1- INTRODUCTION

Despite advances in medical science and nursing, the number of premature births has increased to 8.9% of all deliveries. About 8 to 12% of the annual births in Iran consist of premature infants (1). Feeding premature infants is one of the important outlines of their care in the neonatal intensive care unit (2). Conventional feeding methods for preterm infants include intestinal feeding and oral feeding. The decision on how to start feeding depends on the gestational age of the fetus, the birth weight and the clinical condition of the baby (3). Oral feeding is determined by the infant's ability to coordinate sucking and swallowing and the respiratory pattern (4). One of the important obstacles to oral feeding in premature infants is the gestational age being less than 34 weeks and suffering from respiratory distress (5). Due to the importance of beginning oral feeding in premature infants as soon as possible for the development of the digestive system and regulating the secretion of hormones and digestive enzymes, as well as increasing bowel movements, much emphasis has been placed on beginning oral feeding in premature infants (6).

Oral feeding methods include finger feeding, cup feeding, dropper and breastfeeding (7). Breastfeeding is suggested as the best way to feed infants, but cannot be done in many cases due to problems of the infant and mother (8). Very little research has been done on the use of finger feeding and its efficiency and effectiveness. In this method, as the infant begins to suck the nurse's finger, the nurse gently presses the plunger onto the syringe; or milk is drawn into the baby's mouth from a container at the bottom of the tube and usually the baby is eager to suck and swallow milk (4, 9). On the other hand, various studies have been published on the use, benefits and harmlessness of cup feeding (5). The use of this method - especially in infants who cannot be directly breast fed, in addition to providing infants with adequate nutrition, prevents them from confusion of the nipple, which often occurs while being fed with glass bottles and bottles (10). The results of some research have shown that cup feeding helps the transition from the gastric tube to full breastfeeding. However, the amount of milk that the infant drinks is less and the amount of milk leaking from the side of the lips is more than the tube (10). In another study, finger feeding was preferred to cup feeding; as in this method, the infant gets the required amount of milk and milk leakage is minimal (11). Most studies have been performed on the effect of preterm infant feeding methods on variables such as vital signs during feeding, duration of drinking milk and amount of milk fed (12), while one of the most important issues has been the attention to feeding tolerance and weight gain in these infants (13). Weight is one of the main factors determining physical and cerebral growth and development in infants, especially in premature infants (14). In such a way that lack of proper weight gain prolongs hospitalization and delays in discharge, increases costs and reduces emotional contact with parents (15). Feeding intolerance is common in premature infants; and is characterized by abdominal distention and increased Gastric residual volume (16). Assessing the average Gastric residual volume is one of the most common methods for measuring feeding intolerance or tolerance in premature infants (17). Increased volume of gavage indicates infant feeding intolerance, which is seen in the early stages of necrotizing enter colitis; and is one of the causes of death in infants with low birth weights (18).

The results of a study showed a slight increase in weight in the cup group compared to other feeding methods in one week (4). The study of Claudia et al.

(2017) aimed at "determining the effect of two methods of finger feeding and cup feeding on the change from tube feeding to breastfeeding", showed that weight gain in the finger feeding group was more than the cup feeding group. The authors had proposed that milk leakage is less in finger feeding than in cup feeding (19).

A review study by McKinney et al. (2016) showed that weight gain, lack of aspiration, feeding problems, and physiological stability were better in the cup-feeding method than in other methods (20). On the other hand, another study (2014) showed that there was no significant difference between feeding with cups and bottles in terms of feeding time, feeding problems or weight gain in the hospital (21).

Based on the researcher's experience the mentioned feeding methods are not fully and routinely implemented in the neonatal intensive care unit; and on the other hand there is no definite evidence of which feeding method has a better performance on weight and feeding tolerance of premature infants. Therefore, this study was conducted to determine and compare the effect of cup and finger feeding methods on weight gain and feeding tolerance of premature infants. It is hoped that the results would be used in applying a proper feeding method for premature infants in the neonatal intensive care units.

