Am J Transl Res 2025;17(2):961-973
www.ajtr.org /ISSN:1943-8141/AJTR0161900

*Original Article*

# Combining orofacial stimulation with gentle touch therapy improves breastfeeding tolerance and weight gain in preterm infants

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Received November 11, 2024; Accepted December 27, 2024; Epub February 15, 2025; Published February 28, 2025

**Abstract:** Objective: To investigate the effect of orofacial stimulation combined with gentle touch therapy on breastfeeding intolerance and weight gain in preterm infants. Methods: This retrospective cohort study was conducted at Wuhan Children's Hospital, involving 236 preterm infants diagnosed with breastfeeding intolerance. Of these, 130 infants received a combination of gentle touch and orofacial stimulation (combination group), while 106 infants received only gentle touch therapy (only-touch group). The intervention lasted for three months. Outcomes were assessed using clinical indicators of breastfeeding intolerance, the Neonatal Oral Motor Assessment Scale (NOMAS), growth measurements (weight, height, and head circumference), and levels of calcium, albumin, prealbumin, and bilirubin. Statistical analyses were performed using SPSS 23.0. Results: The combination group demonstrated a higher rate of improvement in breastfeeding intolerance compared to the only-touch group (significantly improved cases: 60 vs. 30; ineffective cases: 7 vs. 44; $\chi^2 = 28.267$, $P < 0.05$). Oral motor function improved significantly more in the combination group ($P < 0.05$). After 1 and 3 months, the combination group showed greater increases in weight, height, and head circumference (Height: $P = 0.025$ at 1 month; Head circumference: $P = 0.034$ at 3 months). The duration of residual milk was significantly reduced in the combination group by the end of the observation period ($P < 0.001$). Nutrient analysis revealed higher levels of calcium, albumin, and prealbumin post-nursing ($P < 0.05$), and bilirubin levels decreased significantly after one month ($t = 5.987$, $P < 0.05$). Conclusion: Combining orofacial stimulation with gentle touch therapy improves breastfeeding tolerance, oral motor function, growth, and nutritional status in preterm infants more effectively than touch therapy alone.

**Keywords:** Orofacial stimulation, gentle touch, preterm infants, breastfeeding intolerance, weight gain, nutritional status

## Introduction

The global rise in preterm births has intensified efforts to improve neonatal outcomes, focusing on developing effective interventions to enhance survival and reduce long-term developmental impairment [1]. Feeding difficulties in preterm infants, particularly breastfeeding intolerance, present significant challenges in neonatal intensive care units (NICUs) [2]. This intolerance can manifest as symptoms such as vomiting, abdominal distension, and diarrhea, which severely worsen nutritional intake, hinder weight gain, and affect overall growth and development [3]. Preterm infants often have immature neurological and gastrointestinal systems, requiring multifaceted approaches to support their physiological functions and promote healthy development [4].

Breastfeeding is universally acknowledged as the optimal source of nutrition for infants, contributing not only to physical growth but also to psychological bonding and immune protection [5]. However, for preterm infants, the complex coordination of suckling, swallowing, and breathing presents a significant challenge, complicating the establishment of effective

https://doi.org/10.62347/NDYX6291

breastfeeding practices [6]. These difficulties are primarily due to the underdeveloped neuromotor functions typical of preterm neonates [7]. Non-nutritive sucking and other forms of oral stimulation have gained attention for their potential role in enhancing oral motor skills among this vulnerable population [8]. Such stimulation is thought to aid in the maturation of feeding reflexes and improve the coordination necessary for effective breastfeeding.

Additionally, while tactile stimulation, commonly referred to as gentle or therapeutic touch, has been widely recognized in neonatal care [9], its full potential when combined with other modalities remains underexplored. Touch therapy has been associated with several benefits, including improved weight gain, enhanced infant-mother bonding, and reduced behavioral stress [10]. Tactile stimulation is believed to activate the parasympathetic nervous system, enhancing gastrointestinal motility and digestion-key functions for preterm infants who experience breastfeeding intolerance [11]. Gentle touch, which includes techniques such as whole-body and abdominal massage, is routinely incorporated into care protocols to promote relaxation and support physiologic functions in premature infants [12].

Despite the known benefits of orofacial and touch therapies, limited research has explored their combined effects on breastfeeding outcomes in preterm infants [13]. Integrating these interventions may offer a comprehensive approach to addressing both sensory deficits and motor inefficiencies underlying feeding challenges [14]. Combined techniques may enhance neuromuscular development more effectively than when applied individually, offering novel avenues for improving feeding capabilities and overall growth metrics, such as weight, height, and head circumference.

While studies on single-modality interventions have provided valuable insights, important questions remain unanswered regarding integrated approaches [15, 16]. Some studies have examined the benefits of gentle touch therapy for reducing stress and enhancing maternal-infant bonding, while others have focused on specific gastrointestinal interventions [17, 18]. However, few studies have comprehensively investigated the combined use of orofacial stimulation and gentle touch therapy. This gap underscores the need for research into how integrating these modalities may improve feeding outcomes and overall neonatal health.

