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RESEARCH ARTICLE

Effectiveness of a Pilot Nutrition Education Program on Pre-Primary Teachers' Knowledge and Perceptions about Child Nutrition Needs and Anthropometric Skills

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ABSTRACT

Early childhood education (ECE) teachers play a critical role in fostering healthy nutrition and physical activity habits in young children, yet studies show that they lack adequate nutrition-related knowledge, confidence, and skills. This pilot study evaluated a nutrition education program aimed at enhancing ECE teachers' knowledge, perceptions, and skills related to child nutrition and the integration of nutrition education (NE) and physical activity (PA) into routine teaching. Using a mixed-methods pre-post design, thirty-three purposively selected ECE teachers from thirteen pre-primary schools in central Uganda participated in a three-day nutrition education training grounded in social cognitive theory. Teachers' nutritional knowledge and perceptions were assessed five weeks before training, while their skills were assessed immediately before the training. Follow-up assessments of knowledge, perceptions, and skills were conducted eight weeks post-training, using the same structured questionnaires and observation checklists. Changes in teachers' knowledge, perceptions, and skills were analyzed using Wilcoxon signed-rank tests, Chi-square tests, paired t-tests, and thematic content analysis. Test selection was based on data type and distribution. Post-training nutrition knowledge scores revealed significant gains in understanding nutrient deficiency diseases ($p = .007$), malnutrition ($p < .001$), food intolerances ($p = .047$), and nutrition assessment methods ($p < .001$). Teachers' positive perceptions improved slightly, although the change was not statistically significant. Teachers' anthropometric assessment skills significantly improved ($p < .001$); however, gaps remained in their interpretation of anthropometric measures. Follow-up observations indicated sustained behavioral changes, including teachers engaging children in food demonstrations, construction of school gardens, and more physical activity. Practical in-service training effectively improved teachers' nutrition knowledge and skills, while reinforcing positive perceptions. Despite the pilot scale and small sample size, these findings suggest the value of providing continuous in-service training to complement traditional teacher educational programs.

Keywords: *nutrition education, physical activity, preschool, early childhood, teachers.*

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INTRODUCTION

Early childhood development encompasses physical, cognitive, and socio-emotional growth, with nutrition playing a fundamental role (Manas, 2020). The pre-primary stage (ages 3–5 years) is marked by growing independence, social engagement, and the development of new skills, making it an opportune time to establish healthy dietary patterns and physical activity habits (Collado-Soler et al., 2023; UNICEF, 2019). Positive exposure to nutritious foods and active lifestyles during these early years positively shapes lifelong health behaviors (Resor et al., 2019; Thabathi et al., 2022).

Young children depend heavily on caregivers for their nutritional needs; hence, caregivers' knowledge, perceptions, and practices directly influence children's dietary and activity patterns (Brown et al., 2017; Motebejana et al., 2022; Shipanga et al., 2023). Early childhood care and education (ECCE) centers serve as strategic avenues, reaching children during this critical stage of development (Toussaint et al., 2019). Teachers in these settings not only deliver academic content but also shape children's eating habits, physical activity, and attitudes toward health through daily interactions (Dunn et al., 2019; Ogada, 2015). It has been recognized that teachers' self-efficacy, nutrition knowledge, and perceptions of their caregiving role influence the extent and quality of these contributions (Bales et al., 2025; Gerritsen, 2016).

Nutrition education (NE) interventions targeting ECCE teachers have been shown to enhance their knowledge, skills, and confidence in promoting healthy practices in the classroom (Bales et al., 2025; Mandiwana et al., 2015; Stapp et al., 2021). Demographic factors such as years of teaching experience, age, and education level may also influence teachers' nutrition knowledge, perceptions, and skills (Cooper & Contento, 2019; Habib et al., 2023; Rapson et al., 2021). Effective programs typically use interactive and skill-based approaches, including peer modelling and practical demonstrations (Chuang et al., 2020; Cooper & Contento, 2019).

Despite these successes, evidence from both high- and low-income contexts shows that many ECCE teachers lack sufficient nutrition knowledge, hold divergent perceptions of their role in nutrition promotion and children's dietary practices, and have limited practical skills such as anthropometric measurement (Ade et al., 2021; Cotton et al., 2020; Mandiwana et al., 2015; Rapson et al., 2020). These gaps constrain their capacity to monitor and support child health effectively.

ECE teachers have been recognized as having the potential to play a significant role in growth monitoring while learners are at school, as children's growth patterns provide a useful basis for assessing nutritional status (Mandiwana et al., 2015). Monitoring children's growth and development contributes to efforts to reduce malnutrition, particularly stunting, and has further been recognized as an opportunity to strengthen early childhood development initiatives by facilitating early identification of at-risk children and promoting responsive caregiving practices (Adwiah et al., 2025; Larson et al., 2025). Teachers, who interact with children daily, are strategically positioned to conduct basic growth monitoring, thus enabling timely detection and intervention of deviations in a child's nutrition status (Mandiwana et al., 2015). Although professional teachers are expected to possess minimum knowledge of child nutrition and identify basic indicators of a child's nutritional status, children's rapid growth and development demand assessment competencies that often exceed teachers' baseline knowledge and skills place specific nutritional demands that require appropriate assessment competencies (Mandiwana et al., 2015; Larson et al., 2025).

Early Childhood Care and Education teachers are also key in promoting and modeling healthy eating and physical activity among young children. By equipping teachers with relevant knowledge, fostering positive perceptions of their role, and building practical competencies, they can create supportive classroom environments for positive dietary and physical activity behaviors and practices. Equipping teachers with validated and age-appropriate nutrition education ensures they deliver accurate and engaging nutrition messages suitable for preschool learners and enables them to identify and respond to child nutrition-related concerns early. Strengthening teacher capacity in these areas could contribute to healthier dietary patterns, improved growth outcomes, and reduced future health risks among children in low-resource settings.

