

ORIGINAL ARTICLE

Effect of soothing techniques on infants' self-regulation behaviors (sleeping, crying, feeding): A randomized controlled study

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Abstract

Aim: To determine the effect of teaching 4S soothing techniques (swaddling, holding at side or stomach position, shushing-white noise, swinging) on parent-reported infants' self-regulation behaviors with respect to sleeping, crying, and feeding.

Methods: This research is a pretest–post-test, single-blind randomized experimental study with 6 month follow-ups. An intervention group (IG) and a control group (CG) were formed, each consisting of 21 mother–infant dyads. A 90 min training program was applied to the mothers in the IG during the home visit in the fourth week after birth. For both groups, the dependent variables of the study are the parent-reported self-regulation behaviors of the infants in weeks 3, 7, 11, and 23.

Results: No significant difference was found between the two groups before the intervention in the pretest in terms of the mean sleep duration, mean crying duration, frequency of feeding, and frequency of waking at night. After the teaching of the 4S soothing techniques had been conducted, it was determined that the mean frequency of waking at night, the mean frequency of daily feeding, and the mean daily crying duration of the infants in the IG was statistically significantly lower in all follow-ups, compared to the infants in the CG. In weeks 7 and 11 after the intervention, the mean daily sleep duration of the infants in the IG was found to be statistically significantly higher, compared to the infants in the CG.

Conclusion: Health professionals can use the 4S soothing techniques to develop self-regulation behaviors of infants during the first 12 weeks of the infancy period.

Key words: crying, feeding, self-regulation, sleeping, soothing techniques.

INTRODUCTION

The birth of a new child is a critical period that requires that parents provide infant care, create a safe environment for the infant, communicate with the infant, learn new roles, develop family sensitivity, and deal with problems related to the infant. The participation of an infant in the family can be a period that is positive for the family, provides satisfaction, and strengthens the family ties; however, it also can be perceived as a period

of crisis for the mother and family (Blunden, Thompson, & Dawson, 2011; Karp, 2003). Sleeping, crying, and feeding problems are among the health complaints with which parents most frequently consult health professionals in relation to their infant (Kaley, Reid, & Flynn, 2012; Meyer & Erler, 2011). In the literature, it has been determined that mothers who cannot respond to their infants' sleeping, crying, and feeding needs feel inadequate and have increased levels of anxiety and that mother and infant attachment is affected negatively (Bilgin & Wolke, 2017; Blunden *et al.*). Recent studies have shown that the failure to resolve regulatory problems during infancy (excessive crying, sleeping, and feeding problems) in the early period is associated with emotional, behavioral, and cognitive impairment in

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childhood and later periods (Bilgin & Wolke; Santos, Matijasevich, Capilheira, Anselmi, & Barros, 2015).

Self-regulation is one of the significant concepts of the social cognitive learning theory that was developed by Bandura and is a research topic that has been widely studied in the literature on child health in recent years (Bandura, 2004; Douglas & Hill, 2013; Kaley *et al.*, 2012). Self-regulation behaviors in the first 0–6 months during infancy include sleeping, feeding, and crying behaviors of the infant (Whittingham & Douglas, 2014). Sleeping, crying, and feeding behaviors are not independent of each other; a change in one of the behaviors also affects the others (Kaley *et al.*). In studies, it has been determined that the infants who are fed >12 times per day in the first 2 weeks of life are further faced with waking at night and crying problems in the 12th week (Bilgin & Wolke, 2017; Paul *et al.*, 2011; Whittingham & Douglas). It is stated that sleeping problems in infants can be prevented by controlling crying (Barnard, 1999). Murray, Tran, Thang, Cass, and Fisher (2018) stated that mothers who do not distinguish the real reasons for their infant's crying frequently breastfeed to stop the crying of the infant and to make him or her sleep. A vicious circle arises along with the mothers' inability to correctly interpret the clues that are shown by their infant. Therefore, the coregulation of these three behaviors in the infant has been reported to be the most effective approach (Kaley *et al.*).

The importance of behavioral interventions applied by the mother in the infant's formation of self-regulation behaviors has been shown in many studies. Within the scope of these behavioral interventions that are called "soothing techniques" in the literature, mothers have been determined to implement various behaviors, such as "hugging," "taking the infant for a ride in a push chair," "taking the infant for a ride in the car," "making an infant listen to music," "swinging," "giving a pacifier," "breastfeeding," "bathing an infant," "massage," "making an infant drink herbal tea," "swaddling," "making the infant sleep in a side or stomach position," "scolding," "giving a sedative" and "giving a pain killer," "changing the diaper," and "5S" (swaddling, side-stomach, shushing, swinging, and sucking) or "4S" (swaddling, side-stomach, shushing, and swinging) soothing techniques that were developed by Karp (Adachi *et al.*, 2009; Barnard, 1999; Karp, 2003; McRury & Zolotor, 2010; Meyer & Erler, 2011; Paul *et al.*, 2011; Richardson, Walker, & Horne, 2010; Yilmaz & Arikan, 2015). Experimental studies have been carried out to determine the effect of these

methods on crying or sleeping in Turkey and in the international arena (McRury & Zolotor; Meyer & Erler; Paul *et al.*; Richardson *et al.*; Yilmaz & Arikan). It has been determined that the sleeping, crying, and feeding behaviors among the self-regulation behaviors of infants have never been examined at the same time in the field of nursing in Turkey and in the world and that no study that reveals the effect of the 4S soothing techniques on the infant's self-regulation behaviors has been found. Thus, 5S soothing techniques have been used to control pain and postvaccination crying in infants (Harrington *et al.*, 2012; Martiningsih & Setijaningsih, 2015; Setiyorini & Wulandari, 2014). In this study, an attempt to develop self-regulation behaviors was made for the sleeping, feeding, and crying habits of the infant with the 4S soothing techniques that were applied by a nurse during the infancy period.

