RESEARCH

Economic outcomes of diabetes self-management education among older Medicare beneficiaries with diabetes

Gang Lv[1†], Eric Chinaeke[2†], Xiangxiang Jiang[3], Xiaomo Xiong[4], Jun Wu[5], Jing Yuan[6*] and Z. Kevin Lu[3*]

Abstract

Background Diabetes self-management education (DSME) has significant clinical benefits on diabetic glycemic control and reduction in the onset of complications. However, the economic benefits of DSME in older Medicare beneficiaries are not well known. The objective of this study is to examine the effect of DSME on different types of costs in older Medicare beneficiaries with diabetes.

Methods This was a pooled cross-sectional study using the Medicare Current Beneficiary Survey (MCBS). The use of DSME was reported by survey respondents. Economic outcomes included total medical costs, total diabetes-related medical costs, total prescription costs, and total anti-diabetic prescription costs were measured based on Medicare claims and prescription drug events data from the perspective of the Medicare system. All costs were adjusted to 2012 U.S. dollars using the Consumer Price Index (CPI). Generalized linear models, with a log link and gamma distribution, were used to examine the effect of DSME on different costs.

Results A total of 3,003 older Medicare beneficiaries with diabetes were included, among whom 35.50% ($n = 1,066$) had DSME. Individuals who did not have DSME had significantly higher total prescription costs than those who had DSME ($4,398.19 vs. $3,966.82, $P = .0134$). After adjusting for covariates, compared to those who did not have DSME, those who had DSME had 16.36% (95% CI: 9.69% to 22.54%) lower total medical costs and 12.83% (95% CI: 6.41% to 18.80%) lower total prescription costs.

Conclusion This study found that DSME is associated with significantly lower spending in total medical and prescription costs for older Medicare beneficiaries. Given the economic benefits associated with DSME, different healthcare providers should further promote and increase the awareness of DSME to ensure sustained activities, enrollment, and patient retention in older Medicare beneficiaries with diabetes.

Keywords Diabetes, Diabetes self-management education, Economic outcomes, Medicare, Older adults

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Introduction

Diabetes was reported as the eighth leading cause of death in the U.S. [1]. About 38.1 million adults had diabetes in the U.S. with the majority of type 2 diabetes in 2021 [2]. Prevalence of diabetes progressively increased over the years and is positively associated with smoking and obesity [2]. Diabetes is often interrelated with a number of other comorbidities and can lead to serious complications such as retinopathy, kidney failure, and amputation of diabetes limb if not well managed [3]. Diabetes is more prevalent among older adults [3]. Over 25% of those enrolled in Medicare fee-for-service have diabetes while an estimated 400,000 new cases are diagnosed annually among Medicare beneficiaries aged 65 and older [3].

The economic burden of diabetes care is high on both patients and the Medicare system. A total of $ 412.9 billion was spent on diabetes care in 2022 [4]. It has been projected that in 2050, one in every three U.S. adults will develop diabetes and this trend will continue to drive high expenditure [5]. For every three dollars in Medicare, one dollar is spent on diabetes-related healthcare [3]. In 2022, the nation spent approximately $205 billion on medical care for diabetes in individuals aged 65 and older, with Medicare covering the majority of these costs [6]. Diabetes complications are major factors causing an increase in the economic burden of diabetes [4]. In 2017, complications related to diabetes accounted for over $37 billion in healthcare costs among Medicare beneficiaries aged 65 and older with type 2 diabetes [7].

