Original article

Title: Trends for the prevalence and management of diabetes in Korea: 2007-2017

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Acknowledgments: This research was supported by Eulji University in 2014 and the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (NRF-2017R1C1B5018142).

Running title: Trends for the prevalence of diabetes in Korea

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Conflicts of Interest: The author declares no conflict of interest.

Author Contributions: J.Y.S. was responsible for the conceptualization, study design, data analysis, interpretation, and writing the manuscript.

Ethical consideration (IRB approval): Data from the KNHANES survey are made publicly available through the KNHANES website (http://knhanes.cdc.go.kr). Thus, ethical approval was not required for this study.
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Abstract

Objectives: This study analyzed the Korea National Health and Nutrition Examination Survey data from 2007 to 2017 to assess trends in prevalence, treatment, and control of diabetes in Korean adults ≥30 years of age.

Methods: Prevalent diabetes was defined as fasting plasma glucose level ≥ 126 mg/dl, self-reported use of antidiabetic treatment (insulin or oral anti-diabetic drugs), or diabetes diagnosis by a physician. Target levels were defined as glycosylated hemoglobin <6.5% or <7.0%, blood pressure <130/80 mmHg, and total cholesterol <200 mg/dl. All survey waves were age-standardized to the 2005 Korean census population.

Results: Diabetes prevalence increased from 9.6% in 2007-2009 to 10.8% in 2016-2017 (p<0.001). Impaired fasting glucose prevalence significantly increased in both sexes and almost every age group. Diabetes awareness and glycemic control did not show an increasing trend; however, the treatment rate and proportion of people diagnosed with diabetes achieving blood pressure and total cholesterol target levels improved from 57.2% to 63.5% (p=0.008), from 41.1% to 53.2% (p<0.001), and from 65.0% to 78.0% (p<0.001), respectively.

Conclusion: From 2007 to 2017, the prevalence of diabetes increased moderately in Korea whereas the diabetes treatment rates as well as the proportion of people diagnosed with diabetes achieving blood pressure and total cholesterol target levels improved. However, awareness of diabetes and the levels of glycemic control all require significant improvements. A national-level action plan is required to raise awareness about diabetes and prediabetes towards improving glycemic control and minimizing the occurrence of adverse health outcomes.
Keywords: Diabetes Mellitus; Prevalence; Awareness; Glycated Hemoglobin A; Blood Pressure; Cholesterol
Introduction

Diabetes is a significant global public health issue and its burden is projected to increase [1]. In South Korea, diabetes is a major contributor to the burden of disease [2, 3], having affected approximately 5 million Korean adults in 2016 [4]. From the 1960s to the late 1990s, the prevalence of diabetes in Korea rapidly increased from less than 1% to 6-9% [5]. From 1998 to 2005, the prevalence in adults aged ≥30 years maintained to 9-11% based on the Korea National Health and Nutrition Examination Survey (KNHANES) data [6].

Health Plan 2020 (HP2020), the Korean national vision of health promotion, aimed to maintain the diabetes prevalence to 11.0% and to improve the awareness, treatment, and control of diabetes to 85%, 65%, and 35%, respectively, among adults with diabetes by 2020 [7]. However, the trends in the diabetes rates in recent decades have not been analyzed. Studies on the trends of awareness, treatment, and control of diabetes are even rarer.

This study sought to examine whether the trend of diabetes prevalence and management index in the last 10 years is approaching the target of HP2020. To update the information on trends in diabetes prevalence in Korea during 1998-2005 [6], this study aimed to investigate the changes in diabetes prevalence, awareness, treatment, and control among Korean adults aged ≥30 years using KNHANES data between 2007 and 2017. We further assessed diabetes trends according to subpopulation by examining age-, sex-, income level-, and BMI-specific prevalences of diabetes. We also aimed to investigate the changes in the impaired fasting glucose (IFG) prevalence among Korean adults, and the changes in control of the blood pressure and cholesterol levels among patients with diabetes to examine the potential of achieving the goal of HP2020. The analyses of the diabetes management status at a national
level could provide an insight into the future direction of diabetes management in Korea.

