

## Diabetes Fact Sheets in Korea, 2018: An Appraisal of Current Status

Bo-Yeon Kim<sup>1</sup>, Jong Chul Won<sup>2</sup>, Jae Hyuk Lee<sup>3</sup>, Hun-Sung Kim<sup>4</sup>, Jung Hwan Park<sup>5</sup>, Kyoung Hwa Ha<sup>6</sup>, Kyu Chang Won<sup>7</sup>, Dae Jung Kim<sup>6</sup>, Kyong Soo Park<sup>8</sup>

<sup>1</sup>Division of Endocrinology and Metabolism, Department of Internal Medicine, Soonchunhyang University Bucheon Hospital, Soonchunhyang University College of Medicine, Bucheon,

<sup>2</sup>Division of Endocrinology and Metabolism, Department of Internal Medicine, Cardiovascular and Metabolic Disease Center, Inje University Sanggye Paik Hospital, Inje University College of Medicine, Seoul,

<sup>3</sup>Division of Endocrinology and Metabolism, Department of Internal Medicine, Myongji Hospital, Goyang,

<sup>4</sup>Division of Endocrinology and Metabolism, Department of Internal Medicine, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul,

<sup>5</sup>Division of Endocrinology and Metabolism, Department of Internal Medicine, Hanyang University College of Medicine, Seoul,

<sup>6</sup>Department of Endocrinology and Metabolism, Ajou University School of Medicine, Suwon,

<sup>7</sup>Division of Endocrinology and Metabolism, Department of Internal Medicine, Yeungnam University College of Medicine, Daegu,

<sup>8</sup>Division of Endocrinology and Metabolism, Department of Internal Medicine, Seoul National University College of Medicine, Seoul, Korea

**Background:** The objective of this study was to investigate the prevalence, management, and comorbidities of diabetes among Korean adults aged 30 years and older.

**Methods:** This study used 2013 to 2016 data from the Korea National Health and Nutrition Examination Survey, a nationally-representative survey of the Korean population. Diabetes was defined as fasting glucose  $\geq 126$  mg/dL, current use of antidiabetic medication, a previous history of diabetes, or glycosylated hemoglobin (HbA1c)  $\geq 6.5\%$ .

**Results:** In 2016, 14.4% (approximately 5.02 million) of Korean adults had diabetes. The prevalence of impaired fasting glucose was 25.3% (8.71 million). From 2013 to 2016, the awareness, control, and treatment rates for diabetes were 62.6%, 56.7%, and 25.1%, respectively. People with diabetes had the following comorbidities: obesity (50.4%), abdominal obesity (47.8%), hypertension (55.3%), and hypercholesterolemia (34.9%). The 25.1%, 68.4%, and 44.2% of people with diabetes achieved HbA1c  $< 6.5\%$ , blood pressure  $< 140/85$  mm Hg, and low density lipoprotein cholesterol  $< 100$  mg/dL. Only 8.4% of people with diabetes had good control of all three targets.

**Conclusion:** This study confirms that diabetes is as an important public health problem. Efforts should be made to increase awareness, detection, and comprehensive management of diabetes to reduce diabetes-related morbidity and mortality.

**Keywords:** Comorbidity; Diabetes mellitus; Hypercholesterolemia; Hypertension; Nutrition surveys; Obesity; Prevalence; Public health; Republic of Korea

### INTRODUCTION

Economic and social developments have affected lifestyles and diet habits, resulting in increases in non-communicable diseases, such as obesity, dyslipidemia, hypertension, and diabe-

tes. Diabetes is associated with a high risk of vascular disease. Cardiovascular disease is a primary cause of death among people with type 2 diabetes [1,2]. In Korea, four million adults aged 30 years or older have diabetes. The prevalence of diabetes has been estimated to be 12.4% in Korea in 2011 [3,4]. In

Corresponding author: Dae Jung Kim  <https://orcid.org/0000-0003-1025-2044>  
Department of Endocrinology and Metabolism, Ajou University School of Medicine,  
164 World cup-ro, Yeongtong-gu, Suwon 16499, Korea  
E-mail: djkim@ajou.ac.kr

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://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.

Received: Apr. 8, 2019; Accepted: May 26, 2019

Copyright © 2019 Korean Diabetes Association <http://e-dmj.org>

2016, diabetes was the sixth leading cause of death and the most common cause of renal replacement therapy in Korea [5]. The increase in diabetes has, consequently, resulted in an increase in diabetes-related morbidity, thus becoming a socio-economic burden. Therefore, recognizing problems in reaching glycemic target goals and seeking solutions are important to decrease the comorbidities and mortality of diabetes. Since 2012, The Korean Diabetes Association (KDA) has published Diabetes Fact Sheets based on the Korea National Health and Nutrition Examination Survey (KNHANES), a nationwide survey conducted by the Korean Centers for Disease Control and Prevention to promote the understanding of chronic diseases, provide comprehensive and systematic prevention and management at the national level, and improve public awareness of diabetes and its risk factors. More active, comprehensive management of diabetic patients is a very important health issue. The objective of this study was to investigate the prevalence, management, and comorbidities of diabetes among Korean adults aged 30 years and older by analyzing nationally-representative KNHANES data.

