



Sucrose solution for alleviating needle pain during inferior alveolar nerve block in children aged 7–10 years: a randomized clinical trial

Supriya Thambireddy, Nirmala SVSG, Sivakumar Nuvvula

Department of Pediatric and Preventive Dentistry, Narayana Dental College and Hospital, Nellore, India

Background: Intraoral local anesthesia is essential for delivering dental care; however, injection of this local anesthetic is perceived as the most painful and distressing agent for children, parents, and healthcare providers. Reducing pain as much as possible is essential to ensure smooth subsequent treatment procedures, especially in pediatric dentistry. In clinical practice, oral sucrose administration has been reported to decrease the pain during heel lance and cold pressor tests in neonates and children. This study aimed to determine whether the prior administration of a 30% sucrose solution reduced the pain related to inferior alveolar nerve block in children.

Methods: A total of 42 healthy children aged 7–10 years requiring dental treatment of mandibular molars involving inferior alveolar nerve block were recruited. The participants' demographic details were recorded, height and weight were measured, and the anesthetic injection was delivered after receiving the respective intraoral sucrose solution and distilled water by the intervention (group 1) and control (group 2) group participants for 2 min. The subjective pain perceived during injection was measured using an animated emoji scale. The pain scores between the groups were compared using the Mann-Whitney U test.

Results: The median pain score and range for the intervention and control groups were 4 (2 – 6) and 6 (4 – 8), respectively, and statistically significant differences ($P < 0.001$) were observed in the intervention group. Age, sex, height, and weight did not influence the analgesic effect of the sucrose solution.

Conclusion: Oral administration of sucrose may relieve pain associated with inferior alveolar nerve block in children.

Keywords: Anesthesia; Child; Pain; Sucrose.



This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.



INTRODUCTION

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage or is described in terms of such damage. Pain is an inevitable factor during various dental procedures and is one of the major reasons for fear of dental treatment in children. The use of local anesthesia for pain control is a requisite

for many procedures, especially in pediatric dentistry [1]. Despite considerable improvements in local anesthetic delivery, injection needle pain remains a common concern, especially in children. This fear impacts the child's behavior during treatment, such as crying, throwing temper tantrums, and reluctance to treatment. To guide this behavior of the child and create a positive attitude towards further treatment, reducing injection needle pain has become a prerequisite. Several methods

Received: May 3, 2023 • Revised: July 3, 2023 • Accepted: September 12, 2023

Corresponding Author: Nirmala SVSG, MDS, Professor, Department of Pediatric and Preventive Dentistry, Narayana Dental College and Hospital, Nellore, A.P, India -524003

Phone: +9440206976 E-mail: nimskrishna2007@gmail.com

Copyright© 2023 Journal of Dental Anesthesia and Pain Medicine

have been cited in the literature like application of topical anesthetics [2], precooling the injection site [3], adjusting the injection rate [4], changing the pH of the anesthetic agent [5], warming the anesthetic agent [6], buffering the anesthetic agent [6], and pretreatment with lasers [7] to reduce the injection needle pain.

Sweet taste-induced analgesia is a physiological analgesic phenomenon, and sweetness may also have pain-reducing properties. Sugar solutions, such as sucrose and glucose are known to increase the pain threshold in venipuncture, heel lance, and cold pressure tests [8]. Sweet solutions induce changes in the endogenous opioid activity and the positive affective state of the brain when held in the mouth. Increased opioid activity and elevated affective state have the potential to reduce pain perception [9,10]. However, long-term sucrose ingestion leads to hyperalgesia in rats, which has been hypothesized to result from a complex interaction of sucrose with the endogenous opioid system, leading to opioid deficiency [11]. This lends credibility to the hypothesis that sweet-tasting solutions exert analgesic effects.

Studies have reported pain thresholds or pain ratings with sucrose solution [8-12], but only two studies have been reported till date addressing the sucrose solution and pain perception with dental injections [13,14]. Therefore, this study aimed to determine the analgesic effect of sucrose solution during Inferior alveolar nerve block in children and the influence of age, sex, height and weight on this analgesic effect.

