Int J Nutr Sci 2025;10(1):22-29

International Journal of Nutrition Sciences

Journal Home Page: ijns.sums.ac.ir

ORIGINAL ARTICLE

# Improvement of Snack Choices among Children by Traffic-Light Food Labeling Education Employing Jigsaw Method

**Mahsa Momeni[1], Maryamsadat Riasatian[1], Zahra Karimian[2], Shiva Faghih[1,3*]**

1. Department of Community Nutrition, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
2. Department of e-Learning in Medical Sciences, Virtual School and Center of Excellence in e-Learning, Shiraz University of Medical Sciences, Shiraz, Iran
3. Nutrition Research Center, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran

ARTICLE INFO

*Keywords:*
Traffic light food label
Education
Children
Snack
Food choice

**Corresponding author:*
Shiva Faghih, PhD;
Department of Community Nutrition, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences,
Shiraz, Iran.
**Tel:** +98-71-37251001
**Email:** shivafaghih@gmail.com
**Received:** June 17, 2024
**Revised:** September 11, 2024
**Accepted:** September 19, 2024

ABSTRACT

**Background:** Use of traffic light food labels has the potential to be an effective nutritional education tool in the community. We aimed to assess the impact of a school-based traffic light food label education program on students' snack choices in Shiraz, Iran.

**Methods:** This school-based randomized controlled educational study was conducted on 80 children aged 10-12 years old, selected via multi-stage cluster sampling in primary schools. Over a period of three months, the intervention group received four sessions of healthy food label and traffic light label education. Before and after the interventions, all participants answered the nutrition and traffic light food label knowledge questionnaire. To evaluate food choices, participants were asked to choose between two types of cakes and fruit juices with different food labels before and after the education.

**Results:** It was shown that knowledge of traffic light food labels increased in the intervention group ($p<0.001$). A significant increase in nutritional knowledge was found in both the intervention ($p=0.026$) and control ($p=0.023$) groups, but the difference between the two groups was not significant. After interventions, participants in the intervention group made healthier choices for cakes and fruit juices ($p=0.004$, $p=0.024$, respectively).

**Conclusion:** Our study indicates that traffic light food labels education can be an effective tool to increase children's knowledge about healthy food choices and leads to make better snack choices too. These findings support the use of traffic light food labels as a useful tool in nutrition education programs.

Please cite this article as: Momeni M, Riasatian M, Karimian Z, Faghih S. Improvement of Snack Choices among Children by Traffic-Light Food Labeling Education Employing Jigsaw Method. Int J Nutr Sci. 2025;10(1):22-29. doi: 10.30476/ijns.2025.100348.1278.

## Introduction

Traffic light food label-as a nutrition education tool is one of the cost-effective policies, which contains information that leads to healthier food choices and better eating habits in consumers (1-3). Food color labels can be one of the most important priorities for the prevention of non-communicable diseases, especially in Iran (4). The World Health Organization (WHO) considers colored food labels to be an important part of its global strategy on food,

physical activity, and health (5). Several studies have shown that increasing nutritional knowledge could increase the use of traffic light food labels and choosing healthy food items, including low-fat and low-sugar ones; hence, traffic light food label education can play an important role in choosing healthy foods (1, 4, 6, 7).

Despite the advances in the general health of Iranian children in recent decades, the quality of eating habits among them have decreased, and the consumption of high-fat foods with low nutritional value increased (8, 9). Results of a study showed that the prevalence of metabolic syndrome in two big cities of Iran, Yazd and Isfahan, was equal to 32.1% and 35.8%, respectively (10). Eating habits have been shown to develop in childhood and continue into adulthood. Numerous factors, such as nutritional knowledge, affect eating habits (11, 12). Findings of nutrition education trials have shown that educational interventions can improve children's nutrition knowledge and eating behaviors (13, 14).

