implications of 21 Nursing Problems Theory to the Study

Nursing theories normally provide a conceptual guide to nursing practice and are crucial in the global effort to provide quality, affordable, and effective care. Nursing theories, like other theories are developed after rigorous deductive and inductive reasoning process and are designed to provide an infrastructure that can be relied on to support quality patient care and highly effective nursing practices (McEwen and Wills, 2017). To find solutions for complex and challenging nursing situations, application of nursing theory via research and education can come in handy.

Faye's 21-Nursing Problems Theory helps identify patients' needs that can be solved by undertaking professional nursing actions. It emphasizes that individual have both overt and covert health needs that need to be met. It then asserts the important role of nurses in correctly identifying both of these problems and providing a solution that satisfies the individuals' needs. Faye notes that need identification is crucial to the development of the correct nursing intervention and that it is from the need identification that effective problem-solving steps can be taken (Abdellah, Levine and Levine, 1986).

In this study, our focus was on the identification of the non-pharmacological pain management methods for children (1-10 years) in clinical settings. While Faye's 21-Nursing Problems Theory has mostly been used in the development of nursing education curricular, its application in nursing care environment is also prevalent (Abdellah, Levine and Levine, 1986). Faye advocates for a comprehensive approach to care by nurses, one that starts with identifying the problem, selecting data on the nursing problem in question, using data collected to test a nursing hypothesis and then revising and taking actions based on conclusions made. In this present study, we have recognized that pediatric pain management is key to a child's health but is often times unmet. Armed with this understanding, we sought to identify effective ways that pain in the pediatric population can be managed using non-pharmacological methods. Pain is a covert need that is often not recognizable but needs to be met. As Faye advocates, nurses need to provide holistic care that meets patient needs. It is with Faye's motivation then that we seek to identify from research ways that pain in the pediatric population can be alleviated using non-pharmacological methods.

4 AIM AND RESEARCH QUESTION

Despite this evidential support, pain alleviation using non-pharmacological techniques in children is minimally implemented in care settings by nurses (Chotolli and Luize, 2015). Lack of sufficient knowledge on their existence has been highlighted as one of the factors that hinder their utilization in care (Yildirim, Cicek and Uyar, 2008; Mwanza, Gwisai and Munemo, 2019). This research study sought to answer the research question: What are the non-pharmacological pain management methods for children (1-10 years) in clinical settings?

By doing so, this research study aims to be an important nursing resource that will both educate and sensitize nurses on effective and safe non-pharmacological pain alleviation methods in pre-school and school aged children (1-10 years).

5 RESEARCH METHODOLOGY

5.1 Introduction

This section is aimed at describing the approach used to answer the study's research questions. The aspects to be addressed in this section include 1) the study's research design, 2) the study's literature search strategy, 3) the study's relevant literature selection procedure, 4) quality assessment of the studies' inclusion suitability, 5) synthesis of the information presented by relevant studies selected for inclusion in the study and 5) qualitative content analysis.

5.2 Data Collection

5.2.1 Research Design

This study sought to detail the Non-pharmacological pain management techniques available for the management of pain in children aged 1-10 years. To answer this question, a literature review methodology was employed. This method involves various important stages that ensure that data collected from literature is of high quality and accurate. The steps involved in systematic literature review include 1) determination of a research questions and as such a research purpose, 2) development of a sound literature search strategy, 3) undertaking of the actual search of peer reviewed literature in scientific databases such as PubMed, CINAHL, and Elsevier, 4) selection of relevant and high-quality studies for inclusion in your study, 5) synthesis of chosen research studies, and 6) conducting a qualitative content analysis.

Via the rigor and comprehensiveness of literature reviews, nearly all studies that are relevant to a certain study purpose are captured. Further, this methodology makes it easy to critically appraise studies before they are included in a review ensuring that only high-quality information that is able to answers a study's research question is included (Bennett, 2012).

Literature reviews can take a variety of thematic forms. Some may be exploratory while others may be descriptive, or evaluative. The choice of either form is usually dependent

on the type of research you intend to undertake. For this systematic literature review, We took a descriptive stance that described what non-pharmacological pain management are available to alleviate the pain in children (1-10 years).

5.2.2 Literature search Strategy

Databases used

To identify relevant studies, a sound literature search strategy is essential while undertaking a systematic review of literature. For this study, an exhaustive literature was conducted on a variety of online repositories. The repositories that were queried included 1) PsycINFO. This is an online repository that indexes literature related to psychology, nursing, sociology, psychiatry, medicine among other disciplines; 2) PubMed. This is a repository managed by the National Health Institute (NIH) which indexes journals papers holding biomedical literature; 3) CINAHL. This is a repository that provides access to health and nursing related literature; 4) Elsevier, this is one of the largest science databases, and 5) Google scholar, a web search engine managed by google which indexes scholarly literature in many disciplines. Additionally, bibliographic lists of journals identified in the initial search were searched to identify any relevant literature that may have been left out.

Keywords used to search literature.

Choosing the right keywords ensures that most of the targeted literature is returned after a search in a literature database. Tips for developing effective keywords and Boolean operators was sought from (Fonseca, 2013). This ensured that most if not all relevant literature was captured during my database searches. Some of the keywords used included child* pediatrics, paediatrics, pain, anxiety, distress, soreness strategies, techniques, coping, management. These keywords were utilized in a variety of combinations to ensure their effectiveness.

Studies Exclusion/Inclusion Criteria

Studies were selected for synthesis if:

1. They were an experimental/ quasi experimental study or a randomized controlled trial
2. They had a study population of children aged 1 to 10 years (studies were also included if their sampled population were of an age that intersected with the 1-10-year range).
3. The type of pain they scrutinized was either procedural/non-procedural
4. The pain management technique they highlighted was non-pharmacological
5. They utilized pain assessment technique whose reliability has been proven
6. The studies were conducted in a clinical setting
7. The studies were published in 2009 or later

Studies were excluded if:

1. Both the treatment and the control arm had <10 patients.
2. They were written in any language other than English.
3. They included adults
4. They included children not within the stipulated 1-10 years age bracket
5. They were undertaken in non-clinical settings.
6. The studies were published earlier than 2009

5.2.3 Study Selection

After undertaking the initial database search in the databases described previously (PsycINFO, PubMed, Elsevier, CINAHL, and Google Scholar), 543 publications were returned. Analysis of the identified publications noted that 60 were duplicated across the databases queried. This were expeditiously weeded out. The inclusion/exclusion criteria also helped remove a further 380 after skimming through all the publications' abstracts. Of the 103 that were left, full texts of 19 could not be accessed, as such, they were dropped. 50 were further eliminated after downloading and reading through their contents and finding that they did not satisfy the inclusion/exclusion criteria fully. 36 studies were included for review in this study, see the list of analysed publications in **appendix 1** and the study selection process in **appendix 2** below.

The articles selected for review (n=36) were from different nations: United States (n =11), India (n=4), Canada, Australia, Turkey, and Italy (n =2); China, Sweden, Indonesia, South Africa, Vietnam, Greece, Brazil, Netherlands, Israel, Germany, Saudi Arabia, Egypt, and Thailand (n=1). Concerning the study designs, most studies were RCTs (n=12), with the rest being either experimental studies, quasi experimental studies, non-blinded clinical trial, prospective and crossectional studies. Various pain clinical events were featured, with most involving some type of venipuncture procedure (n=15). Other pain events included migraines, headaches, chronic pain, and burn wound pain. The study features can be found well tabulated in **appendix 3** below.

