

A Survey on Cognitive Ability and Application of Food Nutrition Labels of Middle School Students in Beijing, China in 2020

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Abstract In recent years, the health status of middle school students is not optimistic in Beijing, China. To understand the status quo and deficiencies of the cognition and application about food nutrition labels in middle school students in Beijing, and to explore the positive effects and weak links of food nutrition labels on healthy diet and scientific weight loss guidance for students, literature review, two-way questionnaire survey, data analysis and practical exploration methods were adopted to study the selected 405 students in terms of cognition, attitude, application and improvement suggestions of nutrition labels. The awareness rate of nutrition labels and nutrition ingredient list was only 49% and 66% respectively in the surveyed students. 94% of the students have the willing to learn about nutrition labels. 83% of students have confidence in the content of nutrition labels, but most them thought that the form and content of nutrition labels need to be optimized and improved, and emphasis should be placed on key information, meanwhile explanatory and warning information should be added. Label checking rate was 55%. Application rate was only 36%. The awareness of diet management based on nutrition labels was weak. There were statistically significant differences in nutrition knowledge, confidence of nutrition labels and health level among the surveyed students of different ages. The surveyed students were lacking of cognition and application on nutrition labels, and nutrition-related knowledge need to be popularized through multi-approach. Publicity and guidance should be strengthened, and health awareness should be raised. The application and decision of nutrition labels were affected by many factors. Attitude and attention play a relatively large role in application and benefit of nutrition labels. Nutrition labels with comprehensive use of colors, fonts, graphics and other presentation modes and prominent key information were more attractive to students. The establishment of food nutrition label one-hand APP effectively promoted the students to learn and use nutrition labels, and provided a simple and feasible solution for the realization of nutrition labels to guide the healthy diet and scientific weight loss for students.

Keywords: nutrition labels, middle school students, cognition, attitude, application, weak, guidance, improve

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1. Introduction

In recent years, the obesity rate of students is relatively high, and the number of obese students has continued to increase. In the United States, the percentage of children and adolescents affected by obesity has more than tripled since the 1970s [1]. The health status of middle school students is also not optimistic in Beijing, China. The obesity rate of middle school students in Beijing was 12.76% in 2017, and the obesity rates of boys and girls were 16.52 % and 8.81% respectively, higher than the level in 2015 (12.8% and 6.8% respectively) [2]. In 2017, the dyslipidemia rate of children and adolescents in Beijing was 20.3%, higher than the average dyslipidemia rate in the seven cities surveyed in 2014 [3]. And the

prevalence of low HDL-C blood disease, which is closely related to obesity, indicates that obesity of school-age children and adolescents in Beijing is becoming increasingly serious, and the incidence of cardiovascular and metabolic risk factors associated with obesity is becoming increasingly prominent [3]. To solve these problems, it is essential for the whole society to work together to enhance health awareness and fitness activities, and to give effective play to the guiding and supporting role of scientific management measures.

Food nutrition labels is a widely recognized and adopted tool that may help consumers to make more healthful food choices, promote dietary nutrition balance, reduce the risk of obesity, thereby correcting poor eating habits and reducing diabetes and other nutrition-related chronic diseases [4]. The Chinese government has announced the “Healthy China Action (2019-2030)”

program to promote use of nutrition labels when choosing foods [5]. A great deal of researches show that understanding and use of nutrition labeling are influenced by numerous factors, such as age, education, attention, nutrition knowledge, familiarity with food nutrition labels [6-10]. There is also a growing body of literature on the use and understanding of nutrition labels by children have shown that simplified nutrition information can be easily understood by children and can trigger changes in their food choices [11].

However, according to the information collected, middle school students in Beijing do not pay enough attention to food nutrition labels, and most of them lack scientific understanding of it. The actual application rate of food purchase and diet management guided by it is low, and its guiding role cannot be fully played [12].

In this study, we conducted a survey gathering information on the food nutrition labels from the perspective of students, to survey students' cognition and application status and focus, find out the weak links in understanding, application and guidance. And we carried out experiments based on the survey results, and propose corresponding suggestions for improvement, better give play to the role of daily health food nutrition labels management tool, and promote to develop healthy eating habits and prevent or reduce nutrition-related chronic diseases.

2. Materials and Method

2.1. Questionnaire Survey

Six districts of Beijing including Haidian, Chaoyang, Fengtai, Shijingshan, Daxing, Pinggu were selected as study areas. The methods of face to face questionnaire survey were adopted in investigation on middle school students in Beijing. The questionnaire included 28 questions in five aspects: basic information of students, cognition, attitude, application status and suggestions for

improvement of nutrition labels.

2.2. Practical Exploration

Combined with the survey results, practical exploration were carried out. From the perspective of students, different expression forms of information were used to design different display modes of food nutrition labels, and visual experiments were carried out among students to compare the influence of different display modes on students' attractiveness judgment, so as to accumulate data for the improvement of food nutrition labels.

2.3. Statistical Analysis

All calculations and statistical procedures were performed using SPSS software version 18.0 for Windows (IBM SPSS Statistics, Chicago, IL, USA). Wilcoxon rank test was used to compare the difference in nutrition knowledge, confidence of nutrition labels and health level. All statistical tests were two-tailed and the significance level was set at $P < 0.05$.

3. Results and Discussion

3.1. Basic Information

A total of 405 students from Haidian, Chaoyang, Fengtai, Shijingshan, Daxing, Pinggu districts of Beijing were surveyed, including 127 junior high school students and 278 senior high school students, consisting of 168 boys and 237 girls. Sixty students, accounting for about 15% of all surveyed students, suffered from obesity, hypertension, diabetes and other nutrition-related chronic diseases.

There were 190 students who had learned nutrition lessons or nutrition knowledge, and 215 students who had not learned. More than half of surveyed students had a relatively weak in nutrition knowledge base.

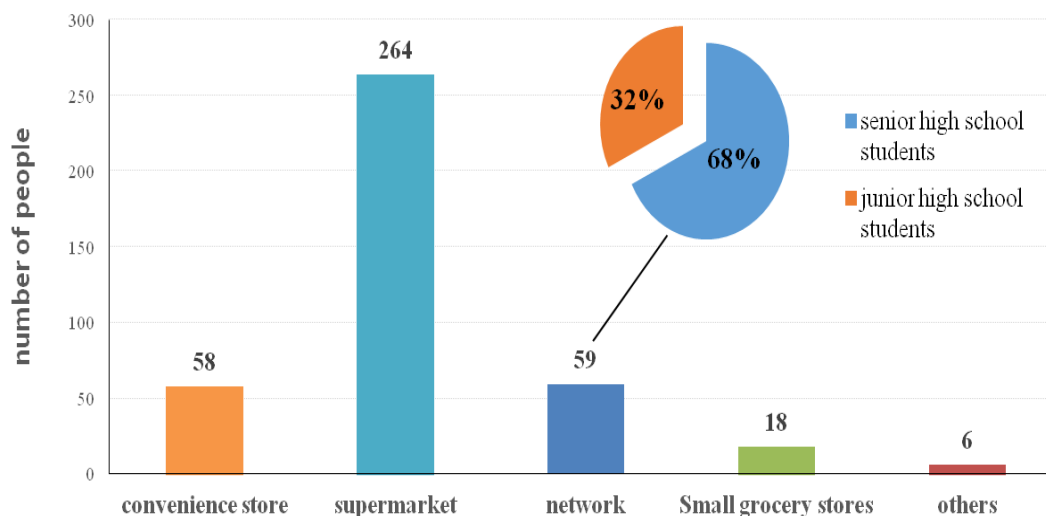


Figure 1. distribution of main ways of buying food for middle school students

As shown on Figure 1, the number of surveyed students who bought food through supermarkets was the biggest, followed by the Internet and convenience stores, and the minority bought food through small grocery stores and other channels. Senior high school students prefer to buy food online, accounting for about 68% of all surveyed students.

3.2. The Cognition Status of Surveyed Students' Nutrition Labels

Among the surveyed students, the awareness rate of nutrition labels was 49%, and only a few students were very familiar with the nutrition labels (Figure 2a). Most of them were familiar or very familiar with nutrition ingredient list, and the awareness rate of that was 66%, better than the awareness rate of nutrition labels (Figure 2b).

In the acquiring nutrition label knowledge, the highest numbers of students were from the Internet, followed by schools, families and WeChat, and the lowest were hospitals (Figure 2c). Most students acquired nutrition label knowledge through multiple ways.

In the attention of nutritional components, students paid more attention to fat, energy, protein, carbohydrate and vitamin, and most of them paid more attention to three or more nutritional components (Figure 2d).

In the food varieties concerned with nutrition labels, the number of students concerned about bread and cakes was the highest. The dairy products and beverages were second. The chocolate and cooked meat products were third, and nuts, vegetables and fruit products was the lowest (Figure 2e). It can be seen that students tended to pay attention to nutrition labels according to their personal dietary preferences rather than the needs of healthy diet.

