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# Medication Engagement, Determinants of Health, and A1C Levels among Adults with Type 2 Diabetes within a Tribal Health System

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## Abstract

**Purpose:** The purpose of this study was to examine the association between determinants of health, medication engagement, and A1C levels in adults with type 2 diabetes (T2DM) receiving Tribal health and pharmacy services.

**Methods:** A retrospective analysis of 2020–2021 electronic health record (EHR) data was conducted and included adult patients with T2DM using Choctaw Nation Health Services

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Declaration of Conflicting Interests
The authors declare that there are no conflicts of interest.

Authority (CNHSA) prescribed ≥1 non-insulin glucose-lowering medication in 2020, had ≥1 A1C value in 2020 and 2021, and a valid zip code in 2021. Patients receiving both insulin and other non-insulin glucose-lowering medication were included. The proportion of days covered (PDC) was used to calculate medication engagement. Statistical analyses included bivariate analysis and linear regression.

**Results:** There were 3787 patients included in the analyses; 62.5% were considered engaged (PDC≥0.8). The mean 2020 A1C level was 8.0 (64 mmol/mol) ±1.8; 33% had an A1C of <7%, 42% had an A1C 7–9%, and 25% had an A1C >9%. The mean A1C in 2021 was 7.9 (63 mmol/mol) ±1.7; 34% had an A1C of <7%, 44% had an A1C 7–9%, and 22% had an A1C >9%. Older age was weakly correlated with higher engagement; higher engagement was associated with lower A1C levels while adjusting for covariates.

**Conclusions:** Medication engagement was associated with lower A1C levels, older age was weakly associated with higher engagement to non-insulin glucose-lowering medications, consistent with previous literature. No determinants of health were significantly associated with A1C levels while adjusting for covariates.

Taking medication is often a vital aspect of managing chronic diseases. Low engagement to diabetes medications has an estimated annual economic impact of over $5 billion in the United States (U.S.).[1] Low medication engagement can be affected by social determinants of health (SDOH)[2] and influence A1C levels[3] and risk for diabetes-related complications such as cardiovascular disease and death.[4] The determinants of medication engagement and the relationship between engagement and A1C levels are not well understood in American Indian adults with type 2 diabetes (T2DM), especially those who receive health care and pharmacy services within a rural Tribal health care system.

Medication engagement, a term in line with person-centered language in diabetes care[5], will be used to describe what has been historically referred to as medication adherence or medication compliance in the scientific literature. According to a systematic review, engagement with oral glucose-lowering medication reportedly ranged from 36% to 93% in patients with diabetes[6]; however, these studies seldom included American Indian or other Indigenous peoples. Little research has examined medication engagement among patients served by Tribal health care systems or the Indian Health Service (IHS). Members of federally-recognized Tribes are entitled to federally funded health care under treaties negotiated between the U.S. government and their respective nations.[7] Therefore, services and medications provided through IHS or Tribal health care systems do not require patient co-payments.

Our 2017–2018 preliminary study used pharmacy fill data in a Tribal health system, and found that medication engagement was associated with lower A1C levels.[8] Also in this study, the majority of patients met the threshold for medication engagement (PDC ≥ 80%) for all included oral glucose lowering medication classes (62–83%).[8] In a non-rural commercial health care system, engagement with oral glucose-lowering medication was lower and A1C levels were higher among American Indian adults compared to non-Hispanic white adults.[9] Glucose-lowering medication engagement was reported as low to medium in

several studies among American Indian adults who used the same self-report medication engagement measure.[10–12]

Previous studies have identified numerous factors that influence medication engagement. Although overall findings have been mixed,[3,13] age and sex or gender may influence medication engagement. Among American Indian adults, not taking diabetes medication as prescribed has been associated with younger age and female sex or gender.[11] Also, use of T2DM-related primary care and diabetes care and education specialist visits may present opportunities for patient education[3] that can lead to higher medication engagement. Although the evidence is inconsistent, travel barriers may be associated with reduced or delayed medication use[14] whereas higher socioeconomic status (SES) has been associated with improved medication engagement.[13]

The electronic health record (EHR)-derived determinants of health were examined which included age, sex, frequency of visits with a diabetes care and education specialist and T2DM-related primary care provider as well as SDOH which included travel distance to the nearest clinic and SES. The World Health Organization (WHO) defines SDOH as the non-medical factors that impact a person's health outcomes.[15] Guided by the WHO SDOH framework,[15] we developed a conceptual framework for this study shown in Figure 1.

