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Abstract

Objective: To examine the five-year trend in clinical care and diabetes self-management activities among adults living in the Appalachian state of West Virginia.

Methods: This study used a cross-sectional design with data from the Behavioral Risk Factor Surveillance System in 2010 (N=685) and 2014 (N=958), among noninstitutionalized adults with diabetes. Five-year trend in recommended diabetes clinical care, diabetes self-management activities and diabetes education was analyzed after adjusting for sex, education, income, insurance, age, obesity, comorbid hypertension, race and lifestyle behaviors (exercise and smoking).

Results: A significant increase in percentage of adults with 2 or more A1C tests was noted from 2010 (63.6%) to 2014 (76.4%) in WV. However, annual eye exam decreased by 7% (71.1% to 63.1%) and no statistically significant changes were noted in annual foot exam, number of physician visits and diabetes self-management behaviors (self-monitoring of blood glucose, foot self-exam, and diabetes self-management education). After adjusting for other factors, results from multivariable logistic regressions indicated that adults with diabetes were less likely to have an annual eye exam (AOR 0.70, 95% CI 0.54, 0.91) and more likely to have received 2 or more A1C tests in 2014 (AOR 1.78, 95% CI 1.37, 2.31) compared to 2010.

Conclusion: A1C testing improved but annual eye-exam declined; other indicators of diabetes clinical care and self-management did not change during this five-year period. The findings of low rates of diabetes education, and annual foot/eye exams underscore the need to identify barriers to access and strategies to overcome these barriers.

Keywords

Behavioral Risk Factor Surveillance System; Diabetes Mellitus; Healthcare Disparities; Disease Management; Appalachian Region

Cover Page Footnote

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Keywords: Behavioral Risk Factor Surveillance System, Diabetes Mellitus, Healthcare Disparities, Disease Management, Appalachian Region

INTRODUCTION

Diabetes affects 30.3 million Americans (9.4%) in the United States (US) and is the seventh leading cause of death (Olives, Myerson, Mokdad, Murray, & Lim, 2013; WHO, 2018). Diabetes can be successfully managed by following standard diabetes care practices (Johnson, Richards, & Churilla, 2015) and self-management activities. The American Diabetes Association recommend clinical care and self-management practices such as two or more A1C tests in a year, annual foot and eye exam, self-monitoring of blood glucose (SMBG), routine foot self-exam for blisters, cuts, scratches or other sores, healthy eating, physical activity, medication adherence, and diabetes self-management education (DSME) to better manage their diabetes and improve health outcomes (ADA, 2018). It has been established that routine diabetes clinical care, self-management and DSME not only improve glycemic control (Johnson, Richards & Churilla, 2015; Johnson, Murray & Huang, 2010; Powers, Bardsley, Cypress et al, 2015) but also reduce the risk of serious complications, such as heart disease, stroke, kidney failure, non-traumatic lower-limb amputations, and blindness in adults (Haas, Maryniuk, Beck et al, 2012; Stolar, 2010; Chrvala, 2016). Diabetes self-management activities also reduce the financial burden on individuals, families and insurance companies such as Medicaid, Medicare and private insurance (Haas, Maryniuk, Beck et al, 2012; Chrvala, 2016).

West Virginia (WV) has the highest rate of diabetes (15.0%) in the US (WV DHHR, 2018), with 255,695 adults who have diabetes (ADA, 2016). It is the 3rd most rural state in the US with 77 people per square mile (WVRHA, 2012). In fact, WV is the only state that completely reside in the Appalachian region where approximately 8% of the U.S. population (25 million) live. Appalachia is characterized by overall rurality and low socio-economic status, poor health status and death from chronic diseases due to a higher percentage of older adults living in the region (ARC, 2015; Auchincloss & Hadden, 2002; Coben, Tiesman, Bossarte, & Furbee, 2009). For example, 91% of WV counties are classified as "isolated small" and "small" and are designated as a medically underserved areas as they are remote from metropolitan areas (WV RHA, 2012).

As a result, WV faces rural health-related challenges such as geographic barriers, lack of access to specialist providers, poor quality of healthcare, and an Appalachian culture of distrust of the healthcare system (Misra, Fitch, Roberts, & Wright, 2016). Due to the unique geographical terrain, low-income or Medicaid eligible population, limited health care facilities and access to specialist providers are limited in the state. The federal government designates Health Professional Shortage Area (HPSA) to identify areas and population groups within the United States that are experiencing a shortage of health professionals. West Virginia has 50 HPSA designated areas that include all or parts of 40 counties (73%) and in WV (KFF, 2017).