## METHOD

### Study population

This study analyzed KNHANES data from 2013 to 2016, a nationally representative, cross-sectional survey designed to evaluate the health and nutritional status of the Korean population. KNHANES consists of three surveys: a health interview survey, a health examination survey, and a nutrition survey. The health interview included prior history of diabetes diagnosis, hypertension, hypercholesterolemia, and medication for those conditions. Informed consent was obtained during the KNHANES process. The estimated percentages and the total number of people over the age of 30 with diabetes and prediabetes were determined by reflecting the 2016 demographic structure. We constructed two datasets from KNHANES as follows: (1) KNHANES 2016 and (2) KNHANES 2013 to 2016 (merged 4 years of data). Data from KNHANES 2016 were used to calculate the prevalence of diabetes and impaired fasting glucose (IFG). And, data for KNHANES 2013 to 2016 (4 years of data) were used to identify current status of managing diabetes and comorbidities in diabetes. The study protocol conformed to the ethical guidelines of the World Medical Association Declaration of Helsinki and was approved by the Institutional Review Board of Soonchunhyang University Bu-

cheon Hospital (IRB No 2018-11-018).

### Biochemical measurements

After an overnight fast, fasting plasma glucose (FPG), total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), triglyceride (TG) level, serum creatinine level, and urinary concentration of creatinine were measured using a Hitachi Automatic Analyzer 7600 (Hitachi, Tokyo, Japan). Low density lipoprotein cholesterol (LDL-C) was measured by direct assay for persons with TG >200 mg/dL (Hitachi Automatic Analyzer 7600). Thus, we used either directly measured or calculated LDL-C according to the Friedewald formula:  $LDL-C = TC - HDL-C - (TG/5)$  [6]. Glycosylated hemoglobin (HbA1c) levels were measured using high-performance liquid chromatography (HLC-723G7; Tosoh, Tokyo, Japan). Urinary albumin levels in random urine samples were measured using a Hitachi Automatic Analyzer 7600.

### Definitions of diabetes and its related comorbidities

The diagnosis of diabetes was based on FPG  $\geq 126$  mg/dL, current use of antidiabetic medication(s), a previous history of diabetes, or HbA1c  $\geq 6.5\%$ . IFG was defined by FPG in the range of 100 to 125 mg/dL among those without diabetes as described above [7]. Glycemic control rate in diabetes was defined as rate of people of HbA1c <6.5% among people with diabetes (%). Obesity was defined as a body mass index (BMI; weight in kilograms divided by the square of height in meters)  $\geq 25.0$  kg/m<sup>2</sup> in accordance with the Asia-Pacific criteria of the World Health Organization guidelines [8]. Abdominal obesity was defined as waist circumference  $\geq 90$  cm in men and  $\geq 85$  cm in women. Hypertension was defined as systolic blood pressure  $\geq 140$  mm Hg or diastolic blood pressure  $\geq 90$  mm Hg and/or current use of antihypertensive medications. Control of hypertension was defined as systolic and diastolic blood pressure <140/85 mm Hg according to the KDA Treatment Guideline for Diabetes 2015 (English version is available at [www.diabetes.or.kr](http://www.diabetes.or.kr)) [9]. Hypercholesterolemia was defined as TC  $\geq 240$  mg/dL or current use of lipid-lowering medication(s), and control of hypercholesterolemia was defined as LDL-C <100 mg/dL [9,10]. Awareness rate was defined as rate of people diagnosed with diabetes by a doctor among people with diabetes (%). Treatment rate was defined as rate of people treated with oral hypoglycemic agents, or insulin therapy among people with diabetes (%). Definition of health behaviors are as follows: current smoking: smoked at least five packs of cigarettes (100 ciga-

rettes) during lifetime; high-risk drinking: more than seven glasses in men or five glasses in women on the same occasion on each of two or more a week; regular walking exercise: 5 days or more per week and for 30 minutes or more per activity.

