

Original Research



Utilization of nutrition labels and related factors among patients with diabetes in Korea

So-Jung Lee ^{1,2}, Mi Ah Han ³, Jong Park ³, and So Yeon Ryu ³

¹Department of Public Health, Graduate School of Health Science, Chosun University, Gwangju 61452, Korea

²Department of Nutritional Management Service Team, Kwangju Christian Hospital, Gwangju 61452, Korea

³Department of Preventive Medicine, College of Medicine, Chosun University, Gwangju 61452, Korea



Received: Feb 28, 2022

Revised: Jul 1, 2022

Accepted: Aug 8, 2022

Published online: Sep 21, 2022

[§]Corresponding Author:

Mi Ah Han

Department of Preventive Medicine, College of Medicine, Chosun University, 309 Philmum-daero, Dong-gu, Gwangju 61452, Korea.

Tel. +82-62-230-6481

Fax. +82-62-225-8293

Email. mahan@chosun.ac.kr

This article is a condensed form of the first author's master's thesis from Chosun University.

©2023 The Korean Nutrition Society and the Korean Society of Community Nutrition

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ORCID iDs

So-Jung Lee 

<https://orcid.org/0000-0001-5938-9098>

Mi Ah Han 

<https://orcid.org/0000-0003-1213-6952>

Jong Park 

<https://orcid.org/0000-0003-3353-3543>

So Yeon Ryu 

<https://orcid.org/0000-0001-5006-1192>

Conflict of Interest

The authors declare no potential conflicts of interests.

ABSTRACT

BACKGROUND/OBJECTIVES: The prevalence of diabetes has continued to increase globally. Changes in eating habits, lack of exercise, increased stress, and aging are major contributors. Glycemic control is the key strategy of diabetes management. The purpose of this study was to analyze the utilization of nutrition labels and related factors among patients with diabetes.

MATERIALS/METHODS: Data from the 7th Korea National Health and Nutrition Examination Survey were used. General, health-related, diabetes-related characteristics from 1,587 adults with diabetes history were included. Nutrition label utilization was assessed with awareness and use of nutrition labels and effects on food choice. For statistical analyses, chi-square test and multiple logistic regression analysis were performed.

RESULTS: The prevalence of awareness, use, and effects of nutrition labels on food choice among diabetic patients were 48.8%, 11.4%, and 9.6%, respectively. High monthly income, walking frequency, family history of diabetes, younger age at diagnosis, and shorter duration of diabetes were associated with higher nutrition label awareness. Nutrition label use and effect on food choice were higher in women, those with high monthly income, those diagnosed at younger than 45 yrs, those with diabetes for less than 10 yrs, those with meal therapy, or patients who had undergone a fundus examination.

CONCLUSIONS: Nutrition label utilization status was low in Korean patients with diabetes. Strategies are needed to promote nutrition label use as a diet management tool for patients with diabetes.

Keywords: Diabetes mellitus; food labeling; health surveys; nutrition surveys

INTRODUCTION

The Korea National Health and Nutrition Examination Survey (KNHANES) reported that the prevalence of diabetes in Koreans over the age of 30 was 8.9% in 2001, 9.1% in 2005 [1], and 11.8% in 2019 [2]. In 2020, diabetes caused a total of 8,456 deaths in Korea, which was the sixth highest cause after cancer, heart diseases, pneumonia, cerebrovascular disease, and intentional self-harm [3]. According to the International Diabetes Federation, the global prevalence of diabetes (based on the age of 20–79) is estimated to increase from 537 million in 2021 to 783 million in 2045. Medical expenditure due to the rise in diabetes is estimated at USD 966 billion dollars per year [4].

Author Contributions

Conceptualization: Lee SJ, Han MA; Formal analysis: Lee SJ, Han MA; Investigation: Lee SJ, Han MA; Supervision: Han MA; Methodology: Lee SJ, Han MA, Park J, Ryu SY; Writing - original draft: Lee SJ, Han MA; Writing - review & editing: Lee SJ, Han MA, Park J, Ryu SY.

A key strategy for diabetic patient management is to reach and maintain glycemic control goals and prevent the occurrence of diabetic complications and slow disease progression with drug treatment, exercise, dietary, and lifestyle modifications [5]. Understanding nutritional information is necessary for healthy eating to make rational choices by identifying food ingredients according to the health status. Diet control, one of the basic methods of managing diabetes, aims to achieve metabolic control by selecting healthy foods [6].

With the enforcement of the US Nutrition Labeling and Education Act of 1994, nutritional information for most packaged foods became mandatory; the nutrition panel has a standardized format with information on total calories and nutrients such as saturated fat, cholesterol, and sodium [7]. In Korea, nutrition labeling was also introduced in 1994 and became compulsory for special purpose foods, health supplements, and nutritional emphasized foods. In 2006, the “Serving Size System” was introduced to the nutritional component labeling unit, and, in 2010, the provision of nutritional information became compulsory for some restaurant menus such as fast food [8].