In Uganda, nutrition education interventions have largely focused on parents and community caregivers (Ickes et al., 2017; Kabahenda et al., 2011; Kansiime et al., 2021; Kimuli et al., 2024; Nabugoomu, 2015), with limited attention given to ECCE teachers. Research on strategies to strengthen ECCE teachers' nutrition-related competencies for integrating nutrition into daily routines and classroom practices remains limited, particularly in low-resource settings such as Uganda. Hence, this study developed and piloted a nutrition education program for ECCE teachers in Uganda and evaluated its effectiveness in

enhancing ECE teachers' knowledge and competences to enable them to integrate nutrition education and physical activity in their routine teaching.

MATERIALS AND METHODS

Study Design and Setting

This pilot study used a single-group pretest–posttest design to assess the effectiveness of nutrition education on improving teachers' knowledge of child nutrition needs, perceptions of their role as child caregivers, and teachers' practical competencies in nutrition assessment. As a pilot study, it did not include a control group, which limits the ability to attribute observed changes solely to the intervention. The study was conducted over six month period, and comprised of four main phases: baseline assessment, intervention development, teacher training and engagement, and follow-up assessment.

In the first month, school recruitment and informed consent was obtained from administrators. Baseline data collection (pretest) of teachers' knowledge, perceptions, and nutrition education practices, was undertaken in the second month over a two-week period. This included key informant interviews with administrators and focus group discussions and completion of questionnaires from consenting teachers. Thereafter, baseline data were analyzed, to identify training needs and inform planning and preparation, and development of nutrition education materials for the intervention. In the fourth month, for three consecutive days, ECE teachers were trained on key nutrition concepts and how to integrate nutrition education and physical activity in their routine childcare activities. Baseline assessment of teachers' skills in anthropometric assessment were also conducted at this stage (pretest). After training, post-intervention engagement with teachers was conducted from the fourth to the sixth month through an online platform. Follow-up assessments (posttests) of knowledge, perceptions, and skills were carried out in the sixth month over a two-week period.

Baseline assessment was conducted in 15 pre-primary schools located in four purposively selected parishes within Wakiso in central Uganda. Following 36 teachers dropouts, and 7 school drop-outs, additional 5 schools (16 teachers) from Kawempe Division, Kampala District, were recruited; in total, 13 schools continued throughout the study, participating in the training and follow-up assessment.

Study Poulation

One school was randomly selected from each parish using a list of licensed and registered schools from the Wakiso District Local Government. Upon obtaining administrator consent, additional nearby schools were identified through snowball sampling, yielding a total of fifteen participating schools. These fifteen pre-primary schools were selected from four parishes in Wakiso District (namely: Masooli, Kiteezi, Nangabo, and Kasangati). . Eligible schools needed to have been in existence for at least 10 years to ensure program stability and staffing consistency, have an enrollment of at least thirty pre-primary children, and have administrators who consented to participate. The 7 schools recruited for training from Kawempe parish in Kampala district were recruited using the same procedure.

To improve understanding of the information needs of the teachers, one administrator from each school was engaged in key informant interviews; which informed the content of the teachers' manual that was used for the training (more details about the manual provided elsewhere). Each administrator was also asked to nominate at least three teachers to represent each of the 3 pre-primary class levels (namely: Baby, Middle, and Top class); however, more teachers were recruited from larger schools. Prior to training, 36 teachers dropped out due to scheduling, and competing obligations. Therefore, sixteen teachers were recruited from schools in Kawempe division, Kampala district, to obtain a sample size of a minimum of 30 trained teachers. Hence a total of 53 teachers participated in the baseline assessment and 33 teachers attended the nutrition education training (which is hitherto referred to as the intervention) and the post-training assessments.

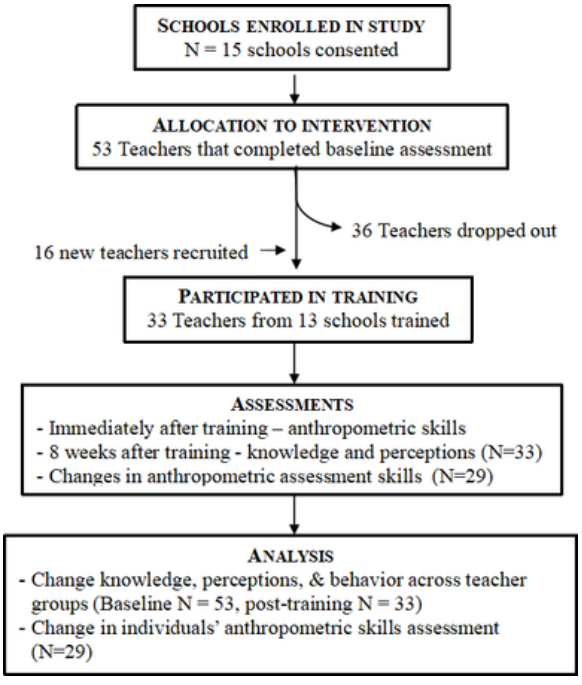

Figure 1: *Consort Diagram*

Data Collection Methods

The questionnaire captured both qualitative and quantitative data through open-ended, binary, and Likert scale items capturing teachers' knowledge of child nutrition and perceptions of their role in a preschooler's dietary and physical activity practices.

Baseline assessment of Teachers' Knowledge, Perceptions and Practices

A self-administered questionnaire was used to assess teachers' nutrition knowledge and perceptions. It included open-ended questions, binary (yes/no), and Likert-scale items adapted from validated instruments from a previous nutrition education intervention for lower primary teachers (Kabahenda, Nandutu, & Cale, 2020). Teachers completed the questionnaire in 30 to 45 minutes, with trained enumerators assisting to clarify questions and explain response expectations as needed. The questionnaire was pre-tested a month prior to baseline assessment, with 10 teachers from two non-participating schools. The scale items had an acceptable internal consistency (≥ .70), except for the perception scale. The internal consistency of the perception scale improved from .57 to .70 after removing 2 items, "Mealtimes should be fun" and "Nutrition is an important factor for promoting health". The removal of these items is unlikely to compromise construct validity, as the remaining items continue to reflect the intended construct of teachers' perceptions of their role in child nutrition.

