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Original Article

Effect of Earplugs and Eye Cover on Physiological and Behavioral Responses among Preterm Infants in Neonatal Intensive Care Unit

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ABSTRACT

Background: Preterm infants may be harmed by excessive light and crowding during the busiest time in the NICU, which can have detrimental short-term impacts on the circulatory and respiratory systems as well as the motor and behavioral responses. Preterm infants' physiological and behavioral conditions are improved by using earplugs and eye shields to shield them from noise and bright light. . **Aim**: Evaluate the effect of earplugs and eye cover on physiological and behavioral responses among preterm infants admitted in NICU. **Method**: A quasi-experimental design was utilized on the current study. Purposive sample of 120 preterm infants who admitted to neonatal intensive care unit at Minia University Hospital for Obstetric and Pediatrics (MUHOP) and Misr El-Hora general hospital. **Tools**: A structured interview questionnaire sheet included preterm infant data, physiological responses tool and behavioral response tool was measured by using Anderson Behavioral State Scoring System (ABSS) were utilized for data collection. **Results**: There was a highly statistically significant difference in preterm infants during and after 5minuts using earplugs and eye covers regarding the mean change of physiological and behavioral responses. **Conclusion:** Using of earplugs and eye covers during crowded and excessive light environment in the busiest time of the NICU was effective to decrease physiological and behavioral responses among preterms' infants. **Recommendation**: Repeated the study on a larger participant to evaluate the long-term outcomes of using earplugs and eye covers on the physiological and behavioral states of newborn infants.

Keywords: behavioural responses, earplugs, eye covers, physiological responses.

Introduction

The American Academy of Pediatrics (AAP) advises against noise levels more than 45 dBA in the neonatal intensive care unit (NICU), although numerous studies have shown that these limits are frequently exceeded. Previous research examining the effects of loud NICU noises on preterm newborns revealed detrimental short-term

changes in blood pressure, oxygen saturation, respiratory and heart rates. Preterm newborns are not largely shielded from outside noise within the incubators, where noise levels vary from 58 to 75 dbA **(Parra et al., 2017).**

The sound levels in the NICU are raised by equipment noise, alarms, and talks. The NICU may occasionally be as noisy as the neighborhood. Studies have indicated that lowering the noise level in the NICU through measures such gently closing the incubator portholes, banning radios, and minimizing strong light had a good impact on physiology and behavior **(Santos et al., 2017).**

During their stay in the NICU, preterm infants are continuously exposed to loud noises such as alarm, ventilator, and phone noises **(Almadhoob & Ohlsson, 2015).** Additionally, the level of high intensity lighting they are exposed to causes stress-related **(Zores et al., 2015).**

The neonate's cardiovascular, respiratory, auditory, and neurological systems may be impacted by noise pollution in the NICU. Both an acute consequence that distresses the child and a long-lasting effect on overall development may result from this. High sound pressure levels have been shown to negatively affect infants, as seen by increased heart rate and oxygen consumption **(Cardoso et al., 2015).**

Research has shown that the neonate's cardiovascular, respiratory, auditory, and neurological systems can be adversely affected by noise pollution in the NICU. Both an acute consequence that distresses the child and a long-lasting effect on overall development may result from this. It is crucial for nurses to have evidence-based practice guidelines since they play a critical role in monitoring and maintaining the stability of the babies. These guidelines will show them how to protect the neonate from environmental stressors like noise **(Khalesi et al., 2017).**

The infant's ability to see, metabolic stability, and central nervous system organization are all directly impacted by ambient light. According to reports, the visual environment in NICUs alters visual attention perception, visual memory, and visual identity in addition to reducing visual activity **(Alemdar, 2018)**.

Due to their relatively fragile eyelids, preterm infants may not be able to keep their eyes closed for lengthy periods of time, allowing light to slip through. Additionally, because to their discomfort, they could be unable to communicate. Infants with serious illnesses who were exposed to high levels of light experienced higher levels of stress. One of the environmental elements that contributes to stress and affects stress coping mechanisms is bright light (**Susilaningsih et al., 2019).**

Neonatal care should be provided under cycled lighting settings, according to the American Academy of Pediatrics and the American College of Obstetricians & Gynecologists. Physical and emotional stability may be ensured through treatment techniques to lessen newborn infants' stress in the neonatal intensive care unit by reducing ambient light levels **(Altimier & Phillip, 2018).**

Preterm newborns' exposure to NICU light and noise is said to enhance physiological stability, even if data suggests that limiting ambient sensory

stimulation may reduce their pain response and prevent long-term sequelae related with pain **(Aita et al., 2015).**

By extending a warm welcome to the family and providing tailored care, nurses play a crucial part in achieving humanized care for high-risk infants. This supports the growth of the neonate as well as the comfort and adjustment of the family members while the baby is in the hospital. To increase the adherence of professionals to best practices, such as those linked to noise and light reduction and uncomfortable stimuli, it is vital to understand the environment around the neonatal unit **(Silva et al., 2018).**

Few studies have been done in Egypt to determine the effects of noise and light reduction techniques on preterm neonates in the NICU. The goal of the current study was to find out how preterm infants' physiological and behavioral responses were affected by wearing earplugs and covering their eyes. It is hoped that the results of the present study will assist newborn infants in overcoming the physiological and behavioral effects of noise and light while also supplying data that is supported by evidence and will advance neonatal nursing practice and research.

