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Influence of Diabetic Kidney and Eye Complications on Annual Health Expenditures using the Medical Expenditures Panel Survey 2012-2016

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Abstract

Background

Diabetes is a critical chronic disease that has exerted considerable health and economic influence on the United States population. Although diabetes has imposed a considerable economic burden on health systems worldwide, the incremental economic effect of certain diabetic complications has not been extensively studied and quantified. The aim of this study is to quantitatively define the economic burden resulting from the presence of diabetic eye and kidney complications.

Methods

Data was analyzed from the Medical Expenditure Panel Survey (MEPS) 2012-2016 to provide an updated evaluation on the association between several forms of annual health expenditures and the presence of diabetic kidney and eye complications. Demographic qualities of the U.S. diabetic population were analyzed by presenting weighted percentages according to complication status. Total expenditures and several component sources were analyzed by presenting mean and standard error of spending. A multivariable regression was used to evaluate effects from comorbidities and complications on total, out of pocket, and prescription-based annual spending. Out of pocket and prescription spending were chosen as supplement models to characterize the individual patient burden.

Results

Diabetic complications were more common among the elderly, Non-Hispanic Black and Hispanic individuals, and those with related comorbid diseases. Increased spending due to the presence of these diabetic complications was generally observed in trends of total annual expenditures as well as several component sources of spending. Total annual spending increased by 74% among those with kidney complications, while

the presence of eye complications was associated with a 33% increase. Diabetic kidney complications were associated with a 54% increase in annual out of pocket spending, while eye complications led to a 15% increase. Annual prescription spending was elevated by 66% in those with kidney complications, and increased by 36% among patients with diabetic eye complications.

Conclusions

This analysis clearly illustrates that the economic difficulty patients with diabetic complications requires targeted interventions. It is also demonstrated that these measures are likely to benefit those who are older and possess other related chronic comorbidities. The presence of diabetic kidney and eye complications generally led to increases among many components of health spending, often with the most considerable elevation among those with both conditions. More specifically, notable increases in out of pocket and prescription expenditures suggest that alleviation of the personal financial difficulty may be most critical when implementing reform to benefit these patients.

Background:

Diabetes is a chronic condition affecting approximately 30.3 million individuals in the United States. This influence comprises an estimated 9.4% of the total population, with an estimated 7 million total hospital discharges in the United States reported among adults with a diabetes diagnosis [1]. Diabetes can also lead to serious medical complications such as cardiovascular disease, diabetic nephropathy and diabetic retinopathy. The risk of complications is often dependent on the management of associated risk factors, with the most critical being smoking, obesity, physical inactivity, high blood pressure, high cholesterol, and high blood glucose [1]. In 2015, diabetes was also the seventh leading cause of death in the United States [1].

With the high overall prevalence of diabetes and the subsequent risk for serious complications, the potential economic burden of this disease is substantial. In the United States, the overall economic cost of diagnosed diabetes was estimated to be 245 billion dollars [1]. The nature of diabetic expenditures has been evaluated extensively in previous literature. It has been previously determined that the spending of individuals with type 2 diabetes is approximately 2.3 times greater than those without diabetes and these differences are also associated with worsened quality of life among these patients [2]. Another study examined the magnitude of lifetime costs associated with diabetes, and found that individuals with diabetes spend considerably more over their lifetime even with an overall decreased life expectancy [3]. Compared to those without diabetes, diabetics possessed a discounted excess lifetime spending of $124,600 when diagnosed at age 40, and $91,200 when diagnosed at age 50 [3]. Much of this increase in spending was attributed to prescription medications and inpatient hospital care [3]. Diabetic individuals not only are susceptible to increased economic burden from direct costs, there is an additional influence from indirect health costs such as absenteeism, decreased work productivity, unemployment from disability, and productivity loss resulting from early mortality [4]. The range of effects from diabetes are shown to greatly influence the broader national burden, ultimately influencing all portions of society through alterations in insurance premiums and changes in quality of life [4].