**Statistical analysis**

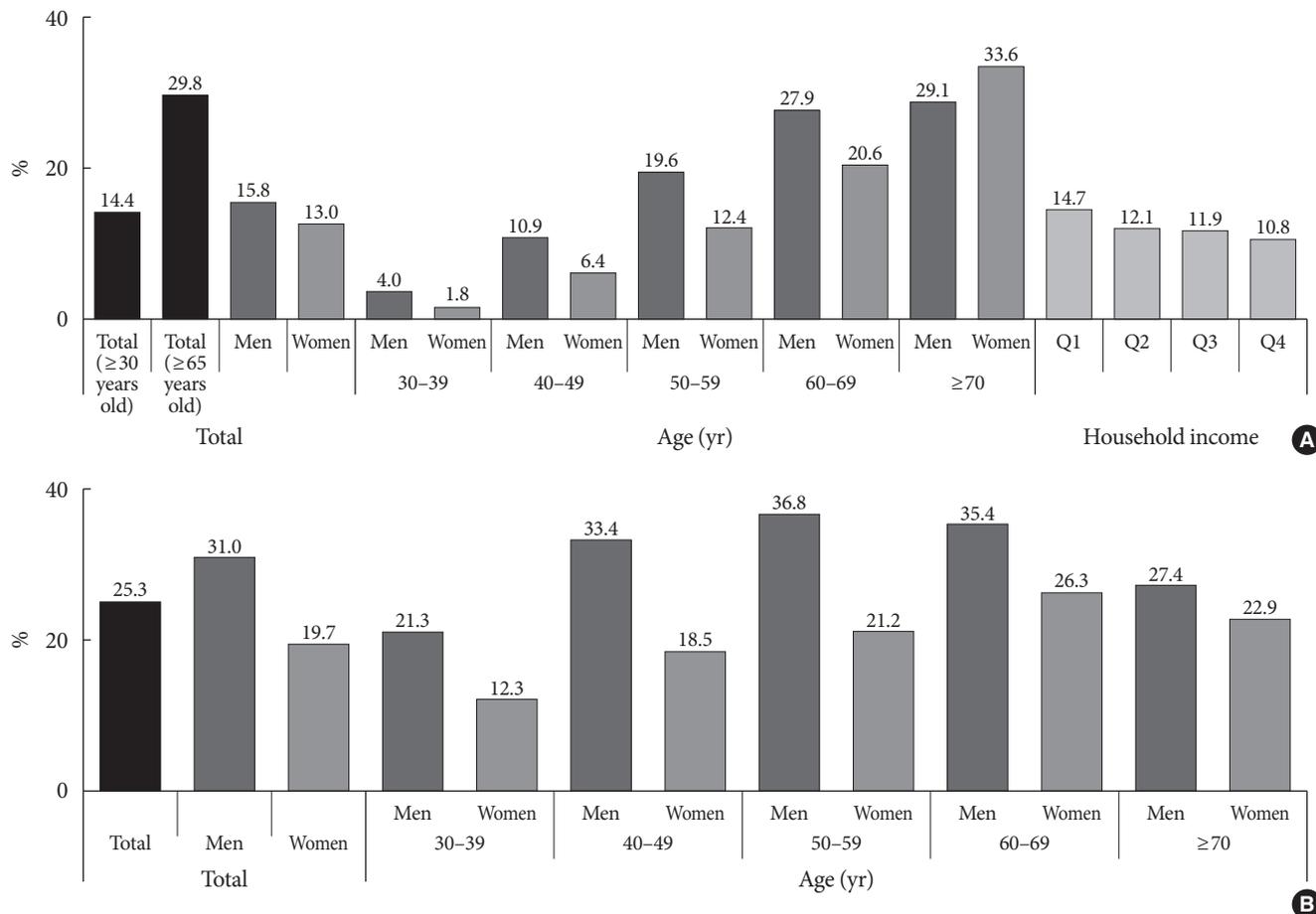
Descriptive statistics were used to evaluate the patient data. Statistical analyses were performed using SAS statistical software version 9.3 (SAS Institute Inc., Cary, NC, USA) to reflect the complex sampling design and sampling weights of KNHANES and to provide nationally representative prevalence estimates using a complex sampling design.

