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The effect of facilitated tucking and white noise on stress and sleep of newborns receiving nasal continuous positive airway pressure

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ABSTRACT

Objective: To investigate the effects of facilitated tucking and white noise on stress and sleep in neonates receiving nasal continuous positive airway pressure (CPAP).
Method: This study was conducted as a randomised controlled experimental study of neonates receiving nasal CPAP in neonatal intensive care units. The study sample consisted of 108 newborns (facilitated tucking ($n = 36$), white noise ($n = 36$) and control ($n = 36$)) receiving nasal CPAP support in the NICU. The neonates' sleep parameters were recorded by actigraphy for 24 h. Data were collected using the Neonatal Descriptive Information Form, the Sleep Tracking Form and the Neonatal Stress Scale. Percentage, mean, chi-squared and one-way ANOVA were used for data analysis.
Results: It was found that 50.9% of the newborns were female, their mean gestational age was 33.54 ± 3.38, their mean height was 43.56 ± 5.12, and their mean weight was 2139.23 ± 827.82. The total sleep time of the neonates in the facilitated tucking and white noise group increased by 3 h, their sleep efficiency increased by 20% and their mean stress scores decreased ($p < 0.05$).
Conclusion: Facilitated tucking and white noise each showed a similar improvement in sleep duration and sleep efficiency and a reduction in stress scores in neonates receiving nasal CPAP. Close monitoring of sleep in this population and supportive care practices are recommended.
Practice implications: The findings of this study may help to reduce sleep problems and stress levels in the clinical care of neonates in the NICU through developmental nursing practices.

Introduction

Sleep is very important for human life and involves both physiological and mental processes during development (Huang et al., 2014). However, sleep habits such as sleep duration and daytime sleep may vary depending on the age of the child (Gündüz, 2015; Yılmaz Kurt et al., 2018). During the neonatal period, sleep can directly affect the development of the central nervous system neurosensory system, energy conservation, increased protein synthesis, growth, and development (Collins et al., 2015; Geib, 2007; Küçük, 2015). In addition, sleep-wake cycles must mature during the neonatal period for neurosensory and cortical development in newborns (Collins et al., 2015; Weisman et al., 2011). However, many individual (e.g., prematurity, gender) and environmental (e.g., light, noise, touch) factors can affect babies' sleep-wake cycles during this period (Foreman et al., 2008; Nunes & da Costa, 2010; Scher et al., 2011).

The neonatal intensive care unit (NICU) is an environment in which many invasive interventions are applied to diagnose, treat, and care for newborns, and in addition to being noisy and excessively bright, it interrupts the neonatal growth and development process (Bazregari et al., 2019; Correia & Lourenço, 2020; Pugliesi et al., 2018). These interventions can cause pain and stress in newborns, as well as changes in breathing and heart rate, crying, restlessness, moaning, and sleep problems (Ceylan & Bolışık, 2017a). Similarly, nasal continuous positive airway pressure (nCPAP) is widely used both as a primary treatment and as a method of respiratory support after extubation in neonates admitted to NICUs (Çakıcı & Mutlu, 2020). However, nCPAP may cause hyperemia and necrosis of the nasal mucosa and injury to the forehead and face, which may affect the newborn's sleep and cause pain (Dewez et al., 2018; Tiryaki & Çınar, 2016). In this context, nurses caring for newborns in the NICU need to provide developmental care to minimise stimuli, support their growth and development, and improve their sleep quality.

