Aliwi *et. al.,* Babcock Univ. Med. J.2025 8(2):234-241
https://doi.org/10.38029/babcockuniv.med.j..v8i2.1026
eISSN: 2756-4657

RESEARCH ARTICLE OPEN ACCESS

Impact of a nutrition-based educational intervention on kindergarten teachers' knowledge of complementary feeding: A randomised controlled trial

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Submitted: 6th July 2025
Accepted: 10th July 2025
Published: 31st December 2025
ID: Orcid ID

Abstract
Objective: This study evaluates the effectiveness of a nutrition-based educational intervention in improving kindergarten teachers' knowledge of complementary feeding (CF) practices.
Methods: A randomised controlled trial was conducted from September 2024 to July 2025 among 100 kindergarten teachers from six public kindergartens in Ramadi, Iraq. Participants were randomly assigned (1:1) to either an intervention or control group using a computer-generated simple randomisation sequence. The intervention group received a four-session, evidence-based nutrition education program focused on CF, while the control group received no training during the study period. Teachers' knowledge was assessed using a validated 10-item questionnaire at baseline, immediately post-intervention, and six weeks later. Data were analysed using repeated measures ANOVA, with statistical significance set at $p < 0.05$.
Results: At baseline, both groups had similarly poor CF knowledge (mean score: 21.92 ± 1.70 vs. 21.90 ± 2.37; $p = 0.96$). Post-intervention, the experimental group's mean score increased significantly to 45.54 ± 2.22 ($p < 0.001$), with 100% attaining "good" knowledge. These gains were sustained at six weeks (mean score: 45.34 ± 2.16), while the control group showed no significant change over time ($p = 0.600$). The intervention yielded a large effect size (Cohen's $d > 9.0$).
Conclusion: Nutrition education interventions can significantly and sustainably improve kindergarten teachers' knowledge of complementary feeding. Integrating such training into teacher development programs may enhance child nutrition outcomes, particularly in socio-cultural contexts where educators serve as trusted community figures.

Keywords: Complementary Feeding, Health Education, Nutrition Education, Early Childhood Education, Teachers, Randomised Controlled Trial

Plain English Summary

Many young children in low-resource settings do not receive the right kinds of foods when they start eating solid foods alongside breast milk, a stage known as complementary feeding. Poor feeding practices during this time can lead to malnutrition, which affects children's growth, health, and brain development. While parents are usually the main source of care, teachers, especially in kindergartens, can also play an important role in guiding healthy practices. This study looked at whether a simple training program could improve what kindergarten teachers in Iraq know about complementary feeding. One group of teachers received special lessons on how and when to introduce food to babies, while another group did not receive any training. The researchers asked both groups questions before, right after, and six weeks after the training.

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They found that the trained teachers learned a lot and remembered what they were taught, while the untrained group showed no improvement. This suggests that teaching educators about child nutrition can be an effective way to support better feeding practices, even if they are not health professionals. Programs like this could help reduce child malnutrition by making teachers partners in early childhood health.

Introduction

Complementary feeding (CF), the gradual introduction of solid and semi-solid foods alongside breast milk, plays a critical role in the health and development of children aged 6 to 23 months. This period represents a unique developmental window during which children require higher nutrient intake per kilogram of body weight than at any other stage of life (1, 2). Proper CF practices are essential to meet these nutritional demands, supporting healthy growth, immune function, and cognitive development (3, 4).

Despite global efforts to promote optimal infant and young child feeding practices, challenges persist, particularly in low- and middle-income countries (LMICs), where caregivers often lack accurate, evidence-based information about when and how to introduce complementary foods. In such contexts, inadequate maternal knowledge, rather than food access, is frequently cited as a major barrier to optimal CF (5, 6). This is particularly evident in conservative and tradition-bound societies like Al-Anbar Governorate in Iraq, where health education systems may be underutilised, and family or community sources often dominate the flow of nutrition-related information (5, 6).