Significance of the study

It has been discovered that in the NICU, loud noise and excessive lighting can cause physiologic instability, which manifests as variations in blood pressure, tachycardia, apnea, and oxygen desaturations. Additionally, it interferes with sleep, which is important for neurodevelopment. Hearing stress could exacerbate co-morbidities related to premature birth and have a severe impact on one's health. **(Almadhoob & Ohlsson, 2015; Chawla et al., 2017).**

The World Health Organization has suggested guidelines for NICU noise levels to reduce newborns' exposure to loud, ongoing noise. It suggests that the NICU's noise levels should not rise above 45 dB during the afternoon and 35 dB at night. However, multiple studies have shown that the typical NICU exposes preterm infants to noise levels that range from 50 to 90 dB with peaks as high as 120 dB**(Fucile et al., 2022).**

Because it resembles the relative darkness of the uterus, near darkness is used in some nurseries. Except for during shift changes or handling, infants receiving ND are not exposed to much light throughout the day or at night. ND is described as 5 to 10 lux in some nurseries. To attain these settings, light protection devices or light dimming may be utilized. This method ignores the fetus' surroundings, which is relatively dark yet full of tactile and kinaesthetic sensory stimuli, during development **(Morag & Ohlsson, 2016).**

Neonatal stress brought on by the environment in NICUs can lead to energy consumption, impede growth and development, and even threaten the delicate balance of an infant's life. Light, noise, taste, touch, and smell have been recognized as the main sources of disruption and potential injury **(Venkataraman et al., 2018).**

Aim of the study

The aim of the current study was to evaluate the effect of earplugs and eye cover on physiological and behavioral responses among preterm infants admitted in NICU.

Research hypotheses

H0: preterm infants who were earplugs and eye cover expects to have not change in physiological and behavioral responses

H1: preterm infants who were earplugs and eye cover expects to have improve in physiological and behavioral responses

Materials and Methods

Research design: - In the current study, a quasi-experimental research approach was used.

Operational definitions

The earplug: is one of the noise-cancelling devices for newborns in the NICU**(Abdeyazdan et al., 2014),** by reducing the volume of sound that newborns hear **(Abdulraoof and Arne, 2015).**

Physiological Responses: Physiological reactions are the body's natural reactions to stimuli such changes in heart rate, breathing rate, and oxygen saturation.

Setting:

The study was conducted in the neonatal intensive care unit (NICU), at Minia University Hospital for Obstetrics and Pediatrics (MUHOP) and Misr El-Hora general hospital. NICU in both hospitals receives neonates from all over Minia governorate who complained of different diseases, and the total numbers of incubators in both units are 50 incubators and provide levels of care up to the 3rd level.

Sample and sample size

A purposive sample of 120 preterm infants who admitted to neonatal intensive care unit at Minia University Hospital for Obstetric and Pediatrics (MUHOP) and Misr El-Hora general hospital who met the case selection criteria over eight months period (the total number was 120 preterm infants). The sample was divided into three equal groups (40 preterm infants) earplugs group& (40 preterm infants) eye cover group and (40 preterm infants) control group. **Inclusion criteria:** conscious, between 30 and 37 weeks gestational age, and both sexes. **Exclusion criteria:** newborn babies that have congenital defects and severe neonatal sepsis (central nervous system and cardiovascular system). A power analysis was performed using 0.05 as the level of significance, 0.95 as the power, and a 0.25 effect size to estimate the sample size. 120 preterm babies the bare minimal sample size were acquired.

Tools used for data collection

Three tools were utilized to gather the current data:-

Tool 1: Structured Interview Questionnaire Sheet: It was created by the researcher after reviewing the related literature and consisted of demographic characteristics of the preterm infants include the birth weight, gestational age, Apagr score, diagnosis, mode of delivery.

