

## Supplementation with Cup-feeding as A Substitute for Bottle-feeding to Promote Breastfeeding

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**Background:** Few studies have provided evidence to verify that bottle-feeding has negative effects on breastfeeding. There is insufficient evidence to support the practice of cup-feeding to supplement breastfeeding. However, it has been applied as a substitute for bottle-feeding to promote breastfeeding. The aims of this study were to explore the differences in infant sucking competence, infant sucking behavior and maternal milk supply among babies who were exclusively breastfeeding (breast group), breast feeding with cup supplementation (cup group) and breast-feeding with bottle supplementation (bottle group) at different periods postpartum.

**Methods:** A longitudinal study was carried out at a medical center located in northern Taiwan. The cup and bottle groups were recruited at two different times to avoid interaction. The breast group consisted of infants who were fully breastfed and were never exposed to a bottle or a cup during the hospital stay. Two hundred and five healthy mothers and their full-term, singleton infants were eligible for enrollment. We used structured questionnaires and made observations to obtain information on breastfeeding at the first breastfeeding and the third day after birth, and then followed up these cases at two and four weeks.

**Results:** The bottle group was significantly more fretful during breastfeeding ( $p < .01$ ). Mothers in the bottle group perceived that their milk supply was less sufficient than those in breast and cup groups ( $p < .01$ ).

**Conclusions:** Some indicators of breastfeeding were similar in the breast and cup groups. Cup-feeding was better than bottle-feeding when supplementary formula was needed for medical treatment.

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**Key words:** infant feeding method, cup-feeding, breastfeeding, infant sucking, maternal milk supply

**B**reastfeeding is the optimal source of nutrition for infants during the first six months of life.<sup>(1)</sup> The best way to achieve this is by sucking on the

breast. If a newborn infant cannot breastfeed exclusively then an alternative form of enteral feeding is required. Alternatives include gastric tube feeding,

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bottle-feeding and cup-feeding.

In the postpartum period, mothers are advised to not introduce an artificial nipple to an infant, because artificial feeding may have negative effects on breastfeeding. Studies describe the difference in oral configuration between sucking from the breast and an artificial nipple,<sup>(2)</sup> and report that nipple trauma and insufficient maternal milk supply syndrome result from infants' incorrect sucking technique.<sup>(3,4)</sup> World Health Organization and United Nations Children's Fund (WHO/ UNICEF) emphasize that formula supplementation and pacifier use be avoided except when medically necessary. The use of cup-feeding has been recommended as a substitute for a bottle to prevent an incorrect sucking technique when a newborn infant cannot be breast-fed exclusively.<sup>(5,6)</sup>

However few studies demonstrate a significant difference in breastfeeding between babies which are also cup-feeding and bottle-feeding. Randomized controlled trials and well designed studies, have shown different results.<sup>(7,8)</sup> Only one study has shown that cup-feeding promotes breastfeeding, but it may have been biased because of its non-randomized design.<sup>(9)</sup> However, one retrospective study and two randomized control trials found no significant differences in breastfeeding outcomes between groups with supplementation by cup-feeding and bottle-feeding.<sup>(7,10,11)</sup> Although there is insufficient evidence to support the practice of cup-feeding, it has been applied to clinical practice to promote and support breastfeeding.

Current studies of cup-feeding explored its relationship with the rate or duration of breastfeeding. These indicators may not reflect the effects on breastfeeding promotion. Even when infants can not latch onto the breast correctly, mothers may try to express human milk from the breast to breastfeed. These were the reasons that investigators have not found a significant correlation between infant feeding methods and breastfeeding outcomes.<sup>(7,8,10,12)</sup> Therefore this study used the variables of infant sucking competence, infant sucking behavior and maternal milk supply to investigate the relationship within these outcome variables. The purpose of this study was to explore the differences in infant sucking competence, infant sucking behavior and maternal milk supply among breastfeeding, cup-feeding and bottle-feeding in different postpartum periods. The

hypotheses were as follows: (1) bottle-feeding is related to ineffective sucking, negative sucking behavior and insufficient milk supply syndrome, (2) using a cup to substitute for a bottle can prevent ineffective sucking, negative sucking behavior, and insufficient milk supply syndrome.