In the systematic review studies that have been conducted on the methods of teaching eating habits to children, almost most of the methods have been effective (15). Some evidences have also investigated collaborative learning in changing behavior in children. Researches have shown that the use of collaborative and peer learning methods in teaching healthy eating habits to children have been effective (16, 17). Jigsaw teaching is one of these collaborartive methods (18) that puts the learners in a situation to take responsibility for their own participation and that of their peers (19). This participatory method puts learners on an active learning path to learn extensively and deeply at the same time (20). School-based intervention programs are considered an important strategy for the prevention of nutrition-related diseases. School environment is a good place with a high potential to influence the behaviors of young children (21). So far, no study has examined the effect of food label education on children's nutrition knowledge and food choices in Iran. Therefore, this study was conducted to investigate the effect of food label education on snack choices in primary school students in Shiraz.

## Materials and Methods

This school-based randomized controlled trial was performed on 80 children aged 10-12 years who were selected by multi-stage cluster sampling from primary schools in Shiraz, Iran. The basis for the selection of the clusters was the urban areas of Shiraz. First 1 area was selected randomly; and then using random sampling, 4 schools (2 girls and 2 boys school) were selected and placed in the control group, and 4 schools in the intervention group. After that, from each school, 10 students were randomly enrolled in the fourth, fifth, and sixth grades. All schools were selected from the public sector. This study was conducted from December 2018 to March 2019, and a written informed consent was obtained from each participant after explaining the purpose of the study. If the students did not want to continue cooperation, did not participate in one-third of the sessions or answered 20% of the questions, they were excluded from the study. The local Ethics Committee of Shiraz University of Medical Sciences approved the study protocol (reference number: IR.SUMS.REC.1397.604 and research project number: 1396-01-84-16664). Based on a similar study (10) ($\alpha$=0.05, $\beta$=0.1, $\delta$1=2.23, $\delta$2=2.01, p1=0.55, p2=0.7), taking into account the minimum study power of 80%, and considering the dropout rate of 20%, 40 students were enrolled in each group.

Students' weight and height were measured at baseline and at the end of the study. A digital scale (SECA Germany) was used to measure students' weight to the nearest 100 g in light clothing. Height was calculated as barefoot to the nearest 0.1 cm using a tape fixed at the wall. Body mass index (BMI) was determined as weight (kg)/height(). Demographic characteristics were assessed by a questionnaire, which included gender, age, parents' education and' occupation, household income, and family's health history. Children's nutritional knowledge and knowledge on traffic light food labels were evaluated using a 25-question questionnaire (14 questions on nutrition knowledge and 11 questions on traffic light food labels). Ten experts (including eight nutritionists and two health education specialists) reviewed the questionnaire to confirm its content validity. Then, the content validity ratio (CVR) (relevance, necessity, simplicity, and clarity of the items) and content validity index (CVI) were assessed. Waltz and Bausell's (15) method was utilized to evaluate the questions' clarity, relevance, and simplicity, and CVR was computed based on Lawshe (12). After that, fifteen primary-school-age children participated in a pilot study to evaluate the questionnaire's reliability.

Figure 1 shows the study diagram. The Jigsaw method used in this study was conducted in two stages. In the first round (knowledge deepening), students were divided into groups of 4 to 6, and each student was given a short topic with different titles (awareness of healthy and unhealthy food groups in terms of sugar, salt, and fat, introduction to food color labels and how to read them, comparison of food color labels of different brands, healthy food choices, and diseases associated with unhealthy nutrition).

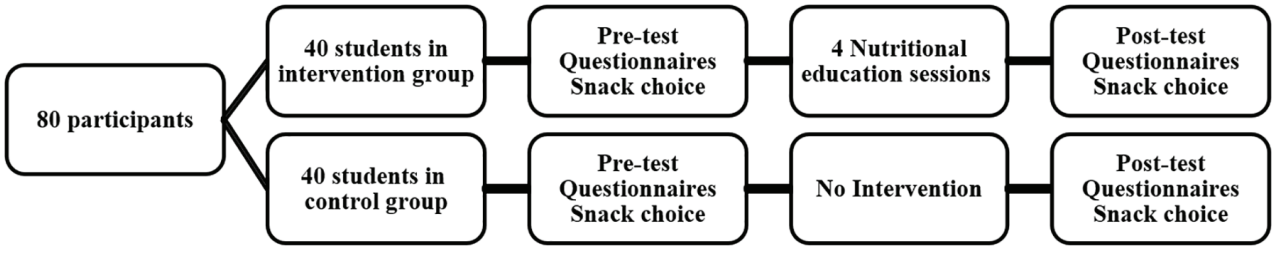


**Figure 1:** Flow diagram of the study.

In each group, students studied their topics well and were given the opportunity to take responsibility for their own and their peers' learning and teach their topic to other classmates. At the end of this round, multiple-choice tests were conducted to create competition between groups, and the scores of the groups were announced, and the students of each group were encouraged with prizes.