Development, Planning, and Implementation of NE Training

The nutrition education program and accompanying materials were developed by the research team with technical support from subject matter specialists in primary science, nutrition, and early childhood education from the National Curriculum Development Centre (NCDC). The content was guided by needs assessment interviews that were conducted with school administrators and teachers plus a review of the ECD learning framework in Uganda. The key thematic areas covered by the nutrition education materials included food groups, appropriate child feeding practices, identification and management of malnutrition, food budgeting, food safety, hydration, engaging learners in physical activity, and integrating nutrition assessment in routine ECCE activities. The NE materials included a draft teachers' resource manual that provided details on each thematic area, charts, PowerPoint presentations, and demonstrations.

The NE training employed a participatory delivery style that combined lectures, group discussions, and practical skill development sessions. The training was conducted over three consecutive days, with each day lasting 8 hours, from 8:00 am to 4:00pm, including of two scheduled breaks: a 30-minute morning break and a 1-hour lunch break. Notably, lectures were used to introduce key nutrition concepts and then discussions were used to relate the points under discussion with the teachers' school environments. Then, using demonstrations and practical sessions, teachers were empowered with skills to use the knowledge acquired to resolve common problems at school. For example, teachers learned about and practiced reading and interpreting food labels to guide learners on healthy snack options, using commonly available food ingredients to enhance the nutrient density of school meals, and design and implementation of physical activity sessions for young children.

Since child growth monitoring is considered a critical nutrition intervention (refs), improving teachers' anthropometric assessment techniques was one area that was emphasized in this study. Emphasis was placed on empowering teachers with skills to enable them to routinely assess the risk of malnutrition among children in their care by using simple anthropometric assessments. Teachers were evaluated before the training to gauge their competences in anthropometric assessment and then demonstrations and experiential learning approaches were employed to address skill gaps and reinforced correct measurement techniques. Specifically, teachers were trained on how to accurately measure weight, height, and mid-upper-arm circumference (MUAC); calculate body mass index (BMI); and interpret MUAC and BMI.

Assessment of Changes in Teachers' Knowledge, Perceptions and skills

This assessment included assessment of teachers' anthropometric skills immediately after the training and a delayed assessment of changes in teachers' knowledge and perceptions plus their implementation of their NE and PA commitments.

Anthropometric skills: Teachers' measurement skills were evaluated using a structured observation checklist at the beginning (pretest) and end (posttest) of the NE training based on the World Health Organization (WHO) Child Growth Standards and Integrated Management of Acute Malnutrition Guidelines (Ministry of Health, 2010; World Health Organization, 2008), focusing on proper child positioning and accurate measurement techniques.

Teachers were divided into three groups, each supervised by a trained enumerator, who filled a structured checklist adapted from a previous study (Abebe et al., 2017) to observe each teacher's skills in measuring weight, height, and calculating body mass index (BMI) based on the WHO growth reference standards for child growth assessment, and skills in measuring MUAC based on Uganda's Integrated Management of Acute Malnutrition Guidelines (Ministry of Health, 2010; World Health Organization, 2008).

Height measurement required the child to stand upright on the baseboard with specific body points touching the board; weight measurement emphasized removing shoes and heavy clothing and standing still; while MUAC assessment focused on correct midpoint identification, tape placement, and reading without compressing the arm. Teachers were rated on a 4-point Likert scale (3 = Advanced to 0 = Does not have the skill), with scores summed for overall skill level. The checklist showed high internal consistency (Cronbach's $\alpha = 0.921$ pre-test; 0.842 post-test).

Individual teachers' knowledge, perceptions and skills - Eight weeks after training, teachers who attended the training were visited in their respective schools for follow-up interviews. The same assessment tools used at baseline were re-administered to measure changes in knowledge, perceptions, and skills. Enumerators also engaged teachers in unstructured conversations to explore teachers' application of NE knowledge and skills they acquired in their school settings.

Data Analysis

Quantitative data were analyzed using SPSS statistics software (Version 20). A significance level of $p < 0.05$ was applied. Demographic data collected before and after the training included teachers age, marital status, education level, years of teaching experience, and class taught. Age was categorized based on national classifications(Uganda Bureau of Statistics, 2018) and teaching experience based on established criteria from prior studies (García-Toledano et al., 2023; Murimi et al., 2007). Age categories were used to describe the demographic characteristics of participants. Chi-square or Fisher's exact tests compared age groups at baseline and follow-up assessment stages.

Categorical variables such as gender, education qualification, and class taught were summarized as frequencies and percentages, while non-normally distributed continuous variables were reported using medians and interquartile ranges (IQRs). Group comparisons were performed using Mann-Whitney U, Chi-square, or Fisher's exact tests, as appropriate, to determine differences in teachers' knowledge and perception scores at baseline and post-intervention assessment. Qualitative data were thematically analyzed in Microsoft Excel.

Fourteen open-ended knowledge items were scored as correct (1) or incorrect (0) to quantify teachers' responses and generate overall knowledge scores. Scoring criteria and definitions were adapted from the draft nutrition education resource book provided to teachers during training. Total knowledge scores were converted to percentages and classified as low (<60%), medium (60 - 79%), or high (≥80%), following a previous study (Thirunavukkarasu et al., 2021). Knowledge scores before and after training were summarized using descriptive statistics (mean, SD, median, IQR). Since the study was designed to improve teachers' nutrition education competences at the institutional level, the results presented in this paper document changes in the group of teachers assessed at baseline compared with those assessed after the training. Wilcoxon Signed-Rank tests were used to assess within-group changes over time (baseline assessment, follow-up assessment). Open-ended knowledge responses were analyzed thematically.

