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The Relationship Between Health Insurance Coverage and Clinical Outcomes Among People with Diabetes at Two Tertiary Centers in Saudi Arabia

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Abstract

Aims: Saudi Arabia's ongoing health sector transformation is expanding private health insurance, yet its relationship with diabetes outcomes is unclear. We examined the association of private insurance with use of newer therapies and glycemic and cardiometabolic outcomes among people with diabetes (PWD). Methods: A retrospective cross-sectional analysis of data from 311 PWD, managed by the same endocrinologist at a public and a private tertiary center (November 2021-November 2022). Participants without private insurance (publicly covered) remained entitled to free care at public facilities. Results: Overall, 40.19% of participants were privately insured; 85.60% of them attended the private clinic, whereas 97.85% of publicly covered PWD attended the public clinic. Prescription of GLP-1 RA, SGLT-2 inhibitors, and combined diabetes medications was more common among privately insured PWD (all $p < 0.01$), as was achieving A1C $\leq$ 8.0% (64.66% vs. 31.84%, $p < 0.01$). Private insurance was associated with greater odds of achieving A1C $\leq$ 8.0% [OR (95% CI): 2.57 (1.26, 5.26)] after adjusting for sociodemographic and clinical factors and utilization of newer diabetes medications and technology. Conclusions: Private health insurance, together with care in the private healthcare setting, was associated with better glycemic outcomes among PWD in Saudi Arabia. Because insurance status was closely linked to the care setting, this association likely reflects coverage-, institution-, and patient-level factors. As insurance coverage expands, monitoring outcomes across insurance groups and care settings may help narrow existing gaps.

Keywords: social determinants of health; health insurance; diabetes; A1C

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1. Introduction

Diabetes is associated with a staggering and growing health and economic burden throughout the world, and it remains a leading cause of death, particularly in developing countries [1,2]. The Middle East and North Africa (MENA) region has one of the highest prevalences of people with diabetes (PWD) worldwide, with approximately 84.7 million adults living with diabetes in 2024, a number projected to increase by 92% to 162.6 million by 2050. Saudi Arabia, the second largest country in the MENA region, has one of the highest prevalence rates of diabetes in adults aged 20–79 years (23.1%) [2]. Such high prevalence of diabetes has led to a significant economic burden across all countries within the MENA Region. Diabetes-related health expenditures are not limited to the costs of

medications, medical supplies, clinic visits, and treatment of diabetes complications, but they also include indirect costs (such as increased absenteeism, premature mortality, family burden, etc.) [3].

Traditionally, healthcare services for almost all PWD in Saudi Arabia have been provided through governmental/public hospitals, where these services are provided free of charge.

However, more recently, the healthcare system in Saudi Arabia has been undergoing a major transformation from a public/governmental-supported system into a private/insurance-based system, as part of the Saudi Vision 2030 [4,5]. The healthcare sector transformation began in 2021 and is still ongoing. It aims to privatize many of the government-supported services. While the traditional system has always identified the Ministry of Health (MOH) as both a regulator and provider of services, the newer system considers MOH as a regulator that monitors healthcare services provided by the private sector. It is estimated that 39% of the Saudi population has health insurance as of 2025 [6,7]. In 2023, the Ministry of Health also announced plans for a state-funded national health insurance program for Saudi citizens, indicating that the financing of diabetes care in the Kingdom is likely to continue to evolve [8]. Such a major shift in the health care landscape is expected to have a significant impact on healthcare accessibility, quality, and efficiency as well as the overall structure of health care delivery nationwide [9]. As of today, most patients attending private clinics have private health insurance, and the minority pay out of pocket. For many privately insured PWD, the utilization of private clinics may facilitate access to newer diabetes medications and diabetes technologies. Conversely, most PWD without private insurance receive care in public clinics and rely on government-funded healthcare services, where access to advanced or novel therapies is subject to public formulary and institutional eligibility criteria. The current ongoing privatization of the Saudi healthcare system provides a unique context in which to examine the association between health insurance, as a social determinant of health (SDH), and health outcomes among PWD during this transition.