Previous studies have demonstrated the usefulness of nutrition labeling to help control diet. Studies evaluating the effect of front-of-package nutrition labeling on food purchases reported that it was effective for helping people make healthier food purchase decisions [9]. People using nutrition labeling tended to eat a low-fat diet [10] with high fruit and vegetable intake [11]. Traffic-light nutrition labels could reduce intake of calories, fat, and sodium [12]. With regard to related factors of nutrition labeling use when selecting processed foods for chronically ill patients, both women and men showed higher rates of use of nutrition labeling [13]. Using the US National Health and Nutrition Examination Survey data, people with diagnosed diabetes were more likely to use nutrition facts label for daily food purchase compared with those without diabetes [14]. A previous study with a representative sample of New York City adults showed that hypertension was associated with the nutrition fact label use for sodium information [15]. Korean adults who read nutrition labels were younger, leaner, less likely to be alcohol drinkers or current smokers, and had a lower prevalence of metabolic syndrome [16].

Although labels contain much nutritional information, few studies have investigated various aspects related to the degree of nutrition labeling utilization, such as the awareness, use, and effect on food selection in Korea. There were limited evidence addressing the utilization of nutrition labels focusing on patients with diabetes, including the clinical characteristics of diabetic patients such as disease duration and treatment status. This investigation attempted to identify the utilization status of nutrition labeling according to general characteristics, health-related characteristics, and diabetes-related characteristics for Korean diabetic patients using data from the 7th KNHANES.

MATERIALS AND METHODS

Data source and study population

This study used the data from the 7th KNHANES (2016–2018). The survey aims to produce representative and reliable statistics on the health status, health behavior, and nutritional status of the Korean people. The most recent available population and housing census data at the time of sampling design were used as a sampling frame. A stratified cluster sampling method was used, and city/province, dong/eup/myeon, and housing type (general house/

apartment) were used as stratification variables. Twenty households were selected per area using the systematic sampling method. Annually, 192 sample areas and 4,416 households were selected, and the survey was conducted from January to December targeting household members aged ≥ 1 yr [17]. The KNHANES was approved by the institutional review board of the Korea Centers for Disease Control and Prevention (2018-01-03-P-A) and informed consent was obtained from all participants.

A total of 24,269 people participated in the 7th KNHANES (8,150 people in 2016, 8,127 people in 2017, and 7,992 people in 2018). Among them, 19,389 were adults aged ≥ 19 yrs and 1,809 had been diagnosed with diabetes by a doctor. Among them, 222 were excluded due to missing values of nutrition label utilization, and 1,587 people were selected as study subjects.

Variables

General characteristics included gender (men, women), age (< 65 or ≥ 65), residence (urban or rural), marital status (married or single), monthly household income (low, middle-low, middle-high, or high). Monthly household income was divided into quartiles.

Health-related characteristics included drinking frequency (none, ≤ 4 /mon, or ≥ 2 /wk), smoking status (current smoking, past smoking, or none), walking days (none, < 4 days, or ≥ 4 days), sleep time (< 6 h or ≥ 6 h), family history of diabetes (no or yes), and number of chronic disease (none, 1, or ≥ 2). Family history of diabetes was defined as those in which at least one of the parents or siblings was diagnosed with diabetes. Number of chronic diseases was defined as physician diagnosis history of hypertension, dyslipidemia, stroke, heart disease, osteoarthritis, rheumatoid arthritis, and cancer.

Diabetes-related characteristics included age at diagnosis (< 45 or ≥ 45 yrs), disease duration (< 10 or ≥ 10 yrs), fasting blood sugar level (< 126 or ≥ 126 mg/dL), hemoglobin A1c ($< 6.5\%$, $\geq 6.5\%$), meal therapy (no, yes), treatment of diabetes (none, insulin treatment, drug or non-drug treatment), and fundus examination (no, yes). Age at diagnosis was divided at years since 45 yrs was known to be a high risk group for diabetes [18], and the disease duration was divided at 10 yrs because the risk of cardiovascular disease was significantly increased after 10 yrs of diabetes diagnosis [19]. Blood samples were collected from the participants fasting after dinner the day before the survey. Fasting blood sugar level was measured using hexokinase UV with a Hitachi Automatic Analyzer 7600-210 (Hitachi, Tokyo, Japan). HbA1c level was analyzed high performance liquid chromatography with a Tosoh G8 (Tosoh, Tokyo, Japan). Meal therapy was defined as a “yes” answer to the question, “Are you controlling your diet for a specific reason?” Fundus examination was defined as a “yes” answer to the question “Have you had an eye examination in the past year to determine whether diabetes-related eye complications have occurred?”

The utilization of nutrition label included awareness (no, yes), use (no, yes), and effect on food selection (no, yes). Awareness of nutrition labels was defined as a “yes” response to the question “Are you aware of nutrition labeling?” The use of nutrition labels was defined as “yes” response to the question “Do you read nutrition labels when buying or choosing processed foods?” The nutrition label effect on food selection was defined as a “yes” response to the question “Does nutrition labeling affect food selection?”

Analysis

SPSS version 26 (IBM Corp., Armonk, NY, USA) was used for statistical analyses. The characteristics of the study subjects are presented as frequencies and percentages. Chi-square tests were performed to analyze the relationships between subjects' general characteristics, health-related characteristics, diabetes-related characteristics, and nutrition label utilization. Finally, multiple logistic regression analysis was performed to analyze the relevant factors that had a significant effect on the awareness, use, and effect of nutrition labels on food selection, including general characteristics, health-related, and diabetes-related characteristics. Differences were considered significant at $P < 0.05$.

