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Travel Time to Healthcare and Type 2 Diabetes Mellitus Management in Korea: A Nationwide Retrospective Study

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The authors have no potential conflicts of interest to disclose.

ABSTRACT

Background: This study aimed to investigate the relationship between average travel time to healthcare facilities and management of type 2 diabetes mellitus (T2DM). In addition, we examined how average travel time and the presence of a usual source of care (USC) interact to influence T2DM management.
Methods: We analyzed National Health Insurance data from 2015 to 2019 for a cohort of 81,588 patients newly diagnosed with T2DM in 2014. Geographic Information System-based road network data were used to calculate travel time. Outcome variables for T2DM management included regular visits, medication adherence, and monitoring tests: hemoglobin testing, lipid panel testing, and fundus examination. Generalized Estimating Equations models were used to assess the effects of travel time on T2DM management.
Results: Patients traveling ≤ 15 minutes to their healthcare facilities had higher rates of regular visits (risk ratio [RR], 1.04; 95% confidence interval [CI], 1.03–1.05), but showed no significant difference in medication adherence (RR, 1.00; 95% CI, 1.00–1.01) relative to patients with longer travel times. The presence of a USC was associated with higher levels of medication adherence (RR, 1.16; 95% CI, 1.15–1.16) and regular visits (RR, 1.38; 95% CI, 1.37–1.40). Patients with both a USC and short travel time had the highest medication adherence and visit rates (RR, 1.14 and 1.42) compared to those without a USC and with longer travel times, reflecting significant interaction effects. Shorter travel time was, however, associated with lower uptake of diabetes monitoring tests. Patients who most frequently visited tertiary or general hospitals had lower regularity of visits and medication adherence but higher rates of diabetes monitoring tests.
Conclusion: This study highlights the importance of the combined effect of travel time and the presence of a USC in promoting regular visits to healthcare facilities among T2DM patients, rather than the effect of either factor alone. These findings underscore the need to consider both proximity and continuity of care when planning healthcare access strategies for T2DM management. In addition, measures are needed to promote the implementation of diabetes monitoring tests in clinics.

Keywords: Type 2 Diabetes Mellitus; Travel Time; Healthcare Access; Usual Source of Care; Diabetes Management; Generalized Estimating Equations Model

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Author Contributions

Conceptualization: Ha R, Kim CY, Jung-Choi K. Data curation: Ha R. Formal analysis: Ha R. Methodology: Ha R, Hwang SS. Project administration: Kim CY. Supervision: Jung-Choi K. Validation: Hwang SS. Visualization: Ha R. Writing - original draft: Ha R. Writing - review & editing: Ha R, Jung-Choi K.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a major risk factor for both poor quality of life and premature mortality worldwide.[1] As of 2020, approximately 13.8% of the adult population in Korea, or about 4.9 million people, were estimated to have T2DM.[2] In Korea, diabetes ranks among the top ten causes of death[3] and can lead to serious complications, including cardiovascular and cerebrovascular diseases, renal failure, lower-limb amputation, and retinopathy.[4-7] Due to its high prevalence and severe consequences,[8] early diagnosis and management are essential to mitigate effects on individuals and society. Key components of T2DM management include medication adherence, regular visits to healthcare facilities, and routine screening for complications.[9-12] Other forms of diabetes include type 1 diabetes, characterized by autoimmune destruction of pancreatic β-cells,[13] and gestational diabetes, which occurs during pregnancy and may resolve after delivery.[14]

Studies investigating diabetes management in Korea have primarily focused on the role of a usual source of care (USC) in medication adherence,[15] emergency room visits,[16] healthcare utilization, and healthcare costs.[16,17] Patients with a USC have been shown to have better medication adherence.[15,18]

Geographic accessibility, defined as the distance and time required to reach and obtain healthcare,[19] may be crucial for enabling continuous management of chronic conditions. Studies from other countries have reported that longer driving distances are associated with poorer glycemic control in patients with diabetes.[20-22] However, research into the relationship between geographic accessibility to healthcare facilities and diabetes management in Korea is lacking.

