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A Meta-analysis to Assess the Effectiveness of a Procedural Scale to Measure Pain in a Child Aged 0-1 Year

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ABSTRACT

Background: Infant pain liability has been assessed in several studies; nonetheless, diminutive is recognized about the relevance and effectiveness of using one type of pain scale affording to the type of painful stimulus and the infant's age. ***Purpose*:** Our purpose was to conduct a meta-analysis to assess and report on the efficiency of using the procedural pain scale to measure pain in a child aged 0-1 year using non-pharmacological interventions. ***Methods*:** A systematic search was performed up to October 2021 in PubMed and Cochrane Library. The current review enrolled randomized clinical trials (RCTs) according to PRISMA guidelines. Cochrane's risk of bias assessment was performed to assess the studies' quality and risk of bias. Meta-analyses were completed by calculating the standardized mean difference (SMD) at a 95% confidence interval (CI) using Review Manager Software. The review variables are: neonatal, pain, RCT and assessment. ***Results*:** The literature search returned 50 trials, but only 8 were involved in this meta-analysis. In most studies related to procedural pain (heel lance and vaccination), three commonly validated pain scales were used in all trials (neonatal infant pain scale NIPS, premature infant pain profile PIPP and neonatal pain, agitation and sedation scale NPASS. The 8 studies with 918 infant participants entered into analysis using effective pain scales (NIPS, PIPP and NPASS) to measure procedural pain effectively. Most studies used effective pain scales to measure procedural pain (NIPS, PIPP and NPASS). The meta-analysis showed a significant reduction in pain using NIPS, PIPP and NPASS tools. The most used was NIPS at 62.5%, followed by PIPP (25%) and NPASS (12.5%). The various interventions in studies reflected the strength of the used pain scale when assessing pain severity and supported the effect of non-pharmacological interventions (swaddling, mother holding and sucrose) in pain reduction compared with the control group (SMD 1.2, 95% CI -1.88 to -0.52, P =0.0005), I` = 95%, P>0.00001. ***Conclusion*:** In this meta-analysis, it has been reported that the pain scales used were an appropriate measure of the outcome of pain reduction. The type and accuracy of the validation of pain scales are also essential when selecting tools for a clinical trial. ***Implications for Nursing*:** The pain scales used in studies are appropriate to assess pain when measuring procedural pain (heel lance and needle-related procedures such as vaccination). Pediatric nurses should take care of selecting appropriate tools to assess pain in children before managing the pain. Further, pediatric nurses should be aware of that the inconsistency about the best tool for children is related to several factors. One is related to matching the pain tool to the age group and type of pain.

Keywords: A Meta-analysis, Pain, Infants.

What does this paper add?

1. This study was the first meta-analysis that aims to assess the effectiveness of non-pharmacological interventions in pain reduction.
2. This review showed the effective pain scales that are best used to assess pain when measuring procedural pain (heel lance, vaccination).

Introduction

Acute procedural pain is the most type of pain experienced by children during the performance of the routinely applied medical procedure (Kassab et al., 2019; Friedrichsdorf et al., 2015). Acute procedural pain is defined as acute pain associated with examinations, treatments or procedures that are frequently performed in the context of healthcare provision (Friedrichsdorf et al., 2015). The procedural pain approach varies according to the severity and duration of the expected pain, the context and the age group (Friedrichsdorf et al., 2015; Xie et al., 2021). Newborns, especially those born prematurely, are significantly susceptible to pain during a premature birth, illness, medical treatment, nursing care, pain and stress for babies (Andropoulos, 2018). Infants in neonatal intensive care undergo an average of 10 to 15 painful procedures daily (Assefa et al., 2022; Hoti et al., 2021, Kassab et al., 2019). Cardiovascular changes, behaviour changes, nutritional disruption, sleep disturbance and increased energy expenditure were caused by painful stimuli. This has several side effects and there is a need for intensive and long-term care (Xie et al., 2021; Uman et al., 2013).