RESULTS

Utilization of nutrition label according to general characteristics

Of the total 1,587 participants, 52.3% were women, and 61.6% were 65 yrs of age or older. And 73.9% lived in urban areas, and 41.1% were responded as low-income level. A total of 48.8% of subjects were aware of nutrition labels, 11.4% used them, and 9.6% were influenced by nutrition labels for food selection. According to the general characteristics, 70.5% were < 65 yrs, 35.2% were \geq 65 yrs ($P < 0.001$); 52.5% of participants in cities and 38.3% of participants in rural areas were aware of nutrition labels ($P < 0.001$). Among the subjects, 14.8% of women and 7.7% of men ($P < 0.001$), 20.8% of < 65 yrs, and 5.5% of over \geq 65 yrs ($P < 0.001$) used nutrition labels for food selection. Approximately 13.1% of women and 5.7% of men ($P < 0.001$), 17.9% of < 65 yrs, and 4.4% \geq 65 yrs ($P < 0.001$) were affected by nutrition labels for food selection (Table 1).

Utilization of nutrition label according to health-related characteristics

According to health-related characteristics, the proportions of nutrition label awareness were 57.7% for those who drank < 4 times a month, 47.5% for those who drank > 2 times a week, and 42.4% for non-drinkers ($P < 0.001$). Nutrition labels were recognized by 50.0% of those with \geq 6 h of sleep and 43.7% of those with < 6 h ($P < 0.047$), 57.9% of those with a family history of diabetes, and 43% of those without ($P < 0.001$). The proportions of nutrition label use were 14.6% for those who walked \geq 4 days, 13.1% for those who walked < 4 days, and 5.6% for those who did not walking ($P < 0.001$); the rates were 13.5% and 10.1% in those with and without a family history of diabetes, respectively ($P = 0.037$). The proportions of nutrition label effects on food choice were 12.6% in those who drank \geq 4 times a month, 8.3% in those

Table 1. Utilization of nutrition label according to general characteristics

Variable	Division	Total	Awareness of nutrition label		Use of nutrition label		Effect of nutrition label	
			No. (%)	χ^2 (P)	No. (%)	χ^2 (P)	No. (%)	χ^2 (P)
Total			774 (48.8)		181 (11.4)		152 (9.6)	
Gender	Men	757 (47.7)	378 (49.9)	0.783 (0.376)	58 (7.7)	20.073 (< 0.001)	43 (5.7)	25.388 (< 0.001)
	Women	830 (52.3)	396 (47.7)		123 (14.8)		109 (13.1)	
Age (yrs)	< 65	610 (38.4)	430 (70.5)	187.101 (< 0.001)	127 (20.8)	86.915 (< 0.001)	109 (17.9)	78.648 (< 0.001)
	\geq 65	977 (61.6)	344 (35.2)		54 (5.5)		43 (4.4)	
Residence	Urban	1,172 (73.9)	615 (52.5)	24.599 (< 0.001)	142 (12.1)	2.241 (0.134)	122 (10.4)	3.580 (0.058)
	Rural	415 (26.1)	159 (38.3)		39 (9.4)		30 (7.2)	
Marital status	Married	1,549 (97.6)	750 (48.4)	3.225 (0.073)	173 (11.2)	3.586 (0.058)	145 (9.4)	3.516 (0.061)
	Single	38 (2.4)	24 (63.2)		8 (21.1)		7 (18.4)	
Monthly household income	Low	653 (41.1)	196 (30.0)	184.748 (< 0.001)	34 (5.2)	47.702 (< 0.001)	27 (4.1)	40.048 (< 0.001)
	Middle-low	394 (24.8)	210 (53.3)		51 (12.9)		48 (12.2)	
	Middle-high	299 (18.8)	197 (65.9)		53 (17.7)		46 (15.4)	
	High	233 (14.7)	170 (73.0)		42 (18.0)		30 (12.9)	

Table 2. Utilization of nutrition label according to health-related characteristics

Variable	Division	Total	Awareness of nutrition label		Use of nutrition label		Effect of nutrition label	
			No. (%)	χ^2 (P)	No. (%)	χ^2 (P)	No. (%)	χ^2 (P)
Drinking frequency	None	726 (45.7)	308 (42.4)	29.639 (< 0.001)	70 (9.6)	13.424 (0.001)	60 (8.3)	9.758 (0.008)
	< 4/mon	562 (35.4)	324 (57.7)		86 (15.3)		71 (12.6)	
	≥ 2/wk	299 (18.8)	142 (47.5)		25 (8.4)		21 (7.0)	
Smoking status	Smoking	239 (15.1)	129 (54.0)	3.342 (0.188)	28 (11.7)	4.841 (0.089)	19 (7.9)	7.776 (0.02)
	Past smoking	450 (28.4)	220 (48.9)		39 (8.7)		31 (6.9)	
	None	898 (56.6)	425 (47.6)		114 (12.7)		102 (11.4)	
Walking days per week (day)	None	486 (30.6)	171 (35.2)	52.979 (< 0.001)	27 (5.6)	24.329 (< 0.001)	21 (4.3)	25.959 (< 0.001)
	< 4	429 (27.0)	226 (52.7)		56 (13.1)		42 (9.8)	
	≥ 4	672 (42.3)	377 (56.1)		98 (14.6)		89 (13.2)	
Sleep time (h)	< 6	311 (19.6)	136 (43.7)	3.935 (0.047)	33 (10.6)	0.241 (0.623)	30 (9.6)	0.963 (0.002)
	≥ 6	1,276 (80.4)	638 (50.0)		148 (11.6)		122 (9.6)	
Family history of diabetes	No	972 (61.2)	418 (43.0)	33.39 (< 0.001)	98 (10.1)	4.344 (0.037)	81 (8.3)	4.485 (0.034)
	Yes	615 (38.8)	356 (57.9)		83 (13.5)		71 (11.5)	
No. of chronic diseases	None	264 (16.6)	144 (54.5)	4.226 (0.121)	30 (11.4)	3.327 (0.189)	27 (10.2)	2.066 (0.356)
	1	506 (31.9)	241 (47.6)		68 (13.4)		55 (10.9)	
	≥ 2	817 (51.5)	389 (47.6)		83 (10.2)		70 (8.6)	