Social determinants of health (SDH) include a range of factors such as socioeconomic status (SES), neighborhood, environment, type of diet, and health care and social context that shape the overall health of individuals. Health beliefs, lifestyle choices, and behavioral patterns represent additional determinants of diabetes-related disparities that could also play an important role in diabetes self-management and glycemic control [10,11]. Generally, PWD with low SES are more likely to have poorly controlled glucose because of limited access to nutritious food and effective diabetes therapeutics and technologies such as continuous glucose monitors (CGMs), insulin pumps, and others [12]. Among these SDH, health insurance coverage has emerged as an important one for PWD [13,14]. Prior studies have reported higher rates of diabetes-related complications among those with no or less generous insurance coverage. [15,16]. Likewise, low levels of income and education and poor neighborhoods have also been linked with poor overall health in PWD [17–19].

Recent international studies further support the relevance of insurance coverage to diabetes outcomes, while also showing that coverage alone may not be sufficient. In the United States, racial and ethnic disparities in glycemic control persisted even among adults with private or public insurance after accounting for social, healthcare, and behavioral factors [20], and a substantial proportion of adults with employer-sponsored insurance did not achieve glycemic goals [21]. Among patients with type 2 diabetes attending federally qualified health centers, uninsured patients and those with Medicaid had higher A1C than those with Medicare or private insurance, and these differences were not fully explained by measured covariates [22]. Coverage policies also appear to shape access to diabetes technologies: expanding Medicaid coverage of CGM increased its uptake and was associated

with improved glycemia [23], although gaps in CGM use between publicly and privately insured patients persisted [24]. Associations between insurance coverage and glycemic control have also been reported in low-resource settings outside the United States [25]. However, most of this evidence comes from health systems in which lacking insurance may mean lacking coverage altogether, which differs from the Saudi context, where citizens without private insurance remain entitled to free care at public facilities.

To our knowledge, no prior study has examined the association between SDH, including health insurance status, and cardiometabolic health, including glycemic control, among PWD in the MENA region. In this study, we aim to evaluate the association between SDHs, health insurance status, accessibility to novel diabetes medications and technologies, and health outcomes among PWD in Saudi Arabia, where healthcare is currently undergoing national privatization.

2. Patients and Methods

2.1. Study Design and Participants

This is a retrospective cross-sectional study conducted at two different healthcare systems in Saudi Arabia: (a) King Saud University Medical City, a major tertiary governmental hospital, and (b) Al-Habib Medical Group, the largest private healthcare center in Saudi Arabia. The two hospitals have well-established tertiary diabetes centers. Both clinics deliver multidisciplinary, evidence-based diabetes care, including endocrinologists, diabetes educators, dietitians, and access to CGM and automated insulin delivery (AID) technologies. The two centers differ primarily in the healthcare financing model and insurance structure, rather than in clinical management approach. Nonetheless, access to certain glucose-lowering medications (e.g., GLP-1RA and SGLT-2i) and advanced diabetes technologies (e.g., CGM and AID systems) is subject to institutional formulary availability in the public sector and to predefined insurance coverage criteria and limits in the private sector. As a result, access to such newer therapies and technologies is generally more limited in the public setting than in the private sector. All data were collected from the clinics of a single endocrinologist who treats PWD at the two centers on different days of the week.

In Saudi Arabia, all citizens are entitled to free healthcare at public/governmental facilities regardless of insurance status. In this study, 'health insurance' refers specifically to private health insurance coverage, which provides access to private-sector healthcare facilities. Therefore, participants with private health insurance are referred to as 'privately insured', and participants without private health insurance are referred to as 'publicly covered'; the latter had access to care through the public healthcare system and could access the private-sector services only by paying out of pocket.

2.2. Outcomes and Covariates

The final sample included 311 PWD who were above the age of 14 years and had available data on insurance status and cardiometabolic health (A1C, body mass index (BMI), or blood pressure) in their records during the period from 1 November 2021 to 30 November 2022. We collected sociodemographic data, such as age, gender, employment status, educational level, monthly income, and insurance status, through electronic medical records during routine clinical care. Clinical data were extracted from the electronic medical records and included diabetes type and duration, type of medications, BMI, systolic blood pressure (SBP), diastolic blood pressure (DBP), A1c, total cholesterol (TC), low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, triglyceride (TG), serum creatinine, and urinary albumin–creatinine ratio (UAC), and diabetes complications such as retinopathy, neuropathy, albuminuria, and end-stage renal disease (ESRD).

