Effects of breastfeeding and heel warming on pain levels during heel stick in neonates

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Abstract
Aim: To determine the effects of two different methods, breastfeeding and heel warming, during heel stick procedures on pain levels in healthy term neonates.

Methods: This study was a prospective, randomized controlled trial. The sample of the study consisted of 150 healthy newborns who matched the case selection criteria and were brought to the nursery for the heel stick procedure. Fifty neonates were randomly assigned to each group: breastfeeding (n = 50), heel warming (n = 50), and control (n = 50), using computer-based randomization. The study data were obtained using an Information Form and the Neonatal Infant Pain Scale (NIPS).

Results: The pre-procedural pain scores of the breastfeeding group (mean 4.44 SD 1.21 seconds) were lower than in the heel warming (mean 6.10 SD 1.07 seconds) and the control group (mean 6.42 SD 0.91 seconds) (P < 0.01). Both the total crying time and the first calming time of the breastfeeding group were shorter than the heel warming and control group. The first calming time of the heel warming group was shorter than in the control group.

Conclusions: Both breastfeeding and heel warming are effective in reducing the calming time during heel stick procedures. However, breastfeeding is more effective than heel warming in reducing pain during heel stick and should be preferred as the first choice.

KEYWORDS
breastfeeding, heel stick, heel warming, newborn, pain

SUMMARY STATEMENT
What is already known about this topic?
• Nonpharmacologic methods are effective in reducing heel stick-related pain in newborns during heel stick procedures.

What this paper adds?
• The results of this randomized controlled trial provide evidence that breastfeeding is effective in reducing pain levels of newborns during heel stick procedures.
• Breastfeeding and heel warming are effective in reducing the calming time of newborns during heel stick procedures.

The implications of this paper:
• This study contributes to the literature on nonpharmacologic pain relief methods during heel stick procedures in healthy term newborns.
• Nurses should encourage breastfeeding to relieve pain during heel stick procedures in newborns and use both breastfeeding and heel warming to reduce the calming time.
• Heal warming methods can be preferred as a pain management strategy for neonates who do not breastfeed.

1 | INTRODUCTION

Healthy newborns face a variety of painful procedures from the first moments of their lives. Acute pain due to medical procedures causes physiologic changes such as behavioural stress and decreased oxygen saturation, haemodynamic instability, and increased intracranial pressure (Zhu et al., 2015; Witt, Conynor, Edwards, & Bradshaw, 2016; Obeidat & Shurique, 2015). These problems, which are caused by pain, adversely affect the baby's sense of the external world, growth and development, and family-baby interaction (Obeidat & Shurique, 2015). In the long term, babies for whom pain has not been relieved or prevented can be observed to have difficulties in adapting to the external world. Additionally, developmental disorders of the brain and senses, adverse effects of family-infant interaction, hypersensitivity to painful stimuli in the future life, and impaired social skills, emotional problems, hyperactivity, and attention deficits may develop (Gradin, Eriksson, Holmqvist, Holstein, & Schollin, 2002; Obeidat & Shurique, 2015). In order to minimize these negative conditions, the International Neuropsychiatric Pain Group and American Academy of Paediatrics recommend reducing pain in infants and using nonpharmacologic pain relief methods as the priority option in newborns (Anand & Phil, 2001; American Academy of Paediatrics (APA), 2000).

Heel stick, which is used for diagnosis in newborn screening tests, is one of the most frequently performed interventions with newborns (da Motta & da Cunha, 2015; Morrow, Hidinger, & Faulk, 2010; Okan, Ozdi, Bulbul, Yapici, & Nuhoglu, 2010; Prasopkittikun & Tilokskulchai, 2003). At present, it is recommended to use pharmacologic and nonpharmacologic methods with invasive medical procedures in newborns. Due to the undesirable adverse effects of pharmacologic interventions in the management of pain, interest in nonpharmacologic methods is increasing and becoming widespread (da Motta & da Cunha, 2015; Shu, Lee, Hayter, & Wang, 2014).