Materials and Methods

Study population

KNHANES is a series of nationally representative survey of the non-institutionalized Korean population conducted by the Korea Centers for Disease Control and Prevention (KCDC). The survey volunteers were selected using stratified multistage probability sampling design. It started in 1998, and from 2007 the survey became a year-round investigation employing a rolling sample design. By using a rolling sample design, the annual data within each wave can be integrated if insufficient to produce stable statistics for analyzing specific groups. We used data from the 4th (2007-2009), 5th (2010-2012), 6th (2013-2015), and the 2016-2017 KNHANES (data from 2017 were the most recent). Details of the KNHANES have been described elsewhere [8]. The KNHANES was approved by the KCDC Institutional Review Board, and all subjects have provided written informed consent.

In this study, we included all adults aged ≥30 years who had undergone phlebotomy after a minimum 8-hour fasting period (n = 13,931 [5931 men; 8018 women], 14,665 [6272 men; 8383 women], 12,289 [5253 men; 7036 women], and 10,131 [4454 men; 5677 women] in the 2007-2009, 2010-2012, 2013-2015, and 2016-2017 KNHANES, respectively). A standardized questionnaire was used to collect information on the sociodemographic characteristics and medical history. For the income level, the equivalent household monthly income, calculated as the monthly household income divided by the square root of the number of persons in the household, was categorized into quartiles (low, mid-low, mid-high, and high) by year and gender. Weight and height were measured using standardized protocols, and the body mass
index (BMI) was calculated as the weight in kilograms divided by the height in meters squared. The BMI was further categorized into <25.0, 25.0-29.9, and ≥30.0 kg/m². The details of the laboratory analytic methods and quality control have been described elsewhere [9, 10].

**Definitions**

Prevalent diabetes was defined as fasting plasma glucose level of ≥ 126 mg/dl, or current anti-diabetic treatment (either insulin or oral anti-diabetic drugs), or previous diagnosis of diabetes made by a physician. IFG was defined as a fasting plasma glucose level of or greater than 100 mg/dl and less than 126 mg/dl. Even if the IFG criteria were met, we excluded prevalent diabetes cases (as defined above) from prevalent IFG cases.

Diabetes awareness was defined as the subjects who had been diagnosed with diabetes by a physician among those with prevalent diabetes. This definition is the same as “known cases of diabetes” in the study of Choi et al. [6].

Treatment of diabetes was defined as the subjects using a pharmacological treatment (either insulin, oral anti-diabetic drugs, or both) for diabetes among those with prevalent diabetes.

We used two definitions for the control of diabetes, as follows: 1) the proportion of patients with glycosylated hemoglobin (A1C) level <6.5% among those diagnosed with diabetes by a physician (known cases of diabetes), suggested by the International Diabetes Federation [11], and 2) the proportion of patients with A1C level <7.0% among those diagnosed with diabetes by a physician (known cases of diabetes), according to the American Diabetes Association standard [12].

The control of hypertension was defined as a systolic blood pressure (BP) less than 130
mmHg and a diastolic BP less than 80 mmHg among those diagnosed with diabetes by a
physician, according to the American Diabetes Association standards of medical care [13, 14].
The control of total cholesterol was defined as a total serum cholesterol level <200 mg/dl
among those diagnosed with diabetes by a physician, according to the National Cholesterol
Education Program Adult Treatment Panel III target level [14, 15].

Data analysis

According to the KCDC guideline [10], all analyses were performed using appropriate
sampling weights to obtain accurate estimates representative of the non-institutionalized
Korean population. Data were analyzed using SAS, version 9.4 (SAS Institute, Cary, NC,
USA). We analyzed the prevalence, awareness, treatment, and control of diabetes, and the
achievement of blood pressure and total cholesterol target levels, further stratified by sex, age,
income level, and BMI category. For all categories, we calculated the weighted percentages
and standard errors.