**RESULTS**

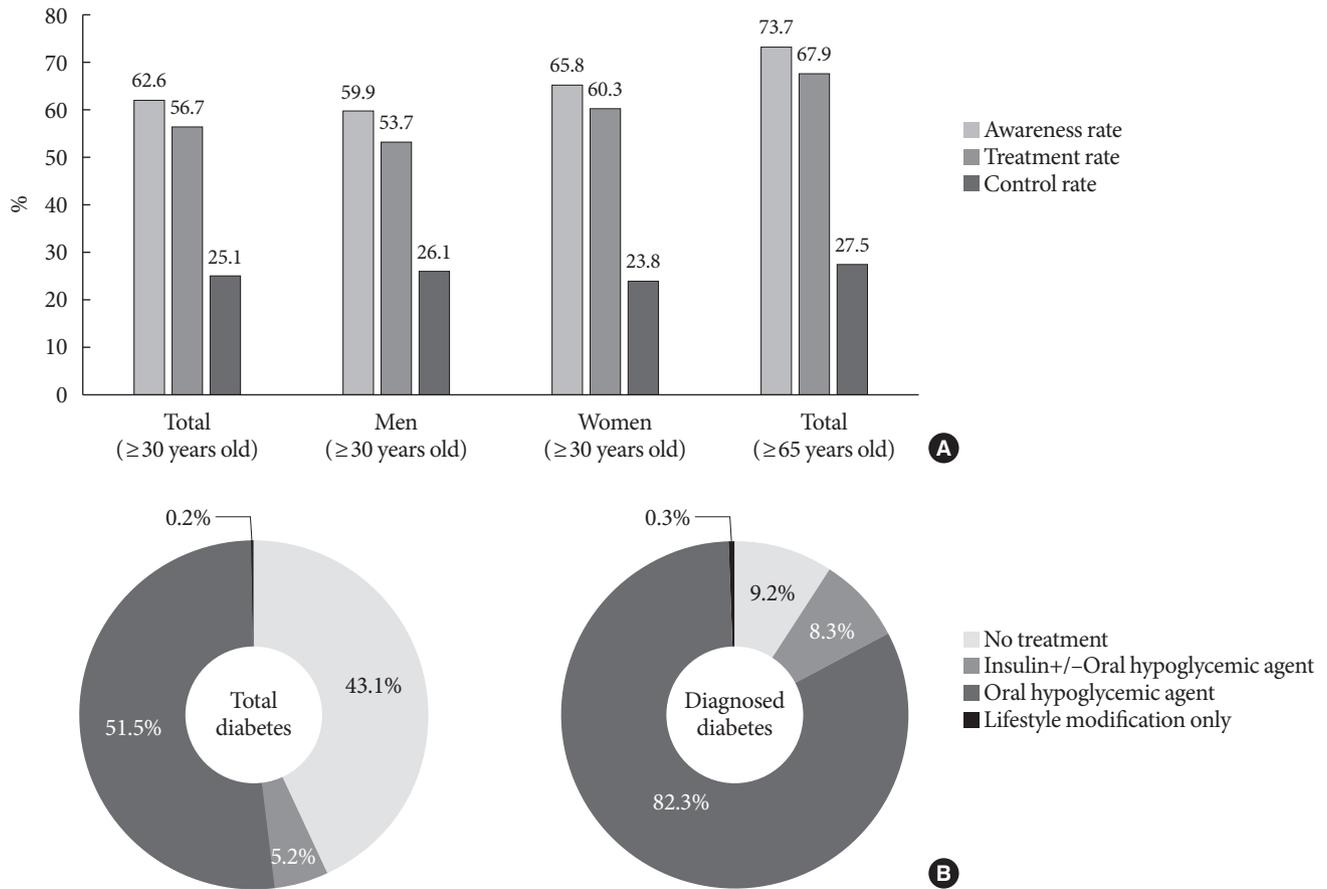
**Prevalence of diabetes and IFG**

Among adults aged 30 years or more in 2016, the prevalence of

diabetes was 14.4%, representing approximately 5.02 million. There were differences in diabetes prevalence by sex, age group, and household income. The prevalence of diabetes among women in 2016 was 13.0%, which was lower than that in men (15.8%). The prevalence increased with age in both sexes. Specifically, the prevalence exceeded 10% for men in the 40 to 49 age group and for women in the 50 to 59 age group. In addition, the prevalence of diabetes among adults 65 years or older was 29.8%. By household income quartile, the prevalence in the lowest household income quartile was 14.7%, while that in the highest household income quartile was 10.8% (Fig. 1). The prevalence of IFG among adults 30 years or older in 2016 was 25.3%. The number of people with IFG was estimated to be 8.71 million in 2016. The IFG prevalence peaked in the of 50- to 59-year-old age group in men and in the 60- to 69-year-old age group in women (Fig. 1).



**Fig. 1.** Estimated prevalence of adults (≥30 years old) with (A) diabetes and (B) impaired fasting glucose (household income: from the lowest to the highest quintiles [Q]).



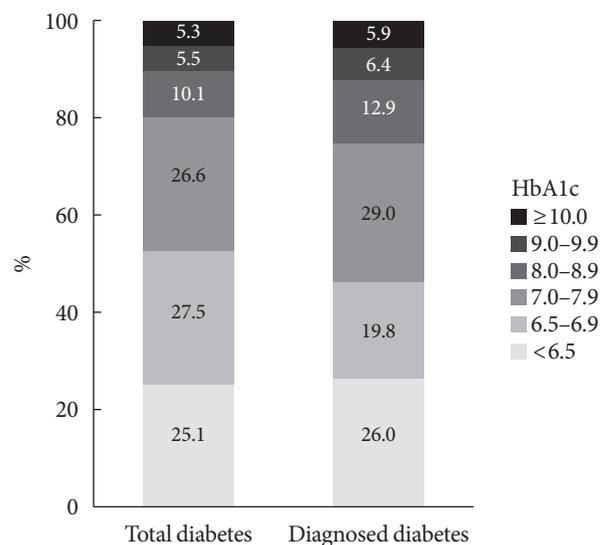
**Fig. 2.** Management of (A) diabetes and (B) type of treatment (awareness rate: rate of people diagnosed with diabetes by a doctor among people with diabetes [%]; treatment rate: rate of people treated with oral hypoglycemic agents, and/or insulin therapy among people with diabetes [%]; control rate: rate of people of glycosylated hemoglobin <6.5% among people with diabetes).

