



Impact of Nutrition Education on Awareness of Gut Health and Functional Dietary Components Among Adolescent Girls in Mumbai

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ABSTRACT

Nutrition plays a vital role in growth, development, and long-term health, particularly during adolescence, a critical phase marked by rapid physical and psychological changes. Despite increased exposure to health information, adolescents often lack structured and scientifically accurate nutrition knowledge, especially those from non-science academic backgrounds. In recent years, growing scientific evidence has highlighted the importance of gut health, gut microbiota, probiotics, prebiotics, and dietary fiber in maintaining digestive and overall well-being. However, awareness regarding these emerging concepts remains limited among younger populations. The present study aimed to assess awareness regarding gut health, probiotics, prebiotics, and dietary Fiber among junior college-going adolescent girls and to evaluate the impact of a nutrition education intervention on awareness levels. A quantitative pre-test and post-test interventional study was conducted among 100 junior college-going adolescent girls (16–18 years) in Mumbai. A self-developed, expert-validated questionnaire was used to assess awareness before and after three structured nutrition education sessions. Paired t-test analysis revealed statistically significant improvement in post-test scores across all domains ($p < 0.001$). The findings indicate that structured, age-appropriate nutrition education can effectively enhance gut health awareness among adolescent girls and may contribute to improved nutrition literacy in this population.

Keywords: Probiotics, Prebiotics, Dietary fiber, Gut microbiome

INTRODUCTION

Nutrition plays a fundamental role in human health and acts as a major determinant of growth, development, metabolic regulation, and disease risk. Beyond macronutrient and micronutrient adequacy, diet influences complex biological systems including immune regulation, metabolism, and homeostasis. In recent years, the gastrointestinal system has been recognized not only for digestion and nutrient absorption but also as a metabolically active ecosystem due to advances in microbiome research. The human gut hosts a diverse community of microorganisms collectively known as the gut microbiota, which contribute to digestion, vitamin synthesis, immune modulation, and protection against pathogenic organisms (Hill et al., 2014; Raghuwanshi et al., 2015). Microbial fermentation of dietary components produces short-chain fatty acids that support intestinal barrier integrity and reduce inflammation (Fu et al., 2022). Disturbances in this microbial balance, termed dysbiosis, have been associated with gastrointestinal, metabolic, and inflammatory disorders.

Diet is a key modulator of gut microbiota composition. Dietary fiber, prebiotics, and probiotics play essential roles in maintaining microbial diversity and function. Fiber serves as a fermentable substrate, while prebiotics selectively stimulate beneficial bacteria (Markowiak & Śliżewska, 2017). Examples of prebiotics include inulin, fructooligosachharides (FOS) and galactooligosaccharide (GOS) (Raghuwanshi et al., 2015). Probiotics, defined as live microorganisms that confer health benefits when consumed in adequate amounts also helps support gut microbial balance (Hill et al., 2014). Common genera include *Lactobacillus* and *Bifidobacterium*, are known for their role in maintenance of intestinal microbial balance and in supporting the immune function. Commonly consumed probiotic foods are yogurt, curd and other fermented foods (Bermudez-Brito et al., 2012). Despite

growing scientific evidence, awareness of these gut health–related nutritional concepts remain limited, particularly among adolescents.

Adolescence is a critical developmental stage characterized by rapid growth and evolving dietary habits (Pushpa et al., 2024). Urbanization and dietary transitions in India have led to increased consumption of processed foods and reduced Fiber intake among young populations. Although fermented and fiber-rich foods are traditionally part of Indian diets, knowledge regarding their functional benefits is often lacking. This gap between traditional dietary practices and scientific understanding highlights the need for targeted educational strategies to improve awareness among adolescents.

Nutrition education interventions in college settings offer an opportunity to enhance awareness during this formative stage. The intervention was conceptually guided by the Knowledge–Attitude–Practice (KAP) framework, which proposes that increasing knowledge serves as a foundation for shaping attitudes and eventually influencing health-related practices. Although the present study assessed awareness as the primary outcome, improving knowledge is considered a critical first step toward long-term behavioural change in adolescents. Therefore, the present study aimed to evaluate the impact of nutrition education intervention on awareness of gut health–related nutritional concepts among adolescent girls.