The purpose of this study was to examine the association among EHR-derived determinants of health, medication engagement, and A1C levels in American Indian adults with T2DM receiving Tribal health and pharmacy services. Our hypothesis was that higher non-insulin glucose-lowering medication engagement would be associated with male sex, older age, closer distance to the nearest clinic, more frequent primary care and diabetes care and education specialist visits, higher SES, and lower A1C levels.

## Methods

### Study Design

A retrospective, correlational study design was used to answer the research question, what is the relationship between medication engagement, A1C levels, and EHR-derived determinants of health., which was based on theory[15,16] and literature-based evidence.[3,11,13,14,17] We analyzed the 2020–2021 EHR data from an available 2017–2021 limited dataset provided by the Choctaw Nation Health Services Authority (CNHSA). Medication engagement and baseline A1C were assessed in 2020 while the remaining variables were assessed in 2021. The Choctaw Nation of Oklahoma (CNO) Institutional Review Board and University of Florida IRB approved the study. Due to Tribal data sovereignty, we do not have permission to share the dataset.

### Sample

Adults ≥18 years of age on the first date of the overall 2017–2021 dataset, January 1, 2017, with a documented diagnosis of T2DM, at least one A1C level drawn in 2020 and in 2021 at CNHSA, and a valid zip code in 2021 were included in the study. Most patients who use CNHSA are members of CNO or another federally recognized tribe. A small proportion of CNHSA patients are family members of a Tribal member or other patients authorized

to use CNHSA for limited services. Study inclusion and exclusion criteria are listed in Table 1. Patients diagnosed with end-stage renal disease (ESRD) were excluded due to the unreliability of A1C and numerous changes to medication that often take place in the setting of ESRD.[18] Patients who were only dispensed insulin were excluded due to difficulty calculating an accurate measure of insulin engagement.[19]

## Setting

CNO consists of an 11,000 square mile area that includes 10.5 counties in Southeastern Oklahoma.[20] There are over 225,000 Choctaw Nation enrolled tribal members.[21] The CNHSA consists of a 44-bed hospital, 8 outlying clinics, and pharmacies with a service area spanning 10.5 counties.[22,23]

## Data Extraction

CNHSA staff members extracted a dataset that included the International Classification of Diseases, Tenth Revision (ICD-10) codes,[24] sociodemographic data, laboratory A1C values, pharmacy dispensing data, and T2DM-related health care visit information. Except for zip codes, the data were de-identified.

## Measures

**Medication engagement.—**PDC was used to assess engagement to medications in 2020. PDC was analyzed as a continuous variable with a range of 0–1. The PDC threshold endorsed by the Pharmacy Quality Alliance was used: ≥80% engaged and <80% not engaged.[25] PDC is one of the primary engagement measures for research and is considered a more conservative measure of medication engagement than another widely used measure called Medication Possession Ratio (MPR) since it does not include overlapping days of medication.[26] Although an estimate of the proportion of days that patients have access to a medication over a specified period of time, variation in approaches to calculating PDC may yield different outcomes.[27,28]

Medication engagement was calculated for patients who were dispensed non-insulin glucose-lowering medication through CNHSA pharmacies. The TEN-SPIDERS tool was used to develop the PDC parameter definitions that were adapted for this study and outlined in Table 2.[29]

**A1C levels.—**Glycemic status was assessed using reliable and validated EHR-derived laboratory values.[30] The mean 2020 A1C value for each patient was used as the baseline measure of A1C (health status indicator) while the mean of the 2021 A1C value was used as the outcome variable.

**Determinants of Health.—**The dataset included the following modifiable and non-modifiable determinants of health including SDOH.