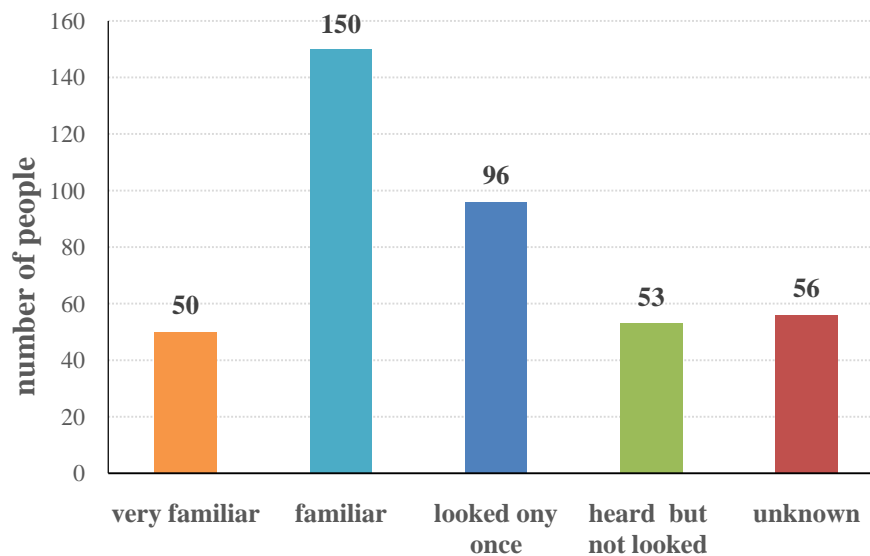


Figure 2a. awareness status of surveyed students' nutrition labels

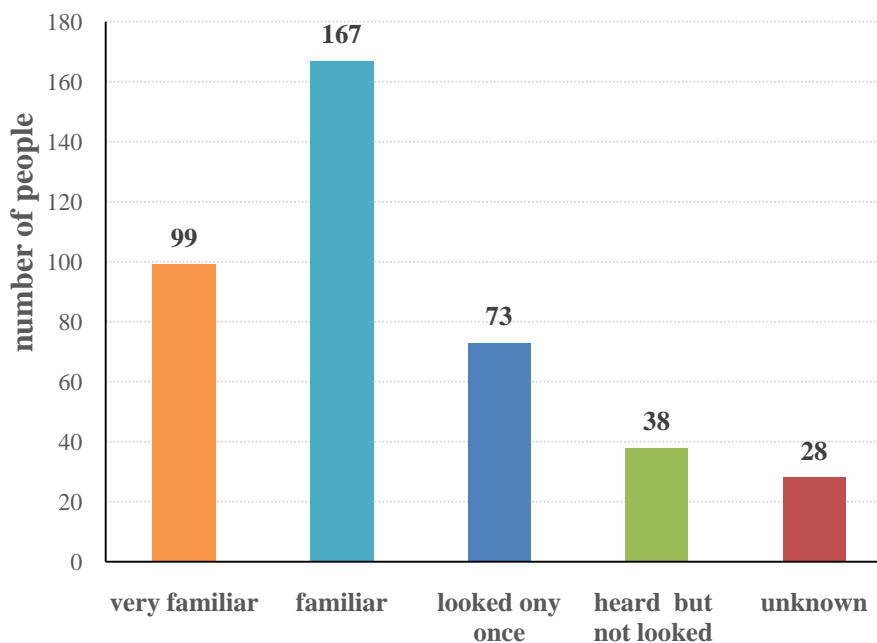


Figure 2b. awareness status of surveyed students' nutrition ingredient list

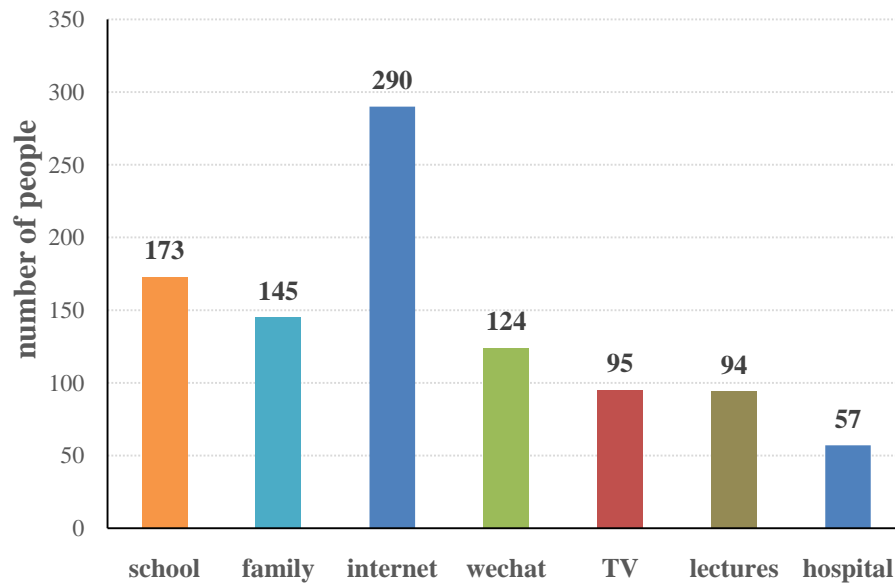


Figure 2c. access to acquire nutrition label knowledge

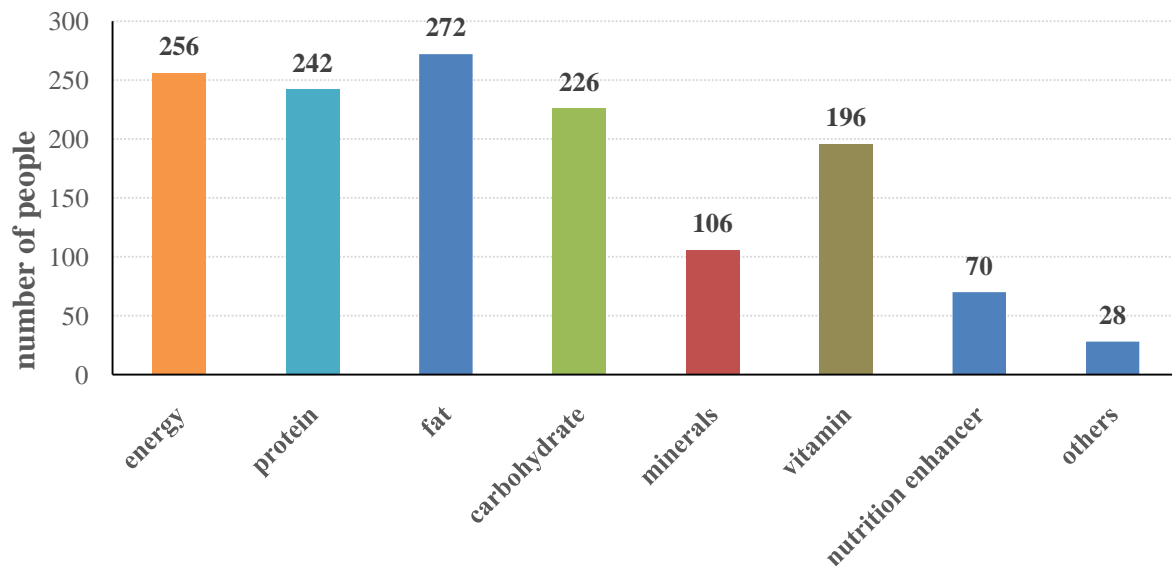


Figure 2d. attention status of surveyed students' nutritional components

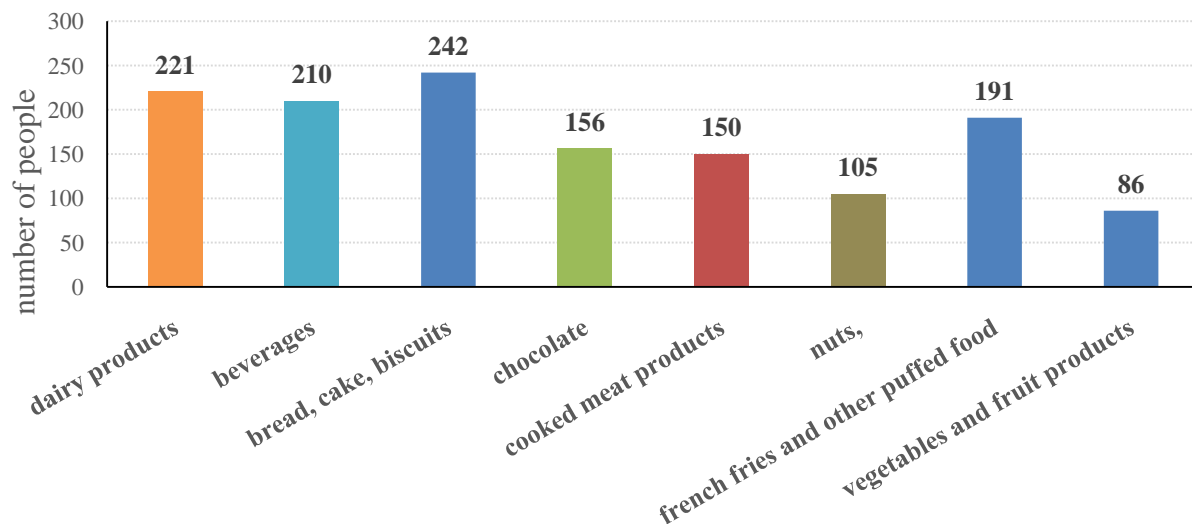


Figure 2e. food varieties concerned with nutrition labels

3.3. Attitudes of Surveyed Students' Nutrition Labels

The willingness to know nutrition label knowledge is shown on Figure 3a, 40% of surveyed students wanted to know nutrition label knowledge very much, and in general, 54% of students had the conditions to know. It could be seen that most students were willing to learn about nutrition label knowledge.

The trust of nutrition labels for pre-packaged foods is shown on Figure 3b, 83% of surveyed students trusted nutrition labels for prepackaged foods, and few students didn't trust them. Trust of nutrition labels played an important role in promoting the use of nutrition labels [13]. The survey results indicated that publicity and guidance

should be strengthened, and more students should be encouraged to learn and apply nutrition labels.

The role of nutrition labels is shown on Figure 3c, the largest numbers of students thought that nutrition labels were used to guide the purchase of food, followed by those who thought that nutrition labels were used to guide the balance of nutrition intake. Few students didn't know the role of nutrition labels or thought it had no role.

The satisfaction with the current form of nutrition labels is shown on Figure 3d, most students were basically satisfied with the current form of nutrition labels, and few students weren't satisfied. Most students thought that further upgrading is needed to make the current form of nutrition labels.