METHODS

This study was prepared in accordance with the 2010 Consolidated Standards of Reporting Trials (CONSORT) guidelines 2010 [15].

1. Ethical approval and protocol registration

The institutional review board and ethical committee under DR. NTR UNIVERSITY OF HEALTH SCIENCES, Andhra Pradesh, India approved all the aspects of the

research protocol (IEC/NDCH/2022/Mar/P-56). This trial was registered in the Clinical Trials Registry of India under reference ID REF/2022/03/052589.

2. Study design, setting, and duration

This was a randomized, parallel-group clinical trial with an equal allocation ratio. The study was conducted on children who reported to the Department of Pediatric and Preventive Dentistry for 6 months from April 2022 to September 2022.

3. Sample size

The pilot was conducted among 14 participants with seven members in the intervention group and seven members in the control group, and the mean rank of pain scores in the intervention and control groups were 4.1 and 5.0, respectively. The sample size was estimated using the G power analysis using Wilcoxon Mann-Whitney test for two groups with an alpha error of 0.05 and power of 80%. The effect size was calculated from the mean and SD of pilot study as 0.91, the allocation ratio was kept at 1:1, and the total sample size achieved was 42 (21 per each group).

4. Study materials

30% sucrose solution - The solution was prepared by dissolving 30 g of preweighted sucrose powder in 100 ml of water in a measuring jar. The solution was freshly prepared for each child.

Local anesthesia - 2% lidocaine with 1:100,000 epinephrine, dental syringe, and 27 gauge long needle. Assessment tool - Animated Emoji Scale (AES; Fig. 1) was used to assess the pain perception during the study procedure. In 1997, a Japanese telecom company employee, Shigetaka Kurita, developed a picture word or image character called an emoji [16]. It is used as a mechanism or tool to portray the emotions and context that abolish the language barrier. The AES contained six animated emoji faces showing facial expressions ranging from happy/laughter to unhappy/sadness or crying. The AES was chosen because it is easier to understand, and

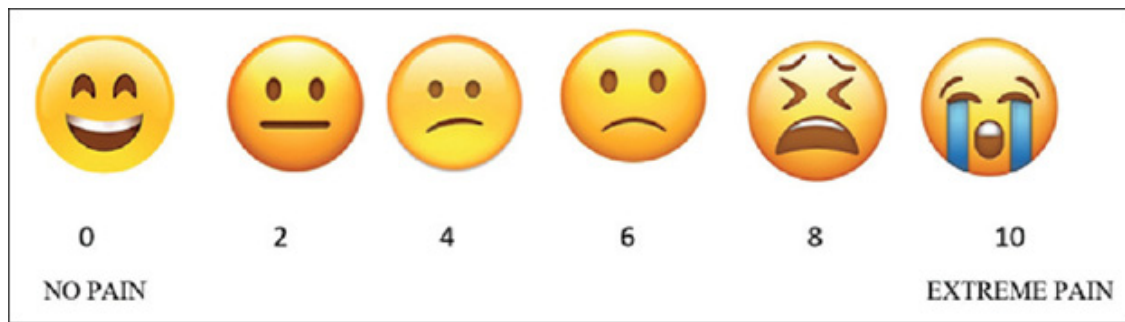


Fig. 1. Assessment tool - animated emoji scale

children are known to have a preference for emojis over still images. This self-reporting tool is the gold standard for pain measurement. In this study, only a subjective scale was used, based on the belief that children aged 7–10 years have good cognitive development with more logical and organized thinking, according to Piaget’s cognitive theory of development [17].

5. Methodology

The participants were enrolled in the study through convenience sampling. All children and their parents/guardians were informed about the nature of the study, and those who provided signed informed consent and assent were recruited.

Inclusion criteria: Wright’s cooperative, healthy children aged 7–10 years requiring dental injections for pulpectomy, root canal treatment, or extraction procedures for primary and permanent mandibular molars.

