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The Effect of Non-Pharmacological Pain Management Using Behavioural Intervention on Pain Scale and Oxygen Saturation Among Preschool Children Undergoing Invasive Procedures

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A B S T R A C T

Pain during invasive medical procedures is a major stressor for preschool children and may trigger physiological responses such as oxygen saturation decline due to crying and anxiety. This investigation examines the effect of a behavioral intervention on pain scale scores and oxygen saturation during the intravenous (IV) insertion procedure in preschoolers. This study used a quasi-experimental design with a post-test-only control group. A total of 80 children aged 3–6 years undergoing intravenous insertion at RSI Jemursari Surabaya were selected through purposive sampling and divided equally into intervention and control groups. The research instruments were the FLACC (Face, Legs, Activity, Cry, Consolability) Scale to measure pain and a pulse oximeter to measure oxygen saturation. Data analysis used the Mann–Whitney U Test. The mean pain score in the intervention group (3.44) was significantly lower than in the control group (7.57). Meanwhile, the mean oxygen saturation in the intervention group (98%) was higher than in the control group (94.12%). Statistical analysis showed a significant difference between the two variables (p=0.001). Behavioral intervention is effective in reducing pain and preventing oxygen desaturation during invasive procedures in preschool children. It can be recommended as a non-pharmacological approach in pediatric nursing practice.

INTRODUCTION

Invasive medical procedures are an important part of children's health services, especially in conditions that require immediate management, such as IV insertion. However, in preschoolers, the procedure is often considered a frightening experience and causes significant pain (Tran Thi et al., 2022). Pain in children is different from that in adults, because children are not able to express pain rationally and tend to react emotionally through crying, rejection, and other defensive behaviors (Sayed et al., 2020). This condition makes pain a major stressor that can affect physiological, psychological, and behavioral responses during medical procedures.

Epidemiological data show that pain from invasive procedures is a global clinical problem. In the United States, approximately 60–80% of children who underwent invasive procedures reported experiencing pain of mild to severe intensity (Walco et al., 2017). Research in Canada showed the prevalence of moderate to severe pain in 70% of preschoolers during blood collection or IV insertion (Friedrichsdorf et al., 2020). In Indonesia, based on the Indonesian Basic Health Research in 2018, 39% of children who underwent hospitalization complained of pain. In Surabaya, a prior study found that 45% of children experienced moderate pain, 32.5% mild pain, 10% severe pain, and 12.5% did not experience pain during invasive procedures (Sayed et al., 2020).

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The pain response in children not only affects behavior but also physiological status, including oxygen saturation. Excessive crying, anxiety, and hyperventilation during the procedure increase sympathetic nervous system activity, which can lead to changes in breathing patterns and decreased oxygen saturation (Taddio et al., 2012; Crumm et al., 2020). A study conducted in infants during intramuscular procedures showed a decrease in saturation of 85–91% during invasive procedures, while normal saturation was 91–97% (Camacho-Cruz et al., 2023). The condition suggests that pain is not only a subjective experience but also a bodily response that can affect physiological stability. To address these problems, health workers have a responsibility to implement effective pain management interventions to prevent long-term impacts, both in the form of psychological trauma and maladaptation to future medical procedures (Azak et al., 2022). Non-pharmacological pain management is widely recommended in pediatric nursing practice because it is safe, easy to apply, has no side effects, and can be combined with pharmacological approaches when needed (Tran Thi, 2022). One non-pharmacological method that has proven effective is behavioral intervention, which includes distraction, simple breathing exercises, positive reinforcement, modeling, and parental involvement during the procedure (Salomons et al., 2024).

However, most previous studies focused more on subjective and behavioral pain scales. In contrast, physiological parameters, such as oxygen saturation, had not been widely studied as objective indicators of pain response in preschoolers. In addition, studies combining behavioral interventions with physiological measurements during invasive procedures in preschool populations remained limited, especially in Indonesia. It shows that there was a scientific gap and the need to test non-pharmacological approaches that can address pain holistically from both behavioral and physiological aspects. This investigation examines the effect of a behavioral intervention on pain scale scores and oxygen saturation during the intravenous (IV) insertion procedure in preschoolers. The results of this study are expected to serve as a basis for the application of non-pharmacological interventions in pediatric nursing services, particularly to minimize the risk of trauma, improve children's comfort, and support the practice of Evidence-Based Nursing (EBN).