An undeveloped nervous system and frequent experience of pain may reduce pain thresholds, increasing infants' sensitivity to subsequent traumatic events. Alterations in pain sensitivity may continue during the neonatal period, leading to impaired brain development. Pharmacological pain therapy should be used selectively due to the immature metabolism of drugs in infants and the known adverse side effects of drugs, such as hypotension and respiratory depression, together with the neuroprotective effect of analgesic and sedative drugs demonstrated in research and animal studies reporting their effect on brain development. To lessen the use of drug therapy, non-pharmacological approaches are usually used; for example, breastfeeding and skin-to-skin contact (Andersson et al., 2022).

Medical procedures frequently performed to evaluate and treat patients can be associated with pain and distress, especially in children (Carbajal et al., 2008). Frequently performed medical procedures include intravenous (IV) cannulation, blood draws, heel spears, lumbar punctures (LPs), urethral catheters, wound repair and medical imaging of fractures and dislocations. The worst pain experience routinely performed in children in the hospital is needle-related pain. Untreated pain has negative short-long-term consequences for children and their families and can lead to avoidance of medical care (Fein et al., 2012).

Pain scale selection in children is crucial to assess pain accurately and manage pain effectively. Pain assessment in children is challenging and requires skilled healthcare providers to indicate the pain event level correctly. The failure to report painful events in children properly is related to many factors. One is related to the fact that children pain is reported differently according to the age stage. For example, non-verbal infants cannot verbalize the feeling of pain. Instead, other symptoms that could be expressed show the severity of the pain. However, in children who can verbalize their pain feeling, the pain severity could be mistakenly reported, as it is associated with stress and anxiety.

Although various best practice strategies for pain management and sufficient evidence of their effectiveness are reported, inadequate pain care in children is still reported (Kassab et al., 2019; Elias et al., 2008). Inadequate pain management in children is related to an inadequate selection of pain scales (Kassab et al., 2019). The inadequate use and selection of required tools to assess pain in children are related to many factors. These are related to the lack of a matching scale with the appropriate age group, the lack of skills to use the pain scale by pain responses, unawareness of different pain intensity scales, such as one-dimensional *vs.* multi-dimensional and the lack of adequate matching of the scale with the type of pain (Kassab et al., 2019; Scopel et al., 2007). All mentioned factors lead to bad decisions in selecting the appropriate pain tool among children.

Time constraints, lack of material resources, personnel or knowledge, as well as safety concerns, are often reported as reasons to limit the use of effective strategies. Both nurses and clinicians indicated that access to structured and updated strategies and institutional support would help modify practice for better pain management (Stevens et al., 2011).

Managing the pain and distress associated with standard minor medical procedures is integral to healthcare provision. Furthermore, enabling the family and the child to take an active part is crucial for pain management to be effective. Healthcare providers are encouraged to indicate the least intrusive methods and when a painful procedure is mandatory, a range of simple strategies to improve the patient parent and healthcare provider experience. Merging strategies are frequently more effective than using one approach and can facilitate successful procedures for caregivers (Friedrichsdorf et al., 2015).

Little is known about reporting pain scales in clinical trials and whether they are appropriately implemented for a specific type of pain or a group of children studied. Therefore, this study aimed to evaluate the characteristics and report pain measures in randomized trials where newborns were exposed to traumatic interventions or conditions. Among the several multi-dimensional pain scales for children and infants, the most studied are the Neonatal Pain, Agitation and Sedation Scale (N-PASS), the Neonatal Infant Pain Scale (NIPS) and the Premature Infant Pain Profile (PIPP). These tools are clinically useable, consistent, age-appropriate assessment and documentation scales for constant infant pain in different clinical settings. Given this context, we aimed to search the scientific literature databases for trials related to used scales for pain assessment in 0-1 year-old children.

Thus, the following questions were raised:

What are the most common pain scales used to assess pain in children aged 0-1 year?

- What is the accuracy of using pain scales to report pain and measure the effectiveness of non-pharmacological interventions in reducing pain?
- This meta-analysis is therefore performed to help present the evidence about the accuracy of pain scales used in included trials to adequately measure pain severity in children aged 0-1 year.

