Bridging the Nutrition Education Gap: From Theory to Practice- A Scalable Model for Nutrition Practicums in Medical Training

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Abstract: *Background:* With Kerala's rising burden of non-communicable diseases (NCDs), it is crucial to strengthen nutrition education for medical students to equip future physicians with the ability to provide evidence-based dietary guidance.

This study examined the effectiveness of incorporating practical demonstrations into the nutrition curriculum of a private medical college in Kerala, Southern India. By integrating hands-on training, the researchers sought to enhance student engagement, deepen understanding of dietetic principles through practical application, and improve confidence in providing dietary counseling.

Methods; The study incorporated practical demonstrations such as meal planning, dietary assessments, and food label interpretation into the nutrition curriculum for third year medical students. Student feedback was collected through open-ended discussions and reflective exercises to assess their engagement and perceptions of the perceived learning outcomes.

Results; Qualitative feedback indicated that students found practical demonstrations highly engaging, improving their confidence in applying nutritional knowledge. Thematic analysis identified key benefits such as enhanced experiential learning, increased ability to interpret nutrition labels, and improved patient counseling skills. However, challenges included limited time for hands-on activities, variability in prior nutrition knowledge, and limited faculty expertise in nutrition education.

Conclusions; Practical demonstrations are an effective strategy for integrating nutrition education into medical curricula in Kerala as underscored by this study. By aligning with the National Medical Commission's emphasis on integrated, application-based learning, and Kerala's goals of addressing its rising burden of non-communicable diseases linked to malnutrition, this study offers a scalable model to strengthen clinical nutrition education, ultimately contributing to better public health outcomes nationwide.

Keywords: Experiential learning, Nutrition education, Medical curriculum, Practicum, Evidence-based practice.

INTRODUCTION

Food is essential for survival, and medicine has long recognized the importance of diet and nutrition for healthy living. It has become evident with time that diet and nutrition interventions go a long way in mitigating and preventing lifestyle-related diseases such as obesity, diabetes, and cardiovascular conditions [1]. Medical education had traditionally placed *limited* emphasis on nutrition, often relegating it as a supplementary topic with limited time allotment, rather than placing it as a central pillar of clinical practice [2, 3]. Medical teachers are uniquely positioned to enhance public health by the exclusive opportunity to educate future doctors early in their training, on the importance of diet and nutrition in patient care, shaping their lifelong clinical practices [4]. There is a critical need to enhance knowledge of nutrition in medical teachers and students *alike* [1, 5].

Current curricula often fall short of the required practical, hands-on experience necessary for medical students to translate theoretical knowledge of diet and nutrition into effective dietary guidance for patients [6, 7]. This gap is compounded by a deficiency of integrated teaching methods with nutritional practicums that blend scientific principles into real-world applications. The gap is particularly evident in regions where formal nutrition education is not emphasized in medical curricula.

Nutrition science is a domain where misinformation and fads thrive, highlighting the need for students to rely on evidence-based research to become well-informed educators [8]. To address these challenges, there is a growing interest in incorporating practical demonstration techniques—such as interactive workshops, cooking classes, and dietary assessment exercises—that equip students with hands-on experience and critical thinking skills to navigate and counter nutrition myths effectively [4, 8]. These methods can not only foster a deeper understanding of nutrition but also empower medical students to confidently discuss and recommend dietary

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modifications for patients as well as apply them to their own lives [8, 9].

Though medical curricula worldwide mandate nutrition education, there is a lack of standardization regarding its placement and mode of delivery within these programs. This inconsistency creates challenges to educationists in ensuring that students acquire the knowledge and skills necessary for effective patient care in disease management [10]. In France, nutrition is incorporated into the Endocrinology curriculum of medical schools, following up on foundational courses in physiology, biochemistry, or cell biology [11]. In India, nutrition is primarily part of the Community Medicine curricula, instructed by medical faculty who often lack specialized training in dietetics [12]. Nutrition and medicine are taught in the United States (US) and the United Kingdom (UK) as a unified science rather than compartmentally [13, 14].

Absence of standardized epistemological approaches to nutritional pedagogy has resulted in different methods being used for teaching nutrition, aligning with the specific needs of the curricula, patient and community demands, or national priorities. One of these methods is the inclusion of culinary medicine programs like Teaching Kitchens [15], or Health Meets Food, [16, 17] developed within individual medical schools in the United States (US), which emphasize hands-on experiential learning to effectively transmit knowledge. As culinary kitchen programs collaborate with communities, hospitals, schools, medical professionals, and the food industry, they help students develop a broader perspective on the profound impact of food on both patients and personal health. Reading food labels on packaged food is another skill that will serve medical students in good stead. Interpretation of nutrition labels is a simple method by which students can understand and act on claims made by the packaged food industry. This is particularly important because research suggests a strong association between higher consumption of packaged foods, obesity markers and many noncommunicable diseases [18, 19].

Understanding the nutritional needs of the population through diet surveys and diet histories, are community-based population approaches that have been used in nutrition education [12]. These help students make recommendations for diet changes and understand the importance of nutrition management in patient care. Studies have also shown that assessing the knowledge and skills of medical students through incorporating questions on nutrition within formal assessments can help improve their communication, diagnostic and referral skills [8, 12].

Building on these insights, we sought to explore whether integrating an experiential nutrition practicum—featuring meal planning, dietary assessment, and food-label interpretation—into a competency-based medical curriculum could significantly enhance third-year medical students' engagement, confidence, and competence in delivering evidence-based nutritional care.

The current study aims to explore the potential of integrating practical demonstrations of dietary and nutritional techniques into medical education, focusing on their impact on students' knowledge, hands-on skills, and self-perceived confidence in applying nutrition principles in clinical practice. Key competencies aimed for included- taking a basic food history, reading, and analyzing food labels, and delivering effective and empathetic nutritional counselling using evidence-based guidelines, which are culturally sensitive and devoid of bias and judgments [21, 22]. By examining the effectiveness of these teaching strategies, this research seeks to offer insights into how medical curricula can evolve to better equip future healthcare providers with the skills essential to address the dietary needs of their patients and community.