Tool 2: The physiological response tool was developed by the researcher to record the physiological parameter (respiration, pulse, blood pressure, and oxygen saturation)

Tool 3: The behavioural response tool was measured by using Anderson Behavioral State Scoring System (ABSS) (specifically designed for use in preterm neonates). ABSS was invented to measure the behavioral state of preterm infants. This scale measures 12 infant's behavioral states including 1; regular quiet sleep, 2; irregular quiet sleep, 3; active sleep, 4; very active sleep, 5; drowsy, 6; alert inactivity, 7; quiet awake, 8; active awake, 9; very active awake, 10; fussing, 11; crying and 12; hard crying. Scores from 1 to 5 indicate that the infant is sleeping. Scores 6–8 indicate that the infant is awake and calm and in the most suitable state for nursing activity. Scores from 9 to 12 indicate that the infant is in a state of restless **(Bahman Bijari et al., 2012) & (Duran et al., 2012).**

Ethical considerations

The Minia University Faculty of Nursing's Research Ethics Committee gave its written consent. Additionally, the researcher secured written approval from the administrators of the aforementioned hospitals and newborn intensive care units. A Parents of the neonates who took part in this study provided formal written consent. Direct personal interviews were used by the researcher to describe the study's aims and methodology, assuring that the information collected would be kept private and used just for that purpose. The parent had the right to refuse participation of his neonate in the study without providing any rationale, and the study complied with generally accepted ethical norms for research participants. Anonymity and privacy were also present through the coding of the data.

Pilot Study

The pilot study, which involved 12 preterm infants who met the criteria of the study, was carried out to assess the feasibility, objectivity, application, clarity, appropriateness, and content validity of the methodology and to identify any potential flaws in the instruments or approach. The recommended statistical and data analysis methodologies have been looked at using the findings of the pilot project. The neonates who took part in the pilot study were a part of the study's overall sample.

Validity and reliability

The instrument is evaluated by three specialists from Minia University's pediatric nursing department. The following factors were assessed: length, structure, clarity, application, relevancy, content coverage, and overall appearance. When the ABSS tool's dependability was evaluated, the Cronbach's alpha value was found to be (0.71).

Data collection procedure

From the start of March 2022 to the conclusion of October 2022, the study was done over an 8-month period. Two days a week, between the hours of 8:00 and 10:00 am, and 2:00 to 4:00 pm, were used for data collecting. **In earplugs group**, in order to lessen the effects of a busy and bright atmosphere during the busiest time of the NICU, premature newborns were given earplugs for two hours in the morning and two hours in the afternoon. To prevent infection and adhere to aseptic

requirements that were purchased by the researchers, each preterm newborn received a unique pair of silicon earplugs that were disposable and not shared with other preterm infants. While **in eye cover group**, the researchers created eye patches that were applied to premature infants' eyes for two hours in the morning and two hours in the afternoon, just like the earplug group. The control group, on the other hand, consisted of the three groups and received only routine treatments and care (earplugs, eye cover, and control). The researchers measured respiration in full minutes by observation and blood pressure using a digital device with an appropriate cuff size for an accurate reading that was purchased by the researchers, as well as their motor and behavioural responses were measured by the researchers through observations of preterm infants' respiratory regularity, opening or closing of the eyes, limb and trunk activity, and the intensity of crying by using the ABBSS Scale. These physiological parameters and behavioral responses were measured three times in the morning shift. Preterm infants were connected with a pulse oximeter to measure pulse and oxygen saturation in the NICU (first time at 8 am, before wearing earplugs & eye cover and before providing any nursing care to the neonate, second time at 9 am, during providing nursing care and one hour after wearing earplugs & eye cover, and third time at 10 am, after 5m of removing of earplugs & eye cover and after ending all nursing care to the neonate) additionally three times during the afternoon shift (at 2 pm, 3 pm, and 4 pm). All physiological and behavioral reactions in the control group where routine treatments and care were the only interventions were evaluated at intervals similar to those in the study groups.

Statistical Analysis

Using a suitable personal computer, data entry was completed. It was edited, tagged, and organized after data gathering. The data were analyzed using a statistical program for the social science version (IBM 25), which includes the test of significance found in mainstream statistical texts. Chi-square test, Kendall's W test, percentages, distribution, mean, and standard deviation, as well as one-way ANOVA (between groups). Less than 0.05 was regarded as significant; probability (P-value) is the measure of significance. The significance of the result increases with decreasing P-value (*).

Results

Table (1): It is clear that there was no statistically significant difference between the studied samples regarding preterm infants' demographic characteristics. The mean ± SD of preterm infants' gestational age in the earplug, eye cover, and control groups were 33.38±1.970, 32.72±2.298, and 33.25±1.932 weeks, respectively, while the mean ± SD of birth weight was 1370±.62±212.959, 1491.50±240.934, and 1445.25±242.667 grams, respectively, and the Apgar score was 7.40±0.810, 7.25±0.870, and 7.53±0.784 days respectively.

Figure (1): shows that 57.5, 47.5, and 72.5 of the participants in the earplug, eye cover, and control groups, respectively, were males.

Figure (2): Illustrates that about half of the studied samples were admitted to the hospital for preterm care 45, 57.5, and 55 in the earplug, eye cover, and control groups, respectively.

Figure (3): shows that more than half of the infants in the earplug, eye cover, and control groups were delivered by caesarean section.