The A1C threshold of ≤8.0% was selected a priori as the primary glycemic outcome, given the heterogeneity of our population, which included people with type 1 diabetes, older adults, and individuals with long-standing diabetes, for whom less stringent individualized goals (e.g., A1C < 8.0%) may be appropriate [26]. This threshold is also consistent with widely used population-level quality-of-care indicators, such as the Healthcare Effectiveness Data and Information Set (HEDIS) Glycemic Status Assessment for Patients With Diabetes measure, which assesses the proportion of adults with diabetes achieving an A1C < 8.0% [27]. Because these reference goals are expressed as an A1C < 8.0% and A1C was recorded to one decimal place, the two definitions differ only for five participants with an A1C of exactly 8.0%.

2.3. Statistical Analysis

All significance testing was 2-tailed with α of 0.05, and data were analyzed using Stata Statistical Software (release 15). Continuous variables were presented as medians and interquartile ranges (IQR) and were compared between groups using the Mann–Whitney test. Categorical variables were presented as percentages and were compared between groups using contingency table arrays and the χ^2 statistic. Given the cross-sectional study design and binary outcome of interest, logistic regression analysis was used to identify factors associated with achieving A1C of ≤8.0%. The associations between potential predictors and outcomes are presented as odds ratios (ORs) and 95% confidence intervals (CIs). We present the ORs before and after adjusting for potential confounders, including age, gender, level of education, income, type of diabetes, diabetes duration, health insurance status, and use of GLP-1RA, SGLT-2 inhibitor, and insulin pump therapy when appropriate. The analysis exploring the association between insulin pump use and achieving A1C of ≤8.0% was limited to PWT1D. Health insurance status and type of clinic utilized (private vs. public) were highly correlated in our sample; therefore, type of clinic was not included in the adjusted model to avoid collinearity. Educational level was categorized as diploma or higher versus high school or less (including other or no formal education), monthly income as ≥10,000 versus <10,000 SAR, and diabetes duration as >10 versus ≤10 years. Descriptive statistics were calculated using all available data for each variable. Unadjusted and adjusted models were fitted as complete-case analyses in the same sample of participants with data on the outcome and all covariates (n = 182); missing data were mainly due to incomplete data on monthly income (37.30%) and educational level (35.37%). Included and excluded participants were compared using the χ^2 and Mann–Whitney tests. Three sensitivity analyses were performed. First, missing data were handled using multiple imputation by chained equations, under the assumption that data were missing at random (i.e., that missingness depended only on observed characteristics). However, this assumption cannot be verified from the observed data. If missingness depended on unobserved values, the imputed estimates could be biased. Logistic imputation models were used for the incomplete variables (educational level, monthly income, diabetes duration, and achieving an A1C ≤ 8.0%); each was imputed conditional on the other incomplete variables and on insurance status, age group, gender, diabetes type, and prescription of GLP-1RA and SGLT-2 inhibitors, which together comprised all variables in the analysis model. Twenty imputed datasets were generated, and estimates were combined using Rubin's rules. Second, the adjusted model was repeated by diabetes type, and an interaction term between insurance status and diabetes type was tested. Third, the adjusted model was repeated with an A1C < 8.0% as the outcome.

2.4. Ethical Considerations

The study protocol was reviewed by the Institutional Review Board (IRB) of King Saud University, College of Medicine (Research Project No. E-21-6468), which determined that the study posed no more than minimal risk to participants and granted it exempt status. Data were retrospectively extracted from the electronic medical records, and the study involved no contact with patients and no study-specific procedures, and it had no influence on clinical care. Accordingly, individual informed consent was not required, including for participants younger than 18 years. Data were handled confidentially, analyzed, and reported without personal identifiers.

3. Results

3.1. Patient Characteristics

Of the 311 study participants, 53% were women, 48% had a diploma/bachelor or higher education level, 54% had diabetes duration >10 years, 52% had type 1 diabetes, and 40.2% were privately insured. The median (IQR) age of the study participants was 40 (24, 60) years. Thirty-one participants (9.97%) were younger than 18 years (range, 14–17 years), 30 of whom had type 1 diabetes. Compared with publicly covered participants, those with private insurance were more likely to receive care in the private clinic (85.6% vs. 2.15%) and to have a higher level of education (50.0% vs. 36.43%). Among participants with type 1 diabetes, insulin pump use was substantially more common in the privately insured group than in the publicly covered group (28.57% vs. 2.8%). In addition, the prescriptions of GLP-1 receptor agonists, SGLT-2 inhibitors, and combination diabetes therapies were more common among privately insured participants (21.6%, 18.4%, and 15.2%, respectively) than among publicly covered participants (8.6%, 5.38%, and 2.15%, respectively) (all $p < 0.01$). The remaining characteristics of the study participants were generally comparable between the two groups, as shown in Table 1.

