Original Article

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Healthcare Utilization and Discrepancies by Income Level Among Patients With Newly Diagnosed Type 2 Diabetes in Korea: An Analysis of National Health Insurance Sample Cohort Data

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Objectives: The use of qualitative healthcare services or its discrepancy between different income levels of the type 2 diabetes (T2D) patients has seldom been studied concurrently. The present study is unique that regarding T2D patients of early stages of diagnosis. Aimed to assess the utilization of qualitative healthcare services and influence of income levels on the inequality of care among newly diagnosed patients with T2D.

Methods: A retrospective cohort study of 7590 patients was conducted by the National Health Insurance Service National Sample Cohort 2.0 from 2002 to 2015. Insured employee in 2013 with no history of T2D between 2002 and 2012 were included. The standard of diabetes care includes hemoglobin A1c (HbAlc; 4 times/y), eyes (once/y) and lipid abnormalities (once/y). Multivariate logistic regression analysis was performed to examine the difference between income levels and inequality of care.

Results: From years 1 to 3, rates of appropriate screening fell from 16.9% to 14.1% (HbA1c), 15.8% to 14.5% (eye), and 59.2% to 33.2% (lipid abnormalities). Relative to income class 5 (the highest-income group), HbA1 screening was significantly less common in class 2 (year 2: odds ratio [OR], 0.78; 95% confidence interval [CI], 0.61 to 0.99; year 3: OR, 0.79; 95% CI, 0.69 to 0.91). In year 1, lipid screening was less common in class 1 (OR, 0.84; 95% CI, 0.73 to 0.98) than in class 5, a trend that continued in year 2. Eye screening rates were consistently lower in class 1 than in class 5 (year 1: OR, 0.73; 95% CI, 0.60 to 0.89; year 2: OR, 0.63; 95% CI, 0.50 to 0.78; year 3: OR, 0.81; 95% CI, 0.67 to 0.99).

Conclusions: Newly diagnosed T2D patients have shown low rate of HbA1c and screening for diabetic-related complications and experienced inequality in relation to receiving qualitative diabetes care by income levels.

Key words: Health inequities, Diabetes complications, Poverty, National Health Insurance, Type 2 diabetes mellitus

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INTRODUCTION

Globally, it is estimated that every six seconds, someone dies from diabetes-related complications and the cost of diabetes care is at least 3.2 times greater than the average per capital healthcare expenditure, rising to 9.4 times in presence of complications [1]. People with low socioeconomic status (SES) are more likely to experience type 2 diabetes (T2D) [2-5] and tend to have poorer glycemic control than those with higher SES [6-8], leading to serious microvascular and macrovascular complications [9,10]. Recent studies have reported that disparities in the quality of diabetes care persist due to a lack of access to or eligibility for affordable medical insurance, even in countries with universal health coverage (UHC) [11-14]. In single-payer systems such as that of Canada, access to quality diabetes care may not be universal. Individuals with lower incomes are more likely to visit a family physician, while higher-income patients are nearly twice as likely to receive referrals for specialty care [15]. Additionally, low income is associated with a higher rate of hospitalization for acute diabetes-related complications. Booth and Hux [16] demonstrated that, even within a universal health care system, the least affluent patients were admitted to hospital 43% more often than the wealthiest patients. Within publicly funded and universally accessible systems, evidence suggests that individuals from lower socioeconomic groups have less access to care, reflected in longer wait times and fewer referrals to specialists [15-17]. This may contribute to worse health outcomes, such as the increased rate of acute diabetic complications observed in lower-income populations by Booth and Hux [16].

Adequate diabetes care and healthcare-seeking behaviors may substantially impact patient prognosis, particularly in the early stages after diagnosis [18]. However, healthcare utilization and its disparities across income levels in T2D have rarely been studied concurrently. Additionally, the present study is notable in that it focuses on patients with T2D in the years immediately following diagnosis. This study aimed to assess the utilization of qualitative healthcare services and the influence of income level on care inequality in this newly diagnosed population.

METHODS

Data and Participants

This retrospective cohort study utilized the National Health Insurance Service National Sample Cohort 2.0 (NHIS-NSC2) database. The NHIS-NSC2, representing 2.2% of the total eligible Korean population in 2006, was constructed through random sampling of a selected cohort. It includes personal and demographic information, medical treatments received from 2002 to 2015, and other relevant data such as income status and medical records [2]. The NHIS-NSC2 dataset indicates the decile of insurance premiums for each participant. The system for calculating premiums differs between employees and the self-employed. A recent study indicated that the mean annual income of employed individuals was US$15 000 higher than that of self-employed people [19]. Additionally, self-employed individuals experience work transitions more frequently than employees, due to the precarious nature of their employment status and the complexity of their work environment. Consequently, we categorized our study cohort into the employed group only and self-employed insured and the Medical Aid beneficiaries were excluded.