Several examples from the literature have previously addressed critical economic effects in vulnerable subpopulations. One such investigation examined the range of diabetic expenditures present in patients with cardiovascular disease, specifically, myocardial infarction and ischemic stroke. It was found that these patients experience a considerable increase in expenditures as a result of diabetes [6]. It was subsequently indicated that improved management of diabetes in these individuals, when better controlling factors such as blood pressure and cholesterol, will likely also decrease the critical financial burden from stroke and myocardial infarction. This study also suggests that utilization of cost-effective diabetic medications may also be important in these at-risk groups [6]. Furthermore, another study examined the reasons for increasing costs of diabetic medications and identified methods of controlling this price elevation [7].

Although these investigations have provided useful insights, it is clear there has not been substantial focus on the subpopulation of diabetics with more severe complications resulting from disease progression or ineffective care. Therefore, the following analysis represents a more specific and unique cost examination. This evaluation is centered on the economic burden of diabetes severity, represented by the presence of eye or kidney complications that commonly result from progression of diabetes. This will provide a more nuanced evaluation of diabetes expenditures by comparing patterns of costs between diabetic individuals with and without these complications. Overall, this study will provide useful insight about whether interventions to improve treatment or limit severity of more advanced diabetic complications can facilitate broader economic benefits among this vulnerable patient population.

Methods:

The Medical Expenditure Panel Survey (MEPS) is a collection of comprehensive surveys and questionnaires used to acquire self-reported health information from families, medical professionals, and employers in the United States. MEPS is sponsored by the Agency for Healthcare Research and Quality (AHRQ), as part of the United States Department of Health and Human Services. The MEPS is composed primarily of two

components, including the household component and the insurance component. The panel design utilizes

multiple rounds of interviewing to account for a two-year period. The survey also acquires quantitative

information regarding broader utilization and costs associated with health services and insurance procedures.

The MEPS database also provides further differentiation of these expenditures by component sources of

payment. Furthermore, the Diabetes Care Survey (DCS) is an additional questionnaire administered through

MEPS since 2000 in order to collect further information from individuals who previously reported having a

diabetes diagnosis. The DCS provides two individual questions that inquire about the presence of diabetic

kidney or eye complications: "Has your diabetes caused problems with your kidneys?" and "Has your diabetes

caused problems with your eyes that needed to be treated by an ophthalmologist?" The sample involved in this

evaluation included U.S. adults above the age of 18 who have been clinically diagnosed with diabetes. The

analysis specifically utilized data pooled from the years of 2012 to 2016 to increase sample size and evaluate

the most recent trends available. This data was subsequently utilized to collectively examine the association

between annual health related expenditures among diabetics and the presence of kidney and eye related

complications. The complex sampling design and corresponding weight variables were considered and utilized

to construct weighted estimates for the broader United States population.

Measures

Variables of Interest

The key dependent variable in this analysis is health care expenditures for individuals diagnosed with diabetes

in the United States. This measure specifically accounts for the overall sum of direct payments for health care of

the corresponding survey year [8]. This value includes out of pocket care payments, as well as payments by

private insurance, Medicaid, Medicare, and other component expenditure sources. Furthermore, payments not

considered in this estimate include those for over the counter drugs and other indirect charges that are not

related to particular health events [8]. These measures of expenditures incorporate information from both the

MEPS Household and Medical Provider Components. The comprehensive definition included office-based physician visits, hospital inpatient events, prescribed medication, dental and vision care, medical equipment, and home health services. The MEPS provides an aggregate measure that includes spending resulting from all applicable sources, as well as more specific variables representing each of the component payment sources. [8]. The key independent variable in this analysis is the presence of specific diabetic complications, including kidney complications and eye complications. As previously described, identification of these complications was based on two individual self-reported questions from the supplement Diabetes Care Survey.