Methods

This meta-analysis was conducted according the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) recommendations (Alessandro Liberati et al., 2009).

Literature Search

A systematic and extensive search was conducted through October 2021 in PubMed and Cochrane Library using combinations of terms/keywords: neonatal, pain, RCT and assessment. Randomized trials on neonatal pain (including procedural pain heel lance and vaccination) that reported at least one pain scale were included. We included trials on both term and pre-term infants. Observational studies, study protocols, conference abstracts and reviews were excluded.

A comprehensive search using the databases PubMed, Cochrane Central Register of Controlled Trials and Science Direct was performed from database inception until October 2021. An additional search was conducted through references to the included studies. Each selected database used different search strings according to the maximum Boolean operators. The articles were selected because they met the inclusion criteria.

Inclusion Criteria

This meta-analysis included randomized controlled trials (RCTs) on the effect of non-pharmacological interventions for managing procedural pain in infants. No date limitations were set for included studies; however, studies were limited to the English criteria, including non-randomized clinical trials and abstracts-only trials.

The trials included infant participants aged (0-1) year with procedural (heel lance and vaccination). All studies with participants suffering from procedural pain as a primary or secondary outcome were included. This review included participants engaged in various non-pharmacological interventions in any setting (e.g. home, hospital, primary care), including mother holding, swaddling and sucrose, compared with no treatment, sham, usual care or other non-pharmacological intervention. No restrictions were made regarding the duration of the program. Also, studies that involved only pharmacological treatment as a comparison group were excluded. The primary outcome is related to pain-intensity reduction. Studies were eligible and entered the meta-analysis if they measured pain at the baseline to ensure the exchangeability of the comparison groups and at the end of the intervention or follow-up period.

Data Extraction

The following data defines all outcomes for which data was sought. Specifying all results that were compatible with each outcome domain in each study

was sought and those results were extracted independently from the included studies using a standardized form; characteristics of the study, characteristics of participants, type of pain, type of experimental and control interventions, duration of the study recruitment and follow-up time, as well as outcome measures.

Study Quality Assessment

The methodological quality of the included studies was assessed using GRADEpro GDT 2021 software. It lists all primary and secondary outcomes, the number of participants, the number of studies and the overall evidence for each outcome. For each outcome, the certainty of the evidence was assessed using the GRADE approach (Balshem et al., 2011), which is based on the consideration of the risk of bias, inconsistency, indirectness, imprecision and publication bias. The certainty of the evidence was assessed for each outcome as high, moderate, low or very low.

Risk of Bias Assessment

The risk of bias in the included studies was assessed using the 'risk of bias' tool outlined in the Cochrane Handbook for Systematic Reviews of Interventions. The following risk of bias domains were assessed: sequence generation, allocation concealment, blinding of participants and personnel, blinding of assessors, incomplete outcome data, selective reporting and whether free of other bias. Each domain was judged at low, unclear or high risk of bias (unclear when inadequate information is provided to make low or high judgment). The overall risk of bias for each study was judged at "high risk of bias" when one domain at least is assessed, at "low risk of bias" when all three domains (allocation concealment, blinding of outcome assessment and incomplete outcome assessment) were assessed and at "unclear risk of bias" in the remaining cases. See Figures 2 and 3.

Outcome Assessment

All scales used to measure pain were the neonatal infant pain scale (NIPS), the neonatal pain, agitation and sedation scale (NPASS) and the premature infant pain profile (PIPP) (Olsson et al., 2021, Ahl et al., 2018). Moreover, all studies reported procedural or therapeutic pain in infants aged 0-1 year. Most of the studies used heel lance (Genik et al., 2021; Yilmaz et al., 2020; Inal et al., 2021; Chang et al., 2020; Stevens et al., 2018; Ranjbar et al., 2020; Inal et al., 2021), while one study used vaccination as procedural pain (Lima et al., 2017).