## METHODS

### Design

A longitudinal study was carried out at a tertiary medical center located in northern Taiwan. Evidence indicates the phenomenon of infant nipple confusion occurs frequently in the early postpartum period. Mothers frequently have unexpected problems and may change the method of feeding when leaving hospital and after the baby's first month of life.<sup>(13,14)</sup> Therefore structured questionnaires were used to obtain information at the first breastfeeding and the third day after birth. Then we followed-up by telephone and mail at two and four weeks after hospital discharge. A longitudinal study usually has some drop-out cases. The effect sample number was more than 30 per group and we estimated the mail reply rate would reach 50%, so we needed more than 180 cases for our research.

### Participants

Inclusion criteria for the study were as follows: (1) full term singletons delivered vaginally, (2) mothers who expressed a desire to practice breastfeeding before the third postpartum day, (3) mothers without maternal postpartum complications, (4) no maternal preference for cup or bottle as the method of supplementary feeding, (5) mothers who were informed about the study and agreed to sign a consent form and (6) babies with no congenital abnormalities that would affect sucking ability.

Two hundred and five mother-infant pairs were eligible for enrollment. Seventy-six infants were exclusively breastfed by the mothers (breast group), sixty-seven infants had supplementary cup-feeding (cup group) and sixty-two had supplementary bottle-feeding (bottle group) by the mothers or other family members.

### Instruments

Infants' sucking competence and behavior were assessed using the Infant Breastfeeding Assessment

Tool (IBAT)<sup>(15)</sup> and a tool assessing five defined types of sucking, created by Matthews and Barnes, Lethin, & Jackson.<sup>(16)</sup> The maternal milk supply was assessed using the H & H Lactation Scale.<sup>(17)</sup>

Infant breastfeeding competence was assessed with the Infant Breastfeeding Assessment Tool (IBAT), which evaluates four components of sucking effectiveness: readiness to feed, arousability, rooting, and the fixing and sucking pattern.<sup>(15)</sup> The scores for each of these four components ranges from 0 to 3. The total score ranges from 0-12. A higher score indicates more effective sucking. The percentage of agreement between nurses and mothers was 91%.<sup>(18)</sup> Test-retest reliability correlations were .88 in one study.<sup>(18)</sup> In our study, the IBAT was reviewed and approved for use by six advanced professionals who worked consistently in the postpartum field. The content validity index (CVI) was .94 and inter-rater reliability was .90 when the tool was used with a sample of 30 mother-infant pairs in the pilot study.

Sucking behavior in the early neonatal period affects the breastfeeding rate at three and six months of age ( $p < .001$ ).<sup>(19)</sup> A tool designed Barnes et al.<sup>(16)</sup> who defined five behavior types to identify infants' sucking behavior was used in this study. Mothers need to choose one of the five types to fit their infants sucking behavior. Types two and three indicate babies with no particular interest or ability in sucking at the breast and those who scream while alternately grasping and losing the breast. The effects of type two are in vain and the characteristic is similar to nipple confusion.<sup>(13)</sup> Mizuno et al. reported nipple confusion in Type three infants and it was the most frequent reason for ceasing breastfeeding.<sup>(19)</sup> Therefore these two types were classified as negative sucking behavior in this study. The CVI was 1, reviewing and approving for use by six advanced professional.

The maternal milk supply was assessed using the H & H Lactation Scale.<sup>(17)</sup> The psychometric properties of this scale were developed for measuring the maternal milk supply. Construct validity was examined through factor analysis, which revealed three factors: confidence/commitment to breastfeeding, perceived infant breastfeeding satiety, and maternal-infant breastfeeding satisfaction. The scale's overall alpha coefficient ranged from .91 to .92 in term babies for weeks 1 through 6. Over the first 6 weeks after birth, alpha reliabilities for the

individual subscales for the term sample ranged from .75 to .84, .80 to .89, and .77 to .92. Test-retest reliabilities for weeks 1 through 6 ranged from .68 to .90, .67 to .89, .73 to .83.<sup>(17)</sup> Twenty items were measured on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The scale was scored so that a higher score indicated that the mother felt positive about her breastfeeding experience. The CVI was .98, and Cronbach's alpha was .93 when the tool was filled by postpartum mothers in the pilot study and formal study.

