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ORIGINAL ARTICLE

Nutritional Traffic Light Knowledge and Food Choices: A Cross-Sectional Study at Purchase Point

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ABSTRACT

Background: Nutrition labeling is a health promotion strategy to improve nutrition information and help consumers make healthier food choices at the point of purchase. This study aimed to assess the association between knowledge of Nutritional Traffic Light Labels (NTLL) and food choices in Shiraz, Iran.

Methods: In this cross-sectional study, 418 individuals were randomly selected from chain stores. Nutrition knowledge including general nutrition awareness and NTLL knowledge were assessed by a validated questionnaire. The participants' purchase patterns were determined based on the color code of NTLL.

Results: Almost half of the participants (48.8%) had high levels of NTLL knowledge. Age of participants (p=0.012) and their level of education (p=0.003) were related to the NTLL knowledge. The findings revealed that males (p=0.037) and participants with a previous disease (p=0.029) had higher food basket score. However, no significant association was observed between the NTLL knowledge and food basket score.

Conclusion: Despite the relatively good knowledge of participants on NTLL, the efficiency of using the labels was paradoxically low. In addition, having knowledge did not necessarily led to a successful performance in healthy food choices.

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Introduction

Food patterns have dramatically changed in recent years, and the accessible per capita of energy has increased by approximately 580 Kcal/day all around the world (1). Considering this trend, unhealthy diets and their consequences have become a major concern for public health (2). Moreover, the rate of nutrition-related non-communicable diseases (NCDs) such as obesity, diabetes, cancer, and cardiovascular disease are notably high in many countries worldwide. The most well-known and practical options to tackle unhealthy diet and improve consumers' healthy behaviors is labeling packaged food items (3, 4).

Front of package nutrition labeling (FOPL) is considered a cost-effective health promotion strategy to enhance nutrition information and increase appropriate nutritional habits (5, 6). This tool is designed to help consumers make healthier food choices at the point of purchase, when most decisions are made (7). Furthermore, they can also be attractive since they do not restrict consumers' freedom of choice. The results of a recent meta-analysis showed that FOPL, regardless of its type, decreased the intake of energy by 6.6% in consumers, and with its impact on the food industry, reduced the contents of trans-fatty acids by 64.3% and sodium by 8.9% in food products (8). Nutritional Traffic Light Label (NTLL) is a preferred method to improve people's food choices compared to other food labeling models such as nutrition fact labels, octagons, logos and numerical levels per serving sizes (9).

The Iran's ministry of health and medical education (MOHME) launched a NTLL policy considering the nutrition□related main health concerns of the country in 2014 (10). The NTLL color-coding communicates information about the content of salt, sugar, fatty acids, trans-fatty acids, calories, as well as portion size. Red, amber and green colors refer to high, medium, and low amount of the aforementioned components in food products, respectively. Insertion of NTLL on food products became a mandatory process for all imported and domestic packaged food products from 2016 (11). It was shown that 80% of foods were labeled with NTLL in 2017, which indicates a relatively high level of cooperation from the food industry in Iran (12).

Although numerous studies have been carried out regarding the effectiveness of NTLL on consumer preferences in other countries (13-17), there are limited and inconsistent published data pertaining to the level of awareness and use of NTLL in Iranian consumers (18). A study on 322 medical university students in Tabriz, Iran showed that 47.6% of participants used food labels at purchase point (19), while another study on consumers in Tehran, Iran indicated that only 4.6% of consumers reported using food labels (20). Therefore, considering the limited evidences about Iranian people's awareness of NTLL and their purchasing behaviors, the present study was conducted to assess the consumers' NTLL knowledge, and evaluate the association between NTLL knowledge and food choices in an urban population in Shiraz, southern Iran.

Materials and Methods

The present cross-sectional study evaluated the association between knowledge of NTLL and food choices among consumers at purchase points. A sample size of 418 participants was determined based on a similar published study which was conducted in Iran (20). The consumers were randomly recruited from the 14 branches of Tirazis chain stores and the hypermarkets located at different socio-demographic and economic locations in the urban area of Shiraz, a city in the south of Iran with a population of 1.8 million. The inclusion criteria of the study were being older than 18 years, having reading and writing proficiency, being responsible for food purchasing in the household, and having at least five food items with NTLL in their food baskets. Consumers who had incomplete questionnaires were excluded from the study.