Inclusion criteria

Case of T2D in the period 2013-2015 were ascertained by following the inclusion criteria: (1) employed insured people were included only, (2) beneficiaries' claims with T2D (International Classification of Diseases, 10th revision, Clinical Modification; ICD-10 codes: E11.xx), and (3) with at least 1 ambulatory visit for diabetes-related illnesses (ICD-10 codes: E11.xx) within 1 year or 1 prescription of oral anti-diabetic agents (ICD-10 codes: A362) within 1 year considering that the accuracy of the diagnosis of health insurance data is about 70% [20,21]. Patient were followed until December 31, 2015.

Exclusion criteria

Individuals were excluded from the study if they were either diagnosed with T2D (ICD-10 codes: E11.xx or A362) or prescribed antidiabetic agents during the washout period of 2002 to 2012. Considering differences in the timing and characteristics of medical usage, only patients who had not received medical care for T2D prior to 2013 were considered eligible for the present research. Those who were not health beneficiaries of the NHIS were excluded from the study population. The sample population included 7590 patients who were newly diagnosed with T2D.

Measurements

Income level

The exposure variable in this study was income level. The average monthly insurance premium, as estimated by the NHIS, was used to indicate household income. Monthly premiums for health insurance subscribers for workplace health insurance are determined based on monthly salary recorded in the NHIS registry archive in 2013 while monthly premiums for local health insurance subscribers are based on the income or property of eligible households. In NHIS, the patient's insurance status is encoded as follows: 0 for medical aid and 1-10 for evenly distributed percentiles according to insurance premium. For this study, these groups were re-categorized into 5 income classes, with class 1 representing the lowest income and class 5 the highest income. The distribution was as follows: class 1 (n=1375), class 2 (n=1207), class 3 (n=1260), class 4 (n=1627), and class 5 (n=2121). Insurance premiums are calculated based on monthly income; thus, the study only included participants with relatively stable employment. Additionally, since T2D is more prevalent among elderly individuals, who tend to be in higher income categories, a relatively large number of participants were classified in income group 5.

Quality of diabetes care

Three screening tests—for hemoglobin A1c (HbAlc) levels, retinopathy (eye screening), and triglyceride levels (lipid abnormalities)—were used as indicators of diabetes care utilization, which was assessed by income level over the study period [2]. The 2021 American Diabetes Association guidelines indicate that standard diabetes care should include HbA1c check-ups 4 times per year, annual low-density lipoprotein (LDL) cholesterol testing, and an annual eye examination [22]. Diabetic-related complication screening guideline recommend HbA1c test at least twice a year however, due to high volume of healthcare service uses in Korea, we defined HbA1c tested at least 4 times in a year [23]. Lipid abnormalities tested at least once of the total cholesterol, high-density lipoprotein cholesterol, and triglyceride or the LDL cholesterol were tested within a year were clinically defined. Eye screening was considered adequate if the patient underwent fundus examination, fluorescein angiography, or indocyanine green angiography at least once during the year.

Statistical Analysis

Baseline proportions of patient demographics and clinical characteristics were described. The association between income disparity and the utilization of diabetes care was examined using multivariable logistic regression models, with adjusted odds ratios (ORs) and *p*-values reported alongside 95% confidence intervals (CIs). The highest-income group (class 5) served as the reference to represent the general population. Covariates included sex; age; comorbidity; National Health Insurance (NHI) registration location (urban or rural); pre-existing diabetes complications (eye issues, nephropathy, neuropathy, lower limb amputation, ischemic heart disease, or cere-

Table 1. Baseline individual characteristics of new cases of type 2 diabetes mellitus (n=7590)

