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Food Insecurity and Medication Adherence in Low-Income Older Medicare Beneficiaries With Type 2 Diabetes

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Little is known about diabetes management among low-income older Americans. This study used statewide self-administered survey and Medicare claims data to examine the relationships of food insecurity and medication (re)fill adherence in a sample of Medicare Part D beneficiaries with type 2 diabetes in need of food assistance in Georgia in 2008 ($n=243$, mean age 74.2 ± 7.8 years, 27.2% African American, 77.4% female). (Re)fill adherence to oral hypoglycemics was measured as Proportion of Days Covered. Food insecurity was assessed using a six-item validated standard measure. About 54% of the sample were food insecure. About 28% of the diabetic sample did not (re)fill any diabetes medication and over 80% had at least one diabetes complication. Food insecure participants showed comparable (re)fill adherence to food secure participants. However, 57% of food insecure participants were nonadherent to oral hypoglycemics. Underlying basic needs must be addressed to improve diabetes management in this population.

KEYWORDS *food insecurity, medicare claims, medication (re)fill adherence, older adults, poverty, type 2 diabetes*

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INTRODUCTION

The aging of the population is thought to be a major driver of the diabetes epidemic in the United States (1). Diabetes is among the most common and costly chronic diseases older Americans are afflicted with (26.5% in 2010), impacting particularly socioeconomically disadvantaged older Americans (2–4). Mismanaged diabetes in this population comes at great human and economic cost. About 32% of Medicare spending is attributed to the diabetes population and almost 36% of Medicare spending is attributed to low-income individuals who are dually eligible for Medicare and Medicaid (5, 6). It is therefore critical to better understand and address everyday problems associated with diabetes management in this population. A Consensus Report on Diabetes and Older Adults, developed by the American Diabetes Association in 2012, identified the need for observational evidence from “real world settings” while considering complex and heterogeneous characteristics of different subgroups of older Americans (7).

High expenses for needed health care and prescription medications among older adults have shown to compete with other basic needs, including food (8–10). Food insecurity is a serious public health problem that is defined as “the limited or uncertain availability of nutritionally adequate and safe foods, or the limited or uncertain ability to acquire acceptable foods in socially acceptable ways” (11). Food insecurity challenges diabetes management, because food insecure individuals are less likely to consume an adequate quality, variety, and quantity of diet due to cost, and develop compensatory behaviors involving reduced food intake during periods of shortage and food overconsumption as resources become available. Other coping strategies may involve higher intake of low-cost, energy-dense foods, all of which jeopardize glycemic control (12, 13). Food insecure adults with diabetes show poorer diabetes management characteristics, including poorer diabetes self-efficacy and glycemic control (hemoglobin A1c $\geq 8.5\%$), and more hypoglycemia-related emergency department visits, than their food secure counterparts (13–15). Trade-off decisions among basic needs also drive vulnerable older individuals into medication nonadherence behaviors (10). Diabetes patients, who are typically burdened with multiple diet-related comorbidities, face higher out-of-pocket expenses for medications than patients suffering from other chronic diseases (16). Medication nonadherence to diabetes medications contributes to poor glycemic control (17), and is associated with increased health care service utilization in older adults with diabetes (18).

Although food insecurity and medication nonadherence likely influence everyday diabetes management in low-income older adults with type 2 diabetes, little is known about these factors, their relationships, and their impact on diabetes management in this population. The objective of this study was

to describe medication utilization and adherence among a vulnerable sample of food secure and insecure Medicare Part D beneficiaries with type 2 diabetes. Findings from this study may serve as basis to design targeted interventions aiming at decreasing diabetes-related disparity in the United States.