Nonpharmacologic methods that are commonly used to reduce the effects of invasive procedures in newborns include breastfeeding (Obeidat & Shurique, 2015; Pillai Ridell, et al., 2015; Harrison et al., 2016; Okan et al., 2010; Yilmaz & Arikan, 2011; Shah, Herbozo, Aliwalas, & Shah, 2012; Uga et al., 2008; Marín Gabriel et al., 2013; Aguilar Cordero, Mur Villar, García García, Rodríguez López, & Rizo Baeza, 2014), pacifiers (da Motta & da Cunha, 2015; Yilmaz & Arikan, 2011), and sucrose and sweet solutions (Kassab, Anabrees, Harrison, Khriesat, & Chen, 2017; Kassab, Foster, Foureur, & Fowler, 2012; Pillai Ridell et al., 2015; Yilmaz & Arikan, 2011). Other alternatives include music therapy (Marofi, Nikobakht, Badiee, & Golchin, 2015); massage, touching, and positioning (Hartley, Miller, & Gephart, 2015); and nesting, kangaroo care, foetal positioning, and wrapping (Morrow et al., 2010; Prasopkittikun & Tilokskulchai, 2003; Okan et al., 2010; Obeidat & Shurique, 2015; Ali, McGrath, & Drendel, 2016; Cong, 2015; Shu et al., 2014). Breastfeeding is reported as effective in reducing pain during minor painful procedures (Chromá & Sikorová, 2012; da Motta & da Cunha, 2015; Obeidat & Shurique, 2015; Shah et al., 2012), and it is suggested that it should be used to reduce pain during interventional procedures in newborns (Ali et al., 2016; Reece-Stremtan & Gray, 2016; Shah et al., 2012).

One of the recently adopted methods used to reduce pain during neonatal heel stick procedures is heel warming (Cong, 2015; Zhu et al., 2015). Heel warming increases vascularity by causing vasodilatation in the region and facilitates sampling by accelerating blood flow (Icke & Genc, 2016; Janes, Pinelli, Landry, Downey, & Paes, 2002). It is also reported that vasodilatation provided by heel warming influenced the duration of the bleeding process and the crying period of the newborn (Cong, 2015; Zhu et al., 2015). It has been found that neonates have a significant decrease in pain perception when heel warming is used during heel stick procedures (Cong, 2015; Obeidat & Shurique, 2015; Shah et al., 2012; Uga et al., 2008; Zhu et al., 2015).

Although heel warming is proposed as an inexpensive, effective, and easy-to-use method in the literature, nurses working in the related field state that heel warming is time consuming and not practical in units with a large number of patients (Janes et al., 2002). In addition, the nurses in the units where the study was conducted also stated that breastfeeding was an easier and more practical way and was effective for reducing pain. Although studies have shown that breastfeeding and heel warming are effective in reducing pain associated with heel stick procedures around the world, no studies have compared the efficacy of breastfeeding and heel warming during heel stick procedures.

For this reason, this research aimed to demonstrate the efficacy of heel warming and breastfeeding in reducing pain during heel stick procedures, and to compare the efficacy of the two methods even though these methods are not similar. The results obtained will provide significant contributions to the literature in terms of the comparative effectiveness of these two methods. This study was therefore planned to evaluate the effect of two different nonpharmacologic pain relief methods (breastfeeding and heel warming) on healthy term newborns' pain levels during heel stick procedures.

The hypotheses of this study were as follows:

Hypothesis 1. Breastfeeding is effective at relieving pain due to heel stick procedures in newborns.

Hypothesis 2. Heel warming is effective at relieving pain due to heel stick procedures in newborns.

Hypothesis 3. Breastfeeding is more effective than heel warming at relieving pain due to heel stick procedures in newborns.

2 | METHODS

2.1 | Design

This study was designed as a prospective, randomized clinical trial that evaluated and experimentally determined the effects of breastfeeding...
and heel warming during heel stick procedures on pain levels in healthy term neonates.

2.2 Setting and sample

This study was conducted in the baby’s nursery of Bandırma State Hospital, Turkey. The study population comprised all newborns who were scheduled to receive routine blood tests for metabolic screening via heel stick procedures; the study sample consisted of 150 healthy newborns who matched the case selection criteria and who underwent heel stick procedures. The inclusion criteria were as follows: term neonates (38-42 weeks of gestation) who underwent heel stick blood drawing for routine metabolic screening, age 2 to 4 days. Babies with congenital feeding-related anomalies were excluded from the study.

