

Effectiveness of an educational and motivational program on food label comprehension skills and use among first-year pharmacy students at Khon Kaen University: a randomized controlled trial

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ABSTRACT

Online education has become an increasingly important tool for promoting health behaviors, especially among adolescents who are at risk due to poor dietary choices. In Thailand, despite the presence of food labeling systems, many young consumers lack the knowledge and motivation to use them effectively. This study evaluated the effectiveness of an online educational and motivational program aimed at promoting behavioral skills in food label comprehension and food selection and the behavior of using food labels to select food products. A randomized controlled trial was conducted involving fifty first-year students aged 18-20 years old from the Faculty of Pharmaceutical Sciences, Khon Kaen University, Thailand. The participants were randomly allocated to experimental (n=25) or control (n=25) groups. The intervention comprised a 3-minute motivational video and an e-book focusing on knowledge specific to promoting food label reading behavior. Both groups initially exhibited fair levels of knowledge, high levels of motivation, fair skills, and a tendency to occasionally read food labels. After the intervention, the experimental group demonstrated significantly higher scores in knowledge (from 10 to 13 out of 16), motivation (shifted from high to very high, score 3.93 to 4.25 out of 5), and frequency of label reading (shifted from occasional to frequent, score 3.00 to 4.00 out of 5). However, no substantial change in food label comprehension or selection skills was observed, possibly due to the short intervention period. This study demonstrates the potential of online interventions in enhancing knowledge and motivation regarding nutritional label reading among university students. Future research should evaluate the effectiveness of such interventions across diverse student groups.

Keywords:

behavior change, motivational intervention, online education, nutrition label

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INTRODUCTION

Adolescents between the ages of 12 and 24¹ are often inclined to consume foods high in starch, sugar, and fat in their diet, primarily because of the widespread availability of commercial package snacks and beverages². This behavior represents one of the risk factors contributing to the increasing prevalence of chronic non-communicable diseases³. The current dietary patterns among Thai adolescents align with the growing trend in non-communicable diseases observed since 2010³, as reported by the Department of Disease Control in 2019. Instilling the habit of reading the labels on food products, especially when selecting of commercial package snacks and beverages, should be prioritized during adolescence⁴. This approach has the potential to mitigate risk factors associated with non-communicable diseases in Thailand.

In Thailand, to assist consumers in making their food choices, labels on food products must comply with the format specified by the Thai Food and Drug Administration⁵. The development of food product labels in Thailand began with the introduction of nutrition labels in 1998. It was found that consumers had difficulty reading the information on nutrition labels and therefore could not benefit from them⁶. Therefore, the Guideline Daily Amount (GDA) nutrition labels were adopted in 2011. The GDA nutrition labels only display information on energy, sugar, fat, and sodium to make them easier and more convenient for consumers to use. In a survey on GDA nutrition labels among Thai people in 2012, 51.9% were not familiar with them, 36.7% did not understand them correctly, and 47.6% could not apply the information accurately⁷. This problem led to the adoption of healthier choice symbols and nutrient content claims in 2016 to help consumers compare the nutrition of

products in the same group and make quick consumption decisions⁶. Earlier research revealed that the public's perception and understanding of health symbols and claims was limited, with minimal utilization of these elements for food selection or controlling food consumption^{8,9}. From an extensive review, intervention studies focusing on education to increase knowledge or encourage good practices of reading food labels among the Thai general population or among adolescents specifically were not found.

Educational programs are often employed to impart knowledge to specific populations with the aim of encouraging positive health behaviors^{10,11,12}. Nonetheless, to truly empower consumers, it is imperative to go beyond education and take into account additional factors that influence behavior. Health behavior theory or models are often employed to guide the development of behavior modification programs, including consumer behavior modification. A review of the health behavioral theories conducted by Munro et al.¹³ compiled various behavioral theories that were employed to study health behaviors, such as Fisher and Fisher's Information Motivation Behavioral Skills Model¹⁴, Rosenstock et al.'s Health Belief Model¹⁵, Fishbein and Ajzen's Theory of Planned Behavior¹⁶, and Schwartz's Theory of Knowledge, Attitudes, and Practices (KAP)¹⁷. Each theory concludes that changing health behavior requires a combination of internal factors, such as individual perceptions, attitudes, expectations, and experiences, as well as external factors, including social beliefs, economic conditions, and influence from peers¹³.

