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Improving the Immune System in Infantile Colic Sufferers

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Abstract: Poor sleep quality will lower the immune system, making babies susceptible to illness. Brain maturity is needed for babies to learn various things. Babies with poor sleep quality will reduce the immune system, so that babies are easily sick, including prolonged crying babies will certainly affect the quality of baby sleep. To determine the effectiveness of baby massage on the quality of sleep of infantile colic babies in North Gorontalo Regency, Gorontalo Province. Non-equivalent quasi-experiment research with quantitative approach and two-group pre-test-posttest control group design. Determination of participants based on purposive sampling technique, namely colicky infants with a normal birth weight of 2500 grams - 4000 grams aged 1 to 6 months. The research instrument used observation sheets and questionnaires. Statistical tests used the Wilcoxon test, Mann-Whitney test, and ordinal logistic regression test. Sleep quality of infantile colic infants before being given baby massage intervention there was 1 baby with 2.9% in the good category. After the massage, the data showed that the baby's sleep quality increased in the "Good" category in as many as 28 respondents with 82.90% of 35 babies in the intervention group with asymp.Sig. (2-tailed) Wilcoxon test is worth (0.000 <0.05). Baby massage is effective on the sleep quality of infantile colic babies in Anggrek District, North Gorontalo Regency, Gorontalo Province.

Keywords: Infant massage; Infantile colic; Sleep problems; Sleep quality

Introduction

Crying is the baby's way of expressing hunger, discomfort, tiredness, pain and fear. Discomfort arises when the baby urinates, defecates, is overheated, cold, itchy and so on. However, prolonged crying, which is one of the signs of infantile colic, can pose a great risk to the baby in its growth and development (Nahidi et al., 2017). Infantile colic which is seen as a common, harmless problem can lead to long-term negative consequences in children who have experienced colic to stress in parents (Romdloni et al., 2023). The diagnosis of this disorder relies on symptom-based criteria, namely the so-called Rome criteria, which date back to 1994 (Al Qahtani & Ahmed, 2021). The overall prevalence of infantile colic is 5-25% of infants and is more common in the first 4 months of life. Australia. A total of 483 first-born infants were prospectively monitored from 2 weeks to 2, 4, 8, 12, 18, and 24 months. Child behavior, maternal depression, parenting stress, and marital quality were assessed. The predictor variables were parental reports of moderate or greater crying and fussing problems at 2 and 4 months of age (Mohammadian-Dameski et al., 2023). The prevalence of infantile colic was similar in exclusively breastfed and formula-fed infants. Although other studies found a higher prevalence of infantile colic in formula-fed infants. The prevalence of infantile colic was greater in lower birth-weight infants than in normal-weight infants (Sridevi et al., 2022).

In Indonesia, some infants experience sleep problems, namely around 44.2% where almost all parents do not consider the disorders experienced by infants as a problem with the number of respondents 285 infants, obtained data on 51.3% of infants experiencing sleep disorders, 42.2% of infants sleep less than 9 hours a night, and at night the baby wakes up more than 3

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times with waking up more than an hour. Despite the fact that it is considered a problem and mothers only consider it a minor problem. In fact, sleep problems can interfere with the baby's growth and development, cause immune function vulnerability, and disrupt the regulation of the endocrine system (Sukmawati & Nur Imanah, 2020). Government support in the Decree of the Minister of Health Number 900/MENKES/SK/VII/2002 concerning Registration and Practice of Midwives states that midwives are authorized to monitor the growth and development of infants through early detection and stimulation of growth and development.

One form of stimulation that has been done is with baby massage (Vicente et al., 2017). Health workers have a role to do promotive-preventive efforts related to the benefits of massage for babies, namely increasing body weight and growth, increasing endurance, making babies relaxed, comfortable and making sleep soundly. In line with the above, it is necessary to carry out baduta massage in health care facilities, according to the Minister of Health Regulation Number 37 of 2017 concerning Integration Traditional Health Services. For this reason, it is necessary to increase the capacity of health workers, namely midwives in baduta massage service. Research Whittall et al. (2023) explains children who have prolonged crying, have poorer results on many cognitive development tests. Over the years, many studies have tried to provide answers to babies with infantile colic and their families from different therapeutic perspectives. On the one hand, there are options such as drug administration, acupuncture diet and manual therapy treatments, such as foot reflexology, physiotherapy and visceral osteopathy, massage, spinal manipulation, and craniosacral therapy, all of which include massage therapy performed on infants.