Teachers' perceptions were quantified using Likert scales. Perception data were summarized as median (interquartile range). Mann-Whitney U tests were used for independent comparisons; Wilcoxon tests assessed paired changes. Effect sizes were derived from z-scores to quantify the magnitude of observed changes (Buro et al., 2022; Mertoglu, 2019; Serdar et al., 2021).

Anthropometric skill scores were summarized using means and standard deviations. Paired t-tests assessed pre-to-post training improvements. Multiple regression analyses identified whether any of the demographic variables (age, years of teaching experience, education level/qualification) were predictors of post-test skills performance and change score (post-test score - pre-test score). Teachers' post-training behavior changes and rates of follow-through were analyzed thematically and presented using frequencies and percentages.

Ethical Considerations

Ethical clearance was obtained from the School of Health Sciences Research Ethics Committee (MAKSHSREC-2024-638), and research approval was granted by the Uganda National Council for Science and Technology, IRB number (Ref H83908ES). After schools were identified for participation, written institutional consent was first obtained from the school administrators. Following this, individual informed consent was sought from selected pre-primary teachers who

were briefed on the study's purpose, their expected roles, and the type of information to be collected. All administrators and teachers who agreed to participate signed individual informed consent forms before baseline assessment. Each school, administrator, and teacher was assigned a unique, randomly generated code number to ensure confidentiality. Data were anonymized for analysis and reporting. School names and original codes were not disclosed in any reports or shared outside the research team, thereby safeguarding participant identity and confidentiality.

Sampling Technique

A systematic random sampling technique was employed to select participants from a total population of N=429. A systematic random sample is characterized by the selection of every kth item, where k is calculated by dividing the total number of items in the sampling frame by the desired sample size. The process begins with the random selection of an initial starting point, followed by the selection of every kth item on the list. This sampling method offers several advantages, including moderate usage and cost, as well as high internal and external validity. Additionally, it is straightforward to implement and easy to verify. However, a notable limitation is that only the selection of the first subject is truly probabilistic, as subsequent selections result in certain subjects having no chance of being chosen (Acharya et al., 2013). With a required sample size of n=250, the sampling interval was calculated by dividing the total population by the desired sample size (N/n), resulting in an interval of approximately 2. Consequently, every second individual was included in the sample.

RESULTS

The demographic characteristics of teachers that participated in the study are presented in Table 1. Fifty-three teachers from fifteen schools completed the baseline assessment; thirty-three from 13 schools attended the training and post-intervention assessment. Only 17 of the 53 baseline participants completed the training, indicating a 67.9% attrition rate. Of the 33 teachers trained, 29 completed both the pre- and post-training skills assessments; 4 missed the pre-skills assessment due to late arrival. There were no statistically significant differences in teachers' sociodemographic characteristics between those who participated in baseline versus those in post-training assessments ($p > .05$).

Table 1:

Socio-demographic Characteristics of Teachers that Participated in Baseline Assessment versus Follow-up Assessment

Characteristic	Teachers with characteristic [n (%)]		p-value
	Before NE training (N = 53)	After NE training (N = 33)	
Age (years):			
20-24	**16 (30.8)**	6 (18.2)	0.518
25-29	18 (34.6)	**16 (48.5)**	
30-34	7 (13.5)	**4 (12.1)**	
35-39	5 (9.6)	2 (6.1)	
40-44	1 (1.9)	2 (6.1)	
45-49	6 (9.6)	3 (9.1)	
Gender:			
Female	50 (94.3)	30 (90.9)	0.421
Male	3 (5.7)	3 (9.1)	
Marital status:			
Married	22 (41.5)	19 (57.6)	0.110
Single	31 (58.5)	14 (42.4)	

Education Qualification:			
Certificate	36 (67.9)	26 (78.8)	0.284
Diploma	14 (26.4)	4 (12.1)	
Bachelors	3 (5.7)	3 (9.1)	
Teaching Experience (yrs):			
0-5	34 (64.2)	16 (48.5)	0.204
6-15	5 (9.4)	14 (42.4)	
16-25	1 (1.9)	3 (9.1)	
26+	13 (24.5)	-	
Class Taught:			
Baby	14 (26.4)	8 (24.2)	0.634
Middle	17 (32.1)	8 (24.2)	
Top	22 (41.5)	17 (51.5)	

Note. *One teacher aged 19 and 54 was merged with adjacent categories (20-24; 45-49) respectively. Age categories are adopted from Uganda Bureau of Statistics, 2018. Categorization of years of teaching experience is adopted from García-Toledano et al., 2023; Murimi et al., 2007. † Mann-Whitney U Test; tests without a symbol used Fisher's exact or Chi-square test (based on cell counts).*

Changes in Teachers' Nutrition Knowledge

Overall, there was a 41.9% increase in mean total knowledge score following the training (from 6.5±2.8 to 9.2±2.3 out of 14 points). A Mann-Whitney U test also indicates that the proportion of teachers with moderate scores (60–79%) significantly increased from 20.8% to 58.5% while those with high scores (≥80%) increased from 5.7% to 15.2% ($p < .001$). Table 1 provides details about the nutrition concepts against which the teachers' knowledge was assessed. The chi-square test revealed significant increases in the proportions of teachers that exhibited improved understanding of good nutrition ($p = .005$), nutrient deficiency diseases ($p = .007$), food intolerances ($p = .047$), meaning of malnutrition ($p < .001$), and nutrition assessment methods ($p < .001$). Notably, the participants' definitions of 'good nutrition' expanded from "balanced diet" to include "eating a variety of foods" and "eating all food values in correct proportions." It was also noted that some teachers began describing malnutrition more accurately as "inadequate or excessive nutrient intake" or as "overfeeding or underfeeding". Additionally, mentions of 'anemia' increased alongside marasmus and kwashiorkor in providing examples of nutrient deficiency diseases. These changes denote improved nutrition knowledge. Conversely, large proportions of teachers were already knowledgeable of the three food groups; hence no significant changes were observed in this area.