In the power analysis conducted based on heel stick literature (Obeidat & Shuriquie, 2015; Shu et al., 2014; Zhu et al., 2015), the sample size required for 80% reliability and \( \alpha = 0.05 \) was calculated as 50 in each of the experimental and control groups, totalling 150 neonates. After the size of the sample was determined, randomization of the experimental and control groups was performed by the researcher using a computer-based random number table program. Neonates were randomized by the researcher into three groups: breastfeeding (n = 50), heel warming (n = 50), and control (n = 50) (Figure 1). Numbers from 1 to 150 were randomly distributed using a computer program to the three groups with no number repetition to determine which child would be allocated to which group. The researcher randomly picked one code for each neonate to ensure the 150 neonates were equally allocated into three groups based on the group number of each code: group 1 (control group), group 2 (heel warming (HW) group), and group 3 (breastfeeding (BF) group).

2.3 Participant groups

2.3.1 Breastfeeding group

Neonates in this group were breastfed during heel stick blood sampling and held in their mothers’ lap while their mothers were seated in a reclined position on a comfortable chair. The heel stick procedure did not start until the neonates were observed to be sucking at the breast. Breastfeeding started just before the procedure (1 minute before) and continued for a minimum of 2 minutes during and after the procedure.

2.3.2 Heel warming group

A thermal bag was used to heat the heel area before the heel stick procedure. The thermal bag, which is also recommended for colic pain in newborns, is made of a nonleaking material with a fabric sheath, filled with warm water, and tightly closed. Superficial heat between 40°C and 45°C increases the blood flow. In the literature, a study (Shu et al., 2014) using Lehmann’s suggested 40°C to 45°C heel warming increased blood flow; we put water at 40°C in the thermal bag and applied it against the puncture point for 3 to 5 minutes before the heal stick procedure. The heel stick procedure was performed immediately after removing the thermal bag.

2.3.3 Control group

In the control group, the heel stick procedure was conducted using the standard method, and the neonates received no intervention during the procedure. No nonpharmacologic methods for reducing pain during routine heel stick procedures were in routine use in the institution where the study was conducted.

2.4 Measurements

The study data were obtained using an Information Form and the Neonatal Infant Pain Scale (NIPS).

2.4.1 Information Form

This form contained questions about the sociodemographic characteristics of the neonates and families.

2.4.2 Neonatal Infant Pain Scale (NIPS)

NIPS was developed by Lawrence et al. (1993) to evaluate behavioural and physiologic pain responses of preterm and term infants. In the present study, NIPS was used to evaluate the interventional (procedural) pain level of newborns. The scale consists of five behavioural (facial expressions, crying, wakefulness, arm and leg movements) and physiologic (breathing) signs; 0 to 2 points are given to the crying indicator, 0 to 1 points are given to the other indicators, and the total
score is between 0 and 7. High scores indicate that the severity of pain is excessive.

2.5 | Data collection

All blood sampling was performed in a quiet nursery room between 09:00 AM and 11:00 AM, the normal time when infants undergo heel stick procedures for routine blood collection for metabolic screening. Blood collection was performed in a standardized manner by the same nurse, with a minimum of 5 years' experience in the performance of heel stick procedures. The clinical decision to undertake heel stick procedures was the responsibility of a paediatrician, not this nurse.

Before the procedure, the newborns were kept in a quiet room far away from the cries of other babies. The infants' nappies were changed before the procedure. For the heel stick procedure, an antiseptic solution (70% alcohol), the heel stick method, heel region for sampling (the outer right side of the ball), needle size (21-G needle), and environmental factors such as heat, light, and noise were all standardized. The whole procedure was video-recorded from before the sampling until 3 minutes after the procedure.

At the beginning of the study, the parents of the newborns were informed about the aim and content of the research, and parental consent was obtained. Neonatal and family demographics were collected using the self-report information forms, which included medical history, gestational age at birth, neonatal age, sex, birth weight, duration of sampling, total crying time, processing time, and the time from the start of the first cry to the last crying during the process.