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It has been reported in the literature that nurses in the field use pharmacological and non-pharmacological practices to accelerate the infant's healing process, reduce pain, stress levels and oxygen requirements, and ensure sleep patterns, comfort and immobilisation (Arslan, 2015; Düken & Yayan, 2023; Modesto et al., 2016; van den Hoogen et al., 2017). Facilitated tucking and white noise applications are commonly used by nurses in their neonatal care practices. Studies have shown that facilitated tucking activates newborns' regulatory systems by providing heat and tactile stimulation, blocks painful stimuli and reduces pain, stabilises babies' physiological parameters, and supports their motor development and energy conservation (Avcin & Küçükoğlu, 2021; Gomes Neto et al., 2020; Perroteau et al., 2018). Similarly, the use of white noise has been found to reduce behavioural stress in babies, such as crying and fussing, increase oxygen saturation, and reduce heart rate and pain (Cetinkaya et al., 2022; Kahraman et al., 2020). However, no studies have assessed stress and sleep in neonates receiving nCPAP support. Despite the recognised importance of sleep for neonatal development, particularly in the NICU setting, there is a gap in the literature regarding the assessment of stress and sleep in neonates receiving nCPAP support. In addition, although there are a limited number of studies evaluating the sleep of neonates in the NICU, no study has evaluated the sleep of these infants using a full-time quantitative measurement tool. This heterogeneous distribution of studies is due to the use of different sleep assessment tools, sample selection and examination of sleep behaviour (van den Hoogen et al., 2017). Nurses who are primarily responsible for neonates in NICUs can support neonates with care practices to reduce their stress levels and to achieve and maintain a deep and peaceful sleep state. In this context, the aim is to implement non-pharmacological applications to reduce stress and improve sleep quality in neonates on nasal CPAP in clinical settings. As part of this aim, it is assumed that the development of babies on CPAP will be supported. In this context, the study was conducted to investigate the effects of facilitated tucking and white noise, which are among the individualised supportive care practices often favoured by nurses in clinical practice, on the stress and sleep of neonates receiving nCPAP support.

Research hypotheses

H1: Facilitated tucking and white noise would be effective on sleep duration, sleep efficiency, number of arousals during sleep, wake time, and stress in neonates receiving nCPAP.

H2: Facilitated tucking would be more effective than white noise on sleep duration, sleep efficiency, number of awakenings during sleep, waking time, and stress in newborns receiving nCPAP support.

Material-method

Design

This study was conducted as a randomised controlled experimental study between November 2021 and February 2022. Institutional approval was obtained from the hospital where the study was conducted, and ethics committee approval was obtained from the Clinical Research and Publication Ethics Committee. The trial was registered in the ClinicalTrials.gov Protocol Registration Data Element Definitions for Interventional and Observational Studies database under the identifier NCT05064683 (22 September 2021). The registry name is "The Effect of Facilitated Tucking and White Noise on Stress and Sleep of Newborns Receiving Nasal CPAP".

Participants and setting

This study was conducted in neonates receiving nCPAP support in the neonatal intensive care units (NICUs) of a university hospital. There are three levels of NICUs in the hospital where the research was conducted. The study was conducted in the first and second level NICUs. Newborns in the at-risk group who have respiratory distress and need mechanical ventilation or continuous positive airway pressure (CPAP) are followed in the first and second level NICUs.

In the NICU, doctors decide whether newborns receive nCPAP support based on the newborns' clinical symptoms (tachypnea, withdrawal, moaning, etc.) and laboratory results (blood gas results, etc.). Care is taken to select the appropriate cannula for neonates to receive nCPAP support. The required device sets are assembled and the necessary materials (i.e., cap, fixation) are prepared by the primary neonatal care nurse. The ventilator is adjusted to the newborn's weight, gestational age and lung capacity. The neonate is positioned appropriately by securing the nasal cannula. The neonate is monitored and observed.

Inclusion criteria for sampling

- Neonates ≥26 weeks' gestation receiving nCPAP support,
- Newborns with a birth weight of 1500 g and above,
- Newborns with no health problems that would prevent positioning,
- Newborns without congenital anomalies (e.g., heart defects, neural tube defects, Down syndrome and other chromosomal defects, diaphragmatic hernia),
- Newborns without hearing loss.

Exclusion criteria for sampling

- Newborns undergoing surgery for any health problem,
- Newborns with other diagnoses (hyperbilirubinaemia, hypoglycaemia, etc.) with NCPAP support.
- Attempting to give painful stimulation to babies within 24 h of enrolment in the study,
- Providing babies with care other than their routine care,
- Babies with interruptions in their sleep reports (actigraph) were excluded from our study.

Sample size

The study population consisted of neonates receiving nCPAP support in the neonatal intensive care unit of a university hospital. From this population, neonates who met the study criteria formed the study sample. The sample size was calculated using G*Power 3.1.9.4. In the calculation, taking into account the effect size ($d = 0.46$), 5% margin of error ($\alpha = 0.05$) and 99% power ($1\text{-}\beta = 0.99$) for the three groups (experimental 1, experimental 2, control) and the ANOVA test, the sample size was determined to be 35 for each group. Considering that there could be a loss of data, it was decided to include 36 newborns in each group. The study by Peng et al. was used as the basis for calculating the sample size in the study (Peng et al., 2018).