**Current status of managing diabetes**

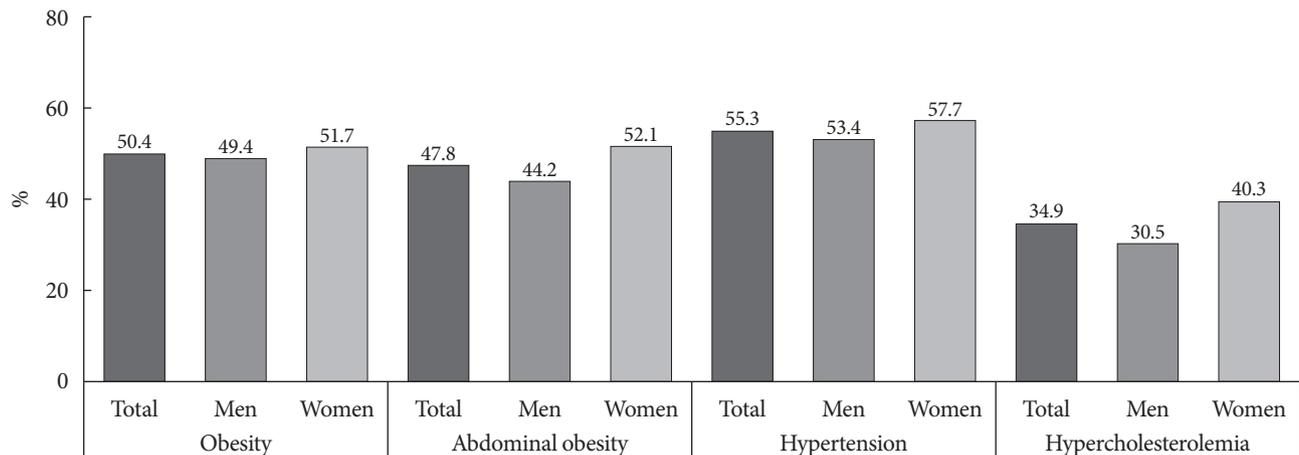
In 2013 to 2016, among people with diabetes, 62.6% were aware of their condition and 56.7% were using glucose-lowering drugs (oral hypoglycemic agent, 51.5%; insulin therapy, 5.2%). However, 43.1% were not receiving any treatment (glucose-lowering drugs and/or lifestyle modification). Among people who were previously diagnosed with diabetes, 9.2% were not receiving any treatment for their disease. However, most of them were being treated with oral hypoglycemic agents (82.3%) and 8.3% of them were receiving insulin therapy (Fig. 2). Glycemic control rate among people with diabetes was 25.1% for HbA1c <6.5% and 52.6% for HbA1c <7.0%. However, 20.9% of people with diabetes had worse glycemic control (HbA1c ≥8.0%) (Fig. 3).

**Comorbidities in diabetes**

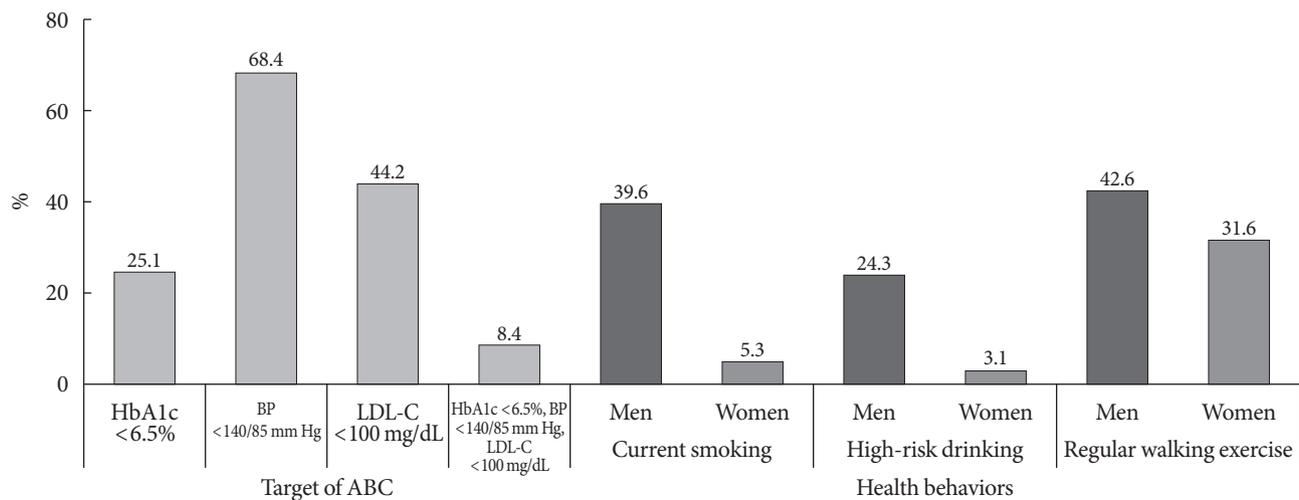
In 2013 to 2016, the prevalence of obesity (BMI ≥25.0 kg/m<sup>2</sup>) in people with diabetes was 50.4%. When obesity was catego-



**Fig. 3.** Glycemic control rate in diabetes. HbA1c, glycosylated hemoglobin.



**Fig. 4.** Estimated prevalence of comorbidities in diabetes (obesity: body mass index [ $\text{kg}/\text{m}^2$ ]  $\geq 25.0$ ; abdominal obesity: men  $\geq 90$  cm, women  $\geq 85$  cm; hypertension: systolic blood pressure  $\geq 140$  mm Hg or diastolic blood pressure  $\geq 90$  mm Hg and/or antihypertensive medications; hypercholesterolemia: total cholesterol  $\geq 240$  mg/dL and/or lipid-lowering medications).