In this study, we investigate the impact of combining orofacial stimulation with gentle touch therapy on breastfeeding intolerance and weight gain in preterm infants. Our objective is to determine whether the integration of these interventions offers greater benefits than touch therapy alone. By assessing changes in oral motor function, growth parameters, gastrointestinal function, and nutritional status over a defined intervention period, we aim to demonstrate the clinical value of this integrative approach. Our research seeks to fill this knowledge gap and provide evidence-based support for the use of combined interventions in neonatal care, ultimately contributing to improved developmental outcomes for preterm infants.

## Materials and methods

### *Study design and patient selection*

This retrospective cohort study was conducted at Wuhan Children's Hospital from June 2022 to May 2024. A total of 236 preterm infants diagnosed with breastfeeding intolerance were included. Medical records were reviewed to identify eligible participants based on predefined inclusion and exclusion criteria.

The inclusion criteria were clinical diagnosis of preterm infants with a gestational age of less than 37 weeks and relatively stable vital signs [19]. To refine the criteria for this retrospective analysis, we ensured that all selected infants had complete medical records available, including documentation of interventions received and outcome measures. The exclusion criteria included infants with intestinal diseases, congenital malformations of the digestive system, metabolic disorders, or congenital genetic disorders.

Infants were allocated to the only-touch group (n = 106) or the combination group (n = 130) based on treatment protocols documented in their medical records. Infants who received only gentle touch care were assigned to the only-touch group, while those who received both gentle touch and orofacial stimulation were assigned to the combination group. Of

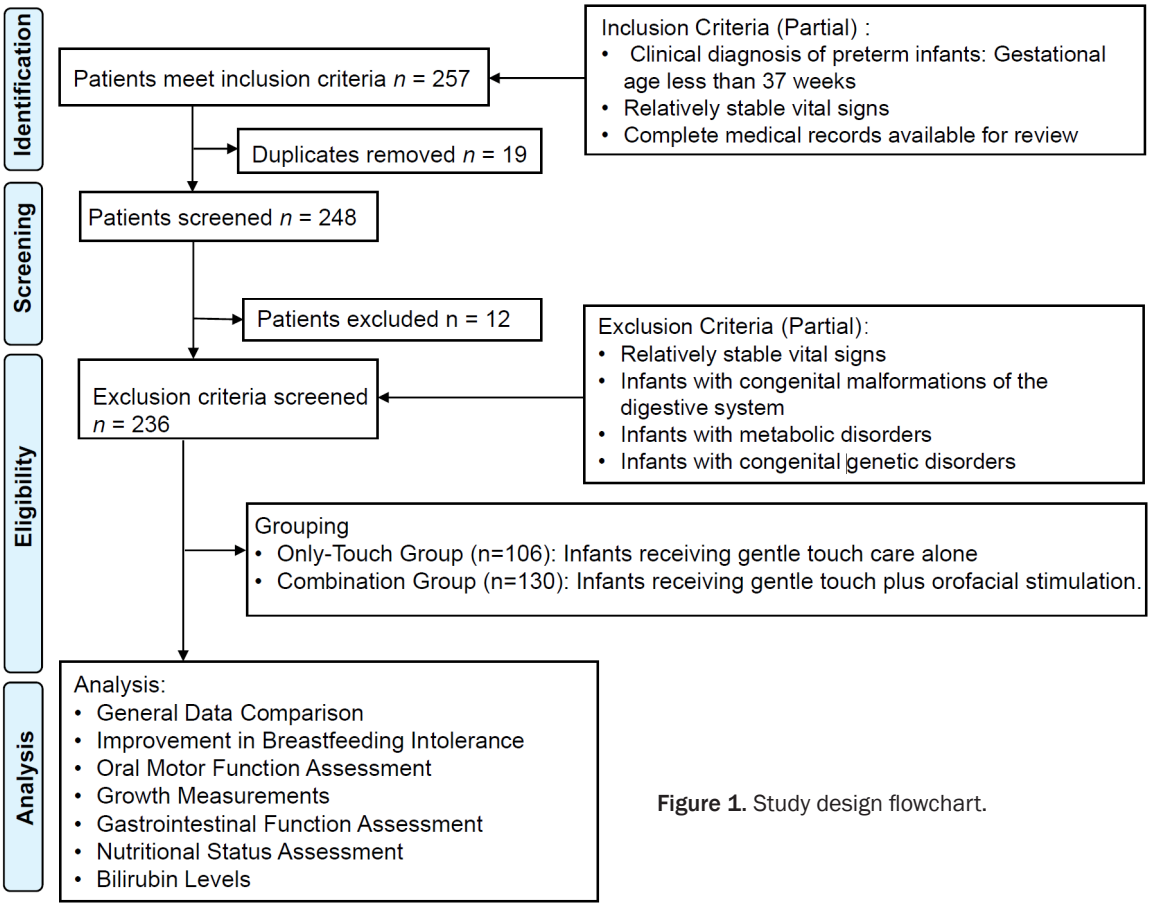


**Figure 1.** Study design flowchart.

note, this was a retrospective analysis of existing patient data; thus, the treatment choice was determined by the attending healthcare providers as part of routine clinical care and was not randomized for research purposes. To ensure that the two groups were well-matched in terms of baseline characteristics, stratified sampling was used during the allocation process, considering key demographic and clinical factors. This approach aimed to minimize confounding effects and provide a fair comparison between the two groups.