Data collection was done by four trained nutritionists at the selected stores on different days of the week, including on holidays and both in the morning and in the evening shifts. A written informed consent form was obtained from each eligible individual before assessing their nutritional knowledge and shopping behaviors. After the interviews, an educational booklet about nutritional food labeling was given to each participant. All the participants were interviewed at the markets and requested to complete a questionnaire included two sections; socio-demographic information and nutritional knowledge. The socio-demographic information included age, sex, educational level, marital status, family size, person's role in the family, and economical status. Moreover, body weight and height were asked from each participant, and Body Mass Index (BMI) was calculated. The participants with BMI <18.5 kg/m^2, 18.5-24.9 kg/m^2, 25-29.9 kg/m^2, and >30 kg/m^2 were defined as underweight, normal weight, overweight, and obese, respectively. Educational level was categorized as under diploma, high school diploma, associate degree, bachelor degree, and master degree or higher. Additionally, economical status was determined according to household income per month and was classified into the quartiles of less than 200 $, 200-260 $, 260-330 $, and more than 330 $ (The national currency of Iran is IRR and household income was converted to USD in the present study.) per month. Also, medical history was asked and participants were categorized as healthy (without any previous diseases) and unhealthy (suffering from diseases such as coronary heart disease, hypertension, diabetes, thyroid dysfunction, pulmonary disorders, kidney failure, etc.).

The participants' nutritional knowledge was evaluated using a questionnaire consisted of 30 questions including (a) 15 questions related to general nutritional knowledge, (b) 11 questions related to the understanding of the NTLL, and (c) 4

questions related to self-reported use of NTLL. In the first part, the participants were asked four-choice questions about different food groups, industrial beverages, and processed foods. Scores <7, 8-11, and >12 indicated weak, moderate, and good general nutrition knowledge, respectively. In the second part, the participants' knowledge on NTLL was evaluated by asking some questions about the traffic light colors and two examples of NTLL for chips and tomato paste. Scores <5, 6-8, and 9 or more represented low, moderate, and high NTLL knowledge, respectively. A sample of NTLL used in Iran was shown in Figure 1. As illustrated in this figure, the amount of energy, sugar, fat, salt, and trans-fatty acids in packaged food were demonstrated by a color code. At the bottom of NTLL, the color guideline revealed high, moderate, and low percentage of these components. Furthermore, at the top of NTTL, the calorie unit per portion size was written in grams and/or milliliters. In the third part, the self-reported use of NTLL was assessed by four questions, which evaluated the frequency of NTLL use at the point of purchasing of food products.

The questionnaire was reviewed by 9 professorial and faculty members and 2 statisticians who were expert to check the content validity of the questionnaire. Content validity was applied in two phases including Content Validity Ratio (CVR) and Content Validity Index (CVI). According to Lawshe's table (21) and the judgment of 11 specialists, if the calculated CVR for each question was equal to or more than 0.59, the content validity of that question was confirmed. In this study, CVI was equal to 0.907. To determine the external reliability of the questionnaire, it was completed by 30 individuals as a pilot study. By using the test-retest method with a 10-day interval, the obtained correlation coefficient was 0.81. Moreover, the internal reliability of the questionnaire items was confirmed by Kuder-Richardson. After applying the necessary modifications, the questionnaire was finalized and used in the study.

After completing the questionnaire, the participants' purchase patterns were assessed based on the NTLL colors. In this study, the names of all purchased food products in food baskets of each participant were recorded in a table. Then, the researchers checked NTLL of each product and noted its color and content of sugar, fat, salt, and trans-fatty acids. Accordingly, scores +1, 0, and -1 were assigned to green, amber, and red colors, respectively. The score of each food product was calculated based on the sum of the color scores for the four nutrients. Finally, the sum of scores of all the purchased food products was determined as the food basket grade for each participant.

The data were analyzed using IBM SPSS Statistics software (Version 22.0, Chicago, IL, USA) and were reported as mean±SD and number (percentage) for continuous and categorical variables, respectively. The univariate association between the demographic variables and nutritional knowledge was assessed using independent t-test or one-way analysis of variance (ANOVA). The Kruskal-Wallis test was also used to assess the association between nutritional knowledge and the food basket score. Additionally, linear regression was utilized to evaluate the association between the participants' demographic features and the food basket score.