This study is among the few, conducted in this part of the world, which includes Kerala, where nutrition education is traditionally underrepresented in medical training. By highlighting an innovative, experiential learning model, this research offers valuable insights into how competency-based medical training (CBME) can be enhanced to better equip future healthcare professionals with essential nutrition counseling skills among others, thus addressing a well-documented, yet unresolved gap in their practice.

With the burden of diet-related non-communicable diseases and malnutrition posing a significant public health, economic, and social challenge, medical professionals must be adequately trained to provide effective nutritional counseling as part of patient management.

THE THEORETICAL FRAMEWORK

This study leverages a dual-theoretical foundation, integrating Kolb's Experiential Learning Theory (ELT) and Constructivist Learning Theory, to shape an immersive nutrition practicum design.

The Kolb's Experiential Learning Theory (ELT) is used as a guiding framework, which posits that effective learning unfolds through a continuous cycle of four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation

For *concrete experience*, third-year medical students actively engage in hands-on practicum tasks—such as meal planning, dietary assessment, and food-label interpretation—providing them with direct, tangible experiences in nutrition education. Hands-on activities can foster reflective thinking, encourage learners to derive meaningful insights, and can deepen the understanding of the concepts learned.

When the students, after each activity, engage in structured reflection sessions and debriefs guided by faculty, which encourages consideration of what occurred, analysis of their actions, and identification of areas for improvement, they go through the stage of *reflective observation*. Thus, the student learner reflects on that concreted experience, gains insights, and applies what is learnt to new situations, so that his or her understanding and skills are reinforced.

The synthesis of these reflections helps students relate to core nutritional theories and clinical guidelines. This enables them to form or refine conceptual models of nutritional counseling, grounded in best practices as part of the stage of *abstract conceptualization.*

As a final step, the students apply their newly formed ideas and strategies in subsequent real-world and simulated patient counseling scenarios. By testing and adapting their approaches in practice through *active experimentation*, they complete the cycle—gaining fresh experiences and beginning the next iteration of learning.

By embedding each phase of Kolb's cycle within the practicum—from engaging in tasks to reflecting, conceptualizing, and applying—this study ensures a comprehensive experiential learning process. Through this structured cycle, we anticipate that students will not only improve their nutrition-related knowledge but also build confidence and competence in delivering evidence-based nutritional care. This research incorporates practical demonstration techniques into nutrition and dietetic learning [20].

Constructivist theory asserts learners construct knowledge actively, drawing on prior understanding and social engagement. This aligns with Kolb's concrete and reflective stages, emphasizing through active participation of students in the co-creation of diet plans, building knowledge collaboratively. Through group discussions, peer critiquing, and shared reflection, students go through the motions of social interaction. Similarly, the scaffolding of the processes is built through faculty facilitating reflection, prompting learners to refine misconceptions and deepen understanding. This constructivist approach ensures learning is not passively received, but constructed through authentic experiences and peer dialogue [20].

METHODOLOGY

Study Setting

This study was conducted as part of a structured nutrition course for third-year medical students. The intervention integrated practical demonstrations, including meal planning, dietary counseling techniques, and nutritional assessments, within a competency-based medical education curriculum (CBME). Student feedback was collected through open- ended discussions and reflective exercises. As part of the year 3 curriculum for medical students, 15-18 hours were designated for diet and nutrition classes. The four-day practical nutrition course was part of the mandated curriculum of the National Medical Council of India. All students had completed their basic science course which included Anatomy, Physiology, and Biochemistry. Thirty third-year MBBS (Bachelor of Medicine and Surgery degree course) students were enrolled in a four-day practical diet and nutrition course. Recruitment for student participants took place in the classroom setting using the convenient sampling method. No consent was taken from the students at this time.

Study Design

This study followed an explanatory sequential mixed-methods design, beginning with a quantitative phase followed by a qualitative phase to enrich understanding of initial results. In the first part, a quantitative intervention and assessment was carried out. Thirty third-year medical students participated in an experiential nutrition practicum. At the end of the course, their learning outcomes were measured using post-test scores and rubric-based quantitative assessments embedded within routine exams.

Following quantitative analysis, the students went through in-depth reflective exercises and open-ended discussion sessions. These qualitative data were purposefully designed to explain and elaborate upon the trends observed in student performances after the quantitative assessments.

INTERVENTIONS

The interventions were carried out in stages.

I. Theory Sessions: Assistant Professors from the Department of Community Medicine made Power Point presentations on topics, which included - principles of nutrition, dietary requirements for various populations, how to read food labels, and the role of nutrition in managing specific health conditions.

II. Practicums

a. Interactive Sessions: Students participated in interactive sessions that included discussions on dietary requirements for different populations- both healthy and diseased- with specific health conditions attributable to malnutrition.

To assess students' nutritional evaluation skills, two well-established, validated dietary assessment instruments: the 24-hour dietary recall and the Food Frequency Questionnaire (FFQ) were used [21]. Both tools are widely utilized in nutritional research and have demonstrated reliability and validity across diverse populations. Students conducted dietary assessments among healthy and malnourished individuals in the community, applying the 24-hour recall to capture detailed food intake and the FFQ to record habitual dietary patterns. As these instruments had already undergone rigorous validation, we did not pilot-test them separately. These tools were integrated into an experiential learning framework to reinforce students' assessment competencies and support reflective practice. These were done as part of the Family Adoption Program [22], in the field area of the Community Medicine Department.

b. Creating Sample Meal plans: Practical sessions that encouraged real-world application of concepts through creating sample meal plans for different populations- both real and hypothetical- and discussed the preparation of balanced meals- provided a well-rounded learning experience that bridged the gap between theoretic knowledge and clinical application. Food ingredients for activities were provided by the teaching faculty while available departmental equipment was used for the practicums.

c. Learning simulations using hypothetical scenarios: Using case scenarios, students were taught meal planning for diverse populations and dietary counselling for specific health conditions. They were used as input for detailed simulation outputs, aligned with Kolb's Experiential Learning Theory to capture hands-on learning outcomes.

d. Evaluation of Student Competencies in Nutrition Assessment and Counseling: Course instructors evaluated student performance using detailed rubrics, focusing on their use of nutritional screening tools and counseling skills. In community settings during the Family Adoption Programme, students assessed diets using the standardized the 24-hour dietary recall and a semi-quantitative Food Frequency Questionnaire (FFQ)—to capture both immediate consumption and habitual dietary patterns. These assessments were conducted as interactive activities, where students shared results with participants, provided personalized advice, and collaboratively designed nutritionally appropriate interventions.