Therefore, this study aimed to analyze the effects of travel time to healthcare facilities visited for management of T2DM, including regular medical visits, medication adherence, and routine screenings for complications. In addition, we investigated the combined effect of travel time and a USC on T2DM management.

METHODS

Data and study population

We utilized the National Health Insurance Database (NHID) provided by the National Health Insurance Service. The NHID includes comprehensive data on individual eligibility, healthcare utilization, and healthcare facilities.[23] We extracted data on patient eligibility, outpatient healthcare utilization, treatment records, diagnosis records, and prescriptions for individuals with T2DM, spanning 2014 to 2019. In addition, we used information on healthcare personnel and facilities utilized by patients.

To measure distances from patients' residences to the healthcare facilities they visited, we utilized data from the Statistical Geographic Information Service provided by Statistics Korea (https://sgis.kostat.go.kr/view/index.jsp), as well as data from the Korea Transport Database (KTDB) from the Ministry of Land, Infrastructure, and Transport and the Korea Transport Institute (https://www.ktdb.go.kr/www/index.do). Both datasets are publicly accessible. Population data by census output area from 2015 to 2019, provided by Statistics Korea, were used to calculate the population centroid for towns (eup, myeon, and dong). Exact

addresses of patients and medical facilities were not available in the NHID[24]; therefore, travel distances were computed at the town level to provide a reasonable approximation of patient travel distances. The Geographic Information System (GIS)-based road network database, spanning 2015 to 2019 and comprising data on links, nodes, turns, and administrative boundaries, was obtained from the KTDB to facilitate vehicle routing.[25]

This was a retrospective cohort study of T2DM management over five years (2015–2019), targeting patients aged ≥ 20 years who were newly diagnosed with T2DM in 2014. Study subjects were defined as adult patients with no medical visits related to diabetes in the three years prior to 2014. T2DM was defined as individuals with an outpatient diagnosis code E11 (principal or secondary) who were prescribed oral hypoglycemic agents, with consideration given to the validity of the diagnosis.[18,26,27] **Fig. 1** shows the flow chart of study subjects; the final study cohort comprised 81,588 outpatients with T2DM.