METHODS

Research Design and Population

This study employed a secondary data analysis using data from the Georgia Advanced Performance Outcomes Measures Project 6 (GA Advanced POMP 6) and the Centers for Medicare and Medicaid Services (CMS). The purpose, study design, study sample, and data collection methods of the GA Advanced POMP 6 study have been described elsewhere (8, 19). The GA Advanced POMP 6 provides self-reported information on sociodemographic, economic, and health characteristics, as well as medication management, nutritional risk, and food security. Through collaboration among the University of Georgia, the Georgia Department of Human Services Division of Aging Services (DAS), and CMS, research-identifiable Medicare data files were obtained and merged for all GA Advanced POMP 6 study participants who were Medicare beneficiaries in 2008–2009. A description of the initial matching and merging process of both datasets was published elsewhere (20, 21). The GA Advanced POMP 6 was a project originally sponsored by the U.S. Department of Health and Human Services Administration on Aging and implemented to monitor and assess the cost-efficiency and effectiveness of the Older Americans Act Nutrition Program (OAANP) on the target population, as required by the 1993 Government Performance and Results Act and U.S. Office of Management and Budget (OMB). The GA POMP 6 represents collaboration among the Georgia Department of Human Resources, Division of Aging Services (DAS), and the University of Georgia (UGA) Department of Foods and Nutrition. The project included a longitudinal and a cross-sectional study using self-administered mail surveys completed by community dwelling OAANP participants and waitlisted individuals who were identified from the Georgia OAANP client database systems, and fell into 1 of 4 categories: Home Delivered Meals (HDM) participants, Congregate Meals (CM) participants, and individuals on the waitlist (WL) for either program (HDMWL and CMWL, respectively). The present study used the baseline sample of the longitudinal study, which collected three waves of self-reported surveys four months apart between October 2008 and September 2009. In order to accrue a sufficient sample size, surveys were mailed to all individuals who requested OAANP services in Georgia between July and early November 2008, and were new to the program or waitlisted for

five consecutive months ($n = 4,731$). As a consequence, newly enrolled and waitlisted OAANP participants sampled in this study have the same level of need for food assistance. This study has been reviewed and approved by the Institutional Review Board at the University of Georgia and Georgia Department of Human Services.

Measures

FOOD INSECURITY

Food insecurity due to a lack of financial resources was measured using a validated modified version of the six-item U.S. Household Food Security Survey Module, which has been validated for use in this population against national food security statistics (22). A food insecurity summary score was calculated as the sum of affirmative responses (score 0–6) and was used to classify individuals as either food secure (score 0–1) or food insecure (score 2–6).

TYPE 2 DIABETES MEDICATION UTILIZATION

Type 2 diabetes medication utilization was defined as (1) the total annual count of unduplicated diabetes medications trichotomized into (a) none, (b) one, and (c) two or more diabetes medications in 2008; and (2) type 2 diabetes medication treatment regimen following the consensus statement from the American Diabetes Association and the European Association for the Study of Diabetes on the management of hyperglycemia in type 2 diabetes (23): (1) oral hypoglycemic monotherapy; (2) oral hypoglycemic combination therapy, and (3) combination of oral hypoglycemic therapy and insulin or insulin alone. Switching was defined as change from a free combination to the equivalent fixed combination therapy with no or little overlap in refill periods, thus was categorized as (2).

MEDICATION ADHERENCE TO ORAL HYPOGLYCEMIC MEDICATIONS

The proportion of days covered (PDC) was calculated for each beneficiary for the period between the first fill date in 2008 (index date) to December 31, 2008, using the medication adherence measure methodology adopted by CMS as part of the mandated Medicare Advantage and Medicare Part D private health plan star rating started in 2012 (24–26). The PDC is defined as the number of days of medication supply in the observation period (numerator), divided by the number of days in the observation period (denominator) multiplied by 100. Any remaining days' supply exceeding the observation period were truncated at 100%. The PDC was first calculated per therapeutic class for each participant, then an average PDC of all

therapeutic classes for each participant was calculated. The average PDC was then described as (1) 0% (“nonadherence”), (2) 1%–79% (“suboptimal adherence”), and 80% and higher (“optimal adherence”).

Cost-related medication nonadherence (CRN) to any medication was assessed based on five self-reported nonadherence behaviors. Participants were considered nonadherent if they reported one or more CRN behavior(s). A more detailed description of the CRN assessment was reported elsewhere (8, 27).