Educators in early childhood settings can serve as effective agents for reinforcing positive nutritional behaviours. Teachers, especially those in kindergartens, spend significant time with young children and can influence both dietary practices and caregiver knowledge through structured interactions. However, most teacher training programs in such contexts do not include sufficient content on early childhood nutrition, including CF (7).

Although several studies have focused on improving parental knowledge, few interventions have targeted kindergarten teachers as a vector for improving CF practices. A recent study in Nova Lima, Brazil, demonstrated that nutrition-focused interventions among teachers can yield positive knowledge and behaviour outcomes (7). Similarly, research from other LMIC settings, including Nigeria, has shown that frontline non-health professionals can effectively deliver public health education when adequately trained and supported (8, 9, 10).

To date, there remains a critical gap in the literature on the effectiveness of structured, evidence-based educational interventions aimed at improving kindergarten teachers' knowledge of CF, particularly in Iraq and comparable contexts in the Global South. This study aims to address the knowledge gap in CF among kindergarten teachers through a structured intervention and to evaluate its impact using a randomised controlled trial (RCT) design.

Materials and Methods

Study Design and Setting

This study employed a true experimental randomised controlled trial (RCT) design to assess the efficacy of a structured nutrition-based educational intervention on kindergarten teachers' general knowledge about complementary feeding (CF). The trial was conducted over nine months, from September 29, 2024, to July 1, 2025, in Ramadi city, Al-Anbar Governorate, Iraq. The setting comprised all six public kindergartens located in the city, each serving distinct geographical districts.

Sample Size and Sampling Procedure

A total of 100 kindergarten teachers working in the six public kindergartens were recruited. A power calculation was not conducted before sampling, which is acknowledged as a limitation of the study. However, total population sampling was used to maximise representativeness, given the relatively small and accessible target population.

Eligible participants were those who had no prior training or formal exposure to CF-related content (via workshops, lectures, courses, or media); worked exclusively in public kindergartens; and provided written informed consent

Teachers were randomly assigned to experimental (n = 50) and control (n = 50) groups using a computer-generated random number sequence. Randomisation was carried out by a third-party statistician not involved in recruitment or implementation, ensuring allocation concealment. Group assignment was revealed to participants only after enrolment and baseline assessment.

Blinding

Due to the nature of the intervention, blinding of participants was not feasible. However, both the data collectors and outcome assessors were blinded to group allocation. The statistician performing the data analysis was also blinded to group identity to minimise potential bias.

Intervention Description

The intervention consisted of a nutrition-focused educational program designed to enhance general knowledge about complementary feeding practices. It was informed by a pre-intervention needs assessment, relevant global and regional literature (including WHO, UNICEF, FAO, CDC, and AAP guidelines), and validated expert input.

The intervention comprised four weekly sessions, each lasting approximately 90 minutes, and was delivered in a classroom setting using a mix of Lectures, illustrated slide presentations, Interactive discussions, practical scenarios, Case-based learning and role play

The session topics included Principles of complementary feeding and optimal timing, Age-appropriate food types and meal frequency, Avoidance of harmful additives (sugar, salt, allergens) and continued breastfeeding during CF and responsive feeding

Participants received a printed handout summarising each session. The control group received no intervention during the study period but was offered the training afterwards for ethical reasons.

Measurement Tool and Data Collection

Data were collected at three timepoints: Pre-test (baseline), Post-test I (immediately after intervention) and Post-test II (six weeks after intervention). A structured self-administered questionnaire was used to assess CF knowledge. It included 10 multiple-choice questions derived from global CF guidelines, Items covering CF initiation, duration, meal frequency, nutrient composition, and common myths. Each correct response earned five points, with a maximum total score of 50. Knowledge levels were classified as

Poor (10–23.33), Fair (23.34–36.66) and Good (36.67–50).

The tool was piloted among 15 teachers in a neighbouring governorate, with feedback used to refine item wording. Internal consistency reliability was evaluated using Cronbach's alpha, yielding a value of 0.82, indicating good reliability. Sociodemographic data (age, qualification, marital status, years of experience, number of children) were also collected to examine baseline comparability between groups.