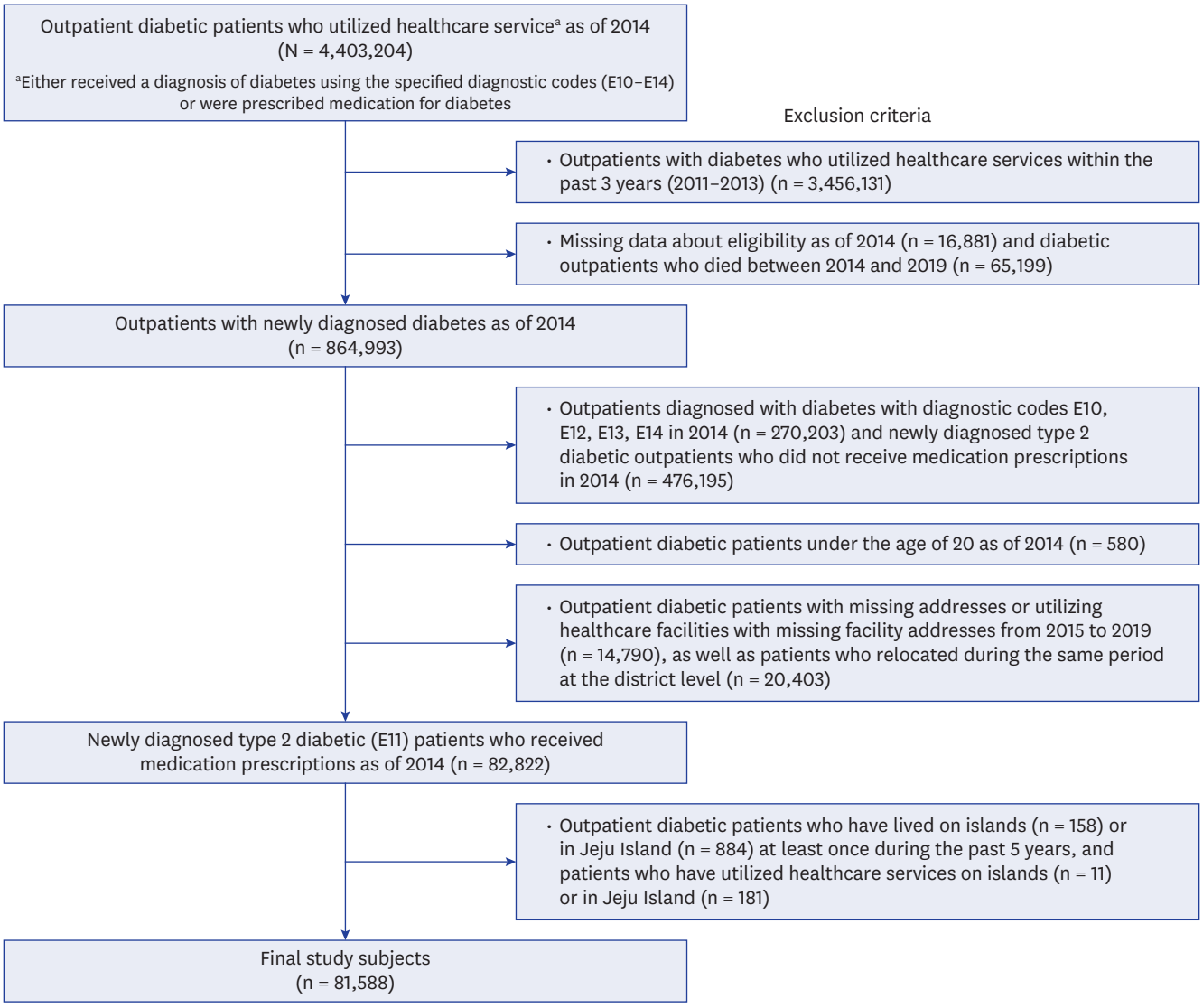


Fig. 1. Flow chart of study subjects.

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Outcomes and variables

Outcome variables were indicators of T2DM management, including adequate medication adherence, regular visits to healthcare facilities, hemoglobin (HbA1c) testing, lipid panel testing, and fundus examination. Medication adherence to oral hypoglycemic agents was measured using the Medication Possession Ratio (MPR) method.[28] MPR is calculated as the total number of days medication was prescribed during the study period,[29,30] and an MPR of ≥ 80% is defined as 'adequate medication adherence.'[31] Regular visits to healthcare facilities were defined as visits to facilities at least once per quarter.[32] HbA1c testing is recommended at least twice annually, and lipid testing and fundus examinations are recommended at least once annually.[33] Each test was assessed as performed or not.[32]

The main explanatory variable was accessibility to visited healthcare facilities, calculated as the average travel time from a patient's residence to the facility, categorized as ≤ 15 minutes (short travel time) or > 15 minutes (long travel time), based on our previous research.[34] Covariates were classified into healthcare utilization, socio-demographic, and health-related characteristics. Patients were classified as having a USC using the continuity of care (COC) index,[19] which reflects both the total number of healthcare providers visited and the number of visits to individual providers.[35] In this study, healthcare utilization data for T2DM from 2015 to 2019 were used to calculate the COC value, which was derived from the total number of outpatient visits, the number of visits to individual healthcare facilities, and the total number of healthcare facilities visited. Patients with COC values of ≥ 0.75 were defined as having a USC.[36,37] To identify the types of healthcare facilities most frequently visited, facilities were categorized annually into five types: tertiary hospitals, general hospitals, hospitals, clinics, and public health facilities (including health centers, health subcenters, and health and medical clinics).

Socio-demographic variables included sex, age, income level (classified into quintiles of health insurance contribution), type of health coverage, and residential area. Health-related characteristics were assessed using the Charlson Comorbidity Index (CCI) and disability status, with CCI stratified as 0, 1, 2, and ≥ 3.

