

Relating Factors for Impaired Fasting Glucose in Korean Adult: A Population Based Study

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Research article

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Abstract

Background: Individuals with impaired fasting glucose who have poor health behaviors are at a greater risk for a variety of health outcomes. This study aimed to investigate the relationship between health literacy and health behaviors in Korean adults with impaired fasting glucose (IFG).

Methods: This study adopted a secondary data analysis of the Korea National Health and Nutrition Examination Survey (KNHANES), which used a stratified, multi-stage, cluster-sampling design to obtain a nationally representative sample. This study analyzed the KNANES Health Examination Survey and Health Behavior Survey from 2016 to 2018. Multiple logistic regression analysis was employed to compute the odds ratios of health behaviors and health literacy to identify the risk factors for impaired fasting glucose.

Results: Among the 9919 participants, 7093 (71.5%) were in the normal fasting glucose group and 2826 (28.5%) were in the impaired fasting glucose group. The presence of an impaired fasting glucose level varied significantly by sex, age, economic status, and whether participants dined out regularly, drank alcohol regularly, recognized nutrition fact labels, and utilized nutrition facts labels.

Conclusions: Individuals with impaired fasting glucose were less likely to practice health behaviors and had lower health literacy compared with those with non-impaired fasting glucose. Our results suggest that improving health literacy in subjects with impaired fasting glucose is effective in improving their health behaviors.

Introduction

Impaired fasting glucose (IFG) is known to progress to type 2 diabetes. It refers to a state in which an individual's fasting blood glucose ranges from 100 to 125 mg/dl, just below the level for diabetes, which starts at 126 mg/dl [1]. IFG has an extremely high probability of progressing to type 2 diabetes [2]. An earlier longitudinal study, which tracked individuals with IFG for six years, found that IFG progressed to type 2 diabetes in 33% of the participants [3]. Another study found that the occurrence of diabetes in participants with IFG was 10 times higher than in those with normal blood glucose levels [2]. Of concern for individuals with IFG is not only a higher likelihood of developing diabetes, but also a greater risk of developing cardiovascular disease [4]. Persons with IFG have a higher body mass index (BMI), higher blood pressure, higher obesity rate, lower HDL cholesterol, and a higher level of triglycerides compared to normoglycemic individuals [5]. Although healthcare providers emphasize the importance of changing one's lifestyle to prevent diabetes [6], individuals with IFG are nevertheless at risk of engaging in unhealthy eating habits, smoking, and the consumption of alcohol [5]. Therefore, there is a need for individuals with IFG to improve their lifestyles.

Previous research shows that a randomized group of overweight IFG participants who participated in health behaviors such as increased physical activity and correct eating habits had a 0.56 (95% confidence interval, 0.36–0.87) reduction in the risk of developing diabetes [7]. This finding suggests that,

unlike individuals with diabetes, individuals with IFG can manage their blood glucose levels by practicing health behaviors such as improving their eating habits and exercising, which can delay or prevent the development of diabetes [6, 8, 9]. However, individuals with IFG must obtain and comprehend a wide range of health information to understand their situation and practice health behaviors [10]. In this regard, health literacy –the ability to understand basic health-related information and obtain and utilize services – is significantly correlated with patients’ abilities to practice health behaviors and maintain target blood glucose levels [11]. An earlier study shows that individuals with lower levels of health literacy experience poor health conditions, poor management of health, and high medical expenses [12, 13].

A low level of health literacy is associated with fewer health behaviors in many countries [14–16]. Despite South Korea’s low illiteracy rate, the research to date on health literacy among the Korean population suggests that health literacy levels tend to be low among older adults, those with low educational attainment, the low-income, and patients with chronic diseases. Still, the studies of health literacy for Korean individuals with IFG are very few.

A previous study showed that in addition to health literacy, age, gender, obesity, and health behaviors were significant factors associated with IFG [5, 17]. However, there is a lack of clarity regarding the relationship between health literacy and the factors affecting IFG. Ultimately, a study is needed that identifies the relationship between the factors influencing IFG and health literacy so that effective IFG health management can be developed for individuals with IFG.

Accordingly, this study aims to perform a comparative analysis of the health literacy levels and health behaviors of persons with IFG and those without IFG.

Methods

Study Design

This study was a secondary data analysis design using population-based data from a nationwide cross-sectional health survey. The purpose of the study was to identify lifestyle and health literacy factors associated with impaired glucose fasting levels among Korean adults.