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics version 26. Descriptive statistics summarised demographic variables. Repeated measures ANOVA tested changes in knowledge scores over time within and between groups. A p-value of < 0.05 was considered statistically significant.

Results

Participant Characteristics

A total of 100 kindergarten teachers were enrolled and randomly allocated into two equal groups: 50 in the experimental group and 50 in the control group. As shown in Table 1, participants were predominantly below 40 years of age (65%), married (87%), and held diploma qualifications (66%). The average age was 36.60 ± 8.56 years, and the average years of teaching experience was 11.87 ± 9.79. No statistically significant differences were found between the two groups across all demographic variables, confirming baseline homogeneity.

For example, mean age did not differ significantly between experimental and control groups ($p = 0.70$), and years of teaching experience also showed no meaningful difference ($p = 0.69$). Similarly, marital status, qualification level, and number of children were comparable ($p > 0.05$ for all). Notably, none of the participants had received prior training in complementary feeding, consistent with the study's inclusion criteria.

Table 1: Baseline Demographic Characteristics of Participants (n = 100)

Characteristic	Experimental Group (n=50)	Control Group (n=50)	p-value
Mean Age (years)	36.26 ± 7.57	36.94 ± 9.52	0.7
Married (%)	90	84	0.29
Diploma Holders (%)	72	60	0.26
Mean Years of Experience	11.48 ± 8.94	12.26 ± 10.65	0.69
Prior CF Training (%)	0	0	–

Baseline Knowledge on Complementary Feeding

At baseline (Pre-test), most participants in both groups demonstrated poor knowledge of complementary feeding. As seen in Table 2, 82% of teachers in the experimental group and 72% in the control group were classified as having poor knowledge based on their total scores.

The mean total knowledge scores were nearly identical between groups: Experimental group (21.92 ± 1.70) vs Control group (21.90 ± 2.37). There was no statistically significant difference between the groups at baseline ($p = 0.96$), and the effect size was negligible (Cohen's $d = 0.01$), indicating strong equivalence at the start of the intervention.

Post-Intervention Knowledge Outcomes

Following the intervention, there was a marked improvement in the experimental group's knowledge, with significant gains sustained over time. Immediately after intervention (Post-test I), all 50 teachers in the experimental group (100%) moved to the "good" knowledge category. The control group remained largely unchanged: 72% retained "poor" knowledge. The Mean knowledge scores were significantly different; Experimental group (45.54 ± 2.22) vs Control group (22.22 ± 2.95); $p < 0.001$; Cohen's d = 9.00 (very large effect)

Six weeks later (Post-test II), the Experimental group sustained gains (100% remained in the "good" category), while the control group again showed no meaningful progress. The Mean scores were 45.34 ± 2.16 (Experimental group) vs 21.98 ± 2.66 (Control group); $p < 0.001$; Cohen's d = 9.11.

Table 2: Knowledge Category Distribution and Mean Scores by Group and Time Point

Test Period	Knowledge Level	Experimental Group (%)	Control Group (%)	Mean Score ± SD (Exp)	Mean Score ± SD (Ctrl)	p-value	Effect Size (Cohen's d)
Pre-test	Poor	82	72	21.92 ± 1.70	21.90 ± 2.37	0.96	0.01
Post-test I	Good	100	0	45.54 ± 2.22	22.22 ± 2.95	<0.001	9
Post-test II	Good	100	0	45.34 ± 2.16	21.98 ± 2.66	<0.001	9.11

Knowledge categories: Poor (10–23.33), Fair (23.34–36.66), Good (36.67–50)

Item-Level Knowledge Improvements

As presented in Table 3, a detailed breakdown of individual knowledge items showed significant improvement across all areas in the experimental group. For example, knowledge of the recommended age for initiating CF, the role of continued breastfeeding, and the avoidance of sugar and salt in complementary meals all shifted from low/moderate levels at baseline to high levels post-intervention.

The control group's scores remained static across all individual items, with most mean scores staying within the "low" or "moderate" range.