In the second round, the groups were combined so that in each group, there was at least one representative from the previous group (previous topics). In this stage, students discussed the topics together and taught each other what they had learned in the previous stage. In fact, in this stage, each member of the group had a part of the information that was necessary to complete the group work and had to share it with others (expanding and disseminating knowledge) (Figure 2). During the intervention, the training was conducted by a nutritionist in one-hour sessions with one-week intervals. Educational pamphlets were provided for the students. Targeted nutritional catering was employed in line with the educational goals for the students before and after training. During the catering hour, different food items with color labels were delivered to the students. The food items included several models of cakes and fruit juices with different food labels. Students were asked to choose a cake and a fruit juice. By examining the students' food choices, changes in their food selection behavior were observed.

All statistical analyses were done using the Statistical Package for the Social Sciences (SPSS) (IBM SPSS Statistics for Windows, version 21.0; IBM Corp., Chicago, IL, USA). Kolmogorov-Smirnov test was used to evaluate the normal distribution of variables. Descriptive results were reported as frequency and percentage. Chi-square and t-tests were utilized to compare general and demographic variables between two groups. The McNemar test was applied to determine the proportion of healthy and unhealthy food choices. Mann-Whitney test and Wilcoxon test were employed to assess changes in nutritional knowledge, traffic light food label knowledge, and general knowledge before and after the interventions between and within groups, respectively. Mann-Whitney test was used to evaluate changes in students' choices (cake fruit juice) before and after the study. A $p<0.05$ was considered statistically significant.

## Results

Eighty participants (40 in the intervention and 40 in the control group) completed the study. Totally, 50% of the participants were male. In total, 27.5% of the students were underweight, and 7.5% were overweight or obese. Age, gender, parents' education, parents' occupation, and household income information were presented in Table 1.