5.3 Data Analysis

As illustrated in the section above, 36 publications were selected for review. To all the 36 studies selected, a thorough content analysis as described by Elo and Kyngäs (2008) was conducted on them. During this content analysis step, Papers were thoroughly read, from abstract to conclusion. During each read, notes of their main content, their main findings, their assertions, their observations and their reservations were made. After this initial open coding step, main categories based on the major themes identified were then identified and noted down. During this categorization step, we utilized latent content interpretation which helped us identify publications whose content were similar which then helped us to place them in clearly defined categories. These categorized findings can be viewed in **appendix 4** below.

5.4 Ethical Consideration

This study strictly followed research directions set out by Arcada's research guidelines. There was also strict adherence to the guidelines of conducting scientific research. First, the study authors went out of their way to ensure that this research undertaking was undertaken with the necessary thoroughness to ensure the accuracy of the research findings and claims made by this research paper. Achievement of this was possible because the study authors deeply scrutinized research papers before they were included in the findings. The thorough content analysis utilized helped identify only relevant, and reliable publications to answer the study's research questions. Further, a thorough account

of the methods used in the compilation of this paper are laid out in the methodology section to enable scrutiny and replicability in future.

Research biases exist and our past experiences in the field could have skewed our findings. However, we prevented this by strictly following our research methods that were clearly outlined before we undertook the study. This meant that we only included research publications that were relevant and met our strict inclusion, exclusion criteria. We also reiterate that there exist no competing interests, either political, financial, personal or academic that could have potentially affected the direction the study took.

6 STUDY RESULTS

6.1 Findings

Of the studies selected for review (n =36), various categorizations were apparent. Most non-pharmacological pediatric pain alleviation strategies identified were psychological or physical.

From the studies that highlighted psychological pain alleviation methods, we identified two main themes. Psychological pain alleviation methods used on pediatrics were either forms of distractions or involved cognitive behavioral therapy. Some psychological pain alleviation methods identified included guided imagery and relaxation (Huth *et al*., 2009; Kline *et al*., 2009; Dobson and Byrne, 2014), playing with toys (Hillgrove-Stuart *et al*., 2013), virtual reality (Nilsson et al., 2009; Brown *et al*., 2014), Watching cartoons (La Vonne and Zun, 2012; Bergomi *et al*., 2018; Feng *et al*., 2018; Hartati *et al*., 2018; Akgül *et al*., 2019), music therapy (Nguyen *et al*., 2010; Hartling *et al*., 2013; Calcaterra *et al*., 2014; Sundar *et al*., 2016; van der Heijden *et al*., 2018), hypnosis (Liossi, White and Hatira, 2009; Chester *et al*., 2018), and biofeedback (Blume, Brockman and Breuner, 2012; Yetwin *et al*., 2012).

Five forms of physical, non-pharmacological pain management methods for pediatrics in clinical settings were identified. They included massage (Post-White *et al*., 2008; da CunhaBatalha and Mota, 2013; Çelebioğlu *et al*., 2015; van Dijk *et al*., 2018), acupuncture (Wu *et al*., 2009; Gilbey *et al*., 2015; Johnson *et al*., 2015; Sherman, 2015; Usichenko *et al*., 2016; Graff and McDonald, 2018), heat and cold therapy (Baxter *et al*., 2011; Hassan *et al*., 2012; Kiran, Kaur and Marwaha, 2013; Alalo, Ahmad and El Sayed, 2016; Wonginchan, Thanasilp and Rodcumdee, 2017), and TENS (Dhindsa *et al*., 2011; Varadharaja *et al*., 2014). See **appendix 4** below for the full breakdown of the study results.

6.1.1 Psychological Pain Management Methods

Playing with Toys

Playing with toys was identified as one of the non-pharmacological ways of managing pediatric pain. In a Toronto study, that sought to determine whether toy-mediated distraction can alleviate post needle pain among toddlers (12-20 months), it was found out that compared to the controls, toddlers who were distracted using a toy during the immunization procedure did not have significantly lower pain scores using the Measure of Adult and Infant Soothing and Distress (MAISD) and the Modified Behavioral Pain Scale (MBPS) pain scores (Hillgrove-Stuart *et al.,* 2013). This showed that its essential for nurses to ensure that toddlers are well regulated before placing them through a painful procedure.

Virtual Reality

Several studies showed that virtual reality is a good distracting mechanism that can be used to alleviate pain in pre-school aged children. One study in Brisbane which wanted to test the efficacy of Ditto™ a virtual reality distraction device in preschool and elementary school children (4-10 yrs) found out that the device was able to sufficiently minimize pain intensity, improve burn re-epithelialization rate and minimizing children's stress and anxiety when carrying out wound burn care procedures (Brown *et al.,* 2014).

This was also the case for a 2009 study, where Nilsson and colleagues sought to determine the effects of virtual reality in alleviating procedural pain in children who had undergone a venous puncture or had a subcutaneous port device. Using the observational Face, Legs, Activity, Cry and Consolability scale (FLACC) score, self-report and measurement of vital signs, it was found out that the virtual reality experience significantly lowered the pain perception in children undergoing the above named painful procedures (Nilsson *et al.,* 2009).

Watching Cartoons

Several studies indicated that watching some interesting items in a screen may be enough to distract preschool and early school going children from pain perception. In a study that sought to determine the effect of animation/cartoon watching during intravenous therapy in pain alleviation in pre-school aged children in a hospital in Indonesia, it was found out that this distraction technique significantly reduced pain response in children. For this,

study, the Wong Baker Faces Pain Rating Scale was used to assess pain response (Hartati *et al.*, 2018).

Another Turkish study reiterates this claim by observing the duration of crying during and after a venipuncture procedure in 3-6-year-old preschool children. This study found out that watching a cartoon significantly by children undergoing a venipuncture procedure reduced the time spent crying after the procedure when compared to a control group that did not watch a cartoon (Akgül *et al.*, 2019). However, no significant difference was found in the duration of crying during the procedure between the cartoon watching group and the group that was not watching the cartoon (Akgül *et al.*, 2019).

In another study that utilized the poker chip tool and the face scale to measure pain intensity in children in the emergency department, it was found out that children who watched a cartoon (Barney) after presenting in the emergency department with acute pain before exhibited a significant relief from pain when compared to their counterparts. The relief from pain was however not significant different from that attained from analgesia (La Vonne and Zun, 2012).

Another RCT among those sampled is that of Bergomi and colleague. Their study that recruited 150, 5-8 year olds, and sought to determine the effectiveness of audiovisual distraction in alleviating pain reiterated the effectiveness identified in past quoted studies. It found out that watching cartoon was a great pain relief technique for children undergoing venipuncture. It also found out that it was better than a heat and cold therapy (Buzzy®) but was more effective when it was used in conjunction with buzzy® device (Bergomi *et al.*, 2018).

On the same topic of using audiovisual techniques to alleviate pain in pre-school and early school going children, a Chinese study provided interesting insight. In a study that measured pain alleviation ability of cartoon watching in 3-7-year-old burn victims, it was found that when compared to common analgesics, cartoon watching significantly reduced pain intensity in children as measured by the Wong-Baker faces pain rating scale and the COMFORT scale after undergoing a wound dressing procedure. However, there was no significant alleviation of pain by watching a cartoon before and during the burn dressing procedure among the study group (Feng *et al.*, 2018).