Table 3: Sample of Item-Level Mean Knowledge Scores (Pre-test, Post-test I, Post-test II)

Knowledge Item	Test Time	Experimental (Mean ± SD)	Control (Mean ± SD)
CF starts at 6 months	Pre-test	2.14 ± 0.57	2.18 ± 0.60
	Post-test I	4.80 ± 0.40	2.24 ± 0.66
	Post-test II	4.74 ± 0.44	2.16 ± 0.55
Sugar should not be added during CF	Pre-test	3.04 ± 0.64	2.90 ± 0.46
	Post-test I	4.42 ± 0.50	2.88 ± 0.48
	Post-test II	4.50 ± 0.51	2.92 ± 0.49
Breastfeeding should continue during CF	Pre-test	1.50 ± 0.61	1.42 ± 0.50
	Post-test I	4.52 ± 0.51	1.50 ± 0.71
	Post-test II	4.54 ± 0.50	1.46 ± 0.61

Complete item-level results are provided in the Supplementary Tables 4, 5 and 6

Table 4: Item-Level Knowledge Scores by Group Across All Study Time Points (n = 100)

Item	Test Time	Experimental Group Mean ± SD	Control Group Mean ± SD	Assessment* (Exp)	Assessment* (Ctrl)
CF is introducing solids/semi-solids alongside breast milk	Pre-test	2.40 ± 0.61	2.68 ± 0.65	M	M
	Post-test I	4.56 ± 0.50	2.66 ± 0.66	H	M
	Post-test II	4.54 ± 0.50	2.62 ± 0.64	H	M
CF starts at 6 months	Pre-test	2.14 ± 0.57	2.18 ± 0.60	L	L
	Post-test I	4.80 ± 0.40	2.24 ± 0.66	H	L
	Post-test II	4.74 ± 0.44	2.16 ± 0.55	H	L
CF continues for 2 years	Pre-test	2.14 ± 0.64	2.06 ± 0.51	L	L
	Post-test I	4.54 ± 0.58	2.10 ± 0.58	H	L
	Post-test II	4.36 ± 0.49	2.08 ± 0.53	H	L
Most children can eat family food at 1 year old	Pre-test	2.14 ± 0.50	2.10 ± 0.74	L	L
	Post-test I	4.34 ± 0.48	2.12 ± 0.80	H	L
	Post-test II	4.24 ± 0.43	2.08 ± 0.70	H	L
Salt should not be added during CF	Pre-test	2.88 ± 0.63	2.78 ± 0.71	M	M
	Post-test I	4.38 ± 0.49	2.82 ± 0.72	H	M

	Post-test II	4.48 ± 0.51	2.72 ± 0.70	H	M
Sugar should not be added during CF	Pre-test	3.04 ± 0.64	2.90 ± 0.46	M	M
	Post-test I	4.42 ± 0.50	2.88 ± 0.48	H	M
	Post-test II	4.50 ± 0.51	2.92 ± 0.49	H	M
Allergic foods may be tolerated if given before 1 year	Pre-test	1.68 ± 0.55	1.78 ± 0.68	L	L
	Post-test I	4.42 ± 0.50	1.82 ± 0.75	H	L
	Post-test II	4.38 ± 0.49	1.84 ± 0.77	H	L
6–8 months: 2–3 meals + 1–2 snacks/day	Pre-test	2.32 ± 0.55	2.28 ± 0.61	L	L
	Post-test I	4.64 ± 0.49	2.32 ± 0.65	H	L
	Post-test II	4.60 ± 0.50	2.30 ± 0.61	H	L
Start with vegetables before fruits	Pre-test	1.68 ± 0.62	1.72 ± 0.57	L	L
	Post-test I	4.92 ± 0.27	1.76 ± 0.66	H	L
	Post-test II	4.96 ± 0.20	1.80 ± 0.67	H	L
Breastfeeding should continue during CF	Pre-test	1.50 ± 0.61	1.42 ± 0.50	L	L
	Post-test I	4.52 ± 0.51	1.50 ± 0.71	H	L
	Post-test II	4.54 ± 0.50	1.46 ± 0.61	H	L