This study was approved by the ethics committee of Wuhan Children's Hospital. The study design flowchart is shown in **Figure 1**.

*Treatment methods*

The only-touch group received gentle touch interventions, organized as follows: First, whole-body touch involved gently applying pressure from the infant's head to various body parts, including the neck, back, and limbs, using warm palms and moderate pressure to promote comfort and relaxation. Second, abdominal massage consisted of gentle clockwise movements on the infant's abdomen to stimulate gastrointestinal peristalsis, avoiding excessive force. Third, hand and foot massage involved gentle manipulation of the infant's hands and feet, with attention to each finger and toe, using moderate pressure.

The combination group received both the interventions applied to the only-touch group and orofacial stimulation. This included non-nutritive sucking using a non-perforated rubber pacifier, allowing the preterm infant to practice sucking without food intake. Non-nutritive sucking was given before and after tube feeding for approximately five minutes each time, totaling about 15 minutes, and conducted 7-8 times per day.

Oral stimulation (OS) involved several techniques: Lip massage consisted of placing the index finger at the corner of the lips, applying

light pressure, and moving in a circular motion from one corner of the mouth to the center of the upper lip, then to the opposite corner. This sequence was repeated twice for each lip, lasting around one minute, to enhance the lip range of motion and closure function. Upper and lower lip massage involved placing the index finger at the center of the lips, applying gentle sustained pressure, and progressively pressing the upper lip towards the lower lip, and vice versa, for each lip.

For teeth massage, the finger was placed at the center of the gumline, applying consistent gentle pressure and slowly moving towards the back of the gums before returning to the starting position. This motion was repeated on the opposite side. Cheek and intraoral massage involved placing a finger at the inner corner of the lips, applying gentle pressure to the inside of the cheek in a C-shaped compression motion towards the molar gumline, then moving back to the inner side of the lips. This was repeated on the opposite side. Tongue and palate massage involved placing the index finger at the center of the oral cavity, applying sustained gentle pressure on the hard palate for a few seconds, and then moving downward towards the center of the tongue while maintaining gentle pressure.

It is essential for those performing these oral motor interventions to undergo proper training and assessment to ensure correct execution. Sterile gloves should be worn during the procedures to maintain hygiene and safety for the preterm infants. Additionally, oral motor exercises should be performed in a quiet environment to minimize unnecessary stimulation, with adjustments made to intensity and frequency based on each infant's condition. Both sets of interventions were carried out for a duration of three months, as documented by the medical records.

*Data extraction*

Data extraction was performed using a standardized form that included demographic information, clinical characteristics, laboratory results, and treatment outcomes. Two independent reviewers extracted data from medical records, with discrepancies resolved through discussion or consultation with a third reviewer. The data were validated by cross-referencing electronic health records to ensure consistency across multiple sources.

*Outcome measures*

The primary outcome measure was improvement in breastfeeding intolerance, evaluated after three months of intervention. Secondary outcome measures included changes in oral motor function, growth parameters (weight, height, and head circumference), gastrointestinal function, and nutritional status. These outcome measures were selected based on their clinical significance and relevance to the health and development of preterm infants. Indicators such as breastfeeding intolerance, oral motor function, growth parameters, gastrointestinal function, and nutritional status are crucial for assessing the effectiveness of interventions aimed at improving feeding and growth in this vulnerable population. Although some of these indices may not be routinely monitored in other institutions due to differences in resources, protocols, or focus, our hospital has prioritized a comprehensive approach to neonatal care, including detailed assessment of these factors. This approach enables targeted interventions and closer monitoring, thereby enhancing the quality of care for preterm infants.

*General data comparison:* This study evaluated several observation indicators to assess the outcomes of care provided to pediatric patients. First, the general data of the two groups were compared.

*Improvement in breastfeeding intolerance:* Improvements in breastfeeding intolerance were assessed after three months of nursing, with significant progress observed. This improvement was characterized by a substantial reduction or complete resolution of digestive symptoms, including diarrhea, vomiting, constipation, and abdominal distension. Consequently, the infants showed normal weight gain and reached favorable growth and developmental milestones. Symptoms categorized as "Effective" indicated partial relief from breastfeeding intolerance, but some abnormalities persisted, leading to slower weight gain. The "Ineffective" category reflected no improvement or worsening of symptoms, with persistent digestive issues and inadequate weight gain, resulting in poor growth and development. The effectiveness rate was calculated using the formula:

(Significant Improvement + Effective)/Total cases × 100%.