Exclusion criteria: Wright’s potential cooperative and lack of cooperative ability in children; juvenile diabetes and an allergy to lidocaine; redness at the site of injection; and a history of abscess, sinus tract, or fistula associated with the teeth.

An assistant performed simple randomization using a shuffled deck of cards. Children who chose the even-numbered card were assigned to the intervention group, whereas those who chose the odd-numbered card were assigned to the control group. No blinding was performed. The weight and height of each child were measured by a resident pediatric dentist.

6. Treatment

Prior to the nerve block, participants of both the groups were administered 10 ml of 30% sucrose solution and 10 ml of distilled water respectively. They were asked to drink and hold the solution in their mouth for 2 min and then spit it out. Subsequently, an inferior alveolar nerve block was given by the pediatric dental specialist to anesthetize both the inferior alveolar and lingual nerves using 1.8 ml of 2% lidocaine with 1:100,000 epinephrine and a 27 gauge short needle. The injection was administered slowly for 1 min preceded by aspiration, to prevent intravascular delivery and adverse reactions.

The pain perception with injection was recorded by the assistant by asking the child to choose one of the animated emojis on the electronic display that best matched their feelings at the moment of the nerve block. The child was instructed on the scale and pain rating using the AES before the injection. None of the patients required supplementary injections to ensure complete anesthesia. The subsequent treatment procedure was continued after the nerve block: 18 children in the intervention group and 15 in the control group underwent pulpectomy, while the remaining three children in the intervention group underwent root canal treatment. In the control group, two children received root canal treatment and four children underwent extraction. No behavioral guidance techniques were used for the study participants before or during the inferior alveolar nerve block procedure.

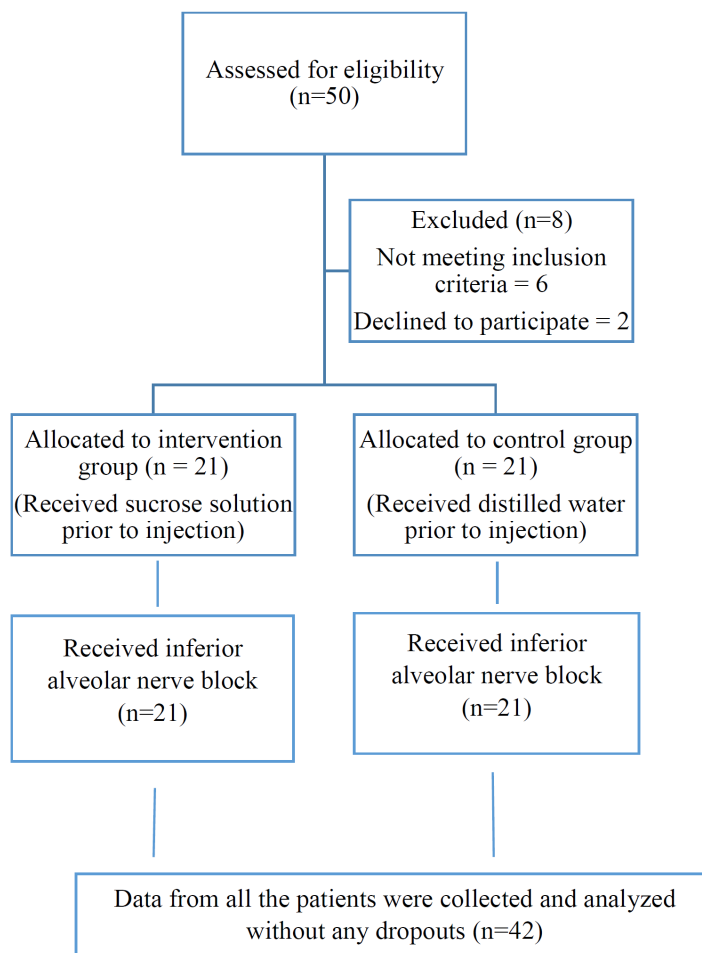


Fig. 2. Consolidated Standards of Reporting Trials flow diagram showing the allocation of participants and the research protocol

7. Statistical analysis

The data collected were tabulated and analyzed using the Statistical Package for Social Sciences (SPSS) software version 20 (SPSS Inc., Chicago, Illinois, USA). The demographic information of the two study groups was compared using the chi-square test and Student's t-test. The pain scores were analyzed using the Mann-Whitney U test.

