Longitudinal Examination of Homebound Older Adults Who Experience Heightened Food Insufficiency: Effect of Diabetes Status and Implications for Service Provision

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Purpose: Healthy eating is important for optimal diabetes self-care. However, the level of food sufficiency may influence the degree of adherence to dietary self-care behaviors through the affordability of nutritionally appropriate food. This study examines whether homebound older adults with diabetes were at greater risk for heightened food insufficiency over 1 year, despite regular receipt of home-delivered meals. Design and Methods: This was a longitudinal study of a randomly recruited sample of 268 homebound older adults in the Nutrition and Function Study (NAFS) who regularly received home-delivered meals and completed baseline and 1-year in-home assessments. Based on an economic context model, self-reported data were collected on fundamental and proximate factors, food-sufficiency status, and intervening events. Determinants of heightened food insufficiency were examined with multivariate logistic regression models. Results: Not only did food-sufficiency status diminish over time in this sample, but it became or remained worse for older adults with diabetes. In addition to diabetes status, heightened food insufficiency was associated with perceived inadequacy of economic resources. Implications: Health care providers and nutrition programs should attempt to identify high-risk older adults – those who have diabetes and are at risk of food insufficiency – and develop community linkages and strategies that integrate nutrition with diabetes care plans, thus supporting a multidisciplinary, chronic care model to improve diabetes management and outcomes.

Key Words: Chronic care, Diabetes management, Dietary adherence, Food insufficiency, Home-delivered meals, Nutrition

Diabetes is a growing problem for older adults, with 500,000 new cases of diabetes diagnosed each year in this age group; more severe consequences are seen for older adults than for younger adults with diabetes (Conn, Valentine, & Cooper, 2002). Older adults experience many of the devastating health and economic effects of diabetes: diminished physical function, injurious falls, disability, increased medical costs, depression, and lowered quality of life (Pinkstaff, 2004; Sharkey, Branch, Giuliani, Haines, & Zohoori, 2004; Sharkey et al., 2003). Vulnerable older subgroups (i.e., women, racial or ethnic minorities, economically disadvantaged persons, and those who are homebound) are disproportionately affected by diabetes (Conn et al.; Ponza, Ohls, & Millen, 1996).

Individuals with diabetes are expected to improve glycemic control through daily self-management of a complex regimen of multiple activities (e.g., glucose monitoring, appropriate food selection, physical activity, and medication use); thus, diabetes is one of the most psychologically and behaviorally demanding of all chronic medical conditions (Cox & Gonder-Frederick, 1992; Glasgow, Hampson, Strycker, & Ruggiero, 1997; Jack, Liburd, Spencer,
Poorly managed diabetes in later life may increase the risk for such diabetes-related complications as heart disease or stroke, diminished vision, high blood pressure, kidney disease, nervous system damage, or nontraumatic amputations (Conn et al., 2002). Healthful eating (i.e., dietary regulation and meal planning) in accordance with dietary recommendations is a key factor of diabetes management and favorable clinical outcomes (American Diabetes Association [ADA], 2003; Nelson, Cunningham, Andersen, Harrison, & Gelberg, 2001; Wen, Shepherd, & Parchman, 2004). Dietary adherence requires the adoption and maintenance of major changes in eating behavior; these changes are influenced by psychosocial, physical, and environmental factors (Glasgow et al., 1997; Glasgow, Toobert, & Gillette, 2001; Jack et al., 2004; Murata et al., 2004). Prior research on overcoming barriers to dietary adherence has primarily focused on motivation, knowledge, and psychosocial characteristics (Hunt, Pugh, & Valenzuela, 1998; Murata et al.).

In addition, though, economic factors—such as adequacy of economic resources—likely influence food selection and the degree of adherence to dietary self-care behaviors (Hunt et al., 1998; Jack, Liburd, Vinicor, Brody, & Murry, 1999; Nelson et al., 2001; Sharkey, 2003; Wen et al., 2004). Prior studies have shown that diminished food sufficiency, which results in an inadequate amount of food intake (primarily due to insufficient economic resources), is associated with low food intakes of individual and multiple nutrients (Briefel & Woteki, 1992; Dixon, Winkleby, & Radimer, 2001; Lee & Frongillo, 2001; Nelson et al.; Rose, 1999; Sharkey; Sharkey et al., 2002). In this study, I used a conceptual model (Figure 1)—influence of individuals’ economic context on healthful eating, diabetes self-management, and diabetes-related clinical outcomes—to categorize fundamental, intermediate, and proximate resource-related factors that may influence healthful eating and served as a guide for data analysis. This model suggests that out-of-pocket expenses likely contribute (either directly or indirectly) to the level of food sufficiency.

Proportionally more homebound older adults than not are women, are members of racial or ethnic minorities, or have limited resources; thus, a lack of food sufficiency has far-reaching implications for chronic disease management. Furthermore, these individuals have an increased burden of multiple chronic conditions, an increased risk of restriction of prescription medication use, or an increased potential for consumption of a nutritionally inadequate amount of food (e.g., cheaper and less nutrient-dense foods, limited food choices, fewer meals, or less food; see Basiotis & Lino, 2002; Klesges et al., 2001; Sahyoun & Basiotis, 2000; Sharkey, 2003; Sharkey, Ory, & Browne, 2005; Wolfe, Frongillo, & Valois, 2003). For example, for older adults with diabetes, inadequate economic resources and diminished food sufficiency pose potentially serious self-management problems, including increased risk for inadequate diabetes care, poor glycemic control, and higher physician utilization (McCall, Sauaia, Hamman, Reusch, & Barton, 2004; Nelson et al., 2001).