METHOD

This study used a quasi-experimental design with a post-test-only control group. The study population was preschool-aged children (3–6 years old) who underwent infusion installation at RSI Jemursari Surabaya on July 20–August 04, 2025. Sampling was conducted using purposive sampling, with 80 respondents divided into two groups: 40 children in the intervention group and 40 in the control group. Inclusion criteria include preschoolers who had undergone their first IV placement, were cooperative, were accompanied by their parents, and had no history of neurological, respiratory, or developmental

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disorders. Exclusion criteria included children in emergency conditions or those who refused intervention. The intervention group received behavioral intervention during the IV insertion. The control group underwent a standard procedure without additional intervention. The research instruments were the FLACC (Face, Legs, Activity, Cry, Consolability) Scale to measure pain and a pulse oximeter to measure oxygen saturation. The assessment was carried out as soon as the IV procedure was completed. Data analysis used the Mann–Whitney U Test with $\alpha = 0.05$ because the data were abnormally distributed.

RESULT

Table 1 Characteristics of Preschool Child Respondents

Characteristics Respondents	K1 (Intervention)		K2 (Control)		Total		Equivalence Test
	f	%	f	%	f	%	P
Age							
3 years	18	45	13	32.5	31	38.7	0.688
4 years	5	12.5	6	15	11	13.7	
5 years	7	17.5	10	25	17	21.3	
6 years	10	25	11	27.5	21	26.3	
Gender							
Women	20	50	19	47.5	39	51.2	0.825
Male	20	50	21	52.5	41	48.8	
Total	40	100	40	100	80	100	

Table 1 shows that the characteristics of respondents by age and gender between the intervention and control groups had a balanced distribution. The majority of respondents were 3 years old and female. The results of the equivalence test showed p-values at age ($p = 0.688$) and sex ($p = 0.825$), which means there was no significant difference between the two groups.

Table 2 Characteristics of Respondents of Parents of Preschool Children

Respondent Characteristics	K1 (Intervention)		K2 (Control)		Total		Equivalence Test
	f	%	f	%	f	%	P
Age							
Early adulthood (20-39 years old)	34	92.5	38	95.0	75	93.7	0.671
Mature Mature (40-64 years old)	3	7.5	2	5.0	5	6.3	
Education							
Elementary (Elementary-Junior High)	6	15.0	4	10.0	10	12.5	0.627
Secondary (SMA/SMK)	21	52.5	19	47.5	40	50.0	
High (Diploma-S3)	13	32.5	17	42.5	30	37.8	
Total	40	100	40	100	80	100	

Table 2 shows that most of the respondents are in the early adult age category and have secondary education. The results of the balance test on the variables age ($p = 0.671$) and education ($p = 0.627$)

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showed that there was no significant difference between the intervention and control groups, so the two groups could be considered equal.

Table 3. Distribution of pain scales in both groups

Pain scale	Intervention Groups		Control group	
	(f)	(%)	(f)	(%)
(0-3) Light	24	60	-	-
(4-6) moderate	16	40	12	30
(7-10) Weight	-	-	28	70
Total	40	100	40	100

The table shows the distribution of pain scales in both groups. In the intervention group, most of the respondents were in the category of mild pain (60%), while in the control group the majority of respondents experienced severe pain (70%). This shows that there is a difference in pain levels between the intervention and control groups.

Table 4. Average oxygen saturation

Groups	Red	Median	Mode	SD	Min	Max
Intervention	98.00	98.00	98.00	0.751	96.00	98.00
Controls	94.12	94.00	95.00	0.822	92.00	95.00

Table 4 shows that the average oxygen saturation in the intervention group was higher (Mean = 98%) than in the control group (Mean = 94.12%). The median and mode values also consistently showed that oxygen saturation was more stable in the intervention group. This indicates that the intervention provided has an effect on increasing the oxygen saturation of the respondents.