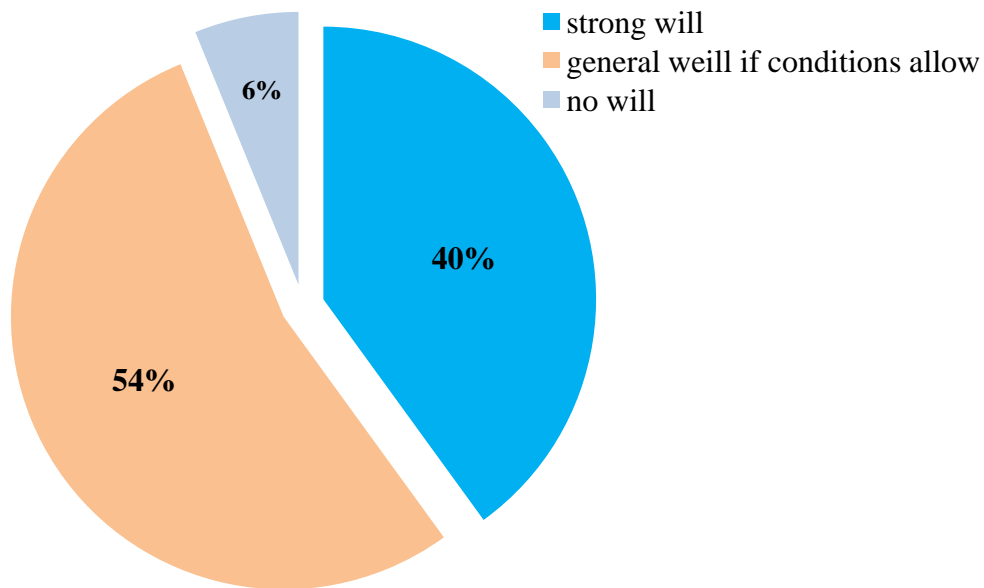


Figure 3a. the willingness to know nutrition label knowledge

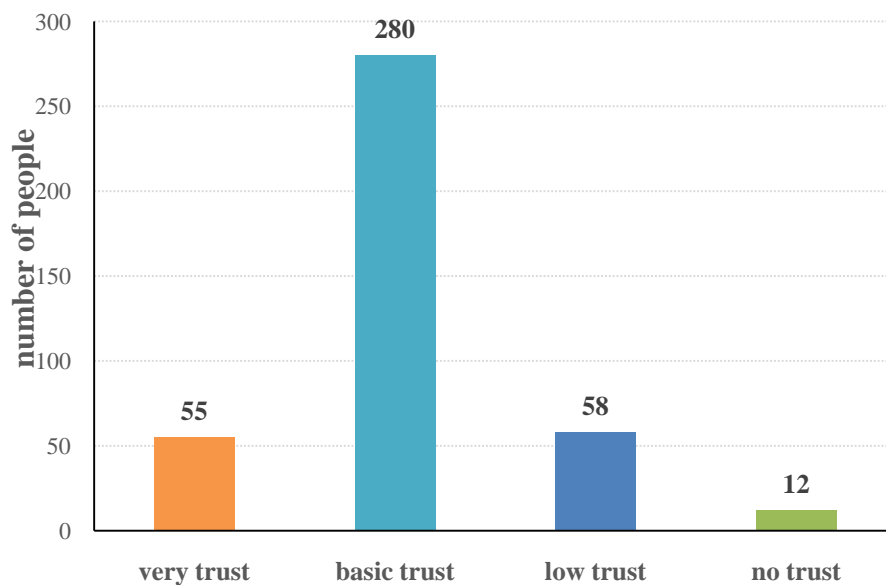


Figure 3b. the trust of nutrition labels for pre-packaged foods

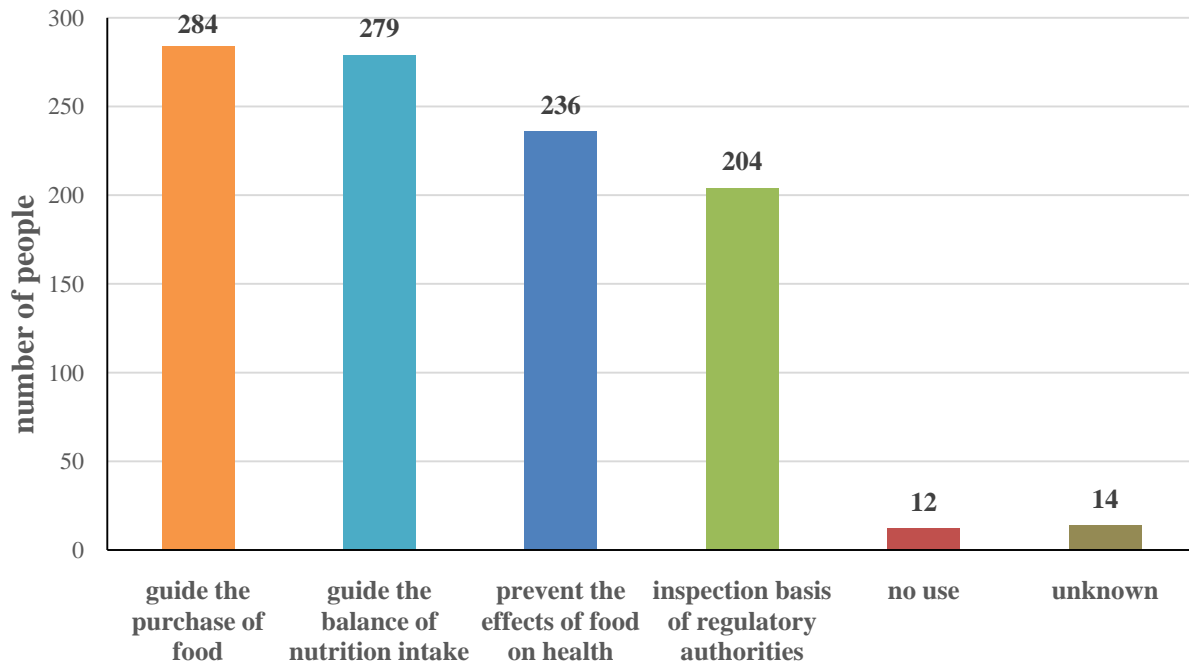


Figure 3c. the role of nutrition labels

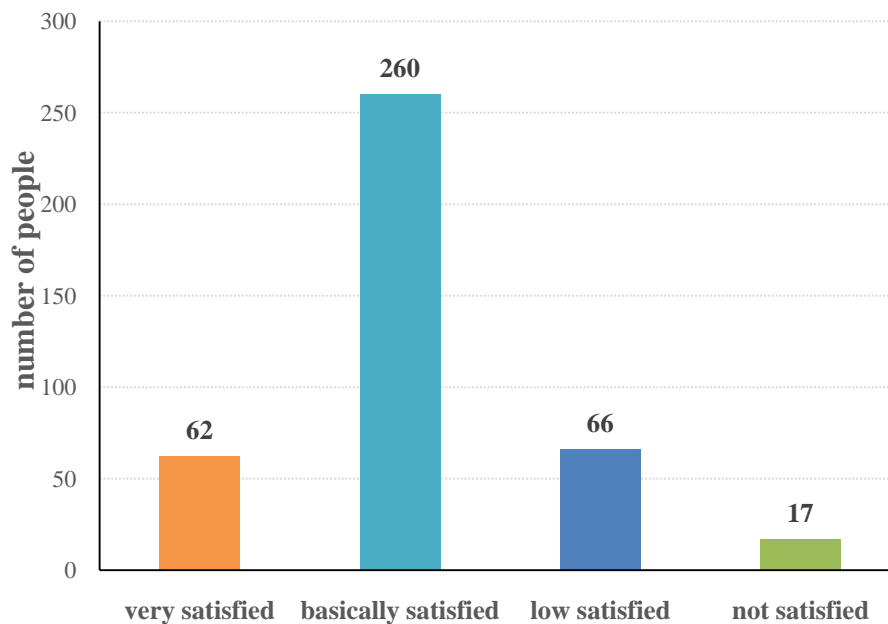


Figure 3d. satisfaction with the current form of nutrition labels

3.4. The Application of Surveyed Students' Nutrition Labels

As shown on Figure 4a, 55% of the students always or often read the nutrition labels. 37% of them read occasionally, and 8% did not.

The main factors to consider when buying food is shown on Figure 4b, the largest numbers of students were concerned about nutrition and health, followed by taste, and a few students were concerned about brand.

The main factors to consider when buying food online is shown on Figure 4c, the largest numbers of students mainly considered online comments, followed by price and brand, and the least was web celebrity food. This indicated that the role of nutrition labels information in

guiding the choice of healthy food hadn't been taken seriously.

Figure 4d describes the main purpose of checking nutrition labels, most students wanted to obtain information of nutrition ingredients, and few students just wanted to look around.

The impact of checking nutrition labels on the purchasing plan is shown on Figure 4e. 56% of students thought it might influence the purchasing plan. 36% of them bought food according to the comparison of nutrition labels, while 8% thought the purchasing plan wouldn't be affected.

Figure 4f shows the reasons for not checking nutrition labels when buying food. Most students thought it as the reasons for not checking nutrition labels when buying food. Some students didn't think it is necessary to read

and felt that the writing was too small and could not be seen easily. A few students thought the labels were boring, uninterested, unable to understand or distrustful.

Figure 4g and 4h show the willingness to manage their own and family diet according to nutrition labels. 43% of students would manage their own diet according to

nutrition labels and 33% of them help their parents to manage their family diet. Students who were interested but couldn't use managing their own and family diet account for 44% and 42% respectively. The proportion of the students who didn't manage their own and family diet was 13% and 25% respectively.