who drank < 4 times a month, 7.0% in those who drank > 2 times a week ($P = 0.008$), and 11.4% in non-smokers, 7.9% in smokers, and 6.9% in former smokers ($P = 0.020$). Overall, 11.5% and 8.3% of those with and without a family history of diabetes, respectively, had their food selection choices influenced by nutrition labels ($P = 0.034$) (Table 2).

Utilization of nutrition label according to diabetes related characteristics

According to diabetes-related characteristics, the proportions of nutritional label awareness were 70.9% in those diagnosed at < 45 yrs and 44.8% in those who were diagnosed ≥ 45 yrs ($P < 0.001$), and 53.5% in those with diabetes < 10 yrs and 43.1% in those with diabetes ≥ 10 yrs ($P < 0.001$). Nutrition labeling was recognized in 55.3% of those with meal therapy and 43.6% of those without ($P < 0.001$), 57% of those who had a fundus examination in the last year and 45.4% in those who did not ($P < 0.001$). The proportions of nutritional label use were 23% in those diagnosed with diabetes at < 45 yrs of age and 9.3% in those ≥ 45 ($P < 0.001$), and 14.7% in those with diabetes < 10 yrs and 7.3% in those with diabetes ≥ 10 yrs ($P < 0.001$). The proportions of nutrition label effect on food selection were 19.3% in those diagnosed with diabetes before age 45 and 7.8% in those diagnosed after age 45 ($P < 0.001$), and 12.4% in those with diabetes < 10 yrs and 6% in those with diabetes ≥ 10 yrs ($P < 0.001$). The rates of subjects who selected food based on nutritional label information were 14.6% in those with meal therapy and 5.6% without ($P < 0.001$), and 14.5% in those with a fundus examination in the previous year, and 7.6% in those without one ($P < 0.01$) (Table 3).

Related factors with utilization of nutrition label among patients with diabetes

Table 4 presents the related factors to nutritional label utilization using multiple logistic regression analysis. The adjusted odds ratios (aORs) for nutrition label awareness were significantly higher in those with high monthly income (aOR, 4.77, 95% confidence interval [CI], 3.32–6.86), those who walked ≥ 4 days a week (aOR, 1.69, 95% CI, 1.28–2.22), those with a family history of diabetes (aOR, 1.40, 95% CI, 1.11-1.77), those diagnosed before 45 yrs of age (aOR, 2.84, 95% CI, 1.98–4.07), and those with the duration of diabetes < 10 yrs (aOR, 1.54, 95% CI, 1.19–1.94). The aORs for nutrition label use were significantly higher in women (aOR, 4.90, 95% CI, 2.72–8.83), those with high monthly income (OR, 3.08, 95% CI, 1.81–5.24), those diagnosed before age 45 (aOR, 3.27, 95% CI, 2.09–5.12), those with diabetes < 10 yrs (aOR, 2.68, 95% CI, 1.77–4.06), those with meal therapy (aOR, 2.18, 95% CI,

Table 3. Utilization of nutrition label according to diabetes related characteristics

Variable	Division	Total	Awareness of nutrition label		Use of nutrition label		Effect of nutrition label	
			No. (%)	χ^2 (P)	No. (%)	χ^2 (P)	No. (%)	χ^2 (P)
Age at diagnosis (yrs)	< 45	244 (15.4)	173 (70.9)	56.518 (< 0.001)	56 (23.0)	38.038 (< 0.001)	47 (19.3)	31.225 (< 0.001)
	≥ 45	1,343 (84.6)	601 (44.8)		125 (9.3)		105 (7.8)	
Duration of DM (yrs)	< 10	892 (56.2)	477 (53.5)	16.727 (< 0.001)	131 (14.7)	21.164 (< 0.001)	111 (12.4)	18.861 (< 0.001)
	≥ 10	689 (43.4)	297 (43.1)		50 (7.3)		41 (6.0)	
Fasting blood sugar (mg/dL)	< 126	649 (40.9)	316 (48.7)	0.003 (0.957)	75 (11.6)	0.025 (0.875)	61 (9.4)	0.041 (0.840)
	≥ 126	938 (59.1)	458 (48.8)		106 (11.3)		91 (9.7)	
HbA1c (%)	< 6.5	519 (32.7)	243 (46.8)	1.174 (0.279)	56 (10.8)	0.289 (0.591)	44 (8.5)	1.077 (0.299)
	≥ 6.5	1,068 (67.3)	531 (49.7)		125 (11.7)		108 (10.1)	
Meal therapy	No	887 (56.0)	387 (43.6)	21.294 (< 0.001)	65 (7.3)	33.333 (< 0.001)	50 (5.6)	36.300 (< 0.001)
	Yes	698 (44.0)	386 (55.3)		116 (16.6)		102 (14.6)	
Treatment of DM	None	97 (6.1)	45 (46.4)	0.593 (0.744)	8 (8.2)	1.668 (0.434)	8 (8.2)	1.203 (0.548)
	Insulin treatment	123 (7.8)	57 (46.3)		17 (13.8)		15 (12.2)	
	Drugs or non-drug treatment	1,367 (86.1)	672 (49.2)		156 (11.4)		129 (9.4)	
Fundus examination	No	1,120 (70.6)	509 (45.4)	17.559 (< 0.001)	104 (9.3)	17.451 (< 0.001)	85 (7.6)	17.872 (< 0.001)
	Yes	463 (29.2)	264 (57.0)		77 (16.6)		67 (14.5)	