For example, after administering the FFQ and discussing its findings, students offered tailored guidance—such as recommending low-sodium meal adjustments for individuals with hypertension—thereby demonstrating their ability to interpret data and counsel effectively. These sessions were evaluated through rubric criteria that included technical proficiency in administering and interpreting the FFQ and 24-hour recall, and empathetic communication through role-play, advice, and real-world counseling interactions, with attention to cultural context, participant engagement, and alignment with current dietary guidelines.

By combining dietary assessment and immediate counseling, this approach ensured that students not only learned to gather nutritional data but also to apply it in meaningful, context-sensitive counseling—an essential skill for evidence-based patient care.

e. Qualitative Feedback on Learning and Application: To capture student perspectives on engagement, learning experiences, and confidence in applying nutrition knowledge, open-ended group discussions were conducted with the entire cohort immediately after classes. Guided by instructors, these sessions used broad, flexible questions—such as "What aspects of today's practicum helped you learn?" and "How confident do you feel in applying this knowledge next time?"—to encourage honest reflection and detailed responses.

Unlike formal focus groups, these discussions were unstructured and inclusive, allowing any student to share insights or build on peers' comments. This format that uses open-ended questions to elicit rich, spontaneous data, without predetermined prompts or structured moderation.

Feedback from these discussions was transcribed. This approach helped identify recurring themes—such as increased engagement, confidence in counseling, and perceived gaps in nutritional knowledge, directly informing the interpretation of the quantitative results.

f. Literature Review: Building on the qualitative feedback, researchers conducted a literature review on practical techniques in medical nutrition education to further contextualize student experiences and identify effective teaching methods and implementation barriers. What began as a teaching and learning exercise gradually evolved into a research endeavour,

as student reflections highlighted valuable insights worth documenting.

This review not only informed the development of questionnaires for a subsequent study on hands-on nutrition education in subsequent classes but also laid the groundwork for a separate narrative review exploring best practices in the field.

g. Thematic analysis: The qualitative data were analyzed to identify common themes related to experiential learning benefits and challenges. Qualitative feedback from open-ended session transcripts was analysed through a reflexive thematic analysis following Braun and Clarke's six-phase framework:

Transcripts were read multiple times by the research team (two independent coders), who noted readers' initial impressions and emerging patterns in students' reflections in the process of familiarization.

Each coder systematically reviewed the transcripts to highlight segments of interest—comments on practical activities, emotional engagement, or perceived challenges—and assigned descriptive codes (*e.g.*, "increased confidence," "hands-on value," "time management concerns") in order to generate initial codes.

Similar codes were grouped into broader categories, in the process of searching for themes.

Themes were examined against the coded data and full dataset to ensure coherence and relevance to the research question. Codes that didn't fit were re-classified or discarded while reviewing themes created.

The final themes were clearly defined and labelled with concise, representative titles through discussion within the team.

A narrative was then constructed relating each theme back to the study's aims and quantitative findings, illustrating how hands-on practicum fostered student confidence and identified areas for curriculum improvement. Key illustrative quotes were included to enrich interpretation, thus producing the report.

This structured process not only ensured a transparent mapping from raw data to analytic insights but also allowed us to identify prominent patterns—such as increased student engagement and experiential learning challenges—that informed and explained our quantitative results.

ETHICAL CONSIDERATIONS

Ethical transparency was maintained by informing students about the purpose of feedback collection, with no identification of participants data in the analysis. Since the course was conducted without an initial intent for research, consent was not obtained at the time of data collection. After recognizing the research value of the collected data, ethical approval was sought and granted by the Institutional Review Board (Approval No. PIMSRC/E1/388A/156/2024) for its retrospective use. The requirement for consent was waived, as the data was not traceable to individual participants, and any publications presenting only aggregated, non-identifiable results.

RESULTS

The following table shows the results obtained in this study.

As shown in Tables **1-3**, the post-test assessments revealed notable outcomes across key domains, reinforcing the effectiveness of the hands-on learning approach.

Table **1** presents the distribution of student scores in the post-class nutrition theory assessment, which

Table 1: Distribution of Student Scores in Post-Class Nutrition Theory Assessment (Table of 30 marks)

	Marks					
Question	**0-6**	**7-12**	**13-18**	**19-24**	**25-30**	**p- value**
Basic human nutrition	0 (0%)	1 (3%)	5 (17%)	15 (50%)	9 (30%)	.000
Dietary guidelines	0 (0%)	3 (10%)	6 (20%)	13 (43%)	8 (27%)	.000
Patient's nutritional status	0 (0%)	1 (3%)	6 (20%)	15 (50%)	8 (27%)	.000
Role of diet in chronic diseases	0 (0%)	3 (10%)	5 (17%)	16 (53.33%)	6 (20%)	.000
Nutritional needs of population	5 (16.67%)	10 (33,33%)	5 (16.67%)	8 (26.67%)	2 (6.67%)	.000

had a total possible score of 30 marks. Across all five assessed domains, the majority of students scored in the higher ranges, indicating a strong understanding of the covered topics. In the Basic Human Nutrition, Patient's Nutritional Status domain, Dietary Guidelines, and in the Role of Diet in Chronic Diseases sections, the majority scored between 19-24 marks, with a small percentage obtaining the highest scores. However, performance in the Nutritional Needs of the Population category was notably lower, with only 7% achieving scores between 25-30 marks, and a considerable proportion (17%) scoring in the lowest range (0-6 marks). A statistically significant difference was observed across all domains (p = .000), suggesting meaningful variations in student performance across the different aspects of nutrition theory.