Statistical analyses

Travel distances were calculated with GIS-based road network data as the shortest car travel distance from the town-level population centroid (eup, myeon, and dong) using Network Analyst. Average road speeds at the town level were applied to estimate travel times, and travel distance calculations were performed in ArcGIS Pro 3.0.2.

Binomial regression analysis was used to examine the effect of average travel time per healthcare visit on diabetes management, based on healthcare utilization data from 2015 to 2019 for patients newly diagnosed with T2DM in 2014. Because repeated measurements over five years are not independent, we applied the Generalized Estimating Equations (GEE) method to account for within-subject correlation. GEE is a robust statistical method that estimates standard errors while accommodating intra-individual correlation structures.[38] Because annual healthcare utilization varies across patients, the dataset represents an unbalanced panel. GEE is well-suited to such data, as it provides efficient estimates even when the number of observations per individual differs and can flexibly accommodate missing or unbalanced data. By appropriately modeling the correlation structure, GEE yields reliable population-averaged estimates based on individual-level data.[39,40]

In the GEE model, Model 1 included average travel time to visited healthcare facilities to estimate unadjusted risk ratios (RRs). Model 2 further adjusted for sex, age, income, residential area, CCI, disability status, and year. Additionally, we analyzed the interaction between average travel time to healthcare facilities and USC on T2DM management. To estimate the interaction effect, we adjusted for sex, age, income, residential area, CCI, disability status, type of frequent healthcare facility, and year. The reference group was defined as patients with travel times exceeding 15 minutes and no USC (> 15 min/no USC). All statistical analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) and the PROC GENMOD procedure.

Ethics statement

The Institutional Review Board (IRB) of Seoul National University, Seoul, Korea, approved the study protocol (IRB No. E2304/002-010), and informed consent was obtained from all participants.

RESULTS

Table 1 presents the general characteristics of the study population in 2014, with 81,588 newly diagnosed T2DM patients, comprising 48,809 (59.8%) males and 32,779 (40.2%) females. The largest proportion of patients was aged 50–59 years. The proportion of patients was also greater in higher income quintiles. Most patients resided in urban areas (45.7%), followed by metropolitan (42.5%) and rural areas (11.7%). The proportion with a CCI score of 1 was highest (37.3%), followed by scores of 2 (29.3%) and ≥ 3 (26.6%). Non-disabled individuals accounted for 91.4%. Regarding the type of healthcare facility most frequently visited, clinics accounted for approximately 65%, followed by general hospitals (about 5%), hospitals (about 9%), tertiary hospitals (about 8%), and public healthcare facilities (about 2%). This pattern remained consistent across study years (**Supplementary Table 1**).

Tables 2 and **3** summarize the associations between average travel time to healthcare facilities and diabetes management indicators. The unadjusted RRs for adequate medication adherence and regular visits among diabetes patients with short travel times to their healthcare facilities were 1.03 (95% confidence interval [CI], 1.03–1.04) and 1.35 (95% CI, 1.34–1.37), respectively, compared to those with travel times exceeding 15 minutes (**Table 2**). In Model 2, short travel time was not significantly associated with medication adherence (RR, 1.00; 95% CI, 1.00–1.01), but remained significantly associated with regular visits (RR, 1.04; 95% CI, 1.03–1.05). Patients with a USC demonstrated greater continuity in medication adherence (adjusted RR, 1.16; 95% CI, 1.15–1.16) and were more likely to have regular visits (adjusted RR, 1.38; 95% CI, 1.37–1.40) compared with those without a USC. As shown in **Table 3**, patients with shorter travel times were less likely to receive HbA1c testing (adjusted RR, 0.93; 95% CI, 0.93–0.94), lipid panel testing (adjusted RR, 0.97; 95% CI, 0.97–0.98), and fundus examinations (adjusted RR, 0.96; 95% CI, 0.95–0.98). The likelihood of undergoing these tests was notably higher in tertiary and general hospitals compared to clinics. Sensitivity analyses further categorized travel time into > 30 minutes, 15–30 minutes, and ≤ 15 minutes; results were consistent with the primary analyses. Stratified analyses by hospital- and clinic-level facilities also produced similar findings (**Supplementary Tables 2** and **3**).