Massage can relieve stress on muscles and internal organs and can result in stimulation and increased blood circulation to tissues and organs (Bervoets et al., 2015). Since colic is caused by muscle spasms of the colon and decreased peristalsis, massage may be able to relieve colic by increasing its movement and improving blood circulation (Suklert & Phavichitr, 2022; Won et al., 2023). On the other hand, the stimulation of vibrotactile massage by the mother on the baby's body surface leads to a decrease in mother-baby stress and an increase in their contact, which can treat infantile colic according to the behavioral theory of the cause of colic (Cabral et al., 2024). In addition, massage can relieve symptoms and calm the baby by helping him or her sleep better. Given the various results and studies, infantile colic is a considerable problem for both parents and babies, and its treatment should be one of the healthcare goals (Mustafa et al., 2023).

Given that this study was conducted on colicky infants aged 1-4 months, it is closely related to one of the causes of colic, namely digestive tract disorders and coverage of infants <6 months of exclusive breastfeeding. So the preliminary study conducted by the researcher was to look for a population of infants with low exclusive breastfeeding coverage. Exclusive breastfeeding coverage data from the Gorontalo Provincial Health Office in 2023 states that North Gorontalo District has the lowest coverage with 13.9% followed by Bonebolango District 15.7%, Gorontalo 29%, Boalemo District 40.1% and Gorontalo City 59.4%. In addition, the 2023 infant target in North Gorontalo District is the lowest with 1873 infants out of 20,471 infants in Gorontalo Province. So from the results of the preliminary study, researchers are interested in conducting research entitled the effectiveness of baby massage on the quality of sleep of infants with infantile colic aged 1-6 months in North Gorontalo Regency, Gorontalo Province. So that it can be one of the efforts to handle infantile colic to optimize further child development.

Method

This study used a non-equivalent quasi-experimental design with a quantitative approach and a two-group pretest-posttest control group design. Each infant was first checked for colic, then an assessment of sleep quality was conducted before and after infant massage was given. The control group received no intervention, while the intervention group received infant massage three times a week for 45 minutes using panimbulu oil. The study population consisted of 158 infants aged 1-6 months in North Gorontalo Regency, with a sample of 70 infants selected using non-probability sampling technique using purposive sampling. Inclusion criteria included infants aged 1-4 months, birth weight 2500-4000 g, not exclusively breastfed, and showed a crying pattern of at least three hours a day, while exclusion criteria included infants who were sick with fever and mothers who were not willing to become respondents.

This study was conducted in Anggrek Sub-district, North Gorontalo District, Gorontalo Province, with the control group consisting of 35 infants at Ilangata Health Center and the intervention group consisting of 35 infants at Anggrek Health Center. The study took place from April to July 2024. The research instruments included an informed consent form, self-characteristic data, colic assessment, and infant sleep quality questionnaire adapted from Cahyawati (2020) and tested for validity and reliability. Data analysis was carried out with the help of the IBM SPSS version 22 program using the Wilcoxon and Mann-Whitney tests to

test for differences between two groups, as well as ordinal regression tests to see the relationship between independent variables (infant massage) and external variables (infantile colic, birth weight, gender).

Result and Discussion

Results

First, Sleep quality of infantile colic infants in the control group.

Table 1. Frequency Distribution of Respondents Based on Sleep Quality of Colicky Infants in the Control Group in Anggrek District, North Gorontalo Regency

Baby's Sleep Quality	First meeting		Second meeting	
	n	%	n	%
Good		0	1	2.90
Fair	30	85.70	28	80
Less	5	14.30	6	17.10
Total	35	100	35	100

Based on table 1 about the frequency distribution of respondents based on the quality of sleep of colicky babies in the control group, it can be seen that at the first meeting most of them fell into the "Fair" category, namely 30 respondents with 85.70% and 5 other respondents fell into the category of less with 14.30%. The second meeting obtained the results of the quality of sleep of most colicky babies still in the "Fair" category as many as 28 babies with 80%, the "Good" category there was 1 baby with 2.90% and the "Less" category as many as 6 respondents with 17.10%. Second, the sleep quality of infantile colic babies in the baby massage group.