DM, diabetes mellitus; HbA1c, hemoglobin A1c.

Table 4. Related factors with utilization of nutrition label among patients with diabetes

Variable	Division	Awareness of nutrition label	Use of nutrition label	Effect of nutrition label
Gender (vs. Men)	Women	1.25 (0.88–1.77)	4.90 (2.72–8.83)	5.09 (2.68–9.68)
Residence (vs. Rural)	Urban	1.41 (1.09–1.83)	0.98 (0.64–1.48)	1.11 (0.70–1.76)
Marital status (vs. Married)	Single	1.88 (0.86–4.07)	2.01 (0.79–5.11)	2.07 (0.76–5.59)
Monthly household income (vs. Low)	Middle-low	2.29 (1.74–3.03)	2.14 (1.32–3.49)	2.61 (1.54–4.41)
	Middle-high	3.49 (2.55–4.78)	2.91 (1.77–4.79)	3.07 (1.78–5.27)
	High	4.77 (3.32–6.86)	3.08 (1.81–5.24)	2.38 (1.31–4.33)
Drinking frequency (vs. None)	≤ 4/mon	1.41 (1.09–1.82)	1.39 (0.95–2.03)	1.34 (0.89–2.02)
	≥ 2/wk	0.94 (0.67–1.32)	1.09 (0.61–1.92)	1.36 (0.73–2.24)
Smoking status (vs. None)	Smoking	1.30 (0.86–1.95)	2.48 (1.30–4.73)	1.68 (0.82–3.46)
	Past smoking	1.17 (0.81–1.70)	1.97 (1.06–3.68)	1.69 (0.86–3.32)
Walking days (vs. None)	Less than 4 days	1.63 (1.21–2.20)	2.10 (1.25–3.54)	1.91 (1.06–3.43)
	More than 4 days	1.69 (1.28–2.22)	2.07 (1.27–3.38)	2.42 (1.41–4.15)
Sleep time (vs. < 6 h)	≥ 6 h	1.28 (0.95–1.71)	1.13 (0.72–1.73)	1.06 (0.65–1.71)
Family history of diabetes (vs. No)	Yes	1.40 (1.11–1.77)	0.93 (0.65–1.33)	0.96 (0.65–1.41)
No. of chronic disease (vs. ≥ 2)	None	1.20 (0.86–1.68)	1.08 (0.64–1.81)	1.23 (0.71–2.14)
	1	0.86 (0.67–1.11)	1.33 (0.91–1.94)	1.29 (0.86–1.95)
Age at diagnosis (vs. ≥ 45 yrs)	< 45 yrs	2.84 (1.98–4.07)	3.27 (2.09–5.12)	2.93 (1.81–4.73)
Duration of DM (vs. ≥ 10 yrs)	< 10 yrs	1.52 (1.19–1.94)	2.68 (1.77–4.06)	2.81 (1.79–4.43)
Fasting blood sugar (vs. ≥ 126)	< 126	1.16 (0.89–1.49)	1.07 (0.73–1.57)	1.05 (0.69–1.58)
HbA1c (vs. < 6.5%)	≥ 6.5%	1.11 (0.84–1.46)	1.09 (0.72–1.66)	1.28 (0.81–2.01)
Meal therapy (vs. No)	Yes	1.44 (1.14–1.82)	2.18 (1.52–3.12)	2.45 (1.65–3.64)
Treatment of DM (vs. None)	Insulin treatment	0.74 (0.38–1.42)	1.63 (0.57–4.64)	1.23 (0.42–3.62)
	Drugs or non-drug treatment	1.18 (0.72–1.92)	1.93 (0.83–4.48)	1.41 (0.60–3.32)
Fundus examination (vs. No)	Yes	1.25 (0.97–1.62)	1.62 (1.13–2.34)	1.74 (1.18–2.58)

Data were expressed as adjusted odds ratio (95% confidence interval).

DM, diabetes mellitus; HbA1c, hemoglobin A1c.

1.52–3.12), and subjects who had a fundus examination (OR, 1.62, 95% CI, 1.13–2.34). The aORs for nutrition label effect on food choice were significantly higher in women (aOR, 5.09, 95% CI, 2.68–9.68), those with high monthly income (aOR, 2.38, 95% CI, 1.31–4.33), those diagnosed before age 45 (aOR, 2.93, 95% CI, 1.81–4.73), those with diabetes < 10 yrs (aOR, 2.81, 95% CI, 1.79–4.43), those with meal therapy (aOR, 2.45, 95% CI, 1.65–3.64), and those who had a fundus examination (aOR, 1.74, 95% CI, 1.18–2.58) (Table 4).