MATERIALS AND METHODS

Study Design and Objectives: A quantitative pre-test and post-test interventional study was conducted among junior college-going adolescents to assess awareness regarding gut health, probiotics, prebiotics, and dietary Fiber.

The objectives of the study were:

1. To assess baseline awareness regarding gut health and functional dietary components (probiotics, prebiotics and dietary fiber) among adolescent girls.
2. To evaluate the impact of a nutrition education intervention on awareness levels among adolescent girls.

Ethical Approval: The study was approved by the Institutional Ethical Committee of Dr. BMN College of Home Science on 24 April 2025. The study was registered with the Clinical Trials Registry of India on 10 September 2025 (CTRI/2025/09/094508).

Study Setting and Participants: The study was conducted among junior college-going adolescents aged 16–18 years in Mumbai. A total of 100 participants who were willing to participate in the study were recruited using purposive sampling. Consent letter from the institution was obtained as well as informed consent was acquired from the parents of all the participants prior to data collection.

Study Variables: The independent variable was Nutrition Education Intervention, while the dependent variable was awareness of gut health and functional dietary components.

Data Collection Tools and Procedure: Data collection was done in offline mode using self-developed, expert-validated, MCQ- based questionnaire. The questionnaire consisted of 29 multiple-choice questions distributed across four domains: digestive system (5 items), gut microbiome (9 items), probiotics and prebiotics (7 items), and dietary fiber (8 items). Each correct response was scored as 1 and incorrect responses as 0. Reliability testing was conducted using Cronbach’s alpha to assess internal consistency, yielding an overall Cronbach’s alpha of 0.728, indicating acceptable internal consistency for a newly developed questionnaire. The same questionnaire was used for both pre-test and post-test to assess adolescent’s awareness. The Nutrition Education Intervention was developed based on an extensive literature review of gut health-related concepts. It was delivered using a PowerPoint Presentation which focused on overview of the digestive system, gut microbiome, definitions and role of functional dietary components in maintaining gut health. Three education interventional sessions were carried out each of 45 minutes, once per week. Following completion of the post-test, a concise handout summarizing the key concepts discussed during the session was distributed among the participants to reinforce learning. The Nutrition Education content including the teaching aid tool, handout and structured questionnaire

was reviewed and validated by M.S.-qualified General and Laparoscopic Surgeon with expertise in gastrointestinal health. Necessary modifications were incorporated based on feedback. The approval was obtained prior to implementation of the intervention.

Statistical Analysis: Data coding was done and analysed using SPSS software. Descriptive statistics including frequency, percentage, mean, and standard deviation were calculated. Paired sample t-test was conducted to compare the pre-test and post-test scores of the participants. Statistical significance was set at $p < 0.05$.

RESULTS

The effectiveness of the intervention was analysed by comparing results of pre-test and post-test of all four domains. Following subtopics cover both pre- and post-test results combined in a table.

Awareness regarding Digestive system

This section assessed participant’s baseline knowledge regarding digestive system including site of digestion, place of nutrients absorption, role of stomach acid.

Table 1. Pre- and Post-test Scores for Digestive System

Questions	Mean Pre-test \pm SD	Mean Post-test \pm SD	t-value	p-value	Cohen’s d (95% CI)
Where does the digestion begin?	2.12 \pm 1.42	4.03 \pm 0.96	-14.157	<0.001	1.416 (1.136–1.692)
Where does the absorption of nutrients take place?					
What is the function of the large intestine?					
Acid secreted in the stomach is mainly to:					
What do you understand by chyme?					

The results shown in Table 1 the mean pre-test score for the digestive system domain was 2.12 ± 1.42 , indicating limited baseline understanding of fundamental concepts related to digestion, nutrient absorption, and gastrointestinal functions. Following the structured nutrition education intervention, the mean post-test score increased to 4.03 ± 0.96 . The paired t-test analysis revealed a highly significant improvement in scores ($t = -14.157$, $p < 0.001$). The effect size was large (Cohen’s $d = 1.416$), indicating substantial practical significance. The 95% confidence interval for the mean difference was 1.136 to 1.692.