Interaction effects between average travel time and the presence of a USC were examined for each diabetes management indicator. Statistically significant interactions were observed

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Table 1. Characteristics of study subjects in 2014

Characteristics	Total (N = 81,588)	Men (n = 48,809)	Women (n = 32,779)
Total	81,588 (100.0)	48,809 (100.0)	32,779 (100.0)
Sex			
Male	48,809 (59.8)		
Female	32,779 (40.2)		
Age, yr			
20–29	977 (1.2)	604 (1.2)	373 (1.1)
30–39	5,884 (7.2)	4,269 (8.8)	1,615 (4.9)
40–49	19,177 (23.5)	13,341 (27.3)	5,836 (17.8)
50–59	27,111 (33.2)	16,908 (34.6)	10,203 (31.1)
60–69	16,806 (20.6)	9,035 (18.5)	7,771 (23.7)
70–79	9,578 (11.7)	4,065 (8.3)	5,513 (16.8)
≥ 80	2,055 (2.5)	587 (1.2)	1,468 (4.5)
Income			
Q1[a]	3,228 (4.0)	1,519 (3.1)	1,709 (5.2)
Q2	15,717 (19.3)	8,806 (18.0)	6,911 (21.1)
Q3	16,724 (20.5)	10,294 (21.1)	6,430 (19.6)
Q4	20,829 (25.5)	12,863 (26.4)	7,966 (24.3)
Q5	25,090 (30.8)	15,327 (31.4)	9,763 (29.8)
Health coverage status			
Insured	78,360 (96.0)	47,290 (96.9)	31,070 (94.8)
Medical Aid beneficiary	3,228 (4.0)	1,519 (3.1)	1,709 (5.2)
Residential area			
Metropolitan	34,702 (42.5)	20,738 (42.5)	13,964 (42.6)
Urban	37,306 (45.7)	22,677 (46.5)	14,629 (44.6)
Rural	9,580 (11.7)	5,394 (11.1)	4,186 (12.8)
CCI			
0	5,589 (6.9)	3,818 (7.8)	1,771 (5.4)
1	30,424 (37.3)	19,098 (39.1)	11,326 (34.6)
2	23,896 (29.3)	14,384 (29.5)	9,512 (29.0)
3+	21,679 (26.6)	11,509 (23.6)	10,170 (31.0)
Disability status			
Non-disabled	74,532 (91.4)	44,343 (90.9)	30,189 (92.1)
Disabled	7,056 (8.7)	4,466 (9.2)	2,590 (7.9)

Values are presented as number (%).
CCI = Charlson Comorbidity Index.
[a]Medical Aid beneficiary.

Table 2. Effects of average travel time to visited healthcare facilities on adequate medication adherence and regular visits

Variables	Adequate medication adherence		Regular visits to healthcare facilities	
	Model 1[a]	Model 2[b]	Model 1[a]	Model 2[b]
Average travel time to visited healthcare facilities				
Long (> 15 min)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Short (≤ 15 min)	1.03 (1.03–1.04)	1.00 (1.00–1.01)	1.35 (1.34–1.37)	1.04 (1.03–1.05)
Having a usual source of care				
No		1.00 (reference)		1.00 (reference)
Yes		1.16 (1.15–1.16)		1.38 (1.37–1.40)
Type of frequent healthcare facility				
Clinic		1.00 (reference)		1.00 (reference)
Tertiary hospital		0.97 (0.96–0.98)		0.02 (0.02–0.02)
General hospital		0.98 (0.97–0.99)		0.01 (0.01–0.01)
Hospital		0.94 (0.93–0.95)		0.01 (0.01–0.01)
Public healthcare facility		1.03 (1.01–1.04)		0.90 (0.88–0.92)
Model fit				
QIC	2,932,392.86	2,944,996.95	1,240,269.92	1,262,710.24

QIC = quasi-likelihood under an independence model criterion.
[a]Unadjusted risk ratio. [b]Adjusted for sex, age, income, residential area, Charlson Comorbidity Index, disability status, and year.