Individuals living with diabetes can reduce the risk of developing complications as well as the associated costs by achieving and maintaining optimum blood glucose levels [8]. However, managing blood glucose levels can be complex for patients, including those who are less educated, or less experienced with diabetes self-care behaviors, and particularly among those newly diagnosed, as therapeutic inertia is documented to be a significant predictor in poor glycemic control [9, 10]. Hence, there is a need for diabetes self-care education such as diabetes self-management education (DSME). "DSME is an ongoing process of facilitating the knowledge, skill, and ability necessary for diabetes self-care" [8]. DSME provides information that helps people with diabetes understand the essentials of diabetes self-management, act to control their disease, and prevent disease progression [11]. It incorporates features of self-care behavior essential for the prevention of diabetes in prediabetes individuals [11]. The use of DSME is associated with a 0.45–0.57% reduction in A1C [12–14] which results in a delay in diabetes complications [15, 16], quality of life improvement [17, 18], reduction in hospital admissions and readmission [19, 20]. It is also associated with a change in lifestyle habits such as healthy eating and physical activities [21], self-efficacy enhancement [22], and healthy coping [23].

Medicare began reimbursing health care facilities for DSME under Part B (coverage for 10 h of the initial training and then 2 h once a year of follow-up activities) in 2000 [24, 25]. Medicare recognizes only the Association of Diabetes Care & Education Specialists (ADCES) and the American Diabetes Association (ADA) for training provision in line with the National Standards for Diabetes Self-Management Education (NSDSME) [24]. Despite the coverage provision for DSME, the training program participation rate is low [26]. Information on the economic benefits of DSME to Medicare beneficiaries and the Medicare system is lacking and there are some literature gaps. Firstly, various DSME programs studied previously were inconsistent in approach and varied from the NSDSME used in Medicare [27]. Additionally, no studies have evaluated the effect of DSME on total prescription and anti-diabetic prescription costs.

To address these literature gaps and to support the benefits of DSME to Medicare beneficiaries, this study aimed to use a nationally representative database to analyze economic outcomes of DSME in older Medicare beneficiaries including total medical costs, total diabetes-related medical costs, total prescription costs and total anti-diabetic prescription costs.

Methods

Data source

This was a pooled cross-sectional study using data from the Medicare Current Beneficiary Survey (MCBS) of 2006, 2008, 2010, and 2012. The MCBS is developed by the Centers for Medicare & Medicaid Services (CMS) using a multistage stratified random sampling design and computer-assisted personal interview protocol. It is nationally representative and provides information about medical care utilization and cost of Medicare uniquely linking both beneficiary's survey information and objective claims data [28]. We used MCBS for this study because it contains survey information necessary to examine the use of DSME and claims necessary to examine economic outcomes. The data is rich in information about respondent demographics, socioeconomics, medical care, and prescription utilization and costs [28].

Study population

The MCBS collects diabetes self-management and prevention information on a biennial basis. To get comprehensive information on the prescription and medical care of DSME, this study included Medicare beneficiaries aged 65 and older with diabetes from MCBS data. Medicare beneficiaries below 65 years, eligible for Medicare because of end-stage renal disease (ESRD) or disability, enrolled in healthcare maintenance organization (HMO) during the study period were excluded from the study.

Measurements

The presence of diabetes was measured based on self-report to the question: "Has a doctor ever told you that you had any type of diabetes?" [29]. A "Yes" response indicated having diabetes. The DSME engagement of Medicare beneficiaries reported having diabetes was identified by survey question: "Have you ever participated in a diabetes self-management course or class, or received special training on how you can manage your diabetes". They were classified as having DSME if they responded "Yes" and classified as not having DSME if they responded "No". The use of DSME was the main independent variable of the study.

Four economic outcome variables considered in the study included total medical costs, total diabetes-related medical costs, total prescription costs, and total anti-diabetic prescription costs. All of the economic variables were measured yearly from the perspective of the Medicare system. Total medical costs and total diabetes-related medical costs were measured based on Medicare Part A and B claims and prescription drug events in a given year. Total diabetes-related medical costs were measured only including Medicare Part A and B claims with diabetes as the primary diagnosis and prescription drug events of anti-diabetic prescriptions. Total prescription costs and total anti-diabetic prescription costs were measured based on prescription drug events in a given year. Total anti-diabetic prescription costs were measured only including prescription drug events of anti-diabetic prescriptions, which were identified if the generic name of the drugs recorded in the claims matched any of the following drugs: alpha-glucosidase inhibitors, biguanides, DPP-4 inhibitors, GLP-1 receptor agonists, insulins, meglitinides, sulfonylureas, and thiazolidinediones. All costs were adjusted to 2012 U.S. dollars using the Consumer Price Index (CPI).