Music Therapy

Our study found conflicting results of the efficacy of music therapy in pain alleviation in children. In a study conducted by Calcatera and colleagues using preschool and school aged children (3-14 years), it was found out that there was no significant difference in pain alleviation, measured using the FLACC and faces pain scale (FPS) scale, in children exposed to music and those not exposed to music after a day surgery. The only difference with respect to the pain experience was improvement in cardiovascular parameters. Strangely, It was noted that music had a better effect on older children compared to younger children and the fastness or slowness of music rhythm was an important factor in pain amelioration (Calcaterra *et al.,* 2014).

In another study by Caprilli and colleagues, musicians (previously trained for the task) who interactively sang to children aged between (4-13) significantly reduced the pain and distress of children undergoing a venipuncture procedure. This pain amelioration by the music was during, before and after the venipuncture procedure (Caprilli *et al.*, 2007). Another study that sought to compare the effect of music therapy and that of standard pain and distress management in children aged 3-11 years in the emergency department had similar results. Music in this case was chosen by a music therapist and delivered via ambient speakers. Pain scores difference between the music and the standard care groups was found to be clinically significant with music doing a better job in pain alleviation (Hartling *et al.*, 2013).

Another study that provided greater insight on the role of music in pediatric pain alleviation is one by van der Heijden and colleagues. In their study that sought to determine whether music therapy ameliorates distress and pain in children (0-13 years) receiving burn wounds care, they found out that music did not reduce pain scores in children below 5 years. There was however a reduction in reported pain in older children (n>5) (van der Heijden *et al.,* 2018).

Another study in India, which sought to determine whether music therapy was an effective pain and distress alleviator in 18 months old children found out that compared to not providing any remedy, music was effective in lowering the pain and distress in children. However, its effect on pain and distress amelioration was not statistically significant (Sundar *et al.*, 2016).

In another RCT study that involved children between 7 and 12 years old undergoing lumbar puncture, it was found out that children who received the music therapy intervention had lower heart and respiratory rates as well as pain scores for the duration of the lumbar puncture and after (Nguyen *et al.*, 2010).

Guided Imagery

An analysis of recent literature also showed that guided imagery may be an important technique in providing sufficient management of procedural pain in the pediatric population. In a study that enrolled children aged 7-12 years, children were guided to envision as story through under the facilitation of an audio prompt in a recorded compact disk. At the end of the guided imagery intervention it was found that the experimental group had significantly lower pain scores compared to the controls (Huth *et al.*, 2009).

Another study investigating the efficacy of the guided imagery in a cohort of young children with sickle cell anemia also found positive results with the use of this technique. After a guided imagery training, it was found out that there was a significant reduction in pain intensity as well as the use of analgesics in the children who were trained on guided imagery (Dobson and Byrne, 2014).

Another comparison study that sought to determine whether teaching children (aged 6-18) guided mental imagery over conducting a detailed inquiry in a bid to manage pain turned out to the affirmative. Children that were taught about guided imagery had better pain scores and were more relaxed than their counterparts (Kline *et al.*, 2009).

Hypnosis

There appears to be conflicting observation on whether hypnosis can be a good pain alleviation technique in pre-school and early school aged children. In an Australian RCT that recruited 33 children aged between 4 and 13, the effectiveness of medical hypnosis in alleviation of pain in burn injury was measured. The results showed that medical hypnosis had no effect on the primary pain outcomes in the children recruited for the study. However, a small effect in alleviating post-procedural anxiety was observed (Chester *et al.*, 2018).

Another study incorporated hypnosis in addition to a local anesthetic to manage pain in cancer pediatric patients (6-16 years). In this study, the group who were placed under

hypnosis in addition to the local anesthetic had significantly less anticipatory anxiety, experienced less procedural anxiety and pain, and were less distressed compared to those who received no intervention and those who received the local anesthetic alone (Liossi, White and Hatira, 2009).

Biofeedback

Another technique that has was shown to have efficacy in pain management in pediatric populations is biofeedback. In a US study that sought to determine the effectiveness of biofeedback therapy in the management of children's (8-18 year old) episodic and chronic headaches were reduced from 3.5 headache days per week to 2 between the start of the intervention and the end of it (Blume, Brockman and Breuner, 2012).

In another study that sought to determine the effectiveness of biofeedback in children and adolescents (10-17 years) with chronic pain; it was found that the children who were enrolled in a biofeedback treatment attained substantial reductions in pain intensity (self-reported) compared to those a control (those not yet enrolled in the program) (Yetwin *et al.*, 2012). This indicates that biofeedback therapy may actually be an effective, non-pharmacological technique of alleviating children pain.

6.1.2 Physical Pain Management Methods

Massage

Massage therapy is one of the physical non-pharmacological techniques that has been associated with pain relief in both adult and children population suffering from both acute and chronic pain (Post-White *et al*., 2008; da Cunha Batalha and Mota, 2013; Çelebioğlu *et al*., 2015; van Dijk *et al*., 2018). In pediatric pain alleviation, utilization of massage therapy as a non-pharmacological pain management technique has been found to exhibit mixed results.

In a single-blind RCT study that enrolled children and adolescents (10-17 years), 20-30 minutes massage therapy sessions were found to significantly relief pain in children undergoing cancer therapy (da Cunha Batalha and Mota, 2013).In another study by Ayda and colleagues that sought to determine whether massage therapy provided pain relief to pediatric cancer patients (0-10 years) undergoing intrathecal therapy or bone marrow

aspiration affirmed its effectiveness. The group that received the massage intervention had lower pain and anxiety levels as measured by the visual analogue scale (VAS) (Çelebioğlu *et al.*, 2015).

In a contradicting pilot study, using pediatric cancer patients (1-18 years) who received either 4 weekly massage sessions or 4 weekly quiet-time sessions (control) found out that massage therapy did not significantly improve pain relief. However, it significantly reduced anxiety, especially in children below 14 years (Post-White *et al.*, 2008). Another study sought to determine the effectiveness of massage therapy in distress alleviation in children (5 weeks to 13 years), with burn surface area of between 10 to 45%. From the results taken from the COMFORT behavior scores, massage did not have significant effect in the alleviation of distress (van Dijk *et al.*, 2018).

Acupuncture

While the acupuncture technique has been widely used in pain alleviation in adults, its efficacy in pediatrics has also been described. In one study that sought to determine the efficacy of acupuncture in pain alleviation in children (3-18 years) who had undergone a tonsillectomy procedure, significant post tonsillectomy pain alleviation in the children who had received the acupuncture intervention was noted. Additionally, the group which had undertaken the acupuncture procedure required less analgesic drug support compared to those who did not receive the acupuncture procedure (Gilbey *et al.*, 2015).

Another study on pediatric acupuncture efficacy sought to determine its pain alleviation capabilities of acupuncture in 6 children with appendicitis pain. The results showed that pain score in the visual analog scale (VSA) had decreased from 46 to 32 points. Additionally, an inflammatory biomarker (white blood cells) significantly dropped after the acupuncture treatment indicating a possible anti- inflammatory foundation (Sherman, 2015).

Graff and McDonald also found acupuncture efficacy in pain alleviation in their study that utilized auricular acupuncture intervention in 19 children (8-18 years) who had a migraine. After taking the pre and post-intervention pain scores using the visual analog scale, they noted that there was a marked and significant reduction in pain scores in the

enrolled subjects after the auricular acupuncture intervention without any adverse events being noted (Graff and McDonald, 2018).