Characteristics	n (%)
Sex	
Male	3718 (49.0)
Female	3872 (51.0)
Age (y)	
20-44	1672 (22.0)
45-54	1825 (24.0)
55-64	1865 (24.6)
65-74	1319 (17.4)
≥75	909 (12.0)
Residential area	
Rural	1573 (20.7)
Urban	6017 (79.3)
Income class	
Class 5	2121 (27.9)
Class 4	1627 (21.4)
Class 3	1260 (16.6)
Class 2	1207 (15.9)
Class 1	1375 (18.1)
Comorbidities	
Hypertension (yes)	817 (10.8)
Heart disease (yes)	85 (1.1)
Stroke (yes)	50 (0.7)
Renal disease (yes)	17 (0.2)
Charlson comorbidity index	
0	1925 (25.4)
1	2598 (34.2)
≥2	3067 (40.4)
Main source of healthcare (level of medical Institution)	
Primary	6681 (88.0)
Secondary	237 (3.1)
Tertiary	672 (8.8)
No. of ambulatory care visits	
1-3	6153 (81.1)
4-6	665 (8.8)
7-9	360 (4.7)
10-12	215 (2.8)
≥13	197 (2.6)
No. of providers	
1 (single)	7166 (94.4)
2	371 (4.9)
≥3	53 (0.7)
Drug prescription days per year (PDC)[1]	
<180	2182 (72.9)
180-269	314 (10.5)
270-359	261 (8.7)
≥360	235 (7.8)

PDC, proportion of days covered.
[1]Participants included only those with insulin and blood glucose-lowering agents (classification code "396") in the prescription.

brovascular disease) identified by ICD-10 codes; type of health coverage; frequency of physician visits; and types of healthcare facilities visited. Residential area and the type of health insurance premiums were determined as of the end of December 2012. During the follow-up period, the main sources of healthcare—divided into primary, secondary, and tertiary medical facilities—were assigned, defined as receiving more than 2 outpatient visits by the participant. Comorbidity was indicated by the identification of at least 2 NHI diagnoses in 2013. Comorbidities were measured using Charlson comorbidity index [24] scores (1, 2, or ≥3) or the presence of at least 1 additional chronic condition among hypertension, heart disease, stroke, and renal disease. These 4 diseases were selected for comorbidity analysis based on the relevant literature, clinical medical textbooks, diabetic medical guidelines, and patterns of hospitalization and outpatient service utilization among the patients analyzed in 2012.

Analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

Ethics Statement

This study was granted ethical approval by the Institutional Review Board of the National Health Research Institutes of Korea (NHIS-2021-2-086), under University of Chung-Ang IRB 1041078-202008-HRSB-210-0.

RESULTS

Table 1 presents the demographic characteristics of individuals newly diagnosed with T2D in 2013. The distribution of patients with T2D was nearly equal between the sexes, with 49.0% male and 51.0% female. Regarding age, 46.0% of patients were under 55 years old, while 54.0% were older than 55 years. The participants predominantly lived in urban areas, outnumbering rural residents in every income class. The most frequent main source of healthcare services was primary care (representing 88.0% of patients), with a single healthcare provider (94.4%) and under 1-3 annual ambulatory care appointments (81.1%) predominating. Of the patients, 72.9% had fewer than 180 days of medication coverage per year.

For HbA1c screenings (Table 2), a steady decline was noted in the proportion of appropriate testing over the follow-up years. Specifically, this rate decreased from 16.9% in the first year to 15.5% in the second year and 14.4% in the third year after diagnosis. The results indicated a strong association with lower income class starting in the second year. Patients newly diagnosed with T2D in the class 2 income category displayed an OR of 0.78 (95% CI, 0.61 to 1.00) in the second year, while those in class 4 exhibited an OR of 0.77 (95% CI, 0.61 to 0.97); both were significantly lower compared to class 5 (reference; OR, 1.00) after adjusting for covariates in the multivariate logistic regression analysis. Similarly, in the third year, the odds were significantly lower in income classes 1, 2, and 4, with ORs of 0.88 (95% CI, 0.77 to 1.00), 0.79 (95% CI, 0.69 to 0.91), and 0.82 (95% CI, 0.73 to 0.93), respectively.

As shown in Table 3, the proportions of patients undergoing eye and lipid screenings at least once a year decreased over time. Specifically, the rate of eye screenings declined from 15.8% to 14.5%, while the rate of lipid screenings dropped from 59.2% to 33.2%. In the multivariable logistic regression analysis for

Table 2. Multiple logistic regression analysis[1] for the effects of selected independent variables on hemoglobin A1c (HbAlc) measurements of employed insured people newly diagnosed with type 2 diabetes