It is planned that among the recorded practices, situations that disrupt babies' sleep will be excluded from the samples. However, no babies were excluded because of this condition. In the study, 120 newborns were assessed according to the inclusion criteria. However, the parents of 7 newborns refused to participate in the study, 5 newborns did not meet the inclusion criteria, and 12 newborns were excluded from the study during enrolment. Thus, the study was completed with 108 newborns. Inclusion, exclusion and withdrawal from the study are shown in Fig. 1.

Randomisation

Stratification and block randomisation methods were used to assign participants to the control and experimental groups. Block randomisation was performed by stratifying neonates according to gestational week (26–30, 31–35, 36–40), sex (female and male) and

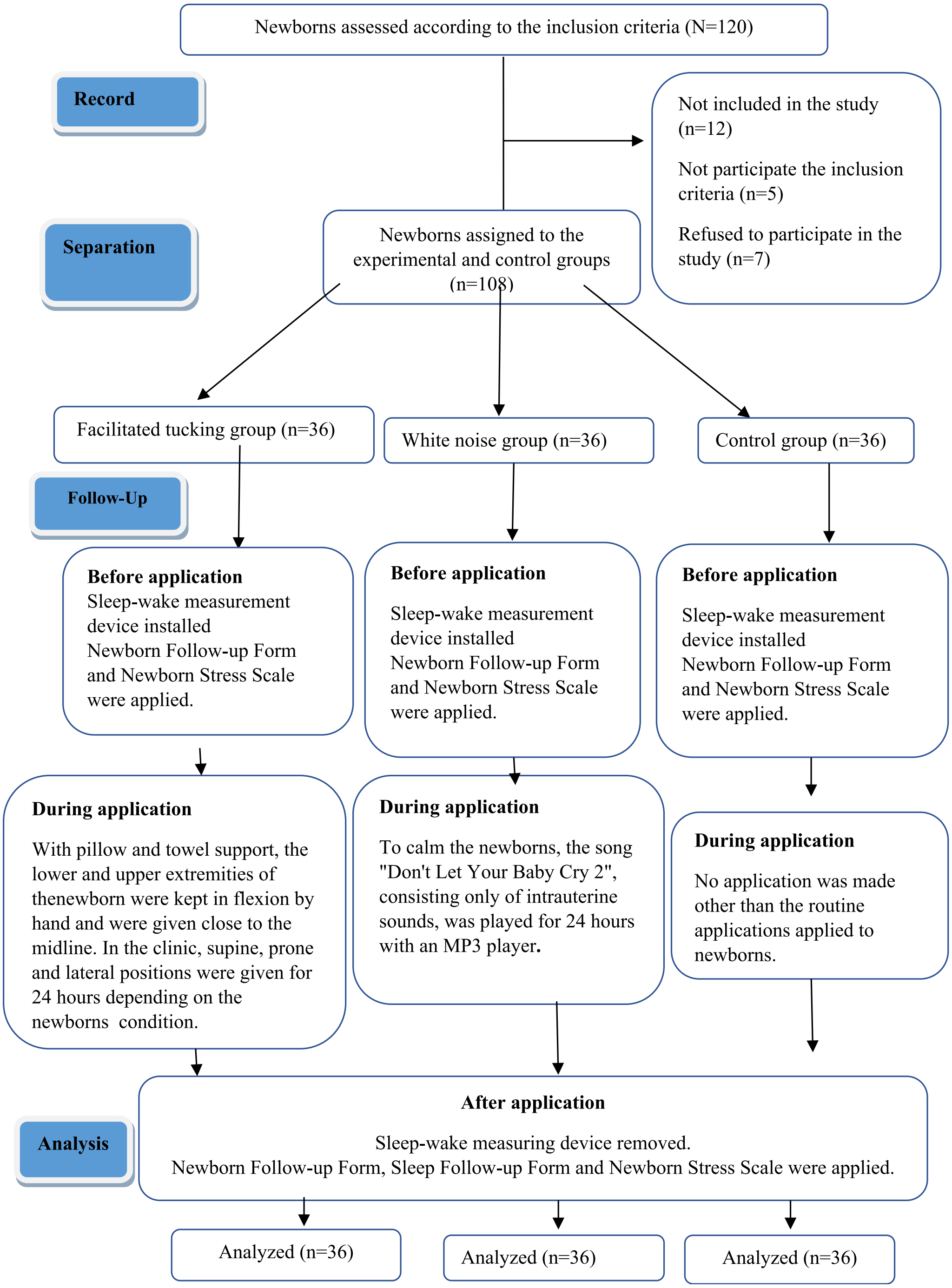

Fig. 1. CONSORT flow diagram of randomised controlled trial.

weight (<1500, 1500–2500, >2500). Thirty-six neonates were included in each group by ensuring that the strata formed according to the specified variables were repeated twice (2X3X3X2). To avoid bias in the babies who underwent stratification, lots were drawn using the trial's randomiser website. The babies were randomly assigned to each group. This equalised the likelihood of each newborn in the study being in either the intervention or control group. As the first author of the study was involved in the data collection, he was not included in the data analysis. In this way, blinding was attempted. The trial followed the recommended intention-to-treat (ITT) analysis to maintain the effect of randomisation and to avoid attrition bias.

Data collection instruments

Data were collected using the neonatal follow-up form, the sleep follow-up form and the neonatal stress scale. An actigraph, an MP3 player, and a sound decibel meter were also used.

Newborn follow-up form

This form, prepared by the researchers, included information such as the newborn's last name, height, weight, diagnosis, sex, gestational age, mode of delivery of the mother, day of hospitalization, and presence of comorbid conditions.

Sleep follow-up form