2- MATERIAL AND METHODS

2-1. Study design and population

This study is a randomized clinical trial conducted on two experimental groups and one control group in parallel. The study participants were preterm infants, admitted to the neonatal intensive care unit of Shahid Sadoughi Hospital in Yazd. Eligible infants were divided into three groups including one control and two experimental groups, using a random number table. Sampling lasted about 4 months from 4 June 2020 to the end of October 2020. The significance level of 0.05, and the test power of 80% were assumed; and according to similar studies (8), achieving to the minimum increase of 150 grams in the average weight of infants in the experimental groups compared to the control group, and the approximate amount of standard deviation of 19 grams were considered. 26 individuals were found to be required in each group, with 10% loss, based on the following formula for deciding on the number of individuals to be included in each group:

$$n = \frac{(Z_{\frac{2}{2}}^{a} + Z\,B)^2\, 2s^2}{(\mu-\mu)^2}.$$

2-2. Inclusion and exclusion criteria

The Inclusion criteria were**:** Infants with gestational age between 32 and 36 weeks, inability to be breastfed. The Exclusion criteria were: infants with anomalies such as heart and respiratory disorders, congenital diseases of the head and neck, necrotizing enter colitis (NEC), infants in need of resuscitation, Having an Apgar score less than 5 in the fifth minute, infants in need of mechanical ventilation, genetic syndromes, bleeding Intracranial grade 3 and 4, sepsis, and respiratory disorders.

2-3. Measuring tools

Data collection tools included: 1- Demographic specifications including the gestational age, chronological age, sex, and type of delivery which were extracted from the patient file. 2- Data related to each infant's feeding tolerance and weight during the intervention period. 3- Infant weight scales with a zyklusmed model and accuracy coefficient of 5 grams, which was calibrated by the person in charge of medical equipment.

2-4. Procedure

In the cup feeding group (No. 1), we implemented the technique standardized by World Health Organization (WHO) and UNICEF (2019) as follows: the infants

were kept securely in a sitting or semi-sitting position in a blanket and the infant's body was leveled. Maternal milk or human milk from the bank was placed in a small cup, usually 30 to 50 cc in volume, and the edge of the cup was placed tangential to the baby's lower lip. With the movements of the tongue, the baby began to suckle. Feeding was completed when a prescribed volume of milk was consumed (18).

In the experimental group No. 2, finger feeding was used. The finger feeding technique was performed similar to the one described by Fuji Naga et al., in 2016 (19). First, the tip of the feeding tube was cut and fixed with scotch tape into the little finger of the glove. The finger pad was then placed upwards inside the infant's mouth and in front of the palate of her mouth. As the infant began to suck the finger, the piston was gently pressed against the syringe; or from a container at the bottom of the tube, the milk taken from the mother or from a human milk bank was drawn into the baby's mouth. In this method, the infant was usually eager to suck and swallow milk.

In the control group, feeding was done by dropper according to the routine of the ward. In feeding with the dropper, the baby's head and torso were placed at an angle of 35 to 45 degrees and the prescribed amount of milk was reduced from the volume of the gavage and given with the dropper. The duration of the study was 7 days based on similar studies and the average time for each feeding was 15 to 20 minutes. To prevent sleep disturbance in infants (22), the intervention was applied 4 times in the morning and evening shifts. And the routine feeding method was done during the night shift. The weight of uncovered infants was measured and recorded in a researcher-made form in three groups before the intervention, and then daily at the beginning of the morning shift before feeding, and after the intervention period with the researcher assistants (trained personnels working in the ward).

To evaluate the feeding tolerance of infants, before the start of each feeding, the residual volume was measured using a syringe attached to the gastric catheter by gastric lavage (23); If this rate was more than 30% of consumed milk, or in case of any of the clinical symptoms such as abdominal distension, vomiting, blood in the stool and fecal remnants, this was considered feeding intolerance and was recorded in the data entry form. To increase the validity of the research results, the nurse who assisted the researcher to record information about feeding tolerance and weight, did not know about the research. Moreover, the nurse who was assisting in feeding, was always the same person (**Fig. 1**).