Data Source and Participants

This investigation utilizes the Korean Health and Nutrition Examination Survey (KNHANES) data, which is a survey conducted by the Korean Ministry of Health and Welfare and the Korea Centers for Diseases Control and Prevention (KCDC). The KNHANES evaluates the health and nutrition status of Koreans, monitors trends in health risk factors and major chronic diseases, and provides data for the development and evaluation of Koreans health policies and programs. This survey used a stratified, multistage probability sampling design to select housing units. This included stratifying by region in the first stage and layering by gender and age in the second stage. To represent the entire Korean adult population and

account for the complex sampling procedure, sampling weights were used. The weighted sample for the KNHANES reflected the sampling fraction and nonresponse bias adjustments.

Total 24269 people who participated in the KNHANES VII (2016–2018) were analyzed whether inclusion criteria were met. After eliminating the data that belonging to exclusion criteria such as those under 29 and over 65 year, diagnosed type I or II diabetes and missing data (weighted $n = 14350$), weighted $n = 9919$ (7093 non-IFG people and 2826 individuals with IFG) were ultimately included in the analysis.

The KNHANES survey comprised the following: The Health Interview Survey, Health Behavior Survey, Nutrition Survey, and Health Examination Survey, and this study's variables were collected from these four surveys. In each survey, data were collected by trained interviewers. All participants were evaluated using self-administered questionnaires; participants who had difficulty completing the questionnaire were able to do so with the help of an interviewer.

Assessment of measurements

The KNHANES VII (2016–2018) was used to obtain information on demographic characteristics, hematologic examinations, health behaviors, and health literacy (i.e., recognition of nutrition fact labels and utilization of the nutrition fact labels).

Demographic characteristics. Sex, age, economic status (low, middle, high), education level (\leq middle school, \geq high school), employed status (yes or no), duty type (day, shift), perceived health status (good, bad), body mass index ($< 23 \text{ kg/m}^2$ or $\geq 23 \text{ kg/m}^2$), and perceived stress (never feel, feel a little, feel much) were used to assess socioeconomic status. Economic status was based on the average monthly household income. Household income was partially adjusted by sex and age based on monthly equivalent income (= monthly household income / number of families). Education level was categorized based on graduation status, such that completion, withdrawal, enrollment, and leave of absence were categorized with the preceding academic background. Citizens in the Republic of Korea receive mandatory education through middle school in accordance with Article 31 of the Constitution. Therefore, the education status was categorized based on whether each participant was a middle school graduate or had received more than compulsory education. For employed status, participants were asked "Have you worked for more than an hour in the last week for income? Or have you worked for your family for more than 18 hours unpaid? If you were originally working but are on a temporary leave of absence, this is considered work." For duty type, people who answered "yes" in response to "Do you work from 6 am to 6 pm?" were classified as day type, and people who answered "yes" in response to "Or do you work during a different time period?" were classified as shift type. The question regarding perceived health status asked, "What do you usually think about your health?" and the result was categorized into good or bad. Body mass index (BMI) was calculated using measured height and obesity. In this study, participants with a BMI of less than 18.5 kg/m^2 were categorized as underweight, those with a BMI of $18.5\text{--}22.9 \text{ kg/m}^2$ were categorized as normal weight, and those with a BMI of at least 23.0 kg/m^2 were categorized as overweight [18]. Participants were considered as not overweight or overweight based on whether their BMI was $< 23 \text{ kg/m}^2$ or $\geq 23 \text{ kg/m}^2$, respectively.

Health behaviors. Dining out was classified as less than once a month, less than twice a week, 3 to 4 times a week, or every day. Participants' alcohol consumption during the recent year was categorized as not at all, less than once a week, and more than two times a week. For smoking, "Smoking every day" and "Smoking occasionally" were classified as "yes", and "I smoked in the past, but not now" was classified as "no". The American Diabetes Association (ADA) recommends that people with prediabetes and IFG walk for at least 150 minutes a week. Weekly walking time was categorized as less than 150 minutes or more than 150 minutes a week. Weekly aerobic activity equivalent to medium-intensity physical activity for over 2 hours and 30 minutes or high-intensity physical activity for over 1 hour and 15 minutes or a mixture of medium- and high-intensity physical activity (high intensity for one minute or medium intensity for two minutes) was classified as yes or no. Total sitting time per day was calculated based on the usual sitting time during the week, and was categorized into sitting less than four hours a day or sitting for more than four hours a day.