Table 1. Characteristics of study participants by insurance status (n = 311).

	All (n = 311)	**Publicly Covered (n = 186)**	**Privately Insured (n = 125)**	***p* Value**
Type of Clinic, n (%)				
Public	200 (64.31)	182 (97.85)	18 (14.40)	<0.01
Private	111 (35.69)	4 (2.15)	107 (85.60)	
Age, median (25th, 75th percentile), years	40 (24, 60)	36 (22, 59)	46 (26, 61)	0.03
Women, n (%)	166 (53.38)	107 (57.53)	59 (47.20)	0.07
Employment Status, n (%)				
Student	60 (29.27)	49 (37.12)	11 (15.07)	<0.01
Employed	69 (33.66)	34 (25.76)	35 (47.95)	
Housewife	31 (15.12)	24 (18.18)	7 (9.59)	
Retired	23 (11.22)	8 (6.06)	15 (20.55)	
Unemployed	11 (5.37)	8 (6.06)	3 (4.11)	
Others	11 (5.37)	9 (6.82)	2 (2.74)	

Table 1. *Cont.*

	All (n = 311)	Publicly Covered (n = 186)	Privately Insured (n = 125)	*p* Value
Education Level, n (%)				
High school or less	99 (49.25)	71 (55.04)	28 (38.89)	<0.01
Diploma/Bachelor	83 (41.29)	47 (36.43)	36 (50.00)	
Graduate or higher	13 (6.47)	5 (3.88)	8 (11.11)	
Others	6 (2.99)	6 (4.65)	0 (00.00)	
Monthly Income, n (%)				
Less than 5k	76 (38.97)	61 (48.41(	15 (21.74)	<0.01
5k–10k	47 (24.10)	30 (23.81)	17 (24.64)	
10k–20k	47 (24.10)	28 (22.22)	19 (27.54)	
>20k	25 (12.82)	7 (5.56)	18 (26.09)	
Type of Diabetes, n (%)				
T2D	113 (36.33)	54 (29.03)	59 (47.20)	<0.01
T1D	163 (52.41)	107 (57.53)	56 (44.80)	
Other type	35 (11.25)	25 (13.44)	10 (8.00)	
Diabetes Duration (Years)				
≤5	77 (25.33)	48 (25.81)	29 (24.58)	0.04
6 to 10	63 (20.72)	34 (18.28)	29 (24.58)	
11 to 20	90 (29.61)	49 (26.34)	41 (34.75)	
>20	74 (24.34)	55 (29.57)	19 (16.10)	
Prescribed GLP-1 RA, n (%)	43 (13.83)	16 (8.60)	27 (21.60)	<0.01
Prescribed SGLT2 I, n (%)	33 (10.61)	10 (5.38)	23 (18.40)	<0.01
Prescribed combined medications, n (%)	23 (7.40)	4 (2.15)	19 (15.20)	<0.01
Prescribed mixed insulin, n (%)	10 (3.22)	9 (4.84)	1 (0.80)	0.05
Prescribed insulin pump among PwT1D, n (%)	19 (11.66)	3 (2.80)	16 (28.57)	<0.01

Abbreviations: T2D, type 2 diabetes; T1D, type 1 diabetes; GLP-1 RA, glucagon-like peptide-1 receptor agonist; SGLT2 I, Sodium and glucose transporter 2 inhibitor; PwT1D, people with type 1 diabetes. Percentages are calculated among participants with available data for each variable; data were available for employment status (n = 205), educational level (n = 201), monthly income (n = 195), and diabetes duration (n = 304).

3.2. Glycemic Control and Other Health Outcomes

The median A1C was significantly lower in the privately insured versus publicly covered PWD (7.4% and 9%, respectively, $p < 0.01$). The proportion of PWD with A1C of ≤8.0% was higher in the privately insured versus publicly covered group (65% vs. 32%, respectively, $p < 0.01$). Likewise, 40% of the privately insured PWD achieved an A1C of ≤7% compared to only 15% of those publicly covered (Table 2). In addition, the median DBP was significantly lower in the privately insured versus publicly covered PWD (74 vs. 79 mmHg, *p* value < 0.01). However, no significant differences were noted in SBP or the

lipid profile by insurance status (Table 2). Publicly covered PWD had a higher prevalence of retinopathy compared to privately insured PWD (25.27% versus 13.22%, respectively, $p = 0.01$). There were no significant differences in the prevalence of albuminuria, ESRD, neuropathy, or sexual dysfunction (Table 2).