Results

This study was conducted on 418 participants including 236 females (58%) with a mean age of 38.24±11.64 years (range: 18-82 years). The socio-demographic characteristics of the participants by sex have been presented in Table 1. The mean BMI of the participants was 25.4±16.31 kg/m^2. Almost half of the participants (54.4%) had normal BMI, which was significantly higher in males compared to females (p=0.031). Moreover, 60% of

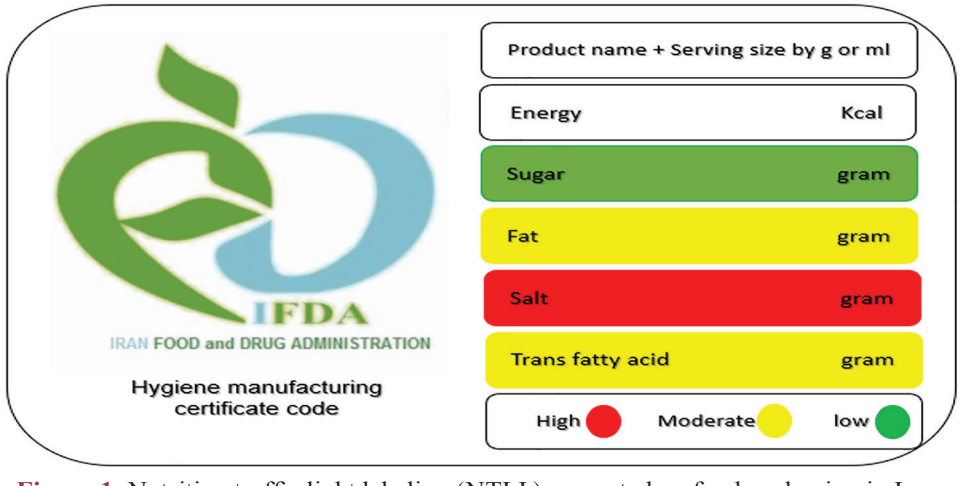

Figure 1: Nutrition traffic light labeling (NTLL) presented on food packaging in Iran.

Table 1: The baseline socio-demographic features and body mass index (BMI) of the study participants.

Variable		Male N (%)	Female N (%)	Total N (%)	*P* value
Age	18-25 years	19 (10.75)	35 (14.8)	54 (13.1)	0.161
	26-55 years	139 (78.5)	186 (78.8)	325 (78.7)	
	Older than 55 years	19 (10.75)	15 (6.4)	34 (8.2)	
Educational level	Under diploma	11 (6.2)	21 (8.7)	32 (7.7)	0.232
	High school diploma	49 (27.7)	73 (30.3)	122 (29.2)	
	Associate degree	10 (5.6)	24 (10.0)	34 (8.1)	
	Bachelor degree	70 (39.5)	86 (35.7)	156 (37.3)	
	Master degree or higher	37 (20.9)	37 (15.4)	74 (17.7)	
Household income per month	Less than 200$	19 (10.9)	42 (19.4)	61 (15.6)	<0.001
	200-260$	96 (55.2)	140 (64.8)	236 (60.5)	
	260-330$	38 (21.8)	21 (9.7)	59 (15.1)	
	More than 330$	21 (12.1)	13 (6.0)	34 (8.7)	
BMI classification	Underweight	2 (1.1)	5 (2.2)	7 (1.8)	0.031
	Normal weight	79 (45.1)	132 (58.7)	211 (52.8)	
	Overweight	70 (40.0)	63 (28.0)	133 (33.3)	
	Obese	24 (13.7)	25 (11.1)	49 (12.3)	

The *p* value was obtained through Chi Square.

Table 2: The classification of participants based on the level of general nutritional knowledge and understanding on nutrition traffic light labeling (NTLL).

Classification	General nutritional knowledge N (%)	NTLL knowledge N (%)
Weak	51 (12.2)	80 (19.1)
Moderate	264 (63.2)	134 (32.1)
Good	103 (24.6)	204 (48.8)

the participants had a moderate monthly income level (200-260 $), which was significantly higher in males ($p<0.001$). Regarding the health status, 84.7% of the participants were healthy (without any previous diseases). Hypertension, coronary heart disease, and diabetes were the most common diseases among the study participants. According to Table 2, the results demonstrated that 25% of the participants had high levels of general nutrition alknowledge. Moreover, 48.8% and 19% of the participants had high and low levels of NTLL knowledge, respectively.

As shown in Table 3, the general nutrition knowledge score was significantly higher among females ($p=0.043$); however, no significant relationship was found between the NTLL knowledge and sex. On the other hand, a significant association was detected between age and the score of NTLL knowledge ($p=0.012$). The NTLL knowledge score was higher among individuals aged 18-55 years when compared to older ones. The findings of univariate analysis also demonstrated that the individuals with academic educational level obtained better scores compared to those who had diplomas or lower degrees ($p<0.001$, and $p=0.003$ for general, and NTLL knowledge, respectively). The participants who claimed to use NTLL during shopping also gained significantly higher scores in all the two categories of nutritional knowledge ($p=0.004$, and $p<0.001$ for general, and NTLL knowledge, respectively). In contrast, there was no significant association between the other demographic variables (including marital status, income level, health status, and BMI) and the two classifications of nutritional knowledge. Furthermore, the participants' self-reported results on the use of NTLL showed that 27% of the respondents always paid attention to the color of the labels at the point of purchase, but 48% of them never used NTLL.

