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Medication Adherence and Its Associated Factors Among Patients With Diabetes and Hypertension: A Patient-Level Health Claims Analysis

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ABSTRACT

Good diabetes and hypertension control requires adherence to medication, sub-optimal adherence is a major problem in long-term pharmacotherapy. The study aimed to analyse medication adherence and factors associated with it at the patient level, based on health claims data. One observational study was performed in 24,084 patients who had diabetes or hypertension. Descriptive, bivariate and multivariable logistic regression analyses were used to determine demographic, clinical, insurance, claims and medication-utilization characteristics. Overall, 40.15% of patients were adherent and 59.85% non-adherent. Diabetic patients had a 43.87% adherence rate and 39.22% adherence rate in patients with hypertension. Higher the age, higher the adjusted odds of adherence and higher the male gender, lower the odds of adherence. Medication use, disease classification, insurance scheme and annual claim amount also were each independently linked to adherence. Patients with diabetes and hypertension were non-adherent with their medicines. Patient-level claims data can be used to derive characteristics that are associated with adherence and assist with targeted medication monitoring, counselling and chronic disease management.

Keywords:
Medication adherence, Diabetes mellitus, Hypertension, Health claims, Chronic disease management

Introduction

Diabetes mellitus and hypertension are two of the most common chronic non-communicable diseases, which must be managed on a long-term basis to minimise the long-term morbidity and avoid unnecessary complications. Pharmacological treatment is the mainstay of treatment for both conditions, but adherence to the recommended treatment regimen is a significant factor in treatment response. Adherence to treatment is therefore an important part of chronic disease management that is critical for addressing the needs of clinicians, pharmacists, health systems and policymakers. Even with the right drugs, poor adherence may limit their effectiveness, exacerbating the disparity between access to therapy and desired health outcomes. Consequently, adherence has become one of the key factors of successful chronic disease management (Burnier, 2024).

One of the biggest challenges with adherence to hypertension treatment is that the treatment is often a long-term regimen, and individuals may not have any symptoms despite having chronically high cardiovascular risk (Adhikari et al., 2023). However, recent data from adults with hypertension has shown that adherence is not uniform across groups, and factors such as demographic, clinical, and treatment-related factors may contribute to the variation, highlighting the need to identify those who might benefit from more adherence support. However, real-world studies have also shown the importance of medication adherence when assessing blood pressure control in patients taking multiple antihypertensive medications, especially when medication complexity and therapeutic inertia are present (Mohl et al., 2025). The results reaffirm the need to consider adherence along with patients' and healthcare characteristics, and not as a stand-alone behavioral outcome.

The same issues apply in the management of diabetes, where there is a need for regular administration of diabetes medication for metabolic control, to prevent the onset of complications, and to prevent the onset of progression of the disease (Hamza et al., 2025). A body of evidence shows that the adherence with medications for T2DM is linked to socioeconomic factors, which may mirror other disparities in healthcare access and patient resources (Ekenberg et al., 2024). Furthermore, adherence quality measures have been shown to be associated with glycemic control, suggesting the clinical significance of adhering to medications consistently for measurable clinical outcomes. It is therefore crucial to identify what is associated with adherence in order to develop interventions more effective than simply giving the prescription that focus on the characteristics impacting adherence.

This challenge becomes even more pertinent in the presence of diabetes and hypertension, or in patients studied as a health group. Medication burden, multiple health care visits and competing treatment needs, and varying levels of clinical complexity can be issues for patients with chronic diseases (Omura et al., 2023). Specific interventions for populations at the same time developing diabetes and hypertension show that treatment adherence can be changed through structured interventions, based on the context and on the characteristics of the intervention's implementation (Maniki et al., 2024). For older adults, diabetes, hypertension, and adherence illustrate the need to consider social and healthcare factors when examining medication adherence. (Heflin et al., 2022) Therefore, whenever possible, demographic, clinical, and utilization and health care system characteristics should be included with the adherence assessment.