Meta-analytic Procedures

The standardized mean differences (SMDs) with corresponding 95% CIs were computed to combine trials that measure the same outcome using different scales. The meta-analyses were carried out using the RevMan (Review Manager 2020). The pooled standard mean difference was computed using a random-effect model in anticipation of natural heterogeneity between studies, where heterogeneity was found and weighted using the sample size for each study. When heterogeneity was absent, a fixed-effect model was used. Heterogeneity was evaluated using the I^2 statistic, considering an I^2 more significant than 50% as substantial heterogeneity. A standard mean difference (SMD) of 0.20 indicated a small effect, an SMD of 0.50 indicated a medium effect and an SMD of 0.80 or greater indicated a significant effect (Durlak, 2009).

Besides, when studies did not report mean and standard deviation, a method proposed by the Cochrane Handbook for Systematic Reviews of Interventions to calculate mean and standard deviation from the median, range or standard error measurement values was used. Likewise, for identified studies with two or more intervention groups (multi-arm studies), all intervention arms were combined into a single intervention group (Higgins, J.P.T., Deeks, J.J. and Altman, D.G. (editors)). Chapter 16: Special topics in statistics. In: Higgins, J.P.T. and Green, S. (editors). Cochrane Handbook for Systematic Reviews of Interventions, version 5.1.0. The Cochrane Collaboration (n.d.).

Search Results

The retrieved literature was searched for 50 scientific articles. The title and abstract were screened after checking for any duplicates. Out of 20 identified studies, only 8 were included in the meta-analysis (Figure 2).

Characteristics of the included studies and pain scales are presented in the text and in detail in the summary of identified studies (see Table 1). Overall, the review includes 8 studies that were included in the eight-analysis. Eight randomized controlled trials (Genik et al., 2021; Yilmaz et al., 2020; Inal et al., 2021; Chang et al., 2020; Steven et al., 2018; Ranjba et al., 2020; Lima

et al., 2017; Inal et al., 2021) involving 918 participants who met the inclusion criteria. Moreover, 10 articles were excluded; three studies because of the study design (Xiao-Zhi Huang et al., 2018; Zeynep Seda Uyan et al., 2009; Mariana Bueno et al., 2020) and two studies did not use a pain scale (Sinkey et al., 2015; Milazzo et al., 2011), one child older than 1 year (Lisa Hartling et al., 2013), two could not retrieve full text (Magdalena Napiórkowska Orkisz et al., 2021; Linda M. Cook et al., 2017), two for other reasons (Sarah & Curtis et al., 2007; Olsson et al., 2021). The study quality of all of the included studies was rated as moderate.