*Oral motor function assessment:* Oral motor function was assessed before and three months after intervention using the Neonatal Oral Motor Assessment Scale (NOMAS) [20]. This scale evaluates 28 items related to the speed, rhythm, and consistency of jaw and tongue movements. Sucking patterns were classified into three categories: normal, disorganized, and dysfunctional, using distinct scoring systems. Normal patterns (10 items) were characterized by effective coordination of sucking, swallowing, and breathing in a 1:1:1 ratio, with a sucking pulse of 10 to 30 times per group. A 3-point scoring system was applied: 0 for absent, 1 for < 50%, and 2 for ≥ 50%. In contrast, disorganized (8 items) and dysfunctional patterns (10 items) exhibited irregular rhythms and lacked coordination, with a 2-point scoring system: 0 for absent and 1 for present.

*Growth measurements:* Growth measurements included comparisons of weight, height, and head circumference before intervention and at 1 and 3 months post-intervention. All measurements were taken using standardized devices. Preterm infants were weighed unclothed on digital scales (BD-585, TANITA, Japan) with an accuracy of 0.1 g. Height was measured in the supine position using a wooden stadiometer (TXHX-100A, Beijing Zhonghui Tiancheng Technology Co., Ltd., China) with an accuracy of 0.1 cm. Head circumference was measured using a tape measure with an accuracy of 0.1 cm. All measurements were repeated twice by different nurses, and the same results were recorded each time; if the results differed, a third measurement was taken.

*Gastrointestinal function assessment:* Gastrointestinal function in preterm infants was assessed in the early neonatal period through analysis of gastric aspirates. Gastric aspirates were routinely evaluated by nursing staff, typically 3 to 4 times daily before initiating enteral feeding, and before each feeding if gavage feeding had started. Abnormal residual gastric fluids were classified into three types: residual milk; bloody gastric juices, including small blood clots; and bile-stained gastric juices. No cases of gross gastrointestinal bleeding were observed in our patients. The number of days each preterm infant experienced abnormal gastric fluid in the first 7 days of life and the last 7 days of the three-month care period was recorded.

*Nutritional status assessment:* Nutritional status, including levels of calcium (Ca), albumin (Alb), and prealbumin (PA), was assessed before and after three months of intervention.

*Bilirubin levels:* Bilirubin levels in both groups were measured at 24 hours after birth and one month after the initiation of feeding.

*Statistical analysis*

Data were analyzed using SPSS 23.0. For normally distributed continuous data, means ± standard deviation were used, and t-tests were employed for comparisons between two groups. One-way ANOVA was used to compare differences in weight, height, and head circumference over multiple time points within each group, followed by Tukey's post hoc test for pairwise comparisons. Categorical data were expressed as "n/%", and chi-square tests were performed, with $P < 0.05$ indicating a significant difference.

## Results

*Comparison of general data*

This study compared the general demographic and clinical characteristics between two groups. Both groups were well-matched (**Table 1**), allowing for an unbiased evaluation of the intervention's effects.

*Comparison of improvement in breastfeeding intolerance*

We investigated the effect of combining orofacial stimulation with gentle touch on breastfeeding intolerance and weight gain in preterm infants. The results showed a significantly higher number of effective cases in the combination group compared to the only-touch group (**Figure 2**). Specifically, 60 cases in the combination group showed obvious improvement, while only 30 cases showed improvement in the only-touch group. Moreover, the number of ineffective cases was significantly lower in the combination group compared to the only-touch group (7 vs. 44). The improvement in breastfeeding intolerance in the combination group

**Table 1.** Comparison of general data between the two groups of patients

| | | Only-Touch group (n = 106) | Combination group (n = 130) | $t/\chi^2$ | P |
|---|---|---|---|---|---|
| Age (days) | | 3.54 ± 1.22 | 3.39 ± 1.31 | 0.899 | 0.370 |
| Gender | Female [n (%)] | 49 (46.23%) | 54 (41.54%) | 0.522 | 0.470 |
| | Male [n (%)] | 57 (53.77%) | 76 (58.46%) | | |
| Type of birth | Cesarean section [n (%)] | 52 (49.06%) | 58 (44.62%) | 0.463 | 0.496 |
| | Vaginal delivery [n (%)] | 54 (50.94%) | 72 (55.38%) | | |
| Gestational age | 30-37 [n (%)] | 99 (93.40%) | 124 (95.38%) | 0.444 | 0.505 |
| | < 30 [n (%)] | 7 (6.60%) | 6 (4.62%) | | |
| 1 minute- Apgar Score | | 7.73 ± 2.11 | 7.82 ± 2.34 | 0.289 | 0.773 |
| Respiratory Support | No [n (%)] | 96 (90.57%) | 112 (86.15%) | 1.087 | 0.297 |
| | Yes [n (%)] | 10 (9.43%) | 18 (13.85%) | | |
| Delayed passage of meconium | No [n (%)] | 79 (74.53%) | 91 (70.00%) | 0.594 | 0.441 |
| | Yes [n (%)] | 27 (25.47%) | 39 (30.00%) | | |
| Apnea | No [n (%)] | 53 (50.00%) | 70 (53.85%) | 0.346 | 0.556 |
| | Yes [n (%)] | 53 (50.00%) | 60 (46.15%) | | |
| Blood Infusion | No [n (%)] | 59 (55.66%) | 79 (60.77%) | 0.628 | 0.428 |
| | Yes [n (%)] | 47 (44.34%) | 51 (39.23%) | | |
| Anemia | No [n (%)] | 44 (41.51%) | 58 (44.62%) | 0.230 | 0.632 |
| | Yes [n (%)] | 62 (58.49%) | 72 (55.38%) | | |
| Time to breastfeed (d) | | 1.58 ± 0.48 | 1.65 ± 0.55 | 1.119 | 0.264 |