Table 2. Frequency Distribution of Respondents Based on the Quality of Infant Colic Sleep in the Baby Massage Group in Anggrek District, North Gorontalo Regency

Baby's Sleep Quality	First meeting		Second meeting	
	n	%	n	%
Good	0	0	29	82.90
Fair	22	62.90	6	37.10
Less	13	37.10	0	0
Total	35	100	35	100

Based on table 2, the frequency distribution of respondents based on the quality of sleep of colicky babies in the baby massage group shows that most of them are in the sufficient category as many as 22 respondents with 62.90%. and 13 babies are in the "Lack" category with 37.10%. After being given a massage, the data shows that the baby's sleep quality rises in the "Good" category as many as 28 respondents with 82.9%,. The "Fair" category decreased in 6 respondents without a single respondent in the "Poor" category. Third, the effectiveness of baby massage on the sleep quality of infantile colic infants.

Based on table 3, the results of the Wilcoxon statistical test on the control group obtained a significant number or pobabilitas value (1,000) much higher than the significant standard of 0.05 or (p <α). While the results of the Wilcoxon statistical test in the baby massage intervention group obtained a significant number or pobabilitas value (0.000) much lower than the significant standard of 0.05 or (p <α). then the data Ho is rejected and Hi is accepted which means baby massage effectively improves the quality of sleep of infantile colic babies in North Gorontalo Regency. Fourth, test the difference in sleep quality between intervention group and control group.

Table 3. Wilcoxon Test Results to Determine the Effectiveness of the Intervention on Respondents

	Control Group	
Z	.000b	-517b
Asymp. Sig. (2-tailed)	1.000	.000

Table 4. Man Whitney Test Results to Determine the Mean Difference between the Intervention Group and the Control Group

	Post Test Variable
Mann-Whitney U	.000
Wilcoxon W	630.000
Z	-7.296
Asymp. Sig. (2-tailed)	.000

Based on table 4 about the results of the Mann Whitney test to determine the average difference between the intervention group and the control group is Asymp.Sig. (2-taled) 0.000 <0.05, which means that the hypothesis is accepted there is an average difference between the group of infantile colic babies given baby massage and the control group of infantile colic babies who are not given baby massage. Fifth, the relationship of baby massage to external variables

Table 5. Ordinal Regression Test Results

Variables	Sign
Sleep Quality of Control Group	.006
Sleep Quality of Intervention Group	.000
Gender	.501
Birth Weight	.418
Infantile Colic	.000

Based on table 5 about the results of ordinal regression test obtained that baby massage is effective on the quality of sleep of infantile colic babies. This is indicated by the P value (0.000) < α (0.05). While gender does not affect the sleep quality of infantile colic babies because the P value (501) > α (0.05) and the baby's birth

weight does not affect the sleep quality of infantile colic babies because the P value (.418) > α (0.05).

Discussion

Based on the quality of sleep of infantile colic babies in the control group, it can be seen that no one is in the good category (0%) and there is an increase of 2.9% with 1 baby in the post test results. The increase in sleep quality in the control group can be caused by several factors, one of which is the state of the baby before bed. According to Halpern et al. (2016), energy is needed by the body to perform its functions, and this energy is obtained through food. The body then breaks down nutrients from food in the digestive system to make glucose which is then converted into energy. After eating, the body releases hormones, including amylin, glucagon, and cholecystokinin. These hormones function to increase blood sugar levels, create a feeling of fullness and to produce insulin that will be flowed into the cells to provide energy to the cells (Bijlsma et al., 2023).

At the same time, the brain also releases the hormone serotonin which causes drowsiness. In addition, food also affects the production of melatonin in the brain. It is these two hormones that cause drowsiness after a meal. Melatonin is made in the brain by converting the amino acid tryptophan into serotonin, and then into melatonin (Tarullo et al., 2016). The amino acid tryptophan can cause drowsiness. This is because it is involved in the production of serotonin. Foods containing tryptophan are generally rich in protein, one of which is infant formula. Not only that, formula milk can also increase melatonin levels. Research by (Angelhoff et al., 2018), shows that high melatonin levels stabilize and strengthen circadian rhythms, namely the rhythm of a person's waking and sleeping biological clock.

It is known that of the 35 respondents studied, most were male with 23 babies (65.7%) in the control group and most of the respondents' birth weight in the control group was 3100 grams (42.9%). Normal birth weight will affect the growth and development of the baby in the future and vice versa, babies who are born with low birth weight are generally less able to reduce the pressure of the new environment, so that it can result in inhibition of growth and development, and can interfere with their survival including the quality of the baby's sleep itself (Agyekum et al., 2022). Based on the frequency distribution table of respondents based on the quality of sleep of colicky babies in the baby massage group, the lowest pre-test value is none of the babies with good values (0%). While in the post test the value of the baby's sleep quality rose to (82.9%) with a total of 29 colicky babies.