Table 1. Comparison of reviewed studies

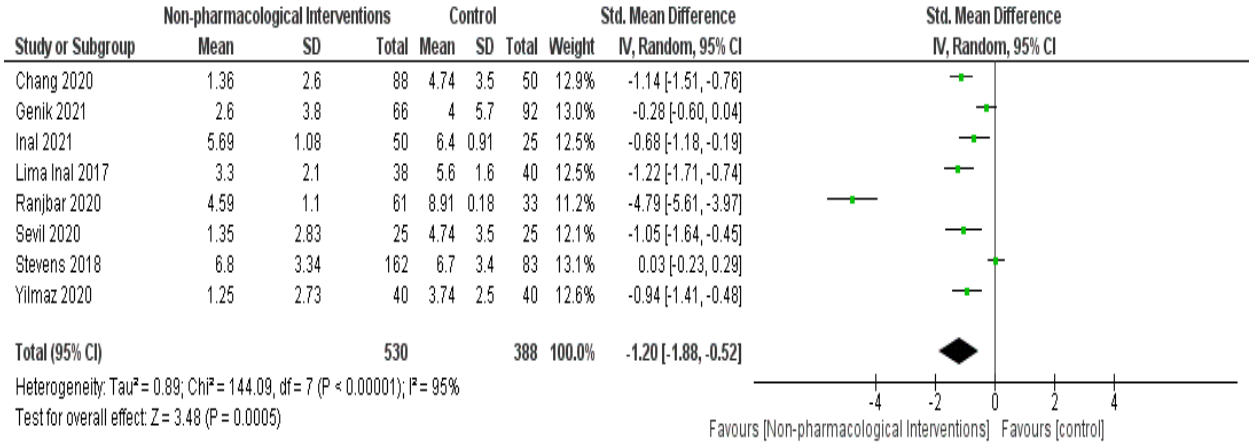
Study	Setting	Pain scale	Type of procedure conducted	Type of intervention	Control intervention	Population (age of sample)	Pain outcome
Genik et al. (2021)	Clinic	Neonatal Infant Pain Scale	Heel Lancing	Swaddling Maternal Holding	Control Group No Intervention	Newborns 1-3 months	Representing a promising step towards enhancing pain-related care for children with IDD
Inalet al. (2021)	Clinic	Neonatal Infant Pain Scale	Heel Stick Procedures	Swaddling Maternal Holding	Control Group No Intervention	Newborns aged from 2 to 4 days	The present study used NIPS to evaluate the newborns' interventional (procedural) pain score, verifying excessive pain
Yilmaz et al. (2020)	NICU	Neonatal Infant Pain Scale	Heel Lancing	Swaddling, Holding, Breastfeeding	Control Group No Intervention	Newborns 0-3 months	All three methods effectively reduce the pain felt during heel lancing in newborns'
Inal et al. (2021)	Clinic	Neonatal Infant Pain Scale	Heel Stick Procedures	Swaddling, Maternal Holding	Control Group No Intervention	Newborns 0-3 months	Both swaddling and maternal holding effectively reduce heel stick procedure, but mother holding may be preferred as a priority rather than swaddling
Chang et al. (2020)	Clinic	Neonatal Pain, Agitation and Sedation Scale (NPASS)	Heel Lancing	Breastfeeding Oral Sucrose Nonnutritive Sucking Skin-to-skin Contact	Control Group No Intervention	Newborns between 24 and 48 hours of age	The results indicate that all intervention groups showed decreased pain levels when compared with the control group
Stevens et al. (2018)	NICU	Premature Infant Pain Profile-Revised (PIPP-R)	Heel Lancing	Administering 24% Sucrose [0.1 ml (Group 1), 0.5 ml (Group 2), 1.0 ml	Group 3 drop-by-drop *via* syringe over the anterior surface of the tongue Then non-nutritive sucking (NNS)	Neonatal borns between 24 and 42 weeks Gestational Age	No difference in pain intensity was shown among 3 doses of the cross
Ranjbar et al. (2020)	NICU	Premature Infant Pain Profile (PIPP)	Six blood samples were collected by heel stick for each infant.	Oral dextrose and facilitated tucking	Control Group No Intervention	Newborns age of 2 days	The severity of pain was reduced after using oral dextrose as compared with the control group
Lima et al. (2017)	Clinic	Neonatal Infant Pain Scale (NIPS)	Hepatitis B vaccination	Glucose (G25)	Non-nutritive sucking (NNS)	0-1 year	The use of 25% glucose before the vaccination procedure was more effective in relieving acute pain than NNS

Meta-analysis Results

The behavioural scales NIPS, FLACC and N-PASS are identified in all included studies. The tools evaluated acute and prolonged pain and measured pain using all types of behavioural indicators. The tools effectively detected the effects of non-pharmacological interventions (swaddling, mother holding, sucrose and breastfeeding) on pain severity.

The pooled analysis (including the eight studies) disclosed a significant improvement in pain intensity under non-pharmacological interventions (swaddling, mother holding, sucrose and breastfeeding), compared with sham or usual-care interventions (SMD 1.2, 95% CI -1.88 to -0.52, P =0.0005), I` = 95%, P> 0.00001.

The forest plot is a graph that compares 8 studies with 918 infant participants using non-pharmacological interventions in pain reduction. The pooled analysis showed statical significance of non-pharmacological interventions (swaddling, mother holding and sucrose) in pain reduction compared with the control group (SMD -1.2, 95% CI -1.88 to -0.52, P =0.0005), I` = 95%, P> 0.00001 (Figure 1) The meta-analysis is of a high effect size, which means a more robust relationship between non-pharmacological interventions and pain reduction. The P-value of less than 0.05 indicates a statistically significant relationship.