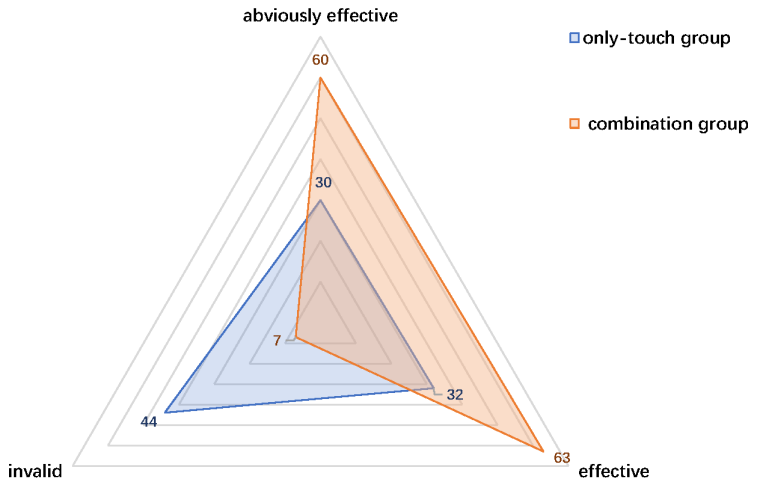


**Figure 2.** Improvement in breastfeeding intolerance in the two groups of patients. Caption: It is observable that the number of significantly effective cases in the combination group is evidently higher than that in the only-touch group, and the number of ineffective cases is noticeably lower than that in the only-touch group.

was superior to that of the only-touch group ($\chi^2$ = 28.267, P < 0.05).

*Comparison of oral motor function*

Before intervention, there were no significant differences in oral motor function between the two groups (P > 0.05). However, after intervention, the combination group showed superior oral motor function compared to the only-touch group (P < 0.05), as shown in **Table 2**.

*Comparison of weight, height, and head circumference*

At baseline, no significant differences were observed in the weight between the two groups (P > 0.05). However, after 1 and 3 months of intervention, the weight in the combination group was significantly higher than that in the only-touch group (P < 0.05), as shown in **Figure 3**.

There were no significant differences in height (P = 0.815) or head circumference (P = 0.532) between the two groups at baseline (**Table 3**). One month post-intervention, the height of patients in the combination group was significantly greater compared to the only-touch group (49.36 ± 4.97 cm vs. 47.77 ± 5.84 cm, t = 2.262, P = 0.025). This difference was more pronounced

**Table 2.** Comparison of oral motor function in the two groups of patients before and after intervention (scores, $\bar{x} \pm s$)

| | Normal | | Disorganized | | Dysfunctional | |
|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After |
| Only-touch group (n = 106) | 10.55 ± 2.48 | 18.27 ± 1.24 | 4.85 ± 1.09 | 2.45 ± 0.82 | 4.56 ± 1.09 | 1.91 ± 0.41 |
| Combination group (n = 130) | 10.43 ± 2.33 | 17.82 ± 1.34 | 4.88 ± 1.07 | 2.68 ± 0.79 | 4.52 ± 1.27 | 2.11 ± 0.57 |
| t | 0.384 | 2.651 | 0.186 | 2.130 | 0.278 | 3.103 |
| P | 0.701 | 0.009 | 0.853 | 0.034 | 0.781 | 0.002 |

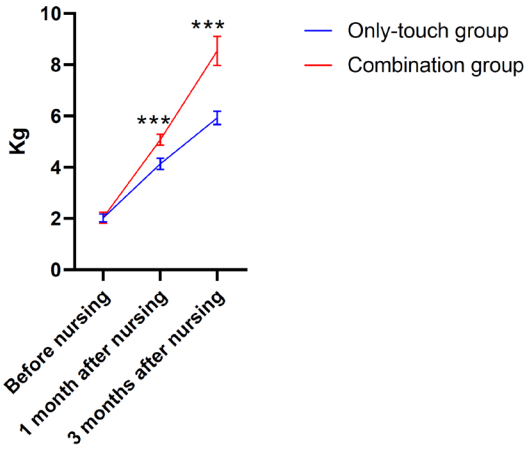


**Figure 3.** Changes in weight of the two groups of patients before and after nursing for 1 and 3 months. Note: ***, *P* < 0.001.

three months post-intervention (57.85 ± 9.83 cm vs. 53.87 ± 9.26 cm, t = 3.180, P = 0.002). In terms of head circumference, there was no significant change in either group one month post-intervention (P = 0.103). However, three months post-intervention, the combination group exhibited a significantly greater head circumference compared to the only-touch group (37.56 ± 7.68 cm vs. 35.39 ± 7.88 cm, t = 2.138, P = 0.034). These findings suggest that the combination intervention promoted superior growth in both height and head circumference over time compared to the only-touch group, highlighting the benefits of the combined nursing approach.