Additionally, students expressed confidence in discussing nutrition, making dietary recommendations, and integrating nutrition into clinical practice. Compared with the traditional lecture-based instruction in the first part of the course, which focused primarily on theoretical knowledge, students perceived the experiential, skills-based learning approach as more effective in building practical competencies. They reported that the interactive nature of the course helped bridge the gap between theory and real-world application, enhancing their ability to assess and counsel patients on nutrition-related issues.

Table **2** summarizes the post-intervention assessment of medical students' confidence in various aspects of nutrition knowledge, as evaluated by teachers. The majority of students (63-70%) were rated as confident across all domains, with a smaller proportion remaining neutral or not confident.

Table **3** presents the teacher-assessed performance of medical students in key competencies related to nutritional evaluation and counseling. The majority of students demonstrated proficiency across all assessed areas, with most scoring in the Excellent (90-100%) or Good (75-89%) categories. Competencies such as correct use of screening tools, realistic and culturally sensitive meal planning, and clear and empathetic communication had the highest proportion of students rated as excellent. A smaller proportion of students fell

Table 2: Post-Intervention Assessment of Medical Students' Confidence in Nutrition Knowledge: Teacher Evaluations

Question	Not Confident	Neutral	Confident	p-value
1. Discussing nutrition	3 (10%)	6 (20%)	21 (70%)	.000
2. Recommending dietary changes	1 (3%)	8 (27%)	21 (70%)	.000
3. Integrating nutrition in plans	3 (10%)	8 (27%)	19 (63%)	.000
4. Interpreting nutritional labs	3 (10%)	8 (27%)	19 (63%)	.000
5. Importance of diet in practice	3 (10%)	8 (27%)	19 (63%)	.000

Table 3: Performance Assessment of Key Competencies in Nutritional Evaluation and Counselling (Teacher Assessments)

	Mark Categorization			
Criterion	Excellent (90-100%)	Good (75-89%)	Satisfactory (50-74%)	Needs Improvement (<50%)
Correct use of screening tools	18 (60%)	8 (27%)	4 (13%)	0 (0%)
Identification of nutritional risks/imbalances	15 (50%)	10 (33%)	5 (17%)	0 (0%)
Correct identification of medical conditions	50% (15)	30% (9)	20% (6)	0% (0)
Use of evidence-based dietary recommendations	40% (12)	40% (12)	20% (6)	0% (0)
Realistic, culturally sensitive meal plan	60% (18)	30% (9)	10% (3)	0% (0)
Justification of the diet plan with references	30% (9)	40% (12)	20% (6)	10% (3)
Recommendation of dietary adjustments	12 (40%)	11 (37%)	6 (20%)	1 (3%)
Clear and empathetic communication	20 (67%)	7 (23%)	3 (10%)	0 (0%)

into the Satisfactory (50-74%) category, while very few required improvements.

The exercise on identifying nutritional risks through case scenarios revealed variability in student performance. While 50% of students demonstrated strong analytical skills, others showed only partial competence, missing key details in dietary assessments. This highlighted the need for improved training.

When asked to recommend dietary adjustments based on identified risks, 40% of students excelled, providing comprehensive, evidence-based recommendations. An equal proportion performed well but lacked depth in justifying their dietary plans.

Empathy in nutrition counselling, assessed through hypothetical case scenarios, showed the strongest student performance, with 67% demonstrating clear, patient-centered communication. Some students needed improvement in conveying dietary advice in an accessible and culturally sensitive manner. These results highlight the effectiveness of the intervention in enhancing students' ability to apply nutrition knowledge in clinical settings.

However, targeted training for lower-performing students could further enhance outcomes.

The qualitative component of the study captured students' reflections on their learning experiences, engagement, and confidence in applying nutrition knowledge in real- world contexts. Compared to lecture-based teaching, students reflected that hands-on, practical demonstrations were far more engaging and effective.

Students highlighted key themes regarding the relevance and impact of the nutrition module. Many students reported a *changed perspective on the role of nutrition* in disease management, recognizing it as a fundamental aspect of effective treatment plans. They expressed they felt more prepared to discuss dietary choices with patients and thus the course addressed *gaps in their training*.

A notable outcome was the *increased confidence in incorporating nutrition into patient care*, as students acknowledged how nutritional interventions influenced clinical decision-making. Additionally, students emphasized the importance of a *holistic, patient-centered approach*, integrating dietary habits into comprehensive care rather than focusing solely on

Table 4: Medical Students' Perspectives on Nutrition Education (Reflections)

Student Feedback	Emerging Themes
"Before this course, I didn't fully grasp how crucial nutrition is in managing diseases. Now, I see it as a cornerstone of effective treatment plans."	Changed perspectives about role of nutrition in management
"Learning about the impact of diet on chronic illnesses has transformed my approach to patient care."	
"The nutrition module was eye-opening. It highlighted a significant gap in our training that I believe is essential for all future doctors."	Gaps in training addressed
"I now feel more equipped to discuss dietary choices with my patients, thanks to the practical sessions we had."	
"During my clinical rotations, I had noticed how often nutrition plays a role in patient outcomes. These classes have given me the confidence to address it directly."	Confidence to approach nutrition in patient care
"Understanding nutritional interventions has already made a difference in how I approach patient care."	
"Integrating nutrition into patient care has allowed me to see the bigger picture, treating the person as a whole rather than just addressing symptoms- realise the importance of patient-centered care	Holistic Treatment Approach to patient centered care
"The importance of considering patients' dietary habits, which is vital for comprehensive care."	
"While the module was informative, I realize there's so much more to learn about nutrition. I'm eager to pursue further studies in this area."	Need for continuous learning
"The necessity for continuous education in nutrition to keep up with evolving research and better serve our patients."	

Need for continuous learning.

disease symptoms. Finally, several students expressed a *desire for continuous learning*, recognizing the need to stay updated on evolving nutrition research to enhance patient care.

Students found interactive activities—such as meal planning, food label interpretation, and real-world nutritional assessments—highly engaging. These activities fostered deeper participation and helped reinforce clinical nutrition concepts. Many students expressed that traditional lecture-based teaching had failed to equip them with practical skills, whereas experiential learning significantly improved their confidence in providing nutrition-related counselling.