All stratified estimates, except the age-specific prevalence, were age-standardized to allow
comparison across the different survey waves. For diabetes and IFG, the prevalence estimates
were age-standardized to the 2005 Korean census population, using the following age groups
and weights (30-39 years, weight 0.305422673; 40-49 years, weight 0.290505987; 50-59 years,
weight 0.182221242; 60-69 years, weight 0.128706547; and ≥70 years, weight 0.093143551).
For awareness, treatment, and control, the estimates were age-standardized to the
subpopulation of persons who had diabetes in the KNHANES 2005 [16]. In 2005, the diabetes
prevalence was 1.4% in persons aged 30-39 years, 7.4% in those aged 40-49 years, 14.0% in
those aged 50-59 years, 18.1% in those aged 60-69 years, and 17.9% in those aged ≥70
The calculated weights were 0.046857872, 0.235580891, 0.279563386, 0.255289214, and 0.182708637, respectively. We repeated the analysis without using age standardization, and these results are presented in Supplementary tables 1 and 3.

To analyze the trends over time, we used weighted logistic regression by including the midpoint of each survey period as a continuous variable. The statistical significance of the differences in the age-adjusted prevalence between the survey years was determined using the ILINK option in the SAS PROC SURVEYLOGISTIC procedure. We considered a two-tailed \( p \) value < 0.05 as statistically significant.

**Results**

The age-standardized prevalence of diabetes in adults aged ≥30 years was 9.6% in 2007-2009 and 10.8% in 2016-2017, showing an increasing trend \( (p<0.001) \) (Table 1). The crude prevalence was 10.0% in 2007-2009 and 12.7% in 2016-2017 (Supplementary table 1). When stratified by age, the prevalence of diabetes showed an increasing trend only among people aged ≥ 70 years \( (p \text{ for trend}<0.001; \text{ Table } 1) \). In 2016-2017, about three in ten (28.5%) adults aged ≥ 70 years had diabetes (Supplementary table 1). When stratified by income level, the diabetes prevalence increased only in the lowest quartile of monthly household income \( (p \text{ for trend}<0.001; \text{ Table } 1) \). When stratified by BMI, a significant increasing trend was observed for those with a BMI ≥30 kg/m\(^2\) \( (p \text{ for trend}=0.023; \text{ Table } 1) \).

Over the past decades, the prevalence of IFG significantly increased in both sexes and almost every age group (Figure 1, Supplementary Table 2). The unadjusted prevalence of IFG was 20.2% in 2007-2009 and 26.3% in 2016-2017. The IFG prevalence was higher in men than in women, and it has increased more sharply in men (23.7% to 31.3% in men; 16.2% to 19.0%
in women; from 2007-2009 to 2016-2017). The IFG prevalence showed a marked increasing trend even among men aged 30-39 years ($p$ for trend<0.001). In 2016-2017, the IFG prevalence in men aged 30-39 was 22.4%, one in five men had IFG. Moreover, the IFG prevalence increased by nearly 10 percentage point among men aged 40-59 years over the past decade (men aged 40-49 years: 25.9% in 2007-2009 and 36.0% in 2016-2017; men aged 50-59 years: 27.9% in 2007-2009 and 36.7% in 2016-2017). The IFG prevalence in women aged 30-49 years was only about half that in men, and it did not show a significant increase over time in women aged 30-39 and 50-59.

The crude diabetes awareness was 72.3% in 2016-2017 (Supplementary table 3). In men, the diabetes awareness decreased over time ($p$ for trend = 0.041; Figure 2 and Supplementary table 4). In other words, undiagnosed diabetes increased among men over the past decades. The crude awareness was higher among women than among men by 10 % (Supplementary table 3).

The proportion of persons receiving antidiabetic drug treatment (either oral antidiabetic drugs, insulin, or both) among those with prevalent diabetes increased in the overall population ($p$ for trend = 0.008; Figure 2 and Supplementary table 4). The crude treatment rate was 62.4% in men and 72.0% in women in 2016-2017 (Supplementary table 3).