### Procedure

After review and approval by the hospital's human investigation committee, the study was conducted in the postpartum unit and nursery. To avoid interaction between the three groups, we recruited the cup and bottle groups at two different times. The hospital is a baby-friendly hospital institution. Cup-feeding is routinely substituted for bottle-feeding in breastfed infants receiving supplemental formula. The cup group was recruited from Dec 1 to Dec 31, 2005. However, if mothers wanted to use supplemental formula, an investigator taught the mothers the advantages and disadvantages of these two containers. We provided bottle-feeding after they received sufficient information and decided to use the bottle. The bottle group was recruited from Feb 1 to Feb 28, 2006. The breast group was recruited from Dec 1, 2005 to Feb 28, 2006 and consisted of infants who were breastfed exclusively and never exposed to a bottle or a cup during the hospital stay.

After birth in the delivery room, the mother and baby practiced skin-to-skin contact for only ten to twenty minutes. They did not have enough time to try breastfeeding because the hospital's standards require a complete physical examination of the newborn on admission to the nursery. Then we would ask mothers about their breastfeeding plan. If they did not intend to use breastfeeding exclusively, the hospital provided mothers with feeding containers and supplementary formula. An investigator explained the process of the study at the first breastfeeding, and taught the mothers how to breastfeed and position infants. Even if mothers selected supplementary feeding using an artificial feeding container, we still encouraged the mother to breastfeed exclusively. Data were obtained from daily chart records and the mothers completed questionnaires at the first breast-

feeding, on the third day, and two and four weeks after giving birth. Pictures of the infants were taken during the hospital stay, and the pictures and questionnaires were sent to their mothers by mail to promote replies to our questionnaires.

### Data analysis

Data were analyzed using SPSS 10.0 statistical software. Values were expressed as mean, standard deviation, frequency and percentage.

The longitudinal analysis concerned changes over time in individual cases. Repeated measures ANOVA and a post hoc test with the Scheffe adjustment were used to test mean scores for infant sucking competence and maternal milk supply between groups over time. The  $\chi^2$  test was used to analyze infant sucking behavior. A *p* value < .05 was considered statistically significant and 95% confidence intervals were used.

## RESULTS

The characteristics of the three groups are shown in Table 1. Complete information at two and four weeks was obtained for 83% and 62% of cases, respectively. Participating mothers were 29.73 years old. About 96.6% of the participants were married and 58.5% were primiparous. Infants were term (38.88 weeks), with an average birth weight of 3201.9 g. Study groups did not differ by maternal age, education, employment status, married state, smoking, parity, previous live births, infant sex, gestational age, birth weight or hospital stay (*p* > .05). Other important variables are recorded in Table 1.

### Sucking competence

Analysis of variance was used to analyze the dependent variable and found that the Mauchly's Test of Sphericity did not fit the assumption, so the Greenhouse-Geisser correction was used. Table 2

**Table 1.** Characteristics Data of Three Groups (N = 205)

Group	Breast group (n = 76)		Cup group (n = 67)		Bottle group (n = 62)		<i>p</i> value
	mean ± SD	n (%)	mean ± SD	n (%)	mean ± SD	n (%)	
Previous duration of breastfeeding (m)	1.62 ± 4.45		1.55 ± 4.35		1.23 ± 2.21		.824 <sup>†</sup>
Breastfeeding goal (m)	5.89 ± 3.75		5.12 ± 3.33		4.66 ± 4.82		.184 <sup>†</sup>
Antenatal breastfeeding education							.908 <sup>†</sup>
Yes	27 (35.5)	22 (32.8)	20 (32.3)				
No	49 (64.5)		45 (67.2)		42 (67.7)		
Nipple type							.190 <sup>‡</sup>
Everted (after stimulation)	73 (96.1)		59 (88.1)		58 (93.5)		
Flap or inverted	3 (3.9)		8 (11.9)		4 (6.5)		
Rooming-in							.214 <sup>‡</sup>
No	52 (68.4)		51 (76.1)		52 (83.9)		
Twelve hours per day	6 (7.9)		3 (4.5)		4 (6.5)		
Twenty-four hours per day	18 (23.7)		13 (19.4)		6 (9.7)		
Duration from birth to first breastfeeding (h)	–		14.7 ± 14.4		15.3 ± 12.6		.777 <sup>§</sup>
Breastfeeding times during hospital stay	–		9.4 ± 4.45		8.6 ± 4.4		.324 <sup>§</sup>
Artificial feeding times during hospital stay	–		9.7 ± 4.9		11.2 ± 5.1		.075 <sup>§</sup>
Artificial feeding volume (ml) during hospital stay	–		363 ± 181		430 ± 220		.061 <sup>§</sup>

\*: *p* < .05; †: one way ANOVA; ‡:  $\chi^2$  test; §: student t test; ||: Fisher exact test.