DISCUSSION

The appropriate management of diabetic patients requires medication, appropriate eating habits, and a healthy lifestyle. This study was conducted to understand the current status and related factors on nutrition label awareness, use, and their effect on food selection in Korean diabetic patients using data from the 7th KNHANES. The proportions of nutrition label awareness, use, and effect on food selection were 48.8%, 11.4%, and 9.6%, respectively, and nutrition label utilization among diabetic patients was low at < 50% in Korea. According to 2016–2018 KNHANES data, the proportions of nutrition label awareness, use, and effect on food selection were 68%, 22.8%, and 18.3% in adults ≥ 19 yrs. Therefore, nutrition label utilization was lower in patients with diabetes compared to the general adult population.

In a study using data from the 2005–2006 US National Health and Nutrition Examination Survey, the proportion of nutritional label awareness and use among adults with type 2 diabetes, hypertension, and hyperlipidemia was 71.2% compared to 59.9% in adults without disease [20]. In the US, nutritional label information displayed in images rather than text might contribute to the influence on food selection [21]. Although graphical nutrition labeling on the front of Korean processed food packages was made possible in 2009 [22], most nutrition labels are presented only in text. This might make it difficult to recognize or use them quickly due to literacy, numerical value confusion, and other problems. It is therefore necessary to discuss easy-to-understand nutrition labeling so that consumers can use them more easily when choosing food [22–24].

Nutritional label awareness, use, and effect on food selection were higher in women than men in this study. This is similar to a previous report that nutrition label use was higher in women compared to men [25]. This may be because women mainly purchase food in the household, and women might be more interested in their body shape and weight control than men [26]. With regard to age, the proportions of nutrition label awareness, use, and effect on food selection were lower in subjects ≥ 65 yrs. Elderly people might lack access to information on nutrition labels or not fully understand them [27,28]. There is a need for a nutritional labeling method that is easy to understand and easily communicated to all age groups in consideration of the cognitive abilities and visual acuity of the elderly.

Subjects with lower incomes were less likely to utilize nutrition labels. In previous studies, people who had a larger household income or higher education level were more likely to use nutrition labels [25,29]. Also, according to previous studies, people with higher incomes who were more educated were more likely to use nutrition information to choose food. It is known that low income levels, price, taste, and food safety are considered more than health and nutritional importance when making food selections [30,31].

Among the health-related characteristic factors, fewer walking days per week was associated with lower use of nutrition labeling. Healthy behaviors were positively associated with other health behaviors [32]. It is thought that people who walk have a higher interest in health and use nutrition labeling in relation to food selection.

Among the diabetes-related characteristics, nutrition label use was lower in those who were diagnosed with diabetes after age 45 and those with disease duration > 10 yrs. In studies with type 2 diabetes, age at diagnosis and diabetes duration were independently associated with macrovascular complications and death [33,34]. Because the risk of complications

increases when longer duration of diabetes, it is necessary to increase the level of utilization of nutrition labeling to promote good eating habits of patients, particularly those who diagnosed diabetes at older age and have longer duration of disease.

Those conducted a fundus examination in the previous year reported high nutrition label utilization. Diabetic retinopathy is a frequent complication of diabetes, and fundus examination is one of the recommended tests for the detection of diabetic complications. Previous studies reported that meeting diabetes care professionals was an independent predictor for undertaking a fundus examination [35,36]. And those who did not receive meal therapy reported low nutrition label utilization. In a previous study of patients with hypertension or diabetes mellitus, those who listened to, practiced, or received nutrition education had a higher rate of use of nutrition labeling [13]. Such programs might include nutrition label education to help guide food selection. Nutrition labeling use was 50% higher when patients with type 2 diabetes, hypertension, or hyperlipidemia were advised to reduce calories by a doctor or other health professional than when they did not receive recommendations [20]. People using nutrition labeling information improved their eating habits by consuming less saturated fat, carbohydrates, and sugar and consuming more fiber [12,20]. People with chronic diseases were more aware of nutritional recommendations, and used nutrition labels [37]. Therefore, the use of nutrition labeling as a means of paying attention to health and practicing good eating habits will help diabetic patients properly manage their meals.

The major limitation of this work is that KNHANES is a cross-sectional study; while we were able to identify factors related to nutrition label utilization, we were unable to define a causal relationship. Secondly, food selection and nutritional intake were not investigated. If these aspects are assessed in the future, it would inform the effect of the use of nutrition labels on the nutritional status and food intake of diabetic patients. Third, the KNHANES did not distinguish between type 1 and type 2 diabetes. Since the prevalence of type 1 diabetes in Korea is relatively low [38], most of the patients in this study would have type 2 diabetes. And nutrition management for diabetic patients would be important regardless of the type.

This study identified the utilization status of nutrition labeling among patients with diabetes in Korea using representative and reliable data. Patients with a high income, those who walk multiple times per week, those diagnosed with diabetes at a young age, those with a short disease duration, and those on meal therapy were more likely to utilize nutrition labels. Our findings can be used to set the direction for improving the nutrition labeling system for patients with diabetes and to plan nutrition label use for health care professionals to manage the health of patients with diabetes.