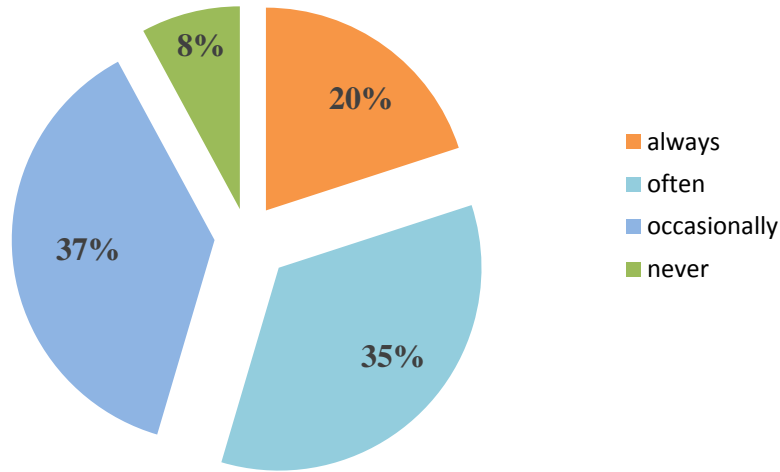


Figure 4a. the checking of surveyed students' nutrition labels

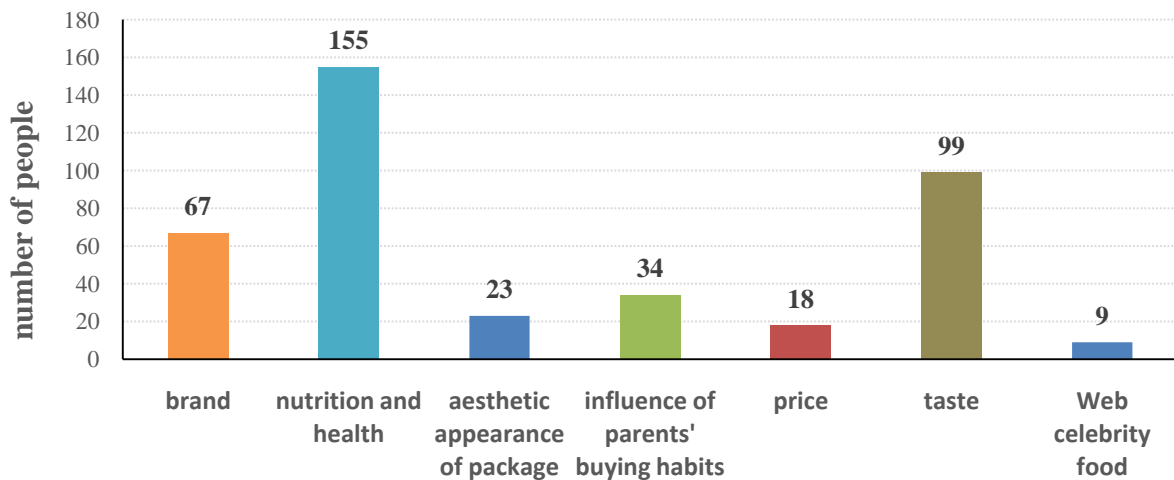


Figure 4b. the main factors to consider when buying food

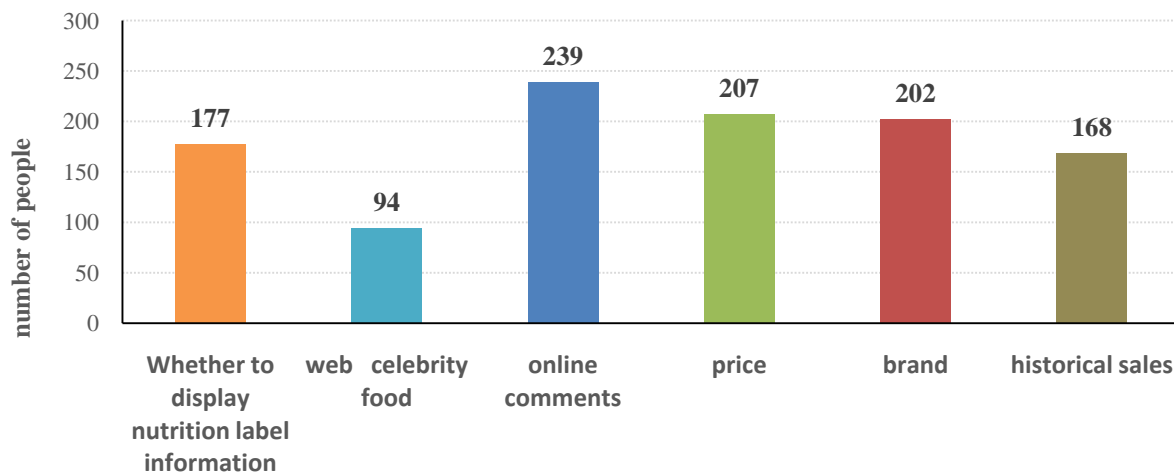


Figure 4c. the main factors to consider when buying food online

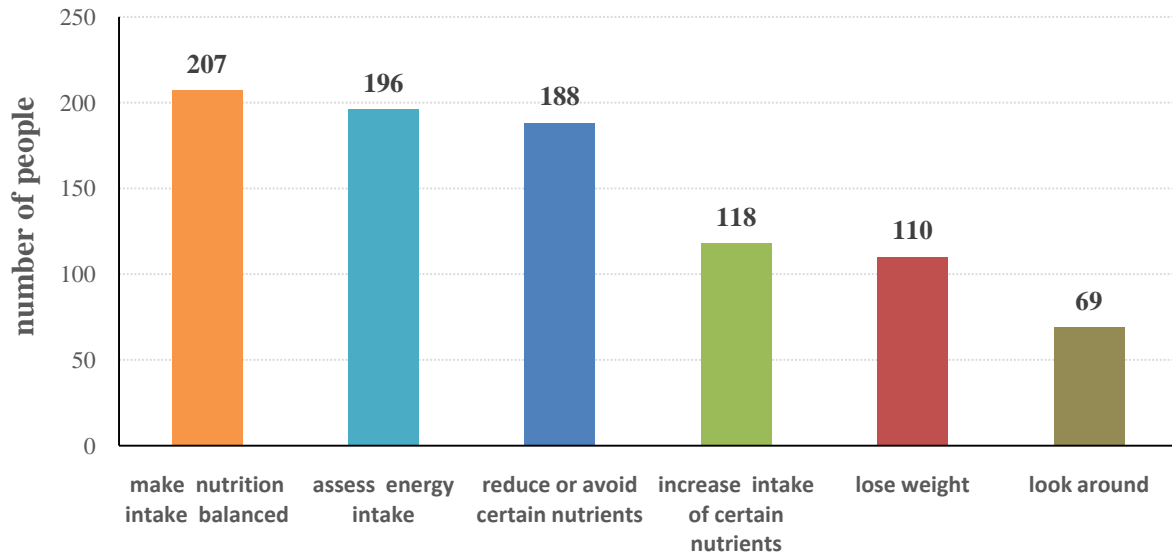


Figure 4d. the main purpose of checking nutrition labels

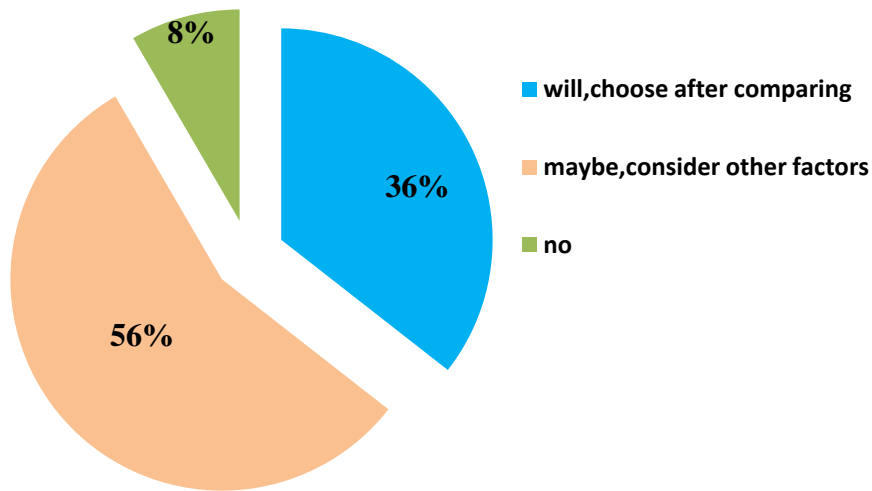


Figure 4e. the impact of after checking nutrition labels on the purchasing plan

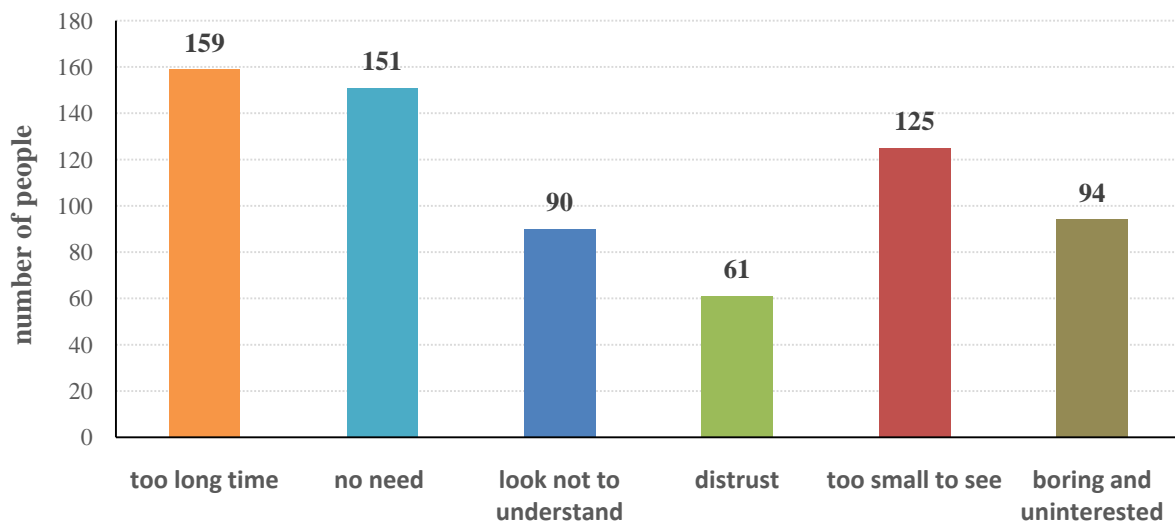


Figure 4f. the reasons for not checking nutrition labels when buying food

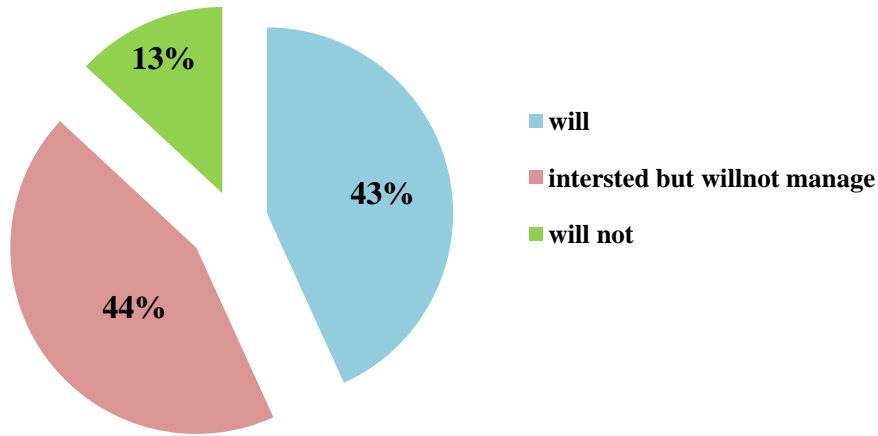


Figure 4g. the willingness to manage their own diet according to nutrition labels

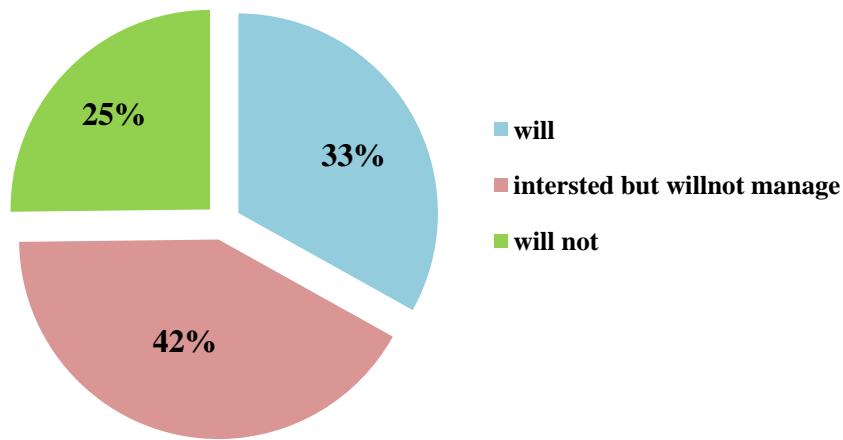


Figure 4h. the willingness to manage family diet according to nutrition labels

3.5. Suggestions on Improving Nutrition Labels of Surveyed Students

Figure 5a shows the form of food nutrition labels, the largest numbers of students concerned about whether important information should be enhanced for labeling. The font, size and icon form is second. The color is third, and the smallest pay attention to other forms.