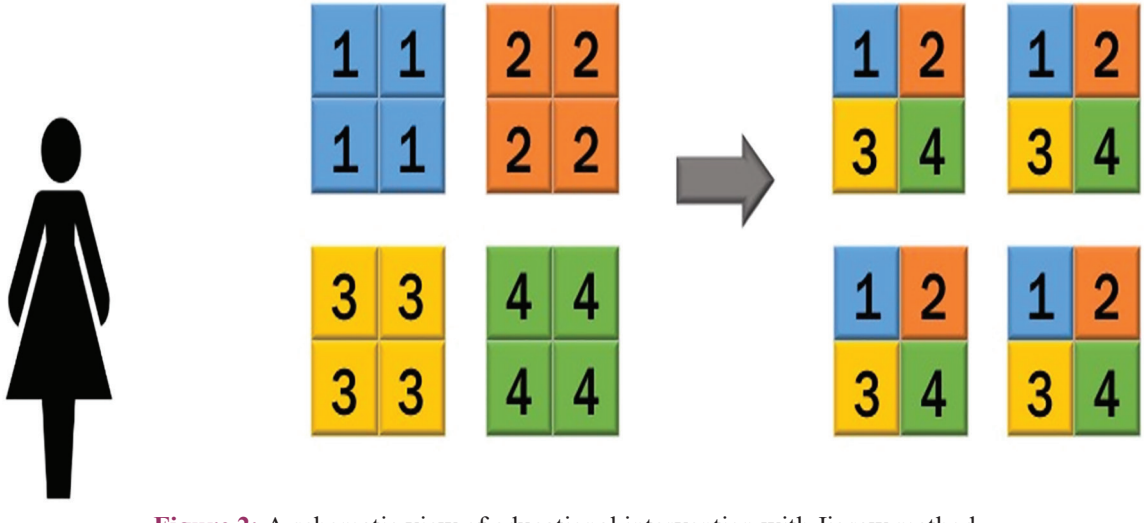


**Figure 2:** A schematic view of educational intervention with Jigsaw method.

**Table 1:** Participants' demographic and anthropometric characteristics.

| Participants characteristics | Frequency N (%) |
|---|---|
| Age (year) | Mean=11.07±0.83 |
| Gender | |
| Male | 40 (50) |
| Female | 40 (50) |
| Mother's level of education | |
| Illiteracy and elementary education | 4 (5) |
| Middle school, High school and Diploma | 39 (48.8) |
| College education | 37 (46.3) |
| Father's level of education | |
| Illiteracy and elementary education | 1 (1.3) |
| Middle school, High school and Diploma | 31 (38.8) |
| College education | 48 (60) |
| Mother's job | |
| Housewife | 61 (76.3) |
| Employee | 10 (12.5) |
| Manual worker | 1 (1.3) |
| Freelance job | 8 (10) |
| Father's job | |
| Unemployed | 2 (2.5) |
| Employee | 26 (32.5) |
| Manual worker | 3 (3.8) |
| Freelance job | 49 (61.3) |
| Monthly family income (1 US$=70,000 Tomans) | |
| 1-3 million Tomans | 35 (43.8) |
| 3-5 million Tomans | 13 (16.3) |
| More than 5 million Tomans | 32 (40) |

**Table 2:** Comparison of traffic light food label knowledge, nutritional knowledge, and general knowledge of students in two intervention and control groups and within the group before and after the intervention.

| Variable | Intervention (n=39) | Control (n=40) | *P* value[a] |
|---|---|---|---|
| Traffic light food label knowledge | | | |
| Before | 12.51±3.98 | 13.12±3.65 | 0.454 |
| After | 14.30±3.48 | 13.25±3.69 | 0.761 |
| Mean difference | 1.71±2.43 | 1.25±2.65 | 0.656 |
| *P* value[b] | <0.001 | 0.262 | |
| Nutritional knowledge | | | |
| Before | 9.17±2.04 | 9.025±2.32 | 0.404 |
| After | 9.77±2.13 | 9.77±2.13 | 0.221 |
| Mean difference | 0.85±2.32 | 0.75±1.95 | 0.590 |
| *P* value[b] | 0.026 | 0.023 | |
| General knowledge | | | |
| Before | 15.67±4.74 | 15.90±4.28 | 0.441 |
| After | 18.00±4.56 | 17.12±4.23 | 0.662 |
| Mean difference | 2.32±3.11 | 1.22±2.65 | 0.759 |
| *P* value[b] | 0.001 | 0.008 | |

[a]Independent t test or non-parametric analysis (Mann-Withney). [b]paired t test non-parametric analysis(Wilcoxon).

There was no significant difference between the mean BMI of the intervention (20.67±2.92) and the control group (20.67±2.92) groups ($p$=0.13). Also, we found no significant difference between father's and mother's educational levels or occupation in the control and intervention groups.

According to Table 2, in comparison to baseline, nutritional traffic-light food label knowledge increased significantly in the intervention group ($p$<0.001); but, this change was not significant compared to the control group. Both intervention and control groups demonstrated significant changes

regarding nutritional knowledge scores compared to the baseline ($p$=0.026, $p$=0.023, respectively); but the difference between the two groups was not significant ($p$=059). At the end of the study, the general knowledge of both groups increased significantly, but there was no significant difference between the two groups ($p$=0.167). Children in the intervention group had significant improvement in choosing a healthy cake and fruit juice (Cake: $p$=0.002; Juice: $p$=0.024, Figure 3 and 4).

## Discussion

The present study showed that educating traffic-light food labels for 12 weeks could increase the knowledge of children about it. In agreement with our results, Hawthorne found that education could increase students' knowledge of traffic light food labels (6). The similarity in findings may indicate the selection of the appropriate age group for education; as childhood is a critical time to develop food preferences and eating habits. At the end of the study, trained children chose healthier cakes and fruit juices, which was in consistent with the results of the study by Steenhuis *et al.* showing that students' ability to read food-colored labels led to healthier food choices (22) . Also, Matvienko *et al.* found that trained children were better than controls at choosing healthy snacks (23).