One-way ANOVA results for changes in weight, height, and head circumference over time showed significant differences in multiple comparisons within both groups (**Table 4**). Specifically, both weight and height increased significantly from baseline to 1 and 3 months post-intervention in both groups (both P < 0.0001). Head circumference also showed significant increases from baseline to 3 months post-intervention in both groups (P = 0.0008 for the only-touch group, P < 0.0001 for the combination group). Notably, the combination group showed a significant increase in head circumference even after 1 month (P = 0.0002), while the only-touch group did not (P = 0.2111 for the pre- to 1-month comparison). These trends indicate that both interventions benefitted growth, with the combination group showing more rapid improvement in head circumference.

*Comparison of gastrointestinal function*

There were no significant differences in gastric aspirates between the two groups during the first 7 days in terms of the duration of residual milk (t = 0.789, P = 0.431), bloody gastric juices (t = 1.438, P = 0.152), or bile-stained juices (t = 1.404, P = 0.162) (**Table 5**). However, in the last 7 days of the observation period, the combination group had a significantly shorter duration of residual milk (0.10 ± 0.03 vs. 0.11 ± 0.03, t = 4.558, P < 0.001), while no significant differences were observed for bloody gastric juices (t = 1.695, P = 0.091) or bile-stained juices (t = 0.014, P = 0.989) (**Table 6**).

*Comparison of nutritional status*

Before the intervention, there were no significant differences in the levels of calcium (Ca), albumin (Alb), or prealbumin (PA) between the two groups (all P > 0.05). However, after the intervention, the levels of Ca, Alb, and PA were all significantly higher in the Combination group compared to the Only-touch group (all P < 0.05), as shown in **Table 7**.

*Comparison of bilirubin levels at 24 hours after birth and one month after feeding*

At 24 hours after birth, there were no statistically significant differences in bilirubin levels

**Table 3.** Changes in height and head circumference of the two groups of patients before and after nursing for 1 and 3 months

| | | Only-touch group (n = 106) | Combination group (n = 130) | t | P |
|---|---|---|---|---|---|
| Height (cm) | Before nursing | 44.15 ± 2.26 | 44.07 ± 3.10 | 0.234 | 0.815 |
| | 1 month after nursing | 47.77 ± 5.84 | 49.36 ± 4.97 | 2.262 | 0.025 |
| | 3 months after nursing | 53.87 ± 9.26 | 57.85 ± 9.83 | 3.180 | 0.002 |
| Head circumference (cm) | Before nursing | 32.03 ± 5.36 | 31.57 ± 5.81 | 0.626 | 0.532 |
| | 1 month after nursing | 33.57 ± 6.54 | 35.06 ± 7.33 | 1.637 | 0.103 |
| | 3 months after nursing | 35.39 ± 7.88 | 37.56 ± 7.68 | 2.138 | 0.034 |

**Table 4.** One-way ANOVA results for changes in weight, height, and head circumference over time (post hoc comparisons)

| Group | Tukey Post Hoc Comparisons | P |
|---|---|---|
| Only-touch group | pre-Weight (kg) vs. 1 Month-Weight (kg) | < 0.0001 |
| Only-touch group | pre-Weight (kg) vs. 3 Months-Weight (kg) | < 0.0001 |
| Only-touch group | 1 Month-Weight (kg) vs. 3 Months-Weight (kg) | < 0.0001 |
| Only-touch group | pre-Height (cm) vs. 1 Month-Height (cm) | 0.0002 |
| Only-touch group | pre-Height (cm) vs. 3 Months-Height (cm) | < 0.0001 |
| Only-touch group | 1 Month-Height (cm) vs. 3 Months-Height (cm) | < 0.0001 |
| Only-touch group | pre-Head circumference (cm) vs. 1 Month-Head circumference (cm) | 0.2111 |
| Only-touch group | pre-Head circumference (cm) vs. 3 Months-Head circumference (cm) | 0.0008 |
| Only-touch group | 1 Month-Head circumference (cm) vs. 3 Months-Head circumference (cm) | 0.1180 |
| Combination group | pre-Weight (kg) vs. 1 Month-Weight (kg) | < 0.0001 |
| Combination group | pre-Weight (kg) vs. 3 Months-Weight (kg) | < 0.0001 |
| Combination group | 1 Month-Weight (kg) vs. 3 Months-Weight (kg) | < 0.0001 |
| Combination group | pre-Height (cm) vs. 1 Month-Height (cm) | < 0.0001 |
| Combination group | pre-Height (cm) vs. 3 Months-Height (cm) | < 0.0001 |
| Combination group | 1 Month-Height (cm) vs. 3 Months-Height (cm) | < 0.0001 |
| Combination group | pre-Head circumference (cm) vs. 1 Month-Head circumference (cm) | 0.0002 |
| Combination group | pre-Head circumference (cm) vs. 3 Months-Head circumference (cm) | < 0.0001 |
| Combination group | 1 Month-Head circumference (cm) vs. 3 Months-Head circumference (cm) | 0.0118 |