Income class	≥4 HbA1c measurements								
	Follow-up								
	First year			Second year			Third year		
	n (%)	Unadjusted	Adjusted	n (%)	Unadjusted	Adjusted	n (%)	Unadjusted	Adjusted
Total	1275 (100)	-	-	1088 (100)	-	-	1085 (100)	-	-
Class 5	382 (18.0)	1.00 (reference)	1.00 (reference)	303 (14.1)	1.00 (reference)	1.00 (reference)	314 (14.4)	1.00 (reference)	1.00 (reference)
Class 4	259 (15.9)	0.86 (0.72, 1.02)	0.84 (0.69, 1.01)	218 (12.9)	0.89 (0.73, 0.99)	0.77 (0.61, 0.97)*	230 (13.7)	0.94 (0.78, 1.13)	0.82 (0.73, 0.93)*
Class 3	219 (17.4)	0.94 (0.78, 1.13)	0.87 (0.71, 1.08)	203 (16.1)	1.15 (0.94, 1.39)	0.99 (0.78, 1.26)	186 (14.7)	1.03 (0.84, 1.25)	0.92 (0.81, 1.01)
Class 2	182 (16.3)	0.87 (0.72, 1.06)	0.85 (0.68, 1.05)	161 (13.8)	0.98 (0.80, 1.21)	0.78 (0.61, 1.00)*	158 (13.5)	0.95 (0.77, 1.17)	0.79 (0.69, 0.91)***
Class 1	233 (16.9)	0.92 (0.77, 1.11)	0.85 (0.70, 1.05)	203 (15.5)	1.12 (0.92, 1.36)	0.85 (0.66, 1.07)	197 (14.4)	1.01 (0.83, 1.23)	0.88 (0.77, 1.00)*

Values are presented as odds ratio (95% confidence interval).
[1]Multivariate logistic regression was adjusted for age, sex, Charlson comorbidity index, comorbidities (hypertension, heart disease, stroke, renal disease), regional area, and the main source of healthcare (level of medical Institution).
*$p<0.05$, ***$p<0.001$.

Table 3. Multiple logistic regression analysis[1] for the effects of selected independent variables on eye and lipid abnormality tests[2] of employed insured people newly diagnosed with type 2 diabetes

Income class	Follow-up								
	First year			Second year			Third year		
	n (%)	Unadjusted	Adjusted	n (%)	Unadjusted	Adjusted	n (%)	Unadjusted	Adjusted
≥1 eye measurement	1229 (100)	-	-	1057 (100)	-	-	1152 (100)	-	-
Class 5	445 (21.0)	1.00 (reference)	1.00 (reference)	374 (17.4)	1.00 (reference)	1.00 (reference)	404 (18.5)	1.00 (reference)	1.00 (reference)
Class 4	259 (15.9)	0.70 (0.59, 0.83)***	0.77 (0.65, 0.92)**	245 (14.5)	0.80 (0.67, 0.96)*	0.90 (0.75, 1.00)	249 (14.8)	0.76 (0.64, 0.91)**	0.82 (0.69, 0.99)*
Class 3	170 (13.5)	0.58 (0.47, 0.70)***	0.65 (0.53, 0.80)***	159 (12.6)	0.66 (0.54, 0.81)***	0.76 (0.61, 0.93)**	178 (14.1)	0.71 (0.58, 0.86)***	0.76 (0.65, 0.97)*
Class 2	160 (14.3)	0.61 (0.50, 0.75)***	0.75 (0.61, 0.92)**	142 (12.2)	0.66 (0.53, 0.81)***	0.77 (0.62, 0.96)*	131 (11.2)	0.55 (0.44, 0.68)***	0.60 (0.48, 0.75)*
Class 1	195 (14.2)	0.62 (0.51, 0.74)***	0.73 (0.60, 0.89)**	137 (10.4)	0.56 (0.45, 0.69)***	0.63 (0.50, 0.78)***	190 (13.8)	0.71 (0.59, 0.86)***	0.81 (0.67, 0.99)*
≥1 exploration of lipid abnormalities	4456 (100)	-	-	2976 (100)	-	-	3114 (100)	-	-
Class 5	1296 (61.1)	1.00 (reference)	1.00 (reference)	887 (41.2)	1.00 (reference)	1.00 (reference)	915 (42.0)	1.00 (reference)	1.00 (reference)
Class 4	949 (58.3)	0.89 (0.78, 1.00)	0.88 (0.77, 1.00)*	644 (38.0)	0.87 (0.76, 0.99)*	0.85 (0.74, 0.99)*	665 (39.6)	0.91 (0.80, 1.04)	0.92 (0.80, 1.17)
Class 3	758 (60.2)	0.95 (0.83, 1.10)	0.93 (0.80, 1.08)	491 (38.9)	0.90 (0.78, 1.04)	0.87 (0.74, 1.02)	526 (41.6)	0.99 (0.86, 1.14)	1.00 (0.86, 1.17)
Class 2	656 (58.7)	0.89 (0.76, 1.03)	0.88 (0.75, 1.03)	451 (38.6)	0.89 (0.77, 1.04)	0.86 (0.73, 1.02)	456 (39.0)	0.91 (0.78, 1.05)	0.85 (0.73, 1.00)*
Class 1	797 (58.0)	0.88 (0.77, 1.00)	0.84 (0.73, 0.98)*	503 (38.3)	0.88 (0.76, 0.99)*	0.80 (0.68, 0.94)**	552 (40.2)	0.94 (0.82, 1.09)	0.93 (0.80, 1.08)