This form included information on the neonate's sleep and total sleep time over 3-h periods, sleep efficiency, and wake times and numbers during sleep. Sleep efficiency: This is defined as the quality of sleep in which the babies' sleep is uninterrupted throughout their 24-h sleep period.

Newborn stress scale (NSS)

The NSS, developed by Ceylan and Bolışık, is a 3-point Likert scale consisting of 24 items. The scale items include eight subgroups, facial expression, body colour, respiration, activity level, calmness, muscle tone, extremities and posture, and each subgroup is scored between 0 and 2. The minimum possible score on the scale is 0 and the maximum possible score is 16. The stress level of the newborn increases as the score increases (Ceylan & Bolışık, 2017b).

Actigraph device

Actigraphs (Actiwatch-2) are non-invasive devices that can be worn on the wrists or ankles of newborns to measure their long-term sleep and wake states. The Actiwatch-2 measures 43 mm × 23 mm × 10 mm and weighs 16 g with the armband. It has a stand for charging and data transfer. The cradle has a USB port and can be charged with a charger. The internal memory of the device is 1 Mbit and runs on Windows 2000, Windows XP or Windows Vista; Windows XP Pro, Windows Vista Business or Vista Ultimate operating systems. It has been reported in the literature that Actiwatch-2 can be safely used in paediatric research (Meltzer, Montgomery-Downs, Insana, & Walsh, 2012). In addition, the validity and reliability of Actiwatch-2 has been investigated in neonates and shown to be reliable and valid for use in neonates (Unno et al., 2022). In this study, actigraphy was used to examine the parameters of sleep and total sleep, sleep efficiency, wake times and number of awakenings during sleep in 3-h periods in newborns. The actigraphy devices were attached to the newborns' legs to keep them stable. The recordings from the actigraphy device were transferred to the computer environment using software. The sleep/wake data collected by the researcher were analysed (Philips., 2022).

MP3 player

A portable digital device was used to allow neonates to listen to white noise.

Sound decibel meter

The decibel meter was used to determine the volume of the white noise presentation. The ambient sound level was maintained at 45–55 dB (Balcı et al., 2021; Gomes et al., 2019).