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Table 3. Effects of average travel time to visited healthcare facilities on type 2 diabetes mellitus management tests

Variables	HbA1c testing		Lipid panel testing		Fundus examination	
	Model 1[a]	Model 2[b]	Model 1[a]	Model 2[b]	Model 1[a]	Model 2[b]
Average travel time to visited healthcare facilities						
Long (> 15 min)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Short (≤ 15 min)	0.91 (0.90–0.92)	0.93 (0.93–0.94)	0.95 (0.94–0.95)	0.97 (0.97–0.98)	0.88 (0.87–0.90)	0.96 (0.95–0.98)
Having a usual source of care						
No		1.00 (reference)		1.00 (reference)		1.00 (reference)
Yes		0.98 (0.97–0.99)		0.95 (0.95–0.96)		0.88
Type of frequent healthcare facility						
Clinic		1.00 (reference)		1.00 (reference)		1.00 (reference)
Tertiary hospital		1.30 (1.28–1.32)		1.18 (1.17–1.19)		1.63 (1.59–1.67)
General hospital		1.08 (1.07–1.10)		1.09 (1.09–1.10)		1.32 (1.29–1.35)
Hospital		0.87 (0.86–0.89)		0.98 (0.97–0.99)		0.95 (0.92–0.98)
Public healthcare facility		0.81 (0.77–0.84)		0.85 (0.82–0.87)		1.09 (1.04–1.16)
Model fit						
QIC	1,157,493.61	1,154,257.4	1,837,610.67	1,833,804.76	493,972.21	493,824.26

QIC = quasi-likelihood under an independence model criterion.
[a]Unadjusted risk ratio. [b]Adjusted for sex, age, income, residential area, Charlson Comorbidity Index, disability status, and year.

for both medication adherence ($P < 0.001$) and regular visits ($P = 0.000$) (**Supplementary Table 4**). **Fig. 2** depicts the magnitude of these interaction effects. Compared with patients without a USC and travel times > 15 minutes, those with a USC and travel times ≤ 15 minutes had an RR of 1.14 (95% CI, 1.13–1.15) for medication adherence. For regular visits, patients with a USC and short travel times had an RR of 1.42 (95% CI, 1.40–1.44), while those with a USC and longer travel times had an RR of 1.35 (95% CI, 1.33–1.37).