Students reported that experiential learning methods, including case scenario analysis and problem-solving exercises, helped them develop critical thinking and decision- making skills in clinical nutrition. The integration of hands-on activities with theoretical concepts enhanced their ability to apply nutrition knowledge effectively in patient care.

Moreover, the collaborative nature of practical sessions prepared students for real- world, multidisciplinary healthcare environments. They appreciated opportunities to work in teams, simulate patient interactions, and practice evidence-based nutrition counselling. Time constraints and varying levels of prior nutrition knowledge were noted as barriers to deeper engagement.

These findings underscore the impact of the nutrition teaching methods in improving students' perceptions, confidence, and preparedness in applying nutrition knowledge in clinical practice.

DISCUSSION

The findings highlight the effectiveness of practical demonstrations in medical nutrition education.

This study, conducted among thirty medical students, evaluated the outcomes of various practical nutrition demonstration interventions. Post-course assessments and qualitative feedback indicated that students gained valuable practical skills and confidence in applying nutrition knowledge. However, areas such as "confidence in applying nutrition knowledge" and "perceived relevance in clinical practice" showed variability, suggesting opportunities for refining the curriculum to better support skill development.

Several international studies emphasize the critical role of nutrition education, particularly hands-on training, in equipping medical students to counsel patients, evaluate dietary patterns to recommend appropriate dietary changes. A 2023 study of French and American medical schools identified gaps in nutrition curricula and underscored the value of multidisciplinary, experiential approaches. Social scientists have recommended pedagogical strategies tailored to nutrition education to bridge these gaps [11].

In India, the National Medical Council (NMC) recommends incorporating nutritional interventions for health promotion and rehabilitation through the Attitude, Ethics, and Communication (AETCOM) module. However, nutrition education is not formally integrated into the medical curriculum and is typically addressed only when time permits. Few published studies from India focus on medical nutrition education, and motivated faculty often resort to innovative teaching methods to compensate for the lack of structured training [23, 24].

In 2014, Dr. Shankar advocated for formal nutrition education in India's medical curriculum, proposing a tailored "Nutrition in Medicine" module inspired by the University of North Carolina's program. He emphasized the need to adapt nutrition education to India's cultural diversity and integrate it into medical training to address the nation's dual burden of over- and undernutrition [25].

Recognizing India's rising burden of chronic diseases linked to poor diets, Gandhi *et al*. introduced a hands-on "Diet Demonstration Program," inspired by Culinary Kitchen classes in the U.S. This program encouraged students to apply theoretical knowledge by cooking with locally sourced ingredients. Most participants reported enhanced understanding of nutritional practices and greater confidence in counseling patients [26].

The practical demonstration exercise showed that most students effectively used screening tools, such as 24-hour dietary recalls and Food Frequency Questionnaires. However, significant performance disparities among student groups suggest the need for targeted training. Limited curriculum time constrained additional teaching, necessitating self-directed learning for underperforming students.

A 2019 systematic review by Crowley *et al*. highlighted global inadequacies in medical students' nutrition knowledge, confidence, and skills, largely due to time constraints, lack of qualified educators, and logistical challenges in implementing nutrition curricula. These findings echo the gaps identified through this study [27].

A study conducted in the neighboring district of Kottayam, Kerala published in May 2024, showed that students recognized the importance of nutrition

education for diet counseling. However, they found dietary surveys using the 24-hour recall method challenging in practical situations [12].

Students who participated in this study, perceived the hands-on, skills-based learning approach as significantly more effective than traditional lecture-based instruction. While theory classes provided foundational knowledge, students felt such knowledge gained lacked practical applications in clinical scenarios. The interactive nature of the practical sessions helped bridge the gap between theory and practice in the real world, reinforcing their ability to assess and counsel patients on nutrition-related issues. However, since no pre-tests were conducted, improvements in knowledge and confidence could only be inferred from post-course feedback rather than if they were direct comparisons with baseline levels.

The study revealed that most students demonstrated empathetic communication skills, crucial for patient-centered care. A 2024 scoping review by de Graaf *et al*. emphasized empathy as integral to effective nutritional counseling, improving patient adherence to dietary recommendations. Structured pedagogical strategies can further enhance students' empathetic capacities [28].

The National Medical Commission (NMC)'s emphasis on integrated, practical, and application-based learning, align with the objectives of this study. By demonstrating the value of experiential learning in nutrition education, this research supports efforts to establish structured nutrition curricula within CBME, ensuring future physicians are well- equipped to address the country's growing burden of nutrition-related diseases.

STRENGTHS OF THE STUDY

This research emphasizes the crucial role of practical training in improving diet and nutrition education within medical curricula. Hands-on sessions would equip medical students with skills to identify dietary risks, formulate evidence-based dietary recommendations, and effectively utilize dietary screening tools.

Practical exercises helped students develop culturally relevant, evidence-based dietary plans and understand real-world challenges, such as preparing affordable, balanced meals. However, variability in the quality of the evidence generated through student feedback and assessments, as well as inconsistencies in the organization of their dietary plans, highlight the need for additional training in systematically justifying nutritional decisions and structuring their findings effectively. Most students demonstrated a good understanding of evidence-based practices, as seen in the alignment of their plans with recommended dietary guidelines. Some students noted the challenges of preparing affordable and balanced meals, reflecting an awareness of real-world constraints. Understanding local ingredients and cooking practices helped students create culturally relevant dietary plans in hypothetical situations. The exercise helped students appreciate the importance of using scientific evidence to support dietary advice, although the level of thoroughness varied across distinct groups.

These discussions provided an open forum for students to share insights, challenges, and suggestions, fostering peer learning and deeper understanding, and the reflections therein captured their perceived strengths, challenges, and areas for improvement, particularly in using nutritional screening tools, developing intervention plans, and communicating dietary recommendations to patients.

The feedback provided insights into students' experiences with nutritional screening tools, intervention planning, and communication of dietary recommendations, offering valuable input for refining teaching strategies. Additionally, these reflections gave the researchers a deeper understanding of student learning processes, helping identify key themes and gaps in student understanding, thus motivating them to refine instructional strategies to enhance experiential learning, in addition to giving them the idea to explore their findings in a research paper on nutrition education and experiential learning.