Other insurance and financing of health care characteristics may offer some additional clues about adherence (Guo et al., 2022). Financial and coverage-related factors have been shown to affect antihypertensive medication adherence; medication coverage disparities have been linked to medication adherence and differences in OOP costs for medications have been linked to medication adherence (Zhang et al., 2024). Real world healthcare data can thus be used to gain insights into adherence as it occurs in the environment where patients are prescribed and receive their medicines. Claims-based information can be very valuable because it can combine the information about medications used with the demographic, diagnostic, insurance, and health care expenditure information for large groups of patients. Further, medication adherence has been shown to adopt variable patterns over time through a longitudinal claims-based analysis rather than being stable for all patients and over time (Pontinha et al., 2024).

Patient-level claims and medication-refill data are also a useful supplement to relying solely on adherence self-reported by the patient, as this could be influenced by recall bias and/or reporting bias. In real-world analyses, routinely collected healthcare data have been examined to evaluate adherence outcomes and patterns, in

addition to laboratory monitoring, with the objective to evaluate the analytical utility of administrative health data for adherence research (Beall et al., 2022). Medication-use information has also been examined for other chronic conditions such as diabetes and hypertension, and adherence measures have been used to determine subsequent health outcome, further highlighting the general utility of medication-use information in population-based health research (Racsa et al., 2023). These can then be used to help identify groups of patients with varying adherence patterns systematically.

The analytical utility of patient-level and medical claims data has also increased recently as the result of health informatics development. Heterogeneous data can be incorporated into structured data sets to study medication adherence in chronic disease populations using data-processing frameworks (Kanyongo et al., 2025). Predictive methods have also been investigated for non-communicable disease patients' adherence to medication, highlighting the rising interest in recognizing complex patterns within the routinely collected health information. However, clinically interpretable analyses continue to be important since statistical pattern does not necessarily reveal which demographic, clinical, insurance, and utilization attributes are independently associated with adherence.

In this context, investigating diabetes and hypertension in a single patient level health claims context can generate a more holistic approach to understanding adherence to medicines. The current study thus investigates patterns of adherence and factors associated with adherence based on demographic, disease-related, insurance, complication, claims characteristics and comorbidities. This evidence may help health care professionals identify individuals who need extra medication management assistance and help guide the creation of more focused adherence strategies. The objectives of this study are as follows:

To characterize medication adherence patterns among patients with diabetes and hypertension using patient-level health claims data.

To examine demographic, clinical, insurance, and healthcare-utilization factors associated with medication adherence among included patients.

To identify factors independently associated with medication adherence after adjustment for relevant patient and healthcare characteristics.

2. Methodology

2.1 Study Design and Data Source

A observational study was performed, based on patient-level health claims and medication adherence data for diabetes and hypertension patients (Kanyongo et al., 2024). Demographic, clinical, insurance, medication-utilization, and healthcare-claim characteristics were aggregated at the patient-level. The unit of analysis was the patient. The variables that were taken into consideration are age, gender, disease diagnosis, annual contribution, annual claim amount, medication units, insurance scheme, cover type, the status of the complication, comorbidity and medication adherence. Adherence patterns were analyzed and examined were patient and healthcare characteristics associated with medication adherence.

2.2 Study Population and Eligibility

The study population consisted of patients that met the criteria for diabetes or hypertension and had information available for medication adherence assessment. In the prepared dataset, there were 24,084 patient records, of which 4,805 were records of patients with diabetes and 19,279 were records of patients with hypertension. Before analysis, the records were evaluated for their completeness, consistency, and duplication. During data-quality assessment, 13 exact duplicate observations were detected. The prepared dataset did not contain any missing values in the analytical variables and no imputation of data was needed. The classification of the disease was kept as it was to allow a comparison of the adherence patterns of the diabetes and the hypertension population.

2.3 Variables and Measurement

The main binary outcome was medication adherence, which was defined as adherent or non-adherent based on the adherence classification in the prepared dataset. Explanatory variables comprised age, gender, diagnosis, annual contribution, annual claim amount, total medication units, scheme type, cover type, comorbidity status and complication-development status. Diabetes was used as the reference diagnosis in multivariable analysis. Where appropriate, categorical variables were coded as indicator variables. Before building models, distributional properties were evaluated for continuous variables, given that the healthcare claims and medication-utilisation measures had high positive skewness and extreme values.