Covariates considered in the study included prescribed diabetes pills, blood sugar/glucose checking, diabetes sore check, age, gender, race, education, marital status, income, residence, census region, and comorbidity. Charlson Comorbidity Index (CCI) was measured based on Medicare claims [30]. Other covariates were measured based on self-report.

Statistical analysis

National estimates were generated using the weights provided by the multistage sampling scheme used in the MCBS. We employed three weights in the analyses: "SUDSTRAT", which adjusts for the stratified sampling design in the MCBS to ensure proper subgroup representation; "SUDUNIT", which accounts for the primary sampling units (PSUs) or clusters to adjust for the clustering effect; and "CS1YRWGT", which adjusts the data for the cross-sectional full sample, ensuring the estimates are representative of the entire Medicare beneficiary population by correcting for the complex sampling design.

Chi-square tests were used to compare the characteristics of individuals with and without DSME. Total medical cost, total diabetes-related medical cost, total prescription cost, and total anti-diabetic prescription cost were compared between individuals with and without DSME through t-tests. Generalized linear models, with a log link and a gamma distribution, were used to examine the impact of DSME on total medical cost, total diabetes-related medical cost, total prescription cost, and total anti-diabetic prescription cost. For costs calculation, we applied the exponential transformation of the cost coefficient derived from the generalized linear model. The percentage change was calculated using the formula:

$$\text{Percentage Change} = 1 - e^{Coefficient}$$

We then multiplied this percentage change by the average costs for individuals without DSME to estimate the cost difference. The formula can be expressed as:

$$\text{Costs Change} = (\text{Average Costs of those without DSME}) \times (\text{Percentage Change})$$

All statistical analyses were conducted using SAS Software version 9.6 (Statistical Analysis Systems, Cary, NC).

Results

As shown in Table 1, a total of 3,003 older adults with diabetes were identified in this study. Among them, 1,066 (35.50%) patients with diabetes had DSME, and 1,937 (64.50%) patients with diabetes did not have DSME. Compared to those who had DSME, patients with diabetes who did not have DSME were less likely to have blood sugar/glucose testing (78.96% vs. 90.70%, $P < 0.0001$) and diabetes sore check (73.39% vs. 88.25%, $P < 0.0001$) (Table 1). Our study found that older adults with diabetes who did not have DSME were more likely to be older, be racial/ethnic minorities, have an education level below college, be widowed, and have a lower income than those who had DSME (Table 1).

Patients with diabetes who did not have DSME had significantly higher total prescription costs of $431.37 than those who had DSME ($4,398.19 vs. $3,966.82, $P = 0.0134$). Total medical costs, total diabetes-related medical costs, and total anti-diabetic prescription costs were similar between the DSME and non-DSME groups (Fig. 1).

In Table 2, after adjusting for covariates, compared to those who did not have DSME, Medicare beneficiaries with diabetes who had DSME had $3,289.67 [16.36% (1-e$^{-0.179}$), 95% CI: 9.69%– 22.54%] lower total medical cost and $564.29 [12.83% (1-e$^{-0.137}$), 95% CI:

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Table 1 Characteristics of older adults with diabetes by diabetes self-management education