As shown on Figure 5b, in the aspect of improvement suggestion of food nutrition labels form, the largest numbers of students suggested a larger font size of important information, followed by suggesting more prominent location such as front and different colors to distinguish high, middle and low content. A few students suggested to convert words into simple ICONS.

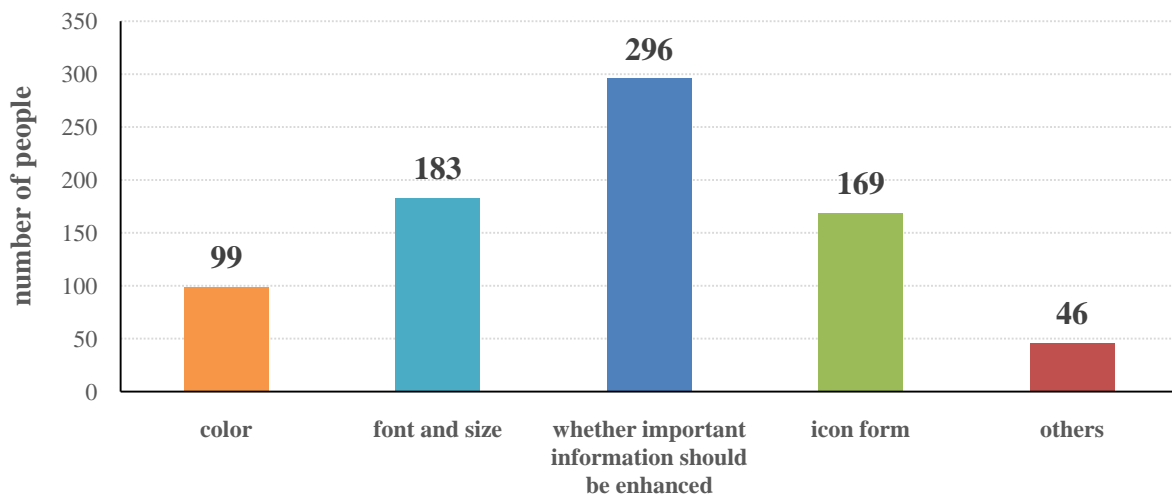


Figure 5a. the attention to the form of food nutrition labels

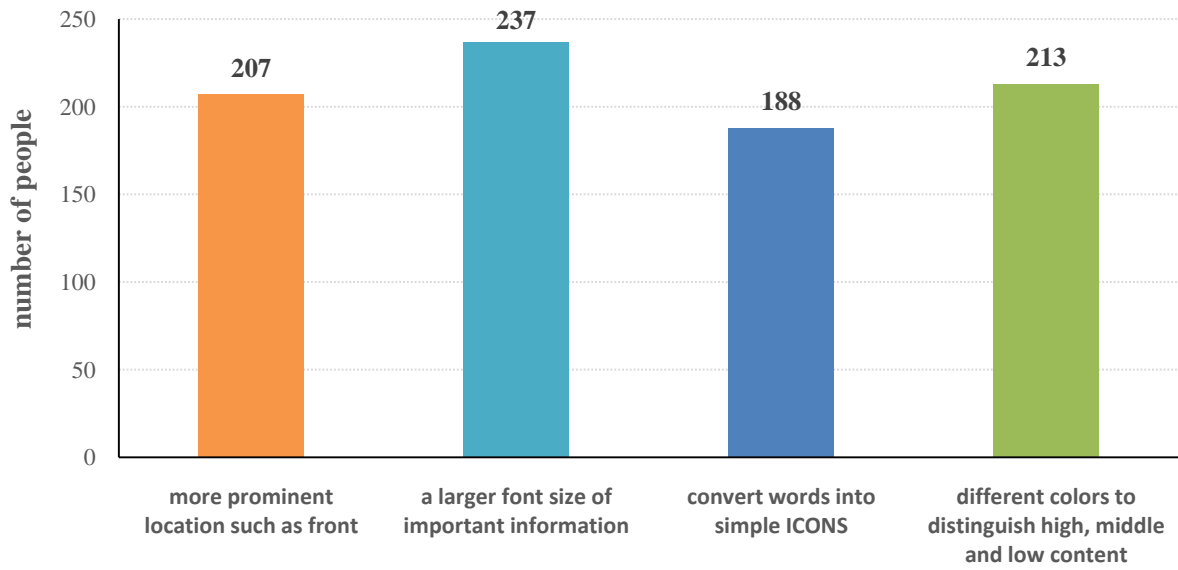


Figure 5b. improvement suggestion of food nutrition labels form

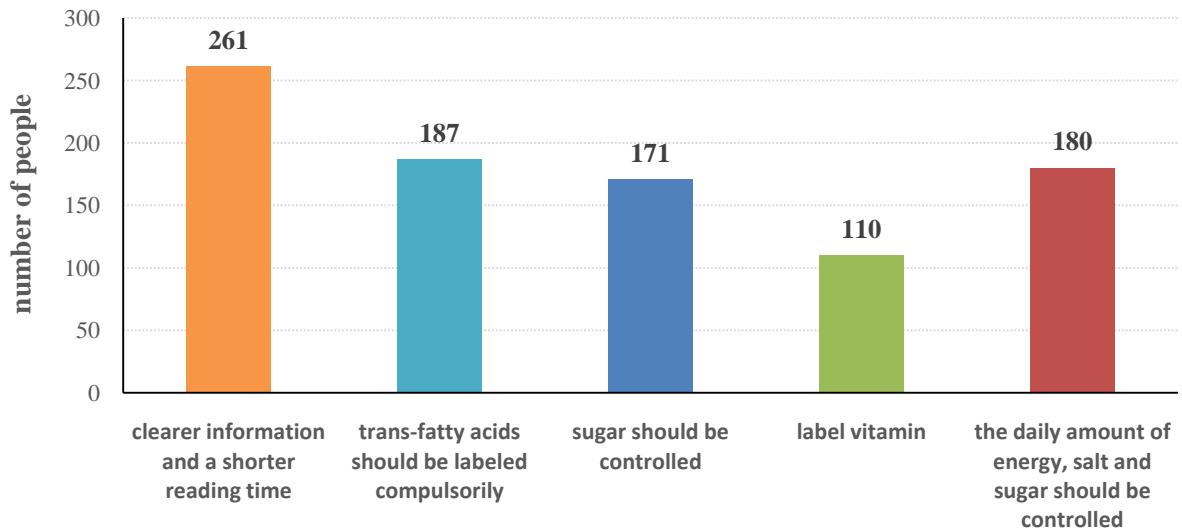


Figure 5c. improvement suggestion of food nutrition labels content

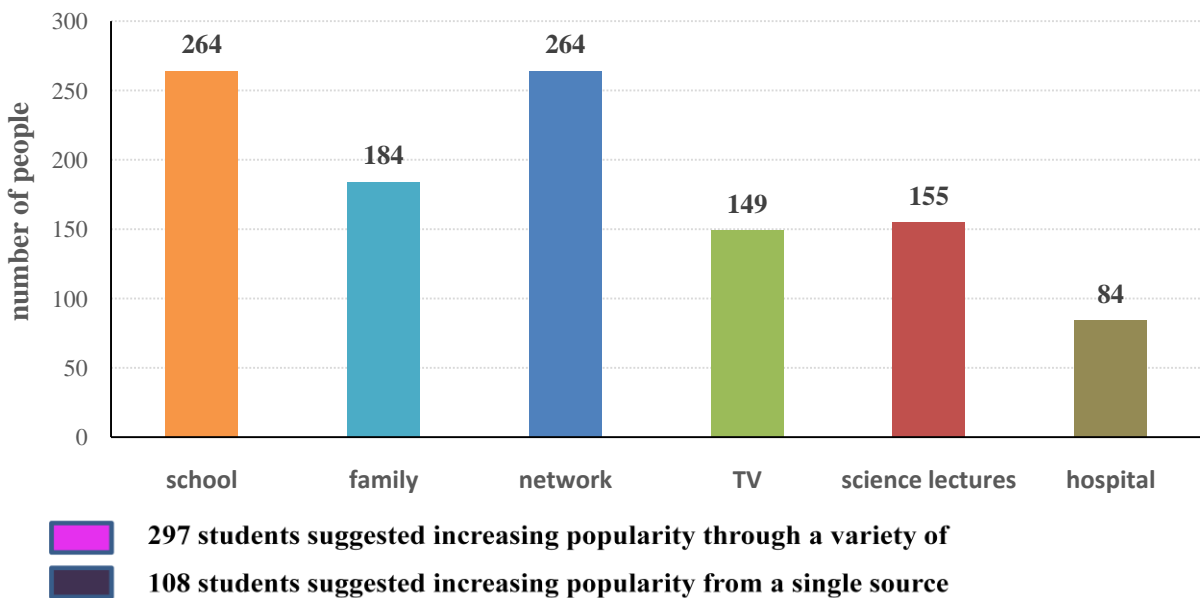


Figure 5d. main channel to strengthen popularization of nutrition label knowledge