Another study by Shelley and colleagues reiterates the efficacy of acupuncture. In their study, a nonrandomized clinical trial, that utilized children (7 months – 18 years) who had had posterior spinal fusion surgery, two (15-30 mins) acupuncture intervention significantly reduced the pain scores in the experimental group compared to the group which did not receive the acupuncture intervention (Wu, Sapru, Stewart, & Milet, 2009). The study by Usichenko and colleagues also show the efficacy of acupuncture in pediatric pain amelioration. This study assessed pain alleviation in children receiving a local anesthetic injection when an acupuncture intervention was provided beforehand. Children who received the acupuncture intervention had low pain scores as measured by the Verbal Rating Scale or Faces Pain Scale when compared to those who did not receive the acupuncture intervention.

This shows that acupuncture can be effectively used to ameliorate pain in pediatrics who are having a venipuncture procedure (Usichenko *et al.*, 2016). Supporting further the acupuncture pain amelioration ability in pediatrics is Johnson and colleagues who noted significant improvement in pain scores of children (5–17 years) with chronic pain conditions (Johnson *et al.*, 2015).

Heat and Cold Therapy

Several studies have sought to determine the efficacy of hot and cold treatments in pain alleviation among pediatric populations. In one such study, the efficacy of ice pack in alleviation of pain in school children (6-12 years) undertaking a venipuncture was assessed with the Wong-Baker face scale as well as the Self- report Pain Rating Scale being used to assess pain intensity. The study results showed that compared to the controls, utilization of an ice pack prior to a venipuncture in children significantly reduced this procedural pain (Alalo, Ahmad and El Sayed, 2016).

Another study sought to determine whether cryotherapy is effective in alleviating pain of 40 children (8-18 years) undergoing hemodialysis. Using the Wong-Baker scale as well as self-reports, it was found that cryotherapy significantly reduced pain during the insertion of large cannulaes compared to controls (Hassan *et al.*, 2012).

In another study, cold alcohol compression was used as a form of cold therapy in children prior to receiving an intravenous fluid infusion with promising results in pain alleviation. In the 20 children (3-5 years) enrolled in the experimental group, the cold alcohol compression caused significant reduction of pain when compared to the control group when measured using the Children's Hospital of Eastern Ontario Pain Scale (Wonginchan, Thanasilp and Rodcumdee, 2017). This is an indication of the efficacy of cold therapy in pediatric pain management.

Further supporting the efficacy of heat and cold treatment in pain alleviation among pediatrics is a quasi-experimental study by Kiran and colleagues. In the 100 children (3-7 years) enrolled in the study, pain measured by the FLACC scale indicated that placing an ice pack in a venipuncture site significantly reduced pain during the venipuncture process (Kiran, Kaur and Marwaha, 2013).

The efficacy of hot and cold therapy in pediatrics has also been supported by other studies. For example, Baxter and colleagues have presented evidence supporting its efficacy in pain amelioration when used in association with a vibration device during venipuncture in children (Baxter *et al.*, 2011).

Transcutaneous electric nerve stimulation (TENS)

Some of the reviewed studies also showed the efficacy of transcutaneous electric nerve stimulation (TENS) in pain alleviation in preschool and school aged children. In a study that recruited 62 children aged between 6 and 12 years, TENS was found to have significant decrease in heart rate and VAS pain scores when compared to local analgesia (Varadharaja *et al.*, 2014). In another study that sought to determine the efficacy of TENS compared to lignocaine in 5-14-year olds found out that there was no significant difference in pain alleviations between the two techniques. However, subjects considered TENS more comfortable (Dhindsa *et al.*, 2011).

7 DISCUSSION

7.1 Psychological Pain Management Methods

Most of the psychological methods identified including use of virtual reality, playing with toys, watching cartoons, music therapy, hypnosis and biofeedback are forms of distraction techniques that can be used to alleviate pain among the pediatric population. Distraction is one of the psychological techniques that can be used by nurses, other healthcare practitioners as well as parents to alleviate pain in children of different age groups including infants and pre-school children. The rationale of using distraction in pain alleviation is premised on the fact that a child's attention can be drawn from the noxious pain stimuli to something else more pleasurable.

The actual mechanism is not well elucidated, however, it's thought that the nociceptive pathway of the nervous system is altered when a distraction is introduced, ultimately leading to pain reduction (Bagnasco *et al.,* 2012). It is however important to note that a child's age and developmental stage is an important determiner of what relevant distraction technique is effective (Koller and Goldman, 2012)

Distractions can take two main forms, either active or passive distraction. This criterion is based on how much a child is in interaction with the distracting item. Some active distractions that may be used to manage pain in children include virtual reality, playing video games, controlled breathing, playing with a toy among others. On the other hand, passive distractions include auditory and audiovisual techniques such as watching television, a cartoon or listening to music among others (Koller and Goldman, 2012). Various research studies however identify a significant difference in pain alleviation abilities between the active and passive distraction techniques, with active techniques being more effective in pain alleviation (Wohlheiter and Dahlquist, 2012)

For a distraction to be effective in pain alleviation in children, the technique must be able to exploit the child's cognitive capacity and sufficiently pull him away from the noxious pain stimuli (Nilsson *et al.,* 2013). When the child is more engaged and the distracting activity has more action a child can be shielded better from the sensation of pain. In

addition to the interactive nature of distractions, they should be what the child consider as fun or interesting if they are to be effective (MacLaren and Cohen, 2005).

Music was touted as an important, inexpensive and effective non-pharmacological technique that can be used to alleviate pain in pediatrics via distraction (Nguyen *et al*., 2010; Hartling *et al*., 2013; Calcaterra et al., 2014; Sundar et al., 2016; van der Heijden et al., 2018). Music listening is itself a complex phenomenon. It is multifaceted involving cardiovascular, emotional, psychological, endocrinological and neurological changes (Bernardi, Porta and Sleight, 2006; Nakahara et al., 2009). Owing to its ability to invoke a controlled alternation of relaxation and arousal it has been applied in various therapeutic applications such as alleviation of pain, stress, and anxiety while acting as an important substitute to anesthetic and analgesic drugs (Caprilli et al., 2007).

The efficacy of hypnosis in pediatric pain alleviation was also noted with Liossi, White and Hatira (2009) and Chester *et al*., (2018) establishing its effectiveness. Hypnosis is a state which is artificially induced, where an individual's state of consciousness is altered. In hypnosis, one individual (the hypnotist), offers suggestions to another person (the subject) making him experience alterations in perception, memory as well as voluntary action. Characterizing hypnosis is intensified suggestibility and increased receptivity to direction. When one is in an altered state of consciousness, they are usually relaxed and experience a trance that differs from the normal wake state or even one's sleep stages (Jensen and Patterson, 2014).

Hypnosis is multifaceted and is known to possess several components. They include relaxation, suggestion, imagery, interpersonal processing, and focused attention. It is not clear which among these components is central to the hypnotic process, a factor that creates confusion in its application in practice. However, there is consensus that it is an effective alternative to standard pain management techniques that exhibit overreliance in pharmacological analgesia (Jensen and Patterson, 2014).

It has been elucidated that there exist no single pain centre in the peripheral and the nervous system. The pain sensation is as a result of interactions that occurs between the various components of the central and peripheral nervous system (Apkarian, Hashmi and Baliki, 2011). Hypnotic analgesia acts to alleviate pain by altering activity of some components necessary in pain perception as well as shifting the brain state (Jensen and

Patterson, 2014). The hypnosis pain alleviation technique assists in shifting the focus of children away from pain by guiding them to focus on intriguing, safe, fun and comforting imaginative experiences.