Table 2:

Changes in Proportions of Teachers with Knowledge about Prioritized Nutrition Concepts

Knowledge demonstrated by the ability to correctly:	Proportion of teachers with correct response [% (n)]		P- value
	Before Training	8 weeks after Training	
Explain the meaning of good nutrition	67.9 (36)	93.9 (31)	.005
State the recommended daily snacking pattern for 3-5-year-olds	64.2 (34)	36.4 (12)	.012
State the recommended daily meal pattern for 3-5-year-olds	47.2 (25)	39.4 (13)	.480
List 3 energy-giving foods	77.4 (41)	78.8 (26	.877
List 3 body-building foods	69.8 (37)	81.8 (27)	.215
List 3 protective foods	75.5 (40)	87.9 (29)	.160

List 2 nutrient deficiency diseases	69.8 (37)	93.9 (31)	.007
Give an example of a food allergy	39.6 (21)	57.6 (19)	.105
Give an example of a food intolerance	15.1 (8)	33.3 (11)	.047
Define malnutrition	54.7 (29)	100.0 (33)	.000
Define nutrition assessment	15.1 (8)	54.5 (18)	.000
Mention at least one method of nutrition assessment	15.1 (8)	78.8 (26)	.000

Among the 17 teachers who completed both assessments, a Wilcoxon Signed-Rank Test showed no significant change in total knowledge scores, $Z = -1.424$, $p = .154$. However, McNemar's tests revealed significant improvements on specific items: correct definitions of nutrition assessment increased from 11.8% to 52.9% ($p = .039$), identification of assessment methods from 23.5% to 70.6% ($p = .021$), and understanding of food intolerance from 17.6% to 70.6% ($p = .012$). These findings suggest gains in key knowledge areas despite the stable total scores. The lack of significant change in total scores may reflect a tendency for scores to cluster around the mean, possibly due to variability across individual items or the small sample size limiting detection of overall change.

Changes in Teachers' Perceptions of Their Role in Preschoolers' Dietary Practices and Physical Activity

Overall, only one perception item, "I personally follow a healthy diet," showed a statistically significant change ($p = .012$) with a small effect size ($r = .27$), implying that while training may have influenced perceptions, the magnitude of change was generally modest. Table 3 presents teachers' median (IQR) perception scores before and after training plus Mann–Whitney U test results and effect sizes. Overall, median perception scores seem unchanged, indicating sustained agreement with most statements. Notably, teachers maintained a neutral perception regarding parental responsibility for a child's physical activity and development; which indicates that teachers as a group were aware of their shared responsibility with parents.

Table 3:

Changes in Teachers' Perceptions about Healthy Dietary and Physical Activity Practices

Perception Statement	Median (IQR) Score		U	P-value	Effect size (r)
	Before Training (N = 53)	After Training (N = 33)			
1. A teacher should provide nutrition advice to students.	5.00 (1.00)	5.00 (1.00)	826	0.599	0.06
2. I believe that I have basic nutrition knowledge.	4.00 (2.00)	4.00 (1.00)	690	0.073	0.19
3. I personally follow a healthy diet.	4.00 (2.00)	4.00 (1.00)	606	0.012	0.27
4. I would change my nutrition attitude to serve as a role model for my students.	5.00 (1.00)	5.00 (1.00)	822	0.588	0.06
5. Preschoolers should finish all the food on their plate.	5.00 (1.00)	4.00 (2.00)	786	0.391	0.09
6. A preschooler's healthy eating is more of the parents' responsibility.	4.00 (3.00)	4.00 (1.00)	836	0.725	0.04
7. A preschooler's physical activity and development are more of the parent's responsibility.	3.00 (2.00)	3.00 (3.00)	761	0.297	0.11
Average Total Score (Out of 35) (SD)	**27.43 (4.49)**	**28.64 (3.06)**	-	-	-

Abbreviations: IQR = interquartile range.
Note: *Scores are on a 5-point Likert scale (5 = Strongly agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree). Effect size: small (r = .1), medium (r = .3), large (r ≥ .5). A smaller U value indicates a greater difference between scores of groups of teachers that participated the two assessments. The corresponding p-value indicates statistical significance.*

Conversely, the Wilcoxon test results for the 17 teachers who completed both pre- and post-assessments revealed several significant changes in individual teacher's perceptions following the training. Teachers reported increased confidence in their nutrition knowledge (p = .020) and perceived adherence to healthier dietary habits (p = .010), both associated with large effect sizes (r = .57 and .63, respectively). After training, teachers were also less likely to be in agreement with the statements that "Preschoolers should finish all the food on their plate" and "A preschooler's healthy eating is more the parents' responsibility", which indicates a possibly large positive influence from the training.

Table 4:

Changes in Individual Teachers' Perceptions about their Role in the Dietary and Physical Activity Practices of Learners (N = 17)

Perception Statement	Z	p-value	Effect size (r)
1. A teacher should provide nutrition advice to students.	-.322b	.748	.08
2. I believe that I have basic nutrition knowledge.	-2.333c	.020	.57
3. I personally follow a healthy diet.	-2.585c	.010	.63
4. I would change my nutrition attitude to serve as a role model for my students.	-.689b	.491	.17
5. Preschoolers should finish all the food on their plate.	-2.041b	.041	.50
6. A preschooler's healthy eating is more of the parents' responsibility.	-2.041b	.041	.50
7. A preschooler's physical activity and development is more of the parent's responsibility.	-1.890b	.059	.46

Note. *Wilcoxon test results for teachers who participated in both the pre-and post-test (n = 17). Bolded p-values indicate statistical significance at p < .05. Superscripts b and c denote positive and negative ranks, respectively. Effect size: small (r = .1), medium (r = .3), large (r ≥ .5)*

There was a slight decrease in agreement and IQR for the statement, "*Preschoolers should finish all the food on their plate,*" suggesting more varied perceptions post-training. During training, many teachers indicated that they would 'encourage children to clean their plates' because 'some children do not like to eat' and to 'avoid food wastage'. Similarly, decreases for IQR for statements such as, *"A preschooler's healthy eating is more of the parents' responsibility," "I personally follow a healthy diet,"* and *"I believe that I have basic nutrition knowledge,"* indicate that teachers' views became more consistent on these items after training. In contrast, slight increases in IQR for "*Preschoolers should finish all the food on their plate"* and *"A preschooler's physical activity and development are more of the parent's responsibility"* suggest greater variability in responses for these perceptions.