The proportion of persons with A1C level of <6.5% among those diagnosed with diabetes by physicians was 28.7% in men and 31.4% in women in 2016-2017 (Supplementary table 3). The proportion of persons with A1C level of < 7.0% was 50.4% in men and 53.4% in women in 2016-2017 (Supplementary table 3). Although the control rate did not show a significant linear trend over time in both sexes (Figure 2 and Supplementary table 4), the control rate of 2016-2017 in women was significantly higher than that in 2007-2009 or 2013-2015 (between 2007-
2009 and 2016-2017, \( p = 0.036 \), A1C < 6.5%; between 2013-2015 and 2016-2017, \( p = 0.004 \), A1C < 7.0%; data not shown).

The age-standardized overall proportion of persons who achieved the blood pressure target level significantly increased from 41.1% in 2007-2009 to 53.2% in 2016-2017 (Figure 2 and Supplementary table 4). The increase was significant in both sexes. The age-standardized proportion of persons who achieved the total cholesterol target level also significantly increased in both sexes; it was 80.4% in men and 74.8% in women in 2016-2017 among those diagnosed with diabetes by physicians (Figure 2 and Supplementary table 4). The blood pressure target level was better achieved in women and the total cholesterol target level was better achieved in men.

**Discussion**

In this representative sample of non-institutionalized Korean adults, the crude prevalence of diabetes in adults aged ≥30 years has increased from 10.0% to 12.7% from 2007 to 2017. The age-standardized prevalence also showed a moderate increasing trend, from 9.6% to 10.8%. Among the diabetes awareness, treatment, and control, only the treatment rate showed an increasing trend.

Although the prevalence of diabetes has shown a moderate increase, the prevalence of IFG has shown a significant increase of more than 5 percentage point over the past decade. When stratified by age, the prevalence of diabetes increased only in adults aged ≥ 70 years. However, the IFG prevalence has increased in almost all age groups. Every year, 5-10% of people with prediabetes could progress to diabetes [18]. Moreover, IFG is associated with an increased risk of cardiovascular disease or diabetic microvascular lesions [18, 19]. In order to reduce the
burden of disease caused by diabetes in the future, it is necessary to systematically manage the pre-diabetes stage. Fortunately, lifestyle modification can prevent the progression from prediabetes to diabetes, with evidence of a 40–70% relative-risk reduction [18].

We observed sex-related differences in the prediabetes, awareness, and management status of diabetes. The prevalence of diabetes was lower in women than in men, and the proportion of awareness, treatment, adequate glucose control, and blood pressure control was higher in women. The awareness in men has decreased over the past decade. Treatment rates have only increased in women over the past decade. As a result, the adequate glucose control showed a statistically significant increase only in women (when the control rates of the previous survey years were compared in pairwise). Sex-related differences were commonly observed in studies of many other countries. In China and Kazakhstan, women showed a higher diabetes awareness and treatment [20-22]. A U.S. study also reported a higher awareness in women [23]. Similar results have been found for hypertension; the awareness and treatment of hypertension are reported to be lower in men [24, 25]. Sex-related differences have been reported for health behaviors and health attitudes [26, 27]. In general, women were more likely to be motivated in participating in health-promoting activities and developing healthy habits [27].

The increase in IFG prevalence in young men can be interpreted in this context. Our results showed that the IFG prevalence was more than twice as high in men in their 30s than in women, and it showed a significant increase only in men (see Supplementary Table 2). This is assumed to be closely associated to the health related lifestyle of men of that age group. According to the 2016 health statistics in Korea [17], the smoking rate, daily smoking rate, and high risk drinking rate in men were 51.5%, 43.9%, and 23.5%, respectively, in the age group 30-39, while those in women were 7.6%, 4.9%, and 8.6%, respectively, demonstrating considerable
sex differences in the health behaviors.

It is notable that the marked increase in diabetes prevalence was only observed in the lowest quartile of income level. This result implies increased socio-economic inequality in diabetes prevalence. Low socioeconomic status (SES) has recently been recognized as one of the risk factors for diabetes [28]. The income level was associated with diabetes even after adjustment for known risk factors of diabetes, such as age, sex, level of education, BMI, physical activity, and smoking [29]. It is not yet fully understood how SES increases the risk of diabetes. However, healthcare accessibility, access to healthy food and exercise, occupational opportunities, and personal lifestyle choices are thought to play a complex role, affecting the development of diabetes [28, 30]. Further research is needed to examine the factors contributing to the worsening socioeconomic inequalities in the prevalence of diabetes in Korea.