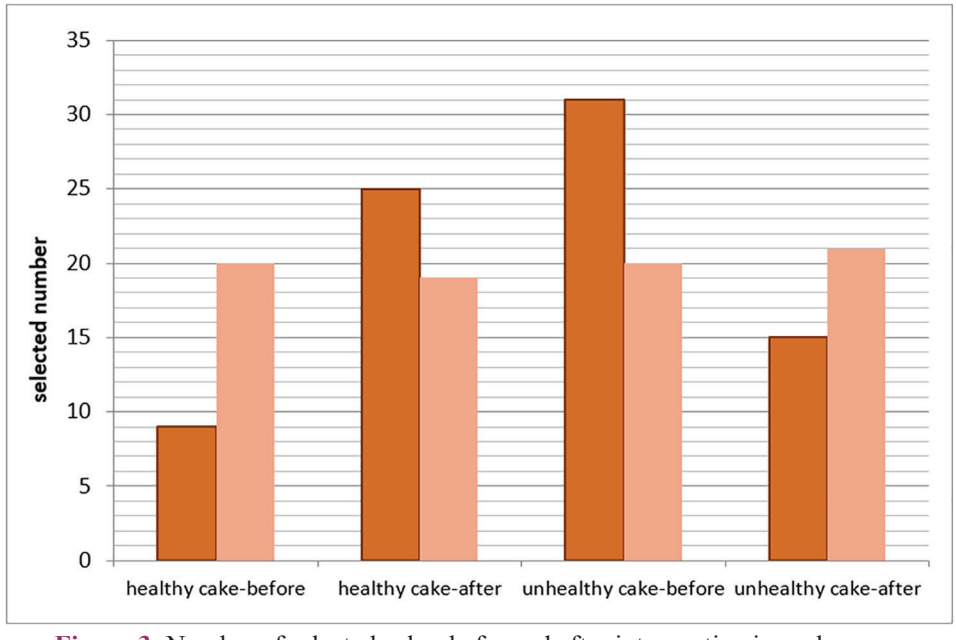


**Figure 3:** Number of selected cakes befor and after intervention in each group.

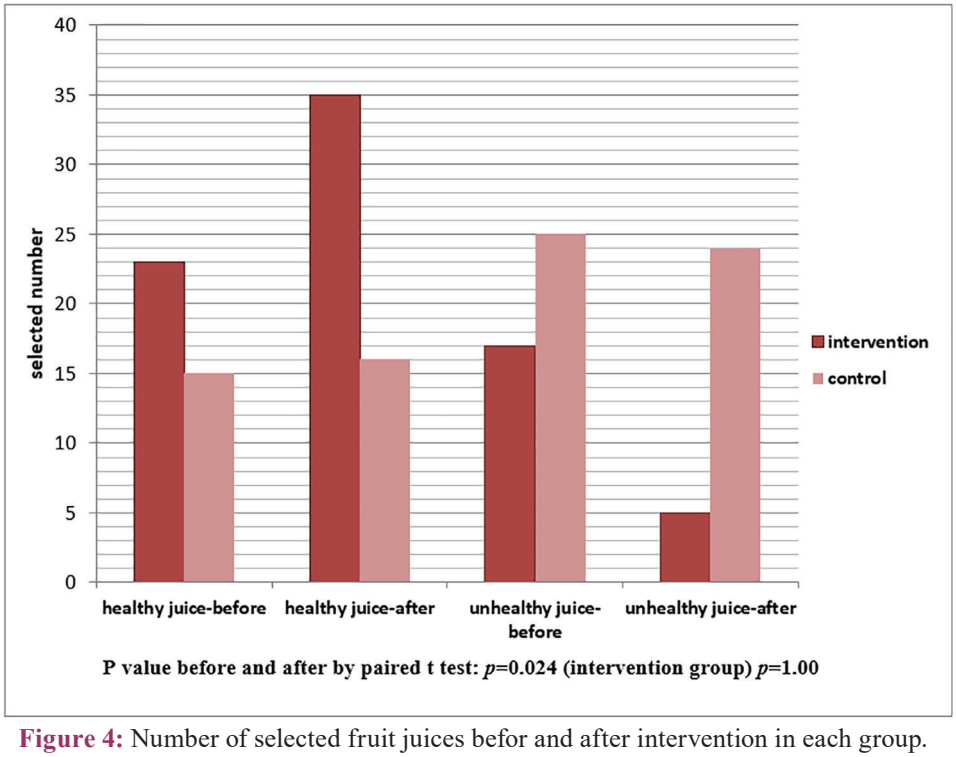


**Figure 4:** Number of selected fruit juices befor and after intervention in each group.

In an online study of adults and children, Talati *et al.* showed that food coloring labels on food packaging resulted in the non-selection of harmful foods (24).