Health literacy. Health literacy was measured by two questions. Participants responded to questions regarding the recognition of nutrition fact labels and utilization of nutrition fact labels with "yes" or "no." The outcome variable, "the presence of IFG" was assessed through responses to questions regarding whether participants have fasted for 8 hours without diabetes and have a fasting glucose level greater than 100 mg/dl but less than 126 mg/dl [1].

Statistical Analysis

All estimates were calculated based on a weighted sample that was evaluated by taking into consideration the stratified and cluster variables to generate the analysis data file. A complex sample analysis procedure was conducted in consideration of the sampling weights, stratification variable, and cluster variable. Through the process of applying these weights, the sampling bias was reduced. Missing data were statistically excluded. First, data from the selected sample were analyzed for individuals with non-IFG and IFG. Chi-square tests were conducted to compare the percentage or mean of all variables for individuals with non-IFG and IFG. In the next step, the logistic regression model was analyzed using variables with significant results in the univariate analysis to investigate the association between variables that were statistically significant at less than 0.05.

Results

Demographic characteristics and IFG

The demographic characteristics of the two groups are shown in Table 1. Among the 9919 participants, 7093 (71.5%) were in the normal fasting glucose group and 2826 (28.5%) were in the IFG group. The mean age of the participants was 45.3 (\pm 0.2) years old. Of total, 36.8% of participants were men, and 30.6% were exactly 40–49 years old. Additionally, 80.5% of the participants had at least a high school education in the IFG group. The presence of an IFG varied significantly by employed status ($p < .001$), duty type ($p = .002$), body mass index ($p < .001$), and perceived stress ($p = .002$)

Table 1
Demographic characteristics of participants (N = 9919)

Variables	Categories	Non-IFG (n = 7093) Weighted n (%)	IFG (n = 2826) Weighted n (%)	χ^2	<i>p</i>
Sex	Women	4492 (56.1)	1233 (36.4)	320.57	< .001
	Men	2601 (43.9)	1593 (63.6)		
Age, years Mean = 45.3, SD = ± 0.2	30–39	2218 (33.9)	476 (18.1)	304.70	< .001
	40–49	2170 (31.7)	866 (32.8)		
	50–59	1914 (25.9)	980 (35.3)		
	60–64	791 (8.6)	504 (13.8)		
Economic status	Low	513 (6.8)	277 (9.3)	18.54	.002
	Middle	3931 (56.4)	1567 (55.4)		
	High	2635 (36.8)	978 (35.2)		
	Missing	14	4		
Education level	≤ Middle school	1013 (13.3)	597 (19.5)	56.07	< .001
	≥ High school	5767 (86.7)	2089 (80.5)		
	Missing	313	140		
Employed status	Yes	4845 (73.7)	2071 (79.2)	33.25	< .001
	No	1936 (26.3)	615 (20.8)		
	Missing	312	140		
Duty type	Day type	4479 (85.0)	1944 (88.0)	12.03	.002
	Shift type	790 (15.0)	276 (12.0)		
	Missing	1824	606		
Perceived health status	Good	5869 (86.3)	2300 (86.0)	0.19	.685
	Bad	934 (13.7)	395 (14.0)		
	Missing	290	131		
BMI Mean = 23.8	< 23 kg/m ²	3493 (48.6)	688 (23.9)	529.70	< .001
BMI: Body Mass Index, IFG: Impaired Fasting Glucose					

Variables	Categories	Non-IFG (n = 7093) Weighted n (%)	IFG (n = 2826) Weighted n (%)	χ^2	<i>p</i>
SD = ± 0.04	≥ 23 kg/m ²	3518 (51.4)	2123 (76.1)	14.04	.002
	Missing	82	15		
Perceived stress	Never feel	819 (10.8)	378 (13.2)		
	Feel a little	4242 (60.2)	1679 (60.4)		
	Feel much	1985 (29.0)	735 (26.4)		
	Missing	47	34		

BMI: Body Mass Index, IFG: Impaired Fasting Glucose

Health behaviors and IFG

In IFG group, 2296 (96.6%) dined out more than twice a week, while 6014 (97.6%) of non-IFG was dining out twice a week and more. In drinking behaviors, 36.4% of IFG drank alcohol, while 23.0% of non-IFG drank alcohol more frequently. There were also significant differences between the two groups in their current smoking status ($p = .009$). In IFG group, 767 (51.7%) did not currently smoke, and in the non-IFG group, 1032 (53.2%) were currently smoke. For other health behaviors, as walking for a week ($p = .451$), practice of aerobic activity ($p = .416$), total time of sitting in a day ($p = .905$) were not significantly difference (Table 2).