Another technique that was revealed by this study to have an efficacy in pain management in pediatric populations is biofeedback (Blume, Brockman and Breuner, 2012; Yetwin et al., 2012). A simple breakdown of this term results in "bio" and "feedback". The former alludes to the body, the latter to the act of feeding information back. As such, biofeedback utilizes instrumentation such as electromyographs (EMG), electrodermographs, thermistors, photoplethysmography, pneumography among others to monitor bodily functions including psychophysiological processes that an individual is usually unaware of but can possibly control via voluntary action (Cosio and Lin, 2015). From the above instrumentation, the patient gains access to immediate data on their own physiological status including breathing rhythm and rate, the heart function, body temperature, sweat, muscle tension and brainwaves. Owing to this physiological awareness, an individual becomes more active working towards health maintenance by undertaking actions to regulate the adverse physiologic conditions (Schwartz and Andrasik, 2017, p. 60) . Overtime an individual is usually able to effectively identify and regulate the body's physiological parameters even without the complicated instrumentation strengthening his endurance.

In our study and based on the findings of Huth, Van Kuiken and Broome (2006), Kline et al. (200) and Dobson and Byrne (2014) the efficacy of guided imagery in the alleviation of pain amongst the pediatric population was identified. Guided imagery is usually a form of cognitive–behavioral methods that seek to aid pediatric patients attain a state of relaxation ultimately influencing pain perception by the body (Huth, Van Kuiken and Broome, 2006). As such, guided imagery seems to present a simple, cost-effective, and noninvasive route of pain alleviation (Koller and Goldman, 2012), that can be appropriately utilized in the preschool and school-age children who are experiencing painful sensations emanating from medical procedures, injuries such as burns or medical conditions.

7.2 Physical Pain Management Methods

In our study, three physical, non-pharmacological pain management methods for children (1-10 years) in clinical settings were identified. They included massage, acupuncture and heat therapies.

Massage therapy has been reported as one of the physical non-pharmacological techniques that has been associated with pain relief in both adult and children population suffering from both acute and chronic pain (Buttle, McMurtry and Marshall, 2011). In our study, its pain relief properties were reported by Post-White *et al*. (2008), da Cunha Batalha and Mota (2013), Çelebioğlu *et al*. (2015) and van Dijk *et al*. (2018). These studies showed that massage could improve pain relief and comfort while reducing anxiety.

According to the National Center for Complementary and Alternative Medicine (NCCAM), massage therapy (MT) involves the mechanical manipulation body's muscles as well as soft tissues with a focus of enabling the proper running of physical structures and systems including the lymphatic and circulatory systems. Generally, massage therapy is a body-based intervention and involves manipulative practices on the physical body. Massage therapy takes a variety of forms. One of the more common massage therapy form is the General Swedish Manipulation. This form of massage therapy entails either effleurage (stroking) petrissage (kneading) (Hughes *et al.*, 2008). During a massage session, moderate pressure is applied at various parts of the body (feet, back, hands, and neck) with the choice of target part being influenced by a patient's needs as well as the intervention's goal. In some instances, the kneading and stroking incorporates essential oils and lotions which are sometimes lightly scented.

Various studies indicate that massage therapy is a promising technique in pain alleviation (Kutner *et al.*, 2008; Field, 2010) and various theories have also been floated to explain how it manages to exert pain relief. One way that massage therapy acts in its pain relief quest is by preventing the perception of pain signals by the brain ultimately reducing the amount of pain perceived by an individual (Field, 2010). The above is consistent with the Gate Control Theory of pain. The other mechanism of massage therapy-instigated pain relief that has been floated contends that a massage inhibits the production of pain chemicals (Field, 2010; Rich, 2010) while also increasing the production of serotonin, a

neurotransmitter associated with the pathophysiology of pain alleviation (Hernandez-Reif *et al.*, 2004). In addition to pain alleviation, massage therapy has been found to significantly reduce anxiety and depression in individuals (Moyer, Rounds and Hannum, 2004), an aspect that may also contribute to its pain alleviation capability. Massage therefore looks like a solid intervention to undertake in the mitigation of pediatric pain by nurses.

Acupuncture's efficacy in the alleviation of pain in pediatric patients was reported by a host of studies including Wu *et al*. (2009), Gilbey *et al*. (2015), Johnson *et al*. (2015) Sherman (2015), Usichenko *et al.* (2016) and Graff and McDonald (2018). Acupuncture relies on the premise that energy flow in and around the body is through some specific channels (meridians) that are usually connected by acupuncture points. If the energy flow is obstructed, pain results. In acupuncture, needles are inserted at certain acupuncture points usually along the obstructed meridian channels restoring the energy flow and ultimately relieving pain (J. Wu *et al.*, 2009). With a wide report of its efficacy, this shows that acupuncture can be effectively used to ameliorate pain in pediatrics who are having a venipuncture procedure

The efficacy of heat and cold therapy in pain allevation among the pediatric population was also widely reported (Baxter et al., 2011; Hassan et al., 2012; Kiran, Kaur and Marwaha, 2013; Alalo, Ahmad and El Sayed, 2016; Wonginchan, Thanasilp and Rodcumdee, 2017). The heat and cold therapy commonly known as therapeutic heat in medical circles is rated highly among adults as an effective pain control technique. It is effective in pain alleviation during childbirth (Yazdkhasti, Hanjani and Tourzani, 2018), to manage back pains (Dehghan and Farahbod, 2014), reduce arthritis pain (Hayes, 1993), relieve procedural pain (Farhadi and Esmailzadeh, 2011) among other uses. Its use in pediatric pain management has not been very common until recently (Lane and Latham, 2009). In real world applications, heat and cold therapies utilization in pain management involves placing either an appropriate hot or cold object at the areas where there is the niggling pain which needs treatment. Such placement results in alteration of both metabolic activity and blood flow in the affected area. Cooling reduces blood flow and metabolic activity in the affected while applying heat does the opposite ultimately raising the normal pain threshold (Lane and Latham, 2009).

The functional premise of heat and cold therapy in pain alleviation is explained by several theories. By superficially cooling or heating tissues, skin chemoreceptors as well as tissues found deep in the skin are stimulated ultimately inhibiting or closing what is called the “pain gate”. The “pain gate” is a mechanism that has been postulated to modulate pain transmission and reception and is thought to exist in the spinal cord. Pain impulses are transmitted to the brain via the spinal cord using myelinated and unmyelinated fibers. Temperature like other non-pharmacological pain management techniques (TENS and massage) impede the onward transmission of pain impulses to the brain, technically “closing the gate”. This is because in presence of both thermal and pain sensation, thermal sensation takes precedence ultimately reducing the perception of pain (Lane and Latham, 2009).

Studied have also shown the efficacy of transcutaneous electric nerve stimulation (TENS) in pain alleviation in preschool and school aged children. TENS is Food and Drug Administration (FDA) approved with its use as a class II device of pain alleviation being certified in 1972 (Katch, 1986). A TENS therapy involves use of pulsed electrical current which is usually generated by batteries or an A.C. mains. When this current comes into contact with the surface of the skin, superficial nerves are stimulated allowing for localized pain relief (Banerjee and Johnson, 2013). TENS is safe and non-invasive with its mechanism of action based on the gate control theory (Banerjee and Johnson, 2013). Its application has been especially prominent in dentistry.

8 CONCLUSION

Overall, the highlighted studies in this review intimate the efficacy of non-pharmacological pain management methods in pain amelioration in pre-school and school-going children. In term of physical-non-pharmacological pain management techniques in this population, massage, acupuncture, transcutaneous electric nerve stimulation, and heat and cold therapy had their efficacy supported by literature. On the other hand, efficacy was also determined in psychological pain alleviation methods that included use of virtual reality, utilization of guided imagery and relaxation, watching interesting audio-visual content, use of electronic games and interactive toys, hypnosis, and music therapy.

