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Financial, Occupational and Physical Challenges and Blood Glucose Monitoring in Type 2 Diabetes

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Abstract

Background: Blood glucose monitoring effects are changing for people living with type 2 diabetes. However, there is a lack of recent data surrounding financial, occupational, or physical stressors that affect the adherence of diabetes self-management practices. This article looks to examine specific financial, physical, and occupational challenges in adherence to blood glucose monitoring in type 2 diabetes.

Methods: Data from the National Health and Nutrition Examination Survey (NHANES) 2017–2020 Pre-Pandemic data of adults 18+ were analyzed. These data were used to examine the relationships between insurance coverage, health status, occupation, and self-monitoring of blood glucose levels in the United States.

Results: This study found that respondents had a statistically significant association with five variables: prescription drug coverage (in-part or full), occupation status, gender, age, and three race subcategories (non-Hispanic White, Black, and Other-Multiracial) with blood glucose monitoring.

Conclusion: This study may help certified health education specialists (CHES) and diabetes care and educator specialists (DCES) to better identify which groups of individuals are at highest risk for poor adherence to specific blood glucose monitoring in type 2 diabetes.

Keywords

chronic disease management, disease management, health insurance, health literacy, health outcomes

Introduction

In 2017 alone, there was an estimated cost of 327 billion dollars spent on diagnosed diabetes in the United States.[1] In fact, 1 in every 4 dollars associated with healthcare is attributed to diabetes care.[1] In a survey conducted by SingleCare, it is approximated that 54% of individuals paid for their diabetes care out-of-pocket.[2] Generally, those afflicted with diabetes have medical expenses more than twice as high, compared to those not diagnosed with diabetes.[1] Further, those that are uninsured with diabetes are less likely to seek medical advice, and less likely to perform daily blood glucose monitoring, than those with private health insurance.[3]

There is no overall cure for diabetes; although, it can be managed to a near cure, accounting for different types of diabetes, duration of how long an individual has had the disease and the severity of the disease. However, individuals diagnosed with the disease can undertake measures to prevent diabetes complications and manage their condition by engaging in self-management practices. Self-management practices refer to an individual's role in managing their chronic disease through methods of support and prevention. One way to prevent diabetes complications is through the use of blood glucose monitoring.

The American Diabetes Association self-management "gold standard" recommendation consists of monitoring blood glucose levels two to three times per day.[4] Blood glucose monitoring requires lancing the fingertip to obtain a drop a blood sample that is applied to a test strip and inserted in a glucose

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meter device for measurement reading. By self-monitoring blood glucose, patients can assess their level of hyperglycemia or hypoglycemia, potentially leading them to make lifestyle modifications.[3]

According to Vincze et al.,[5] of those diagnosed with type 2 diabetes, slightly over half (52%) were considered adherent to self-monitoring of their blood glucose. Moreover, Ruggiero et al. reported there is a separation across age categories in diabetes self-management practices, where blood glucose monitoring increased with age.[6]

The relationship between occupational status, financial status, and insurance coverage among those diagnosed with type 2 diabetes and the adherence to blood glucose monitoring has not been adequately studied. Therefore, exploring the potential contributory factors that affect the adherence to diabetes self-management, especially factors that an individual may not think about (financial status, occupation status, etc.) is the key to preventing potential diabetes complications.

This study was designed to analyze the relationships among specific financial and occupational challenges and adherence to blood glucose monitoring in the United States. In doing so, this article looks to inform Certified Health Education Specialists (CHES) and Diabetes Care and Education Specialists (DCES) professionals identify which groups of individuals are at highest risk for poor adherence to specific blood glucose monitoring.

Survey Design and Data Collection

This was a cross-sectional study using archival NHANES subset data from 2017 to 2020 pre-pandemic data cycle to examine the relationships among insurance coverage, occupation, general health condition, and adherence to blood glucose monitoring among individuals over the age of 18 living in the United States with diagnosed diabetes. The NHANES datasets consist of a multitude of surveys that provide a comprehensive assessment of the American population pertaining to nutrition and health. The NHANES data provided information on health and nutrition status, select chronic diseases, and health and nutrition behavior practices of approximately 5000 adults every year in the United States (Figure 1).