**Table 2.** Analysis of Variance with Scheffe Adjustment of Comparison of Infant Sucking Competence (N = 107)

Group	Third day	2 weeks	4 weeks	Within case (F value)	
				Stage	Stage by group
Breast group	8.79 ± 0.35	9.93 ± 0.30	10.09 ± 0.31	38.428*	.826
Cup group	8.21 ± 0.37	9.53 ± 0.32	10.42 ± 0.33	1 < 2, 1 < 3, 2 < 3	
Bottle group	8.69 ± 0.45	9.73 ± 0.39	10.23 ± 0.39		
Between case (F value)	.644				

\*:  $p < .001$ .

shows there was no interaction between groups and postpartum duration. The main effects were within the postpartum durations. ( $F = 38.428$ ,  $p < .001$ ). That is to say, infant sucking competence was not be changed by the different groups, but was changed by different postpartum durations.

### Sucking behavior

The Mantel-Haenszel trend test was used to analyze negative sucking behavior at different postpartum durations. There was a significant correlation between infant negative sucking behavior and postpartum duration. ( $p = .001$ ). The phenomenon of infant negative sucking behavior decreased over time ( $\chi^2_{MH\ trend} = 16.722$ ,  $p < .001$ ). At four weeks after birth, infants had less negative sucking behavior when attempting to latch onto the breast ( $p < .001$ ).

There was no significant correlation between infant feeding groups and negative sucking behavior during the first breastfeeding, at two weeks and at four weeks. A significant difference was only seen on the the third day ( $p = < .01$ ). We found a difference between the breast and bottle groups based on adjusted residuals (Table 3). In other words, babies in the bottle group displayed more negative sucking behavior during attempts at the breast than the breast group.

### Maternal milk supply

Repeated measures ANOVA was used to analyze the maternal milk supply for different infant feeding methods and at different postpartum durations. We found that the Mauchly's Test of Sphericity did not fit the assumption when analyzing the variance, so the Greenhouse-Geisser correction was

**Table 3.** Cross Table of Group and Infant Sucking Behavior at Different Postpartum Durations

	Breast group n (%)	Cup group n (%)	Bottle group n (%)	$\chi^2$
First time (n = 205)				.131
Negative	18 (23.7)	31 (46.3)	29 (46.8)	
Positive	58 (76.3)	36 (53.7)	33 (53.2)	
Third day (n = 205)				9.557*
Negative	12 (15.8)†	21 (31.3)	24 (38.7)†	
Positive	64 (84.2)†	46 (68.7)	38 (61.3)†	
2 weeks (N = 159)				
Negative	13 (20.3)	15 (26.3)	9 (23.7)	.613
Positive	51 (79.7)	42 (73.7)	29 (76.3)	
4 weeks (N = 107)				
Negative	9 (20.9)	5 (13.2)	5 (19.2)	.886
Positive	34 (79.1)	33 (86.8)	21 (80.8)	

\*:  $p < .01$ ; †: |adjusted residuals| > 1.96.

used. Table 4 shows no interaction effect between groups and postpartum durations ( $p > .05$ ). The main effects were within the groups ( $F = 9.940$ ,  $p < .001$ ) and postpartum durations ( $F = 5.413$ ,  $p < .01$ ). The Scheffe adjustment was used and the results showed mothers' milk supply was significantly higher in the breast and cup groups than the bottle group. But there was no difference between the breast group and

**Table 4.** Analysis of Variance with Scheffe Adjustment of Comparison of Maternal Milk Supply (N = 107)

Group	Third day	2 weeks	4 weeks	Within case	
				stage	Stage by group
Breast feed group	113.767 ± 2.269	110.837 ± 2.633	110.651 ± 2.958	5.413*	.684
Cup feed group	115.026 ± 2.413	108.079 ± 2.801	109.842 ± 3.147	1 > 2, 1 > 3	
Bottle feed group	99.370 ± 2.863	96.704 ± 3.323	94.852 ± 3.733		
Between case	9.490†				
	a > c, b > c				

\* $p < .01$ ; †:  $p < .001$ .

the cup group (Table 4). Mothers had the highest perception of milk supply on the third day and the lowest at four weeks postpartum. All participants' perception of milk supply decreased over time.