DIABETES COMPLICATION-RELATED HEALTH CARE UTILIZATION

Diabetes complication-related health care utilization was measured using a diabetes complications severity index, developed by Young and colleagues (28). The total number of complication types (range 0–7) for which a participant received health care services was presented as (a) no complication, (b) complication(s) from 1 type, and (c) complications from 2+ types.

HEALTH CHARACTERISTICS

Five levels of self-reported health, ranging from “poor” to “excellent” were measured and dichotomized as (a) “poor to fair” and (b) “good to excellent.” Objective health status was assessed by types and number of diagnoses of 18 chronic conditions based on CMS Chronic Condition Warehouse data (29). The total number of 17 chronic conditions was calculated (type 1 diabetes used exclusively for sample exclusion criteria). The total number of physician visits and hospital admissions was calculated. The latter was presented as (a) none, (b) one admission, and (c) two or more admissions.

HEALTH- AND MEDICATION INSURANCE-RELATED CHARACTERISTICS

The maximal Medicare Part D coverage phases reached in 2008 were defined as (a) deductible or initial coverage phase, (b) coverage gap phase, and (c) catastrophic coverage phase (30). Subsidy support for Medicare beneficiaries was summarized as dichotomous variables for health care insurance (dual eligibility; yes/no; ≥ 1 month), and for prescription medications (Medicare Part D Low Income Subsidy (LIS); yes/no; ≥ 1 month).

SOCIODEMOGRAPHIC AND ECONOMIC CHARACTERISTICS

Age was used as dichotomized variable (<75 years vs. ≥ 75 years). Race was categorized as (a) African American and (b) White/other. Education level described (a) <high school diploma (<12 years) and (b) \geq high school diploma (≥ 12 years). County of residence was dichotomized as rural or urban based on the classification by Bachtel and colleagues (31). Poverty

status was determined based on reported household income and number of household members and compared with 2008 federal poverty thresholds (32), and was dichotomized as (a) < Federal Poverty Level (FPL) and (b) \geq FPL. Living arrangement was dichotomized as (a) living alone and (b) living with others. Participation in nutrition assistance was determined if a participant received (a) OAANP services (waitlisted vs. participation in either CM or HDM) and (b) Supplemental Nutrition Assistance Program (Food Stamps) (yes/no).

Analytic Sample

The analytic sample included only GA Advanced POMP 6 longitudinal study baseline participants who had complete information on all variables of interest, were fee-for-service Medicare beneficiaries and enrolled in a private Medicare Part D drug plan throughout 2008 (12 months), and had a diagnosis of type 2 diabetes in 2008. The GA Advanced POMP 6 longitudinal study baseline sample consisted of 1,594 individuals. Compliant with CMS policy 1,377 participants of this sample were merged through encrypted social security numbers with Medicare claims data in cooperation with the Georgia Department of Human Services Division of Aging Services. This sample was the basis for further exclusion and used to derive the final analytic sample. Of the merged sample, 39.7% ($n = 546$) had a diagnosis of type 2 diabetes in 2008 (primary criterion). Of 546 persons with a diagnosis of type 2 diabetes, only 78.4% ($n = 428$) had continuous Medicare Part D coverage (Medicare prescription insurance, thus data on prescription claims) throughout 2008. After further exclusion due to incomplete data on all variables of interest (food insecurity, cost-related medication nonadherence, sociodemographic, and economic variables), the final study sample consisted of 243 (17.7% of the merged sample of $n = 1,377$) individuals.

Statistical Analysis

Descriptive statistics were used to summarize characteristics of the study sample. To compare participant characteristics by food security status and PDC category, chi-square tests were conducted for categorical variables, t tests or ANOVA tests were used for continuous variables with normal distribution, and Mann Whitney U or Kruskal Wallis tests were conducted for categorical variables with non-normal distributions. A multivariate ordinal logistic regression model was used to examine the relationship of food insecurity and level of medication adherence while controlling for potential confounders. All analyses were conducted using SAS (Version 9.3, SAS Institute, Cary, NC) with a level of statistical significance at $P < 0.1$, $P < 0.05$, or $P < 0.01$.