However, there was an observation that the effectiveness in amelioration of pain experienced by the children population this study focused on (1-10 years) using the non-pharmacological pain management methods was influenced by the type and pain experienced. Additionally, there was an observation that some of the highlighted non-pharmacological pain management methods were more effective in pain amelioration if they were used in combination with other methods, with their actions acting synergistically.

Despite the availability of many effective non-pharmacological pain management methods that are effective in pain amelioration in preschool and school children, a choice challenge is posed on nursing staff. What is the best method of this kind to use when, where and to whom? This confusion may distract nursing personnel from utilizing this pain alleviation method. On this, nurses should utilize nursing best practices and patient centered care principles where they consider the child's temperament and choice of preferred pain alleviation method.

Generally, this research is an important resource for nurses, especially those new to the pediatric care practice on the available and effective methods of non-pharmacological pain alleviation methods in pre-school and school aged children.

8.1 Strengths and Limitations.

There exist various methodological and situational factors that may affect the validity and suitability of research results. These factors are discussed in this section. First, this section will highlight the study strengths. Various factors increase the validity of the results obtained in this study. First, the studies explored and reviewed in this study were from different countries. This is an indicator that these results are generalizable and are devoid of systematic errors that mostly affect validity of review studies. Additionally, the study reviewed a significant number of studies for each proposed non-pharmacological intervention study. This acted to further reiterate the validity of this study's results. It is for this reason that we are positive that the results of this study will be an important resource to pediatric nurses who would be faced in situation where they have to safely and effectively alleviate pain in children.

Despite the strength, highlighted above, the study faced various limitations that were both contextual and methodological. For example, lack of access to certain online databases meant that some studies were left out and overlooked in the compilation of this review. The limitation of being cognizant only with the English language also meant that relevant studies that were presented in foreign languages were also overlooked. However, the authors of this research study are confident that the above limitations do not eliminate this study's validity.

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APPENDIX

Appendix 1: Studies selected for analysis

1.	Akgül, E. A., Karahan, Y., Başoğlu, F., Oğul, A., Öztornaci, B. Ö., Yetim, P., & Sari, H. Y. (2019). Effects of watching cartoons on pain scores in children undergoing venepuncture. Nursing Children and Young People, 31(1).
2.	Alalo, F. M. A., Ahmad, A. E. S., & El Sayed, H. M. N. (2016). Pain Intensity after an Ice Pack Application Prior to Venipuncture among School-Age Children: An Experimental Study. Journal of Education and Practice, 7(36), 16–25.
3.	Baxter, A. L., Cohen, L. L., McElvery, H. L., Lawson, M. L., & von Baeyer, C. L. (2011). An integration of vibration and cold relieves venipuncture pain in a pediatric emergency department. Pediatric Emergency Care, 27(12), 1151–1156.
4.	Bergomi, P., Scudeller, L., Pintaldi, S., & Dal Molin, A. (2018). Efficacy of non-pharmacological methods of pain management in children undergoing venipuncture in a pediatric outpatient clinic: a randomized controlled trial of audiovisual distraction and external cold and vibration. Journal of Pediatric Nursing, 42, e66–e72.
5.	Blume, H. K., Brockman, L. N., & Breuner, C. C. (2012). Biofeedback therapy for pediatric headache: factors associated with response. Headache: The Journal of Head and Face Pain, 52(9), 1377–1386.
6.	Brown, N. J., Kimble, R. M., Rodger, S., Ware, R. S., & Cuttle, L. (2014). Play and heal: randomized controlled trial of DittoTM intervention efficacy on improving re-epithelialization in pediatric burns. Burns, 40(2), 204–213.
7.	Calcaterra, V., Ostuni, S., Bonomelli, I., Mencherini, S., Brunero, M., Zambaiti, E., … Tinelli, C. (2014). Music benefits on postoperative distress and pain in pediatric day care surgery. Pediatric Reports, 6(3).
8.	Çelebioğlu, A., Gürol, A., Yildirim, Z. K., & Büyükavci, M. (2015). Effects of massage therapy on pain and anxiety arising from intrathecal therapy or bone marrow aspiration in children with cancer. International Journal of Nursing Practice, 21(6), 797–804.
9.	Chester, S. J., Tyack, Z., De Young, A., Kipping, B., Griffin, B., Stockton, K., … Kimble, R. M. (2018). Efficacy of hypnosis on pain, wound-healing, anxiety, and