Procedures and interventions

After obtaining institutional and ethical approval for the study, the purpose of the study and the procedures were first explained in detail to the families of the newborns by the researcher in the NICU between November 2021 and February 2022, and informed consent was obtained. To ensure the continuity of the study interventions, a training programme on the interventions to be carried out was organised for the nurses providing primary care to the newborns. The clinic where the research was conducted had routine treatment, care and feeding hours. Therefore, the routine practices during the day (e.g. treatment, care, feeding, nappy changing) were recorded in the observation files to determine the factors that might affect the sleep and stress of the newborns. It was found that the routine care given to the babies and its duration were similar. For each group (experimental group (facilitated sleeping position, white noise), control group), the interventions and the use of the actigraphy device on the babies started at 09:00 and ended at 09:00 after 24 h. In the study, each application and measurement was performed by the same researcher. The researcher who carried out the applications and measurements has clinical experience in neonatal intensive care and neonatal studies.

Facilitated tucking position

- ✓ Before starting the use of the facilitated tucking position, parents of neonates receiving nCPAP support were interviewed and informed about the intervention to be used on the newborn and the sleep-wake monitor.
- ✓ Nurses providing primary care to neonates in the NICU were trained in the facilitated tucking position.
- ✓ Information about the newborns in the facilitated tucking group (e.g., newborn sex, gestational week, mode of delivery) was obtained from the newborn records and recorded on the Newborn Descriptive Information Form.
- ✓ Stress scores of neonates receiving nasal CPAP support were assessed by the researchers using the NSS prior to the facilitated tucking intervention.
- ✓ Actigraphy devices were applied to each neonate at the same time (09:00) and left in place for 24 h.
- ✓ The researcher and primary care nurses washed their hands before the intervention to ensure that their hands were warm, and then the babies were placed in the facilitated tucking position.
- ✓ The facilitated tucking position was achieved by the researcher and primary care nurses using a towel support and the NICU towel by holding the newborn's lower and upper extremities flexed with one hand and close to the midline.
- ✓ The facilitated tucking position was applied to each newborn at the same time (09:00) and the positions given to the babies were followed. Scheduling was done according to the babies' feeding and care times. In order to minimise interruptions, position change times were timed to coincide with feeding times. After routine care of the babies, the positions of the babies at that time were given, the positions of the babies were maintained with towels in the incubator, and they were monitored.
- ✓ At the end of 24 h of facilitated repositioning, the actigraphy devices were removed and the neonates' sleep parameters were recorded on a computer using the Sleep Follow-up Form.
- ✓ At the end of the 24-h period, the researcher assessed the neonates' stress levels using the neonates' NSS scores.

White noise

- ✓ Prior to starting white noise, parents of neonates receiving nCPAP were interviewed and informed about the intervention to be used on the newborn and the sleep-wake monitor.
- ✓ Nurses providing primary care to neonates in the NICUs were trained in white noise.
- ✓ Information about the newborns in the white noise group (e.g. sex of the newborn, gestational age, mode of delivery) was obtained from the newborn records and recorded on the Newborn Descriptive Information Form.
- ✓ Stress scores of neonates receiving nasal CPAP support were assessed by the researchers using the NSS prior to the white noise intervention.
- ✓ Actigraphy devices were placed on each neonate at the same time (09:00) and left in place for 24 h.
- ✓ In the study, the song “Don't let your newborn cry-2” from Orhan OSMAN's album “Kolik”, which has been used in previous neonatal studies to calm newborns, was played as white noise on an MP3 player.
- ✓ The researcher washed his hands before the intervention, making sure that his hands were warm, and then started the white noise.
- ✓ The MP3 incubators were placed 30 cm away from the newborns.
- ✓ The sound level inside the incubator was measured with a decibel meter, ensuring that the level did not exceed 50 dB.
- ✓ Neonates were exposed to white noise for 24 h.

- ✓ At the end of the 24 h of white noise exposure, the actigraphy devices were removed and the neonates' sleep parameters were recorded on a computer using the Sleep Follow-up Form.
- ✓ At the end of the 24-h period, the researcher assessed the neonates' stress levels using the neonates' NSS scores.