Awareness regarding Gut Microbiome

This section assessed participant’s understanding of gut, gut microbiome, gut-brain axis, diversity of microbes, examples of bacteria.

Table 2. Pre- and Post-test Scores for Gut Microbiome

Questions	Mean Pre-test \pm SD	Mean Post-test \pm SD	t-value	p-value	Cohen’s d (95% CI)
What, in your opinion, is the gut?	3.95 \pm 1.98	7.01 \pm 1.37	-14.554	<0.001	



What is gut microbiota (microbes)?					
Which is the correct statement from the following?					
What is an essential role of the gut microbiota?					
The connection between the gut and the brain is known as-					
Anxiety or stress during exams often cause?					1.455 (1.172–1.735)
Which of the following hormone is produced in the gut is linked with mood?					
Which vitamin is produced by the gut?					
Gut bacteria strengthen which system?					

Table 2 showed the mean pre-test score for the gut microbiome domain was 3.95 ± 1.98 , reflecting low baseline awareness among participants regarding concepts such as gut microbiota, its functions, the gut–brain axis, microbial diversity, and related physiological roles. Following the structured nutrition education intervention, the mean post-test score increased to 7.01 ± 1.37 . Paired t-test analysis demonstrated a highly significant improvement in scores ($t = -14.554$, $p < 0.001$). The effect size was large (Cohen’s $d = 1.455$), indicating substantial practical significance. The 95% confidence interval for the mean difference ranged from 1.172 to 1.735.

Awareness regarding Probiotics and Prebiotics

This section focused on evaluating the knowledge regarding probiotics, prebiotics, synbiotics, their examples, role in terms of gut health. The objective of this domain was to determine the extent to which adolescent girls were familiar with these functional dietary components and their contribution to gut microbial balance and overall digestive wellbeing.

Table 3. Pre- and Post-test Scores for Probiotics and Prebiotics

Questions	Mean Pre-test \pm SD	Mean Post-test \pm SD	t-value	p-value	Cohen’s d (95% CI)
What do you understand by probiotics?	2.47 ± 1.69	5.24 ± 1.04	-15.042	<0.001	1.504 (1.216–1.789)
Example of probiotic-					
What are prebiotics?					
Example of prebiotic-					



Prebiotics are type of?					
Which of the following bacteria is generally beneficial for the gut?					
Combination of probiotics and prebiotics is known as-					

Table 3 depicted the mean pre-test score for the probiotics and prebiotics domain was 2.47 ± 1.69 , indicating limited baseline awareness among participants. Following the nutrition education intervention, the mean post-test score increased to 5.24 ± 1.04 . The paired t-test analysis revealed a highly significant improvement ($t = -15.042, p < 0.001$). The effect size was large (Cohen’s $d = 1.504$), indicating substantial practical significance. The 95% confidence interval for the mean difference ranged from 1.216 to 1.789.

Awareness regarding Dietary Fiber

This section assessed participant’s baseline knowledge regarding dietary fiber, including its primary food sources, classification into soluble and insoluble types, physiological functions within the gastrointestinal tract, and its role in maintaining overall gut health.

Table 4. Pre- and Post-test Scores for Dietary Fiber

Questions	Mean Pre-test \pm SD	Mean Post-test \pm SD	t-value	p-value	Cohen’s d (95% CI)
Dietary Fiber is mainly found in-	3.26 \pm 1.48	5.44 \pm 1.32	-13.698	<0.001	1.370 (1.095–1.641)
What is the role of fiber in the gut?					
Fiber helps gut in-					
Whole grains are rich source of-					
Example of soluble fiber-					
Which of the following type of fiber is effective in reducing cholesterol level?					
Constipation is associated with-					
Diarrhea is often caused due to-					

The result depicted in Table 4 the mean pre-test score for the dietary fiber domain was 3.26 ± 1.48 , indicating moderate baseline awareness regarding fiber sources, types, and their role in gut function. Following the nutrition education intervention, the mean post-test score increased to 5.44 ± 1.32 . The paired t-test analysis demonstrated a highly significant improvement in scores ($t = -13.698, p < 0.001$). The effect size was large (Cohen’s $d =$



1.370), indicating substantial practical significance. The 95% confidence interval for the mean difference ranged from 1.095 to 1.641.