Table 2. Diabetes-related outcomes stratified by insurance status (n = 311).

	All (n = 311)	**Publicly Covered (n = 186)**	**Privately Insured (n = 125)**	***p* Value**
A1C, median (25th, 75th percentile), %	8.2 (7.1, 9.8)	9 (7.7, 10.2)	7.4 (6.5, 8.7)	<0.01
Patients with A1C of ≤7%, n (%)	72 (24.41)	26 (14.53)	46 (39.66)	<0.01
Patients with A1C of ≤8.0%, n (%)	132 (44.75)	57 (31.84)	75 (64.66)	<0.01
Systolic blood pressure, median (25th, 75th percentile), mmHg	129 (119,141)	128 (118,141)	130 (121,140)	0.25
Diastolic blood pressure, median (25th, 75th percentile), mmHg	77 (70,83)	79 (73,84)	74 (66,81)	<0.01
Cholesterol, median (25th, 75th percentile), mmol/L	4.55 (3.96, 5.42)	4.64 (3.95, 5.62)	4.4 (3.98, 4.96)	0.09
LDL, median (25th, 75th percentile), mmol/L	2.64 (1.97, 3.42)	2.59 (1.85, 3.56)	2.70 (2.20, 3.30)	0.59
HDL, median (25th, 75th percentile), mmol/L	1.37 (1.01, 1.60)	1.38 (1.14, 1.60)	1.34 (1.00, 1.65)	0.32
Triglycerides, median (25th, 75th percentile), mmol/L	1.34 (0.90, 1.83)	1.34 (0.90, 1.83)	1.30 (0.92, 1.90)	0.93
Diabetes-related Complications, n (%)				
albuminuria	49 (30.06)	38 (31.67)	11 (25.58)	0.46
Retinopathy	63 (20.52)	47 (25.27)	16 (13.22)	0.01
ESRD	2 (0.65)	1 (0.54)	1 (0.83)	0.76
Neuropathy	51 (16.61)	33 (17.74)	18 (14.88)	0.51
Self-reported sexual dysfunction	20 (6.54)	13 (7.03)	7 (5.79)	0.67

Abbreviations: LDL, low-density lipoprotein; HDL, High-density lipoprotein; ESRD, end-stage renal disease. A1C was available for 295 participants (publicly covered, n = 179; privately insured, n = 116), and A1C-based percentages are calculated among these participants. Percentages for diabetes-related complications are calculated among participants with available data (albuminuria, n = 163; retinopathy, ESRD, and neuropathy, n = 307; self-reported sexual dysfunction, n = 306).

3.3. Multivariable Logistic Regression Analyses

After adjustment for age, gender, educational level, income, diabetes type and duration, and GLP-1 and SGLT-2 inhibitor prescriptions, private health insurance remained associated with achieving an A1c of ≤8.0% (OR: 2.57; 95% CI: 1.26, 5.26). Educational level was also associated with this outcome, with participants holding a diploma or higher degree having greater odds of achieving an A1C ≤ 8.0% compared with those with a high school education or less (OR: 2.74; 95% CI: 1.36, 5.50). The remaining adjusted and unadjusted analyses of the associations between other covariates and achieving an A1c of ≤8.0% are presented in Table 3. Unadjusted and adjusted estimates were obtained in the same complete-case sample (n = 182). Compared with included participants, the 129 participants excluded from the adjusted model were more often privately insured, older, more likely to have type 2 diabetes, more often prescribed SGLT-2 inhibitors, and more often achieved an A1C ≤ 8.0% (Supplementary Tables S1 and S2). In a sensitivity analysis using multiple imputation for

missing data (n = 311), private health insurance remained associated with achieving an A1C of ≤8.0% (OR: 3.34; 95% CI: 1.91, 5.85). This estimate was in the same direction as, and somewhat stronger than, the complete-case estimate, with overlapping confidence intervals (Supplementary Table S3). Among participants with type 1 diabetes, the adjusted OR was 3.51 (95% CI: 1.38, 8.94). Among participants with type 2 diabetes, the adjusted estimate was imprecise and unstable (OR: 1.02; 95% CI: 0.13, 7.73; n = 39), and an adjusted estimate could not be obtained for other diabetes types. The interaction between insurance status and diabetes type was not statistically significant (p for interaction = 0.31) (Supplementary Table S4); however, the study had limited power to detect such differences. When the outcome was defined as an A1C < 8.0%, private health insurance remained associated with achieving the target (OR: 2.21; 95% CI: 1.08, 4.50); the two definitions differed for only five participants with an A1C of exactly 8.0% (three in the complete-case sample).