The research subject is also included in the basic human needs and the techniques for the regulation of the said behaviors can be implemented by nurses (Kaley *et al.*, 2012; Kelly, Irigoyen, Pomerantz, Mondesir, & Isaza-Brando, 2017; Whittingham & Douglas, 2014; Yilmaz & Arikan, 2015). This study is expected to provide a benefit for the development of infant and child health; therefore, the happiness of the family and ultimately the health of the community. Nurses, midwives, and physicians who provide care for infants will be able to suggest these methods to parents in education programs.

Based on this evidence, in the present study, it was aimed to determine the effect of the 4S soothing techniques, which are taught to mothers by nurses, on infants' self-regulation behaviors with respect to sleeping, crying, and feeding.

Hypotheses

In this study, the following hypotheses were tested during any follow-up that was conducted after the intervention with the T0 measurements (T1, T2, T3):

Hypothesis (H)1: The mean total daily sleep duration of the infants in the intervention group (IG) is higher, compared to the infants in the control group (CG).

Hypothesis (H)2: The mean frequency of waking at night of the infants in the IG is lower, compared to the infants in the CG.

Hypothesis (H)3: The mean total daily duration of crying of the infants in the IG is less, compared to the infants in the CG.

Hypothesis (H)4: The mean frequency of daily feeding of the infants in the IG is lower than the frequency of feeding of the infants in the CG.

METHODS

Study design

This research is a pretest–post-test, single-blind, randomized experimental study with 6 month follow-ups. The study was carried out between July, 2012 and January, 2014 at family health centers (FHCs) in Izmir, in the west of Turkey.

Setting and sample

There were 25 FHCs in the region where the study was conducted. The pregnant women who registered to four FHCs of these were determined by purposeful sampling to constitute the population of the study ($n = 560$). The IG and CG were selected from different FHCs to prevent interaction among the mothers. The mothers and their infant were taken from two FHCs for the IG and from the other two FHCs for the CG. For sampling, the women who were in the 32nd week of pregnancy and met the inclusion criteria of the study were determined by the random sampling method. Direct contact was established with these pregnant women and they were invited to participate in the research by permitting home visits before birth (Fig. 1). According to G*Power software (University of Kiel, Germany), although it was determined that the type I error rate of 0.05, 80.0% testing power, and the sample size of 12 mother–infant dyads would be appropriate, the study (which started with the participation of 54 mother–infant dyads) was completed with 42 mother–infant dyads (power of test: 92.0%).

The inclusion criteria for the infants were as follows. They should: (i) be the first child, born after 37 weeks; (ii) have a birthweight of >2500 g; (iii) be a singleton; (iv) not have a disease that will prevent breastfeeding; (v) be administered with the hearing screening test; and (vi) not have developmental dysplasia of the hip. The mothers should: (i) be primipara; (ii) be >18 years old; (iii) volunteer to participate in the study; and (iv) have the presence of a video CD player (just for the IG). The following exclusion criteria were used: (i) the mother or infant has stayed in hospital for >7 days; (ii) the presence of a mother's chronic illness that will affect the care of her infant before and after birth; (iii) the infant has been diagnosed as a colicky infant during the study and the use of any medication for gas pains for the infant; and (iv) feeding an infant with a formula.

Randomization

In the study, the stratified randomization method was used according to the maternal education level and the sex of the infant. Each stratum was divided into four permuted blocks. The blocks were ordered as “above” or “below” high school education for the educational level and as “female” or “male” for the sex of the infant. Afterwards, the mother–infant dyads were assigned to the IG or the CG to provide equality that was suitable for the block order. It was ensured that the two groups were homogeneous with regard to the infants' sex ($\chi^2 = 0.01$, $P < 0.999$) and their mother's educational level ($\chi^2 = 2.10$, $P = 0.147$) (Table 2).

Instruments

The Mother and Infant Description Form was created for the purpose of describing the characteristics of mother and infant by examining the literature (Blunden *et al.*, 2011; Kaley *et al.*, 2012; Richardson *et al.*, 2010). This form included 22 questions about the age, educational status, income status, smoking status of the mother, whether the mother had a problem with breastfeeding, and about the birth week, sex, and weight of the infant.

The Infant Sleep Activity Record (ISAR) was developed for the Nursing Child Assessment Satellite Training program (Barnard, 1999). The sleep duration, frequency of waking, crying duration and frequency of feeding of the infant during the day and night hours are recorded on the front side of the form and on the back side of the form, respectively. There are seven lines separately on the front side and back side of the form. Each line represents a day of the week. The columns represent the hours of the day. Each time zone is divided into four 15 min units. There is a total of 48 columns on each side of the form. The mother is asked to record “F” in the columns if she has fed her infant, “S” if her infant has fallen asleep, “W” if her infant has woken up, and “C” if her infant has cried. In this study, the mothers wrote down the start and end time of crying duration in 15 min columns. There are also total columns at the end of each line for each behavior. The mother or health professional who follows the infant in a period of 3, 4, or 7 days, including day (06:00–18:00) and night (18:00–06:00), records the sleep duration, frequency of waking at night, crying duration, and frequency of feeding of the infant on the form, covering 24 h time slots (Barnard). The total daily sleep duration per week is divided into seven and the mean daily sleep duration is calculated. A similar calculation is conducted in order to determine the sleep duration at night.