Identically, in a study by Cown *et al.*, after attaching food coloring labels on the food packages, French children and their mothers chose healthier foods than before (25). In agreement with others, Frankel *et al.* reported that financial incentives, combined with the use of traffic-light shelf labels, reduced the purchase and consumption of sugar-sweetened beverages by customers of a local supermarket (1). Finally, according to the results of a meta-analysis in 2018, energy consumption, total fat, and other unhealthy eating behaviors decreased using food labels (26).

In the present study, students' general knowledge increased in both control and intervention groups. An increase in general knowledge in the control group can be due to the students' curiosity and efforts to find the answers of the questions they did not know, which were asked in the pre-test. In this regard, Melvin's study found that nutrition education for children has significantly increased participants' knowledge (27).

At the end of the study, students' nutritional knowledge in both intervention and control groups increased, but no difference was observed between the two groups. As mentioned before an increasein nutritional knowledge of the control group affected other educational programs at schools or had an impact on their curiosity about the answers of the questions. In accordance with our findings, a nutrition education study among 9.5 to 10.5 years old children in Shiraz could increase the nutritional knowledge in both intervention and control groups (13). Some other studies have also shown that nutrition education interventions to increase nutritional knowledge of students (28, 29).

According to Miller's study, prior nutrition knowledge has led consumers to focus on important information about food labels and facilitated comprehension of nutritional information. Previous nutrition knowledge could also support using perceived and memorized information on food selection and led to the use of food labels (2). The results of previous cognitive studies showed that prior knowledge could lead to an improved performance for complex tasks. Sir Francis Bacon stated that "knowledge is power", a phrase that is widely used to convey knowledge, meaning that transfer and education of adequate knowledge can lead to change and improve human performance (2). Due to the increase in unhealthy eating habits and consequent side effects, nutrition education can effectively reduce chronic nutrition-related diseases. Some studies have used active learning methods in health and nutrition and have successfully improved health behaviors (30, 31).

Our study, which is the first study of traffic-light food labeling education on food choices of children in Iran based on available literature searches, led to acceptable changes in children's behavior via utilization of the Jigsaw educational method. Despite the dietary restrictions and the young age of the students, children chose a healthier snack by using traffic-light food labels, which indicates the appropriateness of the educational method in this study. Since traffic-light food labeling is an essential tool for nutrition education, educational programs are needed to understand traffic-light food labeling properly, and students are the proper group for these programs. It is necessary to mention that the use of Jigsaw educational model and the appropriate age of the participants are the strengths of this research. On the other hand, the short training period (3 months) and the absence of parents in training sessions can be the weaknesses of our study.

## Conclusion

The present study showed that an increase in nutritional knowledge and educating the traffic light food labels could lead to healthier food choices. These findings could be helpful for health and nutrition policymakers, nutritionists, and others who are interested in improving the diet and health of the community. Also, there is an urgent need for new strategies to encourage students to improve their nutritional knowledge and use of traffic light food labels.

## Acknowledgement

We thank all of the students for their participation in the study. This work was extracted from the MSc thesis written by Mrs. Mahsa Momeni and was funded by Shiraz University of Medical Sciences, Shiraz, Iran (Grant number: 1396-01-84-16664).

## Funding

A fund was received for this study from Shiraz University of Medical Sciences (Grant no.: 1396-01-84-16664).

## Authors' Contribution

Mahsa Momeni designed the study and significantly contributed to data gathering, data analysis, and preparing the first version of the manuscript. Shiva Faghih designed the study, supervised data gathering data analysis, and prepared the manuscript. Zahra Karimian designed the study and

revised the manuscript. Maryam Sadat Riasatian participated in writing, reviewing, and editing the final version.

## Conflict of Interest

All of authors do not have any of conflict of interest.