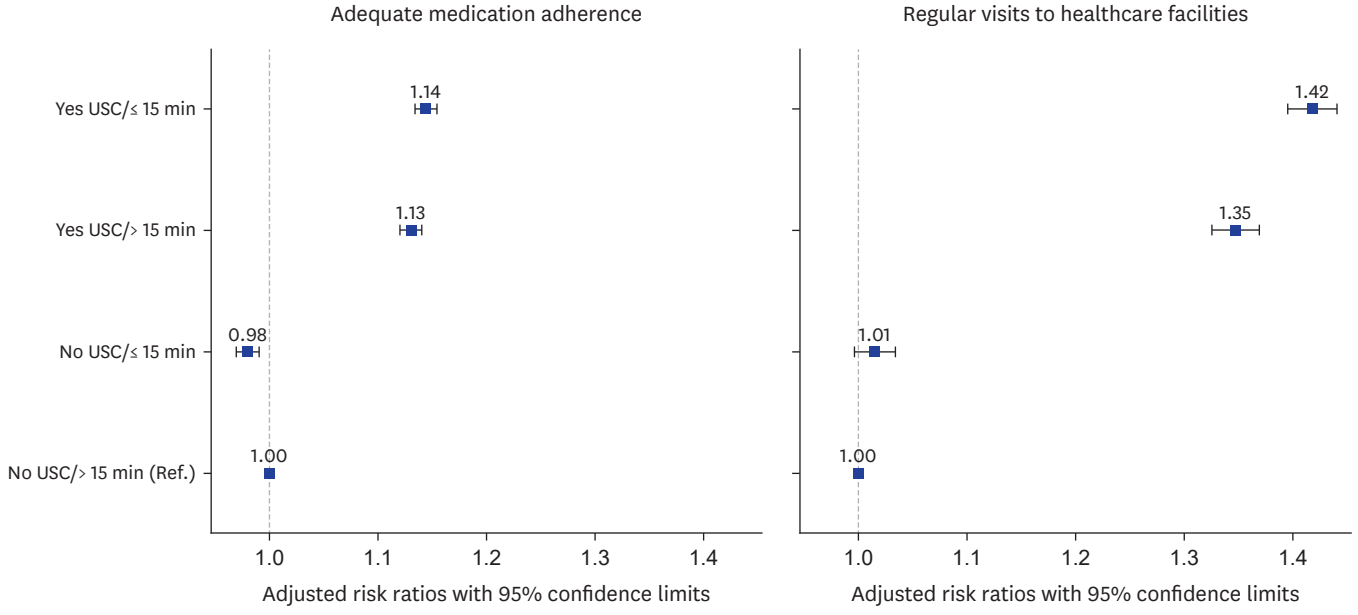


Fig. 2. Effect sizes for statistically significant interaction effects, as shown in **Supplementary Table 4**.
USC = usual source of care.

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DISCUSSION

This study found that short travel time to healthcare facilities was associated with higher rates of regular visits among T2DM patients, but had no significant effects on medication adherence. However, when short travel time was combined with access to a USC, patients showed significantly better outcomes in both regular visits and medication adherence, highlighting the combined effect of proximity and COC. Meanwhile, patients with shorter travel times were less likely to undergo diabetes monitoring tests than those with longer travel times, and those who frequently visited tertiary or general hospitals were more likely to be tested than those who used clinics.

Previous international studies have reported a significant inverse association between distance to healthcare facilities and diabetes management, indicating that patients living farther from primary care facilities tend to have poorer glycemic control.[20-22] Specifically, patients residing within 16 km of a healthcare facility were 2.5 times more likely to have adequate glycemic control,[20] and those living within 10 km had a 2.29 times higher likelihood of achieving glycemic control.[22] The present study's findings were partially inconsistent with these earlier studies. Patients with shorter travel times to healthcare were more likely to make regular visits; however, this was not the case for screening tests for complication monitoring. The finding that longer travel times were associated with higher screening rates suggests potential differences in healthcare-seeking patterns between regular visits and complication screening.[41] Further research is warranted to elucidate the underlying reasons for this discrepancy.

The association between having a USC and medication adherence among patients with diabetes in the present study is consistent with findings from previous studies. In one study, the presence of a USC, whether a regular doctor or a regular site, was associated with approximately 0.6 times lower odds of medication non-adherence.[15] Separately, it was also reported that, compared with diabetic patients who used only one healthcare facility over two years, the odds of being in the adequate medication adherence group decreased as the number of outpatient visits to different facilities increased.[42] In a US study, uninsured diabetic patients without a USC were 0.17 times less likely to have routine check-ups and 3.67 times more likely to have unmet prescription needs compared with diabetic patients with both insurance and a USC.[43] Other research has similarly emphasized the importance of having a regular physician for diabetes management,[44] particularly because diabetes care can be effectively managed in primary care settings. The present study contributes to the existing literature by demonstrating that neither proximity to healthcare facilities nor the presence of a USC alone was sufficient for effective T2DM management in the Korean context; rather, the joint effect of travel time and USC status played a key role in promoting regular visits.