**SES.:** Medical Assistance (Medicaid status) as listed in the EHR for patients was used as a surrogate for SES. Medicaid status is a common proxy for SES in EHR-derived research. EHR data often offer limited self-reported SES measures.[31] An individual or family qualifies

for Medicaid if their income is at or below the 138% Federal Poverty Level (FPL), eligibility for which is determined by income and household size.[32] SES was defined as low (active Medicaid) or not low (no active Medicaid). Medicaid expansion benefits began in Oklahoma on July 1, 2021 for those with income at or below 138% of the FPL.[33] Therefore, each patient's final Medicaid status listed in the EHR in 2021 was used for this study.

**Driving distance to the nearest CNHSA primary care clinic.:** The 2021 EHR-derived individual zip codes were used to generate the geographic centroid of each zip code at baseline.[34] The geographic centroid of each zip code, in turn, was used to estimate the location of each patient's primary residence and the exact addresses for each CNHSA clinic. One way driving distance in miles to the nearest CNHSA clinic was calculated using Google Maps™ on the basis of the geocoded latitude and longitudes of individual zip codes and clinic addresses.[34]

**Frequency of visits with diabetes care and education specialists.:** The 2021 visit information was used to determine the number of diabetes care and education specialist visits for all patients in 2021.

**Frequency of T2DM-related primary care visits.:** The 2021 EHR-derived ICD-10 codes and visit information were used to determine the number of T2DM-related visits with a T2DM-related primary care provider for all patients in 2021. In CNHSA, both primary care providers and endocrinologists provide T2DM-related primary care. Some providers also worked in the Emergency Department (ED) so ED visits may also have been included in this calculation. Of note, minimal CNHSA telehealth visits occurred during the COVID-19 pandemic.

**Patient characteristics.—**Age, sex, and race was assessed using the first value in the 2021 EHR dataset.

## Statistical Analyses

Medication engagement and baseline A1C were assessed in 2020 while the remaining variables were assessed in 2021. Sex, age, and race were collected at baseline in 2021, mean A1C levels were collected in 2020 and 2021, and pharmacy dispensing records collected in 2020. The number of T2DM-related primary care and diabetes care and education specialist visits was collected in 2021, and the last recorded Medicaid status in 2021 was used to determine the SES variable.

All statistical analyses were performed using SAS software version 9.4. Descriptive statistics were used to describe the determinants of health and A1C levels. Chi-square tests of independence were used for categorical data. Continuous and ordinal data were examined using independent *t* tests, Pearson's correlations, and logistic regression. The association between PDC and A1C was assessed using a linear regression model while controlling for covariates. Statistical significance was set at a two-sided alpha of 0.05.

## Results

The study sample included 3,787 patients of 10,506 patients with T2DM in the 2017–2021 CNHSA EHR dataset. Of the 10,506 patients, those who met the following criteria were excluded: <18 years of age, a diagnosis of ESRD (N18.6), hyperglyceridemia (E78.1), a diagnosis of other specified diabetes mellitus (E13), a diagnosis of diabetes mellitus due to underlying condition with diabetic chronic kidney disease (E08.22). Medication engagement and baseline A1C were assessed in 2020 while the remaining variables were assessed in 2021. First, patients with data in 2021 were examined and after applying these exclusions, 8,244 patients remained with EHR data in 2021. An additional 217 patients who did not have valid zip code data in 2021 (2.6%), 2,721 patients who did not have a A1C level drawn in 2020 or 2021 (33%), and 1,519 patients who did not meet the criteria (Table 2) to have engagement measured for ≥1 non-insulin glucose-lowering medication in 2020 (18.4%) were excluded.

The sample was 53.2% female and 99.8% American Indian. Mean age was 59.0±12.5 years; 14.9% received Medicaid Assistance, indicating low SES. The average one-way commute to the nearest CNHSA primary care clinic was 31±77 miles with a median of 13.5 with an interquartile range of 3.9 to 28.9 miles. The mean number of primary care visits in 2021 was 3.0±1.9 and the mean number of diabetes care and education specialist visits in 2021 was 0.67±0.96. The mean PDC in 2020 was 0.8±0.2. More detailed descriptive statistics as well as descriptive statistics by PDC engagement levels (<0.8 versus ≥0.8) can be found in Table 3. The bivariate associations between medication engagement (PDC) and age, sex, SES, driving distance to the nearest CNHSA clinic, and number of primary care visits, were statistically significant (Table 3).

