# DEVELOPMENT AND IMPLEMENTATION OF A NUTRITION EDUCATION PROGRAM USING 3D FOOD GUIDE PYRAMID MODELS FOR SCHOOL CHILDREN

**Sadia Rafiq[1], Hafsa Tahir[2], Saba Nadeem Dar[3], Faran Khan[*4], Zara Arshad[5], Fasiha Ilyas[6]**

*[1,2,3,5]Department of Nutrition and Dietetics, School of Health Sciences, University of Management and Technology, Lahore*
*[*4]Department of Clinical Services, School of Health Sciences, University of Management and Technology, Lahore*
*[6]Department of Food Science & Human Nutrition, Kinnaird College for Women University*

**Corresponding Author:** *
**Faran Khan**

**Abstract**

*The study aimed to assess the impact of a nutrition education program using 3D Food Guide Pyramid models on the nutrition knowledge of school children of grade (1-3). A quasi-experimental design was employed, with two groups of 18 students each. One group received nutrition education using a 3D Food Guide Pyramid model, while the other group was taught using conventional methods. Pre- and post-tests were conducted to evaluate the student's knowledge of food groups, nutrients, serving sizes, balanced diets, and healthy food choices. Results indicated no significant difference in knowledge between the two groups during the pre-test (p > 0.05). However, post-test results showed a significant improvement in the 3D model group compared to the conventional group (p < 0.05). The findings suggest that the use of 3D models in nutrition education significantly enhances children's understanding of dietary guidelines and healthy eating practices.*

## INTRODUCTION

Nutrition education is an integral component for eradicating nutrition-related issues persisting in a community. Nutrition education on the food guide pyramid helps the individual to eat a healthy and balanced diet. It is used to plan a healthy and balanced diet consisting of food from all the food groups. It also improves the knowledge regarding the food and its intake. Nutrition education on the food guide pyramid for first-grade students is necessary as to help them or to aware them about the healthy and balanced diet (Contento, 2011).

Numerous ways exist for imparting nutrition education to school-aged children, with the objective of enhancing their dietary practices and fostering a healthy, balanced lifestyle. Effective nutrition education must incorporate three fundamental elements: nutrition, education, and health. This technique, when implemented at the classroom level, enhances children's comprehension of the importance of healthy eating. Diverse engaging techniques—such as experiential activities, excursions, and special events—can be employed to foster interest and involvement. Integrating nutrition into the school curriculum reinforces these principles, aiding pupils in recognizing appropriate eating options. Furthermore, the utilization of 2-D and 3-D models in nutritional education has demonstrated an improvement in children's understanding of food types and portion sizes (Ho et al., 2023). Farm-to-school projects,

encompassing gardening, culinary instruction, and agricultural field trips, enhance nutritional awareness, foster the exploration of novel foods, and elevate the consumption of fruits and vegetables (Centers for Disease Control and Prevention [CDC], 2024).

Nutrition education is increasingly delivered as a multifaceted approach involving three essential components: delivering clear and culturally appropriate information through effective communication strategies, enabling individuals to apply this knowledge in their daily lives, and fostering supportive environments that facilitate healthy choices (FAO, 2020). The effectiveness of nutrition education is affected by the nature and variety of its delivery medium, which greatly depends on the targeted audience's needs in order to curate and implement strategies that can actually be beneficial (FAO, 2015; Contento, 2016).

Four key strategies have emerged as the foundation of successful nutrition education: public awareness campaigns to increase general knowledge; targeted education that addresses the population's particular needs; practical (in-person) training in food and nutrition-related skills; and structural interventions aimed at improving the food environment (WHO, 2018; FAO, 2020). For example, school-based programs that utilize experiential learning approaches, such as gardening and cooking, have been shown to significantly improve children's dietary behaviors (Asante et al., 2024; Yang et al., 2024). Moreover, involving families and caregivers in educational interventions has been proven to reinforce healthy behaviors beyond the classroom (Wang et al., 2024). Considering the effectiveness of this framework, many countries have adopted this in order to improve public health (via positive dietary practices)