DISCUSSION

The present study demonstrated statistically significant improvement in awareness across all assessed domains, including digestive system concepts, gut microbiome, probiotics and prebiotics, and dietary fiber, following the nutrition education intervention. The low baseline scores observed in the pre-test across these domains reflect limited prior exposure to structured gut health-related education among adolescent girls, particularly in non-science academic streams. This pattern is consistent with findings from Raut et al. (2024), who reported inadequate baseline nutrition knowledge among school-going adolescents prior to intervention, with significant improvement following structured educational programs.

Similarly, Wang et al. (2015) demonstrated that school-based nutrition education significantly improved adolescent's knowledge and attitudes toward nutrition. Their findings confirm that classroom-based interventions can effectively improve understanding of nutrition topics. O'Brien et al. (2021), in an umbrella review, concluded that structured school-based interventions consistently enhance nutrition knowledge across various domains. Salam et al. (2016) further emphasized that targeted educational interventions during adolescence are effective in improving nutrition-related awareness and behaviours. The significant increase in post-test scores across all domains in the present study aligns with this evidence, reinforcing the effectiveness of structured, topic-focused education.

The improvement observed in the gut microbiome domain is particularly relevant given emerging research highlighting its importance in adolescent health. Brown et al. (2025) reported associations between gut microbiome characteristics and mental health symptoms among Danish adolescents, underscoring the relevance of gut-related knowledge in this age group. Increasing awareness in this domain may therefore support broader health understanding.

In the dietary fiber domain, the observed improvement aligns with Reynolds et al. (2020), who emphasized the importance of adequate fiber intake during childhood and adolescence for long-term health outcomes. Furthermore, Shireen and Savanur (2021) reported limited awareness regarding probiotics and prebiotics within Indian populations, supporting the need for targeted education on these functional food components.

Pushpa et al. (2024) highlighted that culturally tailored nutrition education interventions are effective in improving health-related awareness among Asian adolescents. The structured intervention in the present study was designed to be age-appropriate and culturally relevant, which may explain the significant improvement observed across domains.

Overall, the findings of the present study are consistent with existing literature demonstrating that nutrition education interventions significantly improve adolescent awareness. The improvement across digestive system, gut microbiome, probiotics, prebiotics, and dietary fiber domains suggests that focused educational strategies can effectively enhance gut health-related nutritional literacy among adolescent girls.

CONCLUSION

The present study evaluated the impact of nutrition education intervention on awareness related to the digestive system, gut health, gut microbiota, probiotics, prebiotics, dietary fiber among junior college-going adolescent girls in Mumbai. Baseline findings revealed low to moderate knowledge levels across most domains, particularly regarding gut microbiota, the gut-brain axis, and functional roles of probiotics, prebiotics, and dietary fiber, indicating a clear awareness gap among adolescents from non-science backgrounds.

Following the intervention, statistically significant improvement was observed across all domains ($p < 0.001$), demonstrating enhanced understanding of digestive processes, microbial functions, functional foods, and lifestyle influences on gut health. These findings suggest that structured, simplified, and contextually relevant nutrition education can effectively communicate even complex biological concepts to adolescents. The results



highlight the need to integrate targeted gut health education into adolescent health programs, as strengthening foundational knowledge during this formative stage may support informed dietary decisions and long-term wellbeing.

LIMITATIONS

This study has several limitations. First, it used a single-group pre-test and post-test design without a control group. Also, the use of the same questionnaire for both pre-test and post-test may have introduced testing effects, where participants performed better due to familiarity with the questionnaire. Additionally, maturation effects and increased awareness due to classroom discussions outside the intervention (history effect) cannot be ruled out. Second, the study included only female adolescents from one junior college and from a commerce (non-science) background, which means the findings may not apply to male students or students from other academic streams. Third, the study measured only knowledge and awareness, and did not assess changes in attitudes, dietary habits, or actual behaviour. Lastly, the intervention was conducted over a short period, and long-term retention of knowledge was not evaluated through follow-up testing.

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