**Fig. 5.** Control rate of comorbidities and estimated proportion for health behaviors in diabetes (current smoking: smoked at least five packs of cigarettes [100 cigarettes] during lifetime; high-risk drinking: more than seven glasses in men or five glasses in women on the same occasion on each of 2 or more a week; regular walking exercise: 5 days or more per week and for 30 minutes or more per activity). HbA1c, glycosylated hemoglobin; BP, blood pressure; LDL-C, low density lipoprotein cholesterol; ABC, glycosylated hemoglobin, blood pressure, and low density lipoprotein cholesterol.

alized as class I to III, obesity class I (BMI 25.0 to 29.9  $\text{kg}/\text{m}^2$ ) accounted for 40.2% of the diabetes cases and obesity class II (BMI 30.0 to 34.9  $\text{kg}/\text{m}^2$ ) accounted for 8.4%, while obesity class III (BMI  $\geq 35.0$   $\text{kg}/\text{m}^2$ ) only accounted for 1.8%. Abdominal obesity, based on waist circumference (men  $\geq 90$  cm, women  $\geq 85$  cm), accounted for 47.8% of the people with diabetes. The prevalence of abdominal obesity was higher in women than in men (men 44.2%, women 52.1%). In diabetes, the prevalence of hypertension was 55.3% and that of hypercholes-

terolemia was 34.9% (Fig. 4).

According to the 2015 KDA treatment guideline, 25.1% of people with diabetes achieved HbA1c <6.5%, 68.4% achieved blood pressure <140/85 mm Hg, and 44.2% achieved LDL-C <100 mg/dL. Only 8.4% of people with diabetes had good control of all three targets. In addition, more men than women were current smokers (men 39.6%, women 5.3%) or high-risk drinkers (men 24.3%, women 3.1%). Only 36.0% of those with diabetes were walking 30 minutes regularly (Fig. 5).

## DISCUSSION

In a representative sample of Korean adults in 2016, the prevalence of diabetes among adults aged 30 years or more was 14.4% and the estimated number of people with diabetes was 5.02 million. Excluding HbA1c from the definition of diabetes, the prevalence decreased to 13.0%. In addition, the prevalence of IFG was 25.3%.

In Korea, the prevalence of diabetes has mainly increased due to population aging [11]. This study also showed that the prevalence of diabetes increased with age in both sexes. Specifically, the prevalence of diabetes among adults 65 years or older was 29.8%, which was more than twice the prevalence of diabetes among adults aged 30 years or more. Diabetes in the elderly is accompanied by functional disability, several comorbidities, and premature mortality [12]. Thus, the management of diabetes is necessary, especially considering the prevalence and comorbidities in the elderly.

This study showed that the lower the income level, the higher the prevalence of diabetes. Previous studies have shown that people with low socioeconomic status (SES) were more likely to develop type 2 diabetes with worse glycemic control that can lead to more diabetic complications [13,14]. According to the Korean National Diabetes Program (KNDP) cohort study, men with low SES had worse glycemic control and higher risk for retinopathy [15]. In addition, in Korea, low-income people with diabetes had lower medication adherence and lower levels of utilization of fundus examinations and HbA1c tests than high-income people with diabetes [16].

Improved awareness of diabetes through early detection should be prioritized in diabetes management. However, from 2013 to 2016, the diabetes awareness rate was only 62.6%, which was lower than that (68.0%) in 2005 [17]. The reason for the decrease in awareness was that the number of undiagnosed diabetes cases increased when HbA1c was included in the diagnosis of diabetes from 2013 to 2016. In addition, 43.1% did not take treatment with glucose-lowering drugs or modify their lifestyle. Although the rate of worse glycemic control (HbA1c  $\geq$ 8.0%) fell steadily from 33.6% in 2005 to 20.9% in 2013 to 2016 [18], good control (HbA1c  $<$ 6.5%) was only achieved in 25.1% of the patients.

In addition, more than half the people with diabetes had comorbidities. According to the KNHANES 2011 study, the prevalence of dyslipidemia, hypertension, and obesity was 79.6%, 54.6%, and 44.4%, respectively, among adults with dia-

betes [19]. In 2013 to 2016, the prevalence of hypertension and obesity among people with diabetes was higher, while the prevalence of dyslipidemia was lower compared to the data in 2011. However, in 2011, the definition of dyslipidemia included hypercholesterolemia, hypertriglyceridemia, hyper-LDL-cholesterolemia, or hypo-HDL-cholesterolemia. Thus, we could not exactly compare the differences in prevalence.