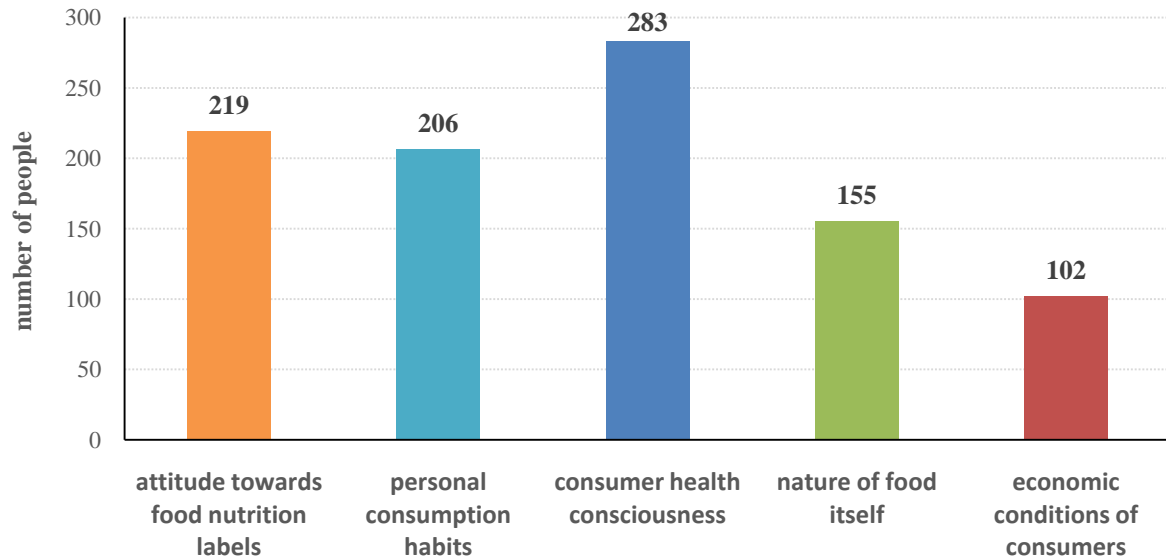


Figure 5e. major determinant of application of food nutrition labels

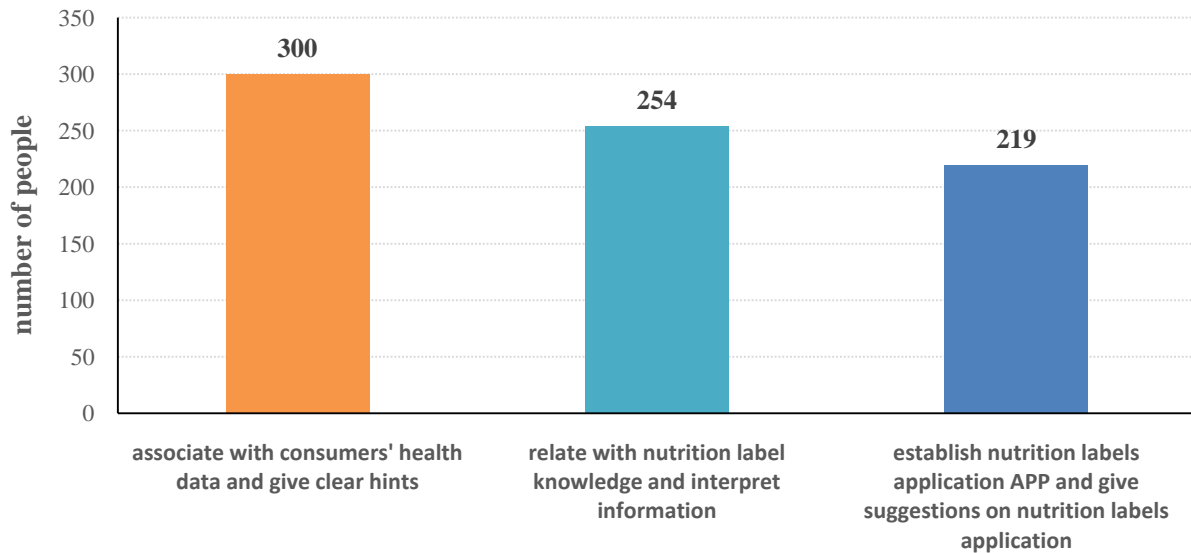


Figure 5f. the suggestion of combination means of food nutrition labels with information technologies

Figure 5c provides the improvement suggestion of food nutrition labels content. The largest numbers of students suggested that nutrition labels should have clearer information and a shorter reading time, followed by trans-fatty acids should be labeled compulsorily and the daily amount of energy, salt and sugar should be controlled. A few suggested to label vitamin.

Figure 5d describes the main channel to strengthen popularization of nutrition label knowledge. Most students suggested to strengthen popularization through school and network, followed by family, and some students suggested through science lectures, TV and hospitals. And most students suggested to adopt multi-approach to strengthen popularization of nutrition label knowledge.

Major determinant of application of food nutrition labels is shown on Figure 5e. Most students thought that consumer health consciousness was main determinant, and some students thought attitude towards food nutrition labels, personal consumption habits also should be considered. A few thought consumer economy condition might be a factor.

Figure 5f presents the combination means of food nutrition labels with information technologies such as big data, most students suggested to associate with consumers' health data and give clear hints. Many students suggested to relate with nutrition label knowledge and interpret information. Some students suggested to establish nutrition labels application APP and give suggestions on nutrition labels application.

3.6. Comparison of the Cognition, Attitude and Application of Nutrition Labels among Different Genders, Grades, Base of Nutrition Knowledge, Trust of Nutrition Labels and Health Status

From the aspects of cognition, attitude and application of nutrition labels, six representative investigation items were selected, including being familiar with nutrition labels, wanting to know nutrition label knowledge very much, trusting nutrition labels, checking nutrition labels,

influencing food purchase after reading nutrition labels, and conducting diet management according to nutrition labels. Wilcoxon rank test was used to analyze the differences in cognition and application ability of nutrition labels among different genders, grades, base of nutrition knowledge, trust of nutrition labels and health status. Results showed that different gender had no statistically significant differences in cognition and application of nutrition labels ($p > 0.05$) (Figure 6a), but

different grades, base of nutrition knowledge, trust of nutrition labels and health status in cognition and application of nutrition labels had statistically significant differences ($p < 0.05$) (Figure 6b-6e). Our study indicated that nutrition knowledge, trust of nutrition labels and health status were significant and positive determinants of middle school students' nutrition label use, which were consistent with the other research results [13-19].

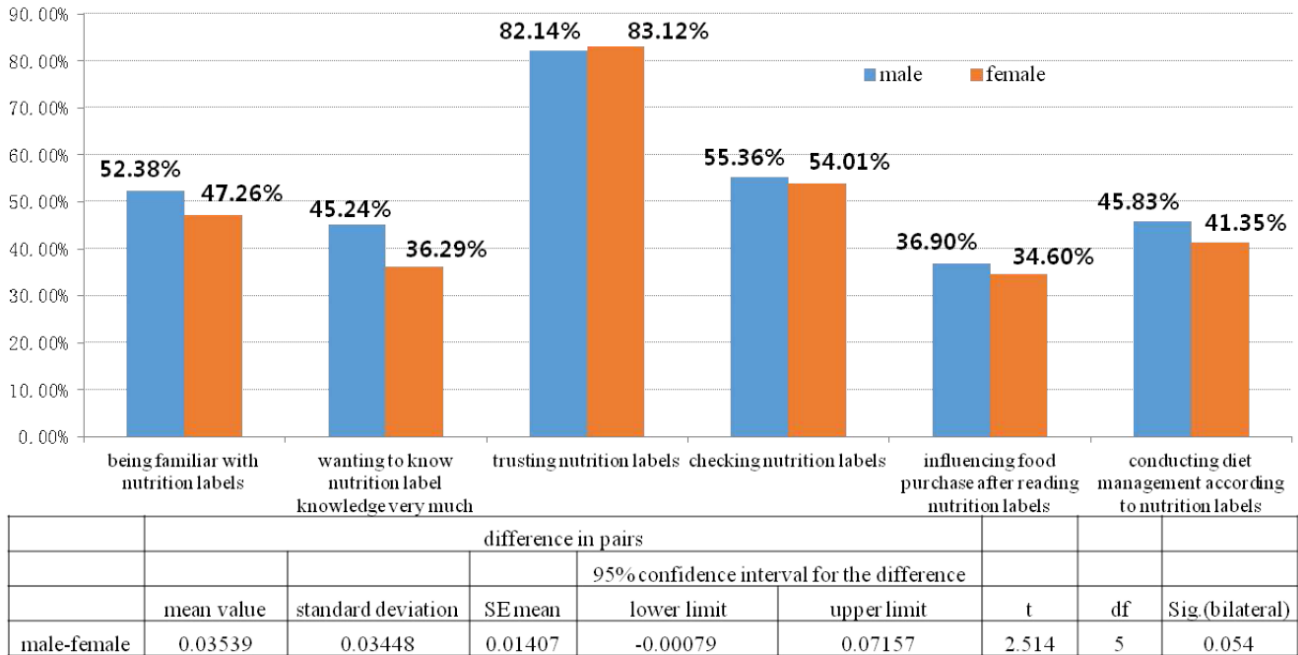


Figure 6a. Comparison the cognition, attitude and application of nutrition labels among different genders