### A1C Levels

The mean 2020 A1C level was 8.0 (64 mmol/mol) ±1.8 with a range of 4.9% (30 mmol/mol) to 17.2% (164 mmol/mol). In 2020, 33% of the participants had a A1C of <7%, 42% had a A1C 7–9%, and a total of 25% had a A1C >9%. The mean A1C in 2021 was 7.9 (63 mmol/mol) ±1.7 (range 4.6% (27 mmol/mol) to 16.2% (154 mmol/mol)). Thirty-four percent of patients had a A1C of <7%, 44% had a A1C 7–9%, and a total of 22% had a A1C >9%.

### Engagement to Non-Insulin Glucose-Lowering Medications

The most frequently prescribed medication classes in 2020 were biguanides (81.1%), sulfonylureas (36.5%), and GLP-1 receptor agonists (17.0%) (Table 4). Patients were most likely to be engaged to DD4-inhibitors (72%) and meglitinides (71%) and least likely to be engaged to biguanides (62%) and alpha-glucosidase inhibitors (65%). The non-insulin glucose lowering medication classes with the highest mean PDC were DPP-4 inhibitors (0.84 ± 0.20) and TZDs (0.84 ± 0.19) and the medication with the lowest mean PDC were biguanides (0.80 ± 0.21).

### Determinants of Health, Medication Engagement, and A1C Levels

There was a weak, positive correlation between age and PDC (r=.21 $P$<.001). Also, a weak, negative correlation between age and 2020 mean A1C (r=−.17, $P$<.001) as well as age and

mean A1C in 2021 (r=−.15, $P$<.001), and a weak, positive correlation between age and number of primary care visits (r=.20, $P$<.001), were observed (Table 5). There was a weak, positive correlation between diabetes care and education specialist visits and primary care visits (r=.19, $P$<.001) and a weak, negative correlation with distance to the nearest clinic (r=−.12, $P$<.001). PDC was weakly, negatively correlated with both A1C in 2020 (r=−.23, $P$<.001) and with A1C in 2021 (r=−.24, $P$<.001). There was a strong, positive correlation between A1C in 2020 and in 2021 (r=.70, $P$<.001).

### Medication Engagement and A1C Levels

The association of medication engagement with A1C levels is described in Table 6. Nonengaged patients (PDC<0.8) had a higher mean A1C (8.42 (69 mmol/mol) ±1.98) compared to the mean A1C (7.65 (60 mmol/mol) ±1.46) for engaged patients (PDC≥0.8) ($P$<.001). Higher engagement was also associated with lower A1C levels (β=−.67, $P$<.001) in a linear regression model while adjusting for covariates (Table 7). Mean A1C in 2020, a proxy for prior T2DM severity, was positively associated with mean A1C levels in 2021 (β=.66, $P$<.001) while adjusting for other covariates. No determinants of health were significantly associated with mean A1C levels in 2021 adjusting for other covariates.

## Discussion

Medication engagement was associated with lower A1C levels in American Indian adults with T2DM receiving non-insulin glucose-lowering medication without copayments. These findings are consistent with our hypothesis as well as other studies.[35,36] The percentage of the sample that were not engaged (37.5%) was similar to the mean poor medication engagement rate (37.8%) in a metanalysis examining the association between engagement to glucose lowering medications and outcomes in patients with T2DM.[37] In our bivariate analysis, older age was weakly associated with increased engagement to non-insulin glucose-lowering medications. None of the included EHR-derived determinants of health were significantly associated with A1C after controlling for medication engagement.

The established engagement threshold of PDC ≥ 80% was used to assess the characteristics of patients engaged and not engaged to non-insulin glucose-lowering medication. Evidence supports that patients who achieve or surpass this threshold have lower hospitalization rates as well as lower health care costs overall.[38,39] Consistent with the hypothesis, patients who met or exceeded the threshold for engagement had an older mean age. Also consistent with the hypothesis, a lower proportion of women were engaged compared to men. This finding is consistent with some prior studies but overall the evidence is generally inconclusive.[11,13,40] The proportion of patients that were engaged versus not engaged was similar for patients deemed low SES, whereas a much larger proportion of patients with higher SES were engaged versus not engaged. Higher income may be a facilitator of medication engagement.[13,40]