Values are presented as odds ratio (95% confidence interval).
[1]The multivariate logistic regression was adjusted for age, sex, Charlson comorbidity index, comorbidities (hypertension, heart disease, stroke, renal disease), regional area, the main source of healthcare (level of medical institution).
[2]At least 1 eye test or lipid abnormality test.
*$p<0.05$, **$p<0.01$, ***$p<0.001$.

eye screening, the ORs for the lower income classes in the first year, compared to the reference value of the highest income class (class 5), were statistically significant: class 1 exhibited an OR of 0.73 (95% CI, 0.60 to 0.89), class 2 displayed an OR of 0.75 (95% CI, 0.61 to 0.92), class 3 had an OR of 0.65 (95% CI, 0.53 to 0.80), and class 4 had an OR of 0.77 (95% CI, 0.65 to 0.92). This trend persisted through the third year of follow-up. For lipid screenings, the first-year results showed that class 1 had an OR of 0.84 (95% CI, 0.73 to 0.98) and class 4 had an OR of 0.88 (95% CI, 0.77 to 1.00). In the subsequent year, class 1 had an OR of 0.80 (95% CI, 0.68 to 0.94) and class 4 had an OR of 0.85 (95% CI, 0.74 to 0.99). By the third year, class 2 had an OR of 0.85 (95% CI, 0.73 to 1.00). These rates were all significantly lower than those of the highest-income group.

DISCUSSION

These findings demonstrate that newly diagnosed patients with T2D have shown less likely to take HbA1c test and diabetic-related complication screenings. Moreover, economically disadvantaged may receive inadequate diabetes care in early stage of diagnosis despite universal health insurance coverage. In our study also have shown that individual with low income levels with T2D were about 20-40% less likely to receive the recommended diabetes check-ups. This may be because of a lack of or inaccessibility of services as there is the substantial out-of-pocket payments for the screenings remained even if UHC existed. As of 2019, NHIS covered 97.4% of the Korean population, while Medical Aid beneficiaries accounted for the remaining 2.5% [25,26]. Except for those supported by Medical Aid, all beneficiaries of the NHI are required to pay monthly premiums to the Health Security System. The beneficiaries are also required to pay a certain portion of co-payment for the health care costs that are covered by NHI for defined medical treatments as well as for the treatments that are not defined in the NHI-approved items, the patient has to pay 100% for the treatment received directly to the hospital.

These low rate of HbA1c test or diabetic-related complication screenings among newly diagnosis patient with T2D were similar to earlier studies identifying a relationship between financial barriers and receiving screenings [27-29]. In Australia, there was limited access and high out-of-pocket costs for medications and monitoring supplies that contribute to essential diabetic cares [30]. Foot and dilated eye tests that are properly taken were found to be less than recommended in particular, in poor people [31] due to the unaffordable co-payment, in Canada. In addition, poor people receive laboratory tests through the NHI program, reinforces the results of other studies that showed financial barriers as one of the largest attributable factors in the under-utilization of essential diabetic care for T2D treatment. Similar results in other countries with UHC like Taiwan indicate that disadvantaged diabetic patients are less likely to access diabetic clinics for essential care such as glycated hemoglobin, LDL cholesterol, triglycerides, and retinopathy diabetes clinics [29]. In France, about 1 in 10 participants were reimbursed for an annual visit to a private endocrinologist; the higher the income levels, the higher the frequency of visits to private endocrinologists. Moreover, those in the lowest income levels were less frequently reimbursed for annual visits to private ophthalmologists and dentists [28]. This indicates that poor diabetes patients may not receive adequate quality medical care to recover. Despite the UHC, it has been credited with lowering financial barriers to medical care, many socioeconomic barriers regarding screening for diabetic complications still remain.