## DISCUSSION

### Nipple confusion

Recently cup-feeding has gained increased use as an alternative feeding method in maternity and neonatal units for preterm and term infants who are unable to breastfeed exclusively.<sup>(5)</sup> The theoretical benefits are said to include avoiding confusion between the breast and bottle and facilitating the ability of newborns to protrude their tongues to obtain milk.<sup>(6,20)</sup> In our study, there was no significant correlation between infant feeding method and infant sucking competence. It seems that exposing an infant to an artificial nipple has much less effect on infant sucking ability than published reports indicate.

The bottle group displayed more negative sucking behavior during attempts to latch on the breast than the breast group on the third day. There was a significant correlation between infant feeding method and infant sucking behavior during breastfeeding on the third day after birth, but no correlation at two and four weeks. Based on this result, we could say that bottle feeding has only a short term effect on infant sucking behavior. When feeding from a container bottle-feeding allows infants to ingest more milk in a shorter period of time than cup-feeding, and the rate of flow is faster than from the breast.<sup>(21)</sup> Perhaps, bottle-feeding affects infant sucking behav-

ior because of the high fluid flow (volume) rate.<sup>(13)</sup>

Neifert et al. indicated that infant nipple confusion occurs frequently in the early postpartum period. This causes mothers to wean from the breast early because of ineffective infant sucking.<sup>(13)</sup> These points of view were similar to our research findings. Nevertheless, the effects of artificial feeding were seen in infant sucking behavior during attempts to latch onto the breast, but not in sucking competence.

The evidence base on nipple confusion is insufficient. Physicians don't have guidelines on avoiding nipple confusion. In our country, staff often do not believe that cup feeding can be substituted for bottle feeding to prevent nipple confusion when mothers can not breastfeed exclusively. Although its safety of has been well verified in published studies,<sup>(6,8)</sup> an evaluation of baby friendly hospitals in Taiwan showed that physicians still worry that cup feeding it takes more time than bottle feeding, and might cause an infant to choke.<sup>(22)</sup> In clinical situations, physicians depend on their clinical experience and individual preference. Therefore, cup-feeding has not been easy to implement in Taiwan. Our research data can support the practice of cup-feeding to promote breastfeeding.

### Maternal milk supply

The maternal milk supply changed in the three groups at different postpartum durations. Compared with the bottle group, the mothers in the breast and cup groups had higher perceptions of maternal milk supply at the three postpartum durations in the study. The relational statements between bottle and mater-



nal milk supply, were introduction as causal and concurrent. Based on the time series, bottle-feeding occurred prior to maternal insufficient milk supply syndrome. Therefore, bottle-feeding could be the cause and insufficient milk supply syndrome could be the effect. However, this study was not designed to verify a causal relationship between these two variances. If the relationship was real, we could infer that mothers introduced bottle firstly, and infant sucked milk from the breast less frequently to block the act of prolactin and influence material milk supply.

In addition to the artificial feeding container, supplementary formula can also affect a mother's milk supply. On the third day after birth, there was no significant difference in breastfeeding frequency, artificial feeding frequency and artificial feeding volume between the cup group and bottle group. Although the artificial feeding frequency was not different at two weeks postpartum, the artificial feeding volume was different between those two groups ( $F = 8.466, p < .001$ ). The Scheffe test showed that the bottle group than the breast group ( $F = 37.93, p = .001$ ) and cup group ( $F = 38.81, p = .005$ ). This result showed mothers who added supplementary formula by bottle in the early postpartum period may have had difficulty breastfeeding and had become more accustomed to using formula at two weeks. These were reasons why infant feeding methods affect a mother's milk supply.