Changes in Pre-primary Teachers' Anthropometric Measurement Skills

While the training explored many methods of nutrition assessment, changes in teachers' nutrition assessment skills only focused on measuring weight, height, MUAC, and BMI calculation. Before the intervention, teachers demonstrated the highest proficiency in weight measurement and the lowest in BMI calculation, with an overall mean skills score of 26.33%. After the training, the overall mean score increased substantially to 67.92%, with the most notable gains observed in MUAC measurement. Paired t-tests (see Table 4) confirmed statistically significant improvements in overall measurement of height, weight, and MUAC ($p < .001$), and BMI calculation skills ($p = .018$). Although the correct citation of the BMI formula did not

improve significantly (p = .094), teachers' ability to apply it correctly when provided with the formula significantly improved (p = 0.006).

Table 5:

Changes in Individual Teachers' Perceptions about their Role in the Dietary and Physical Activity Practices of Learners (N = 17)

Domain of anthropometric assessment on which teachers were assessed about	Mean scores ± SD		Mean differences between Pre- and Post-test Scores [95%CI]	t	p-value. (2-tailed)
	Before Training	After Training			
Measuring height (Total Score = 9)	**2.72±2.25**	**7.21±1.29**	**4.48±2.2 [3.36, 5.37]**	**10.32**	**.000**
Ensures that the child stands straight with their head, shoulders, buttocks, and heels in contact with the stadiometer.	0.90±0.77	2.52±0.57	1.62±0.80 [1.31, 1.93]	10.64	.000
Positions child's head correctly while taking the measurement.	1.03±0.98	2.48±0.57	1.45±1.10 [1.05, 1.85]	7.39	.000
Reads the height measurement accurately.	0.79±0.86	2.21±0.56	1.41±1.00 [1.03, 1.80	7.48	.000
Measuring weight (Total score = 9)	**3.62±2.83**	**7.28±1.34**	**3.67±3.00 [2.53, 4.78]**	**6.66**	**.000**
Ensures that the child is wearing light clothing and no shoes while taking the measurement	1.28±1.07	2.62±0.56	1.34±1.00 [0.95, 1.74]	6.93	.000
Ensures that the child stands still on the scale without leaning or holding onto anything ±	1.03±1.05	2.45±0.63	1.41±1.10 [1.01, 1.81]	7.23	.000
Reads and records the weight measurement accurately	1.31±1.11	2.21±0.49	0.90±1.30 [0.41, 1.39]	3.74	..001
Calculating BMI (Total score = 6)	**0.72±1.53**	**1.59±1.23**	**0.86±1.90 [0.16, 1.55]**	**2.51**	**.018**
Knows the BMI formula	0.48±0.99	0.86±0.69	0.38±1.20 [-0.07, 0.83]	1.74	0.094
Calculate BMI using the formula weight in kg/height in m^2	0.24±0.69	0.72±0.70	0.48±0.90 [0.15, 0.81]	2.99	.006
Measuring MUAC (Total score = 9)	**1.62±2.13**	**6.34±1.91**	**4.72±2.70 [3.67, 5.76]**	**9.34**	**.000**
Ensures child is in a comfortable sitting or standing position	0.66±0.94	2.21±0.68	1.55±1.00 [1.16, 1.94]	8.19	.000
Identifies the midpoint of the left upper arm	0.34±0.55	2.03±0.82	1.69±1.00 [1.31, 2.07]	9.07	.000
Accurately wraps tape snugly and horizontally around the marked midpoint	0.62±0.82	2.10±0.77	1.48±1.10 [1.08, 1.88]	7.56	.000
Overall Total Score (%)	**26.3±22.6**	**67.9±13.4**	**41.6±25.0 [32.1, 51.0]**	**8.98**	**.000**

Note. *Values in Columns 2 and 3 represent the mean and standard deviation (SD) of scores for the same group of 29 teachers assessed before and after the training. MUAC (Middle upper-arm circumference); BMI (Body Mass Index). 95% CI refers to the 95% confidence interval for the difference between the two individual teacher's scores.*

Predictors of Improvement in Teachers' Anthropometric Measurement Skills

Based on the assumption that prior experience or higher education may influence teachers' nutrition education competence or capacity to benefit from training, teacher characteristics were examined as potential predictors of anthropometric skill scores. Multiple linear regression analyses showed no significant associations of teachers' age, education level, or years of teaching experience with improvements in skills following training, as presented in Table 5.

Table 6:

Multiple Regression Analysis Predicting Change in Teachers' Skills (N = 29)

Model	Dependent Variable	Predictor	B	SE	β	t	P value
1	Post Score	Pre-test score	0.04	0.111	0.067	0.359	0.722
		Teaching experience	-0.259	0.15	-0.322	-1.726	0.096
2	Post Score	Pre-test score	0.074	0.115	0.124	0.642	0.527
		Education level	0.753	1.286	0.113	0.585	0.564
3	Post Score	Pre-test score	0.081	0.11	0.136	0.733	0.47
		Age	-0.203	0.121	-0.309	-1.668	0.107
4	Change Score	Teaching experience	0.641	0.467	0.431	1.372	0.182
		Education level	2.365	2.363	0.192	1.001	0.327
		Age	-0.706	0.384	-0.582	-1.838	0.078
5	Change Score	Teaching experience	-0.05	0.29	-0.034	-0.172	0.865
		Education level	1.324	2.397	0.108	0.552	0.586

Note. *B = unstandardized coefficient, SE = standard error, β = standardized coefficient*

These results indicate that the intervention improved teachers' skills regardless of their years of teaching experience, age, and professional training.