Earlier studies have also found that patient with a longer duration of diabetes and who received medical care were more likely to be screened with HbA1c test and diabetic-related complication screenings or better adherence to the diabetes cares [27,32]. Many studies have suggested that a lack of or inadequate knowledge regarding the necessity for those screening is the main barrier to receiving screening, and receiving diabetes education is associated with an increased screening rate for diabetic screening tests in the early stage of disease [33,34]. This was identifying a relationship between education and health behavior in the self-management of chronic diseases from earlier studies. Previous studies regarding diabetes care also showed that lower education is associated with lower screening rates for retinopathy and nephropathy [27,34,35]. These low rate of diabetic screenings tests indicates that is poor diabetes control among the T2D patients in early stage of diagnosis [36], which may result delays in recognition and identification of a worsening prognosis of diabetic complication. Thus, it suggests that education on the quality of diabetes cares should be strengthened in the early stage of diagnosis to prevent development and aggravation of complications. Physicians' attitudes toward caring for T2D patients can be another barrier, as some primary care physicians felt that the guidelines for reaching the goals were not clear and relied on their clinical experience when making decisions to screen

[37,38]. Furthermore, they often faced administrative, time, and information constraints. As preventive care is the cornerstone of primary and secondary prevention of T2D complications, improving diabetes education for both patients and providers in healthcare settings and establishing a system that allows easy referrals to specialists may improve the utilization of preventive services.

One limitation of this study is that changes in the income status of the participants could not be incorporated into the analysis. Future research should employ longitudinal data to account for variations in income status over time within the analytical model. Moreover, while the influence or pattern of medical utilization may differ according to income status, this study did not capture changes in groups over time, such as those transitioning from higher to lower income brackets or vice versa. Nevertheless, insurance premiums were calculated based on monthly income, the study targeted individuals with relatively stable employment to maximize data accuracy, and a 3-year follow-up period after diagnosis was used to assess changes in a complementary manner. As a second limitation, the income levels of participants were determined based on the income status in the NHIS-NSC2 data, which is inferred from the premiums paid for insurance for the household. The NHIS-NSC2 data did not provide the number of household members, which precluded the determination of equalized personal income, a measure obtained by dividing household income by the number of household members. Finally, education level is a major risk factor for diabetes and is closely associated with income; this variable should be considered in future studies. Despite these limitations, this study is valuable in that it utilized cohort research data from the reliable NHIS-NSC2 database to demonstrate the impact of income level on the utilization of medical services by patients with T2D.

In summary, income disparity appear to predispose individuals with diabetes toward receiving unequal diabetes care, which includes delayed diagnosis and inadequate follow-up, even in a nation with a comprehensive universal health insurance system. This study indicates that the improvement of access through comprehensive and UHC is merely a start toward eliminating inequality in diabetes care. Moreover, the research indicates that inequality could be exacerbated if initial patterns of medical utilization become entrenched beyond newly diagnosed patients. Among the various strategies aimed at reducing income disparities in diabetes care, addressing financial burden, encouraging health literacy regarding diabetes, improving the role of primary care physicians, and strengthening the accountability of healthcare providers are essential to ensure high-quality diabetes care.

NOTES

Conflict of Interest

The authors have no conflicts of interest associated with the material presented in this paper.

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Author Contributions

Conceptualization: Park EJ, Lee WY. Data curation: Park EJ, Lee WY. Formal analysis: Park EJ, Lee WY. Funding acquisition: None. Methodology: Park EJ, Ji NJ, You CH, Lee WY. Project administration: Park EJ, Lee WY. Visualization: Park EJ, Lee WY. Writing – original draft: Park EJ, Lee WY. Writing – review & editing: Park EJ, Ji NJ, You CH, Lee WY.

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REFERENCES

1. Al-Maskari F, El-Sadig M, Nagelkerke N. Assessment of the direct medical costs of diabetes mellitus and its complications in the United Arab Emirates. BMC Public Health 2010;10:679. http://doi.org/10.1186/1471-2458-10-679
2. Lee J, Lee JS, Park SH, Shin SA, Kim K. Cohort profile: the National Health Insurance Service-National Sample Cohort (NHIS-NSC), South Korea. Int J Epidemiol 2017;46(2):e15. http://doi.org/10.1093/ije/dyv319
3. Link CL, McKinlay JB. Disparities in the prevalence of diabetes: is it race/ethnicity or socioeconomic status? Results from the Boston Area Community Health (BACH) survey. Ethn Dis 2009; 19(3):288-292.