Study Variables

Outcome Variable. The outcome of interest in this study was blood glucose monitoring. This numeric variable was derived from the question "How often check blood for glucose/sugar"? Those that responded as having checked their blood glucose at least once was factored into the analyses. Individuals that marked never, had missing data or refused to answer were excluded.

Independent Variables. The primary independent variables were insurance and prescription coverage, general health condition, number of times having seen a physician in the past 12 months, occupation status, age, gender, and race.

Statistical Analysis

Study sample characteristics were described by means and standard deviation for age and frequencies for categorical variables for the total population.

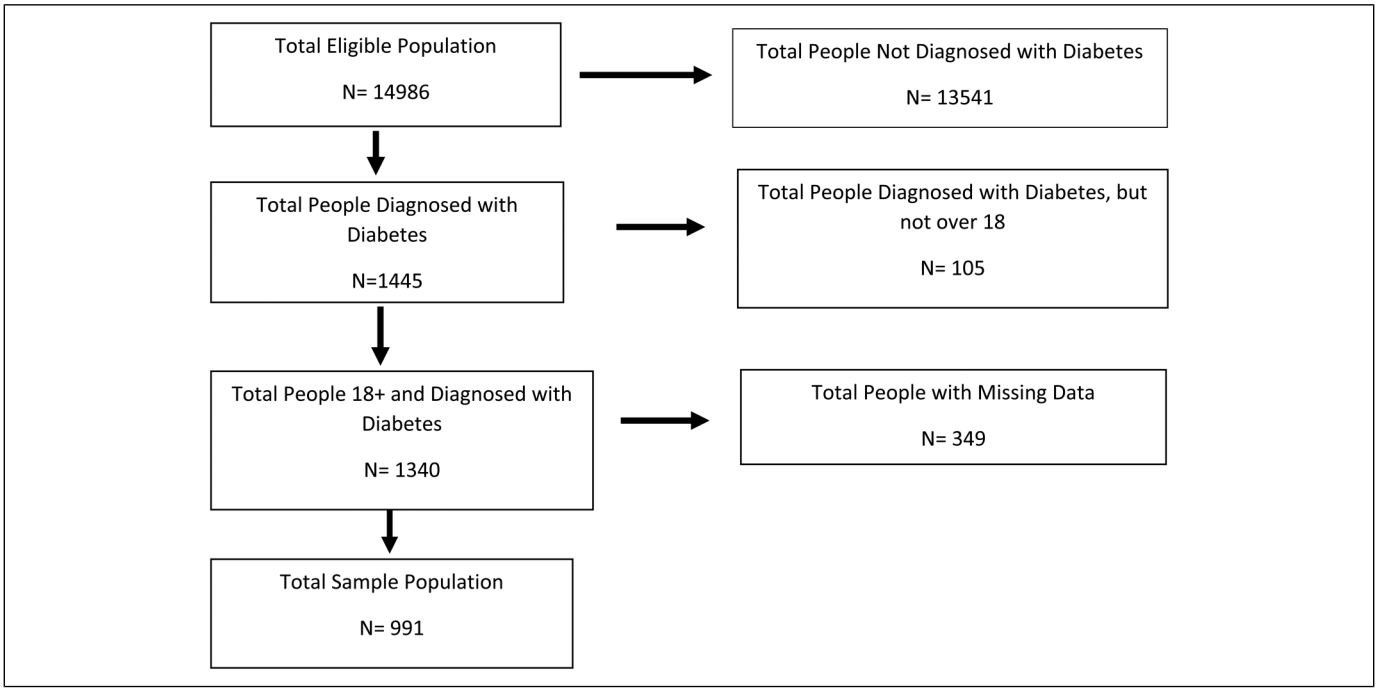

Figure 1. Flowchart of study population.