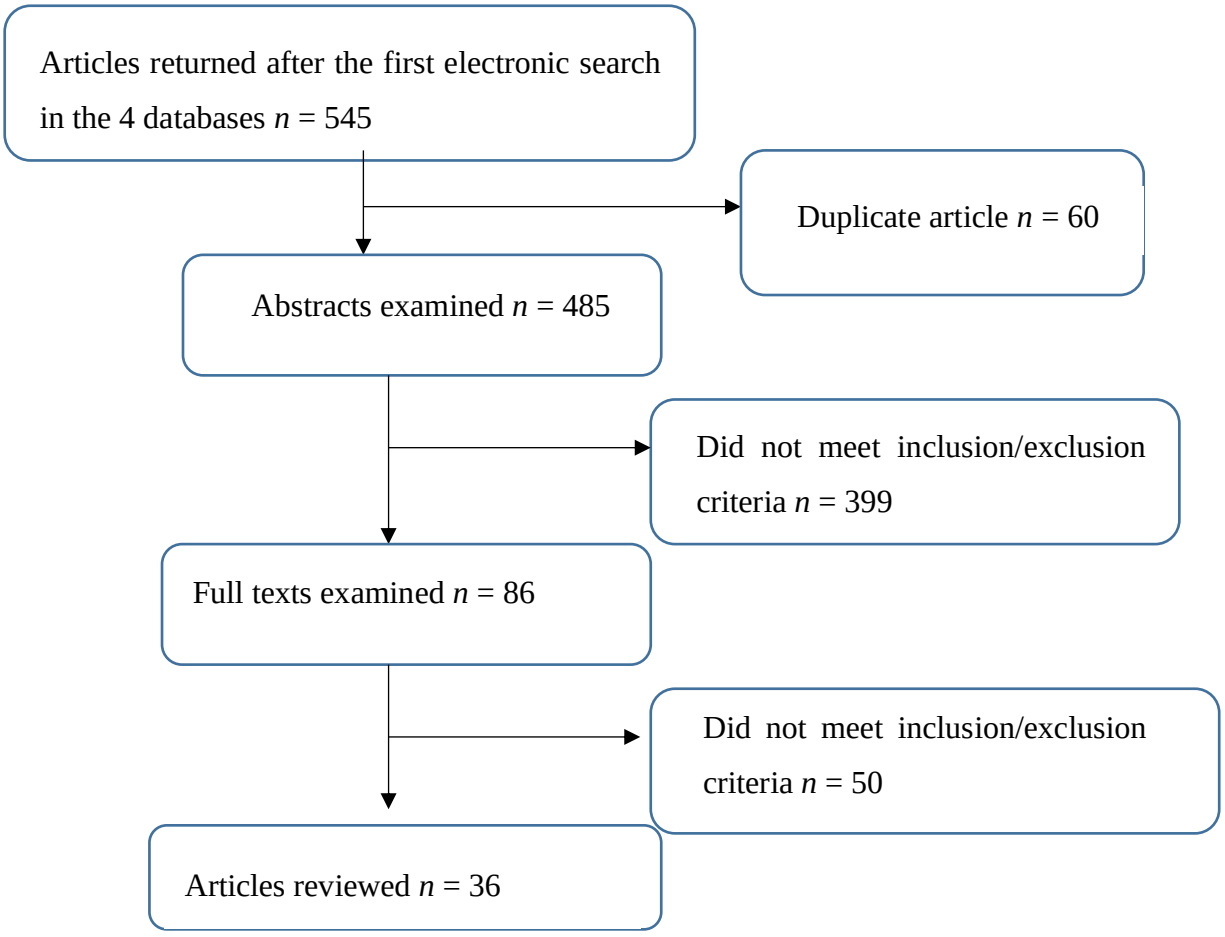
	stress in children with acute burn injuries: a randomized controlled trial. Pain, 159(9), 1790–1801.
10.	da Cunha Batalha, L. M., & Mota, A. A. S. C. (2013). Massage in children with cancer: effectiveness of a protocol. Jornal de Pediatria, 89(6), 595–600.
11.	Dhindsa, A., Pandit, I. K., Srivastava, N., & Gugnani, N. (2011). Comparative evaluation of the effectiveness of electronic dental anesthesia with 2% lignocaine in various minor pediatric dental procedures: A clinical study. Contemporary Clinical Dentistry, 2(1), 27.
12.	Dobson, C. E., & Byrne, M. W. (2014). Using guided imagery to manage pain in young children with sickle cell disease. AJN The American Journal of Nursing, 114(4), 26–36.
13.	Feng, Z., Tang, Q., Lin, J., He, Q., & Peng, C. (2018). Application of animated cartoons in reducing the pain of dressing changes in children with burn injuries. International Journal of Burns and Trauma, 8(5), 106.
14.	Gilbey, P., Bretler, S., Avraham, Y., Sharabi-Nov, A., Ibrgimov, S., & Luder, A. (2015). Acupuncture for posttonsillectomy pain in children: a randomized, controlled study. Pediatric Anesthesia, 25(6), 603–609. https://doi.org/10.1111/pan.12621
15.	Graff, D. M., & McDonald, M. J. (2018). Auricular Acupuncture for the Treatment of Pediatric Migraines in the Emergency Department. Pediatric Emergency Care, 34, 258+. Retrieved from http://link.galegroup.com/apps/doc/A543138446/AONE?u=vic_liberty&sid=AONE&xid=f08933f4
16.	Hartati, S., Mediani, H., Rahmayanti, S., Suryati, Y., Budiman, & Rudhiati, F. (2018). The Effect Of Distraction Techniques Watching Cartoon Animation To Pain Response During Infusion Of Preschool Children's In Rsud Sayang Kabupaten Cianjur. IOSR Journal of Nursing and Health Science, 7(5). Retrieved from http://iosrjournals.org/iosr-jnhs/papers/vol7-issue5/Version-4/A0705040107.pdf
17.	Hartling, L., Newton, A. S., Liang, Y., Jou, H., Hewson, K., Klassen, T. P., & Curtis, S. (2013). Music to reduce pain and distress in the pediatric emergency department: a randomized clinical trial. JAMA Pediatrics, 167(9), 826–835.

18.	Hassan, A., Darwish, M. M., El-Samman, G. A., & Fadel, F. I. (2012). The impact of cryotherapy on pain intensity at puncture sites of arteriovenous fistula among children undergoing hemodialysis. J Am Sci, 8(12), 1490–1500.
19.	Hillgrove-Stuart, J., Pillai Riddell, R., Horton, R., & Greenberg, S. (2013). Toy-mediated distraction: Clarifying the role of distraction agent and preneedle distress in toddlers. Pain Research and Management, 18(4), 197–202.
20.	Huth, M. M., Daraiseh, N. M., Henson, M. A., & McLeod, S. M. (2009). Evaluation of the magic island: relaxation for kids [c] compact disc. Pediatric Nursing, 35(5), 290–296.
21.	Johnson, A., Kent, P., Swanson, B., Rosdil, A., Owen, E., Fogg, L., & Keithley, J. (2015). The Use of Acupuncture for Pain Management in Pediatric Patients: A Single-Arm Feasibility Study. Alternative & Complementary Therapies, 21(6), 255–260. https://doi.org/10.1089/act.2015.29022.ajo
22.	Kiran, N., Kaur, S., & Marwaha, R. K. (2013). Effect of ice pack application at the site prior to venipuncture on intensity of pain among children. Nursing and Midwifery Research Journal, 9, 160–167.
23.	Kline, W. H., Turnbull, A., Labruna, V. E., Haufler, L., DeVivio, S., & Ciminera, P. (2009). Enhancing pain management in the PICU by teaching guided mental imagery: a quality-improvement project. Journal of Pediatric Psychology, 35(1), 25–31.
24.	La Vonne, A. D., & Zun, L. S. (2012). The impact of watching cartoons for distraction during painful procedures in the emergency department. Pediatric Emergency Care, 28(10), 1033–1035.
25.	Liossi, C., White, P., & Hatira, P. (2009). A randomized clinical trial of a brief hypnosis intervention to control venepuncture-related pain of paediatric cancer patients. Pain®, 142(3), 255–263.
26.	Nguyen, T. N., Nilsson, S., Hellström, A.-L., & Bengtson, A. (2010). Music therapy to reduce pain and anxiety in children with cancer undergoing lumbar puncture: a randomized clinical trial. Journal of Pediatric Oncology Nursing, 27(3), 146–155.
27.	Nilsson, S., Finnström, B., Kokinsky, E., & Enskär, K. (2009). The use of Virtual Reality for needle-related procedural pain and distress in children and adolescents

	in a paediatric oncology unit. European Journal of Oncology Nursing, 13(2), 102–109.
28.	Post-White, J., Fitzgerald, M., Savik, K., Hooke, M. C., Hannahan, A. B., & Sencer, S. F. (2008). Massage Therapy for Children With Cancer. Journal of Pediatric Oncology Nursing, 26(1), 16–28. https://doi.org/10.1177/1043454208323295
29.	Sundar, S., Ramesh, B., Dixit, P. B., Venkatesh, S., Das, P., & Gunasekaran, D. (2016). Live music therapy as an active focus of attention for pain and behavioral symptoms of distress during pediatric immunization. Clinical Pediatrics, 55(8), 745–748.
30.	Usichenko, T. I., Wolters, P., Anders, E. F., & Splieth, C. (2016). Acupuncture Reduces Pain and Autonomic Distress During Injection of Local Anesthetic in Children: A Pragmatic Crossover Investigation. The Clinical Journal of Pain. [New York, N.Y.] : Raven Press,. https://doi.org/10.1097/AJP.0000000000000222
31.	van der Heijden, M. J. E., Jeekel, J., Rode, H., Cox, S., van Rosmalen, J., Hunink, M. G. M., & van Dijk, M. (2018). Can live music therapy reduce distress and pain in children with burns after wound care procedures? A randomized controlled trial. Burns, 44(4), 823–833.
32.	van Dijk, M., O'Flaherty, L. A., Hoedemaker, T., van Rosmalen, J., & Rode, H. (2018). Massage has no observable effect on distress in children with burns: A randomized, observer-blinded trial. Burns, 44(1), 99–107. https://doi.org/https://doi.org/10.1016/j.burns.2017.10.002
33.	Varadharaja, M., Udhya, J., Srinivasan, I., Sivakumar, J. S. K., Karthik, R. S., & Manivanan, M. (2014). Comparative clinical evaluation of transcutaneous electrical nerve stimulator over conventional local anesthesia in children seeking dental procedures: A clinical study. Journal of Pharmacy & Bioallied Sciences, 6(Suppl 1), S113.
34.	Wonginchan, A., Thanasilp, S., & Rodcumdee, B. (2017). Effects of cold alcohol compression on pain of preschoolers receiving intravenous fluid infusion. Annals of Tropical Medicine and Public Health, 10(5), 1169.