4. Maty SC, Everson-Rose SA, Haan MN, Raghunathan TE, Kaplan GA. Education, income, occupation, and the 34-year incidence (1965-99) of type 2 diabetes in the Alameda County Study. Int J Epidemiol 2005;34(6):1274-1281. http://doi.org/10.1093/ije/dyi167
5. Ross NA, Gilmour H, Dasgupta K. 14-year diabetes incidence: the role of socio-economic status. Health Rep 2010;21(3):19-28.
6. Houle J, Beaulieu MD, Chiasson JL, Lespérance F, Côté J, Strychar I, et al. Glycaemic control and self-management behaviours in type 2 diabetes: results from a 1-year longitudinal cohort study. Diabet Med 2015;32(9):1247-1254. http://doi.org/10.1111/dme.12686
7. James GD, Baker P, Badrick E, Mathur R, Hull S, Robson J. Ethnic and social disparity in glycaemic control in type 2 diabetes; cohort study in general practice 2004-9. J R Soc Med 2012;105(7):300-308. http://doi.org/10.1258/jrsm.2012.110289
8. Jotkowitz AB, Rabinowitz G, Raskin Segal A, Weitzman R, Epstein L, Porath A. Do patients with diabetes and low socioeconomic status receive less care and have worse outcomes? A national study. Am J Med 2006;119(8):665-669. http://doi.org/10.1016/j.amjmed.2006.02.010
9. Dray-Spira R, Gary-Webb TL, Brancati FL. Educational disparities in mortality among adults with diabetes in the U.S. Diabetes Care 2010;33(6):1200-1205. http://doi.org/10.2337/dc09-2094
10. O'Kane MJ, McMenamin M, Bunting BP, Moore A, Coates VE. The relationship between socioeconomic deprivation and metabolic/cardiovascular risk factors in a cohort of patients with type 2 diabetes mellitus. Prim Care Diabetes 2010;4(4):241-249. http://doi.org/10.1016/j.pcd.2010.08.004
11. Fiscella K, Franks P, Gold MR, Clancy CM. Inequality in quality: addressing socioeconomic, racial, and ethnic disparities in health care. JAMA 2000;283(19):2579-2584. http://doi.org/10.1001/jama.283.19.2579
12. Fisher M, Freeman T, Mackean T, Friel S, Baum F. Universal health coverage for non-communicable diseases and health equity: lessons from australian primary healthcare. Int J Health Policy Manag 2022;11(5):690-700. http://doi.org/10.34172/ijhpm.2020.232
13. Grintsova O, Maier W, Mielck A. Inequalities in health care among patients with type 2 diabetes by individual socio-economic status (SES) and regional deprivation: a systematic literature review. Int J Equity Health 2014;13:43. http://doi.org/10.1186/1475-9276-13-43
14. Kim CB. A historical legacy for universal health coverage in the Republic of Korea: moving towards health coverage and financial protection in Uganda comment on "Health Coverage and Financial Protection in Uganda: A Political Economy Perspective". Int J Health Policy Manag 2023;12:7434. http://doi.org/10.34172/ijhpm.2023.7434
15. Dunlop S, Coyte PC, McIsaac W. Socio-economic status and the utilisation of physicians' services: results from the Canadian National Population Health Survey. Soc Sci Med 2000;51(1):123-133. http://doi.org/10.1016/s0277-9536(99)00424-4
16. Booth GL, Hux JE. Relationship between avoidable hospitalizations for diabetes mellitus and income level. Arch Intern Med 2003;163(1):101-106. http://doi.org/10.1001/archinte.163.1.101
17. Alter DA, Naylor CD, Austin P, Tu JV. Effects of socioeconomic status on access to invasive cardiac procedures and on mortality after acute myocardial infarction. N Engl J Med 1999;341(18):1359-1367. http://doi.org/10.1056/NEJM199910283411806
18. Liao PJ, Lin ZY, Huang JC, Hsu KH. The relationship between type 2 diabetic patients' early medical care-seeking consistency to the same clinician and health care system and their clinical outcomes. Medicine (Baltimore) 2015;94(7):e554. http://doi.org/10.1097/MD.0000000000000554
19. Jung CL, Kwon HC, Nahm JW. The equity of the national health insurance contribution in Korea. Korean Soc Secur Stud 2014;30(2):317-344 (Korean).
20. Jeong H, Lee JH, Shin JW, Song YM. Scale and structure of 2006 total health expenditure in Korea constructed according to OECD/WHO/EUROSTAT's SHA (system of health accounts). Korean J Health Econ Policy 2008;14(14):151-169 (Korean).
21. Park BJ, Park PK, Sung KH. Validity of diagnosis code on national health insurance claim database. Seoul: Seoul National University; 2003 (Korean).
22. Shin JI, Wang D, Fernandes G, Daya N, Grams ME, Golden SH, et al. Trends in receipt of American Diabetes Association guideline-recommended care among U.S. adults with diabetes: NHANES 2005-2018. Diabetes Care 2021;44(6):1300-1308. http://doi.org/10.2337/dc20-2541
23. McCoy RG, Van Houten HK, Ross JS, Montori VM, Shah ND. HbA1c overtesting and overtreatment among US adults with controlled type 2 diabetes, 2001-13: observational population based study. BMJ 2015;351:h6138. http://doi.org/10.1136/bmj.h6138
24. Ricci-Cabello I, Ruiz-Pérez I, Olry de Labry-Lima A, Márquez-Calderón S. Do social inequalities exist in terms of the preven-