2.4 Descriptive and Bivariate Analysis

The study population and medication adherence patterns were described using descriptive statistics. Categorical variables were presented as frequencies and percentages, and continuous variables were presented as means and standard deviations or medians and interquartile ranges as appropriate depending on their distribution. The general level of adherence as well as disease-specific adherence rates were computed. Chi-square tests were used to determine the relationships between categorical variables and adherence status. Continuous variables, which did not have normal distribution, were compared using Mann–Whitney U tests. All statistical comparisons were performed on two sides and statistical significance was determined with a two-sided test at the $p<0.05$ level.

2.5 Multivariable Statistical Analysis

Patient and healthcare characteristics were entered into a binary logistic regression to determine if any of them were independently associated with medication adherence. Adherence was defined as the positive outcome. The variables annual contribution, annual claim amount, and medication unit were log-transformed because they were highly right-skewed; age was modeled as 10-year increments. The simultaneous entry of demographic, diagnostic, insurance, complication, and healthcare utilization characteristics allowed for the adjustment of these variables in the model. Association was expressed as odds ratios (95% confidence intervals) and p-values that were adjusted for the model. The observational study design precludes interpretation of findings as causal effects.

3. Results

3.1 Characteristics of the Study Population

There were 24,084 patients in the study, with a mean age of 56.58±14.48 years and a median age of 56 years. Hypertension was seen in 80.05% of the study participants and Diabetes was seen in 19.95% of the study participants. The percentage of males was 54.27% and females 45.73%. 28.97% of patients were comorbid and 9.60% had recognized complications. The median claim amount was 40,439.74 and the median for medication utilization was 344 units. The premium insurance schemes had 74.29% of patients, and 80.03% of the population were covered under standard insurance schemes (Table 1).

Table 1. Characteristics of the Study Population (N=24,084)

Characteristic	n/Value	%/IQR
Age, mean	56.58	14.48 SD
Age, median	56.00	46.00–66.00
Male	13,071	54.27
Female	11,013	45.73
Diabetes	4,805	19.95
Hypertension	19,279	80.05

Comorbidity present	6,976	28.97
Complication present	2,311	9.60
Medium scheme	5,148	21.38
Premium scheme	17,893	74.29
Standard cover	19,274	80.03
Annual claim, median	40,439.74	12,306.77–102,087.89
Medication units, median	344.00	120.00–720.00

3.2 Medication Adherence Patterns

Among the 24,084 patients, 9,669 were considered to be adherent (40.15%), while 14,415 were non-adherent (59.85%). Among patients with diabetes, 2,108 of 4,805 (43.87%) were adherent and 2,697 (56.13%) were non-adherent. Among patients with hypertension, 7,561 of 19,279 (39.22%) were adherent and 11,718 (60.78%) were non-adherent. In the unadjusted comparison, the difference in medication adherence between the diabetes and hypertension groups was statistically significant ($p<0.001$) (Table 2).

Table 2. Medication Adherence According to Disease Group

Group	Total n	Adherent n	Adherent %	Non-adherent n	Non-adherent %
Overall	24,084	9,669	40.15	14,415	59.85
Diabetes	4,805	2,108	43.87	2,697	56.13
Hypertension	19,279	7,561	39.22	11,718	60.78

Disease-group comparison: $p<0.001$.

3.3 Characteristics According to Adherence Status

Non-adherent patients were younger than the adherent patients (mean age of 53.75 years and 60.80 years, respectively, $p<0.001$). The mean claim value for adherent patients (87,029.21) was significantly higher than non-adherent patients (18,659.61). The median use of medication was also greater for adherent patients (690 units compared with 178 units; $p<0.001$). Adherence was observed in 41.77% females and 38.78% males. The patients who had recorded comorbidities showed 50.62% adherence rates while the patients who had no recorded comorbidities showed 35.88% (Figure 1) (Table 3).