Healthy eating practices and physical activity are incorporated into daily routines when health promotion education is given from early life and later stages in life. Schools are considered potent institutions for nutrition education among children because of their reach, flexibility of learning, and cost-effectiveness (Graziose et al., 2017; Dudley et al., 2015). Nutrition education

in schools must focus on the interests and needs of the students and the people in the surroundings including teachers as well. Recent studies have also focused on these parameters for nutrition education. Other factors that are involved in making the education program effective and beneficial include time, involvement of the parents, and for older children self-assessment should be done (Jung et al., 2019). Another nutrition-based study among primary school students in South Africa confirms that the presence of responsible LOS educators and role-playing appeared as effective factors in terms of knowledge delivery and retention as they ensure active listening, involvement, and eagerness to get things right (Mbhatsani et al., 2017).

Therefore, the present study intended to develop a nutrition education program using 3D models of a food guide pyramid. To assess the effectiveness of nutrition education program with 3D model, a comparison group was educated with nutrition education material based on lectures only.

Food guides in the past showed only the foundation diet but the food guide pyramid is comprehensive, taking into account the overnutrition and undernutrition, and practically implemented by many countries' healthcare facilities (Haack & Byker, 2014). Food guide pyramids illustrate the variety of food, serving sizes, and moderation. One of the most common and important challenges for nutritionists is to help the clients guide for the practical application of dietary guidelines given in the food guide pyramid, the other challenge is to design the nutritional messages in such a way that it is easily understandable for the audience which is to be addressed (Ruxton et al., 2023).

The study developed a nutrition education program based on educating aspects of the food guide pyramid to young children in grade three. A 3D model was used as a tool for education and comparison was done with a study group by conventional teaching methods.

## Methodology
A quasi-experimental research design was implemented to assess the effectiveness of a

nutrition education program in a primary school in Vehari. The study involved two distinct groups, each receiving different teaching methods to compare their impacts. The target population for this study consisted of Grade 1-3 children. A two-stage sampling technique was utilized: A cluster sampling method was employed to choose a classroom, as naturally occurring groups (classrooms) were used for the study. Due to this sampling design, a specific sample size calculation was unnecessary. A structured questionnaire was crafted based on a thorough literature review to evaluate students' knowledge.

The nutrition education program addressed key topics related to the Food Guide Pyramid Model. The learning materials were organized into eleven lesson plans covering: Introduction to Food, nutrition, and Health, Food Guide Pyramid (grains, fruits), Food Groups (vegetables, dairy, meat, oils, and fats), Macronutrients, Micronutrients, Servings of food groups, Serving sizes of common foods, Balanced diet (grains, fruits, vegetables), Balanced diet (meat, dairy, oils,

fats, sweets), Applying the Food Guide Pyramid in daily life, Distributing servings throughout the day.

The study employed a pre-test and post-test design. Both groups were evaluated for baseline knowledge regarding the Food Guide Pyramid using the structured questionnaire. One group received nutrition education through a 3D Food Guide Pyramid Model and posters. The other group was instructed using a conventional teaching method. One week after completing the nutrition education program, the same questionnaire was administered to measure knowledge improvements in both groups.

**Data Analysis**
Data analysis was conducted using SPSS version 24. An independent sample $t$-test was performed to compare pre-test and post-test scores for both groups, assessing the effectiveness of the 3D model-based teaching method versus the conventional approach.