Controlled Covariates

Controlled covariates in this quantitative evaluation were obtained from corresponding portions of the MEPS self-reported questionnaire. Race/ethnicity was categorized into Hispanic, Non-Hispanic White, Non-Hispanic Black, and other races. Age was categorized into 18-44, 45-64, and 65 and older. Health insurance status was categorized into private insurance, public insurance, and no insurance. Marital status was categorized into married, not married (widowed, separated, or divorced), and never married. Comorbid conditions that are commonly associated with diabetes were also evaluated in this analysis. These additional illnesses included coronary heart disease, myocardial infarction, stroke, hypertension, and high cholesterol. Identification of these comorbid disease conditions were based on binary responses to corresponding MEPS survey questions. Survey information was further categorized by individual year, including 2012, 2013, 2014, 2015, and 2016.

Analyses

Diabetic complication status was categorized into the four following groups: no kidney or eye complications, kidney complications only, eye complications only, and both kidney and eye complications. Demographic characteristics of the final sample of diabetic adults were analyzed by presenting weighted percentages for each respective complication category. Total expenditures as well as several component payments sources were examined by presenting the mean spending value and standard error. This portion of the analysis similarly

utilized the previous categorization of diabetic complication status. Both analyses accounted for population weights in the sample of individuals with diabetes. Furthermore, a multivariable regression was performed to examine effect of patient characteristics, particularly the presence of comorbidities and complications, on spending. Three unique regression models were used to analyze total health expenditures, out of pocket expenditures, and prescription expenditures. Out of pocket and prescription spending were analyzed to better illustrate the personal economic burden experienced by patients. Logarithmic transformation of the respective expenditure outcome was utilized to better construct a normal distribution among this data. Logarithmic transformation was chosen as a framework of analysis to allow for utilization of population weights in the sample. A significance level of $p < 0.05$ was used in all components of the analysis.

Results:

Table 1 illustrates the demographic characteristics of the final sample of diabetic individuals in the United States, according to complication status (none, kidney only, eye only, both kidney and eye). The total sample included 8,436 individuals, which represented a weighted total sample of 15,175,124 individuals in the United States. The majority of this sample, comprising 6,163 individuals (73.1%) did not have kidney or eye complications. Kidney complications alone were present in 472 individuals (5.6%), while eye complications alone were present in 1,289 individuals (15.3%). Both kidney and eye complications occurred in 512 individuals (6.1%) from this sample. Individuals with complications were more likely to be older. Groups with complications displayed greater population percentages of Non-Hispanic Black and Hispanic individuals. Individuals with complications were less likely to possess private insurance and more likely to have a form of public health insurance. Patients with complications were also more likely to possess other related comorbidities (coronary heart disease, heart attack, stroke, hypertension, high cholesterol).

Table 1

Weighted demographics of U.S. Adults with diabetes according to complication status (unweighted n=8,436, weighted n = 15,175,124)

Demographic Characteristic	Total Sample (n=8,436) Weighted %	No Diabetic Complications (n=6,163) Weighted %	Kidney Complications Only (n=472) Weighted %	Eye Complications Only (n=1,289) Weighted %	Both Kidney and Eye Complications (n=512) Weighted %	P-value (significance level p < 0.05*)
Age Category						
18-44	11.2	12.1	8.0	9.1	7.9	0.03*
45-64	44.3	45.1	38.4	43.8	41.4	0.14
65+	44.5	42.8	53.6	47.1	50.7	<0.001*
Race/ethnicity Category						
Non-Hispanic White	61.9	63.1	72.9	52.3	57.8	<0.001*
Non-Hispanic Black	15.2	14.6	12.7	18.9	17.4	0.001*
Hispanic	15.0	14.5	8.9	19.6	18.1	<0.001*
Other Race	7.8	7.8	5.5	9.3	6.8	0.17
Gender Category						
Male	48.6	49.1	51.7	44.4	48.6	0.11
Marital Status Category						
Married	56.4	58.0	51.9	51.0	53.0	0.006*
Not Married	32.4	30.8	36.4	36.5	38.6	0.001*
Never Married	11.2	11.2	11.6	12.5	8.3	0.25
Insurance Category						
Private Insurance	58.4	61.9	50.8	49.6	41.4	<0.001*
Public Insurance	35.4	32.0	43.3	44.4	51.0	<0.001*
No Insurance	6.2	6.1	5.8	6.0	7.6	0.78
Comorbidity Category						
Coronary Heart Disease	18.2	15.5	27.6	21.7	36.7	<0.001*
Heart Attack	13.7	11.7	20.6	16.9	26.1	<0.001*
Stroke	12.6	10.3	21.3	16.4	25.6	<0.001*
Hypertension	77.6	75.3	87.2	79.9	93.5	<0.001*
High Cholesterol	74.8	73.1	81.9	77.3	83.8	<0.001*
Survey Year Category						
2012	11.7	11.3	11.5	14.3	11.3	
2013	24.4	23.8	26.7	26.7	24.6	
2014	25.7	25.7	25.7	25.9	25.1	
2015	13.0	13.3	11.4	10.8	15.3	
2016	25.2	25.8	24.6	22.3	23.6	