Table (2): Illustrates that there was no significant difference between the studied samples regarding the mean changes of physiological responses before the wearing of earplugs and eye covers. On the other hand, during intervention (after one hour of putting in earplugs and eye covers and during providing morning care), there was a high statistical significance at P< 0.0001. The lowest mean changes in physiological responses were in the earplug group, followed by the eye cover group, and finally the control group. Also, there was a highly statistically significant difference between preterm infants in the three groups studied regarding the mean changes of the physiological parameters after 5 m of ending morning care and removing earplugs and eye covers; the lowest mean changes in physiological responses were in the earplugs group, followed by the eye cover group, and finally the control group.

Table3: Illustrates that there was no significant difference between the three groups regarding the mean changes in physiological responses before the wearing of earplugs and eye covers. On the other hand, during the intervention (after one hour of putting in earplugs and eye covers and during providing afternoon care), there was a high statistical significance difference at P< 0.001. The lowest mean changes in physiological responses were in the earplug group, followed by the eye cover group, and finally the control group. Also, there was a statistically significant difference between preterm infants in three groups regarding the mean changes of the physiological parameters after 5 m of ending afternoon care and removing earplugs and eye covers; the lowest mean changes in physiological responses were in the earplugs group, followed by the eye cover group, and finally the control group.

Table 4: Illustrates that there was no significant difference between the three groups regarding the mean changes in behavioural responses before the use of earplugs and eye covers. On the other hand, during the intervention (after one hour of putting in earplugs and eye covers and during providing afternoon care), there was a high statistical signficance difference at P< 0.0001. The lowest mean changes in behavioural responses were in the earplug group, followed by the eye cover group, and finally the control group (4.7± 0.73, 7.1± 0.91, and 7.13± 0.89, respectively) in the morning and 3.95± 0.74, 6.94 ±1.89, and 8.03 ±1.08, respectively) in the afternoon. Also, there was a statistically significant difference between preterm infants in three groups regarding the mean changes in the behavioural responses after 5 m of ending morning and afternoon care and removing earplugs and eye covers; the lowest mean changes in behavioural responses were in the earplug group, followed by the eye cover group, and finally the control group (3.95 ± 0.74, 5.7± 0.94, and 8.7± 0.89, respectively) in the morning and (3.33 ±1.78, 4.47 ±1.23000) in the afternoon.

Table 1: Comparison between the Studied Sample Three Group Regarding their Demographic Characteristics Data (n=120).

Demographic characteristics data	Earplug group (40)		Eye cover group (40)		Control group (40)		Test of significance	
	No	%	No	%	No	%	F	P-Value
Gestational age/ weeks								
30-32	13	32.5	22	55	13	32.5	0.126	0.939NS
33-35	20	50	9	22.5	22	55		
36-37	7	17.5	9	22.5	5	12.5		
Mean ± SD	33.38±1.970		32.72±2.298		33.25±1.932			
Birth weight / g								
1000-1300	18	40	10	25	10	25	5.472	0.069NS
1300-1600	15	34	12	30	18	45		
1600-1900	7	26	18	45	12	30		
Mean ± SD	1370.62±212.959		1491.50±240.934		1445.25±242.667			
Apgar score at the 1st minute								
6 score	3	7.5	5	12.5	5	12.5	3.964	0.138NS
7 score	23	57.5	24	60	11	27.5		
8 score	9	22.5	6	15	22	55		
9 score	5	12.5	5	12.5	2	5		
Mean ± SD	7.40±0.810		7.25±0.870		7.53±0.784			

NS=No statistically significant differences

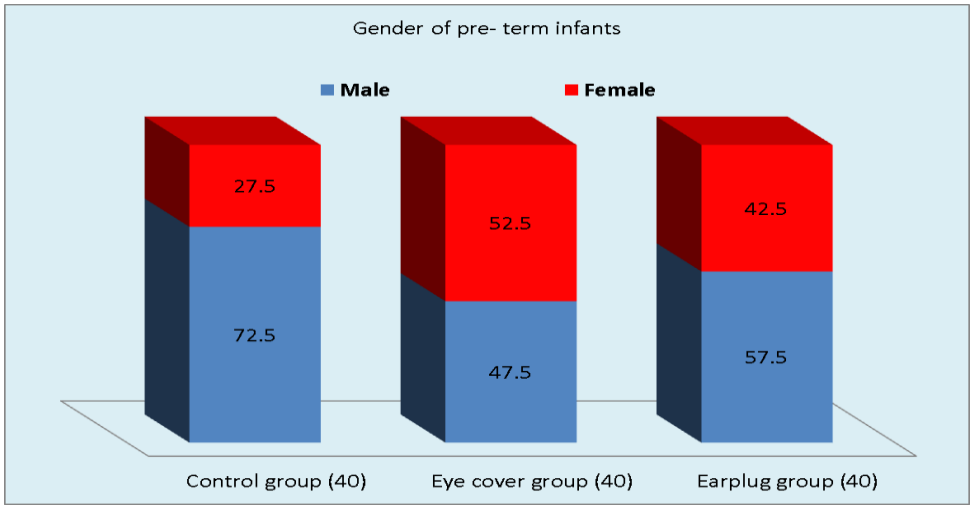

Figure 1: Gender of preterm studied samples n=120.