Table 3. Factors associated with A1C goal attainment (i.e., A1C ≤ 8%).

	Unadjusted OR (95% CI)	***p* Value**	**Adjusted OR (95% CI) ****	***p* Value ****
Health insurance status				
Publicly covered	Reference		Reference	
Privately insured	2.93 (1.56, 5.50)	<0.01	2.57 (1.26, 5.26)	0.01
Age, years old				
<30	Reference		Reference	
30–50	1.42 (0.67, 3.01)	0.36	1.52 (0.59, 3.91)	0.38
>50	0.95 (0.47, 1.89)	0.87	1.69 (0.57, 5.04)	0.35
Gender				
Women	Reference		Reference	
Men	1.74 (0.96, 3.18)	0.07	1.87 (0.95, 3.67)	0.07
Level of education				
High school or less	Reference		Reference	
Diploma or higher	2.98 (1.61, 5.52)	<0.01	2.74 (1.36, 5.50)	<0.01
Monthly income, SAR				
<10k	Reference		Reference	
≥10k	1.69 (0.91, 3.13)	0.10	0.93 (0.45, 1.91)	0.84
Type of diabetes				
T1D	Reference		Reference	
T2D	0.78 (0.37, 1.67)	0.53	0.45 (0.15, 1.33)	0.15
Other types	1.02 (0.47, 2.23)	0.96	0.93 (0.32, 2.69)	0.89
Diabetes duration, Years				
≤10	Reference		Reference	
>10	0.83 (0.46, 1.51)	0.55	0.65 (0.32, 1.31)	0.22
Prescribed GLP-1 RA				
No	Reference		Reference	
Yes	1.64 (0.71, 3.79)	0.24	1.24 (0.47, 3.30)	0.66

Table 3. *Cont.*

	Unadjusted OR (95% CI)	*p* Value	Adjusted OR (95% CI) **	*p* Value **
Prescribed SGLT2 I				
No	Reference		Reference	
Yes	1.34 (0.43, 4.15)	0.62	0.93 (0.23, 3.76)	0.91
Using insulin pump				
No	Reference		Reference	
Yes	4.28 (1.44, 12.72)	0.01	0.86 (0.19, 4.02)	0.85

Abbreviations: OR, Odds ratio; CI, Confidence interval; SAR, Saudi Arabian Riyals; GLP-1 RA, glucagon-like peptide-1 receptor agonist; SGLT2 I, sodium and glucose transporter 2 inhibitor. ** Adjusted for age, gender, level of education, monthly income, type of diabetes, diabetes duration, health insurance status, prescription of GLP-1RA, and prescription of SGLT-2 inhibitor (n = 182, Pseudo $R^2 = 0.1090$). Insulin pump use was analyzed separately among patients with Type 1 Diabetes only (unadjusted model n = 153; adjusted model n = 108, adjusted for age, gender, education level, monthly income, diabetes duration, health insurance status, GLP-1RA use, and SGLT-2 inhibitor use). For medication-use variables, the reference group ("no") includes patients who were not prescribed the medication. Unadjusted and adjusted estimates were obtained in the same complete-case sample. Educational level was categorized as diploma or higher versus high school or less (including other or no formal education).