Table 4 showed the numerical values of the participants' food basket according to the scores obtained from the NTLL. The mean score of the participants' food basket was 1.78±0.67. Among the nutrients on NTLL, trans-fatty acids had the highest score (0.92±0.13). Conversely, the lowest score (0.008±0.40) was related to fat content. Furthermore, no significant association was found between the two classifications of nutritional knowledge and the food basket score. Among the four nutrients on NTLL, the participants with higher general nutritional knowledge obtained a better score for sugar in their food baskets ($p=0.028$).

Table 3: The association between the socio-demographic characteristics and nutritional knowledge.

Variable	Classification	General nutritional knowledge Mean (SD)	*P* value	NTLL knowledge (mean±SD)	*P* value
Sex	Male	9.77±2.04	0.043[a]	7.51±2.94	0.276[a]
	Female	10.19±2.08		7.82±2.77	
Age (Year)	18-25	10.01±2.65	0.252[b]	7.87±2.64	0.012[b]
	26-55	10.06±1.96		7.82±2.80	
	Older than 55	9.44±2.19		6.32±3.25	
Educational level	Under diploma	7.84±2.14	<0.001[b]	6.50±3.0	0.003[b]
	High school diploma	9.95±2.0		7.17±3.09	
	Associate degree	10.26±1.85		8.17±2.28	
	Bachelor degree	10.16±1.95		7.92±2.78	
	Master degree or higher	10.63±2.08		8.35±2.47	
Household income per month ($)	Less than 200	9.63±2.56	0.168[b]	7.60±3.15	0.277[b]
	200-260	9.98±1.97		7.56±2.79	
	260-330	10.40±1.49		8.35±2.36	
	More than 330	10.35±2.46		7.52±3.14	
BMI	Underweight and normal	10.21±2.03	0.070[a]	7.72±2.80	0.942[a]
	Overweight and obese	9.83±2.09		7.70±2.82	
Marital status	Single	10.0±2.26	0.935[a]	7.54±2.93	0.547[a]
	Married	10.01±2.01		7.74±2.82	
Health status	Healthy	9.92±2.10	0.655[a]	7.75±2.97	0.696[a]
	Unhealthy	10.06±2.33		7.59±2.72	
Self-reported use of NTLL	No	9.70±2.0	0.004[a]	6.76±2.93	<0.001[a]
	Yes	10.29±2.07		8.66±2.41	

[a] The *p*-value was obtained through independent t-test. [b] The *p*-value was obtained through ANCOVA. BMI: Body mass index, SD: Standard deviation.

Table 4: The mean score of the participants' food baskets and nutrition traffic light labeling (NTLL) for nutrients.

Score	Mean±SD	Minimum	Maximum
Sugar	0.43±0.41	-1.0	1.0
Fat	0.00±0.40	-1.0	1.0
Salt	0.41±0.33	-0.60	2.0
Trans-fat	0.92±0.13	0.4	1.0
Food basket	1.78±0.67	-0.60	4.0

SD: Standard deviation

Table 5: Linear regression model of the association between the socio-demographic characteristics and the food basket grade.

Food score / Basket	β	95% Confidence interval		*P* value
		Lower limit	Upper limit	
Age	0.00	-0.008	0.008	0.918
Sex (male)	0.184	0.011	0.357	0.037
BMI	-0.045	-0.223	0.133	0.620
Health status (healthy)	-0.254	-0.482	-0.027	0.029
Marital status	0.075	-0.146	0.296	0.505
Education level	0.077	-0.107	0.261	0.412
Income	-0.019	-0.224	0.186	0.855

The *p* value was obtained through univariate linear regression.

The result of linear regression demonstrated that males obtained relatively better food basket scores compared to females (p=0.037). Besides, healthy individuals had lower scores compared to those who suffered from diseases (p=0.029). However, no significant association was visible between the other demographic characteristics and the food basket scores (Table 5).