Table 3. Characteristics of Adherent and Non-Adherent Patients

Characteristic	Adherent	Non-adherent	p-value
Age, mean (years)	60.80	53.75	<0.001
Age, median (years)	60.00	53.00	<0.001
Annual contribution, median	6,889,900.00	6,889,900.00	<0.001
Annual claim, median	87,029.21	18,659.61	<0.001
Medication units, median	690.00	178.00	<0.001
Male adherence (%)	38.78	61.22	<0.001
Female adherence (%)	41.77	58.23	<0.001
Comorbidity present (%)	50.62	49.38	<0.001
No comorbidity (%)	35.88	64.12	<0.001

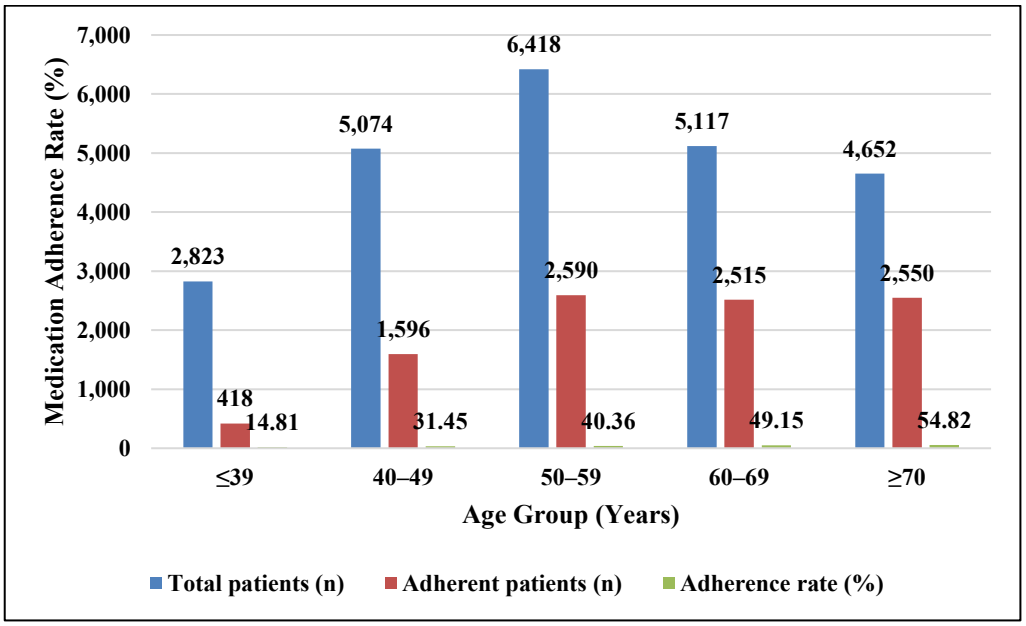


Figure 1. Medication Adherence Across Age Groups

3.4 Bivariate Associations With Medication Adherence

Gender, disease diagnosis, comorbidity, complication status, and insurance scheme were significant unadjusted associations with medication adherence. Patients with complications had a higher level of adherence at 45.52% versus 39.58% for patients with no complications ($p<0.001$). Adherence rates among premium schemes were 41.89%, while the rates in medium schemes were 35.92%. The adherence was higher among female patients than male patients. Contrary to that, there was not a significant difference between standard and alternative insurance coverage in the adjusted analysis ($p=0.217$) (Figure 2) (Table 4).

Table 4. Bivariate Associations With Medication Adherence

Characteristic	Total n	Adherent n	Adherence %	p-value
Male	13,071	5,069	38.78	<0.001
Female	11,013	4,600	41.77	<0.001
Diabetes	4,805	2,108	43.87	<0.001
Hypertension	19,279	7,561	39.22	<0.001
Comorbidity present	6,976	3,531	50.62	<0.001
No comorbidity	17,108	6,138	35.88	<0.001
Complication present	2,311	1,052	45.52	<0.001
No complication	21,773	8,617	39.58	<0.001
Medium scheme	5,148	1,849	35.92	<0.001
Premium scheme	17,893	7,496	41.89	<0.001
Standard cover	19,274	7,776	40.34	0.217