Since 2020, the world, including Thailand, has implemented measures in response to the spread of COVID-19. As a result, people's way of life has undergone significant changes. In Thailand,

individuals are required to adhere to the Distancing-Mask wearing-Hand hygiene-Testing for COVID-19 (D-M-H-T guidelines), which aim to prevent the transmission of the infectious disease¹⁸. These guidelines include practicing social distancing in crowded areas, wearing face masks in public, washing one's hands frequently, and testing for signs of COVID-19, such as elevated temperature. Consequently, work and learning have shifted to online platforms¹⁹. The Thai government also launched a policy to help school and university students gain access to tablets, such as providing tablets for students to borrow or purchase at a reasonable price²⁰.

The COVID-19 situation also affected health promotion activities in Thailand²¹, especially consumer education aimed at empowering individuals to make informed decisions or adopt appropriate behaviors to mitigate risks associated with food consumption. Training has shifted not only from physical classrooms to online platforms but also toward self-directed learning at individuals' convenience. Therefore, it is essential to develop a suitable self-training program.

In this research, the Information-Motivation-Behavioral Skills (IMB) model was employed as a framework to develop an intervention program. The IMB model is a social psychological framework initially developed to provide insight into the psychological factors influencing HIV risk and prevention behaviors¹⁴. The IMB model posits that information and motivation collaborate to develop one's health behavioral skills, thereby resulting in the initiation of health behavior. Additionally, the model suggests that information and motivation may directly affect health behaviors. Information refers to knowledge specific to the desired behavior. Motivation is an integration of personal attitude and perception of social support. Behavioral skills consist of both objective abilities and perceptions of self-

efficacy for performing a behavior. There is evidence to support the utility of the IMB model in forecasting, comprehending, and intervening in various health-related behaviors, including health promotion activities^{22,23,24,25}. Several studies have demonstrated the effectiveness of the IMB model in promoting positive health behaviors across diverse populations by providing information, enhancing motivation, and developing behavioral skills^{26,27,28}. Prior research on food label reading further supports the model, showing that nutritional knowledge and motivation predict food label use²⁹. However, while behavioral skills—such as the ability to read, calculate, interpret nutritional information, and use labels for product selection—are integral to the IMB framework, it remains uncertain whether they can be effectively developed through an online-only intervention.

The objective of this study was to assess the effectiveness of an online educational and motivational program in enhancing students' skills in food label comprehension and food selection, as well as their behavior in using food labels when choosing food products. Specifically, the study measured changes in knowledge, motivation, skills in interpreting nutrition labels and selecting food products, and the frequency of using food labels during food choices.

MATERIALS AND METHODS

The research protocol was approved by the Khon Kaen University Ethics Committee for Human Research HE642200.

Participants and Procedures

The population included first-year pharmacy students from Khon Kaen University, Thailand. The number of participants per group was estimated using the formula:
$$\frac{n}{\text{group}} = \frac{2\sigma^2(Z\alpha/2 + Z\beta)^2/(\mu_1 - \mu_2)^2}{\text{This}}$$

calculation was based on mean scores for food label use behavior reported in previous research³⁰, which were 16.6 ± 3.07 for the intervention group and 12.68 ± 3.25 for the control group, measured after the intervention³⁰. Using a significance level (α) of 0.05 and a statistical power of 0.90, the required sample size was calculated to be 17 participants per group. To account for an anticipated 25% dropout rate, this number was increased to 23 participants per group, resulting in a target total of 46 participants. The three inclusion criteria were as follows: (1) possessed an electronic device, such as a computer, smartphone, or tablet, with internet access; (2) fluent in reading and writing in the Thai language; and (3) willing to participate in the study and signed the consent form to participate in the study on a voluntary basis.

The student services section of the Faculty of Pharmaceutical Sciences was asked to assist in emailing the summary of the project, research protocol, and invitation to participate in the research project to all first-year pharmacy students. The email requested those who were interested in being research volunteers to respond to the researcher. A total of 50 students expressed interest within a short period during the recruitment process. Rather than exclude any volunteers, all were enrolled in the study.