Tight glycemic control and treatment of additional cardiovascular risk factors can decrease diabetic complications [20-22]. Thus, the management of diabetes through achievement of the ABC clinical targets (A, HbA1c; B, blood pressure; and C, LDL-C) is important. However, only 8.4% of subjects achieved all three ABC targets. Also, 24.1% were current smokers, 14.7% were high-risk drinkers, and only 36.4% were walking 30 minutes regularly. Compared to a previous study, the proportion of current smokers among people with diabetes has decreased and that of people who participate in regular walking exercise activities has significantly increased. However, the proportion of high-risk drinkers among people with diabetes has slightly increased. The incidence of type 2 diabetes is closely related to diet and lifestyle [23,24]. Several studies have shown that alcohol consumption can increase the risk of diabetes, even in the case of moderate consumption [25,26], while another study reported that moderate alcohol consumption decreased the risk of type 2 diabetes [27]. Although there is still controversy about the effect of moderate alcohol consumption, heavy alcohol drinking is known to potentiate the development of diabetes through pancreatic  $\beta$ -cell dysfunction [28,29]. In addition, the prevalence of alcohol dependence and alcohol abuse is much higher in Korea compared to other countries [30]. Thus, it is necessary to inform people with diabetes about the danger of alcohol consumption and the importance of decreasing alcohol intake.

In conclusion, increasing awareness and strengthening the management of people with diabetes can have a positive impact on the prevention of diabetes-related complications. However, the prevalence of diabetes is constantly increasing, while the awareness and control rates are still low in Korea. Thus, we need to construct a systemic approach to supporting diabetic patients, ranging from early detection to target-driven management.

## CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

## AUTHOR CONTRIBUTIONS

Conception or design: J.C.W., D.J.K., K.S.P.

Acquisition, analysis, or interpretation of data: B.Y.K., J.C.W., J.H.L., H.S.K., J.H.P., D.J.K.

Drafting the work or revising: B.Y.K., K.H.H., K.C.W., D.J.K.

Final approval of the manuscript: K.C.W., D.J.K., K.S.P.

## ORCID

Bo-Yeon Kim <https://orcid.org/0000-0002-3658-2351>

Dae Jung Kim <https://orcid.org/0000-0003-1025-2044>

## ACKNOWLEDGMENTS

This study was supported by The Korean Diabetes Association.

## REFERENCES

- Roglic G, Unwin N, Bennett PH, Mathers C, Tuomilehto J, Nag S, Connolly V, King H. The burden of mortality attributable to diabetes: realistic estimates for the year 2000. *Diabetes Care* 2005;28:2130-5.
- Morrish NJ, Wang SL, Stevens LK, Fuller JH, Keen H. Mortality and causes of death in the WHO multinational study of vascular disease in diabetes. *Diabetologia* 2001;44 Suppl 2:S14-21.
- Jeon JY, Ko SH, Kwon HS, Kim NH, Kim JH, Kim CS, Song KH, Won JC, Lim S, Choi SH, Jang MJ, Kim Y, Oh K, Kim DJ, Cha BY; Taskforce Team of Diabetes Fact Sheet of the Korean Diabetes Association. Prevalence of diabetes and prediabetes according to fasting plasma glucose and HbA1c. *Diabetes Metab J* 2013;37:349-57.
- Jeon JY, Kim DJ, Ko SH, Kwon HS, Lim S, Choi SH, Kim CS, An JH, Kim NH, Won JC, Kim JH, Cha BY, Song KH; Taskforce Team of Diabetes Fact Sheet of the Korean Diabetes Association. Current status of glycemic control of patients with diabetes in Korea: the fifth Korea National Health and Nutrition Examination Survey. *Diabetes Metab J* 2014;38:197-203.
- Vital Statistics Division Statistics Korea, Shin HY, Lee JY, Kim JE, Lee S, Youn H, Kim H, Lee J, Park MS, Huh S. Cause-of-death statistics in 2016 in the Republic of Korea. *J Korean Med Assoc* 2018;61:573-84.
- Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin Chem* 1972;18:499-502.
- American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care* 2014;37 Suppl 1:S81-90.
- Oh SW, Shin SA, Yun YH, Yoo T, Huh BY. Cut-off point of BMI and obesity-related comorbidities and mortality in middle-aged Koreans. *Obes Res* 2004;12:2031-40.
- Korean Diabetes Association: 2015 Treatment guidelines for diabetes. Available from: <http://www.diabetes.or.kr/bbs/skin/dianews/download.php?code=guide&number=301> (updated 2019 Jan 1).
- Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Bhalha MJ, Dai S, Ford ES, Fox CS, Franco S, Fullerton HJ, Gillespie C, Hailpern SM, Heit JA, Howard VJ, Huffman MD, Judd SE, Kissela BM, Kittner SJ, Lackland DT, Lichtman JH, Lisabeth LD, Mackey RH, Magid DJ, Marcus GM, Marelli A, Matchar DB, McGuire DK, Mohler ER 3rd, Moy CS, Mussolino ME, Neumar RW, Nichol G, Pandey DK, Paynter NP, Reeves MJ, Sorlie PD, Stein J, Towfighi A, Turan TN, Virani SS, Wong ND, Woo D, Turner MB; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics: 2014 update: a report from the American Heart Association. *Circulation* 2014;129:e28-92.
- Ha KH, Kim DJ. Trends in the diabetes epidemic in Korea. *Endocrinol Metab (Seoul)* 2015;30:142-6.
- Sesti G, Antonelli Incalzi R, Bonora E, Consoli A, Giaccari A, Maggi S, Paolisso G, Purrello F, Vendemiale G, Ferrara N. Management of diabetes in older adults. *Nutr Metab Cardiovasc Dis* 2018;28:206-18.
- Ross NA, Gilmour H, Dasgupta K. 14-Year diabetes incidence: the role of socio-economic status. *Health Rep* 2010;21:19-28.
- Lee TC, Glynn RJ, Peña JM, Paynter NP, Conen D, Ridker PM, Pradhan AD, Buring JE, Albert MA. Socioeconomic status and incident type 2 diabetes mellitus: data from the Women's Health Study. *PLoS One* 2011;6:e27670.
- Kim SH, Lee SY, Kim CW, Suh YJ, Hong S, Ahn SH, Seo DH, Nam MS, Chon S, Woo JT, Baik SH, Park Y, Lee KW, Kim YS; KNDDP Study Group. Impact of socioeconomic status on health behaviors, metabolic control, and chronic complications in type 2 diabetes mellitus. *Diabetes Metab J* 2018;42:380-93.
- Shin WY, Kim HC, Lee T, Jeon DH, Ha KH, Kim DJ, Chang HJ. Combined effects of diabetes and low household income on mortality: a 12-year follow-up study of 505 677 Korean adults. *Diabet Med* 2018;35:1345-54.
- Choi YJ, Kim HC, Kim HM, Park SW, Kim J, Kim DJ. Prevalence and management of diabetes in Korean adults: Korea Na-

