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Regional variations in frequency of glycosylated hemoglobin (HbA1c) monitoring in Korea: A multilevel analysis of nationwide data

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ABSTRACT

Purpose: Suboptimal frequency of glycosylated hemoglobin (HbA1c) monitoring is associated with poor diabetes control. We aimed to analyze compliance to HbA1c testing guidelines and explore associated individual and area-level determinants, focusing on regional variation.

Methods: This cross-sectional study between the period of 2012–2013 was conducted by using the Korean National Health Insurance Research Database, and included 45,634 patients diagnosed with diabetes mellitus, who were prescribed any anti-diabetic medications, including insulin. We calculated the proportion of each HbA1c testing frequency (≥ 1 , ≥ 2 , or ≥ 4 times per year) stratified by 17 administrative regions. Multilevel and multivariate logistic analyses were performed with regional (proportion of farmer population) and individual characteristics (age, sex, income level, duration of diabetes, and most visited medical institution).

Results: Overall, 67.3% of the patients received ≥ 1 HbA1c test per year; 37.8% and 6.1% received ≥ 2 and ≥ 4 tests per year, respectively. Those managed in secondary-level hospitals or clinics and those living in rural areas were less likely to receive HbA1c testing. Even after adjusting for individual and regional level characteristics, significant area level variation was observed (variance participant coefficients were 7.91%, 9.58%, and 14.43% for testing frequencies of ≥ 1 , ≥ 2 , and ≥ 4 times a year, respectively).

Conclusions: The frequency of HbA1c monitoring is suboptimal in Korea, especially in rural areas. Moreover, significant regional variation was observed, implying a contextual effect. This suggests the need for developing policy actions to improve HbA1c monitoring. In particular, access to HbA1c testing in rural primary care clinics must be improved.

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1. Introduction

According to the World Health Organization's (WHO) 2014 estimates, 9% of the global population has diabetes mellitus and the prevalence is gradually increasing [1]. The complications of diabetes, including cardiovascular disease, diabetic nephropathy, and diabetic retinopathy, incur a high burden both to patients and society [2]. In Korea, the prevalence of diabetes increased from 8.6% in 2001 to 13.7% in 2014 [3,4]; it is currently the country's sixth leading cause of death [5].

Adequate glycemic control is important to slow disease progression, prevent complications, and decrease hospital admissions [6]. A 1% reduction in the glycosylated hemoglobin (HbA1c) level can reduce the risk of microvascular complications and myocardial infarction by 37% and 14%, respectively [7,8]. Achieving the target HbA1c level of <7% (<53 mmol/mol) by intensive glycemic control was shown to be better than standard glycemic control in preventing and delaying microvascular complications [6–14]. Suboptimal frequency of HbA1c monitoring is associated with poor control of diabetes. In a study performed in a rural area in the US, patients who adhered to the American Diabetes Association (ADA) guidelines for frequency of HbA1c testing had better diabetes control than those who did not [15]. Further, a retrospective study performed in the US between 2009 and 2011 showed that HbA1c results improved when the ADA guidelines for HbA1c testing frequency were followed [16]. A large multicenter study from the UK showed that quarterly monitoring of HbA1c was associated with a 3.8% reduction in HbA1c compared with a 1.5% increase observed with annual testing [17]. Moreover, a recent study of Medicare patients in the US showed that consistent annual HbA1c testing was associated with fewer adverse cardiovascular outcomes [14].

The recent ADA guideline published in 2014 recommends that HbA1c be monitored at least twice yearly in patients who have stable glycemic control and every three months in patients who do not meet their treatment goals or who have changed medication [18]. If it is difficult for patients to access HbA1c testing, the guideline recommends at least an annual monitoring. In particular, HbA1c testing should be performed in patients taking anti-diabetic medications or using insulin, not only to monitor blood glucose levels but also to check for medication side effects. In the UK, the National Institute for Health and Clinical Excellence recommends HbA1c measurements at 6-monthly intervals for patients with stable blood glucose levels or at 3–6-monthly intervals until the HbA1c level becomes stable on unchanging therapy [19]. The Canadian Diabetes Association recommends HbA1c testing every 3 months [20]. In Korea, HbA1c measurement is recommended at least twice yearly, or 3-monthly for patients with unstable blood glucose levels or whose medication is being optimized [21]. However, HbA1c monitoring at intervals outside of these national and international guidelines is widespread [15,22].

A cross-national comparison of 5 Organization for Economic Co-operation and Development (OECD) countries (Australia, New Zealand, the UK, the US, and Canada) showed annual testing rates of 60–90% [22]. Various patient characteristics were associated with HbA1c testing frequency [23–25],

and several studies focused on regional variation, such as differences between rural and urban settings [24–31]. In Korea, the annual HbA1c testing rate was 41.5% in 2016, and varied according to age, income level, provider type, and number of ambulatory care visits. However, most of previous studies were limited in that they were performed in single geographic areas [26,30,32], involved only small numbers of patients [26,32,33], and did not take into account regional variations [34]. To our knowledge, no previous study has adopted a multilevel analysis, which considers both individual and area-level determinants. In this study, using National Health Insurance Claims data, we aimed to analyze compliance to the HbA1c testing guideline and explore individual and area-level determinants associated with compliance, focusing on the regional differences.

2. Research design and methods

2.1. Data source

This research was conducted using the Korean National Health Insurance (KNHI) Research Database. The KNHI is a mandatory universal health insurance in Korea that covers 97% of the Korean population. KNHI claims data includes medical information for reimbursement purposes, such as utilization of medical facilities (both outpatient and inpatient), procedures and diagnostic tests, and prescription of medication. It also contains demographic data, including age, sex, insurance premium (proxy for income level), and place of residence. The KNHI Research Database contains all medical and demographic information of 2% of the total Korean population (approximately one million of 50 million people), randomly selected, and followed from January 1, 2002 to December 31, 2013 [35]. This data is utilized extensively for epidemiologic and health policy studies [36]. For this cross-sectional study, we used the 2012–2013 data. This study was approved by the institutional review board of the National Evidence-based Collaboration Agency (NECAIRB15-028-1).

2.2. Study population

To assess the frequency of HbA1c testing in 2013, we included 45,634 patients with claims for diabetes mellitus (code “E10”, “E11”, “E12”, “E13”, and “E14” of the International Classification of Disease, 10th revision [ICD-10]) in 2013 and who were prescribed any anti-diabetic medications, including insulin, in 2012. We excluded the following: 1) patients who were hospitalized during 2013, because HbA1c testing would then have been performed outside of routine diabetes care ($n = 331$); 2) patients who had made only one claim for diabetes over the year ($n = 1524$); and 3) patients who died in 2013 ($n = 496$). Finally, data from 43,283 patients were included in the analysis (Supplementary Appendix 1).

2.3. Dependent variable: hemoglobin A1c

Reimbursement data for HbA1c from January 1, 2013 to December 31, 2013 (procedure code: C3825) were abstracted from the KNHI claims data. As testing more frequently than

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