A randomized controlled trial was employed in which participants were assigned into groups via simple random

sampling using Excel. A total of 25 participants were randomly assigned to the experimental group, while the remaining 25 were assigned to the control group. At the beginning of the study (Time₁), an online questionnaire was used to assess and collect data on baseline knowledge about food labels, motivation for and behavior of label reading, skill in calculating and interpreting food labels, food selection, and the behavior of using food labels for product selection. After the participants in the experimental group submitted the questionnaire, the program directed them to download the self-learning material and a motivational video. Although participants studied from home during the data collection period due to the lockdown resulting the COVID-19 pandemic, they were also asked to not share the questionnaire, the self-learning material, or the video to anyone. The participants had 5 days to study the material and watch the video. Two weeks after the completion of the self-study period (Time₂), all participants from both the experimental and control groups were reassessed for their knowledge, motivation, skills, and behavior. For ethical reasons, the following day, after completion of the experiment, the self-learning material and a motivational video were emailed to participants in the control group for self-study at their convenience. (Figure 1). All 50 participants completed the trial.

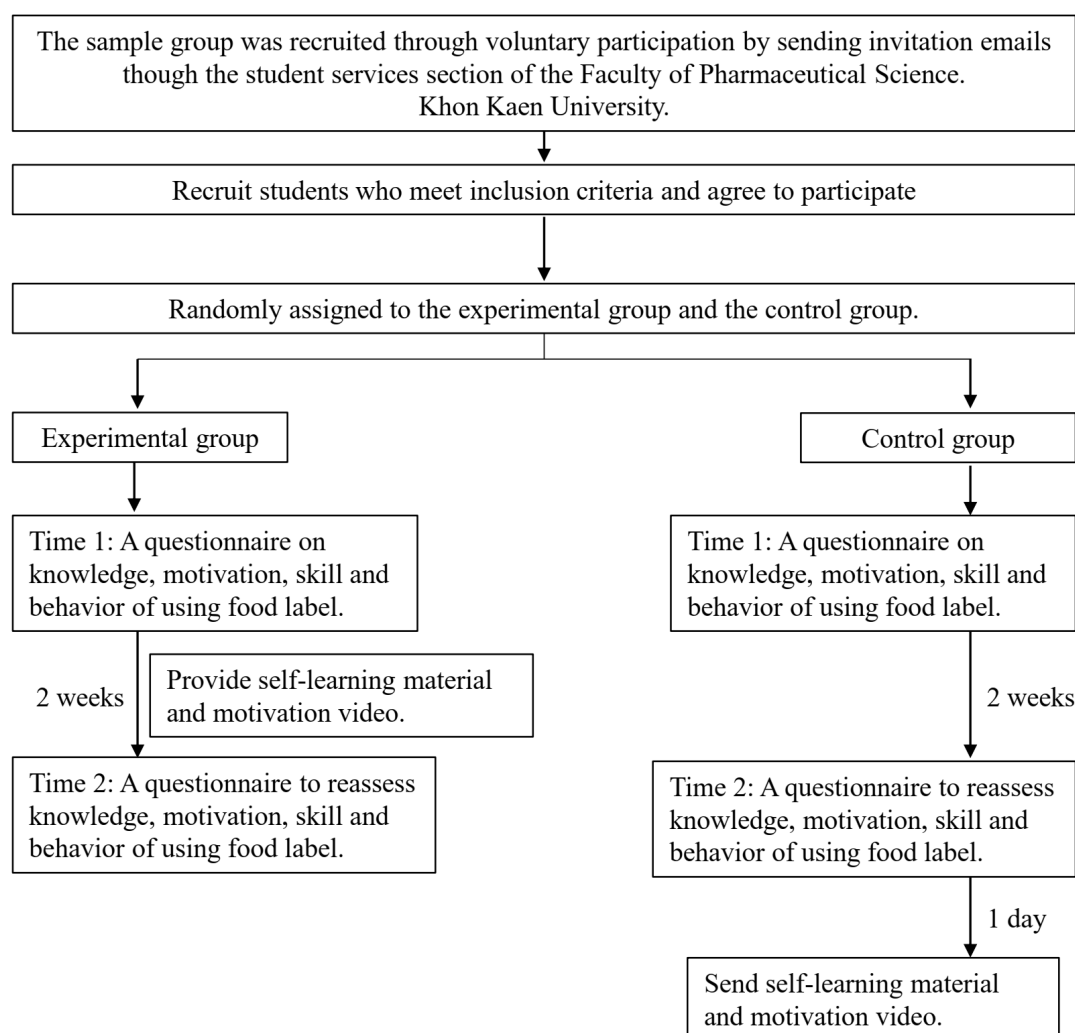


Figure 1. Flow Diagram of Participant Recruitment and Procedures

Intervention, Definition, and Assumption

An expert panel was utilized to identify the knowledge that consumers should possess to make informed decisions when selecting food products, particularly when purchasing of commercial package snacks and beverages items that they have never bought before. In this study, of commercial package snacks and beverages refer to commercially packaged foods or beverages that can be consumed immediately without the need for further preparation, cooking, or heating. Examples include potato chips, cream-filled waffles, cookies, and beverages such as bottled tea or juice boxes. This category also includes foods that require minimal preparation,