Furthermore, the current findings indicate that the likelihood of undergoing HbA1c testing, lipid panel tests, and fundus examinations was primarily influenced by the type of healthcare facility frequented, with T2DM patients more likely to receive essential tests in tertiary and general hospitals than in clinics. These results align with previous research showing that diabetic patients who primarily utilized tertiary hospitals over five years had higher rates of regular HbA1c testing, lipid panel tests, and fundus examinations.[26] The coefficient of variation for testing among healthcare facilities has been reported to be lowest in tertiary hospitals, while clinics and public health facilities have shown greater variability.[32] In a survey of T2DM patients visiting outpatient departments of tertiary hospitals, the reasons for initial fundus examinations were analyzed, and referral rates were found to be higher

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in secondary and tertiary healthcare facilities compared with primary care settings.[45] In addition, a qualitative study examining healthcare utilization among diabetic patients across different types of healthcare facilities found that patients primarily utilized tertiary hospitals due to trust in healthcare providers, superior medical equipment, facilities, and hospital environment. Conversely, the main reason for using clinics was proximity. In addition, interviewees perceived clinics as lacking specialized knowledge, integrated systems such as medical records, and interdisciplinary collaboration.[46] These findings indicate that patients may have low trust in undergoing diabetes-related tests at clinics.

The present study has several limitations. First, the NHID does not provide specific address information for either patients or medical facilities. Therefore, we calculated distances between patient residence and the healthcare facility at the town level (eup, myeon, and dong) rather than precise addresses. Specifically, we utilized population data by census tract from Statistics Korea to calculate the population centroid at the town level. This approach helped to avoid assigning centroids to areas without residents, such as farmlands or forests, by considering only the residential areas. In addition, distances were calculated using GIS-based road network information to estimate the actual travel distances to the healthcare facilities that patients visited. These steps were taken to mitigate the limitations of the NHID database and enhance the accuracy of the analysis by providing a more precise measurement of geographical access to healthcare services. Second, potential confounders at the individual level were not accounted for, such as educational level and health behaviors, nor those at the regional level, such as the availability of healthcare resources and area deprivation, which could influence access to healthcare and T2DM management. However, findings from our previous research showed that individuals with diabetes residing in the most deprived areas were more likely to experience poorer diabetes management. In addition, socioeconomic inequalities in these regions, although limited, could be partially explained by the distribution of healthcare resources.[47,48] In the present study, the use of GIS-based road network data and actual travel distances enabled a more precise understanding of the impact of geographical barriers on T2DM management. This approach enhanced the accuracy of the findings and offered valuable insights into the role of geographical accessibility in healthcare outcomes, addressing some of the limitations identified in our previous research.

The present study also has significant strengths. Methodologically, it analyzed five-year healthcare utilization patterns among patients with T2DM to investigate the association between diabetes management indicators and travel time to healthcare facilities. To account for correlations in repeated measures of healthcare use across years, the GEE method was employed. GEE is a statistical approach that accounts for within-subject correlation and produces robust standard errors, making it suitable for analyzing longitudinal panel data in healthcare research. Furthermore, a comprehensive approach was used to analyze the effects of travel time on various aspects of T2DM management, including medication prescription, regular visits, and essential tests such as HbA1c, lipid panels, and fundus examinations. By incorporating the concept of a USC, the study provides a more detailed understanding of how proximity to healthcare providers affects T2DM management outcomes. The importance of a USC and geographic accessibility to healthcare facilities in managing chronic conditions such as T2DM was reinforced.

Future research should focus on more detailed individual and regional data to further elucidate the factors influencing healthcare access and outcomes in diabetes management.

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In addition, policymakers should consider these findings when planning the distribution of healthcare resources to ensure equitable access to care.

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SUPPLEMENTARY MATERIALS

Supplementary Table 1

Distribution of types of frequently visited healthcare facilities by year[a]

Supplementary Table 2

Effect of average travel time to healthcare facilities (> 15 minutes vs. ≤ 15 minutes) on diabetes management indicators: overall and by type of healthcare facility

Supplementary Table 3

Effect of average travel time to healthcare facilities (≤ 15 minutes, 15–30 minutes, > 30 minutes) on diabetes management indicators: overall and by type of healthcare facility

Supplementary Table 4

Statistical significance of interaction effects between average travel time and usual source of care on diabetes management indicators

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