REFERENCES

1. Choi YJ, Kim HC, Kim HM, Park SW, Kim J, Kim DJ. Prevalence and management of diabetes in Korean adults: Korea National Health and Nutrition Examination Surveys 1998-2005. *Diabetes Care* 2009;32:2016-20. [PUBMED](#) | [CROSSREF](#)
2. Ministry of Health and Welfare (KR); Korea Center for Disease Control and Prevention. Korea Health Statistics 2019: Korea National Health and Nutrition Examination Survey (KNHANES VIII-1). Cheongju: Korea Center for Disease Control and Prevention; 2020.
3. Statistics Korea. Cause-of-death statistics in 2020 [Internet]. Daejeon: Statistics Korea; 2021 [cited 2022 January 28]. Available from: <https://kostat.go.kr/>.

4. International Diabetes Federation. Diabetes around the world in 2021 [Internet]. Brussels: International Diabetes Federation; 2021 [cited 2022 January 28]. Available from: <https://diabetesatlas.org/>.
5. International Diabetes Federation. Recommendations for managing type 2 diabetes in primary care [Internet]. Brussels: International Diabetes Federation; 2017 [cited 2022 January 28]. Available from: www.idf.org/managing-type2-diabetes.
6. Breen C, Ryan M, Gibney MJ, O'Shea D. Diabetes-related nutrition knowledge and dietary intake among adults with type 2 diabetes. *Br J Nutr* 2015;114:439-47.
[PUBMED](#) | [CROSSREF](#)
7. Silverglade BA. The nutrition labeling and education act—progress to date and challenges for the future. *J Public Policy Mark* 1996;15:148-50.
[CROSSREF](#)
8. Kang HN, Shin EJ, Kim HN, Eom KY, Kwon KI, Kim SY, Moon GI, Kang BW, Kim JW. Food nutrition labeling (processing food, food service business) in Korea. *Food Sci Ind* 2011;44:21-7.
[CROSSREF](#)
9. An R, Shi Y, Shen J, Bullard T, Liu G, Yang Q, Chen N, Cao L. Effect of front-of-package nutrition labeling on food purchases: a systematic review. *Public Health* 2021;191:59-67.
[PUBMED](#) | [CROSSREF](#)
10. Neuhaus ML, Kristal AR, Patterson RE. Use of food nutrition labels is associated with lower fat intake. *J Am Diet Assoc* 1999;99:45-53.
[PUBMED](#) | [CROSSREF](#)
11. Navarrete-Muñoz EM, Torres-Collado L, Valera-Gran D, Gonzalez-Palacios S, María Compañ-Gabucio L, Hernández-Sánchez S, Garcia-de-la-Hera M. Nutrition labelling use and higher adherence to Mediterranean diet: results from the DiSA-UMH study. *Nutrients* 2018;10:442.
[PUBMED](#) | [CROSSREF](#)
12. Emrich TE, Qi Y, Lou WY, L'Abbe MR. Traffic-light labels could reduce population intakes of calories, total fat, saturated fat, and sodium. *PLoS One* 2017;12:e0171188.
[PUBMED](#) | [CROSSREF](#)
13. Park SG, Kim HJ, Kwon YM, Kong MH. Nutrition label use and its relation to dietary intake among chronic disease patients in Korea: results from the 2008-2009 Fourth Korean National Health and Nutrition Examination Survey (KNHANES-IV). *Korean J Health Promot* 2014;14:131-40.
[CROSSREF](#)
14. An R. Diabetes diagnosis and nutrition facts label use among US adults, 2005-2010. *Public Health Nutr* 2016;19:2149-56.
[PUBMED](#) | [CROSSREF](#)
15. Elfassy T, Yi S, Eisenhower D, Lederer A, Curtis CJ. Use of sodium information on the nutrition facts label in New York City adults with hypertension. *J Acad Nutr Diet* 2015;115:278-83.
[PUBMED](#) | [CROSSREF](#)
16. Kang HT, Shim JY, Lee YJ, Linton JA, Park BJ, Lee HR. Reading nutrition labels is associated with a lower risk of metabolic syndrome in Korean adults: the 2007-2008 Korean NHANES. *Nutr Metab Cardiovasc Dis* 2013;23:876-82.
[PUBMED](#) | [CROSSREF](#)
17. Kweon S, Kim Y, Jang MJ, Kim Y, Kim K, Choi S, Chun C, Khang YH, Oh K. Data resource profile: the Korea National Health and Nutrition Examination Survey (KNHANES). *Int J Epidemiol* 2014;43:69-77.
[PUBMED](#) | [CROSSREF](#)
18. Lee YH, Bang H, Kim HC, Kim HM, Park SW, Kim DJ. A simple screening score for diabetes for the Korean population: development, validation, and comparison with other scores. *Diabetes Care* 2012;35:1723-30.
[PUBMED](#) | [CROSSREF](#)
19. Hippisley-Cox J, Coupland C, Vinogradova Y, Robson J, May M, Brindle P. Derivation and validation of QRISK, a new cardiovascular disease risk score for the United Kingdom: prospective open cohort study. *BMJ* 2007;335:136.
[PUBMED](#) | [CROSSREF](#)
20. Post RE, Mainous AG 3rd, Diaz VA, Matheson EM, Everett CJ. Use of the nutrition facts label in chronic disease management: results from the National Health and Nutrition Examination Survey. *J Am Diet Assoc* 2010;110:628-32.
[PUBMED](#) | [CROSSREF](#)
21. Sonnenberg L, Gelsomin E, Levy DE, Riis J, Barraclough S, Thorndike AN. A traffic light food labeling intervention increases consumer awareness of health and healthy choices at the point-of-purchase. *Prev Med* 2013;57:253-7.
[PUBMED](#) | [CROSSREF](#)