such as instant noodles. RTE products are typically shelf-stable and widely available in convenience stores and supermarkets. Their packaging often provides nutrition information, either in the full format, the GDA, or both.

The Educational and Motivational Program was developed on the basis of input from the expert panel. Materials were sourced and extracted from the Dietary Reference Intake for Thais 2020³⁴. The program consisted of two self-study components: (1) a 3-minute motivational video emphasizing the importance of reading food labels before purchasing and (2) an e-book providing knowledge on food labels related to sugar. The e-book covered

topics such as reading nutritional labels (full, abbreviated, and GDA formats), calculating nutrient content per serving, interpreting sugar-related symbols and nutrient content claims, challenges in food selection, and a table showing the sugar content in labeled products from supermarkets and convenience stores in Mueang District, Khon Kaen Province.

The face validity of both the video and the e-book was assessed by three experts in the field of health consumer protection. To assess the clarity of the language, the materials were then piloted with 20 fifth-year pharmacy students specializing in health consumer protection.

In this study, the behavior of using food labels to select food products entails examining the full nutrition label, GDA label, nutrient content claims, and healthier choice symbols, which are located on either the front or back of the packaging. This behavior precedes the purchase of instant or of commercial package snacks and beverages products that student participants have never bought before. Behavioral skills in food label comprehension and food selection include skills in calculating and

interpreting the full nutrition labels and Guideline Daily Amount (GDA) labels and skills in making food selections based on information provided on the label. The knowledge required to understand food labels includes knowledge about full nutrition labels, Guideline Daily Amount labels, nutrient content claims, and healthier choice symbols, and recommended daily consumption amounts for carbohydrates and free sugar. Motivation for reading food labels consisted of attitudes toward food label reading and perceptions of social support for food label reading.

It was hypothesized that our Educational and Motivational Program would enhance students' knowledge and motivation for food label reading, leading to improved skills in food comprehension nutrition calculation and food selection. This, in turn, initiates the behavior of using food labels to select food products. The increased knowledge and motivation from our program also positively impact behavior, as evidenced by the increasing frequency of label checking (Figure 2).

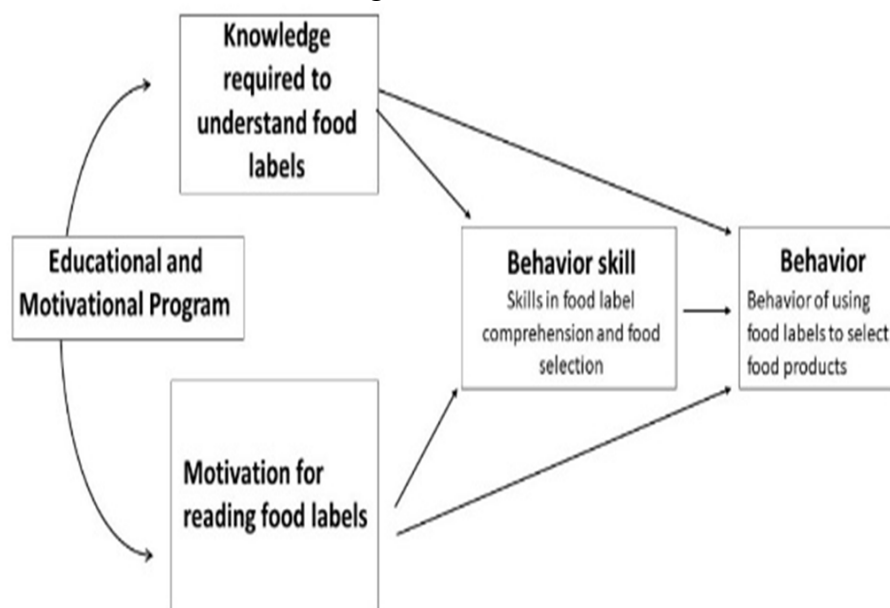


Figure 2. Hypothesized model

Research Tools

The evaluation of the program employed four tools: a knowledge test, a motivation questionnaire, a skill test, and a label-reading behavior questionnaire. The knowledge and skill test questions were self-developed based on the development and validation of the diabetic self-management scale, which is based on information-motivation-behavioral skills theory³¹. Content validity was assessed by three experts with experience in health behavior research, questionnaire design, and food labeling regulations. The Index of Item-Objective Congruency (IOC) for the items ranged from 0.67 to 1.00. Reliability testing was conducted with the same group of 20 fifth-year pharmacy students who participated in the pilot testing of the video and e-book.