Table 2
Health behaviors of participants (N = 9919)

Variables	Categories	Non-IFG (n = 7093)	IFG (n = 2826)	χ^2	<i>p</i>
		Weighted n (%)	Weighted n (%)		
Dinning out	Less than once a month	179 (2.4)	91 (3.4)	6.34	.016
	More than twice a week	6014 (97.6)	2296 (96.6)		
	Missing	900	439		
Drinking for a year	Not at all	1069 (16.2)	337 (12.0)	131.45	< .001
	Less than 1 time/week	3998 (60.8)	1378 (51.6)		
	More than 2 times/week	1513 (23.0)	912 (36.4)		
	Missing	513	199		
Current smoking status	Yes	1302 (53.2)	709 (48.3)	8.93	.009
	No	1194 (46.8)	767 (51.7)		
	Missing	4597	1350		
Walking for a week Mean = 236.8 SD = ± 3.7	< 150 minutes	3792 (54.1)	1555 (55.1)	0.75	.451
	≥ 150 minutes	3301 (45.9)	1271 (44.9)		
Practice of aerobic activity	Yes	3060 (46.2)	1181 (45.2)	0.81	.416
	No	3716 (53.8)	1508 (54.8)		
	Missing	317	137		
Total time of sitting in a day Mean = 490.8 SD = 3.9	< 4 hours	1093 (15.6)	440 (15.7)	0.01	.905
	≥ 4 hours	6000 (84.4)	2386 (84.3)		
IFG: Impaired Fasting Glucose					

Health literacy and IFG

Significant differences were observed between the two groups in health literacy such as recognition and utilization of nutrition fact labels. The number of people who recognized the nutrition fact labels were 87.4% in the non-IFG group and 81.8% in the IFG group. This showed a significant difference ($p < .001$). The utilization of the nutrition facts labels was found that 2180 (38.9%) were in the non-IFG group and 594 (30.5%) were in the IFG group use nutritional labels ($p < .001$) (Table 3).

Table 3
Health literacy of Participants (N = 9919)

Variables	Categories	Non-IFG (n = 7093)	IFG (n = 2826)	χ^2	<i>p</i>
		Weighted n (%)	Weighted n (%)		
Recognition of nutrition fact labels	Yes	5427 (87.4)	1945 (81.8)	42.20	<.001
	No	766 (12.6)	442 (18.2)		
	Missing	900	439		
Utilization of the nutrition facts labels	Yes	2180 (38.9)	594 (30.5)	45.30	<.001
	No	3247 (61.1)	1350 (69.5)		
	Missing	1666	881		
IFG: Impaired Fasting Glucose					

Factors associated with IFG

The results of the complex samples logistic regression model with or without IFG are shown in Tables 4. In the logistic regression model, compared with women, men showed an increased risk of IFG (OR = 2.24; 95% CI 1.99–2.50). Age was associated with the risk of IFG and the OR increased significantly every 10 years (reference group: 30–39); 40–49 (OR = 1.94; 95% CI 1.67–2.26), 50–59 (OR = 2.56; 95% CI 2.21–2.95), and 60–69 (OR = 3.01; 95% CI 2.56–3.55). Economic status (reference group: high) was associated with the risk of IFG, low status (OR = 1.44; 95% CI 1.19–1.73). Other risk factors for IFG included education level (reference group: \geq high school); \leq middle school (OR = 1.58; 95% CI 1.38–1.81), employed status (reference group: no); yes (OR = 1.37; 95% CI 1.20–1.54), and duty type (reference group: shift type); day duty type (OR = 1.29; 95% CI 1.10–1.52). For body mass index, those who were not overweight (BMI < 23 kg/m²) were less likely to report IFG than those who were overweight (BMI \geq 23 kg/m²; OR = 3.01, 95% CI 2.68–3.36).

Additional risk factors associated with IFG were drinking during the past year (reference group: not at all); more than 2 times for a week (OR = 1.86; 95% CI 1.56–2.21), current smoking status (reference group: yes); no (OR = 1.22; 95% CI 1.05–1.41), dining out (reference group: less than once for a month); more

than two times for a week (OR = 0.70, 95% CI 0.53–0.93). Participants not recognizing nutrition fact labels had a risk of IFG that was 1.54 times that of those who recognized nutrition fact labels (95% CI 1.33–1.77). Participants who did not utilize nutrition fact labels had a risk of IFG (95% CI 1.29–1.64) that was 1.45 times that of those who utilized nutrition facts labels.