4. Discussion

Our findings suggest that private health insurance, together with care in the private setting with which it was closely linked, is associated with clinical outcomes, including glycemic control, among PWD. To our knowledge, this is the first study to examine differences in cardiometabolic health and glycemic control by insurance status among PWD in the MENA region. People with diabetes who had private health insurance had more than twice the odds of achieving an A1c of ≤8.0% compared to publicly covered individuals (OR: 2.57; 95% CI: 1.26, 5.26), after adjusting for age, gender, education, income, type of diabetes, diabetes duration, and prescription of GLP-1RA and SGLT-2 inhibitors. Because most privately insured participants received care at the private center and almost all publicly covered participants received care at the public center, this association reflects differences across closely linked insurance and care settings and may reflect institutional factors, such as resources, staffing, and care processes, as much as insurance coverage itself; it should therefore not be interpreted as an independent effect of insurance coverage. In the same model, a higher level of education was also associated with better glycemic control. While prescription of GLP-1RA, SGLT2I, and insulin pumps was more common among privately insured than publicly covered PWD, the absolute rates of use remained modest even among the privately insured population. Access to these therapeutic interventions is often influenced by insurance eligibility criteria, copayment requirements, and formulary restrictions, which persist even among privately insured participants. Moreover, after adjustment, prescription of GLP-1RA and SGLT-2 inhibitors and, among PWT1D, insulin pump use were not independently associated with achieving an A1C of ≤8.0%. Our findings therefore do not establish the mechanisms underlying the association between insurance status and glycemic control. Differential access to newer medications and technologies remains one plausible explanation, which our data could not test directly, alongside differences between care settings and factors we could not measure, such as treatment adherence, frequency of clinic visits, and access to diabetes education; these potential pathways should be tested in longitudinal studies.

Our results align with those from previous studies linking the lack of health insurance coverage with poorer clinical outcomes in PWD [13,16,28], although in those settings lacking

insurance often meant lacking coverage altogether, whereas publicly covered participants in our study remained entitled to free care at public facilities. People with no health insurance and/or low SES are more likely to have poor clinical outcomes and higher diabetes-related mortality even in countries with universal healthcare coverage [29,30]. The association between insurance coverage and clinical outcomes has been linked to access to diabetes technology in one study [13]. However, the association between insurance coverage and clinical outcomes is also influenced by other factors. For instance, while Medicaid expansion in the United States had increased insurance coverage among young adults with type 2 diabetes, glycemic control remained poor in this population, with mean A1c levels of 9.3% to 10.1% depending on insurance type [31]. Beyond insurance coverage, several other social determinants of health (SDH) have been consistently linked to diabetes-related disparities and glycemic control [30]. Food insecurity is independently associated with suboptimal glycemic control and higher rates of severe hypoglycemia, particularly among low-income and low-education populations [32,33]. Lower health literacy and educational attainment have similarly been linked to poorer self-management behaviors and worse glycemic outcomes, consistent with our own finding where higher education was associated with better glycemic control [34]. Neighborhood and environmental factors, including residential access to healthy food outlets and walkability, have also been associated with faster achievement of glycemic targets, while socioeconomic instability, psychosocial stress, and diabetes-related distress further compound these disparities [14,35].

Taken together, these observations suggest that expanding insurance coverage alone may not be sufficient to achieve equitable diabetes care. The complex interplay of social, economic, and environmental factors affecting the health outcomes of PWD needs to be prioritized in any diabetes care model [14]. While insurance coverage is crucial, a truly effective approach must account for SDH and ensure equitable access to advanced diabetes therapeutics and technologies across all socioeconomic groups, particularly in underserved communities [36]. Integrating social support services and innovative distribution and reimbursement models for insulin pumps, CGMs, and novel therapeutics across both public and private healthcare settings may help address the systemic barriers that often lead to disparities in diabetes management. Such an approach could potentially improve individual health outcomes and help reduce the long-term economic burden of diabetes complications on healthcare systems, though this remains to be tested empirically [37]. Our findings highlight the need to monitor differences in treatment accessibility, care processes, and clinical outcomes across healthcare settings as the Saudi healthcare transformation proceeds.

Our study was conducted during the early phase of the national health sector transformation; however, its cross-sectional design does not allow evaluation of the effects of privatization or insurance expansion on health outcomes. Moreover, our study has a unique design in which a single endocrinologist cared for PWD in two different healthcare sectors (private vs. public). This design reduced variability related to physician practice, although institutional differences between the two centers, such as formularies, resources, and care processes, could not be accounted for. The limitations of our study include that we did not have data on the use of CGM, frequency of clinic visits, and accessibility to other team members such as diabetes educators and dietitians. Moreover, we did not have data on other important SDH such as food insecurity, household stability, area of residency, level of health literacy, and religiosity/health beliefs, which have also been linked to diabetes self-management and outcomes [10,11,17–19]. Another limitation is the absence of validated medication adherence measures (e.g., pharmacy refill data or a validated adherence scale). Because these unmeasured factors may differ between insurance groups and are related to glycemic control, residual confounding may have influenced the observed association in either direction. Health insurance status and type of clinic utilized (private vs. public) were