35.	Wu, S., Sapru, A., Stewart, M. A., & Milet, M. J. (2009). Using acupuncture for acute pain in hospitalized children. Pediatric Critical Care Medicine. [Philadelphia, PA] : Lippincott Williams & Wilkins. https://doi.org/10.1097/PCC.0b013e318198afd6
36.	Yetwin, A., Marks, K., Bell, T., & Gold, J. (2012). Heart rate variability biofeedback therapy for children and adolescents with chronic pain. The Journal of Pain, 13(4), S93.

Appendix 2: Flowchart of search strategy results (Research data).



Appendix 3: Features of the Studies Selected for Review (n =36) (Research Data)

Reference	Design	n/age (years)	Type of Painful procedure	Country
(Hillgrove-Stuart *et al.*, 2013)	Clinical Trial	99/12-20 months	immunization procedure	Canada
(Brown *et al.*, 2014)	RCT	4-10 years	Burn wound care	Australia
(Nilsson *et al.*, 2009)	Clinical trial	21/5-17 years	Needle related pain	sweden
(Huth *et al.*, 2009)	Cross-sectional pre / p o s t - t e s t design	16/7-12 years	post-operative pain	USA
(Dobson and Byrne, 2014)	A quasi-experimental interrupted time-series design	20/6-11 years	sickle cell anemia pain	USA
(Kline *et al.*, 2009)	archival analysis of hospital data	44/ 6-18 years	acute injury pain	USA
(Hartati *et al.*, 2018)	Quasi experimental study	36/3-6 years	Infusion or intravenous therapy pain	Indonesia
(Akgül *et al.*, 2019)	Experimental study	81/3-6 years	venipuncture procedure pain	Turkey

(La Vonne and Zun, 2012)	Convenience prospective study	99/3-18 years	Emergency department acute pain	USA
(Bergomi *et al.*, 2018)	RCT	150/5-8 years	Venipuncture pain	Italy
(Feng *et al.*, 2018)	Within-subject study	54/3-7-year	Burns pain	China
(Calcaterra *et al.*, 2014)	Experimental study	42/3-14 years	Pediatric day care surgery pain	Italy
(Hartling *et al.*, 2013)	RCT	42/3-11 years	Pediatric emergency department pain	Canada
(van der Heijden *et al.*, 2018)	RCT	135/0-13 years	Burn wounds pain	South Africa
(Sundar *et al.*, 2016)	Experimental study	100/18 months	Immunization pain	India
(Nguyen *et al.*, 2010)	RCT	40/7-12 years	Lumbar puncture pain	Vietnam
(Chester *et al.*, 2018)	RCT	33/4-13 years	Burn wounds pain	Australia
(Liossi, White and Hatira, 2009)	RCT	45/7-16 years	Venipuncture	Greece
(Blume, Brockman and Breuner, 2012)	Clinical trial	132/8-18 years	Headache pain	USA

(Yetwin *et al.*, 2012)	Clinical trial	21/9-17 years	Chronic pain	USA
(da Cunha Batalha and Mota, 2013)	RCT	52/9-18 years	Cancer pain	Brazil
(Çelebioğlu *et al.*, 2015)	quasi-experimental study	25/4-15 years	Intrathecal therapy or bone marrow aspiration pain	Turkey
(Post-White *et al.*, 2008)	2-period crossover design	23/1-18 years	Cancer pain	USA
(van Dijk *et al.*, 2018)	RCT	284/ 5-weeks to 13 years	Burn wound pain	The Netherlands
(Gilbey *et al.*, 2015)	RCT	60/3-18 years	Post-tonsillectomy pain	Israel
(Graff and McDonald, 2018)	prospective, cohort study	19/8-18 years	Migraine	USA
(S. Wu *et al.*, 2009)	Clinical trial	27/6 months-18 years	Acute pain	USA
(Usichenko *et al.*, 2016)	Prospective randomized, analyst-blinded,crossover study	49/mean age 10 years	Venipuncture pain	Germany

(Johnson *et al.*, 2015)	Clinical trial	55/7-20 years	Chronic pain conditions	USA
(Alalo, Ahmad and El Sayed, 2016)	Experimental study	50/6-12 yrs	Venipuncture pain	Saudi Arabia
(Hassan *et al.*, 2012)	RCT	40/8-18 years	Hemodialysis pain	Egypt
(Wonginchan, Thanasilp and Rodcumdee, 2017)	Quasi experimental study	20/3-5 years	Intravenous infusion pain	Thailand
(Kiran, Kaur and Marwaha, 2013)	Quasi experimental	100/3-7 years	Venipuncture pain	India
(Baxter *et al.*, 2011)	RCT	80/4-18 years	Venous access pain	USA
(Varadharaja *et al.*, 2014)	Clinical trial	62/6-12 years	Dental pain	India
(Dhindsa *et al.*, 2011)	Clinicat trial	180/5-14 years	Dental pain	India

Note. n = size of the sample population, RCT =randomized controlled trial CT= clinical trial

Appendix 4 : Types of Non-Pharmacological Interventions (Research Data)

Category	**Sub Category**	**Pediatric pain management method**	**Studies**

Psychological non-pharmacological pediatric (1-10 years) pain management strategies	cognitive–behavioral methods	Guided imagery and relaxation	(Huth *et al.*, 2009; Kline *et al.*, 2009; Dobson and Byrne, 2014)
	Distraction methods	Playing with toys	(Hillgrove-Stuart *et al.*, 2013)
		Virtual reality	(Nilsson *et al.*, 2009; Brown *et al.*, 2014)
		Watching cartoons	(La Vonne and Zun, 2012; Bergomi *et al.*, 2018; Feng *et al.*, 2018; Hartati *et al.*, 2018; Akgül *et al.*, 2019)
		Music therapy	(Nguyen *et al.*, 2010; Hartling *et al.*, 2013; Calcaterra *et al.*, 2014; Sundar *et al.*, 2016; van der Heijden *et al.*, 2018)
		Hypnosis	(Liossi, White and Hatira, 2009; Chester *et al.*, 2018)
		Biofeedback	(Blume, Brockman and Breuner, 2012; Yetwin *et al.*, 2012)
Physical non-pharmacological pediatric (1-10 years) pain management strategies		Massage	(Post-White *et al.*, 2008; da Cunha Batalha and Mota, 2013; Çelebioğlu *et al.*, 2015; van Dijk *et al.*, 2018)
		Acupuncture	(S. Wu *et al.*, 2009; Gilbey *et al.*, 2015; Johnson *et al.*, 2015; Sherman, 2015; Usichenko *et al.*, 2016; Graff and McDonald, 2018)
		Heat and Cold Therapy	(Baxter *et al.*, 2011; Hassan *et al.*, 2012; Kiran, Kaur and Marwaha, 2013; Alalo, Ahmad and El Sayed,

			2016; Wonginchan, Thanasilp and Rodcumdee, 2017)
		Transcutaneous electric nerve stimulation(TENS)	(Dhindsa *et al.*, 2011; Varadharaja *et al.*, 2014)