Weighted negative binomial regressions were used for assessing all variables to account for overdispersion in the dataset given the outcome count variable. Negative binomial regression was conducted to analyze the relationships between individuals 18+ and insurance coverage, general health condition, occupation status, and self-monitoring of blood glucose levels. All estimated and statistical tests which were weighted to adjust for the complex NHANES survey design and to produce a more nationally representative estimate for the US population. A p-value <0.05 was considered statistically significant in this study. Additionally, the Benjamini–Hochberg procedure was utilized to safeguard against false findings in our results. All analyses were performed using SAS v9.4 (Research Triangle Park, NC).

Results

Descriptive statistics are presented in Table 1. There were 473 men (47.7%) and 518 women (52.3%). The mean age of respondents was 38 (0.82) years of age. The majority of respondents reported their health status as good (29.2%) to very good or excellent (51.8%), with fair or poor health reported by 15.6% and 3.4%, respectively. Overall, blood glucose monitoring was reported by 99.3% of respondents. The bulk of respondents (87.9%) stated that they actually have insurance, while of that percentage, 94.7% health insurance covers any part of a prescription. Many respondents (91.5%) reported to have seen a physician between one and five times in the past 6 months. Largely those surveyed were unemployed (50.5%).

Table 2 presents the results of the weighted negative binomial regressions performed in this study. The variable subcategories listed as having "-" were used as reference categories for the analysis. Individuals 18 and older had a statistically significant relationship with the prescription drug coverage, having a job, age, gender, and three categories of race/ethnicity (White, Black, and Other-Multiracial). It was found that between having insurance and blood glucose measurement was not statistically significant ($p = .59$) and 25% less often to check their blood glucose compared to those who do not have insurance. However, if the insurance covered at least part of a prescription, it was found was deemed to have a statistically significant positive association ($p = .04$) and were 150% more often to engage in blood glucose monitoring compared to their non-prescription coverage counterparts. General health status proved to be non-statistically significant in every subcategory of health among the respondents ($p > .05$). However, those who deemed themselves in fair or good health were 189% and 197%, respectively, more often to engage themselves in blood glucose monitoring. In contrast, self-reported poor and very good individuals were 9% and 25%, respectively, and were less often to engage themselves in checking their blood glucose levels. In addition, individuals did not have a significant relationship with having seen a physician in the past twelve months if they were seen less than six times ($p = .11$), although it did show this group to be 148% more often to engage in blood glucose monitoring. In the type of job category, there was a negative statistically significant association between having a job and this study population ($p < .0001$), where those that were employed were less often to engage themselves in blood glucose monitoring, compared to being unemployed (IRR = 0.49). Those that were documented as having been non-Hispanic White (IRR = 1.51, $p = .01$), Black (IRR = 2.51, $p < .0001$), or Other-Multiracial (IRR = 5.60, $p < .0001$) were all statistically significant, while being an unknown ($p = .07$) or being another Hispanic race ($p = .24$) were deemed non-significant. Further, those who identified as Hispanic race (IRR = .78) and unknown race (IRR = .63) were also less adherent to engaging in blood glucose monitoring. Moreover, this data shows that non-Hispanic Whites are 51% more often to be engaged in blood glucose monitoring. Also, non-Hispanic Black and Other-Multiracial individuals are the most often to be adherent to blood glucose monitoring, where those groups are 151% and 560%, respectively. Furthermore, gender and age were both statistically significant ($p < .0001$), with younger-aged individuals being slightly negatively associated and less often to check their

Table 1. Descriptive Statistics of Variables.

Variable	Value	N	%	Mean (years)	SD (years)
Age		991		38	0.82
Gender	Male	473	47.7		
	Female	518	52.3		
Race/Ethnicity	Mexican American	120	12.1		
	Other Hispanic	114	11.5		
	Non-Hispanic White	343	34.6		
	Non-Hispanic Black	251	25.3		
	Other Race—Including Multiracial	100	10.1		
	Unknown	63	6.3		
Covered by insurance	Yes	871	87.9		
	No	120	12.1		
Does it cover any part of prescription	Yes	938	94.7		
	No	53	5.3		
General health condition	Excellent	259	26.1		
	Very good	255	25.7		
	Good	288	29.2		
	Fair	155	15.6		
	Poor	34	3.4		
Have you seen a doctor in past 12 months?	1–5 times	907	91.5		
	6+ times	84	8.5		
What type of job working	Has a job	491	49.5		
	Does not have a job	500	50.5		

This table describes the frequencies of each of the independent variables and their subcategories studied.