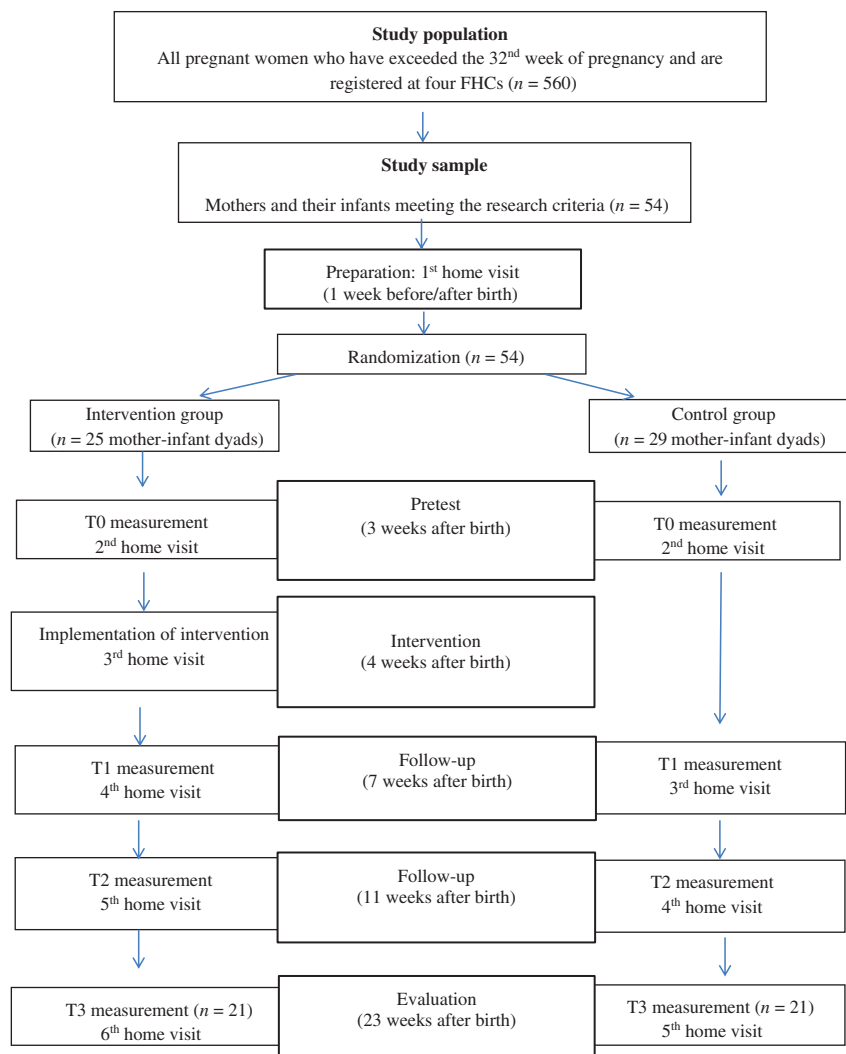


Figure 1 Flow diagram of this study. FHC, family health center.

The total daily sleep duration is determined by adding the day and night sleep durations (min). The crying and feeding status of the infant also is determined in the same way as the calculation of the sleep duration. The mean crying durations, sleep durations, the frequency of waking, and frequency of feeding were calculated by the researchers. The ISAR has been used previously in Turkey and in different countries (Blom, van Sleuwen, de Vries, Engelberts, & L'Hoir, 2009; Elliot, Reilly, Drummond, & Letourneau, 2002; St James-Roberts, 2001; van Sleuwen *et al.*, 2006; Yilmaz & Conk, 2009).

The Easy Way to Soothe the Baby manual consists of 48 pages and was prepared by the researchers by taking "The Happiest Baby on the Block" as a reference (Karp, 2003). How the circadian rhythm of infants is formed, causes of crying, regulation of sleep, and importance of the 4S soothing techniques and how to

use them were explained in the manual. Ten experts (faculty members, physicians, nurses) were asked for their opinions on the content validity of the manual (Kendall's $W = 0.12$, $\chi^2 = 22.50$, $P = 0.951$).

The Easy Way to Soothe the Baby video was prepared by the researchers in accordance with the information in respect to the manual by taking "The Happiest Baby on the Block" video that had been prepared by Karp (2003) as a reference. This 22 min video includes information and skills about how the mother should carry out the 4S soothing techniques. Seven faculty members who are experts in their field were asked for their opinions on the content validity of the video (Kendall's $W = 0.37$, $\chi^2 = 32.72$, $P = 0.810$).

The White Noise CD is a 69 min audio CD consisting of a total of six sounds of a strong and a weak hairdryer sound, rain sound, and strong, moderate, and weak

arterial uterine sounds to create white noise. The mothers were asked to make their infant listen to the white noise from a distance of at least 50 cm away when the crying continued. The level of white noise was as high as the noise level of the infant's crying. It did not exceed the noise level of the infant's crying (Karp, 2003).