A 16-item knowledge test encompassed four sections, i.e., (A) how to interpret nutrition information labels on the back of the food package, (B) how to interpret the Guideline Daily Amount (GDA) label on the front of the food package, (C) the meaning of nutrient content claims and symbols related to sugar used in products in Thailand, and (D) the recommendation of the Department of Health about the amount of daily consumption of carbohydrates and the daily amount of free sugar. The response options were “yes,” “no,” and “don’t know”. The latter option was provided to minimize information bias due to guessing the answers.

An 8-item motivation questionnaire (4 attitudinal items and 4 perceived social norm items) was developed on the basis of the definition of motivation in the IMB model. The response format was a 5-point Likert scale ranging from 5 (strongly agree) to 1 (strongly disagree). The Cronbach's alpha coefficient of the scale was 0.75.

A 16-question test measuring skill in calculating and interpreting food labels was divided into 3 sections. Examples of a nutrition information label (questions 1-7)

and a Guideline Daily Amount (GDA) label (questions 8-12) were provided. The participants were asked to calculate the number of calories and nutrition and write their answers down. The last 4 questions (questions 13-16) tested participants' ability to choose food based on all types of labels.

A 16-item test was developed to assess behavioral skills related to food label use. The test was divided into three sections. The first section (Questions 1-7) measured skills in calculating and interpreting information from a full nutrition label. A sample nutrition label was provided, and participants were asked to calculate nutritional values and caloric content. For example, one question asked, “Based on the information provided in the label, consuming 1 cup of this food provides a total of how many kilocalories?” The second section (Questions 8-12) assessed similar skills using a GDA label. The participants were asked to interpret the label and answer questions regarding nutritional value and caloric content. The third section (Questions 13-16) focused on food selection skills when provided label information. Each question presented two food product labels (either full nutrition labels, GDA labels, or health symbols), and participants were asked to choose the healthier option. An example question was “If you want to consume foods with lower sugar content, which of the following should you choose?”

Label-reading behavior was assessed with 3-item question. The items were “I read the full nutrition label before selecting food products,” “I read the simplified nutrition label before selecting food products,” and “I read the Guideline Daily Amount (GDA) nutrition label before selecting food products.” The response format was a 5-point rating scale ranging from 5 (almost always or approximately 100.0-81.0% of the time), 4 (frequently or approximately 80.0-61.0% of the time), 3

(sometimes or approximately 60.0-41.0% of the time), 2 (seldom or approximately 40.0-21.0% of the time) and 1 hardly or never, or approximately 20.0-0.0% of the time). The Cronbach's alpha coefficient of the scale was 0.80.

Data Analysis

The frequency and percentage were used to present sex, age, and number of meals involving instant food per day. The differences in the proportions of these variables between the experimental and control groups were assessed with the chi-square test. The median and quartile 1 to quartile 3 (Q_1 , Q_3) were used to present the average allowance per month. The Mann-Whitney U test was used to compare the difference in average allowance between the experimental and control groups.

To calculate the knowledge score and skill core, a score of 1 was given for the correct answer, whereas "do not know" and incorrect answers were both given a score of 0. The maximum possible score for knowledge and skill was 16. Scores of less than 10, 10-11, 12-13, 14-15, and 16 were interpreted as poor, fair, good, very good, and excellent, respectively. The motivation score was averaged and interpreted as follows: very low (score ranging from 1.00 to 1.80), low (score ranging from 1.81 to 2.60), moderate (score ranging from 2.61 to 3.40), high (score ranging from 3.41 to 4.20) and very high (score ranging from 4.21 to 5.00). The behavior score was averaged and interpreted as follows: very rarely (score ranging from 1.00 to 1.80), rarely (score ranging from 1.81 to 2.60), occasionally (score ranging from 2.61 to 3.40), frequently (score ranging from 3.41 to 4.20) and very frequently (score ranging from 4.21 to 5.00).