Although there was a weak correlation between distance and medication engagement, living close to a CNHSA clinic was weakly associated with lower engagement to non-insulin glucose-lowering medication. This finding suggests that a longer driving distance was not associated with lower medication engagement in the sample. This lack of association may

be attributed to the availability of a mail-order pharmacy option at CNHSA, which has been associated with medication engagement in previous studies.[40] Further analysis is needed to examine engagement for those who use mail-order pharmacy services compared to those who pick up medications. Patients with ≥3 primary care visits were more likely to be engaged than those with fewer (≤2) visits. A possible explanation may be that more frequent T2DM-related primary care visits provide opportunities to optimize treatment or provide education, which may facilitate engagement. While we expected patients with diabetes care and education specialist visits to have higher medication engagement, we found a similar proportion of those with at least one diabetes care and education specialist visit were engaged compared to those without a diabetes care and education specialist visit. This may be due to diabetes care and education specialist referrals are often for patients who have A1C levels above target or need T2DM-related education.[41] The facilitators and barriers of medication engagement should be assessed from the patient perspective in future studies in the context of the local community.

The most commonly prescribed non-insulin glucose-lowering medication classes were biguanides, sulfonylureas, and GLP-1 receptor agonists. The finding that GLP-1 receptor agonists are a commonly dispensed medication is consistent with more recent medication guidelines for patients with T2DM.[42] Patients were most engaged to DPP-4 inhibitors, which are generally well-tolerated medications.[43] The medication class with the lowest percentage that met the engagement threshold was biguanides. A metanalysis noted similar findings and partly attributed low engagement to metformin to gastrointestinal side effects and high engagement to DPP-4 inhibitors to fewer side effects.[44]

## Limitations

In addition to medication engagement, other factors that affect A1C including diet and exercise could not be assessed in a retrospective study using EHR data. The data spanned the height of the COVID-19 pandemic, which likely affected the typical number of patient encounters, medication engagement, laboratory draws (A1C levels) as well as primary care provider and diabetes care and education specialist visits. Minimal telehealth visits were conducted due to unreliable internet service. Many patients in the sample were excluded which may have reduced the representativeness of the sample. SES is a multidimensional construct and using Medicaid status may not have captured all patients who would otherwise be considered having low SES. This approach does not include patients who qualify for Medicaid but do not receive benefits, although it is not clear how prevalent this is in the CNHSA patient population. Due to the Medicaid expansion, many patients were newly eligible and may have not yet enrolled. Also, American Indian and Alaska Native people may be at increased risk for some barriers to Medicaid enrollment such as limited access to internet or as skepticism towards governmental programs.[45] One limitation to engagement measures based on prescription refill data, like PDC, is that it cannot be confirmed from the EHR that the medication was consumed, only that the medication was picked up from the pharmacy.[46] Necessary assumptions in the operationalization of PDC (Table 2) were made which may affect the accuracy of the PDC calculation. The exclusion of patients taking only insulin and not assessing engagement to insulin, limits the generalizability of the findings.

We also did not have access to hospitalization data or survival data. It is possible that some gaps in engagement were due to hospitalizations.

There are many determinants of health not addressed due to their limited availability in EHR data. Specifically, housing and food insecurity and adverse SDOH collectively were associated with worse engagement to medication in a recent meta-analysis.[2] There is evidence that incorporating individual-level SDOH into the EHR can aid in improving medication engagement.[47] Future studies should focus on integrating SDOH into EHR systems in a culturally and linguistically manner appropriate to the local community.[48]

## Conclusion

Engagement to non-insulin glucose-lowering medications was associated with lower A1C levels among patients receiving medication and health services without copayments from a Tribal health care system. Future studies should compare these findings to other years unimpacted by the COVID-19 pandemic. In the bivariate analysis, older age was weakly associated with engagement to non-insulin glucose-lowering medications, which is consistent with previous literature. No determinants of health were significantly associated with A1C levels. Future studies may need to go beyond the EHR to examine additional SDOH such as access to food, quality of care, transportation, and housing. This study helps to guide future research on determinants of health, medication engagement, and A1C levels in American Indian adults with T2DM using rural Tribal health care systems.