*Assessment key: L = Low (1.00–2.33); M = Moderate (2.34–3.66); H = High (3.67–5.00)

Table 5: Summary of Knowledge Categories Over Time (n = 100)

Knowledge Level	Experimental Group (%)	Control Group (%)
Pre-test		
Poor	82	72
Fair	18	28
Good	0	0
Post-test I		
Poor	0	72
Fair	0	28
Good	100	0
Post-test II		
Poor	0	74
Fair	0	26
Good	100	0

Knowledge classification cutoffs: Poor: 10–23.33; Fair: 23.34–36.66; Good: 36.67–50

Table 6: Repeated Measures ANOVA Summary for Group × Time Interaction

Source of Variation	F-value	df	p-value
Group × Time Interaction	1846.005	2	<0.001
Within-subjects (Control)	0.516	2	0.6

This analysis confirms that only the experimental group demonstrated a statistically significant change in CF knowledge over time, with the control group showing no significant improvement

Summary of Key Findings

Baseline knowledge was low across both groups, with no statistically significant differences.

The educational intervention led to a dramatic and sustained improvement in the experimental group's knowledge. The effect sizes were very large, confirming a strong intervention impact. The control group showed no meaningful improvement at any time point.

Discussion

This study assessed the effectiveness of a structured nutrition-based educational intervention on kindergarten teachers' knowledge of complementary feeding (CF) in Ramadi, Iraq. The results demonstrated a substantial and sustained improvement in knowledge among the experimental group compared to the control group. These findings validate the feasibility and utility of targeting educators, particularly kindergarten teachers, as indirect but influential agents in improving early childhood nutrition.

The observed improvement in knowledge following the intervention aligns with earlier research from Brazil, which also reported significant post-intervention gains among early childhood educators (7). The Brazilian study and our current findings collectively suggest that teachers, although not traditionally positioned as nutrition educators, can acquire and retain critical knowledge when provided with structured, evidence-based content. This underscores the potential for teacher-centred interventions to serve as complementary strategies alongside maternal education efforts.

Notably, this study contributes to a growing body of research from LMICs demonstrating that non-health professionals can be empowered to disseminate health-promoting knowledge. For instance, studies published in Global South Health Horizons and the Babcock University Medical Journal have shown that community health workers, teachers, and religious leaders can be trained to influence health behaviour change in maternal and child health settings (8, 9).

The improvement observed in our intervention group was both immediate and sustained over six weeks, indicating not only knowledge acquisition but retention. This suggests the pedagogical design of the program, featuring interactive sessions, practical examples, and repetition, was well-suited for adult learners in educational settings. Moreover, the consistently high effect sizes reinforce the intervention's impact and suggest that similar models can be adapted to other settings with minimal modification.

Importantly, the study highlights the critical knowledge gaps among kindergarten teachers at baseline. Given that teachers often serve as role models and informal sources of information for both children and parents, neglecting their training in foundational health topics such as CF represents a missed opportunity. This is especially relevant in culturally conservative contexts like Al-Anbar, where health information may not easily reach households through conventional public health channels (5, 6).

These findings support the feasibility of targeting educators to improve child nutrition indirectly, particularly in contexts where access to health professionals may be limited. By incorporating nutrition modules into teacher training curricula or continuing education programs, governments and development partners can amplify their efforts to combat early childhood malnutrition.

From a policy standpoint, the results argue for a nationwide scale-up of similar interventions, potentially embedded within broader maternal and child health initiatives or school-based health programs. Institutionalising nutrition education for kindergarten teachers could create a sustainable model for indirect health promotion within existing educational systems.

Future research should explore the long-term impact of teacher-based interventions on feeding practices, involve mixed-gender and more geographically diverse samples, and investigate whether improved knowledge leads to actual changes in behaviour, either within classrooms or through teacher-parent interactions.

Study limitations

This study, while yielding promising results, is not without limitations that warrant careful consideration. First, the reliance on a self-administered questionnaire as the primary data collection tool introduces the possibility of self-reporting bias. Participants may have provided socially desirable responses, particularly after being exposed to the educational content, which could lead to an overestimation of their actual knowledge levels.