Glycemic control did not show an increasing trend in the 2007-2017 periods, although women had a higher glycemic control in 2016-2017 than in 2013-2015. It seems that it is difficult to improve or maintain the glycemic control to a certain level in the population. In the U.S., the glycemic control rate (percentage of A1C level <7.0% among those diagnosed with diabetes) increased from 44.3% in 1999–2002 to 56.8% in 2003–2006. However, it decreased by 4.6% between 2003-2006 and 2007-2010 [31]. In Canada, the glycemic control rate (A1C level <7.0%) of patients with diabetes managed by the primary care physicians was 51%. However, the longer the diabetes duration was, the lower the control rates were despite the increased treatment rate [32]. In Korea, it may become more difficult to increase the proportion of achieved glycemic target levels with the increase in the elderly population with a longer duration of the disease. In this respect, the recent improvement in the glycemic control
rate in women is encouraging.

There was significant improvement in the blood pressure and total cholesterol control from 2007 to 2017. It is hard to make a direct comparison; however, the blood pressure control (<130/80 mm Hg) in 2016-2017 in Korea (53.2%) was higher than that of 48.3% in 2003-2004 [14] or 51.3% in 2007-2010 in the U.S. [31]. The total cholesterol control was much higher than that in the U.S. (78.0% vs. 50.4%) [14]. In Korea, about eighty-five percent of the patients with prevalent diabetes are concurrently treated for either high blood pressure or dyslipidemia [14]. The improved blood pressure or cholesterol control among the patients with diabetes may be due to the better publicity, effective clinical guidelines on the management of diabetes [33], increased number of people treating for hypertension, diabetes, and dyslipidemia together [34], and an increase in statin prescription [34].

The prevalence of diabetes and impaired glucose tolerance in adults is projected to increase globally, with the highest increase expected in the low- and middle-income countries [35]. South Korea is currently classified as a high-income country, and according to the diabetes prevalence among those aged 20-79 years, it was ranked 135th out of 221 countries in descending order in 2017, when age-standardized with the world population [36]. As other high-income countries, Korea is also thought to have a moderate increasing trend in the prevalence of diabetes, which peaked among those ≥ 75 years of age, whereas the prevalence peaked in the 60–74 age groups in the middle-income countries and the 55–64 age groups in the low-income countries [37]. Considering the aging trend in Korea, the burden of diseases caused by the increased prevalence of diabetes in the elderly population is expected to rise sharply. To reduce the national burden, it is necessary for the government to actively prepare a national policy to delay the onset of diabetes complications as much as possible in the elderly.
patients. In addition, considering our study’s findings, it is necessary to determine the target
groups (such as men or the low-SES group, which have high prevalence and low management
rates) and provide detailed programs to stimulate the management of diabetes. For example,
implementing a diabetes management program in the workplace may help the vulnerable
population to recognize and manage this disease.