Table 2. Negative Binomial Regressions.

Variable $n = 991$	Estimate	95% CI	IRR	*p*-Value
Covered by insurance: 'Yes'	−0.285	[−1.315, 0.744]	0.75	.59
Covered by insurance: 'No'	–	–	–	–
Do plans cover prescriptions: 'Yes'	0.403	[0.022, 0.785]	1.50	.04
Do plans cover prescriptions: 'No'	–	–	–	–
General health condition				.17
Very good	-0.289	[-1.014,0.438]	0.75	.44
Good	0.637	[-0.063, 1.336]	1.89	.07
Fair	0.675	[-0.025, 1.375]	1.97	.06
Poor	-0.098	[-0.840, 0.643]	0.91	.8
Excellent	–	–	–	–
#Times receive healthcare over 12 months				
1–5 times	0.389	[-0.089, 0.866]	1.48	.11
6+ times	–	–	–	–
Type of work done last week				
Has a job	-0.713	[-0.907, -0.519]	0.49	<.0001
Does not have a job	–	–	–	–
Race/ethnicity				.04
Other Hispanic	-0.246	[-0.656, 0.163]	0.78	.24
Non-Hispanic White	0.412	[0.104, 0.721]	1.51	.01
Non-Hispanic Black	0.920	[0.573, 1.268]	2.51	<.0001
Other Race—Including Multiracial	1.722	[1.321, 2.123]	5.60	<.0001
Unknown	-0.460	[-0.954, 0.035]	0.63	.07
Mexican American	–	–	–	–
Age	-0.033	[-0.040, -0.026]	0.97	<.0001
Gender				
Female	0.409	[0.232, 0.587]	1.51	<.0001
Male	–	–	–	–

This table describes regression coefficients, 95% confidence intervals, exponential regression coefficient and *p*-values of independent variables included in weighted negative binomial regression. Abbreviations: – = Reference Category from Regressions.

blood glucose (IRR = .97) and gender being moderately positively associated and with women more often to check their blood glucose (IRR = 1.51).

Discussion

This study focused on U.S. adults diagnosed with diabetes to determine the relationship between financial, occupational, and physical challenges or stressors and adherence to blood glucose monitoring. This study aimed to determine relationships between blood glucose monitoring among those 18+ years of age, with regards to insurance coverage, general health status, and occupation.

This study found 18+ aged respondents had an association with five variables: prescription drug coverage (in-part or full), occupation status, gender, age, and three race subcategories (White, Black, and Other-Multiracial) and blood glucose monitoring.

The results from this study are similar to that of Harris, where those uninsured had was a higher proportion of diabetes complications, such as glycosuria and hyperglycemia.[7] Moreover, it mirrors complaints of participants in Adu et al. and Casagrande and Cowie, where financial burden, due to lack of insurance was a large contributor to lack of adherence in blood glucose monitoring.[8,9] In addition, the data from this study does agree with the findings of Mehrotra et al. where it was found there was a concrete relationship between occupational status and blood glucose monitoring.[10] This is corroborated by the results showing the employment variable had a negative impact on adherence among study population. However, participants in Adu et al. study, were reported as having commented that it wasn't the occupational status, rather what sector of the workforce accounted for their lack of adherence to diabetes self-management.[8] Furthermore, Mostrom et al. found adherence to be low when all supplies for monitoring are provided free of charge by the Swedish healthcare system so finances alone will not explain it.[11]