The median and quartile 1 to quartile 3 (Q_1 , Q_3) were used to present the average and data dispersion, as the number of participants in this study was relatively

small. Nonparametric tests were used to compare the medians. The Wilcoxon test was used to compare the baseline data (Time₁) and data at the time after the completion of the experiment (Time₂) within groups. The Mann-Whitney U test was used to compare the baseline data (Time₁) and data at the time after the completion of the experiment (Time₂) between the experimental and control groups.

The sensitivity of the instructional effect of the knowledge test, which is the degree to which the instructional method is able to produce meaningful changes in the learning outcome³², was also assessed. In this study, data from an experimental group were used to evaluate the effectiveness of the developed e-book in increasing participants' knowledge by comparing the post-test scores (after the intervention) of each question to the pre-test scores (before the intervention). A p value less than 0.05 indicated that a particular knowledge question produced a meaningful change in the knowledge required to understand food labels.

RESULTS

General information

The majority of the participants were female and aged between 18 and 20 years. The monthly allowance ranged between 2500 and 18000 Baht per month. The median allowance per month among the experimental group was 6000 Baht (Q_1 :5000, Q_3 :10000), and among the control group, it was 10000 Baht (Q_1 :6000, Q_3 :15000). The monthly allowance among the experimental group was slightly lower than that among the control group (p value=0.047). The majority of both groups reported consuming instant food once a day. There were no statistically significant differences in sex, age, or instant food

consumption between the experimental and control groups (Table 1).

Table 1. General information of the studied samples (n=50)

Variable	Experimental Group (n=25)	Control Group (n=25)	p value
	Frequency (%)	Frequency (%)	
Sex			0.123 ^a
Female	10 (40.0)	20 (80.0)	
Male	15 (60.0)	5 (20.0)	
Age (years)			0.181 ^b
18	11 (44.0)	4 (16.0)	
19	9 (32.0)	11 (44.0)	
20	6 (24.0)	10 (40.0)	
Eating instant food (meals per day)			0.676 ^a
1 meal	16 (64.0)	18 (72.0)	
2 meals	4 (16.0)	2 (8.0)	
Never	5 (20.0)	5 (20.0)	

a=Chi-square test, b=Mann-Whitney U test

Knowledge, motivation, skill and behavior in label reading

In both groups, before an intervention, their knowledge was at a fair level (score of 10, 62.5%), their motivation to read the label before purchasing the food was at a high level (score within the range of 3.41 to 4.20), their ability to calculate and interpret the label and make food selections was at a fair level (score of 11, 68.8%), and the majority of them occasionally read the label before purchasing the food (score within the range of 2.61 to 3.40). There was no statistically significant difference in the values of the baseline data between the experimental and control groups (Table 2).

In the control group, following the completion of an intervention, their knowledge scores, motivation scores, and

skill scores slightly increased but did not significantly differ from the baseline data statistically. Although the behavior score significantly increased, the frequency of label reading was still classified as "occasional" (Table 2).

In the experimental group, following the completion of an intervention, all scores, except for skill, increased significantly. The knowledge level shifted from fair to good, and the frequency of label reading shifted from occasional to frequent (Table 2).

After the intervention, the Mann-Whitney U test revealed that all scores, except for skill, in the experimental group were significantly higher than those in the control group (Table 2).

Table 2. Comparison of Median (Q1, Q3) of knowledge, motivation, skill and behavior in label reading within and between groups

Data	Experimental group (n=25)			Control group (n=25)			Between groups	
	Before	After	p value	Before	After	p value	Before p value	After p value
Knowledge scores	10.0 (8.5,11.5)	13.00 (12.0,14.0)	<0.001	10.0 (9.0,12.0)	11.0 (9.0,12.0)	0.351	0.883	<0.010
Motivation score	3.9 (3.7,4.2)	4.3 (3.9,4.4)	0.004	3.8 (3.6,3.9)	4.0 (3.7,4.2)	0.815	0.930	0.035

Data	Experimental group (n=25)			Control group (n=25)			Between groups	
	Before	After	p value	Before	After	p value	Before p value	After p value
skill score	11.0 (9.0,13.0)	12.0 (9.0,13.5)	0.834	11.0 (9.5,13.5)	12.0 (11.0,14.0)	0.680	0.597	0.417
Behavior score	3.0 (2.3,3.7)	4.0 (3.6,4.3)	<0.001	2.7 (1.8, 4.0)	3.3 (2.5,4.2)	0.003	0.284	0.020