22. Park HK. Nutrition policy for nutrition labeling in Korea. *Food Ind Nutr* 2009;14:9-14.
23. Velardo S. The nuances of health literacy, nutrition literacy, and food literacy. *J Nutr Educ Behav* 2015;47:385-389.e1.
[PUBMED](#) | [CROSSREF](#)
24. Mansfield E, Wahba R, De Grandpré E. Integrating a health literacy lens into nutrition labelling policy in Canada. *Int J Environ Res Public Health* 2020;17:4130.
[PUBMED](#) | [CROSSREF](#)
25. Hong SW, Oh SW, Lee C, Kwon H, Hyeon JH, Gwak JS. Association between nutrition label use and chronic disease in Korean adults: the Fourth Korea National Health and Nutrition Examination Survey 2008-2009. *J Korean Med Sci* 2014;29:1457-63.
[PUBMED](#) | [CROSSREF](#)
26. Chung JY, Kim MJ. Using and understanding of nutrition labels and related factors among female adults in the Seoul area. *Korean J Community Nutr* 2007;12:417-25.
27. Kim MH. Metabolic risk and nutrient intake by nutrition education in Korean adult men-result from the 2016~2017 Korea National Health and Nutrition Examination Survey. *Korean J Food Nutr* 2019;32:251-8.
[CROSSREF](#)
28. Rothman RL, Housam R, Weiss H, Davis D, Gregory R, Gebretsadik T, Shintani A, Elasy TA. Patient understanding of food labels: the role of literacy and numeracy. *Am J Prev Med* 2006;31:391-8.
[PUBMED](#) | [CROSSREF](#)
29. Jo HS, Jung SM. Evaluation of food labeling policy in Korea: analyzing the community health survey 2014-2017. *J Korean Med Sci* 2019;34:e211.
[PUBMED](#) | [CROSSREF](#)
30. Burns C, Cook K, Mavoja H. Role of expendable income and price in food choice by low income families. *Appetite* 2013;71:209-17.
[PUBMED](#) | [CROSSREF](#)
31. Lo YT, Chang YH, Lee MS, Wahlqvist ML. Health and nutrition economics: diet costs are associated with diet quality. *Asia Pac J Clin Nutr* 2009;18:598-604.
[PUBMED](#)
32. Berrigan D, Dodd K, Troiano RP, Krebs-Smith SM, Barbash RB. Patterns of health behavior in U.S. adults. *Prev Med* 2003;36:615-23.
[PUBMED](#) | [CROSSREF](#)
33. Zoungas S, Woodward M, Li Q, Cooper ME, Hamet P, Harrap S, Heller S, Marre M, Patel A, Poulter N, et al. Impact of age, age at diagnosis and duration of diabetes on the risk of macrovascular and microvascular complications and death in type 2 diabetes. *Diabetologia* 2014;57:2465-74.
[PUBMED](#) | [CROSSREF](#)
34. Nanayakkara N, Ranasinha S, Gadowski A, Heritier S, Flack JR, Wischer N, Wong J, Zoungas S. Age, age at diagnosis and diabetes duration are all associated with vascular complications in type 2 diabetes. *J Diabetes Complications* 2018;32:279-90.
[PUBMED](#) | [CROSSREF](#)
35. Tapp RJ, Zimmet PZ, Harper CA, de Courten MP, Balkau B, McCarty DJ, Taylor HR, Welborn TA, Shaw JE; Australian Diabetes Obesity and Lifestyle Study Group. Diabetes care in an Australian population: frequency of screening examinations for eye and foot complications of diabetes. *Diabetes Care* 2004;27:688-93.
[PUBMED](#) | [CROSSREF](#)
36. O'Keeffe D, Riordan F, Harkins V, Kearney P, Mc Hugh S. Predictors of attendance at diabetic retinopathy screening among people with type 2 diabetes: secondary analysis of data from primary care. *Prim Care Diabetes* 2021;15:1086-94.
[PUBMED](#) | [CROSSREF](#)
37. Lewis JE, Arheart KL, LeBlanc WG, Fleming LE, Lee DJ, Davila EP, Cabán-Martínez AJ, Dietz NA, McCollister KE, Bandiera FC, et al. Food label use and awareness of nutritional information and recommendations among persons with chronic disease. *Am J Clin Nutr* 2009;90:1351-7.
[PUBMED](#) | [CROSSREF](#)
38. Chae HW, Seo GH, Song K, Choi HS, Suh J, Kwon A, Ha S, Kim HS. Incidence and prevalence of type 1 diabetes mellitus among Korean children and adolescents between 2007 and 2017: an epidemiologic study based on a national database. *Diabetes Metab J* 2020;44:866-74.
[PUBMED](#) | [CROSSREF](#)