The Standard Baby Care manual consists of 36 pages and was prepared by the researchers, including topics such as breastfeeding, breast care and milk crust, mouth and eye care, and body bathing (World Health Organization, 2015). Ten experts were asked for their opinions on the content validity of the manual (Kendall's $W = 0.10$, $\chi^2 = 18.70$, $P = 0.228$).

The manuals that were developed to be used in the training sessions were evaluated in terms of readability. The simple measure of gobbledygook (SMOG) formula was used to determine the readability of the written training materials (Mc Laughlin, 1969). The SMOG readability value was determined to be 17.79 for "The Easy Way to Soothe the Baby manual" and 18.59 for the "Standard Baby Care manual." According to the SMOG readability conversion table, it was determined that these values corresponded to the seventh grade level of education. It was determined that the comprehensibility of the written training tools was appropriate for the mothers' educational levels.

Procedure

Preparation stage

During the first home visit, the standard baby care manuals were given to the IG and CG mothers and individualized health training was provided on baby care (Table 1). During the entire study, routine follow-ups of the infants in the IG and CG were maintained by their family physicians.

Implementation of the technique

During the second home visit, the infant sleep activity record (ISAR) was given to the mothers in the IG and CG for the pretest (T0). After the T0 measurement was obtained, the home visit was made in each IG mother's own house 4 weeks after birth by the first researcher and a 90 min education program was applied by using The Easy Way to Soothe the Baby manual and video (Fig. 1, Table 1).

It was demonstrated how to swaddle, how to hold the baby in a side or stomach position, how to apply shushing or white noise, and how to swing vertically on the lap or knee, respectively. The mothers were asked to show what they were taught on their infant again. They controlled the hunger and fullness clues, the desire to be hugged, and the need for changing the diaper in the

Table 1 Training content of the study

Stage	Subject of education	Date	Time	Instrument
Preparation	Breastfeeding training	1 week	45 min	Mother and Infant Description Form
	Duration of breastfeeding Breastfeeding holding positions Breast care Storing milk Pretest of self-regulation behaviors	before/after birth		Standard Baby Care manual
Intervention	Importance of the formation of self-regulation behaviors	3 weeks after birth	45 min	Infant Sleep Activity Record
	What are self-regulation behaviors, how do they develop? (teaching hunger-fullness clues, creating routine, regulation of the environment etc.)	4 weeks after birth	90 min	Mother and Infant Description Form Infant Sleep Activity Record The Easy Way to Soothe the Baby manual and video
	The effect of soothing techniques on self-regulation behaviors			
	Sleeping, crying, and feeding routines of the infant			
Follow-up	Follow-up of self-regulation behaviors	7 weeks after birth	45 min	Infant Sleep Activity Record
	Follow-up of self-regulation behaviors	11 weeks after birth	45 min	Infant Sleep Activity Record
Evaluation	Evaluation of self-regulation behaviors	23 weeks after birth	45 min	Infant Sleep Activity Record

Table 2 Demographics and homogeneity of the intervention and control groups

Characteristic		Intervention group (<i>n</i> = 21)		Control group (<i>n</i> = 21)		χ^2 / t	<i>P</i>
		N or mean \pm SD	%	N or mean \pm SD	%		
Sex of infant	Female	11	52.4	11	52.4	0.01	<0.999
	Male	10	47.6	10	47.6		
Method of childbirth	Vaginal delivery	5	23.8	7	33.3	0.46	0.495
	Cesarean section	16	76.2	14	66.7		
Mean gestation birth week of the infant ($X \pm SD$)		38.85 \pm 1.27		39.52 \pm 1.35		1.63	0.110
Mean of mother's age ($X \pm SD$)		26.76 \pm 3.78		26.00 \pm 4.31		0.65	0.575
		(min. = 22, max. = 34)		(min. = 20, max. = 35)			
Education level of mother	\leq Secondary school	5	23.8	6	28.6	2.10	0.147
	\geq High school	16	76.2	15	71.4		
Family type	Nuclear	7	33.3	10	47.6	1.05	0.293
	Extended	14	66.7	11	52.4		
Income status	Income < expense	1	4.8	4	19.1	4.49	0.105
	Income = expense	16	76.2	15	71.4		
	Income > expense	4	19.0	2	9.5		
Smoking	Yes	2	9.5	5	23.8	1.54	0.214
	No	19	90.5	16	76.2		
Number of cigarettes smoked (cigarettes/day)		2.00 \pm 0.00		3.54 \pm 2.38		0.84	0.448
		(min. = 2, max. = 2)		(min. = 1, max. = 6)			

Max., maximum; min., minimum; SD, standard deviation.

crying episodes of their infant. If none of these was effective, they were encouraged to try the following 4S soothing techniques simultaneously. As a reminder, a mother–infant-themed magnet was given to all the mothers and a blanket was given for the mothers in the IG to carry out swaddling. During the home visit that was made for the mothers in the CG, no health training program that was related to the soothing of the infant was implemented.

Follow-up and evaluation stage

The ISARs that were filled out by the mothers were collected by making home visits in the seventh and 11th weeks for the T1 and T2 measurements. During the last home visit that was made for all the mother–infant dyads 23 weeks after the training program, the ISARs were collected again for the evaluation measures (T3) (Fig. 1, Table 1).