RESULTS

Selected characteristics of the study sample by food security status and level of (re)fill adherence to oral hypoglycemic medications are shown in Tables 1 and 2, respectively. The mean age of the analytic sample was 74.2 ± 7.8 years, 77.4% were female, and 27.2% were African American. About 45.7% had annual household incomes below the FPL while the majority of the analytic sample was homebound, either receiving or waiting for HDM services (85.2%). More than 80% reported fair-poor health, had up to 10 chronic conditions (median 5, interquartile range [IQR] 3.0, 6.0), among which diet-related chronic conditions, including hypertension (66.7%), ischemic heart disease (IHD; 52.3%), and chronic heart failure (CHF; 44.4%) were most prevalent. A large share of the analytic sample received subsidy support for health care (67.7%) and prescription medications (78.6%) for one or more months in 2008. One third of food insecure individuals never reached and an additional 40.2% never exited the Medicare Part D coverage gap. About 68% of the analytic sample was dually eligible for Medicare and Medicaid, and over three quarters had some level of out-of-pocket cost relief through the Medicare Part D LIS (78.6%). Almost half of the sample (45.7%) reported CRN of any medications they were currently taking.

About 54% of the analytic sample was food insecure. Compared to food secure individuals, food insecure individuals were more likely to be younger (72.3 ± 7.4 years), African American (34.1%), less educated (66.7%), poor (53.8%), and to report fair-poor health status (88.6%). In addition, they were more likely in need of nutrition assistance, participating in Food Stamps (43.2%) but on the waiting list for OAANP services (71.2%). At the same time, food insecure individuals were almost twice as likely as their counterparts to be dual eligibles, and one and a half times more likely to receive some level of Medicare Part D LIS in 2008.

About 41.6% of the sample were nonadherent, 23.9% were suboptimally adherent, and 34.6% were optimally adherent to oral hypoglycemic medications, respectively (Table 2). Those with optimal adherence were about twice as likely to live in rural areas as those being nonadherent (32.1% vs. 15.8%). Individuals with optimal adherence also tended to have less hospital admissions (69.1% had none) and to be treated for less chronic conditions (median 4.0 (IQR 3.0, 6.0)). In addition, individuals with two or more hospital admissions were more likely to have a lower level of adherence than those not admitted to the hospital in 2008. Similarly, those utilizing healthcare services for one to two diabetes complication types tended to show a lower level of adherence than those not utilizing any complication-related services (results not shown).

Diabetes management characteristics of the study sample and by food security status are shown in Table 3. About 23% (re)filled oral hypoglycemic