All blood sampling in the study was performed for clinical purposes, such as newborn screening tests. In the clinical procedure, if the neonates were crying before the heel stick, we consolled them until they were settled for at least 5 minutes before the sampling. The neonates were taken to the nursery and placed supine on the examination table. This was the routine blood collection procedure used during standard screening tests in the study venue. The standard protocol for blood sampling involved swabbing the heel with a small gauze pad with disinfectant, lancing the heel, and then gently squeezing the heel intermittently until the amount of blood required for clinical use was collected.

All procedures performed in the experimental and control groups were video recorded by the researcher from the beginning of the procedure. In order to ensure standardization in all groups, the recording process was continued for 3 minutes. Mothers in all groups stayed with the newborns during the procedure. As soon as the monitoring period ended, all newborns were comforted by placing them in their mother's lap. After the procedure, the newborns' pain levels and crying durations were evaluated using video recordings. The procedures were recorded by the investigator. To avoid bias, assessment of pain was conducted independently by an observer nurse using NIPS who was blinded to the group allocation of the newborns. The observer nurse had a minimum of 3 years' experience in neonatal care and was experienced in evaluating pain in newborns.

The newborns' total procedural crying time, procedure duration, and the first calming time were recorded by the investigator. The total crying time of the newborns was measured from the start of crying to the end of crying. The time of the procedure was measured from the beginning to the end of the heel stick procedure. The calming time was measured from the first cry until the baby stopped crying. The independent observer nurse evaluated both the total crying time and the calming time of the newborns for all groups by viewing the video records.

2.6 | Data analysis

Descriptive statistical methods (mean, standard deviation, median, frequency, rate, min., max.) were used to evaluate the study data. The one-way analysis of variance (ANOVA) test was used in the comparison of normally distributed data from the three groups. The Kruskal-Wallis test was used to compare nonnormally distributed data of the three groups, and the Mann-Whitney U test was used to identify the group that caused the difference. Pearson's Chi-square test, the Fisher-Freeman-Halton test, and Yates's continuity correction test were used for the comparison of qualitative data. Significance was considered as $P < 0.05$.

2.7 | Ethical consideration

The study was approved by the ethics committee of Balikesir University Balikesir Medical Faculty, Balikesir, Turkey (approval number 2016/99; November 19th, 2016). The aims, method, nature of the research, and confidentiality of the data collected in the study were explained to the mothers. Mothers who were willing to participate in the study provided written consent and were subsequently recruited to this study. They were also notified that they could leave the study at any time without having to explain their reasons.

3 | RESULTS

3.1 | Comparison of the groups in terms of demographic data

One hundred and fifty neonates (girls $n = 75$ [50%], boys $n = 75$ [50%]) were included in the study. The neonates were randomized into the breastfeeding ($n = 50$), heel warming ($n = 50$), and control ($n = 50$) groups. No notable differences were found between the groups in terms of sex, gestational age, postnatal age, birth weight, birth height, and head circumference ($P > 0.05$). The other demographic data are shown in Table 1.

3.2 | Comparison of the groups in terms of NIPS scores

When the pain levels of the newborns were compared according to the groups, there was a statistically significant difference between all groups during the procedure. It was observed that procedural pain levels were lowest in the breastfeeding group (mean 4.44, SD 1.21),
followed by heel warming (mean 6.10, SD 1.07), and the controls (mean 6.42, SD 0.91). Although there was no statistically significant difference between the controls and the heel warming group in the bilateral comparisons, the pain scores of the breastfeeding group were significantly lower than both the heel warming group and the control group (P = 0.001) (Table 2).

### 3.3 | Comparison of the groups in terms of crying times and calming times

There was a statistically significant difference between the groups according to the total crying time and the first calming time (P = 0.001; P < 0.01, respectively) (Table 3) (Figure 2). When the groups were compared according to crying time, the duration of crying of the breastfeeding group (mean 44.04, SD 33.59 seconds) was statistically significantly shorter than in the heel warming group (mean 62.80, SD 30.44 seconds) (P = 0.003; P < 0.01, respectively) and the control group (mean 75.00, SD 38.81 seconds) (P = 0.001). There was no statistically significant difference in the total crying time between the heel warming group (mean 62.80, SD 30.44 seconds) and the control group (mean 75.00, SD 38.81 seconds) (P = 0.152; P > 0.05, respectively). When the first calming times of the babies were compared, the breastfeeding group (mean 26.7, SD 24.66 seconds) was statistically significantly quicker than the control group (mean 53.52, SD 40.55 seconds) (P < 0.05). There was no statistically significant difference between the heel warming (mean 36.00, SD 27.92 seconds) and breastfeeding groups (mean 26.7, SD 24.66 seconds) with respect to the calming time (P = 0.064; P > 0.05, respectively) (Table 3).