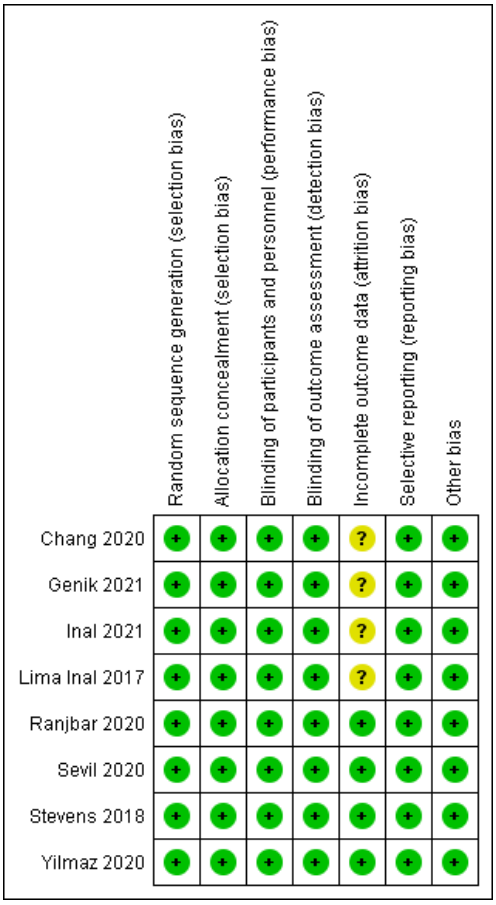


Figure 2. Risk of bias summary

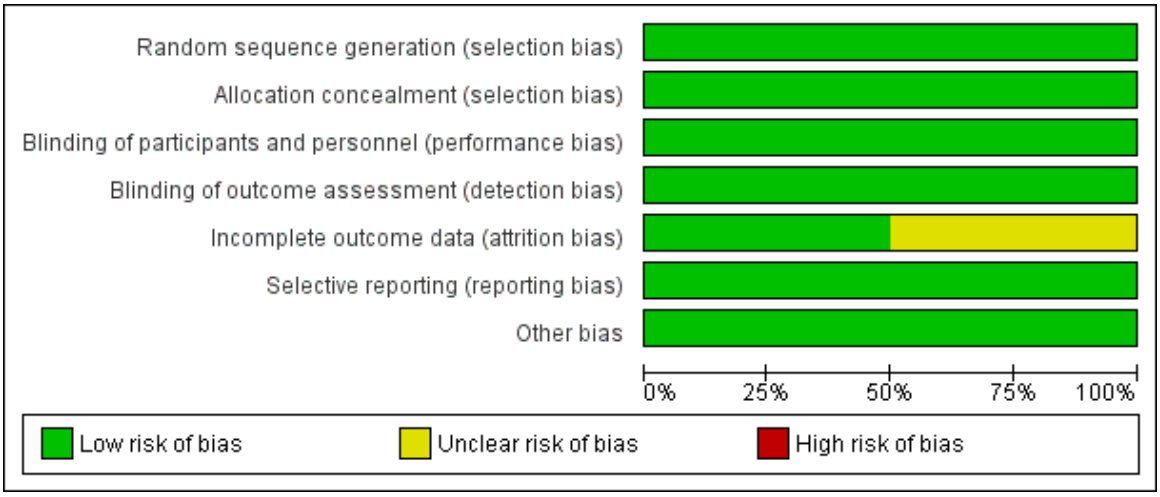


Figure 3. Risk of bias graph

Moreover, the plot reflects that studies used an appropriate and effective procedural pain scale, evidenced by pain reduction. Studies were selected, because they met the inclusion criteria. In Genik et al. (2021), pain was shown when swaddling and mother holding were used compared with no interventions. In the case of heel lance, SMD was less than zero, where it was -0.28, but CI (-0.6, 0.04) values cross the zero. This represents an encouraging phase concerning improving children pain-related care with IDD by using the NIPS scale.