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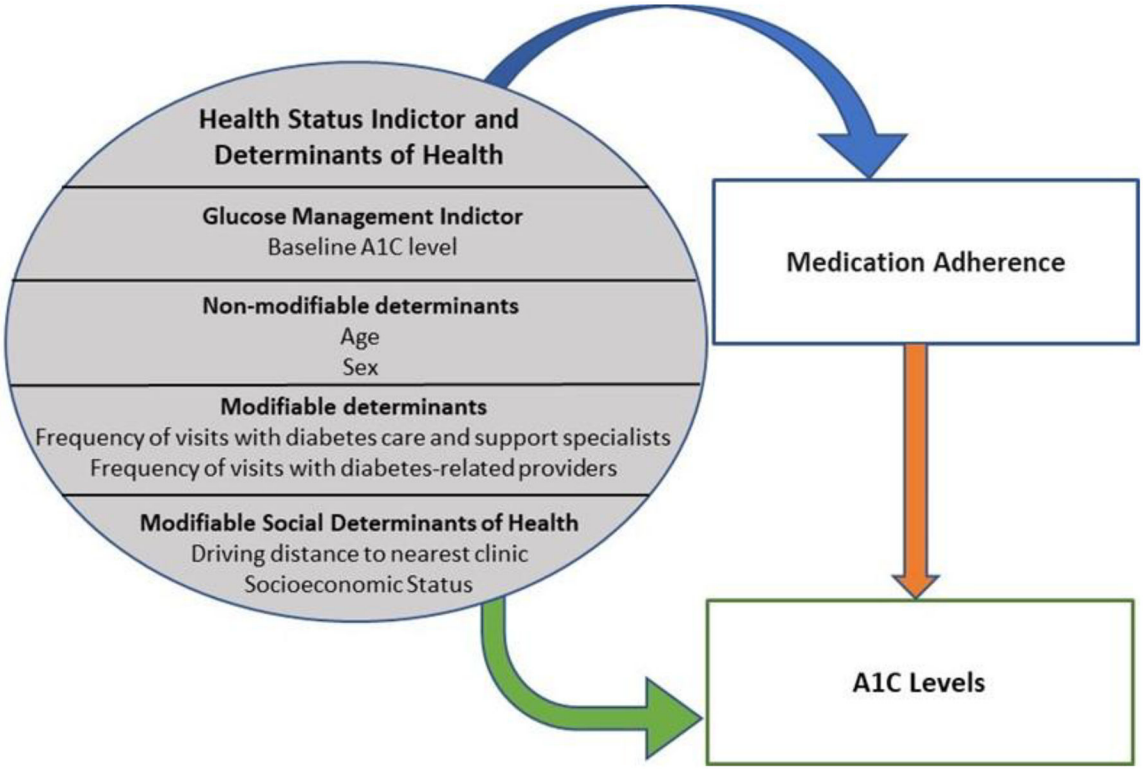


**Figure 1. Conceptual Framework.**
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**Table 1.**

Inclusion and Exclusion criteria.

| Inclusion criteria | Exclusion criteria |
|---|---|
| Patients 18 years or older | Patients diagnosed with end-stage renal disease (ESRD) |
| Dispensed ≥1 non-insulin glucose-lowering medication in 2020 from CNHSA pharmacy<br>Met the TEN-SPIDERS-derived criteria (Table 2)[29]<br>Patients dispensed insulin in addition to other non-insulin glucose-lowering medication were included but engagement to insulin was not calculated | Patients with a diagnosis code of pure hyperglyceridemia, other specified diabetes mellitus, and diabetes mellitus due to underlying condition with diabetic chronic kidney disease<br>Patients who were only dispensed insulin |