Secondly, the study assessed knowledge retention only up to six weeks post-intervention. While this timeframe provides initial insights into the durability of the training effects, it does not capture long-term knowledge retention or behaviour change. Longer follow-up periods would be necessary to determine whether the observed improvements are sustained and whether they translate into real-world changes in classroom practices or parental engagement.

Another limitation concerns the generalizability of the findings. The study was conducted exclusively among female teachers in public kindergartens in Ramadi, a city with specific socio-cultural and educational characteristics. As such, the results may not be directly transferable to other regions of Iraq or more diverse populations, including male educators or teachers in private schools or rural settings.

Additionally, although the intervention successfully improved knowledge, the study did not measure downstream outcomes, such as whether teachers applied this knowledge in their teaching or communicated it to parents. The absence of behavioural or impact indicators limits our understanding of the intervention's practical utility in influencing complementary feeding practices at the household or community level.

Lastly, the study did not include a formal power calculation to determine the optimal sample size in advance. Although the entire eligible population of kindergarten teachers in the study area was included, this methodological limitation should be addressed in future studies for improved statistical precision.

Despite these limitations, the study offers valuable insights into the potential of educator-focused nutrition interventions and lays the groundwork for future research exploring their broader application and impact.

Conclusion

This study demonstrates that a structured nutrition education intervention can significantly enhance kindergarten teachers' knowledge of complementary feeding, with gains sustained beyond the immediate post-training period. By equipping educators, who play a pivotal role in early childhood development, with accurate and practical knowledge, such interventions offer a promising avenue for promoting child nutrition

indirectly, especially in settings where traditional sources of health education may be limited.

The findings support the integration of complementary feeding education into teacher training curricula and continuing professional development frameworks. Doing so could amplify the reach of public health nutrition messages and reinforce early-life feeding practices within educational environments.

For policymakers, the evidence presented here offers a compelling case for scaling such interventions at the national level, embedding them within school health programs, and linking them to broader maternal and child nutrition strategies. From a research perspective, future studies should explore the long-term impact of teacher knowledge on actual feeding behaviours, including parental practices, child dietary diversity, and nutritional outcomes.

Ultimately, leveraging the influence of educators represents a viable, underutilised strategy in the fight against childhood malnutrition, particularly in socio-cultural contexts like Iraq, where teachers often serve as trusted sources of information for both children and caregivers.

List of Abbreviations

CF: Complementary Feeding
LMICs: Low- and Middle-Income Countries
RCT: Randomised Controlled Trial
WHO: World Health Organisation
UNICEF: United Nations Children's Fund
FAO: Food and Agriculture Organisation
CDC: Centres for Disease Control and Prevention
AAP: American Academy of Paediatrics
SPSS: Statistical Package for the Social Sciences
SD: Standard Deviation
GSHH: Global South Health Horizons
BUMJ: Babcock University Medical Journal

Declarations

Ethics Approval and Consent to Participate

This study was conducted following the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the relevant institutional review board. All participants were informed about the study's purpose and procedures, and both written and verbal consent were obtained before participation. Participants were informed of their right to withdraw from the study at any time without penalty. The study was approved under project number FM.SA.268 on August 19, 2024.

Consent for Publication

All authors have reviewed the final manuscript and provided consent for its publication under the Creative Commons Attribution Non-Commercial 4.0 International License.

Availability of Data and Materials

The datasets generated and/or analysed during the current study are available from the corresponding author upon reasonable request.

Competing Interests

The authors declare that they have no competing interests.

Funding

This research received no external funding.

Authors' Contributions

AMH: Conceptualisation, study design, data collection, and manuscript drafting
KNS: Intervention delivery, data analysis, interpretation of findings, manuscript revision
Both authors approved the final version of the manuscript.

Acknowledgments

The authors extend their sincere appreciation to the kindergarten teachers in Ramadi who voluntarily participated in the study. Gratitude is also expressed to the educational experts and public health professionals who reviewed the content of the intervention program and supported the study implementation.

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