Sensitivity of the Instructional Effect

The overall change in knowledge scores after an intervention in the experimental group (Table 2) was statistically significant, suggesting that the developed e-book was an effective tool. After the intervention, the majority of the studied participants' knowledge shifted from poor or fair to good or very good (Table 3). However, upon closer examination of each knowledge question, only three aspects of knowledge changed significantly. These were knowledge about the amount of sodium per serving on the nutrition label, the meaning of "no sugar added," and the meaning of "lower sugar" (Table 4).

The findings from this study supported the effectiveness of the

developed educational and motivational program and partially validated our proposed hypothesis. Our developed intervention effectively enhanced students' knowledge of and motivation for reading food labels. Additionally, an increase in the frequency of reading labels on food products before making purchase decisions was observed, indicating that increased knowledge and motivation contributed to the adoption of using food labels to select products. However, our hypothesis regarding the improvement of students' skills in food comprehension, nutrition calculation, and food selection as a result of enhanced knowledge and motivation for food label reading was not supported by the data.

Table 3. Numbers of participants in each knowledge score range before and after an intervention the experimental group

Knowledge score (%)	Interpretation	Numbers of participants	
		Before	After
<10 (<62.5)	Poor	9	1
10-11 (62.5-68.8)	Fair	10	2
12-13 (75.0-81.3)	Good	5	13
14-15 (87.5-93.8)	Very Good	1	9
16 (100.0)	Excellent	0	0

Table 4. Number of participants (percent) who answered the knowledge question correctly before and after the intervention in the experimental group

Objective of the Questions	Before n (%)	After n (%)	Sensitivity of Instructional Effect p value*
Nutrition information label on the package			
“Readers are able to correctly tell... written on the nutritional label”			
1 the number of calories per serving	20 (80.0)	22 (88.0)	0.414

Objective of the Questions		Before n (%)	After n (%)	Sensitivity of Instructional Effect p value*
2	the amount of protein per serving	21 (84.0)	24 (96.0)	0.083
3	the amount of carbohydrates per serving	22 (88.0)	22 (88.0)	1.000
4	the amount of sugar per serving	22 (88.0)	24 (96.0)	0.317
5	the amount of fat per serving	22 (88.0)	24 (96.0)	0.317
6	the amount of sodium per serving	17 (68.0)	25 (100.0)	0.005
GDA label on the package				
“Readers are able to correctly tell... on the GDA label”				
7	the number of calories per serving	15 (60.0)	19 (76.0)	0.102
8	tell the amount of sugar per serving	17 (68.0)	20 (80.0)	0.366
9	tell the amount of fat per serving	18 (72.0)	18 (72.0)	1.000
10	tell the amount of sodium per serving	14 (56.0)	19 (76.0)	0.059
Meaning of nutrient content claim on the label				
“Readers are able to explain...”				
11	the meaning of no sugar added	10 (40.0)	21 (84.0)	<0.001
12	the meaning of sugar free	7 (28.0)	18 (72.0)	0.002
13	the meaning of lower sugar	5 (20.0)	10 (40.0)	0.059
14	the meaning of the healthier choice symbol on the package.	18 (72.0)	22 (88.0)	0.157
Recommendation of Department of Health				
15	Readers are able to tell the amount of carbohydrates that the Department of Health recommends to consume per day	17 (68.0)	20 (80.0)	0.317
16	Readers are able to tell the maximum recommended daily sugar intake set by the Department of Health	6 (24.0)	10 (40.0)	0.102

DISCUSSION

The findings of this study align with the Information-Motivation-Behavioral Skills (IMB) model in that knowledge and motivation play crucial roles in behavior change. However, the results contradict the model in terms of behavioral skills, which suggests that behavior change should be accompanied by skill development. In this study, while participants demonstrated significant improvements in nutrition label use, there was no measurable increase in skills. This finding indicates that other factors may have contributed to behavioral change, even in the absence of actual skill development.