**Table 2.**

Approach used to calculate the medication engagement measure called the proportion of days covered (PDC) using the TEN-SPIDERS tool.[29]

| Parameter | Our Definition |
|---|---|
| Threshold | • PDC was analyzed as a continuous variable with a range of 0–1<br>• Threshold: ≥80% engaged; <80% not engaged |
| Eligibility criteria for inclusion in sample | • At least one non-insulin glucose-lowering medication dispensed between 1/1/20–12/31/20<br>• ≥180 calendar days of non-insulin glucose-lowering medication (does not need to be consecutive dispensing) per instance to be included<br>• Excluded non-insulin glucose-lowering medications prescribed less than <28 days<br>• Gaps of >365 days constitute the beginning of a new engagement period |
| Numerator and denominator | • Engagement was calculated for each non-insulin glucose-lowering medication a patient was taking using the below numerator and denominator<br>• Numerator: the number of days each medication dispensed between the first and last dispensing in 2020<br>• Denominator: the number of days between the first and last medication dispensed in 2020 plus the accumulated days supplied from the last medication dispensed in 2020<br>• Mean engagement was then calculated for patients taking ≥1 medication(s) |
| Survival | • No access to survival data |
| Pre-supply | • A 30-day look back period was used for previous users of medication. The look back period will be 12-1-2019 thru 12-31-2019. Any unused medication supplied at the start of the observation period from the 30-day look back period will be carried over and included in the PDC numerator and denominator. |
| In-hospital supply | • No access to hospitalization data |
| Dosing information | • Medication, dose, quantity, and days supplied were available |
| Early refills | • Early refills of the same medication could be used at any point in the measurement period |
| Switching | • Carryover was not granted for dose changes, switches to another medication in the same class, or a switch to a fixed combination therapy with a medication from the same class. It is assumed the remainder of the previous prescription was discarded. It is also assumed the previous medication will be discarded if there is a dose adjustment. |

**Table 3.**

Sample characteristics by mean proportion of days covered (PDC) calculated for each patient in 2020 (N=3787).

| | | 2020 Mean PDC | | |
|---|---|---|---|---|
| **Characteristics *n* (%)** | **Total *n* (%)** | **<0.8** | **≥0.8** | ***P*-value** |
| Total patients | 3787 | 1422 (37.5) | 2365 (62.5) | |
| Age (y) mean (SD) | 59.0 (12.5) | 56.0 (12.9) | 60.9 (11.8) | <0.001[a] |
| Patient sex | | | | <0.001[b] |
| Female | 2016 (53.2) | 811 (40.2) | 1205 (59.8) | |
| Male | 1771 (46.8) | 611 (34.5) | 1160 (65.5) | |
| Race[c] | | | | |
| American Indian | 3778 (99.8) | 1419 (37.6) | 2359 (62.4) | |
| Other[d] | 7 (0.2) | 2 (28.6) | 5 (71.4) | |
| SES | | | | <0.001[b] |
| Low SES | 565 (14.9) | 275 (48.7) | 290 (51.3) | |
| Not low SES | 3222 (85.1) | 1147 (35.6) | 2075 (64.4) | |
| Driving distance to nearest clinic | | | | <0.001[e] |
| <5 miles | 1536 (40.6) | 637 (41.5) | 899 (58.5) | |
| 5–<25 miles | 1173 (31.0) | 412 (35.1) | 761 (64.9) | |
| 25–<50 miles | 556 (14.7) | 201 (36.2) | 355 (63.8) | |
| ≥50 miles | 522 (13.8) | 172 (33.0) | 350 (67.0) | |
| PC visits per year | | | | <0.001[e] |
| 0 | 160 (4.2) | 66 (41.2) | 94 (58.8) | |
| 1–2 | 1540 (40.7) | 642 (41.7) | 898 (58.3) | |
| 3–5 | 1696 (44.8) | 584 (34.4) | 1112 (65.6) | |
| >5 | 391 (10.3) | 130 (33.2) | 261 (66.8) | |
| DCES visits | | | | 0.18[b] |
| Yes | 1800 (47.5) | 656 (36.4) | 1144 (63.6) | |
| No | 1987 (52.5) | 766 (38.6) | 1221 (61.4) | |

Abbreviations: DCES, diabetes care and education specialist; PC, primary care; SES, socioeconomic status.

[a] Independent *t*-test.

[b] Chi-Square test.

[c] 2 participants' data were missing.

[d] Limited services available to non-eligible patients.

[e] Logistic Regression.