Control group

The steps taken by the mothers who met the inclusion criteria and were included in the control group are detailed below:

- ✓ Preliminary interviews were held with the parents of children receiving nCPAP support in the control group to inform them about the study and the sleep-wake monitor.
- ✓ Nurses providing primary neonatal care in the NICUs were trained about the study.
- ✓ Information about the newborns in the control group (e.g. sex of the newborn, gestational age, mode of delivery) was obtained from the newborn records and recorded on the Newborn Descriptive Information Form.
- ✓ The stress scores of the neonates receiving nCPAP support were assessed by the researchers using the NSS.
- ✓ Researchers washed their hands and made sure they were warm before applying the actigraphy device.
- ✓ Actigraphy devices (09:00 am) were attached to the newborns' legs and they were kept in step for 24 h.
- ✓ After 24 h, the actigraphy devices were removed and the newborns' sleep parameters were recorded on a computer environment using the Sleep Follow-up Form.
- ✓ Newborn stress levels were assessed by the researcher using the NSS.

Ethical considerations

The study was approved by Inonu University Health Sciences Non-invasive Clinical Research and Publication Ethics Committee (2020/1187). Institutional approval for data collection was obtained from Turgut Ozal Medical Center, Department of Child Health and Diseases (E-68636013-770-142,335). Informed consent was obtained from the families of the newborns by explaining the purpose of the study and the practices in detail before the study, and then the babies of the families who volunteered to participate in the study were included in the study.

Statistical analysis

IBM SPSS statistics were used to evaluate the data obtained during the study, and the data were interpreted by the researcher. The Shapiro-Wilks test was used to determine whether the research data were normally distributed. Descriptive statistics, variance analysis tests and post hoc Tukey analysis were used to evaluate statistical data. Analysis of variance (ANOVA) and chi-squared tests were used to show similarities between groups. Research data were evaluated as p˂0.05 with a 95% confidence interval.

Results

It was found that the socio-demographic characteristics, sex, medical history, height, weight and gestational age of the neonates in the study were similar (Table 1).The mode of delivery for all the neonates included in the present study was caesarean section.

When the sleep parameters of the neonates were examined in relation to the experimental and control groups, a significant difference was found between the sleep times, total sleep time and mean sleep efficiency scores between 15:00 and 18:00, 18:00 and 21:00, 21:00 and 24:00 and 09:00 and 12:00 (Table 2). In the advanced analysis performed to determine which group was the source of the difference, a difference was found between facilitated tucking and the control group for sleep duration and total sleep duration between 15:00 and 18:00 and 18:00 and 21:00, between the white noise and control groups for sleep duration between 09:00 and 12:00, and between all groups for sleep duration and sleep efficiency between 21:00 and 24:00 (p˂0.05).

When the mean stress scores of the neonates in the experimental and control groups were examined, it was found that the neonates in the white noise group had a mean pre-test stress scale score of 8.722 ± 0.741 and a mean post-test stress scale score of 7.333 ± 1.242. 242; the neonates in the facilitated tucking group had a mean pre-test stress scale score of 8.972 ± 0.774 and a mean post-test stress scale score of 6.888 ± 0.979; the neonates in the control group had a mean pre-test stress scale score of 8.527 ± 1.403 and a mean post-test stress scale score of 8.527 ± 0.1.424. A significant difference ($p < 0.001$) was found between the groups in the mean post-test scale scores (Table 3). In the advanced Tukey analysis performed to determine from which group(s) the significance resulted in the neonatal stress score, it was found that the difference resulted from the control group and the stress scores of the neonates in the facilitated tucking group, which decreased more than the neonates in the white noise and control groups (p˂0.05).

Discussion

For various reasons, newborns are separated from the dark, quiet, calm and warm womb and admitted to noisy intensive care units with intense light. This can negatively affect the sleep-wake level, which supports the development of the neurosensory system, in addition to causing intense stress in newborns (Arpacı & Altay, 2017; Küçük, 2015). For this reason, it is very important to assess the sleep-wake state and stress levels of newborns.

In this study, the sleep parameters of newborns receiving nCPAP support were evaluated over a 3-h period. The results showed that the time when newborns slept the most was between 03:00 and 06:00, and the time when they slept the least was between 12:00 and 15:00 and 15:00 and 18:00. In addition, although there was no statistical significance between the groups at some times, the facilitated tucking and white noise groups were found to sleep longer than the control group at all times. This was one of the notable findings of the study. In the related literature, Lan et al. showed that hospitalised neonates had shorter daytime sleep than nighttime sleep (Lan et al., 2019). However, there are no studies in the literature that have evaluated sleep parameters in newborns receiving nCPAP support or over a similar time period to the study. The study is the first to evaluate neonatal sleep duration and sleep efficiency over 24 h, and to demonstrate that neonates in the ICU experience sleep problems. The study also analysed 3-h sleep-wake cycles to provide more detailed data on babies' sleep parameters

Table 1
Distribution of newborns' socio-demographic characteristics.