tion, diagnosis, treatment, control and monitoring of diabetes? A systematic review. Health Soc Care Community 2010; 18(6):572-587. http://doi.org/10.1111/j.1365-2524.2010.00960.x
25. World Health Organization. Republic of Korea health system review; 2015 [cited 2022 Nov 21]. Available from: https://iris.who.int/handle/10665/208215
26. Song YJ. The South Korean health care system. Jpn Med Assoc J 2009;52(3):206-209.
27. Byun SH, Ma SH, Jun JK, Jung KW, Park B. Screening for diabetic retinopathy and nephropathy in patients with diabetes: a nationwide survey in Korea. PLoS One 2013;8(5):e62991. http://doi.org/10.1371/journal.pone.0062991
28. Fosse-Edorh S, Fagot-Campagna A, Detournay B, Bihan H, Eschwege E, Gautier A, et al. Impact of socio-economic position on health and quality of care in adults with type 2 diabetes in France: the Entred 2007 study. Diabet Med 2015;32(11):1438-1444. http://doi.org/10.1111/dme.12783
29. Hsu CC, Lee CH, Wahlqvist ML, Huang HL, Chang HY, Chen L, et al. Poverty increases type 2 diabetes incidence and inequality of care despite universal health coverage. Diabetes Care 2012;35(11):2286-2292. http://doi.org/10.2337/dc11-2052
30. Cuesta-Briand B, Saggers S, McManus A. 'It still leaves me sixty dollars out of pocket': experiences of diabetes medical care among low-income earners in Perth. Aust J Prim Health 2014; 20(2):143-150. http://doi.org/10.1071/PY12096
31. Brown AF, Gregg EW, Stevens MR, Karter AJ, Weinberger M, Safford MM, et al. Race, ethnicity, socioeconomic position, and quality of care for adults with diabetes enrolled in managed care: the Translating Research Into Action for Diabetes (TRIAD) study. Diabetes Care 2005;28(12):2864-2870. http://doi.org/10.2337/diacare.28.12.2864
32. Kirkman MS, Rowan-Martin MT, Levin R, Fonseca VA, Schmittdiel JA, Herman WH, et al. Determinants of adherence to diabetes medications: findings from a large pharmacy claims database. Diabetes Care 2015;38(4):604-609. http://doi.org/10.2337/dc14-2098
33. Do YK, Eggleston KN. Educational disparities in quality of diabetes care in a universal health insurance system: evidence from the 2005 Korea National Health and Nutrition Examination Survey. Int J Qual Health Care 2011;23(4):397-404. http://doi.org/10.1093/intqhc/mzr035
34. Tapp RJ, Zimmet PZ, Harper CA, de Courten MP, Balkau B, McCarty DJ, et al. Diabetes care in an Australian population: frequency of screening examinations for eye and foot complications of diabetes. Diabetes Care 2004;27(3):688-693. http://doi.org/10.2337/diacare.27.3.688
35. Mangione CM, Gerzoff RB, Williamson DF, Steers WN, Kerr EA, Brown AF, et al. The association between quality of care and the intensity of diabetes disease management programs. Ann Intern Med 2006;145(2):107-116. http://doi.org/10.7326/0003-4819-145-2-200607180-00008
36. Lee SW, Chun BY, Yeh MH, Kang YS, Kim KY, Lee YS, et al. Therapeutic compliance and its related factors of patients with hypertension in rural area. Korean J Prev Med 2000;33(2):215-225 (Korean).
37. van Eijk KN, Blom JW, Gussekloo J, Polak BC, Groeneveld Y. Diabetic retinopathy screening in patients with diabetes mellitus in primary care: incentives and barriers to screening attendance. Diabetes Res Clin Pract 2012;96(1):10-16. http://doi.org/10.1016/j.diabres.2011.11.003
38. Zgibor JC, Songer TJ. External barriers to diabetes care: addressing personal and health systems issues. Diabetes Spectr 2001; 14(1):23-28.