	Diabetes Self-Management Education		
	Yes	No	P
	N = 1,066	N = 1,937	
	Weighted %	Weighted %	
Prescribed Diabetes Pill			0.2449
Yes	86.18	88.05	
No	13.82	11.95	
Blood Sugar/Glucose Testing			< 0.0001
Yes	90.7	78.96	
No	9.30	21.04	
Diabetes Sore Check			< 0.0001
Yes	88.25	73.39	
No	11.75	26.61	
Age			< 0.0001
65–74	55.12	47.91	
75–84	38.30	38.49	
85 +	6.58	13.61	
Gender			0.5603
Male	47.58	48.88	
Female	52.42	51.12	
Race			0.0249
Non-Hispanic white	79.17	73.88	
Non-Hispanic black	8.92	11.67	
Hispanic	5.90	8.65	
Other	6.02	5.80	
Education			< 0.0001
Less than high school	15.73	35.75	
High school graduate	29.80	27.24	
Some college	28.10	19.06	
College graduate	26.36	17.95	
Marital status			0.0003
Married	60.53	51.40	
Widowed	25.32	34.05	
Single	14.15	14.55	
Income			< 0.0001
< $25,000 per year	38.08	53.77	
≥ $25,000 per year	61.92	46.23	
Residence			0.1488
Non-metropolitan	25.39	29.35	
Metropolitan	74.61	70.65	
Census region			0.1200
Northeast	15.92	19.87	
Midwest	25.73	22.19	
South	41.76	43.67	
West	16.59	14.27	
CCI			0.1359
0	81.60	79.98	
1	7.69	10.42	
2	8.29	7.52	
3 +	2.42	2.08	

CCI Charlson comorbidity index

6.41%– 18.80%] lower total prescription costs on average. However, DSME was not significantly associated with total diabetes-related medical costs and total anti-diabetic prescription costs.

Discussion

This study assessed the economic impact of DSME on older Medicare beneficiaries, focusing on total medical costs, total diabetes-related medical costs, total prescription costs, and total anti-diabetic prescription costs. The results indicated that DSME is significantly associated with reductions in total medical costs and total prescription costs, but it did not show a significant association with total diabetes-related medical costs or total anti-diabetic prescription costs.

Study findings on the participation rate of DSME in older patients with diabetes were similar to previous reports on the low prevalence of DSME use in patients with diabetes [25, 26, 31]. The benefits of DSME have been demonstrated in several studies [31, 32], however, the participation rate of DSME has been remarkably low as reported in other studies [24, 26]. Special attention should be paid to older patients with diabetes who are less likely to have DSME (e.g. those who are older, are racial/ethnic minorities, are widowed, or have a lower income).

This study found that the use of DSME is significantly associated with lower total medical costs and lower total prescription costs after adjusting for covariates. These results strengthen the available evidence about the benefits of DSME in reducing the economic burden in patients with diabetes. Diabetes complications result in non-diabetes-related medical and prescription utilization, resulting in increased total medical costs and total prescription costs among diabetes with complications [33, 34]. Several studies have found that the use of DSME prevents and delays the onset of diabetes complications [15, 16] which is the major cause of high expenditure for diabetes care, additional medical and prescription costs associated with diabetes complications are averted, thereby, resulting in lower total medical costs and total prescription costs among those who had DSME relative to those who did not. Our results that DSME is associated with lower medical costs are consistent with previous studies. A systematic review found that 18 out of 26 identified papers reported that the use of DSME is associated with lower medical costs [31]. Other studies also found that commercially insured as well as Medicare patients who had DSME had lower medical costs compared to those who did not have DSME [35, 36].