It is known that reflexology induces the release of endorphin and encephalin by stimulating the pituitary gland through pressure and massage performed at reflex points on the hands and feet (Torró-Ferrero et al., 2022). Infantile colic is a condition where the baby cries continuously for no apparent reason (Castejón-Castejón et al., 2022). The modified Wessel criteria states that the diagnosis of colic can be established if prolonged crying occurs for at least 1 week (Sommermeyer et al., 2022). The state of colicky infants certainly greatly affects the quality of infant sleep which has an impact on the development of infant sleep related to brain maturity and age for the total amount of sleep required is reduced, followed by a decrease in the proportion of rapid eye movement and non-rapid eye movement (Saputro & Bahiya, 2021).

After the research was conducted, there were three important points in determining the quality of the baby's sleep, the first was the quantity or duration of the baby's sleep. The average score was 1 in question number 1 with a total score of 35, meaning that all respondents answered "Yes" and those who answered "No" were 0 respondents. Research Lao et al. (2018), Sleep duration on the first and last day of massage intervention showed a significant difference on the first and last day from 9 hours to 13 hours of sleep duration. Infant massage is very influential in increasing the duration of infant sleep, this shows that massaged babies can increase the production of absorption enzymes, increase serotonin neurotransmitters, and increase immunity and result in changes in brain waves that cause babies to fall asleep more soundly (Van Someren, 2021).

The second point is related to Rapid Eye Movement with an average score of 1 on question number 16 with a total score of 35, meaning that all respondents answered "Yes" and 0 respondents answered "No". The brain maturation process occurs when babies sleep in the Rapid Eye Movement (REM) stage. Brain maturity is needed for babies to learn various things. Babies who lack sleep will reduce the immune system, so babies get sick easily. Babies who cry for a long time will certainly affect the quality of the baby's sleep. Infant sleep development related to brain maturity and age for the total amount of sleep required decreases, followed by a decrease in the proportion of rapid eye movement and non rapid eye movement (Pecora et al., 2022).

Although there is no clear evidence whether sleep quality from massage affects the cognitive development of full-term infants, it can be determined early by performing rapid eye movement assessment and EEG examination (Knoop et al., 2021). For most infants, by 4 months of age, the onset of sleep no longer begins in rapid eye movement (REM) but in non-rapid eye movement (NREM) and sleep stages become more mature (de Goederen et al., 2021). Supported by the

research of Kellams et al. (2022) found higher magnitude (i.e. spectral power and (EEG) measurements in various frequency bands and stages of sleep in the intervention group compared to the group who had never been massaged. Sleep spindles are already well established by 4 months of age as a result of thalamic, cortical interactions, memory consolidation, and cognitive skills (Blumberg et al., 2020).

The third point is on the condition that the baby is fussy when awake, the average score is 1 in question number 10 with a total score of 35, meaning that all respondents answered "Yes" and those who answered "No" were 0 respondents. Supported by research (Bičiková et al., 2018) showed that one of the treatments, namely relaxation or massage, can secrete the hormone serotoin as much as 23.1%. The massage will increase the activity of serotonin neurotransmitters, which increases the capacity of receptor cells that function to bind glucocorticoid (adrenaline, a stress hormone). This process will cause a decrease in adrenaline (stress hormone) levels (Pebrianthy et al., 2023).

Increased levels of serotonin secretion produced during massage can directly improve sleep quality and changes in brain waves where there is a decrease in alpha waves and an increase in beta and theta waves which can be seen through the use of EEG (Electroencephalography). Gao et al. (2022), also added that massage triggers neurotransmitters such as DA and 5-HT involved in physiological responses such as emotion, sleep, and memory in the central nervous system. A more comfortable and calm state of the body after a massage will make sleep more quality. Based on statistical tests, it is known that the asymp.Sig. (2-tailed) is 0.000. Because the value of 0.000 is smaller than 0.05 (0.000<0.05) and Baby massage is effective on sleep quality of infantile colic babies indicated by the value of P (0.000) < α (0.05). So it can be concluded that "Ha is accepted". This means that there is a difference between the value of improving sleep quality in infantile colic babies with massage intervention and in the control group without massage intervention.