RESULTS

A total of 42 children were included in the research sample, and all completed the study as mentioned in the Consort flow chart (Fig. 2).

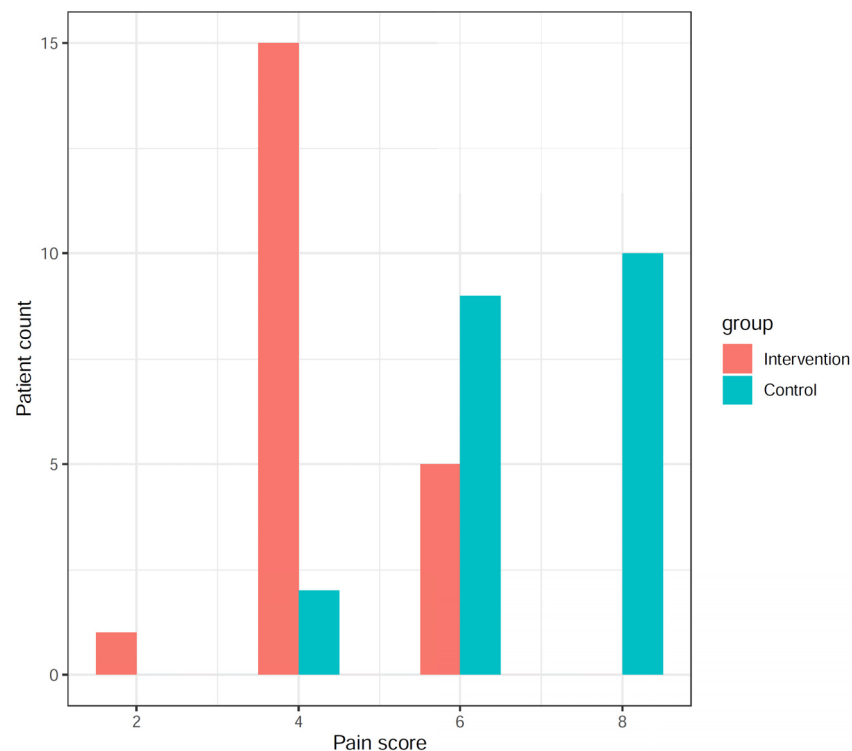
The age of the study participants ranged from 7–10 years with children of 7 years being 23.8%; 8 years, 28.6%; 9 years, 33.3%; and 10 years, 14.3% in the intervention group, while 7 years being 28.6%; 8 years, 23.8 %; 9 years, 19.0%; and 10 years, 8.6% in the control group.

There were 19 male and 23 female participants in the study (Table 1). The intervention group comprised 38.15% (n = 8) of males and 61.95% (n = 13) of females whereas 52.4% (n = 11) of males and 47.6% (n = 10) of females constituted the control group. No significant difference (P=0.352) was observed in the sex distribution among the study groups.

The mean age, height, and weight of intervention group were 8.38 ± 1.02 , 1.20 ± 0.03 , and 21.27 ± 1.9 , respectively. The mean age, height, and weight of the control group were 8.47 ± 1.21 , 1.19 ± 0.03 , and 21.6

Table 1. Number of study participants based on age and gender

Demographics		Intervention Group N(%)	Control Group N(%)	P value
Age	7yrs	5 (23.8)	6 (28.6)	
	8yrs	6 (28.6)	5 (23.8)	
	9yrs	7 (33.3)	4 (19.0)	
	10yrs	3 (14.3)	6 (28.6)	
Gender	Males	8 (38.1)	11 (52.4)	0.535
	Females	13 (61.9)	10 (47.6)	
Mean age (year)		8.38 ± 1.02	8.47 ± 1.21	0.784
Mean height (m)		1.20 ± 0.03	1.19 ± 0.03	0.580
Mean weight (kg)		21.27 ± 1.9	21.6 ± 1.7	0.316

**Fig. 3.** The distribution of pain score

± 1.7, respectively.