Additionally, we did not find a significant impact of DSME on either total diabetes-related medical costs or total anti-diabetic prescription costs, which may be ascribed that DSME is an ongoing process that equips
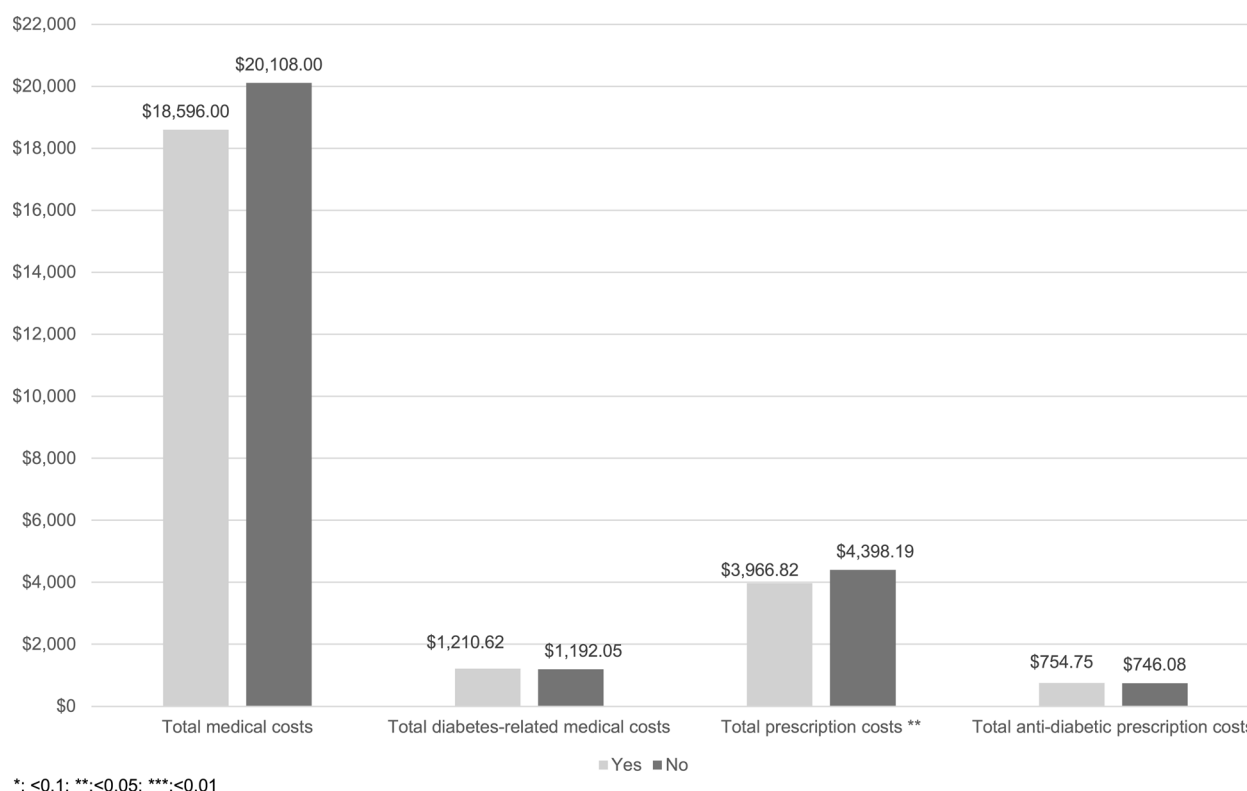
Fig. 1 Different costs of older adults with diabetes by Diabetes Self-Management Education (DSME). Yes: Medicare beneficiaries receiving DSME; No: Medicare beneficiaries not receiving DSME

Table 2 Effect of diabetes self-management education on economic outcome variables after adjusting for covariates

Economic outcome variables[a]	Estimate[b]	95% CI	
Total medical costs	− 0.179	− 0.255	−0.102
Total diabetes-related medical costs	− 0.075	− 0.165	0.015
Total prescription costs	− 0.137	− 0.208	−0.066
Total anti-diabetic prescription costs	− 0.108	− 0.217	0.001

[a]For cost calculation, we applied the exponential transformation of the cost coefficient derived from the generalized linear model. The percentage change was calculated using the formula: $\text{Percentage Change} = 1 - e^{\text{Coefficient}}$

[b]Actual cost change for total medical costs, total diabetes-related medical costs, total prescription costs, and total anti-diabetic prescription costs were $3,289.67, $86.19, $564.29, and $76.40, respectively

individuals with the knowledge and skills for effective self-care in diabetes and prediabetes, rather than directly treating diabetes or prescribing medications [11]. Therefore, DSME might not be significantly associated with anti-diabetic prescription costs and diabetes-related medical costs but might be associated with the prevention of additional costs due to complications. To our knowledge, this study is among the few to provide nationally representative evidence on the impact of DSME, and our study focused on various healthcare expenditures in the Medicare population, including total medical costs, total diabetes-related medical costs, total prescription costs, and total anti-diabetic prescription costs.