2-5. Statistical analysis methods

The collected data was analyzed using SPSS21 software. Kolmogorov-Smirnov test was performed for checking the normality of the distribution. Values are expressed as Mean±SD or percentage. Inferential statistics included one-way analysis of variance, ANOVA with repeated measures, paired t-test, Chi-square and Fisher exact test at a significance level of 0.05.

2-6. Ethical consideration

This study was approved by the Ethics Committee of Shahid Sadoughi University of Medical Sciences of Yazd (IR.SSU.REC.1398.211), and registered in the Iranian Clinical Trial Site (IRCT) - number IRCT20100411003679N2. For ethical considerations, the researchers received written consent for participation in the research from the parents of the infants participating in the study.

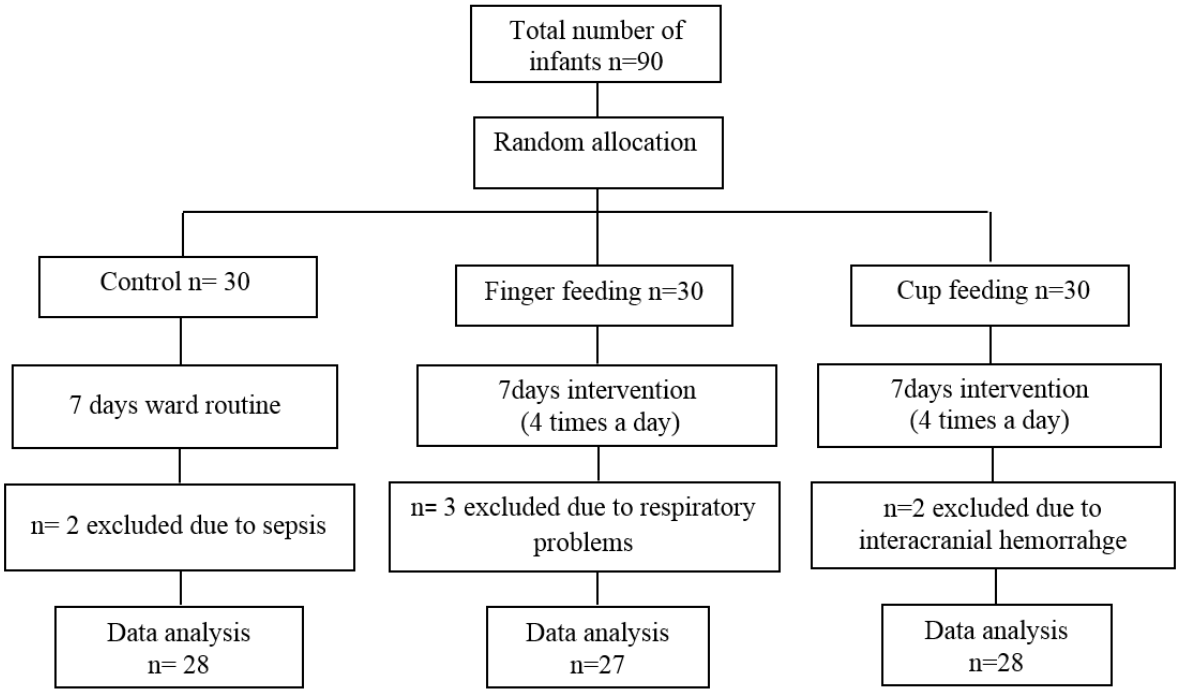

Fig. 1: Study diagram

3- RESULTS

A total of 83 premature infants were investigated in three groups, including group 1 cup feeding (n = 28), group 2 finger feeding (n = 27) and group 3 control group (n = 28). 10 infants were twins and 6 infants were triplets. Sample loss was reported in 7 cases, including 2 cases of sepsis in the control group, 2 cases of intracerebral hemorrhage in the cup group and 3 cases of respiratory problems in the finger group.