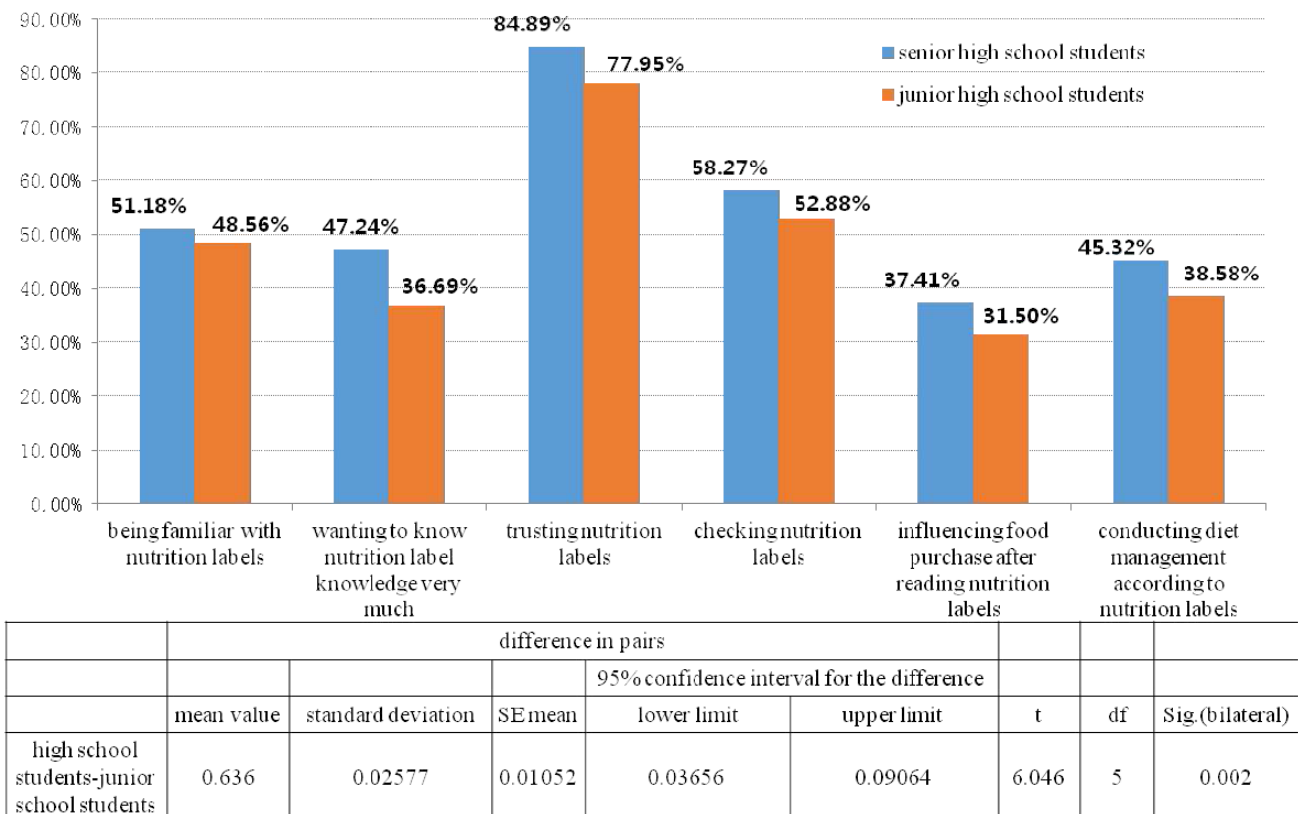


Figure 6b. Comparison the cognition, attitude and application of nutrition labels among different grades

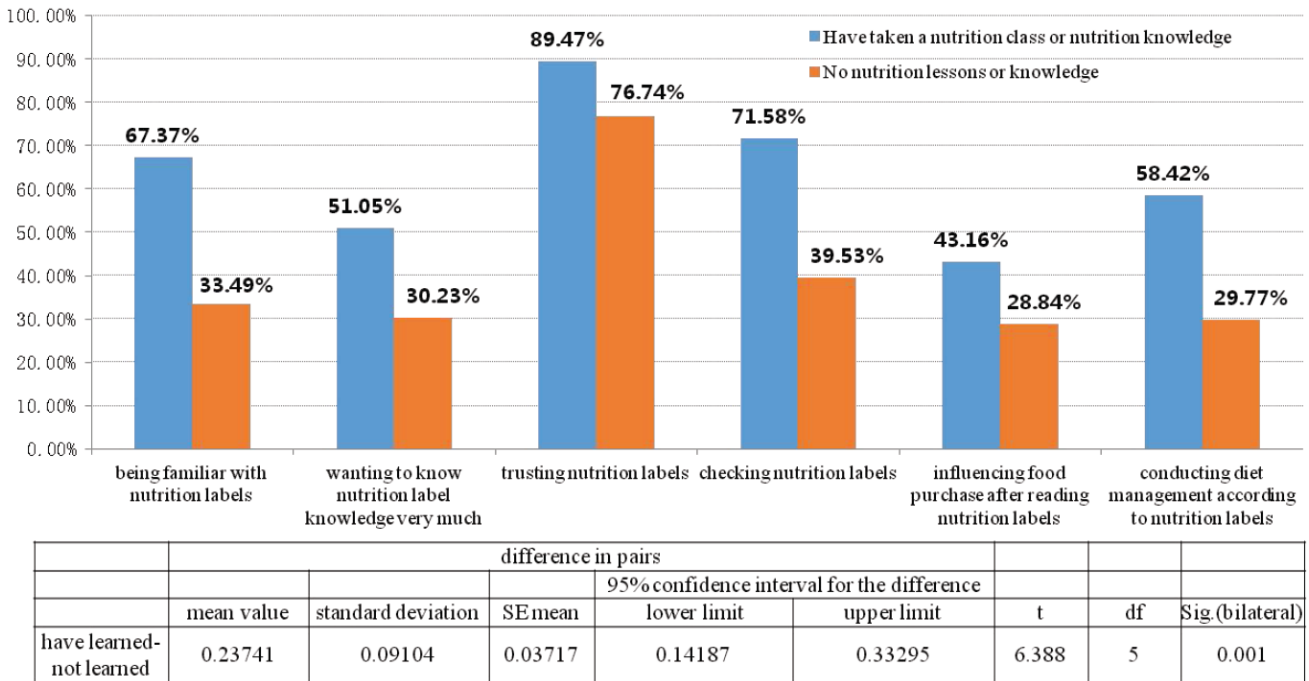


Figure 6c. Comparison the cognition, attitude and application of nutrition labels among different basic nutrition knowledge

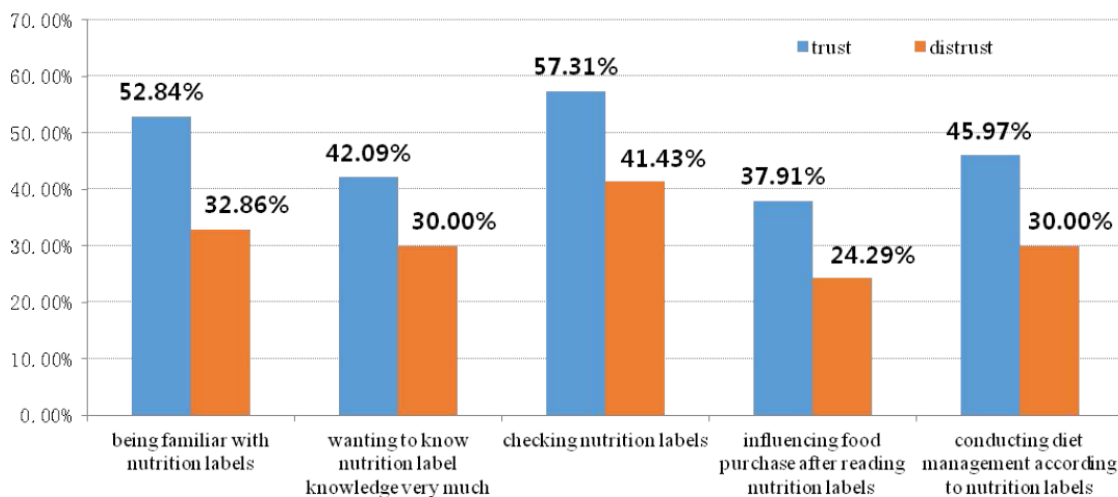
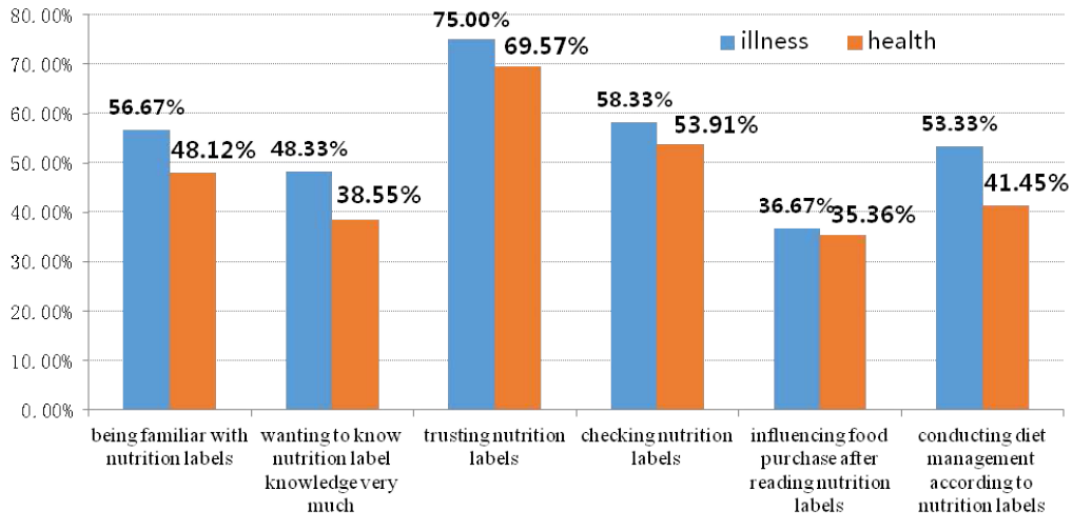


Figure 6d. Comparison the cognition, attitude and application of nutrition labels among different nutrition label trust

Cognition, attitude, attention, application and benefit of nutrition labels are a series of benefit-oriented and application-centered interrelated processes. The influences and effects of each link are complex. 65% of students who would be affected by nutrition labels when they purchased food (application) were familiar with nutrition labels. 66% of students who would be affected by nutrition labels when they managed their diet (benefit) were familiar with nutrition labels. 88% of those students trusted nutrition labels. The proportion of them who checked nutrition labels in application and benefit was 82% and 81%

respectively. The application and decision of nutrition labels were affected by many factors. Attitude and attention play a relatively large role in application and benefit of nutrition labels, while cognition played a relatively small role. Some other factors such as personal preference and consumption habit maybe also played a certain role. Consumers may use food labels more actively if they are familiar with the label [4]. To increase middle school students' familiarity with the nutrition information on labels should take some steps, e.g., explaining its content, and stressing nutritional warnings.



difference in pairs								
	mean value	standard deviation	SEmean	95% confidence interval for the difference		t	df	Sig.(bilateral)
				lower limit	upper limit			
illness-health	0.06896	0.03885	0.01586	0.02819	0.10974	4.348	5	0.007

Figure 6e. Comparison the cognition, attitude and application of nutrition labels among different health status

Nutrition Ingredient List

item	per100g	NRV%
Energy	1978KJ	24%
Protein	7.2g	12%
Fat	24.0g	40%
Carbohydrate	39.1g	13%
Sodium	20mg	1%

Figure7a

Nutrition Ingredient List

item	Per 100g	NRV%
Energy	1978KJ	24%
Protein	7.2g	12%
Fat	24.0g	40%
Carbohydrate	39.1g	13%
Sodium	20mg	1%

Figure7b

Nutrition Ingredient List

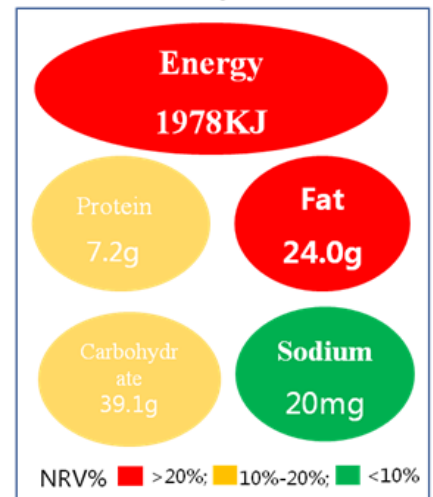


Figure7c

Nutrition Ingredient List

(Content.NRV% per 100g)