## References


1 Franckle RL, Levy DE, Macias-Navarro L, et al. Traffic-light labels and financial incentives to reduce sugar-sweetened beverage purchases by low-income Latino families: a randomized controlled trial. *Public Health Nutr.* 2018;21:1426-34. DOI: 10.1017/S1368980018000319. PMID: 29493476.

2 Miller LMS, Cassady DL. The effects of nutrition knowledge on food label use. A review of the literature. *Appetite*. 2015;92:207-16. DOI: 10.1016/j.appet.2015.05.029. PMID: 26025086.

3 Nasimi N, Mohammad Hosseini M, Mohammadi Nasrabadi F, et al. Nutritional Traffic Light Knowledge and Food Choices: A Cross-Sectional Study at Purchase Point. *Int J Nutr Sci.* 2024;9:299-307. DOI: 10.30476/ijns.2024.100342.1273.

4 Seyedhamzeh S, Nedjat S, Shakibazadeh E, et al. Nutrition labels' strengths & weaknesses and strategies for improving their use in Iran: A qualitative study. *PLos One*. 2020;15:e0241395. DOI: 10.1371/journal.pone.0241395. PMID: 33126236.

5 Organization WH. Global strategy on diet, physical activity and health: a framework to monitor and evaluate implementation. 2006.

6 Hawthorne KM, Moreland K, Griffin IJ,et al. An educational program enhances food label understanding of young adolescents. *J Am Diet Assoc.*. 2006;106:913-6. DOI: 10.1016/j.jada.2006.03.004. PMID: 16720132.

7 Drichoutis AC, Lazaridis P, Nayga RM. Nutrition knowledge and consumer use of nutritional food labels. *Eur Rev Agric Econom.* 2005;32:93-118. DOI: 10.1093/erae/jbi003.

8 Kelishadi R. Childhood overweight, obesity, and the metabolic syndrome in developing countries. *Epidemiol Rev.* 2007;29:62-76. DOI: 10.1093/epirev/mxm003. PMID: 17478440.

9 Mohit M, Mousavinezhad H, Karami E, et al. The Effect of Different Types of Dietary Fatty Acids on Body Fat: A Review. *Int J Nutr Sci*. 2022;7:125-130. DOI: 10.30476/IJNS.2022.95602.1190.

10 GhariPour M, Baghei A, Boshtam M, Rabiei K. Prevalence of metabolic syndrome among the adults of central of areas of Iran (as part of" Isfahan Healthy Heart Study"). *J Birjand Uni Med Sci*. 2006;13:9-15.

11 Vereecken C, De Pauw A, Van Cauwenbergh S, et al. Development and test–retest reliability of a nutrition knowledge questionnaire for primary-school children. *Public health Nutr.* 2012;15:1630-8. DOI: 10.1017/S1368980012002959. PMID: 22691728.

12 Aghakhani L, Masoumi SJ. Effects of Glutamine, Growth Hormone and Modified Diet in Short Bowel Syndrome: A Systematic Review. *Int J Nutr Sci* 2019;4:2-8. DOI: 10.30476/IJNS.2019.81731.1011.

13 Keshani P, Mousavi SM, Mirzaei Z, et al. Effect of a school-based nutrition education program on the nutritional status of primary school children. *Nutri Food Sci Res.* 2016;3:27-34. DOI:10.18869/acadpub.nfsr.3.1.27.

14 Vulpio C, Bossola M, Di Stasio E, et al. The Effect of Dietician Education Program on Nutritional Knowledge, Dietary Intake and Phosphate Control in Patients with Renal Failure. *Int J Nutr Sci.* 2021;6:22-31. DOI: 10.30476/IJNS.2021.88200.1093.

15 Dudley DA, Cotton WG, Peralta LR. Teaching approaches and strategies that promote healthy eating in primary school children: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act.* 2015;12:1-26. DOI: 10.1186/s12966-015-0182-8. PMID: 25889098.

16 Hayball FZ, Pawlowski CS. Using participatory approaches with children to better understand their physical activity behaviour. *Health Educ J.* 2018;77:542-54. DOI: 10.1177/0017896918759567. PMID: 30166649.

17 Septiani V, Paidi P, Syamsurizal S, Darussyamsu R. Jigsaw as a community learning strategy: Improving students' social attitudes in digestive system material. *JPBI (Jurnal Pendidikan Biologi Indonesia).* 2020;6:397-404. DOI: 10.22219/jpbi.v6i3.13630.