In Chang et al. (2020), SMD is -1.14 and CI (- 1.51, -0.76) values were less than zero and therefore, pain was reduced because of the SMD significant effect, indicating that breastfeeding, oral sucrose, non-nutritive sucking and skin-to- skin contact are all approaches that caused pain reduction as compared with the control group as measured by the NPASS.

In Inal et al. (2021), pain stimulated using the heel lancing procedure was reduced as measured with the NIP scale. The pain level was different among groups. The pain severity in the swaddling and maternal holding groups was less than that for children in the control group (no pain control interventions). When heeling lance procedure was used, SMD was -1.05 and CI (-1.64, -0.45) values were less than zero. Pain was reduced as the 95% CI was less than zero. SMD was more than 0.8, indicating that the NIPS tool significantly assessed the neonatal interventional (heel lancing) pain level.

The study conducted by Yilmaz et al. (2020) showed a significant level in reducing pain (95% CI less than zero), where the SMD value was -0.94, indicating a significant effect when swaddling, mother-holding and breastfeeding were used. The findings indicate that heel lancing pain was less felt with applying all the three mentioned methods as measured by the NIP scale.

In Inal et al. (2021), SMD was -0.68 and CI (- 1.18, -0.19) values were less than zero and therefore, pain was reduced, because SMD (0.68) has a moderate effect, where both swaddling and maternal holding effectively minimize the feeling of heel stick pain. Interestingly, mother holding showed preference over swaddling as measured with the NIP scale.

In the study conducted by Ranjbar et al. (2020), pain was reduced, because the confidence interval was less than zero. The SMD value was -4.79, with CI (-5.61, -3.97). This significant effect lowers pain after using oral dextrose assessed by PIPP. In Lima et al. (2017), the SMD value was -1.22, with CI (-1.71, -0.74) values less than zero; therefore, pain was reduced, because the SMD has a significant effect. The use of 25% sweet solution (glucose) before immunization needles was more effective in relieving acute pain as assessed by the NIP scale.

In Steven et al. (2018), the SMD value and CI cross of zero did not decrease pain much, because no difference in pain intensity appeared between the 3 doses of sucrose used according to PIPP. SMD was 0.3 with a mild effect size.

The Effect of Non-pharmacological Interventions on Pain and Its Relation with the Pain Scale

Most of the included studies showed that non-pharmacological interventions reduced the pain level. A pain scale assesses pain, so when it shows pain

reduction, that's an evidence that the tool used to assess pain is adequate and accurate (Andersen et al., 2015; Kassab et al., 2019).

Discussion and Implications

There are many different pain scales available to the children population. However, a valid and reliable procedural pain scale is needed; i.e., a scale that can detect and measure the reduction of procedural pain. Clinical appraisals of available pain scales among infants are crucial for selecting the appropriate and precise scale according to age group and the type of applied procedures. Furthermore, it has been found that most trials were conducted on neonates who experienced procedural pain, while there is a paucity of studies on post-operative pain and persistent pain/stress. The explanation for this is likely that the era of pain research began with studies of procedural pain in the 1990s and that these studies are easier to conduct.

This first meta-analysis focuses on pain scales that measure 0 to 1-year child pain in randomized trials. In this meta-analysis, pooled analysis showed the significance of the tool used to report the reduction in pain when non-pharmacological interventions (swaddling, mother holding and sucrose) were used, compared with the control group. Most studies used effective pain scales to measure procedural pain (NIPS, PIPP, NPASS). The most used was NIPS at 62.5%, followed by PIPP (25%) and NPASS (12.5%). The various interventions in studies reflect the strength of the used pain scale when assessing pain severity. The intervention group and the control group in one of these studies are the same, but different in sucrose dose, so the results of this study show no difference in pain intensity, which does not reflect the pain-scale effectiveness.