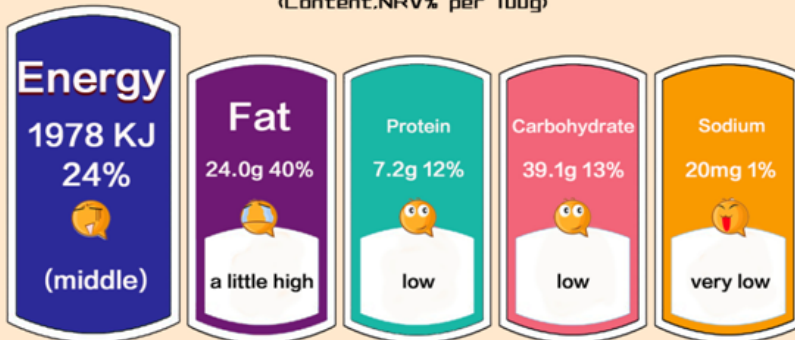


Figure 7d

Nutrition Ingredient List

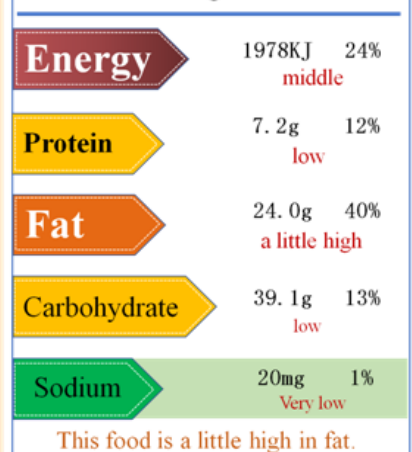


Figure7e

Figure 7. Diagram of visual test card for food nutrition label



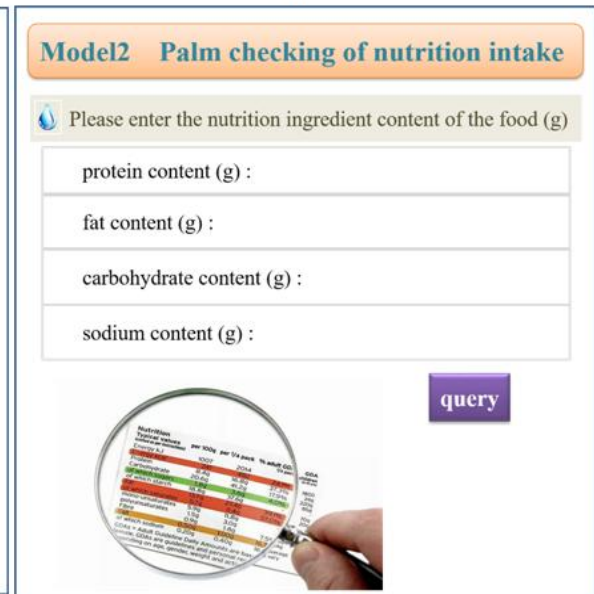
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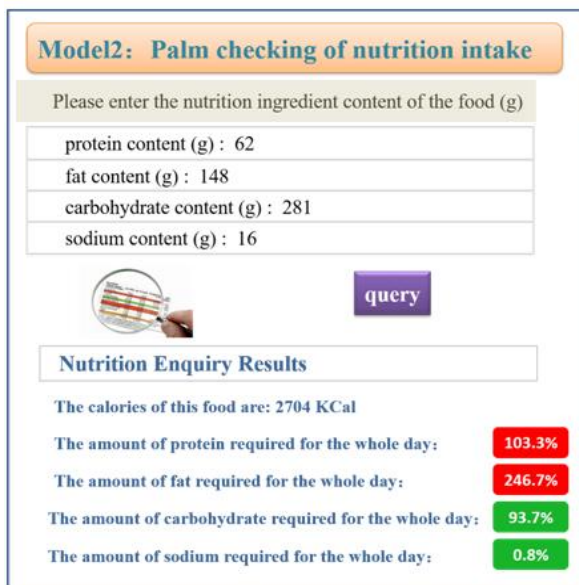
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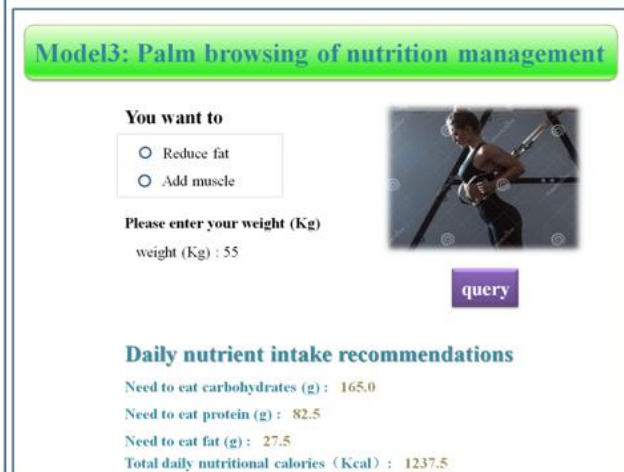
8c



8d



8e



8f

Figure 8. Food nutrition label One-Hand APP

3.7 Practical Exploration

3.7.1. The Influence of Different Presentation Modes of Food Nutrition Labels on the Students' Attractiveness Judgment

The surveyed results showed that viewing and paying attention to nutrition labels played an important role in the application and benefit of nutrition labels. Thus, the surveyed students put forward suggestions on the form and content of food nutrition labels, such as larger font size for important information, different colors to distinguish high, middle and low content, clearer information, and shorter time to read labels. Based on the survey results, through the perspective of students, this study designed different food nutrition labels presentation modes by using color, font, graphics and other elements as well as different expression forms of descriptive, explanatory and warning information, and made test cards (Figure 7), then carried out visual experiments among representative students to compare the influence of different presentation modes on students' attractiveness judgment, so as to accumulate data for promoting the improvement of food nutrition labels.

Figure 7a presents nutritional information in single way, larger font size for important information. Figure 7b presents nutritional information in two ways, namely, larger font size for important information and different color classification and identification content. Figure 7c presents nutritional information in three ways: larger font size for important information, different color classification and identification content, and graphics. Figure 7a, 7b and 7c all adopt descriptive information. Figure 7d and Figure 7e add explanatory and warning information on the basis of Figure 7b and Figure 7c.

The time for consumers to check and read nutrition labels is ten seconds usually. Therefore, the form and content of food nutrition labels must be concise, understandable and attractive. Food nutrition label visual test cards were sent out to 205 students to complete the experiment. 73% of them chose Figure 7d. The results showed that multiple presentation modes were more attractive to students than single presentation mode, and enabled them to better understand and use the information. Explanatory and warning information was better than descriptive information for students to get key information quickly.

Several nutrition labeling schemes have been developed worldwide, such as the guideline daily amount (GDA) system, the traffic-light system (TLS) and nutritional warnings which are not equally effective in the extent to which they guide healthfulness judgments. The GDA only provide numerical information about nutrient content. The TLS uses color codes (red, yellow and green) to indicate low/medium/high nutrient levels. Nutritional warnings highlight high nutrient content with the expression "High in" [11,20]. Research has shown that a label with simply information is inadequate. Instead, an effective label must be designed so that it catalyzes exposure, attracts attention and is easily encoded and comprehended, then the label can influence decision-making [17]. The TLS labels are more effective than GDA labels, nutritional warnings are more effective than the TLS labels at attracting more attention and promoting healthy eating [11,20].

3.7.2. Establish Food Nutrition Label One-Hand APP

The surveyed results showed that there was an obvious deficiency in learning food nutrition labels among surveyed students, and there was an important relationship with their weak nutrition knowledge, lack of attention to nutrition labels and inability to use nutrition label knowledge due to the longtime of checking nutrition labels. Therefore, the students put forward to establish a nutrition label APP. Combined with survey results, this study explored the independent design and development of Food Nutrition Label One-Hand APP. This APP integrated the learning, understanding and application of nutrition label knowledge by information means, promoted the learning and application of food nutrition labels in a form that middle school students were willing to accept, and guided the scientific slimming.

The Food Nutrition Label One-Hand APP includes three modules. Module 1: Palm reading of nutrition knowledge. The knowledge of food nutrition will be collected and the base of food nutrition knowledge will be established. Module 2: Palm checking of nutrition intake. The nutrient content of the input food will automatically calculate the calories of the food and the percentage of nutrients required for the whole day. If the amount is over, it will automatically alert. Module 3: Palm browsing of nutrition management. It will generate automatically daily nutrient recommendations based on different health needs (Figure 8).

The students recorded the daily use of nutrition labels and carried out health management by using Food Nutrition Label One-Hand APP. One month later, the students' application rate of nutrition labels reached 100%, and the daily diet had reduced energy and fat intake and increased carbohydrates, which achieved obvious effects. Information technology is used to simplify the cognition, understanding, application and decision-making process of food nutrition information for middle school students, so as to benefit more students, further increase their trust in nutrition labels, promote better learning and use of nutrition labels, and achieve a benign interaction between middle school students and nutrition label knowledge.

4. Conclusions

The surveyed students were lacking of cognition and application on nutrition labels, and nutrition-related knowledge need to be popularized through multi-approach. Publicity and guidance should be strengthened, and health awareness should be raised. The application and decision of nutrition labels were affected by many factors. Attitude and attention play a relatively large role in application and benefit of nutrition labels. Nutrition labels with comprehensive use of colors, fonts, graphics and other presentation modes and prominent key information were more attractive to students. The establishment of Food Nutrition Label One-Hand APP effectively promoted the students to learn and use nutrition labels, and provided a simple and feasible solution for the realization of nutrition labels to guide the healthy diet and scientific weight loss for students.

It is suggested that relevant departments should further improve food nutrition labels, use graphics, large font size

of important information, different color classification to mark the content level, and increase explanatory and warning information, so as to improve the attractiveness of nutrition labels to help middle school students quickly get the key information. Drinks, cakes, chips and other foods are very popular with middle school students, which often contain sugar or trans-fatty acids. Eating too much sugary food can lead to obesity, diabetes and so on. High intake of trans-fatty acids can lead to cardiovascular disease. It is recommended that sugar, trans-fatty acids and should be mandatory labeling. It is beneficial to promote weight loss.

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