The mean fetal age was 33.68 ± 1.58 in the cup group, 33.56 ± 1.32 in the finger group and 33.86 ± 1.58 in the control group. The majority of infants in all three groups were girls and they were the result of a cesarean section. Statistical analysis using independent t-test and Chi-square showed that the three groups were not significantly different in terms of the above quantitative and qualitative contextual variables (0.05> p) (**Table 1**).

Table-1: Comparison of quantitative demographic variables in the three groups

Group Quantitative variable	Group 1: Cup feeding intervention	Group 2: Finger feeding intervention	Group 3: Control	P
	Standard deviation ± mean	Standard deviation ± mean	Standard deviation ± mean	
Weight before intervention	2246.96 ± 360.62	2227.4 ± 353.20	536.17 ± 2431.96	0.14
Gestational age (weeks) GA	33.68 ± 1.58	33.56 ± 1.32	33.86 ± 1.58	0.78
chronological age (days) CA	1.75 ± 1.005	2.33 ± 1.10	1.75 ± 0.887	0.06
Age of feeding onset (days)	1.75 ± 1.005	2.33 ± 1.10	1.75 ± 0.887	0.06
Number	28	27	28	83

The results of paired t-test showed that the weight variable before and after the intervention did not change significantly in none of the three groups; the p-values were as follows: group 1, cup feeding intervention: p=0.52; group 2, finger feeding intervention: P = 0.17; group 3, control: P = 0.06. Also, analysis of variance test showed that the differences of weight means before the intervention (p = 0.14) and after the intervention (p = 0.29) were not statistically significant among the three groups (**Table 2**).

The results of analysis of variance further showed that the daily mean weights in each of the intervention days were not significantly different among the three groups (p> 0.05) (**Table 3**).

Table-2: Comparison of the weights of the three groups before - after the intervention

Variable	Group	Before intervention	After intervention	Weight difference	P pair t test
		Standard deviation ± mean	Standard deviation ± mean	Standard deviation ± mean	
Weight (gram)	Group1	2246.96 ± 360.62	2254.46±342.32	7.500±61.09	0.52
	Group2	2227.41 ± 353.20	2183.33±402.28	-44.074±165.77	0.17
	Group3	2431.96 ± 536.17	2372.50±575.01	59.464±159.086	0.06
P - ANOVA	-	0.14	0.29	-	-

Group 1: Cup feeding intervention, Group 2: Finger feeding intervention, Group 3: Control

Table-3: Comparison of mean weight in three groups on intervention days

Weight	Group	Group 1: Cup feeding intervention	Group 2: Finger feeding intervention	Group 3: Control	**P**
day		Standard deviation ± mean	Standard deviation ± mean	Standard deviation ± mean	
1		2246.96 ± 360.62	2227.41 ± 353.20	2431.96 ± 536.17	0.14
2		2246.78 ± 359.14	2223.88 ± 354,87	2424.64 ± 533.64	0.16
3		2247.50 ± 356.46	2215.92 ± 353.95	2418.57 ± 535.72	0.16
4		2248.21 ± 352.77	2214.81 ± 354.06	2380.53 ± 576.72	0.34
5		2249.64 ± 348.57	2206.66 ± 359.03	2368.39 ± 568.83	0.36
6		2250.17 ± 346.25	2208.14 ± 356.11	2373.75 ±574.76	0.35
7		2254.46 ± 342.32	2183.33 ± 402.28	2372.50 ± 575.01	0.29

The results of repeated measures analysis of variance revealed that regardless of group type, changes in mean weight over time were significant (p =0.004). Additionally, the trend of changes over time was different among the groups (p = 0.044). However, the comparison of groups in the total time duration did not show any significant difference (p = 0.250) (**Fig. 2**). Chi-square test showed that the percentage of feeding tolerance in general and also the percentage of vomiting, abdominal distance, blood in the stool, Gastric residual volume before feeding, and gastric discoloration were not statistically significant among the three groups (**Table 4**). In addition, analysis of variance with repeated measures showed that the changes in the average volume of milk consumed in three groups, in the total time duration, were not significant (p = 0.250) (**Fig. 3**).