A sustained focus on nutrition education from the first year through internship is crucial with a broader integration into medical training. Innovative teaching methods, including case-based learning, role-playing, and culinary classes, can strengthen students' theoretical knowledge and practical skills. While curriculum revisions by regulatory authorities like the NMC are underway, faculty and students must explore creative interim solutions.

Encouraging students to critique each other's recommendations and communication skills may further help in cultivating the interpersonal skills essential for their future roles as practicing clinicians [29].

Incorporating feedback from social scientists, dietitians, and medical educators can help students create balanced, realistic, and culturally sensitive dietary plans. Detailed scoring rubrics and peer review activities can enhance learning by clarifying expectations and fostering collaboration [27].

The design of this research aligns with Kolb's Experiential Learning Theory, as students engaged in practical activities such as dietary planning and food label interpretation, which helped them internalize what they learned. By connecting these activities to their theoretical nutrition knowledge, they developed a deeper understanding of dietetics. Students applied their knowledge to real-world clinical scenarios, such as counseling hypothetical patients, thus closing the loop of experiential learning [20, 30].

The connection with Constructivist Learning Theory is also evident, as students actively integrated prior knowledge with new experiences, allowing them to conceptualize and personalize their understanding of nutrition principles. This research could be further strengthened by incorporating hands-on practicum sessions involving food preparation or observation, which would highlight the role of social and cultural factors in nutrition, in accordance with Vygotsky's Sociocultural Theory [31].

The conceptual framework of this study demonstrates the interplay of theory, practicum, and student outcomes. Theoretical learning is integrated into the framework through faculty-led teaching of nutritional principles and practical tools like diet surveys. The learning process is reinforced through experiential activities such as case-based exercises, student feedback, and post-course assessments. The outcomes from this intervention include enhanced student confidence in applying nutritional principles, improved skills, and a better understanding of real-world dietary challenges.

The theoretical foundation, learning process, and student outcomes align with the medical curricular requirement of Competency-Based Medical Education (CBME). Educational innovation through experiential learning supports the CBME goal of producing practice ready healthcare professionals. Post-course feedback and qualitative inputs from students align with Dewey's philosophy of learning as a continuous reconstruction of experience. Student reflections on their roles in addressing nutrition-related challenges helped them develop a deeper understanding of the subject [32-34].

Barriers to effective nutrition education include overcrowded curricula, a shortage of medical faculty with specialized expertise, frequent changes in course instructors, limited resources, competing teaching priorities, and resistance to curricular change. Integrating nutrition education into already dense curricula may challenge the breadth of medical training. Additionally, establishing infrastructure for experiential learning requires substantial financial and logistical investment, which resource-constrained institutions may struggle to sustain. Nutrition practices and dietary needs vary widely across regions and cultures, making it difficult to develop a standardized curriculum that maintains both local and global relevance. Moreover, the long-term impact of nutrition education on patient care and public health outcomes may take years to materialize, making its inclusion in medical curricula less immediately compelling compared to subjects with more direct and tangible clinical outcomes.

LIMITATIONS OF THE STUDY

This study has several limitations that should be considered when interpreting the findings. First, the small sample size limits the generalizability of results to broader populations of medical students. Additionally, the study was conducted within a single institution, which may not reflect the diversity of nutrition education practices across different medical colleges regionally or nationally. The reliance on self-reported information introduces the potential for response bias, as participants may have overestimated their knowledge or confidence in alignment with socially desirable responses.

Furthermore, as only post-tests were conducted and no pre-tests were available for comparison, the study could not assess knowledge gains or confidence improvements relative to a baseline, or measure objective learning gains. While qualitative feedback from students provided insights into the perceived effectiveness of hands-on learning compared to traditional lecture-based instruction, objective measurements of long-term knowledge retention and clinical application were not included. The perspectives of faculty members and institutional leaders were also not explored, missing valuable insights into systemic challenges and opportunities for integrating nutrition education into medical curricula.

CONCLUSIONS

This study aimed to investigate whether integrating an experiential nutrition practicum—featuring meal planning, dietary assessment (including 24 hour recall and FFQ), and food label interpretation—within a competency-based medical curriculum could enhance third-year medical students' engagement, confidence, and competence in delivering evidence-based nutritional care.

Kerala being a state with rising rates of non-communicable diseases linked to poor dietary choices, and a growing epidemic of obesity and diabetes, this research will draw the attention of future healthcare professionals to practical nutrition education. The findings underscore the importance of experiential

learning in improving students' confidence and ability to integrate nutrition advice into patient care. Addressing gaps in nutrition education can enhance medical graduates' capacity to provide evidence-based dietary counseling, contributing to better public health outcomes. As the state grapples with the dual burden of overnutrition and undernutrition, incorporating structured, hands-on nutrition education into medical training is an essential step toward improving healthcare delivery and chronic disease prevention.

In the broader Indian context, this study holds significance as medical education regulations evolve to prioritize competency-based medical education. The study presents a feasible, scalable model for integrating nutrition education into medical curricula, offering a framework that can be adapted across diverse healthcare education systems. Given the limited number of studies exploring practical interventions in medical nutrition education, this research fills a critical knowledge gap and provides an evidence-based approach to strengthening clinical nutrition training. Strengthening medical training in this domain is essential for improving dietary counseling practices and ultimately enhancing public health outcomes nationwide.

RECOMMENDATIONS

To enhance nutrition education through medical curricula, this study recommends conducting training workshops focused on effective referencing and interdisciplinary collaboration, involving expertise from social scientists, dieticians, nutritionists, clinicians, and nursing professionals. The integration of artificial intelligence (AI) to generate culturally relevant evidence on nutritional practices should be explored, ensuring AI-generated content is supplemented with expert validation. Curricular innovations should prioritize innovative teaching strategies, such as simulations, virtual cooking sessions, hybrid modes of teaching, and telehealth dietary counseling, grounded in frameworks like Kolb's Experiential Learning Model and the Five A's Model for behavior change [20, 35]. Establishing a teaching kitchen within the Community Medicine laboratory can provide students with hands-on experience in meal planning and cooking, using locally sourced ingredients while addressing affordability and contextual, experiential learning.