Table 2 displays mean health spending for total expenditures, as well as several payment sources and utilization categories. Compared to the spending of individuals without complications, total expenditures were increased in the presence of either of the diabetic complications, and considerably higher when both complications were present. This trend among complication categories was observed for payments by Medicaid and Medicare, with these associations being statistically significant. With regards to payments by private insurance, the presence of either complication did not strongly affect the mean expenditure value, although the presence of both complications did lead to a noticeable increase in payment. In the case of out of pocket spending, the most considerable increase in expenditure occurred among patients with kidney complications alone. Patterns among office-based expenditures and prescription expenditures were similar in that the presence of either complication significantly increased spending and the most substantial effect was observed among individuals with both complications. With regards to outpatient and emergency room expenditures, the most considerable increases in spending occurred among patients with kidney complications alone.

Table 2
Mean (standard error) of annual health expenditures for aggregate and component payment sources according to complication status, accounting for population weights

Expenditure Category (mean annual value in U.S. Dollars)	Total Sample (n=8,436)	No Diabetic Complications (n=6,163)	Kidney Complications (n=472)	Eye Complications (n=1,289)	Both Kidney and Eye Complications (n=512)	P-value (significance level p < 0.05)
Total Expenditures	12,712 (346)	10,879 (366)	19,824 (1,272)	13,880 (551)	26,641 (2,035)	<0.001*
Total Payments by Medicaid	1,438 (99)	1,078 (88)	2,535 (438)	1,716 (174)	4,359 (902)	<0.001*
Total Payments by Medicare	5,445 (207)	4,252 (210)	10,398 (1,010)	6,464 (440)	13,558 (1,049)	<0.001*
Total Payments by Private Insurance	3,350 (209)	3,319 (241)	3,301 (448)	3,054 (332)	4,498 (1,362)	0.075
Total Payments Out of Pocket	1,236 (42)	1,157 (45)	1,756 (117)	1,345 (117)	1,469 (106)	<0.001*
Total Office Based Expenditures	2,564 (96)	2,082 (75)	3,737 (378)	2,836 (194)	7,024 (1,245)	<0.001*
Total Prescription Expenditures	4,635 (173)	4,176 (209)	6,491 (503)	5,197 (275)	7,415 (358)	<0.001*
Total Outpatient Expenditures	819 (52)	719 (49)	1,392 (289)	951 (164)	1,229 (204)	<0.001*
Total Emergency Room Expenditures	364 (19)	326 (23)	579 (72)	419 (51)	517 (62)	<0.001*

Table 3 illustrates the association between various patient characteristic and the change in total health spending for a given year. Total spending was significantly associated with increasing patient age. Furthermore, Non-Hispanic Blacks, Hispanics, and other races possessed significantly decreased spending compared to Non-Hispanic Whites. Males spent significantly less in total than females, while marital status did not significantly impact total expenditures. Individuals with either private or public insurance spent significantly more than those without health insurance. The presence of related comorbidities led to increased total expenditures and the impact of coronary heart disease, stroke, and hypertension were most considerable and statistically significant. These represented percent changes of 35%, 57% and 21% respectively. The presence of kidney complications led to a 74% increase in total annual spending, while the presence of eye complications led to a 33% increase.