To prevent and better manage chronic conditions, specifically diabetes, the West Virginia Bureau of Public Health has implemented many initiatives since 2011 (WV DHHR, 2017). There are several ongoing community-based lifestyle or diabetes self-management programs in WV: Dining with Diabetes (focused on nutritional factors; 5 sessions; targets individuals with diabetes and their family members), Chronic Disease Self-management Program (CDSMP), 6-sesions; (designed to help individuals with chronic diseases gain confidence and skills to better manage their health), and Diabetes Self-Management Program (DSMP), 6 sessions; (designed to help individuals with diabetes gain confidence and skills to better manage their health (ARC, 2011). All of WV's free-clinics also offer diabetes services

for very low-income individuals who do not qualify for Medicaid or cannot afford to buy health insurance. Similarly, the federally-funded community health centers offer one-on-one diabetes self-management training. However, these classes are not free but have fees based on income.

While there has been many initiatives to improve diabetes care, it is not known whether these programs and improved access to care by the Affordable Care Act has resulted in increased diabetes clinical care and self-management activities among West Virginia adults with diabetes. Therefore, the primary objective of this paper was to examine 5-year trend (between 2010 and 2014) in recommended diabetes clinical care and self-management activities in West Virginia adults with diabetes.

METHODS

Study Design

This study used a retrospective pooled cross-sectional study design.

Data Source. This study derived data from the West Virginia Behavioral Risk Factor Surveillance System (BRFSS) in 2010 and 2014 The BRFSS is an annual, cross-sectional, state-based telephone survey that uses multistage design in all 50 states, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and Guam (https://www.cdc.gov/brfss/about/index.htm) (CDC, 2017). The objective of the BRFSS is to collect uniform state-specific data on preventive health practices and key behavioral risk factors and chronic conditions among non-institutionalized U.S. adults aged ≥ 18 years (McEwen, Lin, & Pasvogel, 2013). The survey, a set of core questions and optional supplemental modules (e.g., diabetes), is developed, coordinated, and funded by the Centers for Disease Control and Prevention (CDC, 2017). Details about the sampling design, purpose, validity, and reliability of the BRFSS have been published elsewhere (CDC, 2017).

The BRFSS contains three components: 1) the core questions, 2) optional modules, and 3) state added questions. The core component is a standard set of questions administered to all states and territories. Optional modules collect additional information on select topics and are administered on a state-by-state basis. In this study, we utilized data from the West Virginia state Diabetes module questions. In 2010, the response rate was 65.3% (BRFSS, 2010), resulting in a sample size of 4,401 and in 2014, the combined cellphone and land line response rate was 55.8% (BRFSS, 2014), resulting in a sample size of 6,199 adults aged 18 or older.

Study Sample: Adults with Diabetes in West Virginia

The final sample included adults who had self-reported diabetes, living in West Virginia, who had no missing data on age, and who completed the interview (N= 685 in 2010 and N = 958 in 2014). It has to be noted that women diagnosed with gestational diabetes were not considered to have diabetes. The Institutional Review Board determined that the study was exempt from IRB approval for human subject projection because the study used publicly available data.

Measures

Dependent Variables - Diabetes Clinical Care and Self-Management Activities. The 2010 and 2014 BRFSS diabetes module, administered in the respondent's language of choice, either English or Spanish, included nine questions about diabetes clinical care and self-management. Clinical diabetes care was analyzed with four variables: 1) testing at least two times/year for hemoglobin A1C (yes/no); 2) foot-exam by a physician (yes/no); 3) dilated eye-exam by a physician during the past year (yes/no) and 4) at least two visits to the doctor in the past 12-months for diabetes care (yes/no). We selected the above-mentioned tests because BRFSS state coordinators reported that these questions were useful for program evaluation and development of community interventions (Mukhtar, Murphy, & Mitchell, 2003).

We included SMBG (everyday/other), self-foot exam (at least once a week/other), and diabetes education (yes/no). SMBG was based on the question "About how often do you check your blood for glucose or sugar? Include times when checked by a family member or friend, but do NOT include times when checked by a health professional. Based on answers to "how often do you check your feet for any sores or irritations? Include times when checked by a family member or friend, but do NOT include times when checked by a health professional." Receipt of diabetes education was based on the affirmative response to the question "Have you ever taken a course or class in how to manage your diabetes yourself?"