TABLE 1 Selected Characteristics of Study Sample by Food Security Status

Characteristics Percent or mean \pm SD or median (Q1, Q3)	Total sample	Food insecure	Food secure
<i>Total sample (%)</i>	<i>243 (100.0)</i>	<i>132 (54.3)</i>	<i>111 (45.7)</i>
<i>Sociodemographic and economic characteristics</i>			
Age, years	74.2 (7.8)	72.3 (7.4)	76.5 (7.6) [†]
Aged <75 years	56.4	66.7	44.1 [†]
Female	77.4	74.2	81.1
Less than high school diploma	57.2	66.7	46.0 [†]
African American	27.2	34.1	18.9 [†]
Rural (location)	22.6	23.5	21.6
Household income < FPL	45.7	53.8	36.0*
Living alone	55.1	53.0	57.7
Food stamp recipient	30.9	43.2	26.2 [†]
OAANP participation status: WL (vs. participant)	60.9	71.2	48.7 [†]
OAANP: HDM/WL (vs. CM/WL)	85.2	86.4	83.8
<i>Health characteristics</i>			
Fair-poor self-reported health	83.5	88.6	77.5*
No. of chronic conditions treated in 2008 (1–10)	5.0 (3.0, 6.0)	5.0 (3.0, 6.0)	5.0 (4.0, 6.0)
No. of different prescription medications filled in 2008 (0–39)	14.0 (10.0, 20.0)	15.0 (9.5, 20.0)	13.0 (10.0, 19.0)
Selected types of chronic conditions treated in 2008			
Alzheimer disease and related disorders of senile dementia	17.3	17.4	17.1
Cataract	19.8	19.7	19.8
Chronic obstructive pulmonary disease	22.2	26.5	17.1 [¶]
Chronic kidney disease	32.9	30.3	36.0
Depression	19.8	21.2	18.0
Congestive heart failure	44.4	43.2	46.0
Hyperlipidemia	35.4	31.8	39.6
Hypertension	66.7	67.4	65.8
Ischemic heart disease	52.3	50.0	55.0
Rheumatoid arthritis/osteoarthritis	36.2	30.3	43.2*
No. of hospital admissions in 2008 (0–11)			
None	57.2	61.4	52.3
1 admission	21.4	19.7	23.4
2+ admissions	21.4	18.9	24.3
No. of physician visits in 2008 (0–52)	9.0 (5.0, 15.0)	9.0 (5.0, 14.5)	9.0 (5.0, 15.0)
1+ cost-related medication nonadherence behaviors	45.7	51.5	38.7 [†]
<i>Health and medication insurance characteristics</i>			
Medicare dual eligibility (1+ months in 2008)	67.7	82.6	48.6 [†]
Medicare Part D LIS ² receipt (1+ months in 2008)	78.6	92.4	62.2 [†]

(Continued)

TABLE 1 Continued

Characteristics Percent or mean \pm SD or median (Q1, Q3)	Total sample	Food insecure	Food secure
Maximal Part D coverage phase reached in 2008 (2 missing)			
Deductible or initial coverage phase	34.0	33.3	34.9
Coverage gap phase	41.5	40.2	43.1
Catastrophic coverage phase	24.5	26.5	22.0

Note. In accordance with the CMS data use agreement, all data displayed follows the CMS's cell size suppression policy that mandates that no cell 10 or less may be displayed. CM = congregate meals participant or waitlisted; FPL = Federal Poverty Level; HDL = home-delivered meals participant or waitlisted; LIS = low-income subsidy; OAA NP = Older Americans Act Nutrition Program; WL = waitlisted (vs. participant).

*Statistical significance at $P < 0.01$.

[†]Statistical significance at $P < 0.05$.

[‡]Statistical significance at $P < 0.10$.

medications from one therapeutic class exclusively (monotherapy), 20.6% (re)filled a combination of oral hypoglycemic medications from different therapeutic classes, and the remaining 27.6% (re)filled a combination of oral hypoglycemic therapy and/or one or more types of insulin. Despite a diagnosis of type 2 diabetes, however, 28.4% of the study sample did not (re)fill any diabetes medication. More than 80% of the sample utilized health care services related to diabetes complications, among which cardiovascular (62.6%), neuropathic (35.4%), and nephropathic complications (30.5%) were most common. Nonadherent individuals in comparison to optimally adherent individuals were twice as likely to be diagnosed with a diabetes complication (Table 4).

Type 2 diabetes management characteristics did not significantly differ by food security status. Multivariate ordinal logistic regression results showed that food insecurity was not independently associated with lower adherence levels to oral hypoglycemic medications (data not shown). However, about 57% of food insecure individuals with a diagnosis of type 2 diabetes were entirely nonadherent to oral hypoglycemics. In addition, food insecure individuals were significantly more likely to report cost-related medication nonadherence (51.5%) regardless of medication types.