Table 4
Odds ratios for IFG among participants (N = 9919)

Variables (references)		OR	95% CI	<i>p</i>
Sex (Women)	Men	2.24	1.99–2.50	< .001
Age (30 year)	40 yr	1.94	1.67–2.26	< .001
	50 yr	2.56	2.21–2.95	< .001
	60 yr	3.01	2.56–3.55	.033
Economic status (High)	Low	1.44	1.19–1.73	< .001
	Middle	1.03	0.91–1.15	.676
Education level (\geq High school)	\leq Middle school	1.58	1.38–1.81	< .001
Employed status (No)	Yes	1.37	1.20–1.54	< .001
Duty type (Shift type)	Day duty type	1.29	1.10–1.52	.002
BMI ($< 23 \text{ kg/m}^2$)	$\geq 23 \text{ kg/m}^2$	3.01	2.68–3.36	< .001
Perceived stress (Never feel)	Feel a little	0.82	0.70–0.96	.001
	Feel much	0.75	0.63–0.88	.070
Drinking for a year (Not at all)	Less than 1time / week	1.06	0.89–1.26	< .001
	More than 2 times / week	1.86	1.56–2.21	< .001
Current smoking status (Yes)	No	1.22	1.05–1.41	.009
Dinning Out (Less than once a month)	More than 2 times / week	0.70	0.53–0.93	.014
Recognition of nutrition fact labels (Yes)	No	1.54	1.33–1.77	< .001
Using the nutrition facts labels (Yes)	No	1.45	1.29–1.64	< .001
BMI: Body Mass Index, OR: Odds Ratio, 95% CI: 95% Confidence Interval				

Discussion

This study aimed to clarify the relationship between health behavior and health literacy. The results suggested that the subjects with IFG were less likely to practice health behaviors and had lower health literacy than those without IFG. These results are similar to those of a previous study involving American adults [19]. A study using data from the 2016 Behavioral Risk Factor Surveillance System (BRFSS) reported that adults with prediabetes had lower health literacy and more unhealthy behaviors compared with adults without prediabetes [19]. Previous studies of patients with diabetes mellitus showed that patients with low health literacy had poor diabetes knowledge [20] and a high risk of developing unhealthy consequences due to poor health behaviors [21]. This phenomenon is not only seen in adults with prediabetes, but also in adults with chronic diseases such as hypertension and cancer [22, 23], which can be interpreted as the impact of health literacy. It is known that the role of health literacy is to acquire, process, and understand basic health information and the services required to make appropriate healthcare decisions [24].

The results of this study indicate that the proportion of individuals with IFG who were actually using food and nutrition information was lower than that of individuals with non-IFG. Individuals with IFG need health and food information they can understand and use in order to maintain target blood glucose levels and properly manage their health [25]. Fasting blood glucose levels and obesity are affected by balanced caloric intake rather than daily caloric intake [26]. In addition, the outcome of body mass index (BMI) control through dietary intake and physical activity affects IFG [5]; thus, it is important to choose a balanced diet. Western countries are using strategies to improve individuals' health literacy for managing their blood glucose and utilizing nutritional information on various foods [27, 28]. However, in South Korea, there is still a lack of understanding of food information and systems that can be properly utilized in everyday life [29]. In several countries where there is a high illiteracy rate, low health literacy can be understood as an inability to read or understand essential health-related data, and thus, to manage health [19]. However, the illiteracy rate is low in South Korea because of the high level of education; more than 80% of the subjects in this study had an educational background of 10th grade or higher. The low level of health literacy compared to the high level of literacy can be interpreted as a lack of health education and public relations in terms of health. Low health literacy may be affected by a lack of personal competencies to use information as well as health literacy-related demands and complexity. Previous studies have highlighted the importance of developing educational programs or strategies to improve individuals' health literacy [30], and there is a need in South Korea for strategies to increase accessibility to health information through the development and provision of effective health information media for adults with IFG. In addition, interventions for improving health education in primary care and community settings can be effective in changing health behavior [31]. Thus, health literacy can improve health status, health-related attitudes, and health behavior [32]. To enhance health behavior, educational interventions for improving health education should be implemented simultaneously with health promotion efforts.