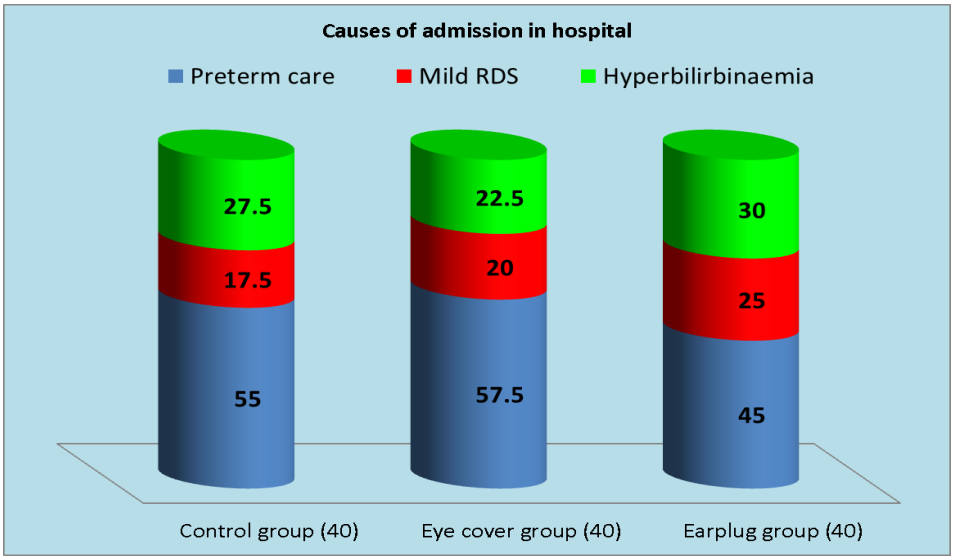

Figure 2: Causes of admission in hospital among studied samples n=120

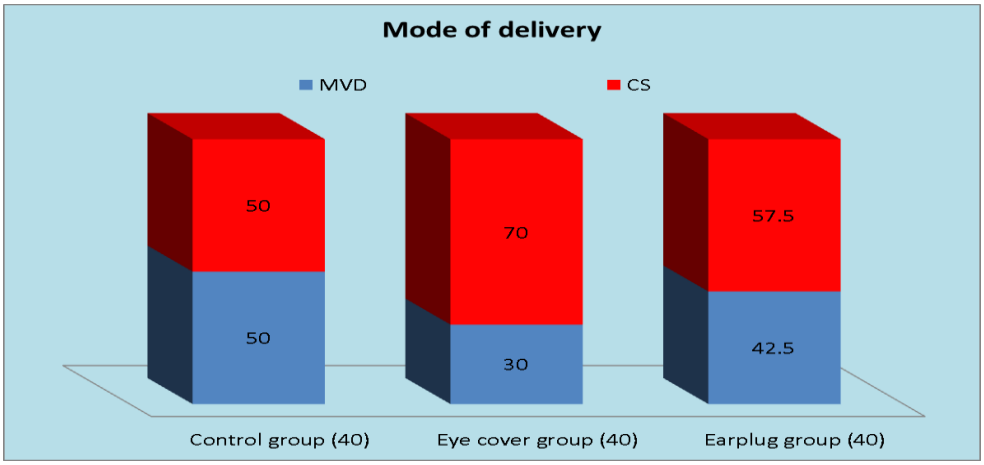

Figure 3: Mode of delivery of studied samples n=120.

Table 2: Compression between Studied Samples in Three Groups Regarding Mean Changes in Physiological Responses at Various Time Points in the Morning (n = 120)

Time	Earplug group (40)	Eye cover group (40)	Control group (40)	Test of significance	
At Morning	Mean ± SD	Mean ±SD	Mean ± SD	F	P-Value
RR					
Before (8 am)	43.01±2.12	43.63±1.91	44.1±2.36	4.994	0.08NS
During (9 am)	51.38±2.89	54.02±3.47	57.38±2.84	51.042	0.0001**
After 5m(10am)	42.93±2.28	47.65±2.99	51.33±3.35	32.044	0.0001**
PR					
Before (8 am)	139.73±3.29	139.95±1.63	139.65±1.88	4.307	0.116NS

During (9 am)	150.18±7.29	155.40±6.18	159.98±5.78	32.426	0.0001**
After 5m(10am)	139.5±4.46	146.95±4.51	152.30±6.25	31.537	0.0001**
Systolic blood pressure					
Before (8 am)	73.65±2.15	73.43±1.52	73.10±1.75	0.740	0.691NS
During (9 am)	79.33±2.21	81.98±2.11	84.86±1.57	88.190	0.0001**
After 5m(10am)	81.13±1.94	84.88±2.01	88.56±2.19	40.553	0.0001*
Diastolic blood pressure					
Before (8 am)	38.40±1.99	38.88±2.24	38.26±1.59	4.745	0.093NS
During (9 am)	48.21±2.23	51.95±2.85	54.23±3.96	74.661	0.0001**
After 5m(10am)	40.13±1.42	43.1±1.95	47.93±4.45	51.673	0.0001**
Oxygen saturation (SaO2)					
Before (8 am)	98.65±0.78	98.63±0.65	98.78±0.76	5.403	0.069NS
During (9 am)	96.13±0.81	95.25±0.95	93.31±1.25	46.142	0.0001**
After 5m(10am)	98.93±0.57	97.0.87	95.50±0.98	80.742	0.0001**