In summary, there are many at-risk groups that have been identified as a heightened threat for non-adherence to their blood glucose monitoring regimen. Those include employed individuals, those that are covered by their insurance, individuals that believe they are in very good health, and those of a Hispanic or Unknown race. The findings of this study may assist health education specialists and diabetes care education specialists to identify which sociodemographics or at-risk groups are at a heightened threat for poor adherence to diabetes self-management, specifically blood glucose monitoring. This new knowledge will be useful to create a specific plan for these high-risk non-adherent individuals designed to prioritize lifestyle modifications and adherence in checking blood glucose levels more frequently, while curtailing the increased likelihood for diabetes complications. Moreover, a CHES/DCES can provide linkage to care to a community-based organization that can assess and monitor an individual's blood glucose levels on a more routine basis. In addition, linking a social worker to an at-risk individual can be useful given the heightened predisposition to non-adherence of blood glucose monitoring and potential issues with insurance or prescription coverage. All of these intervention strategies should be utilized to combat diabetes complications as these can manifest in numerous forms such as: Uncontrolled high blood glucose can produce diabetic ketoacidosis and coma (short-term complications) and heart disease, stroke, kidney failure, damage to the eyes, and a variety of infections (long-term complications).[12,13]

In addition, targeted approaches towards the youngest age demographic is warranted, given that prescription drug coverage has a significant relationship with adherence to blood glucose monitoring; thus, it is imperative that sustained coverage is maintained throughout a lifetime. This is due to the

likelihood of severe diabetes complications if those diagnosed with diabetes are not adherent to self-management practices from early onset diagnoses.

Moreover, maintenance of physical health is vital in the elderly age population, specifically pertaining to adherence of blood glucose monitoring. With this age population being the most at-risk for developing diabetes and the most susceptible to severe complications, it is crucial that prevention efforts and physical well-being are maintained to ensure strong adherence to blood glucose self-management.[14,15]

Finally, while utilizing CHES and DCES may be an excellent strategy to augment poor adherence to blood glucose monitoring, education does not necessarily resolve financial issues that an individual may face. Therefore, given the results of this study, it is imperative for legislators to know that paying for blood glucose monitoring services might lower overall costs to taxpayers. Healthcare can become quite costly to the taxpayer; thus, if specific allocation of funding is made for these services, it may increase adherence to diabetes self-management. In doing so, making diabetic individuals healthier and experiencing less diabetes-related complications, while reducing taxpayer costs for healthcare.

There are several limitations to this study. The cross-sectional nature prevents the establishment of causality. The major limitation is that the respondents are not randomly selected and are not geographically representative of the United States. The self-report format of the NHANES questionnaire could potentially lead to inaccuracies of results, which may threaten the validity of the findings. This is especially true for self-reported diagnosis of diabetes, undiagnosed diabetes or prediabetes and self-management practices. Further, there is a considerable number of unemployed persons in this sample. This category was dichotomized to include: retired, disabled and not having a job into one subcategory; thus, this may inflate the true number of unemployed persons. Finally, those that were marked for checking their blood sugar at least once, were considered adherent to diabetes self-management practices. This might inflate numbers of those that are truly adherent to checking their blood glucose.

Moreover, further research is necessary to explore specific occupations to assess potential relationships among different sectors of the workforce and their potential effects those occupations may have on adherence to blood glucose monitoring. In addition, the specific type of insurance an individual carries is a potential key element in extrapolating the barriers of adherence to diabetes self-management. Furthermore, conducting a geographically nationally representative sample would be useful in determining the needs of certain geographical areas of the United States and the general populations of the United States.

Conclusions

This study found that respondents had a statistically significant association with five variables: prescription drug coverage (in-part or full), occupation status, gender, age, and three race subcategories (White, Black, and Other-Multiracial) with blood glucose monitoring.

With the number of individuals diagnosed with diabetes rises with time, this study exemplifies that there are numerous financial, occupational, and physical challenges that may not be considered factors contributing to adherence to diabetes self-management, specifically blood glucose monitoring, in an individual living with diabetes. Intervention and mitigation methodologies are warranted to limit the disparity in contributory variables in the lack of adherence to diabetes self-management, specifically blood glucose monitoring.

These data may be useful for health professionals, such as: CHES and DCES to recognize which sociodemographic groups of individuals are at heightened predisposition for poor adherence to diabetes self-management practices specifically blood glucose monitoring. Moreover, promoting interventional strategies, such as diet, physical activity or medication adherence must be stressed to convey the overall importance of self-monitoring blood glucose levels, irrespective of financial, occupational, and physical challenges.

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