This study had some limitations. First, diagnosed diabetes was determined by self-report and
was not verified by medical records. Second, most participants only measured fasting plasma
glucose once because they visited the KNHANES Examination once, although the American
Diabetes Association recommends repeated measurements after a positive result for A1C,
fasting plasma glucose or 2 hours of plasma glucose. Therefore, there may be a
misclassification in our study, such that participants who do not have diabetes are categorized
as having prevalent diabetes. Third, the denominators of glucose control, BP control, and total
cholesterol control were all in those with diabetes diagnosed by a physician. However, when
conducting age standardization, we used the subjects who had prevalent diabetes in the
KNHANES 2005 as a standard population, instead of the subjects diagnosed with diabetes by a
physician. In 2005, the number of persons diagnosed with diabetes by physicians was 5 in the
30s and 47 in the 40s; thus, it was unreasonable to use this as a standard population because the
number of persons per age group was very small and unstable. As a result, the age-standardized
glucose, blood pressure, and total cholesterol control may be overestimated or underestimated
in the age standardization process. However, the use of prevalent diabetic population as a
standard population would be sufficient for the purpose of wave-to-wave comparisons with the
same age structure during the 2007-2017 periods. Fourth, in HP2020, the denominator of
glucose control was prevalent diabetes cases. However, we used diabetes cases diagnosed by a
physician as the denominator of glucose control, because we thought it was more appropriate from a public health perspective to investigate glucose control in persons diagnosed with diabetes who were aware of their status; we wanted to make the proportion of glucose control comparable by using the same definitions as used in previous studies [6, 14]. Therefore, compared to the HP2020 results, this study may have overestimated the results and thus, caution is needed during comparison. Nonetheless, interpretation would not be very problematic as our results were lower than the HP2020 targets. Fifth, dyslipidemia management standards for diabetic patients are generally based on LDL-cholesterol levels [13]. However, in this study, we examined the control of total cholesterol instead of LDL-cholesterol. In 2009, the KNHANES began measuring LDL-cholesterol using the direct method; however, this test was not performed for all subjects undergoing blood tests. Thus, LDL-cholesterol should be calculated using the Friedewald’s formula; the data on calculated LDL-cholesterol levels are not available in the KNHANES database. Moreover, the Friedewald's formula applies poorly in some situations, such as extreme triglyceride levels (≥400 mg/dl) [38]. Even if the triglyceride level is <400 mg/dl, the use of this formula is not recommended in diabetes patients [39]. Therefore, we investigated the control of total cholesterol to <200 mg/dl, as in the study by Ong et al [14]. If conditions permit, it may be necessary to investigate LDL-cholesterol control in diabetes patients in future studies.

Despite all these limitations, this study offers meaningful insights into long-term trends in the burden and control of diabetes using rigorously collected national population-based data. The findings could provide useful insights into future healthcare planning and the design of appropriate strategies both in Korea as well as in countries with similar demographic and health system structures.
In conclusion, from 2007 to 2017, the prevalence of diabetes increased moderately in Korea whereas the diabetes treatment rate and the proportion of people diagnosed with diabetes who achieved the blood pressure and total cholesterol target levels improved. However, the prevalence of impaired fasting glucose increased significantly in nearly every age group. Awareness of diabetes and the level of glycemic control all require significant improvements. The goal of HP2020 of maintaining the prevalence of diabetes at 11.0% by 2020 is likely achievable, as well as the treatment rate target of 65%. However, the 85% and 35% targets for awareness and glycemic control are unlikely to be achieved until 2020, considering the 69.2% and 28.0% rates in 2016-2017, respectively. A national-level integrated action plan is required to raise awareness about diabetes and prediabetes towards improving glycemic control and minimizing the occurrence of adverse health outcomes.

Acknowledgments

This research was supported by Eulji University in 2014 and the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (NRF-2017R1C1B5018142).
References


10. Korea Centers for Disease Control and Prevention. The guideline for the usage o


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Table 1. Age-standardized weighted diabetes prevalence among Korean adults aged ≥30 years, 2007-2017.