The effect of non-pharmacological interventions was measured on pain-reduction scales. In this meta-analysis, it has been reported that the pain scales used accurately evaluated acute procedural pain in infants (NIPS, NPASS, PIPS) using associated signs and symptoms, such as behavioural parameters. Unfortunately, such approaches are not always available in the neonatal setting. Therefore, pain assessment with the help of validated pain scales is the best available method, highlighting the essence of the validation process (Manocha & Taneja, 2016; Beltramini et al., 2017).

As for the age range by scale, it was observed that the NIPS is a scale that is used to assess behavioural and pain reactions during procedural pain in newborns. NPASS is an age-appropriate assessment scale for acute and constant procedural pain (Hummel et al., 2010) that frequently assesses pain in children aged zero to three years, including both behavioural and physiological parameters (Stevens et al., 1996).

Research focused on procedural pain has taught us about the physiology of pain in pre-term and term infants in a highly structured way, while in studies on the complexity of pain after surgery, traumatic conditions or persistent pain/stress, for example, during ventilator support in a Neonatal Intensive Care Unit (NICU) (Andersson et al., 2022), severely ill infants with a variety of different conditions and different clinical situations are more challenging to conduct.

Persistent pain; e.g. pre-term necrotising enterocolitis pain, is hard to be measured. This is because unknown symptoms, such as hypotonia and immobility, in response to severe pain and tension will hide the experience of pain. There, inadequate procedural pain assessment may translate a low score into a procedure to indicate that the infant is not adequately treated for persistent pain (Andersson et al., 2022; Beltramini et al., 2017; Yamada et al., 2008).

Study Limitations and Recommendations

This study has several strengths; the strengths of our meta-analysis include the study design's originality and the study search's comprehensive strategy. The included studies vary in pain scales. They used 3 pain scales and varied in non-pharmacological interventions.

Despite its strengths, the results of this study are subject to several limitations. Among these limitations is the small sample size, in addition to language limitations, where it included only English-language studies. The main recommendation is to include more diverse studies, like other types of procedures and age groups, so that detailed conclusions can be drawn. Once more studies are obtained, a more detailed analysis of the studies and pain scales should be carried out. This expands our knowledge of the research issue. More research should be conducted to expand our knowledge and conclusions on this topic.

Conclusions

PIPP, NIPS and NPASS are valid scales correlating to procedural pain in newborns and infants. These scales

provide nurses with an objective measure of infants' procedural pain. Children, especially newborn babies, are very susceptible to pain. Pre-mature birth, illness and inappropriate health care, including nursing care, cause frequent pain and anxiety for newborns. The fact that tension increases pain sensation is well supported in the neonatal population. This correlates with the pre-maturity stage and distinguishing stress from pain in the pre-term population is hard to distinguish.

Recognizing the intensity of painful stimuli and separating it from anxiety is the key to pain reduction effectively. In a non-verbal neonatal patient, conventional self-report cannot do this. Instead, valid and reliable tools are needed to assess the severity of stress and pain. Several observation scales have been created and tested for different groups of newborns and different types of pain.

Compared with the control group, we can show the significance of non-pharmacological interventions (swaddling, mother holding and sucrose) in pain reduction. The reviewed studies used NIPS at 62.5%, PIPP at 25% and NPASS at 12.5%. The 8 studies used effective pain scales to measure procedural pain (NIPS, PIPP and NPASS). This means that the pain scales used in those studies are appropriate to assess pain when measuring procedural pain (heel lance, vaccination). However, more consistency is needed to decide on the best tool to use in children related to several factors.

The findings of this meta-analysis contribute to practice, administration, education and policy. Although three scales (NIPS, PIPP and NPASS) are used, more is needed to avoid inadequate pain assessment. More training is needed to improve pediatric nurses' competencies in scale selection. one can see that there are areas for improvement that can be made in the future. The main recommendation is to include more diverse studies, applying other types of procedures and older age groups to draw accurate and detailed conclusions. More research should be done to expand our knowledge on the field, emphasizing other selected scales related to different types of progressive pain. We lack research for more complicated painful procedures with persistent pain and pain after surgery.

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Conflict of Interest

All authors declare that there is no conflict of interest.

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