NS=No statistically significant differences **= High statistical significance differences

Table 3: Compression between Studied Samples in Three Groups Regarding Mean Changes in Physiological Responses at Various Time Points in the Afternoon

Time	**Earplug group (40)**	**Eye cover group (40)**	**Control group (40)**	**Test of significance**	
At Afternoon	**Mean ± SD**	**Mean ±SD**	**Mean ± SD**	**F**	**P-Value**
RR					
Before (2 pm)	42.11±1.32	41.34±2.21	41.51±2.01	1.015	0.602NS
During (3 pm)	50.12±1.45	52.67±2.04	54.11±3.21	10.246	0.006**
After 5m(4pm)	42.87±2.01	44.22±1.89	46.78±2.05	6.397	0.041*
PR					
Before (2 pm)	135.23±4.25	134.99±2.21	135.34±3.44	2.815	0.249NS
During (3 pm)	147.11±5.67	150.11±4.89	152.45±7.21	8.515	0.014*
After 5m(4pm)	140.34±2.98	142.42±3.76	145.24±2.98	9.134	0.012*
Systolic blood pressure					
Before (2 pm)	71.23±3.33	70.22±2.78	70.98±2.89	1.088	0.580NS
During (3 pm)	74.99±3.11	76.22±2.89	78.23±3.23	14.245	0.001**
After 5m(4pm)	80.88±2.13	81.99±3.35	84.23±1.89	8.660	0.013*
Diastolic blood pressure					
Before (2 pm)	33.23±2.77	32.55±1.98	32.98±2.45	1.278	0.528NS

During (3 pm)	42.98±3.78	44.54±3.24	46.56±2.88	10.227	0.006**
After 5m(4pm)	40.45±1.11	41.1±2.45	43.54±2.97	7.191	0.027*
Oxygen saturation (SaO2)					
Before (2 pm)	99.40±1.24	99.06±1.14	99.14±1.67	3.573	0.168NS
During (3 pm)	97.26±1.92	95.96±1.82	94.96±1.92	9.979	0.007**
After 5m(4pm)	99.10±0.66	97.15±0.71	6.79±1.34	7.153	0.028*

NS=No statistically significant differences **= High statistical significance differences

Table 4: Compression between Three Groups Regarding Mean Changes in Behavioural Responses According to the Total of the ABSS Score at Various Time Points in the Morning and Afternoon

Time	**Earplug group (40)**	**Eye cover group (40)**	**Control group (40)**	**Test of significance**	
	Mean ± SD	**Mean ±SD**	**Mean ± SD**	**F**	**P-Value**
At Morning (ABSS Score)					
Before (8 am)	2.9±0.91	2.6±0.88	2.6±0.87	3.697	0.157NS
During (9 am)	4.7±0.73	7.1±0.91	8.7±0.89	94.682	0.0001**
After 5m(10 am)	3.95±o.74	5.7±0.94	7.13±0.89	84.837	0.0001**
At Afternoon (ABSS Score)					
Before (2 pm)	2.86± 1.82	2.51±1.41	2.51±1.64	3.307	0.197NS
During (3 pm)	4.02±1.11	6.94±1.89	8.03±1.08	15.160	0.001**
After 5m(4pm)	3.33±1.78	4.47±1.23	6.78±1.95	6.845	0.03*

NS=No statistically significant differences **= High statistical significance differences

Discussion

The study results indicated that there was a highly significant difference between preterm infants in the intervention (earplugs & eye cover) and control groups regarding the mean change of physiological parameters (respiratory rate, heart rate, systolic & diastolic blood pressures, and oxygen saturation) and behavioral responses during and after 5m of intervention.

Concerning demographic characteristics data of the studied participant, the study results cleared that the Mean±SD of preterm infants' gestational age in earplugs, eye cover and control groups (33.38±1.970, 32.72±2.298, and 33.25±1.932 weeks) respectively, birth weight was (1370.62 ±212.959, 1491.50±240.934, and 1445.25±242.667 grams) respectively, Apgar score was (7.40±0.810, 7.25±0.870, and 7.53±0.784 days) respectively. On the other hand, more than half of neonates were male. Furthermore, about half of them were admitted to hospital for preterm care. Concerning route of delivery, more than half of them were delivered by a caesarian section with no significant difference between three groups regarding demographic characteristics data.