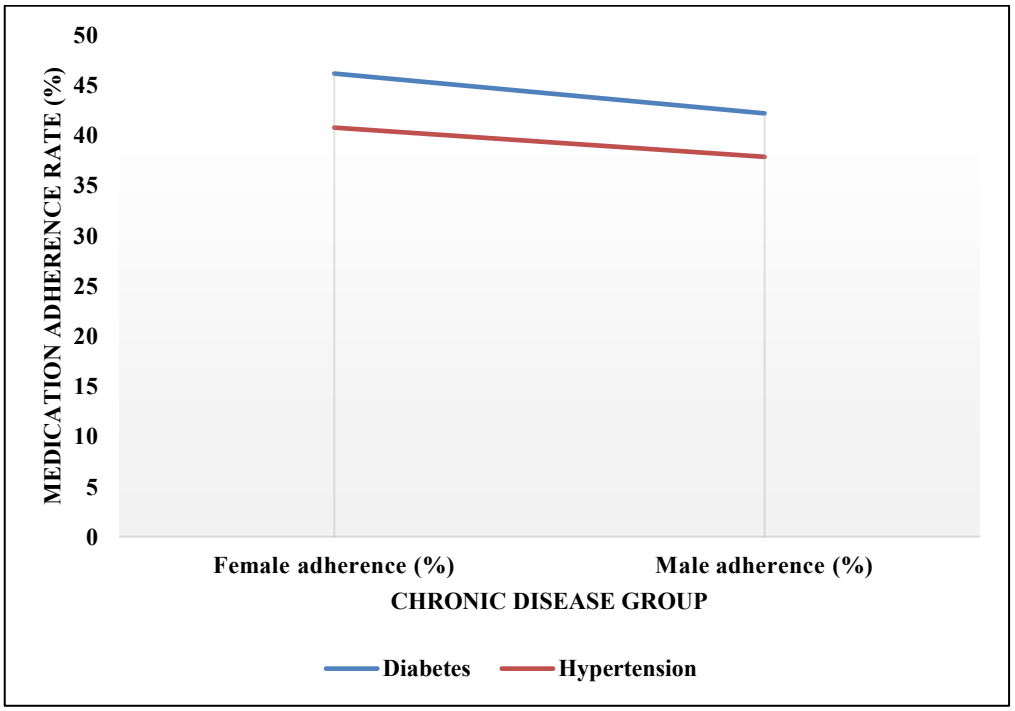


Figure 2. Gender-Specific Adherence Within Diabetes and Hypertension

3.5 Multivariable Factors Associated With Medication Adherence

Several patient and health care characteristics were independently associated with adherence after simultaneous adjustment. Each 10-year increase in age corresponded to greater odds of adherence (AOR=1.149, 95% CI: 1.119–1.179). Male gender was found to have lower odds (AOR=0.861) while hypertension had higher adjusted odds compared to diabetes (AOR=1.499). Log-transformed annual claim amount (AOR=1.603) and medication units (AOR=3.297) were positively associated with adherence. The other characteristics included with standard in the figure were not statistically significant after adjustment, so they were not included in the model.The other characteristics included with standard in the figure were not statistically significant after adjustment, so they were not included in the model (Table 5) (Figure 3).

Table 5. Multivariable Logistic Regression for Medication Adherence

Variable	AOR	95% CI	p-value
Age, per 10 years	1.149	1.119–1.179	<0.001
Log annual contribution	0.476	0.306–0.740	0.001
Log annual claim amount	1.603	1.538–1.670	<0.001
Log medication units	3.297	3.118–3.487	<0.001
Male gender	0.861	0.805–0.920	<0.001
Medium scheme	2.720	1.546–4.785	<0.001
Premium scheme	5.612	2.152–14.630	<0.001
Hypertension	1.499	1.360–1.652	<0.001
Standard cover	1.059	0.947–1.185	0.315
No comorbidity	0.947	0.871–1.030	0.206
No complication	9.143	7.977–10.480	<0.001

AOR: adjusted odds ratio; CI: confidence interval.