		White noise		Facilitated tucking		Control		
		n	%	n	%	n	%	
Sex	Female	17	47.2	19	52.8	19	52.8	**$p = 0.862$**
	Male	19	52.8	17	47.2	17	47.2	
Disease history	Prematurity	7	19.4	6	16.7	7	19.4	**$p = 0.860$**
	Low birth weight	8	22.3	9	25	9	25	**$p = 0.866$**
	Respiratory distress	21	58.3	21	58.3	20	55.6	**$p = 0.875$**
(Mean ± SD)								
Height		44.95 ± 4.45		43.30 ± 5.27		42.41 ± 5.15		**$p = 0.769$**
Weight		2488.30 ± 792.94		1962.58 ± 783.58		1966.80 ± 815.03		**$p = 0.486$**
Gestational ages		35.0 ± 2.65		32.80 ± 3.26		32.83 ± 3.75		**$p = 0.256$**

Table 2
Actigraphy sleep parameters of newborns in the experimental and control groups.

	White Noise	Facilitated tucking	Control	F/p
Sleep time between 15:00–18:00	0.569 ± 0.821	0.751 ± 0.807	**0.261 ± 0.509	*F = 4.171 **p = 0.018**
Sleep time between 18:00–21:00	1.256 ± 1.07	1.583 ± 0.731	**0.782 ± 1.026	*F = 6.401 **p = 0.002**
Sleep time between 21:00–24:00	1.750 ± 1.204	1.722 ± 0.778	**0.972 ± 1.158	*F = 6.188 **p = 0.003**
Sleep time between 24:00–03:00	0.960 ± 0.997	1.194 ± 0.668	1.0477 ± 0.982	*F = 0.628 p = 0.536
Sleep time between 03:00–06:00	2.318 ± 0.795	2.177 ± 0.595	2.105 ± 1.077	*F = 0.590 p = 0.556
Sleep time between 06:00–09:00	1.527 ± 1.275	1.679 ± 0.746	1.147 ± 1.236	*F = 2.188 p = 0.117
Sleep time between 09:00–12:00	1.326 ± 0.981	1.140 ± 0.929	**0.651 ± 1.045	*F = 4.484 **p = 0.014**
Sleep time between 12:00–15:00	0.597 ± 0.780	0.697 ± 0.787	0.391 ± 0.677	*F = 1.557 p = 0.216
Sleep efficiency (%)	60.190 ± 25.973	62.629 ± 16.211	**40.980 ± 28.914	*F = 8.563 **p < 0.001**
Waking times during sleep (minutes)	66.958 ± 55.267	72.263 ± 49.124	79.291 ± 81.919	*F = 0.339 p = 0.713
Number of awakenings during sleep	43.722 ± 30.497	51.888 ± 36.497	63.500 ± 71.737	*F = 1.140 p = 0.242
Total sleep time (hours)	10.313 ± 6.292	10.696 ± 5.171	**7.356 ± 5.628	*F = 4.009 **p = 0.021**

* ANOVA.
** Tukey.

over a 24-h period. Doctors in NICUs need to be aware of this situation and monitor the sleep of newborns through various studies. In addition, the study measured the sleep parameters of newborns receiving nCPAP using actigraphy and the results were quantitative, which is the strength of the study and the results are important in evaluating the sleep of newborns receiving CPAP support. The reason why the babies in the study slept less between 12:00 and 15:00 and 15:00 and 18:00 may be because the clinic routines coincide with the processes and daytime activity of the clinic. For this reason, different interventions may be needed for neonates' daytime sleep periods, such as shortening the duration of clinical routines or dividing them into intervals.