No significant difference ($P = 0.784$) was observed in the age distribution among the study groups with the mean ages of 8.38 ± 1.02 and 8.47 ± 1.21 in the intervention and control groups, respectively (Table 1). The median pain scores and ranges for the intervention and control groups were 4 (2 – 6) and 6 (4 – 8), respectively, and statistically significant differences (Mann-Whitney U test, $P < 0.001$) were found in the intervention group (Fig. 3).

No significant influence of age, sex, height, and weight

on pain scores was observed between the two groups.

DISCUSSION

From routine pediatric immunization to dental treatment, children of all ages are subjected to traumatic needle exposure, causing a long-term fear of needle pain. Although necessary, dental anesthetic injections can cause discomfort and apprehension in children and their parents. Therefore, effective pain-relief techniques are required in

all areas where needle-related procedures are performed [13]. Thus, this study aimed to determine the effect of 30% sucrose solution on the pain perceived during inferior alveolar nerve block in children, and the obtained results showed that intraoral sweet-tasting sucrose solution was capable of lightening the pain when administered prior to dental injection.

As advocated by Prophet Mohammed, the human first taste experience is that of a sweet solution. It might be breast milk, sugar water, honey, or even dates as in some cultures [18] for soothing and calming effects. Leng HY et al. (2013) reported that 30% sucrose solution provided better pain relief than other concentrations of sucrose (12 and 24%) and glucose (10, 25, and 50%) during heel lancing procedures in neonates [8]. The sucrose solution was held in the mouth for 2 min because the pain-inhibiting effect of sucrose was reportedly maximal at this time duration [19, 20]. Over the past century, oral sucrose and other sweet remedies have been used to relieve discomfort in children [13]. The 30% sucrose solution was preferred in this study because it is the most prevalent choice in the literature [12].

The inferior alveolar nerve block was used in this study because the finger pressure while locating the coronoid notch (anatomical landmark), needle positioning, depth of needle penetration, and the amount of local anesthetic that need to be deposited during this injection technique caused pain and discomfort for children. Kaufman et al. (2005) reported that participants graded the inferior alveolar nerve block as the most painful, with higher rates of pressure and discomfort compared with other dental injection techniques. The oral mucosa contains more free nerve endings than the oral submucosa, leading to an increased perception of pain [21].

Intraoral 30% sucrose solution showed a greater reduction in subjective pain scores in this study. Ghaderi et al. (2020) reported that the administration of a sweet-tasting sucrose solution before dental injections reduced pain and discomfort in children [14]. Janiani and Gurunathan D (2021) stated that a sweet-tasting honey solution was effective in mitigating discomfort during

infiltration anesthesia and inferior alveolar nerve block [13]. Shiiba et al. (2012) examined the effect of sweet taste stimulation on the pain tolerance threshold of the oral mucosa using a Neurometer CPT/C and found that the sweet taste stimulation increased the pain threshold in children but not in adults [20].

In contrast to our results, Lewkowski et al. (2003) reported that chewing sweet-tasting gum did not relieve the pain associated with a needle prick. This disparity was due to the presence of sweet substances in the medium. The control group also received gum in their study, and rhythmic chewing movements induced analgesia, thereby masking its sweet taste effect [22]. In this study, age did not affect the pain-reducing ability of the sucrose solution, which was consistent with the results of Ghaderi et al. (2020) [14]. This was attributed to the smaller age range of the participants, and the analgesic effect was found to be similar in middle-aged children (6-12 years).

Sex had no influence on analgesia with sucrose solution in the study participants. Taste acuity and preference for sweet tastes may be the same in both male and female children [23,24].

Body weight and height were also associated with the analgesic effects of sweet-tasting substances. Thus, the findings of this study were inconsistent with those of previous studies [25,26]. This may be due to the alterations in the hormonal levels of the individuals or dietary factors played a role.