Measurement

The pretest (T0) measurement was carried out during the follow-up in the third week before the intervention was applied and the post-test measurements were made in the seventh week (T1), 11th week (T2), and 23rd week (T3) after the intervention was applied. These follow-ups were decided to be conducted during the

weeks before vaccination as it can cause pain and discomfort (Fig. 1).

The parent-reported total daily sleep duration, frequency of waking at night, total daily crying duration, and frequency of daily feeding of the infants in weeks 3, 7, 11, and 23 are the dependent variables of the study. The main independent variables of the study are the 4S techniques.

Data analysis

The IBM SPSS (v. 17.0; IBM Corporation, Armonk, NY, USA) program was used in the analysis of the data. Kendall's goodness-of-fit was used in the examination of compliance among the experts and Fisher's Kurtosis–Skewness coefficient and Kolmogorov–Smirnov with Lilliefors significance correction were used in the determination of the homogeneity of the data. The number–percentage distribution, Mann–Whitney U-test, independent *t*-test, chi-squared test, and Friedman analysis were used in the analysis of the data. The significance level was accepted as $P < 0.05$. The Bonferroni-corrected Wilcoxon's signed-rank test was used to determine from which follow-up the difference that was occurring in the self-regulation behaviors during the follow-up weeks resulted. The corrected significance level was determined to be $0.05/6 = 0.0083$. Accordingly, the significance level was accepted as 0.01.

Ethical considerations

Approval was obtained from the Scientific Ethics Committee at Ege University (approval no. 2011-170), Izmir, Turkey, and written consent was obtained from the Provincial Directorate of Health and the mothers. The first researcher participated in The Happiest Baby online educator certification program in order to apply the 4S soothing techniques.

RESULTS

Sample characteristics

Table 2 shows the descriptive characteristics of the infants and their mother. The chi-squared and independent *t*-tests determined that there were no statistically significant differences between the IG and CG for all variables ($P > 0.05$).

Self-regulation behaviors (sleeping, crying, and feeding)

Sleep duration

In the third week (before the intervention, T0), the mean total sleep duration of the infants in the IG was found to be 739.82 ± 68.40 min/24 h, while the mean total sleep duration of the infants in the CG was 779.97 ± 46.76 min/24 h ($U = 164.500$, $P = 0.159$). In T1 after the intervention, the mean total sleep duration of the infants in the IG was 625.91 ± 57.81 min/24 h, while the mean total sleep duration of the infants in the CG was 542.13 ± 46.76 min/24 h ($U_{T1} = 107.000$, $P = 0.004$). In T2, the mean total sleep duration of the infants in the IG was 615.85 ± 57.81 min/24 h and the mean total sleep duration of the infants in the CG was 550.22 ± 48.26 min/24 h ($U_{T2} = 134.500$, $P = 0.030$). In T3, the mean total sleep duration of the infants in the IG was 626.18 ± 58.50 min/24 h, whereas the mean total sleep duration of the infants in the CG was 586.24 ± 56.42 min/24 h ($U_{T3} = 155.000$, $P = 0.089$) (Table 3).

There was a statistically significant difference between intragroup comparisons in terms of the mean daily sleep duration of the infants ($\chi^2_{IG} = 13.35$, $P = 0.001$; $\chi^2_{CG} = 33.56$, $P = 0.005$) (Table 3). In the comparisons that were made for the groups in the Bonferroni-corrected Wilcoxon's signed-rank test, it was determined that the statistical difference in the mean total sleep duration of the infants in the IG was related to the T1 and T2 measurements ($P = 0.002$) and the intragroup difference in the mean total sleep duration of

the infants in the CG was related to the T0 measurement ($P = 0.007$).

Frequency of waking at night

In the T0 measurement, the infants in the IG woke up 6.01 ± 1.68 times on average and the infants in the CG woke up 7.24 ± 2.07 times on average during the night hours ($U_{T0} = 173.000$, $P = 0.224$). In the T1 measurement, the infants in the IG woke up 5.46 ± 1.20 times on average and the infants in the CG woke up 7.01 ± 2.24 times on average ($U_{T1} = 88.500$, $P = 0.001$). In the T2 measurement, the infants in the IG woke up 4.26 ± 1.68 times on average, while the infants in the CG woke up 7.17 ± 1.63 times on average ($U_{T2} = 72.500$, $P = 0.001$). In the T3 measurement, the infants in the IG woke up 3.84 ± 1.09 times on average, whereas the infants in the CG woke up 4.75 ± 1.75 times on average ($U_{T3} = 133.000$, $P = 0.022$) (Table 3).

A statistically significant difference was found between the T0 and T3 measurements in the mean frequency of waking at night of the infants in the IG and CG ($\chi^2_{IG} = 33.07$, $P = 0.001$; $\chi^2_{CG} = 35.91$, $P = 0.001$) (Table 3). It was determined that the statistical difference in the mean frequency of waking at night in the IG was related to the T3 measurement ($P = 0.001$) and the intragroup difference in the mean frequency of waking at night in the CG was related to the T1 and T3 measurements ($P = 0.001$).