The key significance of this study is to provide evidence that DSME is an important tool for scaling down the total medical costs and total prescription costs of diabetes and to suggest the need to encourage and promote more participation. Furthermore, this study presented the inequality of the characteristics between patients with diabetes who had or did not have the DSME, which serves as a guide to DSME educators in strategizing for effective training, DSME use evaluation, monitoring, and retention of patients in DSME. Our findings might directly benefit Accountable Care Organizations (ACO) and other providers to a degree as they seek to address various barriers to effective diabetes care and achieve the quality measures required to make the most of value-based reimbursement. The U.S. healthcare system and the Medicare system would also benefit from our findings. Based on the current trend in diabetes incidence rates and complications, it is projected that one in three individuals will develop type 2 diabetes by 2050 and the U.S. health systems may not afford the costs of diabetes [5]. Our results are in line with previous studies, therefore suggesting that DSME might be a key cost-containment strategy suitable to nullify the 2050 projection.

This study also has some limitations. First, as a cross-sectional study, the long-term effect of DSME cannot be determined and we cannot establish a time

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sequence to verify if DSME was utilized before our measurements. As such, this study cannot establish causality between DSME and various cost measures. Second, DSME was identified based on a self-reported survey, as such, the measure of DSME might be subject to recall bias from respondents. Third, although we included a wide range of confounding factors, the presence of unmeasured confounders (e.g. severity of diabetes, pension information, etc.) may not be overruled in this study. Fourth, the diabetes-related medical costs of Part A and Part B claims were measured based on the primary code of diabetes, but sometimes patients with diabetes are admitted due to cardiovascular diseases or other diabetic complications, which might lead to selection biases to a certain degree. Fifth, the results of this study might not apply to excluded age groups of disabled and Medicare beneficiaries with ESRD. Finally, the data utilized in this study are from 2006−2012, so it is important to consider the possible changes in healthcare practices and policies over time when interpreting the findings. Future research should aim to use longitudinal data based on more recent data to assess the impact of DSME on various cost types.

In general, although it is still needed to confirm the inconsistency between the unadjusted and adjusted results of the association between DSME and total medical costs by further studies, this study further strengthens the evidence that the use of DSME would result in a reduction in total medical costs and total prescription costs for Medicare beneficiaries with diabetes. DSME has positive effects on clinical, psychosocial, and behavioral aspects of diabetes thereby leading to the patient's general well-being and consequent reduction in the cost of care [37].

Based on our results and previous findings from the literature, we suggest that: 1) DSME offers an opportunity to further reduce the medical costs of diabetes for the CMS; 2) increasing patient participation in DSME is needed to further reduce expenditure for medical costs of diabetes; and 3) the features of DSME, including self-care behavior, lifestyle modification, and self-management are crucial factors for cost containment of diabetes complications in Medicare patients with diabetes.

Conclusion

The use of DSME is associated with lower total medical costs and total prescription costs among Medicare beneficiaries. Our results strengthen existing evidence of the benefit of DSME using a nationally representative database of Medicare beneficiaries to determine the direct impact of DSME on the costs of patients with diabetes. Based on our results, we recommend further promotion and awareness of the benefits of DSME to ensure more participation, sustained DSME activities, enrollment, and patient retention in DSME.

Abbreviations

ACO	Accountable Care Organization
ADA	American Diabetes Association
ADCES	Association of Diabetes Care & Education Specialists
CCI	Charlson Comorbidity Index
CMS	Centers for Medicare & Medicaid Services
CPI	Consumer Price Index
DSME	Diabetes self-management education
ESDR	End-stage renal disease
HMO	Healthcare maintenance organization
MCBS	Medicare Current Beneficiary Survey
NADSME	National Standards for Diabetes Self-Management Education
PSUs	Primary sampling units

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12913-025-12796-5.

Supplementary Material 1.