DISCUSSION

The study aimed to evaluate the effectiveness of the pilot nutrition education program on pre-primary teachers' nutrition knowledge, perceptions of their role in children's dietary and physical activity practices, and their skills in integrating nutrition concepts in their routine childcare activities. The nutrition education training improved teachers' nutrition knowledge in several core areas, likely aided by interactive and visual teaching methods grounded in social cognitive theory (Bandura, 1986; Li et al., 2019). Changes in teachers' perceptions were minimal, likely due to high baseline agreement with statements regarding their role in promoting children's dietary and physical activity practices. Improvements in teachers' skills indicate that the practical approach to training was effective in fostering experiential learning to support immediate changes indicated by teachers' anthropometric skills and fostering behavior change. Overall, findings indicate that the program effectively improved specific aspects of teachers' nutrition knowledge and skills.

Changes in Pre-primary Teachers' Anthropometric Measurement Skills

The study aimed to evaluate the effectiveness of the pilot nutrition education program on pre-primary teachers' nutrition knowledge, perceptions of their role in children's dietary and physical activity practices, and their skills in integrating nutrition concepts in their routine childcare activities. The nutrition education training improved teachers' nutrition knowledge in several core areas, likely aided by interactive and visual teaching methods grounded in social cognitive theory (Bandura, 1986; Li et al., 2019). Changes in teachers' perceptions were minimal, likely due to high baseline agreement with statements regarding their role in promoting

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Changes Teachers' Knowledge of Child Nutrition

The overall modest improvements in knowledge following training are consistent with findings by Bales et al. (2025) who reported improvements in teachers' knowledge and self-efficacy after structured nutrition training - even among teachers with high baseline knowledge scores. The large effect sizes observed for teachers' increased agreement that they had basic nutrition knowledge following training suggest that this intervention substantially improved teachers' understanding of nutrition concepts. This reinforces prior research showing that targeted education effectively enhances teacher knowledge (Kaschalk-Woods et al., 2021).

The improved understanding of nutrition assessment methods was likely due to the practical, hands-on activities during sessions. This aligns with findings by Singano et al. (2025), where caregivers trained using similar theory-practice approaches successfully used color-coded MUAC tapes to screen for malnutrition. Similarly, Mangwane et al. (2024) found that experiential learning among caregivers improved nutrition knowledge. Therefore, by providing practical, hands-on experiences, the training likely enhanced teachers' self-efficacy and behavioral capability, consistent with social cognitive theory, which suggests that confidence in performing a task and observing modeled behaviors are key drivers of behavior change.

Remarkably, the improved understanding of malnutrition was observed in teachers' changes in perspectives beyond undernutrition to include overnutrition. These improvements may be attributed to the use of visual aids and guided discussions that supported observational learning (Bandura, 1986), aligning with evidence that visuals enhance nutrition education outcomes (Mekam et al., 2024). This demonstrates SCT principles in action, where modeling and visual cues reinforce behavioral capability and understanding. However, misunderstandings, such as mentioning obesity as a nutrient deficiency disease, highlight the need to clarify overlapping concepts in future interventions.

Teachers' improved knowledge of food allergies and intolerances likely reflects the training's emphasis, emphasizing the importance reinforcing definitions with clear examples and practical exercises. Supporting this, Alzahrani et al. (2023) found that most teachers lacked prior knowledge or awareness of food allergies before training, while Canon et al. (2019) demonstrated that nutrition education training significantly improved teachers' nutrition knowledge related to allergies.

In Uganda, although teacher education programs include specialized nutrition-related units such as 'Child health and nutrition' and 'Science, health, and nutrition for early childhood' (Kyambogo University, 2025; Islamic University in Uganda, 2025), the depth and delivery of this content may be inadequate. This highlights the need to review and enhance the nutrition content in ECD teachers' pre-service curricula. There is also need for regular refresher, in-service training to improve teachers' nutrition education competences.

Despite global recommendations that children aged 3–5 years should consume three main meals and two to three nutritious snacks daily (Pan American Health Organization, 2003; UNICEF, 2024; World Health Organization, 2000), teachers' confusion of recommended meal and snack frequencies may have been heightened by cultural interpretations, such as equating "snacks" with unhealthy foods and referring to mid-morning snacks as "breakfast." Similar gaps have been observed in other contexts. Adu (2016) reported limited nutrition knowledge among certificate-level educators in Nigeria, while Motebejana et al. (2022) found confusion around feeding frequency and serving sizes among caregivers. Even in high-income settings, misconceptions persist, as Rapson et al. (2021) found limited knowledge of food group recommendations among U.S. early childhood educators. These findings highlight the need to use locally relevant terminology and examples when teaching key concepts.

Shifts in Teachers' Perceptions

The persistent positive perceptions suggest that teachers were already aware of their role in fostering healthy dietary and physical activity practices among learners before the intervention. Nevertheless, the slight shift in teachers' agreement that they personally followed a healthy diet indicates positive shifts in their own behaviors - an important factor for modeling and promoting nutrition within the school environment. This aligns with social cognitive theory, which

emphasizes that behavior change is influenced by personal capability, self-efficacy, and the observation of modeled behaviors. By engaging teachers in practical, hands-on activities, the intervention likely enhanced their confidence and behavioral capability, supporting their role as positive role models for learners. Additionally, the shifts in perceptions of responsibility for learners' physical activity and dietary habits reflect increased awareness of their shared role in supporting children's health, which is critical for sustained behavior change.

The results align with findings from Zambia (Kalinde et al., 2023) and the U.S. (Rapson et al., 2021), where early childhood educators also recognized their responsible in supporting appropriate practices to enhance child nutrition and health. Moreover, a review by Rapson et al. (2021) reported that early childhood education teachers broadly believed nutrition is vital for health and acknowledged their role in promoting it to children. Together, these studies highlight the potential of practical, engaging training to enhance teachers' confidence and behavioral capability in supporting healthy habits.