Crying duration

In the T0 measurement, the infants in the IG and CG cried for 130.26 ± 22.16 min/24 h and 138.42 ± 27.09 min/24 h on average, respectively ($U_{T0} = 166.000$, $P = 0.169$). In the T1 measurement, the mean crying duration of the infants in the IG and CG was 139.24 ± 23.15 min/24 h and 190.22 ± 24.96 min/24 h, respectively ($U_{T1} = 87.000$, $P = 0.001$). In the T2 measurement, the infants in the IG and CG cried for 97.85 ± 16.93 min/24 h and 142.91 ± 25.35 min/24 h on average, respectively ($U_{T2} = 56.500$, $P = 0.001$). In the T3 measurement, the mean crying duration of the infants in the IG and CG was 42.37 ± 11.22 min/24 h and 58.33 ± 13.24 min/24 h, respectively ($U_{T3} = 145.500$, $P = 0.030$) (Table 3).

There was a statistically significant difference in the average total daily crying duration between the T0 and T3 measurements of the infants in the IG and CG ($\chi^2_{IG} = 49.95$, $P = 0.001$; $\chi^2_{CG} = 51.26$, $P = 0.001$) (Table 3). In the comparison that was made within the

Table 3 Comparison of the self-regulation behaviors of infants in the intervention and control groups during the measurements

Self-regulation behavior	Intervention group (mean \pm SD)				Control group (mean \pm SD)				Group effect U	P
	Total sleep duration (min) [†]	Frequency of waking at night [‡]	Total crying duration (min) [§]	Frequency of feeding [¶]	Total sleep duration (min) [†]	Frequency of waking at night [‡]	Total crying duration (min) [§]	Frequency of feeding [¶]		
T0 (3rd week)	739.82 \pm 68.40	6.01 \pm 1.68	130.26 \pm 22.16	15.89 \pm 1.91	779.97 \pm 46.76	7.24 \pm 2.07	138.42 \pm 27.09	15.64 \pm 2.01	164,500	0.159 [†]
									173,000	0.224 [‡]
									166,000	0.169 [§]
									172,500	0.224 [¶]
T1 (7th week)	625.91 \pm 57.81	5.46 \pm 1.20	139.24 \pm 23.15	12.61 \pm 1.69	542.13 \pm 46.76	7.01 \pm 2.24	190.22 \pm 24.96	15.92 \pm 1.93	107,000	0.004 [†]
									88,500	0.001 [‡]
									87,000	0.001 [§]
									78,000	0.001 [¶]
T2 (11th week)	615.85 \pm 57.81	4.26 \pm 1.68	97.85 \pm 16.93	10.76 \pm 1.54	550.22 \pm 48.26	7.17 \pm 1.63	142.91 \pm 25.35	14.93 \pm 1.72	134,500	0.030 [†]
									72,500	0.001 [‡]
									56,500	0.001 [§]
									73,500	0.001 [¶]
T3 (23th week)	626.18 \pm 58.50	3.84 \pm 1.09	42.37 \pm 11.22	8.03 \pm 1.19	586.24 \pm 56.42	4.75 \pm 1.75	58.33 \pm 13.24	10.51 \pm 1.44	155,000	0.089 [†]
									133,000	0.022 [‡]
									145,500	0.030 [§]
									101,000	0.002 [¶]
χ^2	13.350	33.070	49.950	56.340	33.560	35.910	51.260	55.520		
P ^{††}	0.001	0.001	0.001	0.001	0.005	0.001	0.001	0.001		

[†] Mann-Whitney U-test for total sleep duration.[‡] Mann-Whitney U-test for frequency of waking at night.[§] Mann-Whitney U-test for total crying duration.[¶] Mann-Whitney U-test for frequency of feeding.^{††} The Bonferroni corrected Wilcoxon's signed-rank test.

group, the difference in the mean crying duration of the infants in the IG was related to the T2 and T3 measurements ($P = 0.001$), while the intragroup difference in the mean crying duration of the infants in the CG was related to the T3 measurement ($P = 0.001$).

Frequency of feeding

In the T0 measurement, the mean total frequency of feeding of the infants in the IG and CG was $15.89 \pm 1.91/24$ h and $15.64 \pm 2.01/24$ h, respectively ($U_{T0} = 172.500$, $P = 0.224$). In the T1 measurement, the mean total frequency of feeding of the infants in the IG and CG was $12.61 \pm 1.69/24$ h and $15.92 \pm 1.93/24$ h, respectively ($U_{T1} = 78.000$, $P = 0.001$). In the T2 measurement, the mean total frequency of feeding of the infants in the IG and CG was $10.76 \pm 1.54/24$ h and $14.93 \pm 1.72/24$ h, respectively ($U_{T2} = 73.500$, $P = 0.001$). In the T3 measurement, the mean total frequency of feeding of the infants in the IG and CG was $8.03 \pm 1.19/24$ h and $10.51 \pm 1.44/24$ h, respectively ($U_{T3} = 101.000$, $P = 0.002$) (Table 3).

In the T0–T3 measurements, a statistically significant difference was found in the mean total frequency of feeding of the infants in both groups ($\chi^2_{IG} = 56.34$, $P = 0.001$; $\chi^2_{CG} = 55.52$, $P = 0.001$) (Table 3). In the comparison that was made within the group, the difference in the mean frequency of feeding of the infants in the IG and CG was related to the T2 and T3 measurements ($P = 0.001$, $P = 0.001$).