Explanatory Variables

Key explanatory Variable: Year of the BRFSS Survey. To analyze the 5-year trends in diabetes clinical and self-care management, we pooled BRFSS years 2010 and 2014 and compared the rates of diabetes clinical and self-care management in year 2014 to year 2010. We selected these years because of the changes in healthcare policies (i.e. implementation of the affordable care act in 2010) and the availability of data.

Other explanatory Variables

Demographic factors included age (18-44 years, 45-64, and 65 or older), sex (women/men), race (whites and non-whites), and marital status (married, divorced/separated/widowed, and never married).

Socio-economic factors included education (less than high school, high school/GED, some college, and college).

Lifestyle health practices included all lifestyle including body mass index (BMI) (< 25 kg/m2, 25–29.9 kg/m2, ≥ 30 kg/m2, or unknown/refused), smoking (never, past, and current smokers), and physical activity. Physical activity indicates whether the respondent participated in any physical activities or exercise in the past 30 days. As 4.5% of BMI values were missing, we used an indicator variable for missing data in the regressions.

Access to Care Factors: The BRFSS access to care module includes questions regarding whether the person has health insurance coverage and have usual source of care; there was a low number of individuals without a personal doctor or health care provider and hence this variable was excluded from the analysis. Similarly only 35 individuals with diabetes did not have insurance in 2014 and therefore, this variable was not included in the regression analyses.

Other health factors were examines were as follows: activity limitation, presence or absence of heart disease and self-reported general health (excellent/very good, good, fair/poor).

Statistical Analysis

Unadjusted group differences in sample characteristics by year of the survey (2010 and 2014) were analyzed with Rao-Scott chi-square tests. Statistically significant differences in rates of diabetes clinical and self-management care between 2010 and 2014 were tested with chi-square statistics. To account for the complex sampling design, we used the BRFSS stratification variables and weights and conducted all statistical analyses using SAS 9.4. We showed changes in absolute rates by respondent characteristics in 2010 and 2014 (Table 1). For multivariable analyses, we performed logistic regression analyses to evaluate the association between year of survey and diabetes clinical care and self-management activities, after adjusting for sex, age, race, marital status, education, heart disease, perceived physical health status, obesity, lifestyle behaviors (exercise and smoking) and health insurance coverage in the model. Data were analyzed using the survey procedures in SAS 9.4, which accounted for the disproportionate stratified sample sampling

design of the BRFSS. Statistical inferences were based on a significance level of *P* (two-sided) ≤ 0.05.

RESULTS

Table 1 displays unweighted numbers and weighted percentages of sample characteristics for 2010 and 2014 among adults with diabetes in West Virginia. In general, an overwhelming majority of the sample was white (92%). In 2010, 37.7% adults were 65 years or older and this percentage increased to 42.8% in 2014. However, this increase was not statistically significant (p = 0.17). A majority of the sample adults were obese (54.1% in 2010 and 57.1% in 2014). As seen from the table, except for education and an increase in access to health care represented by health insurance coverage there were no significant differences in sample characteristics of adults between BRFSS 2010 and 2014.

Table 1: Selected Characteristics of West Virginia Adults (> 18 years) with Diabetes Over Time, Behavioral Risk Factor Surveillance System, 2010 and 2014

	2010		2014			
	N	Wt %	N	Wt %	P-value	Sig
ALL	**685**	**100.0**	**958**	**100.0**		
Sex						
Female	404	50.9	548	50.8	0.939	
Male	281	49.1	410	49.2		
Race						
White	634	92.4	898	91.6	0.639	
Non-white	54	7.6	60	8.4		
Age in Years						
18-44 years	53	14.5	64	11.4	0.174	
45-64 years	306	47.9	421	45.8		
65 and older	326	37.7	473	42.8		
Education						
LT HS	157	22.0	183	27.0	0.023	*
HS	312	46.2	373	38.7		
Above HS	216	31.8	402	34.3		
Employment						
Employed	160	28.3	210	24.0	0.196	
Not employed	225	35.2	335	39.2		
Retired	300	36.5	412	36.8		
Health Insurance						
Yes	631	90.0	923	94.5	0.011	*
No	54	10.0	35	5.5		
Heart Disease						
Yes	176	24.7	268	27.5	0.237	
No	509	75.3	690	72.5		
Health Status						