Cronenwett et al. found infants who received bottles in the hospital were more likely to have mothers who reported severe breastfeeding problems.<sup>(23)</sup> Kearney et al also found that mothers whose babies received bottles in the hospital had the highest breastfeeding problem scores at one week postpartum.<sup>(24)</sup> ( $R^2 = .154, p = .0004$ )

The significant correlation of infant feeding methods with maternal milk supply may result from milk ingestion. Compared with bottle-feeding, infants spilled more milk when sipping from a cup.<sup>(21)</sup> Although the volume of formula given to infants with cup group and bottle group were the same on the third day in this study, the ingestion volume may have been different. This would explain that the correlation between infant feeding methods and maternal milk supply resulted from the volume of formula that infants' ingest during artificial feeding in the early postpartum period.

## Conclusion

In our study, the bottle group displayed more negative sucking behavior during attempts to latch onto the breast than the breast group on the third day, and mothers in the bottle group had a lower perception of maternal milk supply on the third day, at two weeks and at four weeks postpartum. These results display a relationship between bottle-feeding and breastfeeding in the short- term and long term. Therefore, physicians should encourage mothers to avoid artificial nipples and supplementary formula except when medically necessary.

Our study found that some outcome indicators of breastfeeding were similar in the breast and cup groups, such as infant sucking behavior during attempts to latch onto the breast and maternal milk supply. Therefore, cup-feeding is better than bottle-feeding when supplementary formula is needed for medical treatment.

Infants learn to attach to the breast and suckle properly during the first few days of life and sucking ability matures gradually. In our study, neither ineffective sucking nor negative sucking behavior was irreversible. Physicians should teach mothers how to maintain lactation and use lactation aids or a cup to substitute for artificial nipples until infants achieve sucking effectiveness and positive sucking behavior.<sup>(25)</sup>

There were several limitations inherent in this study. This study controlled the variance of delivery by excluding cesarean section cases, but did not consider birth trauma resulting from other types of delivery, such as the use of obstetric forceps or vacuum induction. Birth trauma may interfere with infant sucking ability and affect the study results.<sup>(26)</sup> This study did the group assignments at different times to avoid interaction among different groups, but investigators did not design a double blind randomized control trial to prevent a Hawthorne effect and sampling error. The mothers may know somebody observed them, which could have spurred them to a better performance.

Also, we selected postpartum women as our samples and gathered the information by mail. Postpartum women may feel tired in the first month after giving birth and we could not be sure that they would fill out the questionnaires. The above limitations may interfere with the reliability and validity of the study and limit inferences from the research. This

study only followed up cases until four weeks postpartum. There are possible long-term correlations between infant feeding methods and breastfeeding outcomes. Further studies should control the variances and extend the follow-up duration to investigate their relationships.

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## 使用杯子餵食取代奶瓶餵食是否可促進母乳哺餵

黃雅儀 高美玲<sup>1</sup> 黃久美<sup>2</sup> 李絳桃<sup>3</sup>

**背景：** 很少科學證據證實奶瓶餵食對母乳哺餵有負面的影響，儘管杯子餵食於哺乳上的成效尚未具備穩固的實證基礎，卻已被廣為應用在產後的領域，本文之目的在於探索採用不同餵食方式之嬰兒，於產後幾個階段之嬰兒吸吮能力、嬰兒吸吮行為及母親乳汁分泌之異同。

**方法：** 本研究為縱貫性研究設計，收案地點為北台灣某醫學中心，為避免不同餵食組別交互影響，杯子餵食及奶瓶餵食組分別於不同階段進行收案，乳房餵食組則蒐集產後留院期間哺餵母乳、從未接觸過奶瓶及杯子等餵食工具之母嬰，共收案 205 對自然生產之健康足月母嬰。於產後第一次及第三天蒐集母乳哺餵資訊，並於母嬰返家後以郵寄問卷方式收集產後二週及滿月之哺乳資訊。

**結果：** 奶瓶餵食組比乳房餵食組有較大的機會出現負向的吸吮行為 ( $p < .01$ )，其母親乳汁分泌不足的感知亦顯著的高於乳房組與杯子組 ( $p < .01$ )。

**結論：** 本研究證實杯子餵食在某些哺乳指標上較接近乳房餵食組，故當嬰兒在醫療需求下需補充配方牛奶時，杯子仍是優於奶瓶的一種輔助餵食方式。  
(長庚醫誌 2009;32:423-31)

**關鍵詞：** 嬰兒餵食方法，杯子餵食，母乳哺餵，嬰兒吸吮，乳汁分泌