DISCUSSION

The infant's ability to form self-regulation behaviors is one of the most important indicators of healthy development in his or her later years (Bilgin & Wolke, 2017; Kaley *et al.*, 2012; Karp, 2003; Whittingham & Douglas, 2014). It has been stated in studies that the women who become a mother for the first time pose a risk in terms of the regulation of their infant's behaviors, such as sleeping, crying, and feeding, because they have difficulty in adapting to their new roles (Kaley *et al.*; Yilmaz & Arıkan, 2015). In the studies carried out on the subject, it has been proven that behavioral interventions have a positive contribution to the regulation of sleeping, crying, and feeding of the infant (Blom *et al.*, 2009; Douglas & Hill, 2013; Richardson *et al.*, 2010). However, the effect of 4S soothing techniques on these three behaviors has not been examined at the same time in any study. The 5S soothing techniques that were developed by Karp previously were used to control pain and

postvaccination crying (Harrington *et al.*, 2012; Martiningih & Setijaningsih, 2015; Setiyorini & Wulandari, 2014). In this study, the effect of soothing techniques, which are taught to mothers by nurses using the video and manuals, on the formation of self-regulation behaviors in 3–23 week old infants was examined. The mothers applied what they had learned in the training program during the follow-ups. Adachi *et al.* (2009) and Hiscock *et al.* (2014) carried out 10 min training with a training manual in their studies.

Along with the determination that the IG slept more than the CG, H1 was confirmed. The difference between the two groups was statistically significant in the other follow-ups, except for the T3 measurement ($P < 0.05$). In the study, the gradual decrease in the sleep duration of the infants in the IG and CG in the T3 measurement also suggested that the infants had experienced an improvement, depending on their biological maturity in the sixth month (Barnard, 1999; Karp, 2003; Paul *et al.*, 2011).

The total sleep duration of the infants in the IG and CG in the baseline measurement is similar to the literature (Hiscock *et al.*, 2014; McRury & Zolotor, 2010). McRury and Zolotor did not find a difference between the sleep duration in the sixth and eighth weeks of the infants who were administered with the 5S soothing techniques and the sleep duration of the infants in the CG, to which no intervention was applied. Kelly *et al.* (2017), Meyer and Erler (2011), and Richardson *et al.* (2010) determined that the swaddled infants slept more than the infants who were not swaddled, similarly to this study. Bayer *et al.* (2011) proved that rocking has positive effects on the sleep quality of infants, Adachi *et al.* (2009) proved that hugging and changing the diaper have positive effects on the sleep duration of infants, and because the hypothalamus is insufficient to regulate the body temperature until the first 2 months, it has been determined that behavioral interventions, such as 4S of the mentioned evidence, are important and necessary for the formation of the circadian rhythm (Karp, 2003).

In the study, it was determined that the infants woke up at a similar frequency in all follow-up weeks, compared to the durations specified in the literature (Adachi *et al.*, 2009; Anuntaseree *et al.*, 2008). It was determined in the study that the frequency of waking at night in the IG decreased, while the frequency of waking at night in the CG remained unchanged during the weeks after the intervention. The fact that the difference between the two groups was found to be statistically significant confirmed H2 of the study. Although Adachi

et al. determined in their study that the infants who were administered with an intervention for organizing the sleeping environment woke up less frequently at night, compared to the infants in the CG, Meyer and Erler (2011) determined that the swaddled infants woke up less frequently than the infants who were not swaddled. Anuntaseree *et al.* determined that the infants who were swung when they were 3 months old woke up 1.5-fold more at night, compared to the infants who were not swung, while Douglas and Hill (2013) determined in their systematic review study that behavioral interventions had a positive effect in terms of the sleeping outcomes of infants during the first 6 months of life. It was determined that the administration of soothing interventions decreased the frequency of waking at night of the infants.

In the literature, it has been stated that the crying behaviors of infants are mostly observed in the fourth and sixth weeks after birth and gradually decrease after the 12th week (Barr, Trent, & Cross, 2006; Blom *et al.*, 2009; Yilmaz & Arıkan, 2015). In this study, the highest amount of crying of the infants in both groups was observed in week 7, as indicated in the literature. In the studies that were carried out in Iran and Turkey, it was determined that the crying duration of infants was longer, compared to infants in North America and Europe (Barr *et al.*; Blom *et al.*; Çiftçi & Arıkan, 2007; McRury & Zolotor, 2010; Nahidi, Gazerani, Yousefi, & Abadi, 2017; van Sleuwen *et al.*, 2006).

In this study, although the crying duration decreased in the IG after the T1 measurement, it was determined that the mean crying duration in the CG during the T2 measurement was even more than in T1, compared to those in the IG. Along with the determination that the infants in the IG cried less than the infants in the CG ($P < 0.05$), H3 of the study was confirmed. Blom *et al.* (2009) examined the crying duration of infants to whom a swaddling intervention was applied; they determined that the crying duration, which was 30–40 min on the first day, decreased by 42%, 50%, and 75% in weeks 1, 2, and 8, respectively. van Sleuwen *et al.* (2006) determined that the infants cried for 170 min on the first day, on which the intervention began to be applied, and for 110 min on the seventh day of the intervention, and that the crying duration decreased by 60 min (35%) at the end of the 7 day follow-up. In their study in which Nahidi *et al.* (2017) examined the effect of massage and rocking interventions on the crying duration, they determined that the crying duration of the infants in the massage group (298 min) and the infants in the rocking group (180 min) statistically