Additionally, dedicated funding and structured frameworks with measurable competencies, such as case-based nutritional counseling and reflective writing assignments, should be implemented. The development of patient education materials can further enhance communication skills. Multidisciplinary training among departments like Physiology, Biochemistry, Pharmacology, and Community Medicine is crucial for a comprehensive approach to nutrition education, aligning with Vygotsky's Sociocultural Theory. Encouraging international collaborations can promote shared learning opportunities to address similar healthcare challenges across different settings

To overcome barriers in the learner-centric nutritional curriculum, faculty mentorship should be strengthened through workshops, bedside and outpatient learning, and online media- for integrating evidence-based practices into curricula. Training faculty members in evidence-based practices and sociocultural dimensions of nutrition can facilitate team-based learning and ensure that future healthcare professionals are empathetic, competent, and equipped to address evolving nutrition-related challenges [25, 26].

Future research should explore the impact of digital tools on personalized student learning outcomes and competency development in dietary counseling. The effectiveness of culturally tailored nutrition education modules, incorporating local dietary habits, cooking practices, and socioeconomic factors, should be evaluated. Additionally, interdisciplinary teaching approaches can be assessed for their ability to enhance students' understanding of sociocultural, clinical, and community health aspects of nutrition. Studies should explore integrating formative assessments to quantify learning outcomes more effectively.

The feasibility and effectiveness of establishing teaching kitchens in medical colleges as a means of promoting hands-on learning should be explored. New tools for assessing competencies gained through experiential learning, such as counseling skills and empathetic communication, should be developed and validated. Studies on faculty training workshops should focus on their long-term effects on student learning and professional practices, particularly regarding the integration of nutrition counseling into clinical practice and its influence on patient outcomes. Furthermore, cost-effectiveness and benefit analyses should be conducted to evaluate innovative teaching strategies, such as virtual cooking sessions and telehealth-based nutrition training, to ensure scalability and sustainability in resource-constrained settings.

DECLARATIONS

Ethics approval and consent to participate: Ethical approval was sought and granted by the Institutional Review Board (Approval No. PIMSRC/E1/388A/156/2024) for its retrospective use. The requirement for consent was waived, as the data was not traceable to individual participants, and any

publications presenting only aggregated, non-identifiable results.

CONSENT FOR PUBLICATION

Not applicable

AVAILABILITY OF DATA AND MATERIALS

All data generated or analyzed during this study are included in this published article [and its supplementary information files]. These include results of post class tests. No publicly archived datasets were analyzed or generated during the study.

COMPETING INTERESTS

None that we can identify

FUNDING

None, no institutional or agency support

AUTHORS' CONTRIBUTIONS

Dr. Anjum John taught the nutrition class for the medical students that semester. The idea, the research protocol, the ethics submission, the data collection, analysis, result writing, manuscript preparation, and journal submission were done under her supervision and guidance.

Ms. Reshma V.R, the biostatistician is currently unattached to any institution and moved to the United Arab Emirates at this time- she contributed by critiquing the proposal, helping with the data analysis, writing the results, reading the manuscript critically and providing general support for the project along with approval of the manuscript for final submission.

Ms. Khadija El-Hazimy is the Research and Data Specialist on the project; she provided all the references for the study and helped with the literature review and writing the discussion part of the manuscript, critiquing the manuscript and approval of the manuscript for submission.

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Dr. Felix Johns, Head of the Department of Community Medicine at Pushpagiri Medical College and Research Centre approved the project.

ANIMAL OR HUMAN DATA OR TISSUE

“Not applicable”

Food Frequency Questionnaire – Kerala Region

Instructions:
Please indicate how frequently you have consumed the following foods over the past 12 months. Use the checkboxes to indicate frequency.

Frequency Options:
☐ Daily ☐ 4–6 times/week ☐ 1–3 times/week ☐ 1–3 times/month ☐ Rarely/Never

Cereals and Grains

Food Item	Daily	4–6×/wk	1–3×/wk	1–3×/mo	Rare/Never
Boiled white rice	☐	☐	☐	☐	☐
Red rice (matta)	☐	☐	☐	☐	☐
Wheat (chapati)	☐	☐	☐	☐	☐
Ragi porridge	☐	☐	☐	☐	☐
Upma (semolina)	☐	☐	☐	☐	☐

Pulses and Legumes

Food Item	Daily	4–6×/wk	1–3×/wk	1–3×/mo	Rare/Never
Toor dal	☐	☐	☐	☐	☐
Bengal gram	☐	☐	☐	☐	☐
Green gram sprouts	☐	☐	☐	☐	☐

Vegetables

Food Item	Daily	4–6×/wk	1–3×/wk	1–3×/mo	Rare/Never
Spinach (cheera)	☐	☐	☐	☐	☐
Ash gourd	☐	☐	☐	☐	☐
Drumstick	☐	☐	☐	☐	☐
Tapioca	☐	☐	☐	☐	☐
Carrot	☐	☐	☐	☐	☐

Fruits

Food Item	Daily	4–6×/wk	1–3×/wk	1–3×/mo	Rare/Never
Banana	☐	☐	☐	☐	☐
Papaya	☐	☐	☐	☐	☐
Guava	☐	☐	☐	☐	☐
Jackfruit	☐	☐	☐	☐	☐
Mango	☐	☐	☐	☐	☐

Milk and Dairy

Food Item	Daily	4–6×/wk	1–3×/wk	1–3×/mo	Rare/Never
Milk	☐	☐	☐	☐	☐
Curd	☐	☐	☐	☐	☐
Paneer	☐	☐	☐	☐	☐
Butter	☐	☐	☐	☐	☐
Ghee	☐	☐	☐	☐	☐