1. Mechanism of action of Sucrose

According to Bhattacharjee and Mathur, sucrose induces a biphasic response to initial analgesia and late hyperalgesia by affecting the endogenous opioid system, as explained using the naloxone challenge test. This test is based on the fact that opioids exert tonic inhibition of gonadotrophin-releasing hormone-secreting neurons in the hypothalamus. This tonic inhibition may be reversed by naloxone, an opioid antagonist that causes the release of luteinizing hormone (LH) into the circulation. Serial estimation of LH in serum indicates the status of the

endogenous opioid system (EOS) and its functional ability. The naloxone challenge test has been used to assess the EOS status in healthy individuals [11].

2. Limitations of the study:

Only one nerve block was assessed and no comparison was made with other maxillary and mandibular injection techniques.

3. Conclusion

In light of the obtained results, using sweet-tasting solutions in pediatric dental practice is of advantageous to alleviate the pain during local anesthetic dental injections, such as inferior alveolar nerve block, in both male and female middle-aged children.

Despite many available ways to decrease the pain in this age group, the palatable nature of sucrose with a higher hedonic quality increases the pain threshold in children. The sweet taste gives the children a pleasant experience and acts as a reward for treatment, thereby having a positive impact on future dental treatments.

4. Recommendations

Studies assessing a broader-age range in children as an influencing factor of sweet taste analgesia and dental injections are required in the future, and studies comparing the analgesic effects of sucrose and other pain control methods should also be conducted.

AUTHOR ORCID*s*

Supriya Thambireddy: <https://orcid.org/0000-0002-5438-7736>

Nirmala SVSG: <https://orcid.org/0000-0001-7876-7277>

Sivakumar Nuvvula: <https://orcid.org/0000-0002-1204-5551>

AUTHOR CONTRIBUTIONS

Supriya Thambireddy: Conceptualization, Data curation, Formal analysis, Methodology, Validation, Visualization, Writing - original draft, Writing - review & editing

Nirmala SVSG: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing

Sivakumar Nuvvula: Conceptualization, Project administration, Writing - review & editing

DECLARATION OF INTERESTS: There are no conflicts of interest to declare.

FUNDING: There is no financial support and sponsorship to declare.

REFERENCES

1. M M A, Khatri A, Kalra N, Tyagi R, Khandelwal D. Pain perception and efficacy of local analgesia using 2% lignocaine, buffered lignocaine, and 4% articaine in pediatric dental procedures. *J Dent Anesth Pain Med* 2019; 19: 101-9.
2. Santhosh T, Balakrishnan RN, Malaiappan S. Comparative analysis of use of topical anesthetics and local anesthetic infiltrations among pediatric dental patients -a retrospective study research article. *Int J Dent Oral Sci* 2021; 8: 2906-10.
3. Amrollahi N, Rastghalam N, Faghihian R. Effect of pre-cooling on pain associated with dental injections in children: a systematic review. *J Evid Based Dent Pract* 2021; 21: 101588.
4. Johnson J, Primosch R. Influence of site preparation methods on the pain reported during palatal infiltration using the Wand Local Anesthetic System. *Am J Dent* 2003; 16: 165-9.
5. Cepeda MS, Tzortzopoulou A, Thackrey M, Hudcova J, Arora Gandhi P, Schumann R. Adjusting the pH of lidocaine for reducing pain on injection. *Cochrane Database Syst Rev* 2010; (12): CD006581.
6. Kurien RS, Goswami M. Comparative evaluation of anesthetic efficacy of warm, buffered and conventional 2% lignocaine for the success of inferior alveolar nerve block (IANB) in mandibular primary molars: a randomized controlled clinical trial. *J Dent Res Dent Clin Dent Prospects* 2018; 12: 102-9.
7. Ghaderi F, Ghaderi R, Davarmanesh M, Bayani M, Arabzade Moghadam S. Pain management during needle insertion with low level laser. *Eur J Paediatr Dent* 2016; 17: 151-4.
8. Leng HY, Zheng XL, Yan L, Zhang XH, He HY, Xiang