The current study results were congruent with the study of **Mater, (2018)** that conducted a study in an El Manial University Hospital about "Effect of earplugs on the physiological response of preterm infants during a nebulizer session" who indicated that mean of birth weight was 1451±357g and more than half of them (53.3%) were delivered by a caesarian section, also there with no significant difference between studied samples regarding demographic characteristics data but our result regarding sex of studied sample was contradicted with this study as the majority of sample with female neonate not male as our results.

On the other way, the current study result also was consistent with **Parmar et al. (2018)** who conducted a study about "a study to assess the impact of earmuffs on physiological parameters in neonates in neonatal intensive care unit" and cleared in his study that about half of the sample with male and the majority of the were admitted to hospital for preterm care.

The current study results were supported by **Bahman Bijari et al. (2012)** about "gentle human touch and yakson: the effect on preterm's behavioral reactions" and they proved that, mean of gestational age was 33.14±1.59 and mean of Apger Score 8.7±1.2.

Regarding mean change in physiological responses before intervention, it was clear from the current study results that there was no significant difference between three groups regarding the mean changes of physiological parameters before putting of earplugs and eye covers. The study result was congruent **with Chouery & Dunckley (2018)** who studied "use of hearing protection in neonatal intensive care unit patients: A systematic review of the evidence" which included seven studies all of them cleared that there was no significant difference between interventions and control groups regarding the mean changes of physiological parameters before putting of earplugs or earmuffs.

A similar study conducted by **Mater et al., (2019),** they performed a research about "Effects of eye cover among high risk neonates at night shift on their distress levels" who showed that there was no significant difference between interventions and control groups before intervention.

Concerning physiological parameters during intervention

Regarding mean change in respiratory rate during intervention, the finding of this study indicated that the lowest mean in earplugs than eye cover groups compared with control group (51.38±2.89, 54.02±3.47, and 57.38±2.84, respectively). These findings are consistent with the results of **Mater, (2018)** who showed lower mean change in earplugs compared with control group (53.13±6.48, and 58.13±7.61, respectively).

Regarding mean change in heart rate during intervention, it was noticed that the lowest mean in earplugs than eye cover groups compared with control group (150.18±7.29, 155.40±6.18, and 159.98±5.78, respectively). These results agree with the findings of **Allinson et al., 2017**, who conducted a study about "Physiological stress responses in infants at 29–32 weeks' postmenstrual age during clustered nursing cares and standardized neurobehavioral assessments" who showed that mean of HR during nursing care is (165.2±13.1).

Similary, **Deswinda et al., (2022**) titled "The effect of earmuff and earplug use on preterm infants towards oxygen saturation and pulse" who studied the impact of earplugs on vital signs in the NICU documented that the linear elevated in heart rate was significantly decreased within the earplugs group compared with control group during intervention (138.15±15.91,147.53 ± 16.94).

Concerning the mean change of blood pressure during intervention, the study illustrated that an mean in systolic and diastolic blood pressures during a nursing care in the intervention groups was lower than the control group (systolic blood pressure was 79.33±2.21, 81.98±2.11, and 84.86±1.57, respectively and the diastolic blood pressure was 48.21±2.23, 51.95±2.85, and 54.23±3.96, respectively. **Sweeney and Blackburn (2013),** who conducted a study about "Neonatal Physiological and Behavioral Stress during Neurological Assessment" who showed that the neonatal physiological responses during neurological assessment had increase in blood pressure but the earplugs group had lower mean change.

Incongruent with the study of **Nasimi et al., (2015)** who conducted a study about "Study the effect of quiet time protocol on physiological characteristics of preterm infants" who found no significant difference between the groups regarding systolic & diastolic BP. A Systematic Review of Eight studies done by **Ozdemir & Balci, (2020) with titled** "The Effect of Earmuffs on Physiological Parameters in Preterm Infants: A Systematic Review" examined preterm neonatal response to auditory and visualy overstimulation and automatic responses to measure the effectiveness of earplugs or earmuffs and eye shield. Five of the studies found fewer fluctuations in heart rate, respiratory rate, and oxygen

saturation in the earplugs or earmuffs and eye shield groups with significant difference between the groups.

Regarding the mean change of oxygen saturation during intervention, the study illustrated that an increase in oxygen saturation during a nursing care in the intervention groups was higher than in control group (96.13±0.81, 95.25±0.95, and 93.31±1.25, respectively). These results are similar to the findings of other studies by **Babu (2017)** who studied "Effect of Noise level on selected physiological parameters among neonates admitted in NICU" and **Almadhoob and Ohlsson (2015)** who conducted a study about "Sound reduction management in the neonatal intensive care unit for preterm or very low birth weight infants" and they found that noise may cause alternation in oxygen saturation and increased oxygen consumption secondary to elevated heart and respiratory rates and may decrease the amount of calories available for growth. Furthermore, **Mater et al., (2019) who showed** changing the illumination in the NICU may promote sleep, lower the level of motor activity, and keep physiological stability.