### 4 | DISCUSSION

Healthy newborns are usually exposed to various levels of pain during medical procedures such as routine metabolic scans, injections of vitamin K, hepatitis vaccine, and circumcision during the first days of life. Nonpharmacologic methods are often used for pain control during these practices (Cong, 2015; Gargiulo, Lynch, & Slogar, 2010; Obeidat & Shurique, 2015; Pillai Riddell et al., 2015; Zhu et al., 2015). In newborns, these methods contribute to the control of short-term and long-term negative results of pain, shorten hospital stay, and make it easier for newborns to adapt to their environment. In this context,
newborns in their breastfeeding group had decreased physiologic parameters and pain scores compared with newborns in a skin-to-skin care group. Obeidat and Shuriquie (2015) determined that pain levels of full-term newborns were reduced when breastfeeding and maternal holding were combined during heel stick procedures. Our study results are similar to the study results of Zhu et al. (2015), Okan et al. (2010), and Obeidat and Shuriquie (2015).

One of the methods used to reduce pain during heel stick procedures is heel warming (Cong, 2015; Shu et al., 2015; Pillai Riddell et al., 2015). Although the procedural pain levels of newborns were not significantly different in the heel warming group compared with the control group in our study, Shu et al. (2014) reported that pain scores of newborns in their heel warming group were significantly lower than the control group. Cong (2015) also reported that newborns who received heel warming had lower pain scores than newborns in the wrapping group, and that heel warming had to be included in the overall policies of the unit (Cong, 2015; Shu et al., 2014).

Crying is the most obvious and most visible behavioural response of newborns during painful interventions (Kassab, Hamadneh, Nuseir, ALmomani, & Hamadneh, 2018). In the present study, although there was no difference in the crying time between the control group and the heel warming group, the initial calming period was shorter in the heel warming group than in the control group. In addition, despite not being at a significant level, the breastfeeding group cried for a shorter period and calmed down more quickly than the heel warming group. In addition, despite not being at a significant level, the breastfeeding group cried for a shorter period and calmed down more quickly than the heel warming group.

Breastfeeding has been reported as effective in reducing pain associated with minor painful procedures in newborns (Chromá & Sikorová, 2012; da Motta & da Cunha, 2015; Obeidat & Shuriquie, 2015; Shah et al., 2012). Breastfeeding includes skin-to-skin contact, mother-baby communication, sensory receptors at the periphery, and activation of the sense of taste. Breast milk has an analgesic effect (Okan et al., 2010; Shah et al., 2012; Witt et al., 2016) by stimulating opioid receptors and blocking pain in the spinal cord. In the literature, breastfeeding has been recommended to reduce pain during interventional procedures in newborns (Ali et al., 2016; Reece-Stremtan & Gray, 2016; Shah et al., 2012). A Cochrane review of 20 randomized controlled trials assessed the effect of breastfeeding on painful procedures. It was reported that newborns in the breastfeeding group had a significantly lower heart rate, crying time, and pain levels during heel stick procedures and vein cannulation (Shah et al., 2012). Zhu et al. (2015) stated that newborns in their breastfeeding group had significantly lower pain scores during heel stick procedures compared with a group to which music was played. Okan et al. (2010) reported that

![Table 3](image_url)

**TABLE 3** Comparison of crying of newborns by groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Total (Mean) (SD)</th>
<th>Heel warming (Mean) (SD)</th>
<th>Breastfeeding (Mean) (SD)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
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<td>Group 2</td>
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<td>Group 3</td>
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<tr>
<td>Total crying time (seconds)</td>
<td>5-160 (36.53)</td>
<td>5-160 (38.81)</td>
<td>5-130 (33.59)</td>
<td>0.001**</td>
</tr>
<tr>
<td>Time to first calming</td>
<td>2-160 (33.49)</td>
<td>2-140 (27.92)</td>
<td>5-100 (26.7)</td>
<td>0.001**</td>
</tr>
</tbody>
</table>

*aKruskal-Wallis test.  
bMann-Whitney U test.  
*P < 0.01.