**Results**

**Table 1: Comparison of pre-test & post-test knowledge about food groups**

| Section I Food Groups Group | | Pre-test | Post-test |
|---|---|---|---|
| **3D model** | N=18 | | |
| | Mean | 0.39 | 5.00 |
| | SD | ±0.502 | ±0.00 |
| **Conventional** | N=18 | | |
| | Mean | 0.28 | 2.89 |
| | SD | ±0.461 | ±0.90 |
| | Mean Difference | 0.111 | 2.111 |
| | t-value | 0.692 | 9.494 |
| | p-value | 0.494 | 0.00 |

Table 1 shows the comparison of knowledge about food groups between the 3D model group and the conventional group of pre-testing and post-testing. In pre-testing, the 3D model group (M=0.39, SD=±0.502) and conventional group (M=0.28, SD=±0.461) showed a p-value of 0.494 which indicates that there was no significant difference in knowledge about food groups. Both

groups were not aware of the food groups. However, in post-testing 3D model group with a higher score (M=5.00, SD=±0.00) than the conventional group (M=2.89, SD=±0.90) showed the p-value of 0.00 which indicates that there was a significant difference in knowledge between these groups.

**Table 2: Comparison of pre-test & post-test knowledge about nutrients**

| Section II Nutrients Group | | Pre-test | Post-test |
|---|---|---|---|
| 3D model | N=18 | | |
| | Mean | 0.67 | 5.00 |
| | SD | ±0.767 | ±0.00 |
| Conventional | N=18 | | |
| | Mean | 0.94 | 3.72 |
| | SD | ±0.725 | ±0.018 |
| | Mean Difference | -0.278 | 1.278 |
| | t-value | -1.116 | 5.326 |
| | p-value | 0.272 | 0.00 |

Table 2 shows the comparison of knowledge about nutrients present in different food groups between the 3D model group and the conventional group of pre-testing and post-testing. In pre-testing, the 3D model group (M=0.67, SD=±0.767) and conventional group (M=0.94, SD=±0.725) showed a p-value of 0.272 which indicates that there was no significant difference of knowledge about nutrients present in different food groups. Both groups were not aware of the nutrients present in different food groups. However, in post-testing 3D model group with a higher score (M=5.00, SD=±0.00) than the conventional group (M=3.72, SD=±0.018) showed the p-value of 0.00 which indicates that there was a significant difference of knowledge between these groups.

**Table 3: Comparison of pre-test & post-test knowledge about serving sizes**

| Section III Serving Sizes Group | | Pre-test | Post-test |
|---|---|---|---|
| 3D model | N=18 | | |
| | Mean | 0.39 | 4.83 |
| | SD | ±0.698 | ±0.383 |
| Conventional | N=18 | | |
| | Mean | 0.56 | 3.50 |
| | SD | ±0.616 | ±1.043 |
| | Mean Difference | -0.167 | 1.333 |
| | t-value | -0.760 | 5.090 |
| | p-value | 0.453 | 0.00 |

Table 3 shows the comparison of knowledge about serving sizes between the 3D model group and the conventional group of pre-testing and post-testing. In pre-testing, the 3D model group (M=0.39, SD=±0.698) and the conventional group (M=0.56, SD=±0.616) showed a p-value of 0.453 which indicates that there was no significant difference in knowledge about serving sizes. Both groups were not aware of the serving sizes. However, in post-testing 3D model group with a higher score (M=4.83, SD=±0.383) than the conventional group (M=3.50, SD=±1.043) showed the p-value of 0.00 which indicates that there was a significant difference of knowledge between these groups.

**Table 4: Comparison of pre-test & post-test knowledge about a balanced diet**

| Section IV Balanced Diet Group | | Pre-test | Post-test |
|---|---|---|---|
| 3D model | N=18 | | |
| | Mean | 1.83 | 12.00 |
| | SD | ±1.886 | ±0.00 |
| Conventional | N=18 | | |
| | Mean | 1.56 | 5.17 |
| | SD | ±1.381 | ±1.33 |
| | Mean Difference | 0.278 | 6.833 |
| | t-value | 0.504 | 21.644 |
| | p-value | 0.617 | 0.00 |

Table 4 shows the comparison of knowledge about a balanced diet between the 3D model group and the conventional group of pre-testing and post-testing. In pre-testing, the 3D model group (M=1.83, SD=±1.886) and conventional group (M=1.56, SD=±1.381) showed a p-value of 0.617 which indicates that there was no significant difference in knowledge about a balanced diet. Both groups were not aware of the balanced diet. However, in post-testing 3D model group with a higher score (M=12.00, SD=±0.00) than the conventional group (M=5.17, SD=±1.33) showed a p-value of 0.00 which indicates that there was a significant difference in knowledge between these groups.