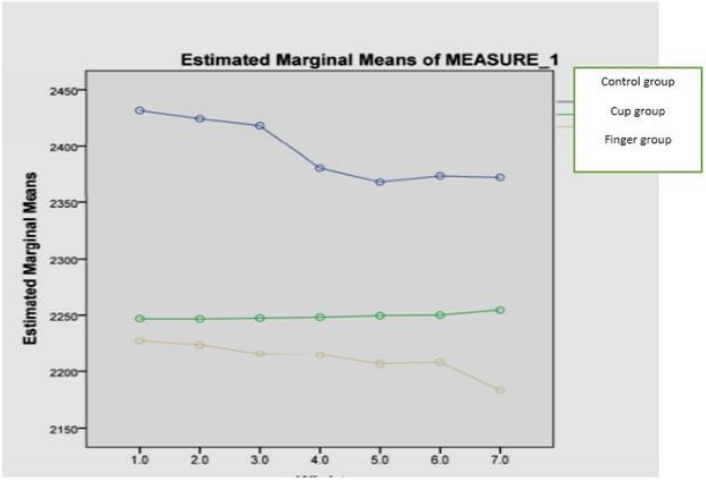

Fig. 2: Graph of weight change trends in the three groups

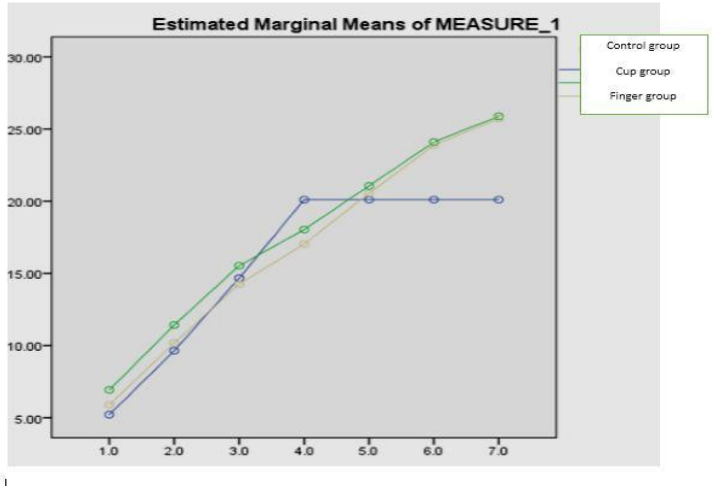

Fig. 3: Average volume of milk consumed on intervention days in the three groups

Table-4: Comparison of the frequency of feeding tolerance variables in the study groups

Variable	Group	Group 1: Cup feeding intervention		Group 2: Finger feeding intervention		Group 3: Control		P
Vomit		Yes	No	Yes	No	Yes	No	
		14.3%	85.7%	18.5%	81.5%	17.9%	82.1%	0.90
Abdominal distension		7.1%	92.9%	25.9%	74.1%	25%	75%	0.13
Blood in the stool		0	100%	0	100%	0	100%	*
Discolored residual		0	100%	3.7%	96.3%	0	100%	0.35
gastric residual before feeding		0	100%	14.8%	85.2%	7.1%	92.9%	0.10
Percentage of feeding tolerance		85.7%	14.3%	63%	37%	64.3%	35.7%	0.11