One possible explanation for the lack of skill improvement is the nature of

the skill being assessed. The measured skill was not just basic label reading but also involved calculating calorie and nutrient content per serving, which requires mathematical proficiency, analytical thinking, and familiarity with unit conversions. Developing such a skill typically requires continuous practice and feedback, and a two-week period may have been insufficient for participants to attain proficiency. Skill acquisition usually follows a gradual process that includes exposure, practice, and reinforcement, which may explain why no significant improvement in actual skills was observed within the study's timeframe.

Although actual skills did not improve, the observed behavioral change may be explained by an increase in "perceived skills." Actual skills refer to

measurable competencies, whereas perceived skills represent an individual's confidence in their abilities¹⁴. While participants may not have significantly improved their ability to calculate nutritional values accurately, they may have felt more confident in their ability to use nutrition labels, leading to increased engagement with food labels, despite their unchanged actual skills. This increase in perceived competence could have encouraged participants to apply what they learned, even if their calculations were not entirely accurate. Future research should consider assessing perceived skills alongside actual skills to better understand their role in driving behavior change.

While it is often perceived that achieving at least 80% correct answers on a knowledge test reflects a good level of understanding, the cutoff score for "good" knowledge can theoretically vary based on the specific educational intervention. In our study, the experimental group presented an increase in knowledge scores from 10 (62.5%) to 13 (81.3%). However, this improvement should not be considered sufficient, as the knowledge provided in this intervention was designed by an expert panel and considered essential for making informed decisions on product selection. For students to effectively make informed decisions when selecting of commercial package snacks and beverages, they need to thoroughly understand or acquire all the knowledge required to interpret food labels. In other words, students are expected to achieve a full score of 16 after the intervention.

Our findings regarding the knowledge score before the intervention revealed that, of the four areas covered, students demonstrated a better understanding of nutrition information labels on the back of food packages than the Guideline Daily Amounts (GDA)³³. The majority of the students seemed to lack a

good understanding of nutrient content claims related to sugar and were unaware of the recommended daily sugar intake recommended by the Thai Department of Health. Notably, while the amount of carbohydrates recommended by the Thai Department of Health can be found or calculated from the nutrition label on the package, the recommended daily sugar intake of less than 24 grams³⁴ cannot. This finding emphasizes the urgent need to educate students about nutrient content claim related to sugar. The sensitivity of the instructional effect of the knowledge test revealed a significant increase in students' understanding of these claims due to the intervention. These findings suggest that the knowledge package developed in this study can effectively educate students about sugar in food.

Motivation serves as a driving force behind behavior, influencing how individuals approach tasks and achieve outcomes^{35,36,37}. Several health behavior models, such as Self-Determination Theory (SDT)^{38,39}, Transtheoretical Model (TTM)^{40,41}, and the Health Action Process Approach (HAPA)^{42,43}, recognize motivation as an independent variable shaping health behavior and behavior change processes. For instance, SDT suggests that autonomous motivation sustains behaviors, whereas TTM identifies motivation as central to behavior change. Additionally, our study findings support the effective use of well-designed video clips to increase motivation, particularly in the development of self-directed interventions.

RECOMMENDATIONS

When interpreting the results of this study, caution is necessary due to certain limitations. First, it was challenging to confirm whether all participants engaged with the intervention materials sent via email, as the absence of a tracking system

limited our ability to verify whether participants in the experimental group received and reviewed the intended content. Additionally, while it was assumed that students did not acquire knowledge from other sources during the intervention period, external influences cannot be entirely ruled out as potential factors affecting knowledge scores.

Furthermore, this study was conducted among pharmacy students with a limited sample size, which may restrict the generalizability of the findings to broader populations. Differences in educational background, prior knowledge, and learning environments could influence the effectiveness of similar interventions in other groups. Future research should consider expanding the sample to include students from various disciplines and institutions to enhance the external validity of the findings. Additionally, implementing a tracking system to monitor engagement with intervention materials could provide more accurate assessments of the intervention's impact.

AUTHOR CONTRIBUTIONS

PP: Methodology, Investigation, Formal analysis, Data Curation, Writing - Original Draft, TK: Conceptualization, Methodology, Formal analysis, Data Curation, Supervision, data interpretation, and validation, Writing - Review & Editing, SC: Methodology, Formal analysis, data interpretation, and validation, Writing - Review & Editing

ETHICAL CONSIDERATION

The research protocol was approved by the Khon Kaen University Ethics Committee for Human Research (HE642200) on 12 October 2021, and conformed to the Helsinki Declaration.

CONFLICT OF INTEREST

All the authors declare that they have no conflicts of interest regarding this study.

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