Discussion

In this study, assessment of nutrition knowledge revealed that almost half of the participants had a high level of NTLL knowledge. Additionally, evaluation of association of demographic factors with the nutritional knowledge illustrated that females had a significantly higher level of general nutritional knowledge. However, no significant correlation was observed between sex and NTLL knowledge. In the available literature, there are many contradictions on sex differences in this area (22-24). For instance, Grunert *et al.* reported that females were more interested in healthy eating (23). In contrast, some studies indicated that the nutrition knowledge status was similar in both sexes (24). The current study findings showed that the participants in the 26–55 year age group had higher NTLL knowledge level when compared to older counterparts. Concordantly, a study in the UK revealed that although older consumers were more interested in healthy eating, they had lower nutritional knowledge in comparison to younger respondents (23).

Our results revealed a significant association between the participants' educational level and their nutritional knowledge. Accordingly, customers with university degrees obtained better scores in both classifications of nutritional knowledge (including general nutrition and NTLL understanding). Consistently, it was shown that higher educational level and studying nutrition-related topics resulted in better nutritional knowledge (25). Based on the self-reported findings in the current investigation, 48% of the participants never paid attention to the NTLL on food products. In a similar study in China, 70% of the respondents claimed that they rarely or never used nutritional labels during shopping (26). In the research carried out before, the use of nutritional labeling for food selection was moderately low and 32% of immigrants and 5% of indigenous women used nutritional labels for purchasing packaged food items (27). In contrast, Besler *et al.* reported that 72.4% of the participants made use of nutritional labels (consumers aging 12-56 years) (28). In a research in New Zealand and Australia, the use of nutritional labels was high according to the participants' self-reports, but the actual use and understanding of the nutritional labels seemed to be limited (29). It is noteworthy that in most studies, the use of nutritional labels was evaluated based on the participants' self-reporting behaviors, which could lead to exaggerated results (23). Moreover, it was demonstrated that if there are some danger signs on a food item's NTLL, familiarity with and trusting the commercial name can act like an obstacle against accepting the fact that the product is unhealthy (30).

In the current study, males performed better than females at the point of purchase and gained higher grades from the food baskets. In other words, although females received better scores in nutritional knowledge, males had a more successful performance in choosing healthier food products. An interesting finding of the present study was that the individuals who suffered from diseases obtained higher general nutritional knowledge and food basket scores. These correlations could be explained by the fact that individuals with nutrition-related illnesses increased their nutritional knowledge and made them to pay more attention in food choices. There are many studies in the literature that have reported the positive effects of NTLL on food choices (31-34). Ashmann *et al.* found that awareness on NTLL could increase the selection of healthy products amongst German consumers (35). In contrast, some studies showed no relationship between the NTLL use and food choices (36, 37). A study carried out on Harvard University students in 2015 including a large number of students revealed the use of NTLL, but no significant relationship was found between the use of NTLL and the quality of their diets (37). Consistently, no significant association was noticed between the food basket score and nutritional knowledge in the current research. This might imply that the individuals did not use their nutritional knowledge in choosing food products that denotes to a potential knowledge-practice paradox. It could also indicate that a high level of nutritional knowledge might not necessarily influence the food choice (38). A recent systematic review showed that NTLL without other educational interventions might have no considerable impact on healthy food choices at purchase points (39). Moreover, our findings demonstrated that the people with higher general nutritional knowledge level had higher sugar color score in their food baskets. The excessive attention to sugar on NTLL could be due to its well-established risk for chronic diseases such as diabetes.

The strength of this study was that the analysis of food baskets and evaluation of food choices were not based on self-reporting behaviors. However, this study had several limitations. The first limitation was that the sample of this research cannot be considered as a national sample of Iranian adults and the results cannot be generalized to the entire Iranian population. The willingness to participate in our study was less than 50%, so that one out of every two people did not choose to answer our questionnaire. The low response rate was because the questionnaires were completed at the end of the purchase and many consumers were reluctant to participate due to lack

of time. Moreover, participants' self-report of height and weight can be a potential source of error that may confound the investigation of correlations. Furthermore, the data were collected from chain stores, and small stores and local supermarkets were not included in sampling due to their great number and widespread distribution.

Conclusion

The findings of the present study showed that despite the participants' relatively good knowledge on NTLL, the efficiency of using these labels was paradoxically low. In addition, having knowledge did not necessarily lead to a successful performance among healthy food choices.

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Authors' Contribution

NN participated in the research idea, study design, data interpretation, and writing and preparation of the manuscript. MMH participated in the research idea, study design, data acquisition, data interpretation, and writing and preparation of the manuscript. FMNF participated in the research idea, study design, data interpretation, and critical revision of the paper. CTC participated in the critical revision of the paper. Sh-F participated in the research idea, study design, data interpretation, and critical revision of the paper. All authors read and approved the final manuscript.

Conflict of Interest

None declared.

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