The role of neonatal intensive care is to use developmental care practices to meet the individual needs of newborns in accordance with evidence-based practices (Kılıç Başkan et al., 2013). It is known that facilitated tucking and white noise interventions are frequently used by nurses in clinical care. It has been reported in the literature that facilitated tucking calms newborns, makes them feel safe, stabilises physiological parameters, reduces pain and crying time during invasive procedures, and enables body control (Avcin & Küçükoğlu, 2021; Çantaş Ayar et al., 2023; Hill et al., 2005; Obeidat et al., 2009; Oliveira et al., 2015).

Various studies have shown that facilitated tucking has a positive effect on sleep and stress levels in newborns (Axelin et al., 2006; Valizadeh et al., 2016). In a review of the literature, Valizadeh et al. found that in a study of 32 preterm infants at 33–36 weeks' gestation, newborns who received facilitated tucking and lateral positioning had longer sleep durations and less waking and crying(Valizadeh et al., 2016). Hill et al. found that facilitated tucking during routine care reduced stress in preterm infants (Hill et al., 2005). Özdemir and Küçük found that facilitated tucking provided physiological stability, comfort and reduced stress in late preterm infants after vaginal delivery (Özdemir & Küçük, 2023).

Similarly, white noise has been found to have a calming effect on newborns because it is similar to the sounds in the uterus, it makes newborns feel safe, it can be effective in facilitating their transition to sleep, improving their sleep quality, and reducing pain and stress in newborns (Akça, 2014; Cetinkaya et al., 2022; Corna et al., 2014; Karakoç & Türker, 2014; Riedy et al., 2021; Ross & Balasubramaniam, 2015; Sezici & Yigit, 2018).

Sezici and Yiğit found that white noise decreased crying time and increased sleep time (Sezici & Yigit, 2018). Butt found that music therapy during heel blood sampling decreased stress behaviour in preterm infants (Butt & Kisilevsky, 2000). Zhang and He reported that the auditory combination of the mother's heartbeat and white noise in preterm neonates may support neonatal development (Zhang & He, 2023).

Similar to the literature, the study found that facilitated tucking and white noise increased total sleep time and sleep efficiency in newborns, decreased wake time, number of arousals during sleep, and stress levels, and that facilitated tucking had a more positive effect on these parameters than white noise. However, studies of facilitated tucking and white noise have generally used sleep measures based on neonatal behavioural responses and scores on scales to assess sleep. In the present study, for the first time, sleep parameters were recorded in the sleep programme using a quantitative measurement tool, independently of the researchers, and objective results were obtained. The results showed that white noise and facilitated tucking could be used in the neonatal intensive care unit to improve sleep parameters and reduce stress in neonates. It can be said that healthcare professionals working

Table 3
Average stress scores of newborns in the experimental and control groups.

	White noise	Facilitated tucking	Control	F/p
Pre-test stress scale mean score	8.722 ± 0.741	8.972 ± 0.774	8.527 ± 1.403	*F = 1.719 p = 0.184
Post-test stress scale mean score	7.333 ± 1.242	6.888 ± 0.979	**8.527 ± 0.1.424	*F = 17.129 **p < 0.001**

* ANOVA.
** Tukey.

in NICUs can reduce the stress levels of newborns and support them to reach and maintain deep sleep using non-pharmacological care practices.

Practice implications

The study results show that approaches to reduce sleep problems and stress in babies should be implemented in NICUs. In this regard, it is important to support approaches to developmental care practices such as fetal positioning and white noise in NICUs and to make arrangements for their use in clinics.

Limitations

The first limitation of this study is that it was conducted in a single centre NICU. Another limitation is that studies with larger sample groups are needed to generalise the beneficial effects of facilitated tucking and white noise on neonatal sleep and stress.

Conclusions

This study found that facilitated tucking and white noise increased sleep efficiency and total sleep time in neonates receiving nCPAP, and decreased wake times and number of awakenings during sleep and neonatal stress levels. The study also showed that neonates in intensive care units experience sleep problems. It is important to identify factors that affect the sleep of neonates in NICUs and to monitor their sleep. To this end, it is recommended that training in the use of facilitated tucking and white noise in clinical care in NICUs be provided, and that studies of different non-pharmacological methods be conducted.

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Yeliz Suna Dağ: Writing – review & editing, Writing – original draft, Supervision, Software, Resources, Methodology, Funding acquisition, Data curation. **Emriye Hilal Yayan:** Project administration, Methodology, Funding acquisition, Formal analysis, Data curation.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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