DISCUSSION

To our knowledge, this is the first study to explore medication utilization and adherence among food secure and insecure older fee-for-service Medicare Part D beneficiaries with type 2 diabetes. Although we found comparable levels of (re)fill adherence to oral hypoglycemic medications among food

TABLE 2 Selected Characteristics of Study Sample by Level of (Re)fill Adherence to Oral Hypoglycemic Medications

Baseline characteristics Percent or mean \pm SD or median (Q1, Q3)	Total sample	Nonadherence	Suboptimal adherence	Optimal adherence
<i>Total sample (%)</i>	<i>243 (100.0)</i>	<i>101 (41.6)</i>	<i>58 (23.9)</i>	<i>84 (34.6)</i>
Food insecure	54.3	57.4	50.0	53.6
<i>Sociodemographic and economic characteristics</i>				
Age, years	74.2 (7.8)	74.4 (8.0)	74.6 (7.2)	73.7 (7.9)
Aged <75 years	56.4	56.4	53.5	58.3
Female	77.4	75.3	77.6	79.8
Less than high school diploma	57.2	56.4	56.9	58.3
African American	27.2	26.7	20.7	32.1
Rural (location)	22.6	15.8	20.7	32.1 [†]
Household income < FPL	45.7	40.6	48.3	50.0
Living alone	55.1	54.5	55.2	56.0
Food stamp recipient	30.9	31.7	25.9	33.3
OAANP participation status: WL (vs. participant)	60.9	52.5	70.7	64.3 [¶]
OAANP program: HDM/WL (vs. CM/WL)	85.2	81.2	87.9	88.1
<i>Health characteristics</i>				
Fair-poor self-reported health	83.5	77.2	93.1	84.5 [†]
No. of chronic conditions treated in 2008 (1–10)	5.0 (3.0, 6.0)	5.0 (4.0, 7.0)	5.0 (4.0, 6.0)	4.0 ^c (3.0, 6.0)
No. of different prescription medications filled in 2008 (0–39)	14.0 (10.0, 20.0)	12.0 (9.0, 17.0)	17.0 (13.0, 22.0)	14.0* (10.0, 19.0)
Selected types of chronic conditions treated in 2008				
Alzheimer disease and related disorders of senile dementia	17.3	20.8	13.8	15.5
Cataract	19.8	17.8	19.0	22.6
Chronic obstructive pulmonary disease	22.2	27.7	27.6	11.9 [†]
Chronic kidney disease	32.9	34.7	36.2	28.6
Depression	19.8	23.8	17.2	16.7
Congestive heart failure	44.4	47.5	51.7	35.7
Hyperlipidemia	35.4	29.7	37.9	40.5
Hypertension	66.7	63.4	75.9	64.3
Ischemic heart disease	52.3	53.5	53.5	50.0
Rheumatoid arthritis/ osteoarthritis	36.2	41.6	36.2	29.8
No. of hospital admissions in 2008 (0–11)				
None	57.2	52.5	48.3	69.1 ^{¶¶}
1 admission	21.4	23.8	24.1	16.7
2+ admissions	21.4	23.8	27.6	14.3
No. of physician visits in 2008 (0–52)	9.0 (5.0, 15.0)	9.0 (5.0, 15.0)	10.5 (6.0, 16.0)	8.5 ^{¶¶} (4.0, 13.0)
1+ cost-related medication nonadherence behaviors	45.7	44.6	43.1	48.8

(Continued)

TABLE 2 Continued

Baseline characteristics Percent or mean \pm SD or median (Q1, Q3)	Total sample	Nonadherence	Suboptimal adherence	Optimal adherence
<i>Health and medication insurance characteristics</i>				
Medicare dual eligibility (1+ months in 2008)	67.7	64.4	69.0	69.1
Medicare Part D LIS receipt (1+ months in 2008)	78.6	74.3	82.8	81.0
Maximal Part D coverage phase reached in 2008 (2 missing)				
Deductible or initial coverage phase	34.0	46.0	22.4	27.7 [†]
Coverage gap phase	41.5	36.0	48.3	43.4
Catastrophic coverage phase	24.5	18.0	29.3	28.9

Note. In accordance with the CMS data use agreement, all data displayed follows the CMS's cell size suppression policy that mandates that no cell 10 or less may be displayed. CM = congregate meals participant or waitlisted; FPL = Federal Poverty Level; HDL = home-delivered meals participant or waitlisted; LIS = low-income subsidy; OAANP = Older Americans Act Nutrition Program; WL = waitlisted (vs. participant).

*Statistical significance at $P < 0.01$.