Table 1: Selected Characteristics of West Virginia Adults (> 18 years) with Diabetes Over Time, Behavioral Risk Factor Surveillance System, 2010 and 2014

		2010		2014			
		N	Wt %	N	Wt %	P-value	Sig
ALL		**685**	**100.0**	**958**	**100.0**		
	Ex/Very Good	94	14.3	125	11.7	0.362	
	Good	203	32.2	304	31.7		
	Fair/Poor	388	53.5	529	56.6		
BMI							
	Underweight/Normal	90	11.1	112	10.1	0.728	
	Overweight	202	30.2	278	28.3		
	Obese	361	54.1	522	57.1		
	Missing	32	4.5	46	4.6		
Physical Activity							
	Yes	352	52.8	555	56.6	0.197	
	No	333	47.2	403	43.4		
Smoker							
	Current	98	15.4	173	20.2	0.113	
	Former	260	37.3	333	36.2		
	Non-smoker	327	47.3	452	43.6		

Note: Based on adults aged 18 years or older with diabetes living in West Virginia, who completed Behavioral Risk Factor Surveillance System surveys in 2010 (N = 685) or 2014 (N = 958) interview and did not have missing age or any of the diabetes clinical- or self-management activities. Asterisks represent significant group differences in characteristics by year of interview, based on chi-square values.

BMI: Body Mass Index; LT: less than; HS: High School; Wt: Weighted; Sig: Significance

Table 2 summarizes the weighted percentages of diabetes clinical and self-care in 2010 and 2014 among adults with diabetes in West Virginia.

Five-year trend in Diabetes Clinical Care:

We observed significant differences in A1C exam with provider as well as dilated eye-exams between 2010 and 2014. The percentage of individuals who had at least 2 A1C exams in the past 12 months increased by 12.8 percentage points from 63.6% in 2010 to 76.4% in 2014 ($p < .001$). However, dilated eye-exam by provider declined by 7.0 percentage points (71.1% in 2010 to 64.1% in 2014). We did not observe any differences in the rate of foot-exam by providers and visit to physicians (two per year) between 2010 and 2014 among adults with diabetes living in West Virginia.

Five-year trend in Diabetes Self-Management Activities

No statistically significant differences in SMBG, self-foot exam and DSME were reported over the five-year period. SMBG was 53.5% in 2010 and 51.4% in 2014. Diabetes education marginally increased from 43.6% in 2010 to 48.5% in 2014 ($p = 0.098$). Percentage of adults with self-foot exam declined marginally from 87.6% in 2010 to 84.1% in 2014 ($p = 0.094$).

Table 2: Number and Weighted Percentages of Diabetes Clinical- and Self-Management Activities Over time West Virginia Adults (> 18 years) with Diabetes, Behavioral Risk Factor Surveillance System, 2010 and 2014

	2010		2014			
	N	Wt %	N	Wt %	Chi-sq	P-value
ALL	**685**	**100.0**	**958**	**100.0**		
Self-Management						
Self-Foot Exam					2.708	0.094
At least once /week	599	87.5	807	84.1		
Other	86	12.5	151	15.9		
Self-Glucose Monitoring					0.457	0.499
At least once /day	374	53.3	494	51.4		
Other	311	46.7	464	48.6		
DM Education					2.671	
Yes	300	43.6	480	48.5		0.102
No	385	56.4	478	51.5		
Clinical Management						
A1C Exam					21.992	<0.0001
Yes	451	63.7	742	76.4		
No	234	36.3	216	23.6		
Foot Exam by Provider					0.000	0.976
Yes	473	69.4	674	69.3		
No	212	30.6	284	30.7		
Eye Exam by Provider					6.238	0.013
Yes	499	71.1	657	64.1		
No	186	28.9	301	35.9		
Visits to Physicians					4.700	0.106
GE 2 Visits	578	82.6	783	81.3		
1 visit	39	6.1	88	9.3		
None	68	11.4	87	9.4		

Note: Based on adults aged 18 years or older with diabetes living in West Virginia, who completed Behavioral Risk Factor Surveillance System survey in 2010 (N = 685) or 2014 (N = 958) interview and did not have missing age or any of the diabetes clinical or self-management activities. DM: Diabetes Mellitus

Adjusted Analyses: Five-year trend in Diabetes Clinical Care and Self-management

Table 3 summarizes the results from separate logistic regressions on diabetes clinical care and self-management activities in terms of the adjusted odds ratios (AOR) and 95% Confidence intervals (CI).