**Table 5: Comparison of pre-test & post-test knowledge about healthy foods**

| Section V Healthy Foods Group | | Pre-test | Post-test |
|---|---|---|---|
| 3D model | N=18 | | |
| | Mean | 0.89 | 5.33 |
| | SD | ±1.079 | ±0.594 |
| Conventional | N=18 | | |
| | Mean | 1.06 | 4.17 |
| | SD | ±1.056 | ±0.857 |
| | Mean Difference | -0.469 | 1.167 |
| | t-value | -0.167 | 4.745 |
| | p-value | 0.642 | 0.00 |

Table 5 shows the comparison of knowledge about healthy foods between the 3D model group and the conventional group of pre-testing and post-testing. In pre-testing, the 3D model group (M=0.89, SD=±1.079) and the conventional group (M=1.06, SD=±1.056) showed a p-value of 0.642 which indicates that there was no significant difference in knowledge about healthy foods. Both groups were not aware of the healthy foods. However, in post-testing the 3D model group with a higher score (M=5.33, SD=±0.594) than the conventional group (M=4.17, SD=±0.857) showed a p-value of 0.00 which indicates that there was a significant difference in knowledge between these groups.

**Table 6: Overall comparison of pre-test & post-test scores**

| Overall Comparison of Pre-test & Post-test Scores | | | |
|---|---|---|---|
| Group | | Pre-test | Post-test |
| **3D model** | N=18 | | |
| | Mean | 5.33 | 32.17 |
| | SD | ±2.990 | ±0.786 |
| **Conventional** | N=18 | | |
| | Mean | 4.72 | 19.44 |
| | SD | ±2.109 | ±2.640 |
| | Mean Difference | 0.611 | 12.722 |
| | t-value | 0.709 | 19.598 |
| | p-value | 0.482 | 0.00 |

Table 6 shows the overall comparison of pre-test and post-test scores of the questionnaire between the 3D model group and the conventional group. In pre-testing, the 3D model group (M=5.33, SD=±2.990) and the conventional group (M=4.72, SD=±2.109) showed a p-value of 0.482 which indicates that there was no significant difference of knowledge between the two groups. However, in post-testing the 3D model group with a higher score (M=32.17, SD=±0.786) than the conventional group (M=19.44, SD=±2.640) showed a p-value of 0.00 which indicates that there was a significant difference of knowledge between these groups.

**DISCUSSION**
This study evaluated the effect of a 3D Food Guide Pyramid model on enhancing nutrition knowledge in Grade 3 pupils and identified substantial post-intervention advancements across various domains, including food groups, nutrients, portion sizes, balanced meals, and healthy food selections. These findings corroborate and expand upon prior studies illustrating the advantages of experiential and visual learning modalities in nutrition education. Ho et al. (2023) indicated that the integration of 2D and 3D digital models in dietetic education markedly improved student comprehension and portion size estimation, reinforcing the notion that concrete learning tools may connect theoretical knowledge with practical application. The enhancement in comprehension of serving sizes and balanced meals within the 3D model group corroborates the findings of Faulkner et al.

(2012), who determined that visual aids could enhance portion size interpretation and possibly match dietary practices with recommended intakes. A school-based intervention in Korea conducted by Park and Kim (2018) employing dietary guidebooks demonstrated enhanced food selection and knowledge among elementary students, indicating that structured visual aids—whether printed or model-based—are essential in promoting dietary literacy in early childhood.

The efficacy of the 3D model in improving knowledge of food groups and nutrients aligns with the findings of Dudley et al. (2015), who highlighted that interactive and integrative pedagogical approaches such as cross-curricular and experiential learning—yield more significant educational outcomes than traditional didactic methods alone. Cotton et al. (2020) further substantiates this, since their meta-analysis revealed that nutrition education via engaging pedagogical methods resulted in significant enhancements in children's eating patterns, particularly in fruit and vegetable consumption.