Table 3
Multivariable adjusted regression model using log transformation of annual total health expenditures, accounting for population weights

Demographic/Health Characteristic	Regression Coefficient	Percent Change (standard error) in Mean Total Health Expenditures	p-value (significance level $p < 0.05$ *)
Age Category			
18-44 (reference)	-	-	-
45-64	0.33	39 (7.0)	<0.001*
65+	0.43	53 (7.3)	<0.001*
Race/ethnicity Category			
Non-Hispanic White (reference)	-	-	-
Non-Hispanic Black	-0.37	-31 (6.1)	<0.001*
Hispanic	-0.40	-33 (6.2)	<0.001*
Other Race	-0.38	-31 (8.1)	<0.001*
Gender Category			
Female (reference)	-	-	-
Male	-0.16	-15 (4.5)	<0.001*
Marital Status Category			
Never Married (reference)	-	-	-
Not Married	-0.063	-6.0 (7.0)	0.39
Married	-0.058	-6 (7.2)	0.37
Insurance Category			
No Insurance (reference)	-	-	-
Private Insurance	1.01	174 (8.8)	<0.001*
Public Insurance	1.09	196 (9.5)	<0.001*
Comorbidity Category			
Coronary Heart Disease	0.30	35 (5.7)	<0.001*
Heart Attack	0.077	8.0 (5.7)	0.17
Stroke	0.45	57 (6.5)	<0.001*
Hypertension	0.19	21 (5.5)	<0.001*
High Cholesterol	0.10	11 (5.2)	0.05
Diabetes Complication Category			
Kidney-related Complications	0.55	74 (7.6)	<0.001*
Eye-related Complications	0.29	33 (5.4)	<0.001*

Table 4 demonstrates the associations between diabetic patient characteristics and annual out of pocket spending on health services. Out of pocket expenditures were significantly elevated with increasing age, and significantly decreased among other races when compared to Non-Hispanic Whites. Males spent significantly less than females, while married individuals spent more than those never married. Individuals with public forms of health insurance spent significantly less out of pocket compared to those without insurance. Significant increases in out of pocket spending occurred in the presence of coronary heart disease, stroke, and hypertension. These conditions were associated with 16%, 16%, and 12% increases in out of pocket spending, respectively. The presence of diabetic kidney complications was associated with a 54% increase in out of pocket expenditures, while the presence of eye complications was associated with a 15% increase in out of pocket expenditures.

Table 4
Multivariable regression model using log transformation of annual out of pocket expenditures and population weights

Demographic/Health Characteristic	Regression Coefficient	Percent Change (standard error) in Mean Out of Pocket Health Expenditures	p-value (significance level $p < 0.05$ *)
Age Category			
18-44 (reference)	-	-	-
45-64	0.41	51 (8.0)	<0.001*
65+	0.62	87 (8.1)	<0.001*
Race/ethnicity Category			
Non-Hispanic White (reference)	-		-
Non-Hispanic Black	-0.58	-44 (5.6)	<0.001*
Hispanic	-0.73	-52 (6.8)	<0.001*
Other Race	-0.60	-45 (9.1)	<0.001*
Gender Category			
Female (reference)	-		-
Male	-0.13	-12 (4.4)	0.003*
Marital Status Category			
Never Married (reference)	-		-
Not Married	0.089	9.3 (8.2)	0.26
Married	0.23	26.3 (8.7)	0.01*
Insurance Category			
No Insurance (reference)	-		-
Private Insurance	-0.091	-8.7 (8.4)	0.26
Public Insurance	-0.92	-60 (8.6)	<0.001*
Comorbidity Category			
Coronary Heart Disease	0.14	16 (6.9)	0.03*
Heart Attack	-0.13	-12 (7.5)	0.08
Stroke	0.15	16 (6.8)	0.03*
Hypertension	0.11	12 (5.4)	0.03*
High Cholesterol	0.066	6.8 (5.9)	0.25
Diabetes Complication Category			
Kidney-related Complications	0.43	54 (8.0)	<0.001*
Eye-related Complications	0.14	15 (6.2)	0.02*