Compared to 2010, West Virginia adults with diabetes were 78% more likely to receive A1C tests in 2014 (AOR = 1.78, 95% CI = 1.37, 2.31 and were 30% less likely to receive dilated

eye exam in 2014 (AOR = 0.70, 95% CI = 0.54 and 0.91). None of the other clinical-management activities changed over time. After adjusting for demographic, socioeconomic, access to care, life-style practices and general health status, WV adults with diabetes were 29% less likely to perform self-examination of their feet in 2014 as compared to 2010 (AOR = 0.71, 95% CI = 0.50, 0.99). None of the other diabetes self-management activities i.e., SMBG and participating in DSME changed in the five-year period.

Table 3: Adjusted Odds Ratios (AOR) and 95% Confidence Intervals (CI) from Separate Logistic Regressions on Diabetes Clinical Care and Self-Management Activities West Virginia Adults (> 18 years) with Diabetes, Behavioral Risk Factor Surveillance System, 2010 and 2014

	AOR	95% CI	Sig
Diabetes Clinical Care - HbA1c Exam			
Five-Year Trend			
2014	1.78	[1.37 , 2.31]	< 0.001
2010 (Ref)			
Diabetes Clinical Care – Eye Exam			
Five-Year Trend			
2014	0.70	[0.54 , 0.91]	0.007
2010 (Ref)			
Diabetes Clinical Care – Foot Exam			
Five-Year Trend			
2014	0.96	[0.75 , 1.24]	
2010 (Ref)			
Diabetes Clinical Care – Diabetes Care Visits			
Five-Year Trend			
2014	0.85	[0.62 , 1.16]	
2010 (Ref)			
Diabetes Self-Management – SMBG			
Five-Year Trend			
2014	0.90	[0.71 , 1.14]	
2010 (Ref)			
Diabetes Self-Management – Self-Foot Exam			
Five-Year Trend			
2014	0.71	[0.50 , 0.99]	0.046
2010 (Ref)			
Diabetes Self-Management – Diabetes Education			
Five-Year Trend			
2014	1.27	[1.00 , 1.61]	
2010 (Ref)			

Note: Based on adults aged 18 years or older with diabetes living in West Virginia, who completed Behavioral Risk Factor Surveillance System in 2010 survey (N = 685) or 2014 (N = 958) interview and did not have missing age or

any of the diabetes clinical- or self-management activities. The regressions also controlled for sex, age, race, marital status, education, heart disease, health status, obesity, physical activity, and smoking status.

DISCUSSION

Our study findings indicated that clinical care for diabetes (having at least 2 A1C tests) increased by nearly 13 percentage points between 2010 and 2014. This increase may be partly attributed to the proposed pay-for-performance by the National Committee on Quality Assurance (NCQA) modifications to comprehensive diabetes care (O'Connor, Bodkin, Fradkin et al., 2011) that promotes A1C testing to identify patients with poor control (A1C > 9.0) (Dowd, Li, Swenson, et al., 2014).

Despite increases in health insurance coverage, many adults with diabetes did not have an annual foot exam (30.7%) or eye exam (35.9%) in 2014. Although A1C testing increased between 2010 and 2014, one in four adults with diabetes in WV did not meet the goal of having the recommended two or more A1C tests in 2014. During the same period, the percentage of adults with diabetes who had health insurance increased (from 90.0% in 2010 to 94.5% in 2014). Many of the clinical tests for diabetes care are covered by health insurance. Taken together, these findings suggest that improving health insurance coverage alone may not be enough; other efforts such as reminders from the providers and patient education are needed to improve diabetes clinical care.