significantly decreased on the seventh day after the intervention. In the comparison between groups, they determined that the massage group was more effective than the rocking group (79.2 min *vs* 134 min). Yilmaz and Arıkan (2015) determined that the crying duration of the infants who were swung both on the lap and in the blanket decreased after the intervention. However, McRury and Zolotor (2010) did not find a significant relationship between the crying duration of the infants who were administered with the 5S soothing techniques and the infants in the CG without any intervention in weeks 1, 6, 8, and 12. In this study, it was determined that the infants in the IG cried for ~50 min less at the T1 and T2 measurements and 17 min less at the T3 measurement, compared to those in the CG ($P < 0.05$). In the relevant studies, it was determined that the difference between the crying duration of the infants in the IG and CG was at its maximum in weeks 6–8 and that the difference between groups decreased after week 12 (Barr *et al.*, 2006; Blom *et al.*; Çiftçi & Arıkan, 2007; McRury & Zolotor; Nahidi *et al.*). The reason for the decrease in the difference between the two groups during week 23 was interpreted as the result of a gradual decrease in crying after the fourth month. According to the Bonferroni-corrected Wilcoxon's signed-rank test analysis, the fact that the difference in the crying duration of the IG was related to the T2 and T3 measurements and that the difference in the CG was related to the T3 measurement also supports this interpretation. This result also shows the necessity of the early start of soothing techniques.

In a study on the subject, it was stated that the most important variable that disturbs mothers' sleep and causes them to feel inadequate in the first 6 months of their infant's life is the feeding irregularity of their infant (Bilgin & Wolke, 2017). It was determined that the frequency of breastfeeding in the IG linearly decreased from the T0 measurement towards the T3 measurement. It was determined that the infants in the CG continued in a similar way in the T1 and T2 measurements.

Along with the determination that the infants in the IG were breastfed for about threefold less at the T1 measurement, about fourfold less at the T2 measurement, and about twofold less at the T3 measurement, compared to the CG ($P < 0.05$), H4 of the study was confirmed. When the relevant literature was examined, it was realized that the effects of behavioral interventions on the frequency of the feeding of infants have never been examined, except in one study by Paul *et al.* (2011), who determined that the frequency of feeding at

night of the group that received the “soothe/sleep” intervention decreased statistically significantly, compared to the group that did not receive the intervention. The necessity of carrying out investigations has been revealed for the determination of the effects of behavioral interventions on the regulation of infants' frequency of feeding.

Within the scope of the self-regulation behaviors in the infants in the IG and CG, the sleep duration, frequency of waking at night, crying duration, and frequency of feeding were found to be statistically different during the T0–T3 measurements. The reason is that feeding, sleeping, and crying depend on regulation in the sixth month that is related to the nature of the dependent variable that was examined. However, this improvement took place in the IG as from the T1 measurement, while it took place in the CG as from the T3 measurement. Based on this result, although feeding, sleeping, and crying improved in the sixth month without applying any intervention, a statistically significant improvement took place in the first measurement after the intervention was applied in the IG.

As a result of this study and the application of any soothing intervention, the results that were obtained for the regulation of infants' sleeping, crying, and feeding behaviors can be compared. Thus, generalization of the findings can be made through comparisons.

Recommendations for future research

The 4S soothing techniques have a positive contribution to the regulation of sleeping, crying, and feeding of the infant. As a result of the reduction of time and workforce losses of researchers in terms of cost-effectiveness, it will be useful for them to conduct interventions regarding self-regulation behaviors during the first 12 weeks of the infancy period. Differences that might occur during the application of soothing techniques at early or later weeks can be examined by other investigations. Furthermore, it was determined that the effects of behavioral interventions on the frequency of the feeding of infants were examined in a very limited number of studies. It was revealed that studies should be carried out to determine the effect of behavioral interventions on the regulation of the infants' frequency of feeding. The differences between the self-regulation behaviors, especially the crying behaviors, of infants in different cultures can be examined. Thus, culture-specific approaches can be created. Health professionals can evaluate the crying, sleeping, and feeding patterns of infants by collecting detailed data on infants' crying,

sleeping, and feeding patterns within the scope of diagnosis during the follow-up process of infants and can inform and follow families by identifying early-period problematic situations that are related to self-regulation behaviors.

Limitations of the study

As the research was a randomized controlled experimental study, the sample group was limited to 42 mother–infant dyads. In the study, the follow-up of the mother and infant was limited to 6 months. As a result of the researchers' home visits and the ease of access to the families, the study was carried out in only a single region. The results that were related to the sleeping, crying, and feeding behaviors of infants that were recorded in the infant sleep diary were evaluated according to the parental reports. The soothing techniques, the effect of which were examined in this study, were limited to swaddling, the side or stomach position, shushing or white noise, and swinging, called “4S.”

CONCLUSION

The results of the study have provided pieces of evidence concerning the importance of the 4S techniques in the formation of the self-regulation behaviors regarding the frequency of feeding, sleep duration, and crying duration of the infant. In the formation of these pieces of evidence, the 4S techniques were found to be the most effective during the seventh and 11th weeks in the development of the sleeping, crying, and feeding behaviors within the context of the infants' self-regulation behaviors. It was determined that the difference with respect to the regulation of sleeping, crying, and feeding behaviors in week 23 between the two groups of infants decreased and the effect of the soothing techniques decreased in week 23.

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DISCLOSURE

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

R. Ö. D. and A. B. T. contributed to the design of the study; R. Ö. D. coordinated the data collection, analyzed the data, and wrote the manuscript; and R. Ö. D. and A. B. T. revised the manuscript. Both authors read and approved the final version of the manuscript.

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