Table 5 illustrates the association between diabetic patient characteristics and annual prescription spending in this population. Increasing patient age was associated with significantly increased spending. Additionally, prescription spending was significant decreased among Non-Hispanic Blacks, Hispanics, and other races when compared to Non-Hispanic Whites. Males spent significantly less than females, while marital status did not have a considerable impact on prescription expenditures. The presence of private or public health insurance led to a significant increased in prescription spending. The comorbidities of coronary heart disease, stroke, hypertension and high cholesterol were associated with 33%, 37%, 34%, and 21% changes in prescription spending, respectively. These effects were also statistically significant. The presence of kidney complications was associated with a statistically significant 66% increase in prescription spending, while diabetic eye complications were similarly associated with a significant, 36% increase in prescription expenditures.

Table 5
Multivariable regression model using log transformation of annual prescription expenditures and incorporating population weights

Demographic/Health Characteristic	Regression Coefficient	Percent Change (standard error) in Mean Prescription Health Expenditures	p-value (significance level $p < 0.05$ *)
Age Category			
18-44 (reference)	-	-	-
45-64	0.32	37 (9.4)	<0.001*
65+	0.29	33 (10.1)	0.003*
Race/ethnicity Category			
Non-Hispanic White (reference)	-	-	-
Non-Hispanic Black	-0.46	-37 (6.5)	<0.001*
Hispanic	-0.50	-39 (7.2)	<0.001*
Other Race	-0.33	-28 (9.0)	<0.001*
Gender Category			
Female (reference)			
Male	-0.12	-11 (5.8)	0.04*
Marital Status Category			
Never Married (reference)			
Not Married	-0.086	-8.3 (8.5)	0.29
Married	-0.10	-9.6 (9.1)	0.25
Insurance Category			
No Insurance (reference)			
Private Insurance	0.89	143 (9.9)	<0.001
Public Insurance	1.02	177 (10.6)	<0.001
Comorbidity Category			
Coronary Heart Disease	0.28	33 (7.3)	<0.001*
Heart Attack	-0.084	-8.1 (8.6)	0.31
Stroke	0.32	37 (7.0)	<0.001*
Hypertension	0.30	34 (7.0)	<0.001*
High Cholesterol	0.19	21 (6.2)	0.002*
Diabetes Complication Category			
Kidney-related Complications	0.51	66 (8.9)	<0.001*
Eye-related Complications	0.31	36 (7.3)	<0.001*

Discussion:

Kidney complications affected 5.6% of diabetic individuals in this sample, while eye complications affected 15.3% of individuals. Both kidney and eye complications were present in 6.1% of the sample. Accordingly, a majority of this sample not have diabetic kidney or eye complications. Complications were more frequent in older segments of this sample, as well as among Non-Hispanic Black and Hispanic individuals. Diabetic kidney and eye complications were also more common among individuals with public health insurance and among those with related cardiovascular comorbidities. Total health expenditures were elevated when either complication was present, while the presence of both conditions led to a more substantial increase in spending. Increased spending due to the presence of these diabetic complications was generally observed across many component sources of spending, including payments by Medicaid and Medicare, of out of pocket spending, office-based expenditures, prescription expenditures, outpatient spending, and emergency room expenditures.

Total annual spending, out of pocket spending, and prescription spending in this diabetic sample was significantly increased due to older patient age and decreased among Non-Hispanic Blacks, Hispanics, and other races. Males spent significantly less among all sources compared to females. Individuals with private or public insurance spent significantly more in total and on prescriptions, but possessed lower out of pocket expenditures. Elevations among all spending sources resulted from comorbidities of coronary heart disease, stroke, and hypertension. Total spending experienced a 74% increase among those with kidney complications, while the presence of eye complications led to a 33% increase. Diabetic kidney complications led to a 54% increase in out of pocket expenditures, while diabetic eye complications were associated with a 15% increase. Prescription spending increased by 66% in the presence of kidney complications, and was elevated by 36% in those with diabetic eye complications.