This study contributes to the increasing evidence that early-life nutrition education is an essential public health strategy. Initiatives aimed at young learners employing developmentally suitable, multimodal resources are more likely to cultivate fundamental nutrition knowledge that can impact lifelong dietary habits (Graziose et al., 2017; Contento, 2016). This intervention was undertaken in a rural environment, underscoring the feasibility and significance of utilizing low-cost, tactile educational materials in resource-

limited contexts—an aspect frequently neglected in the research.

The absence of notable disparities in pre-test scores among groups enhances the internal validity of the findings, indicating that the observed improvements can be ascribed to the training methodology rather than pre-existing knowledge discrepancies. Nevertheless, although the first post-intervention enhancements are encouraging, aligning with the results of Wang et al. (2015) in rural China, subsequent study must include extended follow-up durations to assess knowledge retention and genuine behavioral change. The research findings underscore the necessity to transcend conventional lecture-based formats and promote policies that incorporate new, child-centered technologies into regular nutrition curriculum.

## RECOMMENDATIONS AND LIMITATIONS

The study illustrated the efficacy of a 3D Food Guide Pyramid model in augmenting the nutritional knowledge of Grade 3 students, suggesting that interactive, visual instruments can markedly enhance children's comprehension of food groups, nutrients, serving sizes, balanced diets, and healthy food selections. In light of these findings, it is advisable to include such models into school-based nutrition education programs, complemented by teacher training in active learning methodologies and increased parental involvement to reinforce healthy behaviors at home. Extending this methodology to additional grade levels and institutions, especially in underprivileged regions, could enhance its efficacy. Nevertheless, the study possesses multiple drawbacks. The limited sample size and concentration on a singular institution in Vehari constrain the generalizability of the findings. The short-term evaluation solely measured knowledge retention one week post-intervention, neglecting to investigate long-term impacts or real modifications in eating behavior. Moreover, despite both groups receiving identical content, the absence of comprehensive experience elements—such as practical activities or parental workshops—may have limited the program's overall efficacy. Subsequent research

must rectify these shortcomings by utilizing bigger, more heterogeneous samples, assessing behavioral outcomes, and integrating prolonged follow-up periods to evaluate the durability of the acquired information.

## CONCLUSION

Nutrition knowledge regarding different aspects of the food guide pyramid can be increased or enhanced by providing nutrition education through the food guide pyramid 3D model to the students. 3D models help increase nutrition knowledge regarding food guide pyramid and balanced diet as compared to conventional lectures.

## REFERENCES

Ho, D., Lee, Y., Chiu, W., Su, H., & Chang, J. (2023). A pilot study of integrating interactive digital 2D and 3D food models for virtual dietary assessment training in dietetic course. *Clinical Nutrition ESPEN*, *54*, 514–515. https://doi.org/10.1016/j.clnesp.2022.09.168

Food and Agriculture Organization of the United Nations. (2020). *School-based food and nutrition education: A framework and recommendations for implementation.* https://www.fao.org/3/ca4091en/CA4091EN.pdf

Food and Agriculture Organization of the United Nations. (2015). *Nutrition education in primary schools: A planning guide for curriculum development.* https://www.fao.org/3/a0333e/a0333e00.htm

Contento, I. R. (2016). *Nutrition education: Linking research, theory, and practice* (3rd ed.). Jones & Bartlett Learning.