- M. Effects of different types and concentration of oral sweet solution on reducing neonatal pain during heel lance procedures. *Zhonghua Er Ke Za Zhi* 2013; 51: 654-8.
9. Mysels DJ, Sullivan MA. The relationship between opioid and sugar intake: review of evidence and clinical applications. *J Opioid Manag* 2010; 6: 445-52.
 10. Kakeda T, Ogino Y, Moriya F, Saito S. Sweet taste-induced analgesia: an fMRI study. *Neuroreport* 2010; 21: 427-31.
 11. Bhattacharjee M, Mathur R. Antinociceptive effect of sucrose ingestion in the human. *Indian J Physiol Pharmacol* 2005; 49: 383-94.
 12. Stevens B, Yamada J, Lee GY, Ohlsson A. Sucrose for analgesia in newborn infants undergoing painful procedures. *Cochrane Database Syst Rev* 2016; 7: CD001069.
 13. Janiani P, Gurunathan D. Effectiveness of pre-administered natural sweet-tasting solution for decreasing pain associated with dental injections in children: a split-mouth randomized controlled trial. *J Contemp Dent Pract* 2021; 22: 1434-7.
 14. Ghaderi F, Ahmadbeigi M, Vossoughi M, Sardarian A. The efficacy of administering a sweet-tasting solution for reducing the pain related to dental injections in children: A randomized controlled trial. *Int J Paediatr Dent* 2021; 31: 184-90.
 15. Schulz KF, Altman DG, Moher D; CONSORT Group. CONSORT 2010 Statement: updated guidelines for reporting parallel group randomised trials. *BMC Med* 2010; 8: 18.
 16. Khatri A, Kalra N, Tyagi R, Sharma M, Yangdol P, Garg N. Evaluation of pain in children using animated emoji scale: a novel self-reporting pain assessment tool. *Int J Pedod Rehabil* 2021; 6 :20-4.
 17. Piaget J. Piaget's theory of cognitive development. *Childhood cognitive development: The essential readings*. 2000; 2: 33-47
 18. Nuseir K, Kassab M, Al-Azzani M. Sweet solution analgesia. In: *Pain Relief-From Analgesics to Alternative Therapies*. 1st ed. Edited by Maldonado c, INTECH 2017: 301-13.
 19. Slater R, Cornelissen L, Fabrizi L, Patten D, Yoxen J, Worley A, Boyd S, Meek J, Fitzgerald M. Oral sucrose as an analgesic drug for procedural pain in newborn infants: a randomised controlled trial. *Lancet* 2010; 376: 1225-32.
 20. Shiiba SJ, Sakamoto E, Sago T, Furuta H, Yamamoto T, Tada Y, et al. Effect of sweet solutions on pain tolerance threshold in pediatric oral mucosa. *Pediatr Dent J* 2012; 22: 22-6.
 21. Kaufman E, Epstein JB, Naveh E, Gorsky M, Gross A, Cohen G. A survey of pain, pressure, and discomfort induced by commonly used oral local anesthesia injections. *Anesth Prog* 2005; 52: 122-7.
 22. Lewkowski MD, Barr RG, Sherrard A, Lessard J, Harris AR, Young SN. Effects of chewing gum on responses to routine painful procedures in children. *Physiol Behav* 2003; 79: 257-65.
 23. Lee J, Russell CG, Mohebbi M, Keast R. Grating orientation task: a screening tool for determination of oral tactile acuity in children. *Food Qual Prefer* 2022; 95: 104365.
 24. Kostecka M, Kostecka-Jarecka J, Kowal M, Jackowska I. Dietary habits and choices of 4-to-6-year-olds: do children have a preference for sweet taste? *Children* 2021; 8: 774.
 25. Pepino YM, Mennella JA. Sucrose-induced analgesia is related to sweet preferences in children but not adults. *Pain* 2005; 119: 210-8.
 26. Mennella JA, Pepino MY, Lehmann-Castor SM, Yourshaw LM. Sweet preferences and analgesia during childhood: effects of family history of alcoholism and depression. *Addiction* 2010; 105: 666-75.