There are many potential factors that can lead to the results observed in this analysis. When the presence of self-reported kidney complications can signal the progression of underlying diabetic kidney disease, the associated difficulties with the management of this condition is likely responsible for much of this increased

spending. Providing the necessary, regular treatment for patients with diabetic kidney disease is an expensive process. Patients with this condition often require comprehensive clinical management of measures such as blood pressure, glucose, and lipids [9]. These individuals may also require lifestyle modifications such as an exercise regimen, smoking cessation, and weight reduction [9]. Unfortunately, attaining consistent control of such an extensive range of physiological factors is often difficult to achieve, and can lead to worsened health outcomes in this vulnerable population. Nonadherence to treatment can result from difficulties in self-regulation, variation in physician recommendations, and problems regarding emotional well-being [9]. For these reasons, it can be clearly demonstrated that the presence of more severe kidney complications easily results in a considerable economic burden for the individual patient.

In a similar manner, it can be shown that the presence of diabetic eye complications can feasibly result in an increased economic burden for this at-risk population. Such complications may include considerable vision impairment from the progression of diabetic nephropathy, as well as the presence of cataracts, glaucoma, and macular degeneration [10]. Management of these conditions requires consistent ophthalmologic screening and corresponding management of clinical risk factors. More severe conditions may also necessitate regular forms of surgical intervention [10]. Improving awareness and education regarding optimal treatment of diabetic eye disease represents another substantial barrier to patient adherence and positive wellbeing [10]. As a result, poor or inconsistent management of these conditions may similarly lead to an overwhelming economic burden for these individuals.

Ultimately, the findings from this analysis indicate the importance of interventions to alleviate economic difficulties among patients in the United States with diabetic complications. Expanding access to health insurance and the provision of discounted community health services may help to counteract the considerable amount of out of pocket spending in this population. Additionally, methods to address prescription-based expenditures, such as modification of copay amounts and broader utilization of generic pharmaceuticals, may also be beneficial to combat this critical aspect of the economic burden among diabetic individuals. Furthermore, characterizing the individual experience of this patient population by analyzing out of pocket and

prescription expenditures highlights how efforts to minimize diabetic severity can provide tangible benefits. In this manner, targeting more thorough and regular methods treatment among those at-risk for developing complications can help to prevent subsequent financial difficulty. In a similar way, managing the progression and severity of complications among diabetics who already possess these conditions can help to mitigate the economic difficulties that stem from issues of nonadherence and inconsistent regimens of care.

The strengths of this analysis include the more narrow and meaningful scope attained by focusing on the specific burden for diabetic individuals with kidney or eye complications. Additionally, expanding the notion of health expenditures to include more specific component sources of spending provides a more nuanced outlook on the nature of these economic patterns. Use of regression analysis also allows for a direct and quantitative comparison among patients in this vulnerable population. Potential limitations of this analysis include the inability to specifically identify differences between individuals with Type 1 and Type 2 diabetes using information from MEPS, since variation between these populations may affect the quantification of spending among all individuals with diabetes. Additionally, the original categorization of complication status was not maintained in subsequent regression analyses, which only facilitated a comparison between individuals with and without each respective condition. Furthermore, there does not always exist a clear differentiation among all separate component sources of health spending. For example, the spending on prescription medications may include expenditures that naturally fall under the out of pocket categorization. Another possible limitation involves the potential bias that results from relying on self-reported measure regarding factors involving health and illness. Future research in this area can possibly evaluate the economic burden of other prominent diabetic complications.

<u>Conclusions:</u>

While a majority of diabetics in the United States may not specifically possess kidney or eye complications, this study demonstrates that the extent of the economic burden that results for patients with these conditions justifiably necessitates more targeted interventions. It is also shown that individuals in the at-risk population for which these measures would be beneficial is likely to be older and possess other related chronic comorbidities. The presence of these complications generally led to increases among many components of health spending, with some facets experiencing more substantial elevation among those with both conditions. Notable increases in out of pocket and prescription expenditures suggest that alleviation of the personal aspects of financial difficulty may be most important when implementing reform to benefit these patients.

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