Individuals with IFG and low health literacy were remarkably more likely to engage in unhealthy behaviors. In this study, 76.1% of subjects with IFG were found to be obese (BMI > 23 kg/m²). Since there

was a very high correlation between an increase in BMI and the prevalence of diabetes mellitus and IFG [5], exercise and healthy eating habits for BMI control are considered important. However, our study found that “walking for 150 minutes or more per week” did not have a significant effect on IFG prevalence. It was also found that about 50% of all subjects “walked for 150 minutes or more a week,” indicating that about half of Korean adults have a considerable lack of activity. Studies have reported that the prevalence of IFG increased with a lack of exercise [19, 33]. Therefore, further studies are needed to understand basic metabolism in individuals with IFG, and consider the intensity and degree of exercise that affects the consequences of obesity and BMI.

The results of this study indicate that IFG prevalence was high in male subjects who were employed. This result is similar to the general characteristics of individuals with IFG as found in a previous study [5], and is also similar to the results of a study that showed Korean office workers as having various health problems such as diabetes mellitus due to a lack of exercise, poor eating habits, and drinking and smoking [34]. Although the legal working hours per week in South Korea were shortened with the introduction of the 5-day workweek system in 2004, South Korea continues to have the longest work hours in the world [35]. A substantial number of Korean office workers experience a lack of exercise due to their overtime work [34], and they experience many drinking problems due to the get-together culture and public drinking [34, 36]. The latter is accepted as an extension of work and serves as a causal factor for excessive drinking, regardless of individuals’ health statuses. In South Korea, where a get-together and drinking culture is developed such that people are encouraged to drink and have difficulty refusing to drink [36], and long working hours are prevalent [35], male workers who lack adequate stress-relieving methods other than drinking and smoking [34] face significant threats to their health [30]. This study demonstrated that health literacy was related to sex, age, educational level, and economic level. Baker et al. [12] reported that those with low health literacy had poor health status and health management. The results of our study are consistent with those of previous studies, suggesting that more attention should be paid to persons with IFG.

This study has several limitations. First, since the subjects were examined based on responses to a multidimensional questionnaire at a single time point, this study could not analyze in detail the causal relationship between health literacy and health behavior factors affecting IFG. Second, we evaluated health literacy using two items (i.e., “recognition of nutrition fact labels” and “utilization of the nutrition facts labels”). Since an exact measurement of health literacy levels was not used, the relationship between health literacy level and health behavior in those with IFG could not be closely evaluated. Further studies using more detailed surveys are suggested to verify the results of this study.

Despite these potential limitations, our study has several strengths. This study used national statistical data that covered three years, and the subjects represented the total adult population in South Korea. The survey design included multi-level sampling, stratification, and clustering. Therefore, the results of this study can be generalized to the adult population of South Korea. In addition, the results confirmed the differences in health behavior and health literacy between Korean individuals with IFG and those with non-IFG. Particularly, individual with IFG have a poor tendency to use of health literacy to ensure the

practice of health behaviors, such as exercise, avoiding alcohol, obesity management, and food information utilization in this study. Because health literacy is related to health status [33], national policies and support should be focused on mitigating the impacts of low health literacy in individuals with IFG. Above all, it is important for those with IFG to be aware of the importance of health literacy, so that they can practice effective health behavior.

Conclusion

This study found a significant relationship between health literacy and health behaviors in the subjects with IFG. Those with IFG were found to be less likely to practice health behaviors, and to have lower health literacy, compared with those with non-IFG. Improving health literacy in those with IFG can be effective in changing health-related behaviors. To promote health behaviors in those with IFG, national and medical service providers should provide educational interventions for improving health literacy to those with IFG. To resolve the problem of low health literacy in those with IFG, medical service providers should understand the barriers of health information services and explore processes that can effectively deliver health information services.

Abbreviations

KNHANES: Korea National Health and Nutrition Examination Survey, KCDC: Korea Centers for Disease Control and Prevention, Lifestyle, Health literacy, KFNG: Korean Foods and Nutrients Guideline, IFG: Impaired fasting glycemia

Declarations

Ethics approval and consent to participate

The KNHANES 7th were managed by the Korea Center for Disease Control and Prevention (KCDC) and approved by the KCDC Institutional Review Board (7th 2016 :2018-01-03-P-A and according to the Bioethics Law). All participants voluntarily participated and gave a written informed consent prior to participating the study.

Availability of data and materials

Korea National Health and Nutrition Examination Survey data are available at (<https://knhanes.cdc.go.kr/knhanes/main.do>) publicly. Entire data from KNHANES are coded and available freely.

Competing interests

The authors declare that they have no competing interests.

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Authors' Contributions

Y Song designed and supervised the study as a PI. HJ Lee reviewed and evaluated the included literatures. BH Kwon analyzed the data and all authors contributed to draft the manuscripts.

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