We also observed a decline in annual eye exam from 71.1% to 64.1% during the five-year period, which is concerning. It is well established that diabetic retinopathy is highly prevalent complication of diabetes and can lead to blindness if not treated (Sabanayagam, Banu, Chee, et. al. 2018). The global burden of disease study reported that world-wide diabetes retinopathy is the fifth most common cause of blindness (Leasher, Rupert, Bourne, et. al., 2016). Not receiving an eye-exam every year may place West Virginians at an increased risk for ocular disease and blindness. It has been reported that 64% of patients with diabetes may be at risk for blindness (Iris, 2018). Possible explanations for the lower rates may be related to perception of the eye exams as expensive, poor understanding of the increased risk of vision loss, cost for retinopathy referrals, geographical isolation and lack of specialists, or not covered by their current health insurance (Bryne, Parker, Tannenbaum et. al., 2014). As geographical isolation is an inherent feature of rural Appalachia, solutions to increase eye-screening may need to include "tele-ophthalmology" services, which may reduce the challenges of patient traveling long distances to seek eye-screening. Initial results from a collaborative telemedicine program to prevent blindness in WV patients with diabetes suggest that telemedicine can provide improved access to specialty care in rural Appalachia (Iris, 2018).

Although our findings showed no statistically significant change in DSME from 2010 to 2014, it is a critical element of care for all individuals with diabetes. Less than half (48.5%) of WV adults with diabetes received DSME in 2014, much lower than the baseline rate (56.8%) reported by the Healthy People 2020. In fact, *Healthy People 2020* (ODPHP, 2016) has identified increasing the number of individuals who receive formal diabetes education as one of the objectives.

Our study did not explore the reasons behind the low rates of DSME or other diabetes initiatives currently implemented in the state. However, existing literature shows there are a number of barriers to receiving DSME. A state-specific study in Maine found individuals with diabetes do not attend DSME due to aversion to group classes, perception that it is not necessary,

undesirable times/places, transportation issues, and lack of information about DSME. These issues apply to West Virginians and hence a positive perception of DSME and other available community-based programs may improve utilization (Johnson, Murray, Huang, 2010). In addition, it has been reported that DSME programs are limited in rural areas (Rutledge, Masalovich, Blacher, & Saunders, 2017). We speculate that because most of the DSME programs in WV are hospital- or clinic-based and require referrals from physicians, adults with diabetes may experience access barriers. Requiring referral from a physician for DSME and distance to the clinic or locations for diabetes self-management programs may also have discouraged many patients with diabetes from receiving diabetes education or change their health behaviors. West Virginia community pharmacies can provide DSME, however, only four pharmacies are ADA certified to provide reimbursable DSME. These findings suggest that significant efforts and resources need to be devoted to expand diabetes education in West Virginia.

Limitations

The findings of this study is subject to several limitations. First, the use of a cross-sectional study design for which no temporal causation can be inferred. Second, due to the addition of cell phone sampling frame and changes in weighting methodology, BRFSS 2014 is not directly comparable to BRFSS 2010. The 2010 WV BRFSS used a telephone-based questionnaire administered to a sample of individuals living in households with landlines and has the exclusion bias of those without landline telephones and those who do not reside in a household (e.g., homeless individuals and those who reside in institutional settings). Although a vast majority of US adults (~95%) have telephone service, a higher proportion of minority and low socioeconomic status citizens do not have coverage (Pew Research Center, 2018). Hence, these subgroups are likely underrepresented in our results. The study did not analyze other lifestyle behaviors such as diet and sleep that are important for diabetes management. The surveys were administered in English and likely included only English-speaking adults. Lastly, the findings from the survey were self-report, plausibly introducing recall bias, completion rate due to the length of the survey, social desirability bias, and interviewer bias.

The study also has several strengths. This study is the first to comprehensively assess diabetes clinical care and self-management activities in rural Appalachia. Because of the BRFSS design, the study results can be generalized to West Virginian adults with diabetes. A comprehensive list of factors were adjusted to assess the five-year trend in diabetes clinical care and self-management activities. The study included periods after the implementation of the affordable care act, which expanded access to healthcare services. An examination of the data on a state level allows for agencies and programs that design and implement diabetes self-management education and support as well as interventions to meet the needs of the patient/providers as well as consider West Virginia specific needs.

CONCLUSION

Given the high burden of diabetes and its complications in West Virginia that is associated with high economic costs for diabetes care in the state of West Virginia, our findings highlight low rates of DSME, annual foot and eye exam and self-management activities. There is an urgent need to assess and address these low rates for diabetes care and education. Future studies should identify patient/provider barriers, especially in HPSA areas and population groups, so that adults with diabetes can better manage their chronic conditions. Furthermore, targeted efforts for improved

diabetes care and self-management education strategies should focus on evidence-based programs approaches for lifestyle modifications to prevent diabetes-related complications.

