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## Prevalence of diabetes and pre-diabetes among workers: Japan Epidemiology Collaboration on Occupational Health Study

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## ABSTRACT

**Aims:** Few studies have examined the prevalence of diabetes using glycated hemoglobin (HbA1c), a newly recommended diagnostic test. We examined the prevalence of diabetes and pre-diabetes using both HbA1c and fasting plasma glucose (FPG) and their associations with risk factors for type 2 diabetes in a large-scale Japanese working population.

**Methods:** Participants were 47,172 men and 8280 women aged 20–69 years who received periodic health checkup in nine companies which participated in the Japan Epidemiology Collaboration on Occupational Health study. Participants were categorized into diabetes (HbA1c  $\geq 6.5\%$  ( $\geq 48$  mmol/mol), FPG  $\geq 126$  mg/dl ( $\geq 7.0$  mmol/L), or medication for diabetes), pre-diabetes (HbA1c 6.0–6.4% (42–46 mmol/mol) or FPG 110–125 mg/dl (6.1–6.9 mmol/L) among those without diabetes), and normal glucose regulation.

**Results:** The prevalence of diabetes was 8.0% and 3.3% in men and women, respectively. Of individuals with diabetes, approximately 80% were defined by HbA1c  $\geq 6.5\%$  ( $\geq 48$  mmol/mol) criterion. The prevalence of pre-diabetes was 14.1% in men and 9.2% in women. Prevalence of these glucose abnormalities increased with advancing age, especially during mid-40s and 50s. Higher body mass index and waist circumference, hypertension, dyslipidemia, and current smoking were each associated with higher prevalence of diabetes in both men and women.

**Conclusions:** Using HbA1c and FPG criteria or current medication, one in 13 men and one in 30 women had diabetes in the present Japanese working population. Interventions targeted for those in an early stage of impaired glucose metabolism would be required to prevent diabetes.

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## 1. Introduction

The prevalence of diabetes has been increasing globally, with estimated number of diabetes being 592 million by 2035 [1]. Diabetes is associated with an increased risk of cardiovascular disease events [2,3], cancer [4,5], and mortality [6]. In Japan, the prevalence of diabetes has markedly increased in the last few decades [7]. According to health surveys of a Japanese community of Hisayama using the 75g oral glucose tolerance test (OGTT), the age-adjusted prevalence of diabetes among residents aged 40 years or older increased from 14.3% to 20.6% in men and from 9.0% to 11.5% in women from 1988 to 2002 [8]. However, OGTT is difficult to perform in practice and thus not recommended for routine use by the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus [9].

Recently, the Expert Committee [9] and the American Diabetes Association (ADA) [10] recommended a new definition of diabetes using a glycated hemoglobin (HbA1c) criterion ( $\geq 6.5\%$ , 48 mmol/mol). According to a national survey in Japan using HbA1c criterion, the prevalence of diabetes has considerably increased from 9.9% in 1997 to 15.3% in 2007 in male adults, whereas it was stable in female adults (from 7.1% to 7.3%) [11]. The prevalence of pre-diabetes has also increased from 8.0% to 14.0% and from 7.9% to 15.9% in men and women, respectively, between 1997 and 2007 [11]. In the 2003–2006 US National Health and Nutrition Examination Survey (NHANES), the prevalence of diabetes defined as a HbA1c  $\geq 6.5\%$  ( $\geq 48$  mmol/mol) was 9.6% in adults [12]. In that study, however, a HbA1c  $\geq 6.5\%$  ( $\geq 48$  mmol/mol) criterion identified one-third fewer cases of undiagnosed diabetes than a fasting

plasma glucose (FPG)  $\geq 126$  mg/dl ( $\geq 7.0$  mmol/L) [12]. It might thus be better to diagnose diabetes using both HbA1c and FPG criteria than using only HbA1c criterion [13,14].

To our best knowledge, few studies reported the prevalence of diabetes [13,14] and pre-diabetes [15] using both HbA1c and FPG criteria. The participants of these studies, however, were examinees of a specific screening facility and thus may not be representative samples. Moreover, data are limited on the prevalence of diabetes and pre-diabetes stratified by age and other risk factors for diabetes including higher body mass index (BMI), higher waist circumference, smoking, hypertension, and dyslipidemia. The objectives of the present study were to estimate the prevalence of diabetes and pre-diabetes using criteria of HbA1c and FPG and to examine these conditions in relation to type 2 diabetes risk factors using data from a large, multi-center study of working population in Japan.

## 2. Materials and methods

### 2.1. Study procedure

The Japan Epidemiology Collaboration on Occupational Health (J-ECOH) is an ongoing multi-center epidemiologic study among workers from several companies in Japan. According to standard procedure of the study, researchers obtained several types of worker health data including those of periodic health checkup (2008 and thereafter), cardiovascular event (myocardial infarction and stroke), death from all causes, and long-term sick leave (1 month or longer) from participating

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