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<tr>
<td></td>
<td>% (SE)</td>
<td>% (SE)</td>
<td>% (SE)</td>
<td>% (SE)</td>
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<tr>
<td>No. with diabetes 1)</td>
<td>1536</td>
<td>1700</td>
<td>1590</td>
<td>1469</td>
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<tr>
<td>Overall</td>
<td>9.6 (0.3)</td>
<td>9.4 (0.3)</td>
<td>10.2 (0.3)</td>
<td>10.8 (0.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Adjusted</td>
<td>9.5 (0.3)</td>
<td>9.4 (0.3)</td>
<td>10.2 (0.3)</td>
<td>10.8 (0.4)</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Men</td>
<td>10.9 (0.4)</td>
<td>11.0 (0.4)</td>
<td>12.1 (0.5)</td>
<td>12.6 (0.5)</td>
<td>0.003</td>
</tr>
<tr>
<td>Women</td>
<td>8.2 (0.3)</td>
<td>7.9 (0.3)</td>
<td>8.3 (0.4)</td>
<td>9.0 (0.4)</td>
<td>0.023</td>
</tr>
<tr>
<td>Age-group(years) 2)</td>
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<tr>
<td>30-39</td>
<td>2.7 (0.3)</td>
<td>2.4 (0.3)</td>
<td>2.5 (0.4)</td>
<td>2.4 (0.5)</td>
<td>0.057</td>
</tr>
<tr>
<td>40-49</td>
<td>6.5 (0.5)</td>
<td>6.1 (0.6)</td>
<td>7.2 (0.6)</td>
<td>7.3 (0.7)</td>
<td>0.070</td>
</tr>
<tr>
<td>50-59</td>
<td>12.6 (0.7)</td>
<td>13.2 (0.7)</td>
<td>11.4 (0.7)</td>
<td>14.7 (0.9)</td>
<td>0.058</td>
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<td>60-69</td>
<td>21.2 (0.9)</td>
<td>19.2 (0.8)</td>
<td>22.4 (1.0)</td>
<td>20.7 (1.1)</td>
<td>0.077</td>
</tr>
<tr>
<td>≥70</td>
<td>19.9 (1.0)</td>
<td>22.3 (1.0)</td>
<td>25.2 (1.2)</td>
<td>28.5 (1.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Income level 3)</td>
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<tr>
<td>Low</td>
<td>11.4 (0.8)</td>
<td>12.8 (1.1)</td>
<td>14.0 (1.2)</td>
<td>16.9 (1.3)</td>
<td>&lt;0.001</td>
</tr>
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<td>Mid-low</td>
<td>10.3 (0.6)</td>
<td>9.3 (0.5)</td>
<td>11.5 (0.6)</td>
<td>10.6 (0.7)</td>
<td>0.077</td>
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<tr>
<td>Mid-high</td>
<td>8.9 (0.6)</td>
<td>9.3 (0.6)</td>
<td>9.1 (0.6)</td>
<td>10.3 (0.6)</td>
<td>0.015</td>
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<td>High</td>
<td>8.6 (0.6)</td>
<td>9.0 (0.6)</td>
<td>9.5 (0.6)</td>
<td>8.9 (0.6)</td>
<td>0.017</td>
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<td>BMI (kg/m²) 4)</td>
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<tr>
<td>&lt;25</td>
<td>7.4 (0.3)</td>
<td>7.5 (0.3)</td>
<td>8.1 (0.3)</td>
<td>7.6 (0.3)</td>
<td>0.059</td>
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<td>25.0-29.9</td>
<td>13.0 (0.6)</td>
<td>12.0 (0.6)</td>
<td>12.4 (0.6)</td>
<td>14.5 (0.7)</td>
<td>0.036</td>
</tr>
<tr>
<td>≥30</td>
<td>21.0 (2.0)</td>
<td>20.3 (1.8)</td>
<td>24.0 (1.9)</td>
<td>26.1 (2.0)</td>
<td>0.028</td>
</tr>
</tbody>
</table>

3) SE, standard error; BMI, body mass index.
4) 1) Unweighted total number of cases of diabetes.
5) 2) Age-specific crude rates are presented.
6) 3) Calculated as monthly household income divided by the square root of the number of persons in the household, categorized into quartiles by year and gender.
7) 4) Calculated as the weight in kilograms divided by the height in meters squared.
8) 5) Derived using weighted logistic regression by including the midpoint of each survey period as a continuous variable.
**Figure 1.** Weighted prevalence of impaired fasting glucose among Korean adults aged ≥30 years according to age group and sex, 2007-2017. The asterisk indicates significant ($p<0.05$) for trend, which is derived using weighted logistic regression by including the midpoint of each survey period as a continuous variable. 1) Estimates are age-adjusted by direct standardization to the 2005 Korean census population.

**Figure 2.** Age-standardized weighted proportion of diabetes awareness, treatment, and control among Korean adults with diabetes aged ≥30 years, 2007-2017. The asterisk indicates significant ($p<0.05$) for trend, which is derived using weighted logistic regression by including the midpoint of each survey period as a continuous variable. All estimates are age-standardized to the subpopulation of persons who had diabetes in the KNHANES 2005.