4- DISCUSSION

The aim of this study was to determine the effect of two methods: cup and finger feeding methods on weight gain and feeding tolerance in premature infants. There was no significant difference between the mean weight after the intervention and the trend of weight changes in the three groups. The onset of feeding intervention in this study was in the first week of life, but despite the normal weight loss of infants in the first week of life, the cup feeding group showed a slight increase in weight. In terms of feeding tolerance, the cup feeding group showed a higher percentage compared to the other two groups; however, no significant difference was obtained. To the best of our knowledge, in the current literature there is no study comparing the effects of cup and finger feeding on infant weight and feeding tolerance. Most studies have compared each of these methods with other feeding methods such as bottle feeding, syringes, etc. The variables evaluated in the studies were mostly physiological stability, safety, duration of milk consumption, transition time to breastfeeding, hospitalization period, adaptation and acceptance of the method. A study by Jana Al-Nekar et al. (2019) Showed that there were no signs of aspiration and feeding problems in the cup feeding group compared to finger feeding (18) which is consistent with the present study. In a systematic review study (2018) it was found that in two articles, slight weight gain in the cup group compared to other methods was shown within a week, but there was no statistically significant difference (8), in line with the results of the present study. In a study by Rocha et al. (2004), although weight gain was higher in the cup-fed group than in the bottle-fed group, it was not statistically different. According to the researcher, more weight gain in cup feeding can be due to less energy consumed during feeding, compared to bottle feeding (11).

In a study by Gonkailmaz (2014) there was no significant difference between groups of Cup Feeding and Bottle Feeding in terms of feeding problems or weight gain in the hospital (24). In a review study by McKinney et al. (2016), the results indicated that weight gain and lack of nutritional problems in the cup-feeding method were better than in the other methods (20). Literature suggests that there are many advantages in cup feeding. These include the fact that cup feeding is a simple procedure that can involve parents, early positive body and eye contact is fostered, the infant receives positive tactile and olfactory stimulation, cardiorespiratory and oxygen saturation can be maintained, the infant controls the feed and can pace the intake and the total volume of milk taken, and there is minimal risk of aspiration and minimal energy expended. The theoretical benefits include avoiding the confusion between breast and bottle, enhancing the newborn's ability to develop a suckling action for breastfeeding and facilitating the newborn's ability to self-regulate feeds and demand feeds (25).

On the other hand, some studies have shown the beneficial effects of finger feeding in premature infants. The study of Claudia et al. (2017) showed that weight gain in the finger feeding group was more than that in the cup group. According to the researcher, milk leakage is less in finger feeding than in cup feeding (19). It can be said that differences in weight loss measures make it difficult to compare studies. Standardization of this measure would benefit future studies.

Finger feeding method is an artificial technique; it is recognized in the current literature as a physiological method facilitating transition to breastfeeding and also improves sucking and breathing coordination. Correcting the sucking technique of a baby by the finger feeding method may improve breastfeeding rates and the hospital discharge process. Babies

fed by the finger feeding method had fewer signs of physiological stress, better comfort levels, and showed earlier development of sucking and swallowing functions (4).

The amount of milk prescribed for feeding premature infants is 10 to 20 cc / kg per day (17), which was also applied in this study. On the other hand, changes in the average volume of milk consumed in the three groups in total time were not significant. Therefore, it seems that, whatever that could be the cause of milk leakage or feeding intolerance and affects the volume of milk consumed, was the same among the three groups. However, some articles have suggested that cup feeding can be time consuming; in addition, the amount of milk infants need is not received due to milk leakage (10, 19). Because most studies did not describe the cup used, it was impossible to evaluate the impact of cup design on the outcomes. Shape, material, and ergonomics of feeding tools may influence intake, spillage, and feeding efficiency (24). It is also possible that the process of the cup feeding method is inconsistent between studies and there may be some inadequacies in the cup technique. Therefore, further studies should be conducted to evaluate these feeding transition techniques (4).

5- LIMITATIONS

The main limitation of this study included the low cooperation of ward nurses. Despite the training they had received in terms of the investigated techniques, they had little tendency to perform feeding procedures rather than the routines of the ward during the prolonged sampling period, due to covid-19 epidemic**.**

6- CONCLUSION

According to the results of this study, it seems that the three feeding methods with cup, finger and dropper have similar effects on weight and feeding tolerance of premature infants. Applying this study on infants with different gestational and chronological ages with larger sample size over a longer period of time is also recommended. Determining the effect of different feeding methods on achieving breastfeeding is also necessary.

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