Data availability
All data generated or analyzed during this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The University of South Carolina Institutional Review Board approved this study. Because we used deidentified data from the Medicare Current Beneficiary Survey (MCBS), the University of South Carolina Institutional Review Board has waived the need for informed consent for this study. Specifically, the Office of Research Compliance, on behalf of the Institutional Review Board, approved the referenced study. This study was conducted in accordance with the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

References
1. Statistics About Diabetes. American Diabetes Association. https://diabetes.org/about-diabetes/statistics/about-diabetes. Accessed 16 Jan 2025.
2. National Diabetes Statistics Report. Centers for Disease Control and Prevention. https://www.cdc.gov/diabetes/php/data-research/index.html. Accessed 30 Aug 2024.

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3.   Narayan KM, Gregg EW, Fagot-Campagna A, et al. Diabetes–a common, growing, serious, costly, and potentially preventable public health problem. Diabetes Res Clin Pract. 2000;50(Suppl 2):S77-84.

4.   Parker ED, Lin J, Mahoney T, et al. Economic costs of diabetes in the U.S. in 2022. Diabetes Care. 2024;47(1):26–43.

5.   Boyle JP, Thompson TJ, Gregg EW, et al. Projection of the year 2050 burden of diabetes in the US adult population: dynamic modeling of incidence, mortality, and prediabetes prevalence. Popul Health Metr. 2010;8:29.

6.   Medicare Diabetes Prevention Program (MDPP) Expanded Model. Centers for Medicare & Medicaid (CMS). https://www.cms.gov/priorities/innovation/in novation-models/medicare-diabetes-prevention-program. Accessed 16 Jan 2025.

7.   Cost of Diabetes Complications for Medicare Beneficiaries. Centers for Disease Control and Prevention (CDC). https://www.cdc.gov/diabetes/data-rese arch/research/older-adults.html. Accessed 16 Jan 2025.

8.   Funnell MM, Brown TL, Childs BP, et al. National standards for diabetes self-management education. Diabetes Care. 2009;32 Suppl 1(Suppl 1):S87-94.

9.   Menke A, Casagrande S, Geiss L, et al. Prevalence of and Trends in Diabetes Among Adults in the United States, 1988–2012. JAMA. 2015;314(10):1021–9.

10.   Blonde L, Aschner P, Bailey C, et al. Gaps and barriers in the control of blood glucose in people with type 2 diabetes. Diab Vasc Dis Res. 2017;14(3):172–83.

11.   Haas L, Maryniuk M, Beck J, et al. National standards for diabetes self-management education and support. Diabetes Care. 2014;37 Suppl 1(Suppl 1):S144-53.

12.   Steinsbekk A, Rygg LO, Lisulo M, et al. Group based diabetes self-management education compared to routine treatment for people with type 2 diabetes mellitus. A systematic review with meta-analysis. BMC Health Serv Res. 2012;12:213.

13.   Chrvala CA, Sherr D, Lipman RD. Diabetes self-management education for adults with type 2 diabetes mellitus: A systematic review of the effect on glycemic control. Patient Educ Couns. 2016;99(6):926–43.

14.   Powers MA. 2016 Health Care & Education Presidential Address: If DSME Were a Pill, Would You Prescribe It? Diabetes Care. 2016;39(12):2101–7.

15.   Diabetes C, Complications Trial Research G, Nathan DM, et al. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. N Engl J Med. 1993;329(14):977–86.

16.   Stratton IM, Adler AI, Neil HA, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ. 2000;321(7258):405–12.

17.   Cooke D, Bond R, Lawton J, et al. Structured type 1 diabetes education delivered within routine care: impact on glycemic control and diabetes-specific quality of life. Diabetes Care. 2013;36(2):270–2.

18.   Toobert DJ, Glasgow RE, Strycker LA, et al. Biologic and quality-of-life outcomes from the Mediterranean Lifestyle Program: a randomized clinical trial. Diabetes Care. 2003;26(8):2288–93.