also highly correlated in our sample, precluding their simultaneous inclusion in the adjusted model, so our insurance-status estimate should be interpreted as reflecting a broader bundle of structural, financial, and setting-related factors rather than insurance coverage in isolation. Because most privately insured participants were seen at the private center and most publicly covered participants at the public center, our findings describe differences between two combined coverage-and-care settings and cannot indicate whether extending private insurance alone, without corresponding changes in the resources and formularies of public-sector facilities, would be associated with better outcomes. Our relatively small sample size limited the number of covariates that could be reliably included in the multivariable model and reduced precision for some estimates. Moreover, our study combined people with type 1 and type 2 diabetes, which differ in pathophysiology and treatment approach and may obscure type-specific associations despite adjustment for diabetes type. However, the association was in the same direction among participants with type 1 diabetes, whereas the adjusted estimate among those with type 2 diabetes was close to the null but highly imprecise. Although the interaction was not statistically significant, our sample size, particularly the small numbers of participants with type 2 or other diabetes types in the adjusted sample, provided limited power to detect differences across diabetes types, and this finding should not be interpreted as evidence of equivalent associations. In addition, socioeconomic data were incomplete for a substantial proportion of participants, and missingness was more frequent among privately insured participants. As a result, participants excluded from the complete-case analysis were more often privately insured, older, and more likely to have type 2 diabetes, and, among privately insured participants, those excluded more often achieved the glycemic target. This pattern could have attenuated the complete-case estimate, although bias in either direction cannot be excluded. The association was stronger after multiple imputation, with overlapping confidence intervals; however, this estimate depends on the missing-at-random assumption, which cannot be verified, and should be interpreted cautiously, as supporting the direction rather than the magnitude of the association. More broadly, our findings may not be generalizable to all PWD, especially those managed by other clinicians or in non-tertiary, rural, or lower-resource settings.

5. Conclusions

Among PWD attending two tertiary centers in Saudi Arabia, private health insurance, together with care in the private setting, was associated with better glycemic outcomes. Because insurance status and care setting largely overlapped, this association should not be interpreted as an independent effect of insurance coverage. It likely reflects a combination of coverage-, institution-, and patient-level factors rather than insurance coverage alone. Privately insured participants were also more frequently prescribed GLP-1 receptor agonists and SGLT-2 inhibitors and, among those with type 1 diabetes, more often used insulin pumps; whether differences in access to these therapies contribute to the observed differences in glycemic control warrants investigation in longitudinal studies that directly measure prescribing, access, and adherence. Additional interventions beyond the expansion of insurance coverage may be needed to improve accessibility to effective therapies and technologies [36,38,39]. As insurance coverage and private-sector participation expand under the national health sector transformation, routine monitoring of treatment accessibility, care processes, and diabetes quality indicators, such as attainment of A1C goals and use of guideline-recommended therapies, across insurance groups and care settings may help detect and address emerging disparities. In addition, the association between educational level and glycemic control supports the integration of structured diabetes self-management education across all care settings. Further research, including longitudinal and interventional studies, is needed to determine whether changes in insurance coverage and care

delivery are associated with changes in diabetes outcomes, and to inform strategies that promote equitable access to diabetes care across all populations.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/healthcare14234012/s1.

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Informed Consent Statement: Individual informed consent was not required because the study was granted exempt status by the King Saud University IRB as a minimal-risk, retrospective review of electronic medical records with no contact with patients.

Data Availability Statement: The de-identified data supporting the main findings of the study may be made available by the authors upon reasonable request, subject to applicable institutional and ethical requirements.

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Conflicts of Interest: M.A. has served on an advisory panel for Medtronic, Insulet, Abbott, VitalAire, Sanofi, and Dexcom; has received honoraria for speaking from Abbott, Eli Lilly, Medtronic, Novo Nordisk, Sanofi, and VitalAire; and has received research support from Medtronic. Y.A. has no conflict of interest.

Abbreviations

SDH	Social determinants of health
PWD	People with diabetes
GLP-1 RA	Glucagon-like peptide-1 Receptor Agonist
SGLT-2	Sodium-glucose co-transporter 2
MENA	Middle East and North Africa
SES	Socioeconomic status
CGM	Continuous glucose monitors
BMI	Body mass index
SBP	Systolic blood pressure
DBP	Diastolic blood pressure
A1C	Glycated hemoglobin
TC	Total cholesterol (TC)
LDL	Low-density lipoprotein
HDL	High-density lipoprotein
UAC	Urinary albumin–creatinine ratio
ESRD	End-stage renal disease

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