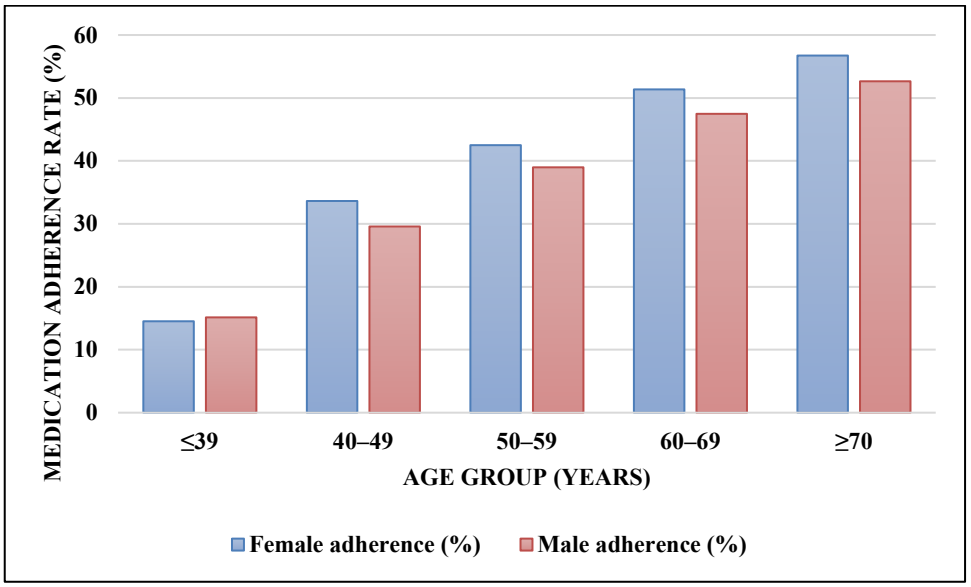


Figure 3. Age-Specific Medication Adherence by Gender

4. Discussion

Factors associated with medication adherence and evaluated them in patient-level health claims data from 24,084 diabetes and hypertension patients. The results showed that there was a significant gap in adherence to medications, and 40.15% were adherent, while 59.85% were non-adherent. In addition, adherence was different by age, sex, disease group, presence of comorbidities, complications, insurance scheme, claims expenditures and medication use. Several of these relationships remained after simultaneous adjustment in multivariable analysis. Together, these results suggest that a network of demographic, clinical, utilization, and health care factors are linked to medication adherence in the management of chronic disease; none of them is singularly the cause.

The high proportion of non-adherent patients is clinically significant since diabetes and hypertension both require a lifelong course of treatment in order to control the disease and avoid long-term diabetes-related complications. Past studies in patients who had both conditions showed that patients maintained suboptimal blood pressure and blood glucose levels and that patient and healthcare characteristics were associated with differences in disease management (Hinneh et al., 2025). The current findings build on this evidence by demonstrating that suboptimal medication adherence is also prevalent in a large claims-based population. This highlights the need to integrate adherence monitoring into standard chronic disease management, not because it is simply a matter of having medications available, but because it is a necessary component of the management.

Age was an important factor with adherent patients being significantly older than the non-adherent patients, and odds of adherence rising with each 10 year increase in age after adjustment. Age-stratified results likewise revealed increasing adherence with increasing age. This trend could be due to older adults' increased awareness of illness, more established medication regimes or more access to health care services. However, the issue of adherence in older adults is complicated, and there are cognitive, behavioral, socioeconomic and digital barriers that could affect adherence to medications. There is evidence that strategies that are implemented at multiple levels might be effective in increasing adherence when they target multiple barriers among older adults. In other words, it is not appropriate to discount the importance of patient adherence assessment because some older patients achieve greater average adherence.

There were also gender differences found. Female patients were somewhat more adherent than male patients and male gender was independently associated with decreased odds of adherence post-adjustment. The difference was small but indicates that demographic factors can be used to better determine patient populations that could benefit from further support. At a broader level, large-scale real-world evidence suggests that factors influencing adherence to medication use are not consistent across all medicines and patient groups, but are dependent on the specific context (Arshed et al., 2025). This further bolsters the notion

that gender needs to be taken into account in addition to the disease characteristics, service utilization and insurance coverage; not as an independent variable.