[†]Statistical significance at $P < 0.05$.

[‡]Statistical significance at $P < 0.10$.

secure and insecure individuals, the overall levels of medication adherence were alarmingly low. Low (re)fill adherence to oral hypoglycemic medications was independently associated with a higher utilization of diabetes complications-related health care services and more hospital admissions, and persisted in the sample despite high levels of subsidy support for health care services and medications. These findings underscore the need to address basic food and medication needs to optimize type 2 diabetes management in low-income older Americans.

Our analytic sample is an important, yet understudied, target group for fighting diabetes-related health disparity. In comparison to a nationally representative sample of older Americans (33), our sample of low-income older adults in Georgia was more vulnerable in many regards, as was reported in our previous study (21). Our sample showed a 1.4 times higher prevalence of diagnosed diabetes and had higher rates of comorbidity diagnoses for CHF (44% vs. 17%), IHD (52% vs. 34%), chronic obstructive pulmonary disease (22% vs. 12%), and depression (20% vs. 12%) than a national sample (34). In addition, our sample used a higher number of prescription medications compared to a national 5% sample of older Medicare fee-for-service beneficiaries with a diagnosis of diabetes (35). Finally, the high level of food insecurity and need for nutrition assistance

TABLE 3 Diabetes Management Characteristics of Study Sample by Food Security Status

Characteristics (%)	Total sample	Food insecure	Food secure
<i>Total sample (%)</i>	<i>243 (100.0)</i>	<i>132 (54.3)</i>	<i>111 (45.7)</i>
<i>Diabetes treatment characteristics</i>			
No. of diabetes Rx (re)filled			
No diabetes Rx	28.4	26.5	30.6
1 Diabetes Rx	30.0	30.3	29.7
2+ Diabetes Rx	41.6	43.2	39.6
Type 2 diabetes Rx treatment regimen			
No oral hypoglycemic Rx	28.4	26.5	30.6
Oral hypoglycemic monotherapy	23.5	19.7	27.9
Oral hypoglycemic combination therapy	20.6	23.5	17.1
Combination oral hypoglycemic therapy + insulin or insulin monotherapy	27.6	30.3	24.3
<i>Diabetes complication-related health care utilization</i>			
Microvascular complications			
Retinopathy	20.6	20.5	20.7
Nephropathy	30.5	31.1	29.7
Neuropathy	35.4	34.9	36.0
Macrovascular complications*			
Cerebrovascular complications	23.5	23.5	23.4
Cardiovascular complications	62.6	61.4	64.0
Peripheral vascular disease	27.2	28.8	25.2
No. of complications by types (0–7)			
No complication	18.9	16.7	21.6
Complications from 1 type	50.2	50.8	49.6
Complications from 2+ types	30.9	32.6	28.8

Note. In accordance with the CMS data use agreement, all data displayed follows the CMS's cell size suppression policy that mandates that no cell 10 or less may be displayed. Rx = prescription medication(s).

*Metabolic complications not shown.

in our sample reflects the unique situation of and study results may therefore be generalized to low-income older adults with type 2 diabetes.

There may be several potential interpretations to the comparable levels of (re)fill adherence to oral hypoglycemic medications between food secure and insecure individuals found in this study. First, subsidy support available to food insecure participants may have enabled them to use comparable levels of prescription medications, and therefore improve adherence to oral hypoglycemics, relative to food secure participants. Second, we limited measurement of medication (re)fill adherence to oral hypoglycemic medications. While measuring medication (re)fill adherence to a larger selection of diabetes comorbidity and complication-related medications was not the main focus of this exploratory study, such effort may be critical for better understanding the relationships among food insecurity, medication adherence, and diabetes outcomes among low-income older Medicare beneficiaries with multiple chronic conditions. Third, point-of-sale claims data are limited

TABLE 4 Diabetes Complication-Related Health Care Utilization by Level of (Re)fill Adherence to Oral Hypoglycemic Medications