Meat and Eggs

Food Item	Daily	4–6×/wk	1–3×/wk	1–3×/mo	Rare/Never
Chicken	☐	☐	☐	☐	☐

Fish (fresh)	☐	☐	☐	☐	☐
Fish (dry)	☐	☐	☐	☐	☐
Mutton	☐	☐	☐	☐	☐
Egg	☐	☐	☐	☐	☐

Fats and Oils

Food Item	Daily	4–6×/wk	1–3×/wk	1–3×/mo	Rare/Never
Coconut oil	☐	☐	☐	☐	☐
Sunflower oil	☐	☐	☐	☐	☐
Groundnut oil	☐	☐	☐	☐	☐
Butter	☐	☐	☐	☐	☐
Vanaspati	☐	☐	☐	☐	☐

Snacks and Sweets

Food Item	Daily	4–6×/wk	1–3×/wk	1–3×/mo	Rare/Never
Mixture	☐	☐	☐	☐	☐
Banana chips	☐	☐	☐	☐	☐
Puffs	☐	☐	☐	☐	☐
Cakes	☐	☐	☐	☐	☐
Laddu	☐	☐	☐	☐	☐

Beverages

Food Item	Daily	4–6×/wk	1–3×/wk	1–3×/mo	Rare/Never
Tea	☐	☐	☐	☐	☐
Coffee	☐	☐	☐	☐	☐
Soft drinks	☐	☐	☐	☐	☐
Packaged juice	☐	☐	☐	☐	☐
Tender coconut	☐	☐	☐	☐	☐

Others

Food Item	Daily	4–6×/wk	1–3×/wk	1–3×/mo	Rare/Never
Pickles	☐	☐	☐	☐	☐
Chutney	☐	☐	☐	☐	☐
Alcohol	☐	☐	☐	☐	☐
Salted snacks	☐	☐	☐	☐	☐
Instant noodles	☐	☐	☐	☐	☐

ICMR-NATIONAL INSTITUTE OF NUTRITION, Hyderabad
Diet & Bio Maker Survey in INDIA (DABS-1)
24 hour Recall Diet Survey-Household & Individual Dietary Intake

1	Schedule Number	8-10	Census Enu. Block / Village
2-3	State	11-12	Sl. No. of Household
4-5	Name of the city _	13-18	Date of survey
6-7	Name of the ward _	19-20	Duration of Stay(yrs)* in same city
Name of Head of the Household		21-22	Total Family Size
Contact number Landline _		Mobile No	
email:		Recall – 1 ☐ 2 ☐ 3 ☐	

Name of the individual																			
Sl.no. (*as per HH Schedule*)																			
Age (*years & months*)																			
Sex (*Male:1 Female:2*)																			
Physiological status Code*																			
Activity status Code#																			
Two Major Meals (1. Yes 2. No)																			
1. Home Diet 2. Outside Food 3. Home & Outside Food																			
Consumption Units(Refer list)																			
Meal pattern	Food group (Refer list)	Recipe Code	Recipe Name (Local)	Recipe Name (Common name)	Ingredients	Ingredient Code	Raw amount (g/ml/no.)	Total cooked quantity (g/ml/no.)	*Individual Intake(ml/g/No.)*										*Left over*

Name of the individual																			
Sl.No. (*as per **HH Schedule***)																			
Meal pattern	Food group (Refer list)	Recipe Code	Recipe Name (Local)	Recipe Name (Common name)	Ingredients	Ingredient Code	Raw amount (g/ ml/	Total cooked quantity (g/ml/ no.)	***Individual Intake(ml/g/No.)***										***Left over***

Name of the individual																			
Sl.No. (*as per **HH Schedule***)																			
Meal pattern	Food group (Refer list)	Recipe Code	Recipe Name (Local)	Recipe Name (Common name)	Ingredients	Ingredient Code	Raw amount (g/ ml/ no.)	Total cooked quantity (g/ml/ no.)	***Individual Intake(ml/g/No.)***										***Left over***

Name of the individual																			
Sl.No. (*as per HH Schedule*)																			
Meal pattern	Food group (Refer list)	Recipe Code	Recipe Name (Local)	Recipe Name (Common name)	Ingredients	Ingredient Code	Raw amount (g/ ml/	Total cooked quantity (g/ml/ no.)	*Individual Intake(ml/g/No.)*										*Left over*
Outside Foods																			
Snacks/Biscuits/Chips/Chocolates																			
Beverages-NON-Alcoholic (type and Quantity (ml)																			
Beverages-Alcoholic (type and Quantity (ml)																			
Participation in supplementary nutrition programme (ICDS, MDM , Other Food schemes/programmes)																			
Cup Volumes: C1: 1400 C2: 1035 C3: 750 C4: 520 C5: 350 C6: 235 C7: 200 C8: 140 C9: 105 C10: 82 C11: 65 C12: 30																			

Name of the Investigator: ..... Signature: .....

Instructions:

1. As per the enumeration and HH the serial no. & other details of HH and the individual details have to be copied from the respective HH list to the diet tab schedule. The number of individuals entered in the household schedule will be auto populated/selected from drop down list.
2. Each and every individual details have to be crossed checked by the nutritionist doing the diet in the HH.
3. Write the sl no of individual who cooks and serves the food to the family members at HH
4. Write the date and day of the diet recall of
5. Write whether it is first, second or third recall.
6. Type the Local recipe name and Common name. The codes will be set apriori for all standardized/average recipes. For a non-standardized recipe, the codes can be generated post facto or it should be a dynamic process in consultation with the supervisor.
7. Meal time wise recipes should be noted carefully by conversing with the respondent.
8. The recipe at each meal time whether consumed at Home or Away from home has to be recorded.
9. The name of the food ingredients has to be selected by the investigator using drop down list/typing the key word. Foods will be listed Food group wise. A quick access list including the most common foods to speed up data collection followed by "other foods" that will include the rest of the foods in a given food group
10. A radio button to Add/Remove an ingredient will to be provided.
11. After listing every ingredient for the given recipe, the raw weights can be weighed using the kitchen weighing scale wherever possible and recorded for the foods available in the household or the weight recorded as reported by the respondent.
12. In the next screen the meal time Recipe name will be displayed whether the option of total cooked quantity have to be assessed
13. Next assess whether the same recipe has been consumed at other meal times during the previous day and record
14. Assess the individual distribution of consumption along with left over in terms of g/nos/ml (cup volume) using potable water as proxy.

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