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Contributors

Usha Sambamoorthi analyzed the data; both US and Ranjita Misra drafted the manuscript; interpreted results and approved the final version of the manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

REFERENCES

CDC (2017). About the BRFSS. Retrieved from Centers for Disease Control and Prevention website. https://www.cdc.gov/brfss/about/index.htm.

ADA (2016). *The Burden of Diabetes in West Virginia*. Retrieved from American Diabetes Association website http://main.diabetes.org/dorg/PDFs/Advocacy/burden-of-diabetes/west-virginia.pdf.

ADA (2018). *Standards Of Medical Care In Diabetes*. *Diabetes Care, 41(1). Supplement S1-S156.* https://diabetesed.net/wp-content/uploads/2017/12/2018-ADA-Standards-of-Care.pdf

ARC (2011). Appalachian Diabetes Coalitions Win Grants for Community Initiatives. Retrieved from Appalachian Regional Commision http://www.arc.gov/news/article.asp?ARTICLE_ID=314.

ARC (2015). The Appalachian Region. Retrieved from Appalachian Regional Commision website (http://www.arc.gov/appalachian_region/TheAppalachianRegion.asp).

Auchincloss, A. H., & Hadden, W. (2002). The health effects of rural-urban residence and concentrated poverty. *J Rural Health, 18*(2), 319-336.

BRFSS (2010). *Centers for Disease Control and Prevention (CDC). Behavioral Risk Factor Surveillance System Survey Questionnaire. Atlanta, Georgia: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. Summary Data Quality Report* Retrieved from https://ftp.cdc.gov/pub/data/brfss/2010_Summary_Data_Quality_Report.pdf.

BRFSS (2014). *Centers for Disease Control and Prevention (CDC). Behavioral Risk Factor Surveillance System Survey Questionnaire. Atlanta, Georgia: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. Summary Data Quality Report* Retrieved from https://www.cdc.gov/brfss/annual_data/2014/pdf/2014_dqr.pdf.

Byrne, M. M., Parker, D. F., Tannenbaum, S. L., Ocasio, M. A., Lam, B. L., Zimmer-Galler, I., & Lee, D. J. (2014). Cost of a community-based diabetic retinopathy screening program. *Diabetes Care, 37*(11), e236-237. doi:10.2337/dc14-0834.

Chrvala, C. A., Sherr, D., & Lipman, R. D. (2016). Diabetes self-management education for adults with type 2 diabetes mellitus: A systematic review of the effect on glycemic control. Patient Educ Couns, 99(6), 926-943. doi:10.1016/j.pec.2015.11.003

Coben, J. H., Tiesman, H. M., Bossarte, R. M., & Furbee, P. M. (2009). Rural-urban differences in injury hospitalizations in the U.S., 2004. *Am J Prev Med, 36*(1), 49-55. doi:10.1016/j.amepre.2008.10.001.

Dowd, B., Li, C. H., Swenson, T., Coulam, R., & Levy, J. (2014). Medicare's Physician Quality Reporting System (PQRS): quality measurement and beneficiary attribution. *Medicare Medicaid Res Rev, 4*(2), doi: 10 5600/mmrr 5004 5602 a5604. doi:10.5600/mmrr.004.02.a04.

Haas, L., Maryniuk, M., Beck, J., Cox, C. E., Duker, P., Edwards, L., . . . Standards Revision Task, F. (2012). National standards for diabetes self-management education and support. Diabetes Care, 35(11), 2393-2401. doi:10.2337/dc12-1707.

Iris. (2018). Intelligent Retinal Imaging Systems (Iris). Caseostudy: Using Telemedicine to Prevent Blindness in West Virginia's Diabetic Population. Retried at http://www.retinalscreenings.com/customers/case-studies/west-virginia-university.

Johnson, Richards, J., & Churilla, J. R. (2015). Care Utilization Patterns and Diabetes Self-Management Education Duration. *Diabetes Spectr, 28*(3), 193-200. doi:10.2337/diaspect.28.3.193.

Johnson TM, Murray MR, Huang Y (2010). Associations between self-management education and comprehensive diabetes clinical care. Diabetes Spectrum, 23:41–46.