World Health Organization. (2018). *Healthy diet: Key facts.* https://www.who.int/news-room/fact-sheets/detail/healthy-diet

Yang, Y.-C., Hsieh, P.-L., & Liu, H.-C. (2024). Effectiveness of a nutrition education intervention using simulation videos and parental involvement among elementary school students. *Nutrients, 16*(2), Article 342. https://doi.org/10.3390/nu16020342

Asante, M., Amo-Adjei, J., Mahama, A., & Asirifi, M. (2024). A school-based food and nutrition education intervention increases nutrition-related knowledge and fruit consumption among primary school children in Northern Ghana. *BMC Public Health, 24*(1). https://doi.org/10.1186/s12889-024-19200-7

Wang, S., Li, Y., Chen, R., & Zhang, J. (2024). Effect of nutrition education on family food environments and children's dietary habits: A quasi-experimental study. *BMC Nutrition, 10*(1), Article 55. https://doi.org/10.1186/s40795-024-00850-0

Graziose, M. M., Koch, P. A., Wang, Y. C., Gray, H. L., & Contento, I. R. (2017). Cost-effectiveness of a nutrition education curriculum intervention in elementary schools. *Journal of nutrition education and behavior, 49*(8), 684-691.

Dudley, D. A., Cotton, W. G., & Peralta, L. R. (2015). Teaching approaches and strategies that promote healthy eating in primary school children: a systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity, 12*, 1-26.

Jung, T., Huang, J., Eagan, L., & Oldenburg, D. (2019). Influence of school-based nutrition education program on healthy eating literacy and healthy food choice among primary school children. *International Journal of Health Promotion and Education, 57*(2), 67–81. https://doi.org/10.1080/14635240.2018.1552177

Mbhatsani, V. H., Mbhenyane, X. G., & Mabapa, S. N. (2017). Development and implementation of nutrition education on dietary diversification for primary school children. *Ecology of Food and Nutrition, 56*(6), 449–461. https://doi.org/10.1080/03670244.2017.1366319

Haack, S. A., & Byker, C. J. (2014). Recent population adherence to and knowledge of United States federal nutrition guides, 1992-2013: a systematic review. *Nutrition reviews, 72*(10), 613–626. https://doi.org/10.1111/nure.12140

Ruxton, C. H., Ruani, M. A., & Evans, C. E. (2023). Promoting and disseminating consistent and effective nutrition messages: challenges and opportunities. *The Proceedings of the Nutrition Society, 82*(3), 394–405. https://doi.org/10.1017/S0029665123000022

Hartati, N., Aryanti, S., & Destriana, N. (2019). Factors that influence the nutrional status of elementary school children. *Journal of Physics Conference Series, 1166*, 012010. https://doi.org/10.1088/1742-6596/1166/1/012010

Park, M., & Kim, S. (2018). Effects of Nutrition Education using Dietary Guidebook in Higher grade Elementary students of Jeonbuk area. *Korean Journal of Community Nutrition, 23*(1), 13. https://doi.org/10.5720/kjcn.2018.23.1.13

Faulkner, G. P., Pourshahidi, L. K., Wallace, J. M. W., Kerr, M. A., McCrorie, T. A., & Livingstone, M. B. E. (2012). Serving size guidance for consumers: is it effective? *Proceedings of the Nutrition Society, 71*(4), 610–621. doi:10.1017/S0029665112000766

Dudley, D. A., Cotton, W. G., & Peralta, L. R. (2015). Teaching approaches and strategies that promote healthy eating in primary school children: a systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1). https://doi.org/10.1186/s12966-015-0182-8

Cotton, W., Dudley, D., Peralta, L., & Werkhoven, T. (2020). The effect of teacher-delivered nutrition education programs on elementary-aged students: An updated systematic review and meta-analysis. *Preventive Medicine Reports*, *20*, 101178. https://doi.org/10.1016/j.pmedr.2020.101178

Wang, D., Stewart, D., Chang, C., & Shi, Y. (2015). Effect of a school-based nutrition education program on adolescents' nutrition-related knowledge, attitudes and behaviour in rural areas of China. *Environmental health and preventive medicine*, *20*(4), 271–278. https://doi.org/10.1007/s12199-015-0456-4

Contento, I. R. (2011). *Nutrition education: Linking research, theory, and practice* (2nd ed.). Jones & Bartlett Learning.

Centers for Disease Control and Prevention. (2024). *School nutrition: Nutrition education*. U.S. Department of Health & Human Services. https://www.cdc.gov/healthyschools/nutrition/schoolnutrition.htm