Concerning physiological parameters after 5 M of intervention, Results of the current study highlighted that there was a highly statistically significant difference between preterm infants in three groups regarding the mean changes of the physiological parameters after 5 m of ending morning care and removing of earplugs and eye cover, the lowest mean changes in physiological responses was in earplugs group follow by eye cover and finally control group. Similarly, an Egyptian study carried out by **Abdel Hamid et. al.(2021**) to evaluate the "Effect of Light and Noise on Physiological Parameters in a Sample of Preterm Neonates in the Neonatal Intensive Care of Cairo University Teaching Hospital" who showed there was a statistically significant difference between preterm infants groups regarding the mean changes of the physiological parameters after intervention. Additionally, they discovered that the neonates they studied saw a considerable rise in heart and respiratory rates as well as systolic and diastolic blood pressure as a result of exposure to light and noise. Additionally, they showed a significant drop in oxygen saturation and advised against using bright lights in pre-term infants' rooms because their pupillary light responses are still developing at this stage.

Concerning physiological parameters in the afternoon, it was observed that before intervention, there was no significant difference between three groups regarding the mean changes of physiological parameters before putting of earplugs and eye covers. On the other hand, during intervention (after one hour of putting of earplugs and eye covers and during providing afternoon care), there was a highly statistically significant difference at $P< 0.001$, the lowest mean changes in physiological responses was in earplugs group follow by eye cover and finally control group. Furthermore, after 5 m of ending afternoon care and removing of earplugs and eye cover, the lowest mean changes in physiological responses was in earplugs group follow by eye cover and finally control group with a statistically significant difference. This finding is in line with the findings

of **Parmar et al. (2018)** and **Deswinda et al., (2022**) they stated that physiologic parameters in the afternoon shift before intervention there was no significant relation between studied sample while during and after 5 M of intervention there was a highly statistically significant difference with lower mean changes belonging to earplugs and eye cover groups compared with control groups.

Regarding behavioral responses in morning and afternoon, Results of the current study highlighted that there was a highly statistically significant difference at P< 0.0001, the lowest mean changes in behavioral responses was in earplugs group follow by eye cover and finally control group (4.7±0.73, 7.1±0.91, and 7.13±0.89, respectively) in the morning and (3.95±o.74, 6.94±1.89, 8.03±1.08. respectively) in the afternoon. Furthermore, after 5 M of intervention there was a statistically significant difference between preterm infants in three groups regarding the mean changes of the behavioral responses. The lowest mean changes in behavioral responses was in earplugs group follow by eye cover and finally control group (3.95±o.74, 5.7±0.94, and 8.7±0.89, respectively) in the morning and (3.33±1.78, 4.47±1.23, 6.78±1.95, respectively) in the afternoon**.** This finding is in line with the findings of **Khalesi et. al. (2017)** who studied "The effectiveness of earmuffs on the physiologic and behavioral stability in preterm infants" and showed that in comparison to preterm infants without earmuffs, those who wore them had lower ABSS scores and better light sleep (2.38 0.47 versus 4.8 0.97, p 0.05). Additionally, they were able to enhance the amount of oxygen saturation while decreasing the cardiac and respiratory rates (p 0.05). On other hand, our results were agreed with the findings of **Orsi et. al. (2017)** who conducted astudy with title "Effects of handling and environment on preterm newborns sleeping in incubators" and found decrease light had a significant correlation with decrease behavioral responses score and sleep.

This result comes in line with the study of **Park (2020).** Who studied "Sleep promotion for preterm infants in the NICU" and recommended the importance of identification of appropriate interventions as earpugs or earmuffs and eye covers that promote & improve preterm infants' physiological & behavioral responses in the NICU and also incorporate them in practice. From the researcher's point of view, as much as possible decreasing the noise and controlling the light in the NICU may reflect in decreasing motor and behavioural responses activity level, maintain physiological stability, and promoting calm sleeping in preterm infants.

Conclusion

Considering the present results of the current study which concluded that the preterms' infants in earplugs and eye covers groups had lowest mean changes in physiological and behavioral responses during and after 5M of intervention with a highly statistically significant differences. Using of earplugs and eye covers during crowded and excessive light environment in the busiest time of the NICU was effective to decrease physiological and behavioral responses among preterms' infants.

Recommendations

Based on the study's findings, the researchers recommend that:

- Earplugs and eye covers should be applied during crowded and excessive light environment in the busiest time of the NICU as a routine care for preterm infants.
- An educational program is needed to raise awareness among nurses and other health-care providers about the effects of noise and excessive light on the physiological and behavioral responses and identification of appropriate interventions as earplugs and eye covers that promote & improve preterm infants' physiological & behavioral responses in the NICU and also incorporate them in practice.
- Repeated the study on a larger participant to evaluate the long-term outcomes of using earplugs and eye covers on the physiological and behavioral states of newborn infants.

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Conflicts of interest

There are no conflicts of interest.

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