**Table 5.** Comparison of gastric aspirates between the 2 groups within the first 7 days

| | Only-touch group (n = 106) | Combination group (n = 130) | t | P |
|---|---|---|---|---|
| Residual milk (days) | 0.30 ± 0.07 | 0.31 ± 0.09 | 0.789 | 0.431 |
| Bloody gastric juices (days) | 1.01 ± 0.31 | 0.95 ± 0.27 | 1.438 | 0.152 |
| Bile-stained juices (days) | 0.40 ± 0.08 | 0.39 ± 0.10 | 1.404 | 0.162 |

between two groups (t = 0.322, P = 0.747). However, one month after the intervention, bilirubin levels were significantly lower in the Combination group compared to the only-touch group (t = 5.987, P < 0.05), as shown in **Figure 4**.

## Discussion

Orofacial stimulation plays a key role in improving breastfeeding tolerance in preterm infants [21]. Due to underdeveloped oral muscles and nerves, preterm infants often have weak sucking and swallowing abilities, leading to breastfeeding intolerance [22]. Oral motor training, including oral massage and sucking exercises, has been shown to strengthen the oral muscles of preterm infants, improving their sucking and swallowing efficiency, thereby alle-

**Table 6.** Comparison of gastric aspirates between the 2 groups within the last 7 days

| | Only-touch group (n = 106) | Combination group (n = 130) | t | P |
|---|---|---|---|---|
| Residual milk (days) | 0.11 ± 0.03 | 0.10 ± 0.03 | 4.558 | < 0.001 |
| Bloody gastric juices (days) | 0.35 ± 0.03 | 0.34 ± 0.05 | 1.695 | 0.091 |
| Bile-stained juices (days) | 0.10 ± 0.03 | 0.10 ± 0.03 | 0.014 | 0.989 |

**Table 7.** Comparison of nutritional status before and after intervention in the two groups of patients

| | | Only-touch group (n = 106) | Combination group (n = 130) | t | P |
|---|---|---|---|---|---|
| Ca (mmol/L) | Before | 2.02 ± 0.22 | 2.03 ± 0.23 | 0.462 | 0.645 |
| | After | 2.55 ± 0.42 | 2.37 ± 0.41 | 3.196 | 0.002 |
| Alb (g/L) | Before | 28.82 ± 1.03 | 28.84 ± 1.04 | 0.094 | 0.925 |
| | After | 32.69 ± 2.09 | 31.92 ± 1.99 | 2.870 | 0.004 |
| PA (g/L) | Before | 97.88 ± 6.27 | 97.86 ± 6.37 | 0.016 | 0.987 |
| | After | 110.85 ± 7.31 | 108.54 ± 7.22 | 2.430 | 0.016 |

Note: Alb = Albumin; PA = Prealbumin.

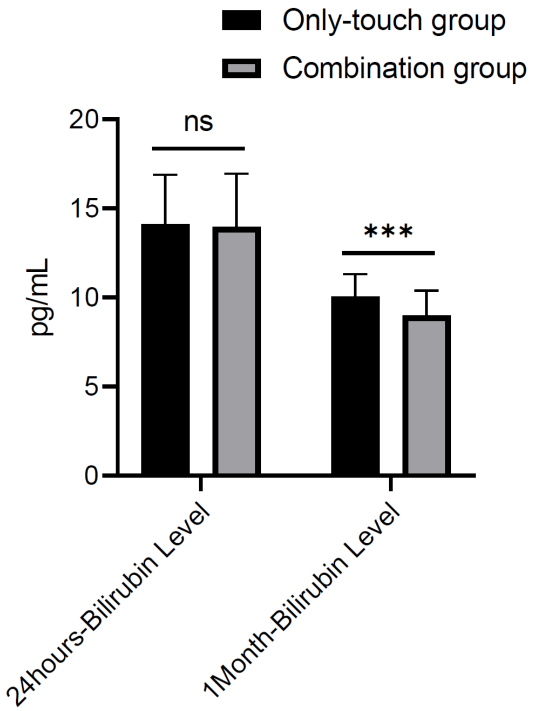


**Figure 4.** Comparison of bilirubin levels in the two groups of patients at 24 hours after birth and one month after feeding. Note: ns, No significant difference; ***, $P < 0.001$.

viating breastfeeding intolerance [23]. Touch therapy also helps reduce tension and anxiety in preterm infants, promoting relaxation and improving breastfeeding outcomes [24]. This study examined the combined effects of these interventions on breastfeeding intolerance and weight gain in preterm infants.

Our results showed significant improvements in breastfeeding tolerance, oral motor function, and growth parameters - particularly weight, height, and head circumference - in preterm infants who received the combined intervention compared to those who received only touch therapy. These findings highlight the benefits of integrating comprehensive sensorimotor interventions into neonatal care, particularly for vulnerable populations like preterm infants. Compared to the study by Harrison et al., which focused solely on tactile therapy [25], our research demonstrates that adding orofacial stimulation to the intervention protocol yields more significant improvement in oral motor function and growth.