When the literature was examined, it was observed that no studies had compared the effects of breastfeeding and heel warming during heel stick on pain levels of newborns. Our findings show that the breastfeeding was more effective for pain reduction than heel warming and no intervention (controls) during this procedure (Table 2; Figure 2). We demonstrated that breastfeeding is beneficial in reducing pain felt during heel stick procedures.

Breastfeeding has been reported as effective in reducing pain associated with minor painful procedures in newborns (Chromá & Sikorová, 2012; da Motta & da Cunha, 2015; Obeidat & Shuriquie, 2015; Shah et al., 2012). Breastfeeding includes skin-to-skin contact, mother-baby communication, sensory receptors at the periphery, and activation of the sense of taste. Breast milk has an analgesic effect (Okan et al., 2010; Shah et al., 2012; Witt et al., 2016) by stimulating opioid receptors and blocking pain in the spinal cord. In the literature, breastfeeding has been recommended to reduce pain during interventional procedures in newborns (Ali et al., 2016; Reece-Stremtan & Gray, 2016; Shah et al., 2012). A Cochrane review of 20 randomized controlled trials assessed the effect of breastfeeding on painful procedures. It was reported that newborns in the breastfeeding group had a significantly lower heart rate, crying time, and pain levels during heel stick procedures and vein cannulation (Shah et al., 2012). Zhu et al. (2015) stated that newborns in their breastfeeding group had significantly lower pain scores during heel stick procedures compared with a group to which music was played. Okan et al. (2010) reported that

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Nonpharmacologic methods should be practical, inexpensive, and compatible with clinic-specified care protocols (Kassab et al., 2012; Kassab et al., 2017; Morrow et al., 2010). Although it is reported in the literature that heel warming is effective at reducing pain during heel stick (Cong, 2015; Shu et al., 2014), it was not found effective

**FIGURE 2** Distribution of total crying times according to groups

one of the primary duties of nurses who serve newborns should be to reduce or relieve their pain.

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in our study (Table 2). However, it was effective in calming infants in shorter periods (Table 3). Nurses working on the clinic of the study stated that heel warming was time-consuming and impractical and that breastfeeding was an easier and more practical way. Breastfeeding may be an alternative to heel warming because our findings suggest that breastfeeding is effective both in reducing the pain and calming babies without heel warming. However, it was concluded that using heel warming would also be beneficial because it helps to calm babies in a shorter time.

4.1 | Limitations of the study

The study has two limitations. The first is that only one independent observer nurse evaluated the pain levels of all newborns. To avoid bias, assessment of pain was conducted independently of the investigator by the observer nurse who was blinded to the group allocation. The other limitation of the study was that no nonpharmacologic methods were used to reduce pain in the control group because they are not routinely administered in our unit; routine heel stick procedures were performed for newborns in the control group.

5 | CONCLUSIONS

Breastfeeding was more effective than heel warming in reducing pain during heel stick procedures. Both breastfeeding and heel warming contribute to calming babies in a shorter period. The contribution of breastfeeding to the calming period of babies is greater than heel warming. Both can be used to reduce pain and shorten the calming time during heel stick procedures in newborns.

5.1 | Implications for nursing practice

The results of this randomized controlled trial are clinically important because they provide evidence that both breastfeeding and heel warming are effective in reducing heel stick-related pain in newborns.

Considering that the annual number of births is 1 325 783 in Turkey, the use of breastfeeding and heel warming during heel stick to eliminate pain and shorten the calming time would affect more than 1 million neonates each year and have relevant short-term and long-term results. The use of breastfeeding and heel warming will contribute to the contemporary care of newborns in Turkey. As a result, both breastfeeding and heel warming can be used during heel stick procedures in newborns.

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CONFLICT OF INTEREST

The authors do not have any conflict of interest to declare.

AUTHORSHIP STATEMENT

DA and Sİ designed the study, collected and analysed the data and prepared the manuscript. All authors approved the final version for submission.

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