18 Jacobs GM, Renandya WA, Jacobs GM, et al. Student centered cooperative learning: an introduction. *SpringerBriefs in Education*. 2019:1-17. DOI:10.1007/978-981-13-7213-1_1.

19 Şengül S, Katranci Y. Effects of jigsaw technique on seventh grade primary school students' attitude towards mathematics. *Procedia-Social and Behavioral Sciences*. 2014;116:339-44. DOI:10.1016/j.sbspro.2014.01.218.

20 Chang WL, Benson V. Jigsaw teaching method for collaboration on cloud platforms. *Innovat Educat Teach Int.* 2022;59:24-36. DOI: 10.1080/14703297.2020.1792332.

21 Momeni M, Akhlaghi M, Ahmadi A, et al. Undesirable Knowledge and Practice of Mothers about Under 2 Years Old Children Nutrition are

Related to Socio-Economic Factors in Shiraz, Southern Iran. *Int J Nutr Sci* 2018;3:192-197.

22 Steenhuis I, van Assema P, van Breukelen G,et al. The effectiveness of nutrition education and labeling in Dutch supermarkets. *Am J Health Promot.* 2004;18:221-4. DOI: 10.4278/0890-1171-18.3.221. PMID: 14748311.

23 Matvienko O. Impact of a nutrition education curriculum on snack choices of children ages six and seven years. *J Nutr Educ Behav.* 2007;39:281-5. DOI: 10.1016/j.jneb.2007.01.004. PMID: 17826348.

24 Talati Z, Norman R, Kelly B, et al. A randomized trial assessing the effects of health claims on choice of foods in the presence of front-of-pack labels. *Am J Clin Nutr.* 2018;108:1275-82. DOI: 10.1093/ajcn/nqy248. PMID: 30351342.

25 Poquet D, Ginon E, Goubel B, et al. Impact of a front-of-pack nutritional traffic-light label on the nutritional quality and the hedonic value of mid-afternoon snacks chosen by mother-child dyads. *Appetite*. 2019;143:104425. DOI: 10.1016/j.appet.2019.104425. PMID: 31465810.

26 Shangguan S, Afshin A, Shulkin M, et al. A meta-analysis of food labeling effects on consumer diet behaviors and industry practices. *Am J Prev Med.* 2019;56:300-14. DOI: 10.1016/j.amepre.2018.09.024. PMID: 30573335.

27 Cown MH, Grossman BM, Giraudo SQ. Nutrition education intervention to improve nutrition-related knowledge, attitudes, and behaviors for Hispanic children. *Ecol Food Nutr.* 2017;56:493-513. DOI: 10.1080/03670244.2017.1381606. PMID: 29023136.

28 Raby Powers A, Struempler BJ, Guarino A, Parmer SM. Effects of a nutrition education program on the dietary behavior and nutrition knowledge of second-grade and third-grade students. *J Sch Health*. 2005;75:129-33. DOI:10.1111/j.1746-1561.2005.00010.x. PMID: 15987006.

29 Fahlman MM, Dake JA, McCaughtry N, et al. A pilot study to examine the effects of a nutrition intervention on nutrition knowledge, behaviors, and efficacy expectations in middle school children. *J Sch Health*. 2008;78:216-22. DOI: 10.1111/j.1746-1561.2008.00289.x. PMID: 18336681.

30 Lonsdale C, Rosenkranz RR, Sanders T, et al. A cluster randomized controlled trial of strategies to increase adolescents' physical activity and motivation in physical education: results of the Motivating Active Learning in Physical Education (MALP) trial. *Prev Med.* 2013;57:696-702. DOI: 10.1016/j.ypmed.2013.09.003. PMID: 24035889.

31 Kang K-A, Kim S, Kim S-J, Oh J, Lee M. Comparison of knowledge, confidence in skill performance (CSP) and satisfaction in problem-based learning (PBL) and simulation with PBL educational modalities in caring for children with bronchiolitis. *Nurse Educ Today.* 2015;35:315-21. DOI: 10.1016/j.nedt.2014.10.006. PMID: 25456258.