The adherence was higher with the presence of comorbidity, which was not statistically significant after multivariable adjustment. Patients with multiple chronic diseases may have higher levels of health care contact as well as higher perceived need for care, but also higher levels of medication burden. Previous evidence has shown that increasing medication-regimen complexity can adversely influence adherence among patients with multimorbidity (Kassaw et al., 2024). Likewise, it has been noted that high adherence is a key issue amongst patients with chronic comorbidities and complex medication regimens (Gatwood et al., 2022). The adjusted relationship between comorbidity and adherence, as found in the present study, implies that the crude association between the two may be partly due to other clinical and healthcare utilization factors.

Adherence was significantly associated with healthcare utilization with the strongest relationships observed for this measure. Patients with good adherence had much greater annual claim amounts and medication units, and both were found to be positively related with adherence after controlling for other factors. The results suggest that frequent contact with healthcare and pharmaceutical services is associated with better adherence with medication. However, due to the observational nature of the study, findings of higher claims are not necessarily interpreted as causing improved adherence (Lee et al., 2025). A growing body of claims-based research has shown the benefit of routinely collected medical data for uncovering adherence patterns and predicting clinically relevant outcomes (Oluwagbade et al., 2025). In the real world, adherence information has also been proven to be useful for understanding preventive pharmacotherapy continuity.

Healthcare-financing arrangements may influence medication-use behavior as the insurance scheme was found to be independently associated with the medication adherence. The adjusted odds of adherence were higher than the reference scheme for premium and medium schemes, but this should be interpreted with caution as the insurance schemes may be additionally distinguishing between socioeconomic resources, access to health care, or benefit design. Previous studies have shown that insurance-based medication quality measures can have a meaningful impact between patient groups with diabetes, hypertension, and other chronic diseases (Chisholm-Burns et al., 2022). The results demonstrate the need to account for structural factors in the healthcare system when creating strategies to improve adherence.

The results have applications in the management of chronic diseases. Claims data at the patient level may help identify patients with characteristics linked to poor adherence and provide opportunities for personalized medication counselling, refill follow up, and monitoring. Pharmacist involvement might be especially pertinent due to the observed benefits of structured pharmacist-led care in older adults with common chronic conditions' medication adherence (Smith-Ray et al., 2024). Adherence-support programs should not give the same interventions to every patient, but could instead integrate demographic, clinical, utilization and insurance data to determine who needs more support to adhere.

There are a few caveats to be noted. The observational design does not allow for causal interpretation, and the claims data available do not capture all influences on medication use, including behavioral, socioeconomic, psychological or provider factors. Adherence is defined by the operational definition of the dataset and is not necessarily indicative of medication adherence. It is important to consider extreme values in claims and medication use as well. Although there are some of these limitations, the sample size of patients is large and the demographic, clinical, insurance, and utilization data give a meaningful real-world picture of adherence to medications among patients with diabetes and hypertension.

5. Conclusion

Adherence to medication and factors associated with it in health claims data at the patient level for people with diabetes and hypertension. The results showed that there was a significant adherence problem and less than half of the participants were considered to be adherent to medication. Medication-taking patterns differed by demographic, clinical, and insurance and health-care-utilization characteristics, providing evidence that there are many interrelated factors that affect medication-taking behavior. The older age was linked to higher adherence and male patients had lower adjusted odds of adherence. Additionally, there were some differences between the diabetes and hypertension populations, reflecting the need to take disease-specific factors into

account when assessing medication use. Specifically, healthcare utilization was relevant as annual claim amounts and medication units were highly positively associated with adherence after adjustment. The characteristics of the insurance scheme were also independently related to adherence, indicating that conditions of healthcare access and financing could be a factor in variation in medication-use patterns. The results of this study highlight the benefits of claims level data at a patient level to help identify those who may need further support to adhere to their treatment. Specific adherence monitoring, counseling on medication use, refill monitoring and personalized follow-up should be considered for individuals with a higher risk of non-adherence. Longitudinal studies with clinical outcomes, socioeconomic factors and standardized measures of adherence are required in the future to better understand these relationships and to inform more effective chronic disease management.

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