Table 5. The results of the Mann-Whitney test

	Oxygen Saturation			
Groups	F	Mean Rank	Z-value	Effect size r
Intervention	40	20.65	-7.710	0.93
Controls	40	60.35		
Mann Whitney Test Results				*p = 0.001*

Table 5 shows the results of the Mann-Whitney test which shows a significant difference in oxygen saturation between the intervention and control groups (p = 0.001). The mean rank value in the control group was higher than in the intervention group, with a value of Z = -7,710 and an effect size of 0.93, indicating that the intervention had a strong effect on oxygen saturation.

Table 6. The results of the follow-up statistical test

	Oxygen Saturation			
Groups	F	Mean Rank	*z-value*	*Effect size r*
Intervention	40	60.50	-7.856	0.87
Controls	40	20.50		
Mann Whitney Test Results				*p = 0.001*

Table 6 shows the results of the follow-up statistical test which again reinforces the significant difference between the two groups (p = 0.001). Z values = -7.856 and effect size of 0.87 showed that the intervention had a large effect in improving oxygen saturation compared to the control group.

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DISCUSSION

This investigation showed a significant difference between the intervention and control groups on the pain scale in preschool children who underwent an IV insertion procedure (Table 5). These findings suggest that behavioral intervention is effective in reducing pain intensity and maintaining the child's physiological function during invasive procedures. The pain scale in the intervention group had a lower average score than in the control group (Table 3). It aligns with the concept that preschoolers are at a stage of cognitive and emotional development that makes them more responsive to external stimuli, including distractions and emotional support (Sayed et al., 2020). Verbal distractions, breathing exercises, and positive reinforcement have been proven to reduce children's focus on the source of pain, thereby reducing pain perception. Tran Thi (2022) state that behavioral interventions can inhibit pain stimuli through cognitive control mechanisms, thereby reducing pain perception. In addition, this investigation aligns with the study by Salomons et al. (2024) which showed that behavioral approaches were effective in reducing pain responses through cognitive and operant mechanisms that promote adaptive coping patterns. Modeling coping and emotional drive contributes to the formation of positive experiences with medical procedures. Thus, this paper reinforces previous research's findings that non-pharmacological management is a safe, effective, and widely applicable strategy in pediatric clinical practice.

In addition, this study found a significant difference in oxygen saturation between the intervention and control groups among preschool children who underwent an IV insertion procedure (Table 6). The intervention group had an average oxygen saturation of 98%, higher than the control group's 94.12% (Table 4). Decreased oxygen saturation in the control group may occur as a physiological response to anxiety, excessive crying, and tension during invasive procedures (Crumm et al., 2020). This mechanism involves activation of the sympathetic nervous system by pain stimuli, which affects breathing patterns and the body's oxygen balance. It is in line with the research of Camacho-Cruz et al. (2023), who found that invasive procedures in neonates could lead to decreased oxygen saturation and other physiological changes due to stress and pain response. Behavioral interventions help maintain physiological stability by promoting relaxation and emotional support, thereby reducing anxiety and attenuating the hyperresponse of the neuroendocrine system. Parental presence during the procedure also plays an important role in increasing the child's sense of security and strengthening the child's coping response, as Bindler et al. (2020) affirm that family presence supports stable emotional regulation during medical procedures. It suggests that a combination of behavioral techniques and emotional support has a synergistic effect in reducing excessive physiological responses, including decreases in oxygen saturation. Overall, the

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findings of this study contribute to pediatric nursing practice by demonstrating that behavioral intervention is a non-pharmacological approach that is easy to implement, does not require specialized equipment, and can improve children's comfort during treatment. In addition to being physiologically and psychologically effective, these interventions also encourage the adoption of family-centered care and evidence-based practice, which are important components of modern nursing services.

CONCLUSION

Behavioral intervention is effective in reducing pain and preventing oxygen desaturation during invasive procedures in preschool children. It can be recommended as one of the non-pharmacological strategies in pediatric nursing practice to improve comfort, reduce stress response, and minimize the physiological impact of invasive procedures.

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