Diabetes complication-related health care utilization (%)	Total sample	Nonadherence	Suboptimal adherence	Optimal adherence
<i>Total sample (%)</i>	<i>243 (100.0)</i>	<i>101 (41.6)</i>	<i>58 (23.9)</i>	<i>84 (34.6)</i>
Microvascular complications				
Retinopathy	20.6	13.9	32.8	20.2*
Nephropathy	30.5	31.7	32.8	27.4
Neuropathy	35.4	36.6	41.4	29.8
Macrovascular complications [†]				
Cerebrovascular complications	23.5	23.8	22.4	23.8
Cardiovascular complications	62.6	68.3	65.5	53.6
Peripheral vascular disease	27.2	22.8	29.3	31.0
No. of complications by types (0–7)				
No complication	18.9	13.9	15.5	27.4*
Complications from 1 type	50.2	59.4	43.1	44.1
Complications from 2+ types	30.9	26.7	41.4	28.6

Note. In accordance with the CMS data use agreement, all data displayed follows the CMS's cell size suppression policy that mandates that no cell 10 or less may be displayed.

*Statistical significance at $P < 0.05$.

[†]Metabolic complications not shown.

in capturing underutilization, because only secondary nonadherence to (re)filled prescriptions can be measured in the absence of prescription information from the physician's office. Initial failure to fill a prescription may have been a very prevalent behavior among food insecure individuals that could not be detected with the measures used in this study. The discrepancy between the higher likelihood of reporting CRN, but following comparable levels of objectively measured (re)fill adherence to oral hypoglycemics among food insecure individuals may further indicate the limited ability of (re)fill adherence measures to comprehensively detect all medication nonadherence behaviors prevalent in low-income populations.

Our results, however, bear plausible explanations why food insecure individuals are likely at high risk of mismanaging diabetes. Food insecure individuals had a significantly higher risk to engage in self-reported medication nonadherence behaviors due to cost than their counterparts, as was reported in previous literature (8, 9, 27, 36, 37). The majority of food insecure individuals never reached or exited the Medicare Part D coverage gap, thus it is likely that food insecure individuals restricted out-of-pocket spending on all medications needed throughout the year. Given the poor socioeconomic, health, and diabetes management characteristics of food insecure older individuals in our sample, reduced spending on medications may suggest the increased risk of omitting needed health care among them. This is in agreement with previous studies conducted in younger populations that suggest food insecure individuals delay needed health care and require

acute or inpatient care more often than their counterparts (9, 15, 38, 39). In fact, many beneficiaries in our sample did not (re)fill any diabetes medication despite a diagnosis of type 2 diabetes in 2008 (28.4%), and only about one third of the sample showed optimal (re)fill adherence to oral hypoglycemic medications (34.6%). Poor adherence to oral hypoglycemic medications was associated with more inpatient hospital admissions and diabetes complication-related health care utilization independent of potential confounding factors. Also, the prevalence of diabetes complications was higher than that observed in a national sample (81.1% vs. 26.0%) (35). This carries importance because poor adherence is associated with significantly higher risk of hospitalization, more hospital days, and greater Medicare spending in Medicare beneficiaries with diabetes (40).

Our approach was novel in that we used Medicare beneficiary and claims data merged with statewide data collected by validated self-reported measures of food insecurity and medication adherence in a sample of vulnerable, low-income older adults in need of meals and health care services. More studies are warranted to better understand medication utilization and adherence in high-risk low-income older individuals with type 2 diabetes. Better understanding of everyday needs and problems associated with type 2 diabetes management in an ever increasing population of low-income older Americans is critical to ensure effective treatment and prevention approaches in this population.

TAKE AWAY POINTS

- Although levels of (re)fill adherence to oral hypoglycemic medications were comparable among food secure and insecure individuals, overall levels of medication adherence were alarmingly low.
- Low (re)fill adherence to oral hypoglycemic medications was independently associated with higher utilization of diabetes complications-related health care services and more hospital admissions, and persisted in the sample despite high levels of subsidy support for health care services and medications.
- Findings from this study underscore the need to address basic food and medication needs to optimize type 2 diabetes management in low-income older Americans.

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