KFF (2017). State Health Facts. The Kaiser Family Foundation Data Source: The Centers for Disease Control and Prevention (CDC), Primary Care Health Professional Shortage Areas (HPSAs). Data for West Virginia, December 31, 2017.

Leasher, J.L, Rupert, R.A., Bourne, Seth R.F., et al (2016). Global Estimates on the Number of People Blind or Visually Impaired by Diabetic Retinopathy: A Meta-analysis From 1990 to 2010. *Diabetes Care*, 39(9), 1643-1649.

McEwen, M. M., Lin, P. C., & Pasvogel, A. (2013). Analysis of behavior risk factor surveillance system data to assess the health of Hispanics with diabetes in US-Mexico border communities. *Diabetes Educ, 39*(6), 742-751. doi:10.1177/0145721713504629.

Misra, R., Fitch, C., Roberts, D., & Wright, D. (2016). Community-Based Diabetes Screening and Risk Assessment in Rural West Virginia. *J Diabetes Res, 2016*, 2456518. doi:10.1155/2016/2456518

Mukhtar, Q., Murphy, D. L., & Mitchell, P. L. (2003). Use of data from the Behavioral Risk Factor Surveillance System optional diabetes module by states. *J Public Health Manag Pract, Suppl*, S52-55.

O'Connor, P. J., Bodkin, N. L., Fradkin, J., Glasgow, R. E., Greenfield, S., Gregg, E., Wysham, C. H. (2011). Diabetes performance measures: current status and future directions. *Diabetes Care, 34*(7), 1651-1659. doi:10.2337/dc11-0735.

ODPHP (2016). Office of Disease Prevention and Health Promotion (ODPHP). Heart disease and stroke. In *Healthy People 2020*. Retrieved from https://www.healthypeople.gov/2020/topics-objectives/topic/heart-disease-and-stroke.

Olives, C., Myerson, R., Mokdad, A. H., Murray, C. J., & Lim, S. S. (2013). Prevalence, awareness, treatment, and control of hypertension in United States counties, 2001-2009. *PLoS One, 8*(4), e60308. doi:10.1371/journal.pone.0060308.

Pew Research Center. (2018). Mobile Fact Sheet. Retrieved from http://www.pewinternet.org/fact-sheet/mobile/.

Powers, M.A., Bardsley, J., Cypress, M., Duker, P., Funnell, M.M., Hess Fischl, A., Maryniuk, M.D., Siminerio, L., Vivian, E. (2015). Diabetes Self-management Education and Support in Type 2 Diabetes: A Joint Position Statement of the American Diabetes Association, the American Association of Diabetes Educators, and the Academy of Nutrition and Dietetics. *J Acad Nutr Diet, 15(8):1323-34.*

Rutledge, S. A., Masalovich, S., Blacher, R. J., & Saunders, M. M. (2017). Diabetes Self-Management Education Programs in Nonmetropolitan Counties - United States, 2016. *MMWR Surveill Summ, 66*(10), 1-6. doi:10.15585/mmwr.ss6610a1.

Sabanayagam C, Banu R, Chee ML, Lee R, Wang YX, Tan G, Jonas JB, Lamoureux EL, Cheng CY, Klein BEK, Mitchell P, Klein R, Cheung CMG, Wong TY. (2018). Incidence and progression of diabetic retinopathy: a systematic review. Lancet Diabetes Endocrinol. S2213-8587(18)30128-1.

Stolar, M. (2010). Glycemic control and complications in type 2 diabetes mellitus. Am J Med, 123(3 Suppl), S3-11. doi:10.1016/j.amjmed.2009.12.004.

WHO (2018). Country and regional data on diabetes. Retrieved from World Health Organization http://www.who.int/diabetes/facts/world_figures/en/index3.html .

WV DHHR (2018). Fast Facts. Retrieved from West Virgnia Department of Health and Human Resources https://dhhr.wv.gov/hpcd/data_reports/Pages/Fast-Facts.aspx.

WV DHHR (2017). Diabetes Prevention and Management Programs Offered in West Virginia. Retrieved from http://www.dhhr.wv.gov/hpcd/Documents/DiabetesProgramsWV_8_30_2017_Final.pdf.

WVRHA (2012). *Health Care in West Virginia: A Workforce Analysis. 2012.* Retrieved from West Virgnia Rural Health Association https://wvrha.org/wp-content/uploads/2017/06/2017-FINAL-WV-Workforce-8312017.pdf.