Interestingly, however, a study by Kupolati et al. (2015) in South Africa, found that teachers often view their role narrowly, primarily as providers of nutrition information, despite their broader desire to encourage lifelong healthy habits. The present study complements this by revealing that many teachers perceive improving children's nutrition as partly their responsibility, rather than leaving it solely to parents. Yet, smaller changes in perceptions related to providing nutrition advice and role modeling suggest that some beliefs may be deeply ingrained or require more focused training. This points to an evolving understanding among teachers of their influential role beyond mere information sharing, consistent with SCT principles, which suggest that increasing self-efficacy and reinforcing behavioral skills are critical to enabling sustained behavior change. This highlights the need for clearer guidance and support to empower teachers to act confidently alongside parents in nurturing learners' healthy behaviors.

Persistent uncertainty about the respective roles of teachers and parents further illustrates the complex challenge educators face in balancing their responsibilities with those of caregivers. This echoes findings from India by Rathi et al. (2018), who recommended involving key stakeholders, such as parents and teachers, in implementing school health policies. This emphasizes the importance of fostering stronger partnerships between teachers and parents to ensure consistent support for children's healthy habits.

Changes Teachers' Skills

The nutrition education program's strong emphasis on practical approaches likely contributed to improvements in teachers' anthropometric skills, particularly in measuring MUAC. Practical sessions also motivated their intention to apply new skills, such as enriching school meals and promoting physical activity. Activities that focused on identifying food allergies and intolerances, reinforced safe nutrition practices, and exposed teachers to age-appropriate physical activities increased teachers' confidence in encouraging healthy behaviors.

The observed positive outcomes align with social cognitive theory, which emphasizes that behavioral capability and self-efficacy are key to behavior change. In the training, these were reinforced through practical strategies, including peer learning and provision of immediate feedback. Interestingly, improvements in skills were not significantly associated with teachers' age, education level, or years of experience, indicating the program's broad applicability. This also highlights the value of tailored approaches, consistent with recommendations from other research (Prelip et al., 2006).

More complex skills like BMI calculation proved challenging, similar to previous studies. A study by Mandiwana et al. (2015) in South Africa reported that teachers' low literacy has an impact on understanding growth charts. This highlights the need for simplified instruction, provision of visual aids such as color-coded BMI-for-age charts, and extended training time to build understanding. Tailoring training approaches to teachers' literacy levels may be crucial for improving their competence in applying nutrition assessment techniques effectively.

Implications for School Health Policy, Practice, and Equity

This study highlights the importance of in-service training in addressing nutrition education gaps among pre-primary teachers by enhancing their knowledge, skills, confidence, and behaviors. Experiential skills-based training proved effective in preparing teachers to engage in the promotion of pre-primary learners' positive dietary practices and physical activity. However, challenges with technical tasks like BMI calculation highlight the need for simplified instruction and numeracy support within training programs. To address this, nutrition education resources such as manuals could include detailed step-by-step examples on how to calculate and interpret BMI. The resources should also include color-coded BMI-for-age charts that teachers can refer to for growth monitoring. To address the difficulty of

calculating BMI, weight-for-height may be an alternative measure for assessment. Incorporating user-friendly tools, such as pictorial guides, can further support teachers in accurately assessing children's nutritional status. Improved teacher competencies not only strengthen classroom practices and role modeling but also foster positive attitudes and a sense of responsibility that can influence peer collaboration, parental engagement, and school policy.

These findings align with the growing emphasis of investing in early childhood development strategies as highlighted in the Lancet series. The series emphasizes the significance of investing in early childhood development interventions, developing and improving policies, and allocating resources to promote child health and nutrition, especially during the first 1000 days, for optimal growth and development. through policy, training, and resource allocation (Umar et al., 2024; Draper et al., 2024; Nores et al., 2024). Ultimately, it can promote equitable, health-conscious learning environments. Therefore, integrating nutrition education as a core component of early childhood training, and refresher in-service trainings is essential for supporting consistent promotion of children's positive dietary and physical activity behaviors.

Limitations and Recommendations of the study

Despite these outcomes, several limitations should be noted. This study involved a small sample size, which, along with a high dropout rate, limited the generalizability of findings and the assessment of long-term knowledge retention. Additionally, the short training duration constrained the coverage of key nutrition topics and practical skill development, which may have contributed to persistent knowledge gaps.

Incorporating both digital platforms (e.g., WhatsApp groups) and offline supports (printed materials, mentorship visits) can sustain peer learning and reinforce practical application beyond formal sessions, which on their own may not provide sufficient time to cover complex topics. Alternatively, training could be distributed through multiple shorter sessions spread over several weeks. This extended timeframe would allow for thorough coverage of both foundational and advanced nutrition content, increased practical activities, and opportunities for feedback and peer discussion. Such scheduling supports better retention and application of knowledge and skills. Embedding nutrition-related skills into pre-service and in-service teacher education is also critical for long-term sustainability. Future evaluations should incorporate the assessment of teachers' growth monitoring skills over time to capture program impact and identify areas for improvement accurately. These future interventions should involve larger, more diverse samples and enable more comprehensive evaluation of teachers' knowledge and skill retention and behavior change over time.

Conclusion

This study demonstrates that a structured nutrition education (NE) program, delivered through interactive lectures, hands-on practical activities, and learning aids, was effective in enhancing teachers' knowledge and practical skills, and reinforcing positive perceptions regarding their role in learners' nutrition and physical activity practices. The tailored nutrition and physical activity manual provided a tangible reference that reinforced learning and guided teachers in applying concepts in classroom routines. These findings highlight the need to reinforce core nutrition concepts through periodic refresher training and tailored support for early childhood education settings. Ongoing support, such as follow-up mentoring, peer learning, and guidance via various communication platforms (including social media), can facilitate sustainable teachers' integration of nutrition education and physical activity into daily classroom activities.

Conflict of Interest

The authors declare no conflict of interest.

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