**Table 4.**

Non-insulin glucose lowering medications dispensed and medication engagement in 2020.

| | | PDC in 2020 | |
|---|---|---|---|
| **Medication class** | **Medications dispensed, *n (%)*** | **% ≥0.80[a]** | **Mean ± SD** |
| Alpha-Glucosidase Inhibitors | 40 (1.1) | 65% | 0.83±0.17 |
| Biguanides | 3073 (81.1) | 62% | 0.80±0.21 |
| DPP-4 Inhibitors | 629 (16.6) | 72% | 0.84±0.20 |
| GLP-1 Receptor Agonists | 645 (17.0) | 67% | 0.81±0.20 |
| Meglitinides | 17 (0.4) | 71% | 0.83±0.24 |
| SGLT-2 Inhibitors | 203 (5.4) | 70% | 0.83±0.20 |
| Sulfonylureas | 1381 (36.5) | 66% | 0.82±0.20 |
| TZDs | 481 (12.7) | 69% | 0.84±0.19 |

Abbreviations: PDC, proportion of days covered; TZDs, Thiazolidinediones.

[a]PDC≥0.8=threshold for medication engagement.

**Table 5.**

Correlations among study variables.

| | Age | Distance to nearest clinic[a] | PC visits | DCES visits | 2020 mean A1C | 2021 mean A1C |
|---|---|---|---|---|---|---|
| Distance to nearest clinic[a] | .02 | | | | | |
| PC visits | .20*** | −.07*** | | | | |
| DCES visits | .02 | −.12*** | .19*** | | | |
| 2020 mean A1C | −.17*** | −.03* | .10*** | .16*** | | |
| 2021 mean A1C | −.15*** | −.05** | .06*** | .14*** | .70*** | |
| 2020 PDC | .21*** | .06*** | .08*** | .009 | −.23*** | −.24*** |

Abbreviations: DCES, diabetes care and education specialist; PC, primary care; PDC, proportion of days covered.

[a]log transformed.

*$P < 0.05$;

**$P < 0.01$;

***$P < 0.001$.

**Table 6.**

Association between medication engagement and A1C levels.

| PDC[a] | *n* (%) | 2021 A1C (Mean±SD) | 95% CI | *P*-value |
|---|---|---|---|---|
| <0.80 | 1422 (37.5) | 8.42 (69 mmol/mol) ±1.98 | (8.32,8.53) | <0.001[b] |
| ≥0.80 | 2365 (62.5) | 7.65 (60 mmol/mol) ±1.46 | (7.59,7.71) | |

Abbreviations: PDC, proportion of days covered.

[a] PDC≥0.8=threshold for medication engagement.

[b] Independent *t*-test.

**Table 7.**

Association between a health status indicator (2020 mean A1C), medication engagement, determinants of health, and 2021 A1C levels.

| Health status indicator, medication engagement & determinants of Health | Estimate | SE | *t* | *P*-value |
|---|---|---|---|---|
| 2020 mean A1C | 0.659 | 0.012 | 55.4 | <0.001 * |
| 2020 PDC | −0.667 | 0.102 | −6.54 | <0.001 * |
| Age | −0.003 | 0.002 | −1.62 | 0.105 |
| Female sex | −0.036 | 0.040 | −0.91 | 0.363 |
| Male sex[a] | | | | |
| Not low SES | −0.043 | 0.057 | −0.74 | 0.459 |
| Low SES[a] | | | | |
| Nearest clinic <5 miles | 0.082 | 0.063 | 1.30 | 0.195 |
| Nearest clinic 5–<25 miles | 0.035 | 0.065 | 0.54 | 0.590 |
| Nearest clinic 25–<50 miles | −0.033 | 0.075 | −0.44 | 0.663 |
| Nearest clinic ≥50 miles[a] | | | | |
| No PC visits | −0.110 | 0.116 | −0.95 | 0.343 |
| 1–2 PC visits | −0.013 | 0.071 | −0.19 | 0.852 |
| 3–5 PC visits | −0.018 | 0.069 | −0.26 | 0.796 |
| >5 PC visits[a] | | | | |
| No DCES visits | −0.072 | 0.041 | −1.77 | 0.773 |
| DCES visits[a] | | | | |

Abbreviations: DCES, diabetes care and education specialist; PC, primary care; PDC, proportion of days covered; SES, socioeconomic status.

[a]reference group.

*$P$<0.05.