So, the difference between the intervention group and the control group can be interpreted that baby massage is effective in improving the quality of sleep of infantile colic babies in North Gorontalo Regency, Gorontalo Province 2024. The frequency distribution of respondents based on gender can be seen that of the 35 respondents studied, most were male with 21 babies (60%) and most of the respondents' birth weight in the Intervention group was 3100 grams (37.1%). Birth weight can be an indicator to see the survival, growth, long-term health, and development of children's sleep quality. Low birth weight babies may experience digestive tract disorders, because the digestive tract is not yet functioning, such as less able to absorb fat and digest protein, resulting in a lack of nutrient reserves in the baby's body. The results of research on the quality of sleep of infantile colic babies before and after being given baby massage in this study also showed a significant difference from 35 babies who fell into the category of good sleep quality reaching 29 babies with 82.9% with a significant number or probability value (0.000) much lower than the significant standard of 0.05 or (p <α).

Baby massage performed to infantile colic babies by mothers in Anggrek District, North Gorontalo Regency began to be done by some mothers even though it was only done on some parts of the baby's body, namely the abdomen and legs. However, this slightly affects the decrease in colic symptoms so that the quality of sleep of infantile colic babies becomes better supported by the results of the ordinal regression test in this study showing a value of 0.00 less than 0.05 (0.000 <0.05) on colic items. Immaturity of the infant's digestive system, leaky gut syndrome, and impaired performance of the gut-brain axis are some of the etiologies thought to cause infantile colic. Research Icke (2018) showed that the severity of colic was significantly reduced after reflexology intervention was applied to the study group compared to the control.

Supported by research Rahman et al. (2024) showed that abdominal massage with olive oil had the same effect as paraffin oil in improving the symptoms of infantile colic. Crying duration and frequency improved significantly in both groups (65% vs. 58% reduction in crying duration and 57% vs. 50% reduction in crying duration). Massage therapy not only impacts colicky infants but has also been shown to benefit the mother-infant relationship, weight gain, digestive issues and the infant's immune system (Mahalakshmi et al., 2024). The results of the ordinal regression test between infant birth weight and infant sleep quality showed that there was no effect on infant sleep quality with a sign of .481 greater than 0.05 (0.000 <0.05). It is known that gender also does not show significant changes with a sign value of .501 where the figure is greater than 0.05 (0.000>0.05). It is known that respondents in this study had a normal birth weight with a minimum birth weight of 2800 Kg and a maximum birth weight of respondents at 3300 Kg. But actually baby massage if done regularly can increase the weight of the baby (Manacero & Nunes, 2021). The results of (Zalejska-Fiolka et al., 2022) show that there is a difference in weight gain before and after intervention in the intervention group, namely 500 grams. Meanwhile, in the control group there was a smaller difference in weight gain before and after, namely 268.75 grams (Lestari et al., 2021). Infant massage can improve food absorption because massaged babies will experience an increase in vagus nerve tone (10th brain

nerve) which will cause an increase in the absorption rate of gastrin and insulin enzymes.

The provision of baby massage in Anggrek sub-district is still fully carried out by traditional healers but only at the beginning of birth, the rest of the massage is done when there are complaints. After the midwife performs massage to the baby, the baby's mother begins to learn and perform baby massage independently. Maternal care is responsible for epigenetic modulation and affects synaptogenesis (Roshanray et al., 2020). However, mothers were more aware of the benefits of baby massage from TBAs and chose TBAs to perform traditional massage on their babies compared to midwives or medical personnel. In line with research (Chaturvedi et al., 2020) The majority of mothers had started massage as a traditional practice (82%) rarely started on the advice of a health care provider (4%). Moderate pressure touch used in conjunction with anti-inflammatory and analgesic essential oils (Copaiba and Deep Blue) with Aroma Touch Hand Technique allows positive effects on individuals with severe pain.

Conclusion

Based on the results of the research that has been conducted, several things can be concluded. First, there is no significant difference in the control group with a probability of 1.000, which is much higher than the significant standard of 0.05 ($p > \alpha$). Second, there is a significant difference in the intervention group, with a probability of 0.000, which is lower than the significant standard of 0.05 ($p < \alpha$). Third, baby massage is effective in improving the sleep quality of infantile colic babies, which is indicated by a P value of 0.000, which is smaller than α of 0.05. As suggestions, first, for midwives or baby massage facilitators, it is hoped that village midwives, especially in Anggrek District, can take part in baby massage training as a basis for developing care in overcoming the problem of infantile colic baby sleep quality. Second, for the baby's mother, it is recommended to do baby massage independently at least 15 minutes before the baby sleeps at night in order to improve the sleep quality of infantile colic babies while strengthening the bond between mother and baby. Third, for future researchers, it is recommended to conduct further research related to the use of traditional Panimbulu oil and compare the effectiveness of baby massage interventions with the swing method (rooting) in improving the quality of sleep of infantile colic babies.

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Author Contributions
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