- tional Health and Nutrition Examination Surveys 1998-2005. *Diabetes Care* 2009;32:2016-20.
18. Ha KH, Kim DJ. Current status of managing diabetes mellitus in Korea. *Korean J Intern Med* 2016;31:845-50.
  19. Korean Diabetes Association: Diabetes fact sheet in Korea 2018. Available from: <http://www.diabetes.or.kr/bbs/skin/dianews/download.php?code=admin&number=1859> (updated 2019 Jan 1).
  20. Diabetes Control and Complications Trial Research Group, Nathan DM, Genuth S, Lachin J, Cleary P, Crofford O, Davis M, Rand L, Siebert C. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med* 1993;329:977-86.
  21. UK Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet* 1998;352:837-53.
  22. Nathan DM, Cleary PA, Backlund JY, Genuth SM, Lachin JM, Orchard TJ, Raskin P, Zinman B; Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications (DCCT/EDIC) Study Research Group. Intensive diabetes treatment and cardiovascular disease in patients with type 1 diabetes. *N Engl J Med* 2005;353:2643-53.
  23. Hu FB, Manson JE, Stampfer MJ, Colditz G, Liu S, Solomon CG, Willett WC. Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. *N Engl J Med* 2001;345:790-7.
  24. Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales VS, Marks JS. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA* 2003;289:76-9.
  25. Ajani UA, Hennekens CH, Spelsberg A, Manson JE. Alcohol consumption and risk of type 2 diabetes mellitus among US male physicians. *Arch Intern Med* 2000;160:1025-30.
  26. Davies MJ, Baer DJ, Judd JT, Brown ED, Campbell WS, Taylor PR. Effects of moderate alcohol intake on fasting insulin and glucose concentrations and insulin sensitivity in postmenopausal women: a randomized controlled trial. *JAMA* 2002;287:2559-62.
  27. Seike N, Noda M, Kadowaki T. Alcohol consumption and risk of type 2 diabetes mellitus in Japanese: a systematic review. *Asia Pac J Clin Nutr* 2008;17:545-51.
  28. Lee DY, Yoo MG, Kim HJ, Jang HB, Kim JH, Lee HJ, Park SI. Association between alcohol consumption pattern and the incidence risk of type 2 diabetes in Korean men: a 12-years follow-up study. *Sci Rep* 2017;7:7322.
  29. Kim JY, Lee DY, Lee YJ, Park KJ, Kim KH, Kim JW, Kim WH. Chronic alcohol consumption potentiates the development of diabetes through pancreatic  $\beta$ -cell dysfunction. *World J Biol Chem* 2015;6:1-15.
  30. Min S, Noh S, Shin J, Ahn JS, Kim TH. Alcohol dependence, mortality, and chronic health conditions in a rural population in Korea. *J Korean Med Sci* 2008;23:1-9.