19.   Healy SJ, Black D, Harris C, et al. Inpatient diabetes education is associated with less frequent hospital readmission among patients with poor glycemic control. Diabetes Care. 2013;36(10):2960–7.

20.   Robbins JM, Thatcher GE, Webb DA, et al. Nutritionist visits, diabetes classes, and hospitalization rates and charges: the Urban Diabetes Study. Diabetes Care. 2008;31(4):655–60.

21.   Toobert DJ, Strycker LA, King DK, et al. Long-term outcomes from a multiple-risk-factor diabetes trial for Latinas: inverted exclamation markViva Bien! Transl Behav Med. 2011;1(3):416–26.

22.   Tang TS, Funnell MM, Oh M. Lasting effects of a 2-year diabetes self-management support intervention: outcomes at 1-year follow-up. Prev Chronic Dis. 2012;9:E109.

23.   Thorpe CT, Fahey LE, Johnson H, et al. Facilitating healthy coping in patients with diabetes: a systematic review. Diabetes Educ. 2013;39(1):33–52.

24.   Strawbridge LM, Lloyd JT, Meadow A, et al. Use of Medicare's Diabetes Self-Management Training Benefit. Health Educ Behav. 2015;42(4):530–8.

25.   Brunisholz KD, Briot P, Hamilton S, et al. Diabetes self-management education improves quality of care and clinical outcomes determined by a diabetes bundle measure. J Multidiscip Healthc. 2014;7:533–42.

26.   Li R, Shrestha SS, Lipman R, et al. Diabetes self-management education and training among privately insured persons with newly diagnosed diabetes–United States, 2011–2012. MMWR Morb Mortal Wkly Rep. 2014;63(46):1045–9.

27.   Ernawati U, Wihastuti TA, Utami YW. Effectiveness of diabetes self-management education (DSME) in type 2 diabetes mellitus (T2DM) patients: Systematic literature review. J Public Health Res. 2021;10(2):2240.

28.   Medicare Current Beneficiary Survey (MCBS). Centers for Medicare & Medicaid Services. Updated July 06, 2024. https://www.cms.gov/data-research/rese arch/medicare-current-beneficiary-survey. Accessed 30 Aug 2024.

29.   Park J, Zhang P, Wang Y, et al. High Out-of-pocket Health Care Cost Burden Among Medicare Beneficiaries With Diabetes, 1999–2017. Diabetes Care. 2021;44(8):1797–804.

30.   Comorbidity SAS Macro (2021 version). National Cancer Institute. https://he althcaredelivery.cancer.gov/seermedicare/considerations/macro-2021.html. Accessed 16 Jan 2025.

31.   Boren SA, Fitzner KA, Panhalkar PS, et al. Costs and benefits associated with diabetes education: a review of the literature. Diabetes Educ. 2009;35(1):72–96.

32.   He X, Li J, Wang B, et al. Diabetes self-management education reduces risk of all-cause mortality in type 2 diabetes patients: a systematic review and meta-analysis. Endocrine. 2017;55(3):712–31.

33.   Young BA, Lin E, Von Korff M, et al. Diabetes complications severity index and risk of mortality, hospitalization, and healthcare utilization. Am J Manag Care. 2008;14(1):15–23.

34.   Clarke PM, Glasziou P, Patel A, et al. Event rates, hospital utilization, and costs associated with major complications of diabetes: a multicountry comparative analysis. PLoS Med. 2010;7(2):e1000236.

35.   Duncan I, Birkmeyer C, Coughlin S, et al. Assessing the value of diabetes education. Diabetes Educ. 2009;35(5):752–60.

36.   Duncan I, Ahmed T, Li QE, et al. Assessing the value of the diabetes educator. Diabetes Educ. 2011;37(5):638–57.

37.   Welch G, Zagarins SE, Feinberg RG, et al. Motivational interviewing delivered by diabetes educators: does it improve blood glucose control among poorly controlled type 2 diabetes patients? Diabetes Res Clin Pract. 2011;91(1):54–60.

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