A plausible explanation for the observed improvements in breastfeeding tolerance in the combination group may lie in the complexities of neuromuscular development and sensory integration. Orofacial stimulation likely enhances neural pathways involved in the coordination of sucking, swallowing, and breathing, which are essential for efficient feeding. Preterm infants often have immature neurological systems, which may result in disorganized or dysfunctional oral motor patterns [26]. Nonnutritive sucking and structured oral stimulation exercises may facilitate synaptic plasticity in relevant neural circuits, leading to improved rhythm and coordination of oral motor functions [27]. The significant reduction in ineffective cases within the combination group suggests that this synergistic approach accelerat-

es neuromotor development, enabling more effective breastfeeding and providing a foundation for sustained growth and development.

Integrating orofacial stimulation with touch therapy not only improves oral motor function but may also positively affects the infant's gastrointestinal system through intrinsic neural interactions [28]. Specifically, abdominal massage likely activates the parasympathetic nervous system, promoting gastrointestinal peristalsis. This may help alleviate symptoms of gastrointestinal discomfort often linked to breastfeeding intolerance, such as abdominal distension and constipation [29, 30]. Moreover, improved gastrointestinal function could result from more efficient coordination of oral motor activities, enhancing swallowing mechanics and reducing aspiration or reflux, ultimately leading to better nutrient absorption [31]. This hypothesis is partially supported by the faster clearance of residual milk in the combination group, suggesting more efficient gastric emptying. Compared to prior research by Samara et al., which focused solely on gastrointestinal interventions the combination of orofacial stimulation and touch therapy provided a more comprehensive benefit, demonstrating superior outcomes in both feeding efficiency and gastrointestinal comfort [32].

To further validate these observations, a two-way ANOVA (Analysis of Variance) was conducted to examine the interaction between the type of intervention (combined vs. touch therapy alone) and time (baseline vs. post-intervention). The analysis revealed a significant interactive effect, indicating that the improvements in breastfeeding tolerance and growth measures were due not only due to the passage of time but also to the specific effects of the combined intervention. Post-hoc tests confirmed that the combination group showed significant improvements at each time point, emphasizing the efficacy of the multimodal approach.

The increased weight gain observed in infants receiving the combined intervention highlights the clinical significance of improved nutritional intake and absorption. Weight gain not only serves as a primary indicator of adequate nutrition but also reflects overall health and development [33]. Enhanced oral motor skills lead to improved feeding efficiency, allowing preterm infants to consume more milk in less time, thereby optimizing caloric intake [34]. Given that weight gain is a critical concern in neonatal intensive care, the improved growth metrics in the combination group suggest that adopting such multimodal interventions could be crucial for optimizing developmental outcome.

In addition to physical growth, the study also observed improved nutritional status markers, including higher levels of calcium, albumin, and prealbumin in the combination group. These biochemical markers reflect the body's ability to maintain homeostasis and support metabolic processes essential for growth. Improved nutrient absorption is likely a result of better feeding techniques and enhanced gastrointestinal function, suggesting that the synergistic effects of orofacial and touch therapies extend beyond feeding behaviors to improve systemic nutritional status.

A noteworthy finding was the reduction in bilirubin levels in the combination group, which may be attributed to both improved feeding practices and better liver function resulting from enhanced nutritional status. Bilirubin metabolism depends heavily on adequate caloric intake and efficient hepatic processing [35]. By facilitating more effective breastfeeding and reducing enteral stressors, the combined intervention may promote more efficient hepatic clearance of bilirubin, thus reducing the risk of jaundice - a common complication in preterm infants [36].

The diverse yet interconnected benefits observed in this study emphasize the importance of addressing both sensory and motor pathways in preterm infant care. While touch therapy has long been recognized for enhancing maternal-infant bonding and reducing behavioral stress, integrating orofacial stimulation provides an additional dimension to support the critical development of feeding capabilities. This integrative approach may offer a framework for developing care strategies aimed at optimizing neurological, gastrointestinal, and nutritional outcomes in preterm infants.

Despite these promising results, several limitations must be acknowledged. First, the study was conducted at a single center, which limits the generalizability of the findings. Multi-center trials are needed to validate these results

across diverse populations. Second, while the immediate benefits are evident, longitudinal studies are needed to determine whether these early advantages lead to sustained developmental improvements. Finally, future research should examine the individual contributions of various components within the oral stimulation regimen to further refine intervention protocols. Additionally, our study did not assess the incidence of complications in the two groups during the intervention period, which would be important for evaluating the safety and efficacy of the combined therapy. Future studies should address adverse events and complications throughout the intervention period.

In conclusion, combining orofacial stimulation with gentle touch therapy presents an effective intervention for reducing breastfeeding intolerance and promoting healthier growth trajectories in preterm infants. This dual approach integrates both established and innovative techniques, highlighting the importance of multidimensional therapeutic strategies in neonatal care. By addressing the complexity of feeding behavior and its associated physiologic pathways, these interventions may substantially improve clinical outcomes for this vulnerable population. Broader implementation of the combined therapeutic strategy, supported by further research and tailored to individual needs, may lead to significant advances in the management and care of preterm infants.

## Disclosure of conflict of interest

None.

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