Although it is hypothesized that homebound older adults with diabetes are at greater risk for lower levels of food sufficiency than those without diabetes, our understanding of whether the extent and dynamics of food sufficiency differs over time between these two groups is limited. Information is especially lacking for older persons who rely on the traditional model of home-delivered meals for food assistance, namely, five nutritionally balanced meals each week (i.e., one per weekday), which each provide at least 33% of daily nutrient requirements.

My purpose in the present study is to determine whether diabetes status increases the likelihood for heightened food insufficiency. That is, I seek to determine whether such status increases the likelihood of diminished food sufficiency or persistent food

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**Figure 1. Influence of individuals’ economic context on healthful eating, diabetes self-management, and diabetes-related clinical outcomes.**

- **Fundamental Factors:** Population Characteristics (Gender, Race, Age, Marital status, Residence)
- **Intermediate Factors:** Out-of-Pocket Medical Expenses (expected and unexpected)
- **Proximate Factors:** Adequacy of Economic Resources
- **Outcomes:** Healthful Eating, Diabetes Self-Management, Diabetes-Related Clinical Outcomes

- **Populations:**
  - Economic Factors: Income, Drug coverage, Food assistance programs
  - Health-Related Factors: Medical conditions, Prescription medication use

- **Effects:**
  - Out-of-Pocket Expenses
  - Level of Food Sufficiency
  - Healthful Eating
  - Diabetes Self-Management
  - Diabetes-Related Clinical Outcomes
insufficiency over 1 year, independent of baseline fundamental factors and intervening events (e.g., hospitalization or major illness) or change in economic or health-related factors (e.g., loss of drug coverage or food stamps or increased medication use).

**Methods**

**Study Population**

The North Carolina Nutrition and Function Study (NAFS) was conducted as a 2-year collaborative project between the School of Public Health at the University of North Carolina at Chapel Hill and Older Americans Act Nutrition Program (OAANP) home-delivered-meals service providers in four North Carolina counties. Comprehensive assessments, which included face-to-face interviews and a visual inspection of medications, were conducted in each participant’s home by trained interviewers at two time points: (a) baseline (October 2000 to May 2001) and (b) 1 year later (October 2001 to June 2002). Using a probability sample of 1,866 home-delivered-meal recipients, I recruited study participants by telephone and considered them eligible if they were at least 60 years of age, homebound, and scored >16 out of 22 possible points on the telephone version of the Mini-Mental State Examination (Roccaforte, Burke, Bayer, & Wengel, 1992). A detailed description of the recruitment, including sample comparisons and data-collection procedures, is reported elsewhere (Sharkey, 2002). I obtained informed consent from all participants, and all aspects of the study were approved by the University of North Carolina at Chapel Hill School of Public Health Institutional Review Board.

**Data Collection: Food-Sufficiency Status—A Measure of Resources**

Interviewers asked homebound participants three questions that have been used previously to assess level of food sufficiency in the past 6 months: (a) Were there days when there was no food in the house and no money or food stamps for food?; (b) Were there days when you had to choose between buying food and buying medication?; and (c) Were there days when you had to choose between buying food and paying bills? I placed participants into one of three groups of diminished food sufficiency: (a) being food sufficient (FS), that is, responded no to all three questions; (b) at risk of becoming food insufficient (RFI), that is, responded yes to either Question 2 (food or medication) or Question 3 (food or bills) and no to Question 1 (no food); or (c) food insufficient (FI), that is, responded yes to Question 1 (no food; see Sharkey, 2003).

**Baseline Fundamental Factors**

**Population Characteristics.—**Participants reported their gender, race (Black or non-Hispanic White), age, marital status, living arrangement (lived alone or lived with others), and education completed.

**Economic Factors.—**This category included current monthly income, drug coverage (no drug insurance, government coverage, or supplemental drug coverage), and participation in food assistance programs (participation in the Food Stamp Program or other local food assistance programs such as a food pantry). Government drug coverage included Medicaid, indigent medication assistance, or Veterans Affairs pharmacy benefits.

**Health-Related Factors.**—Interviewers asked participants if a physician had ever told them that they had specific health conditions, including arthritis, congestive heart failure, diabetes, heart disease or angina, high blood pressure, kidney disease, lung disease (e.g., asthma, emphysema, or chronic bronchitis), osteoporosis, or stroke. I constructed a summary score for coexisting disease conditions from a total of these nine health conditions. I defined a dichotomous comorbidity variable as having reported three or more of the nine disease conditions (compared with fewer than three disease conditions). I visually inspected and listed prescription-medication containers, and I divided the total number of unique medications into tertiles (i.e., zero to four, five to seven, and eight or more medications).

**Intervening Events**

I collected data during the 1-year in-home assessment related to exposure to intervening events that might have occurred since the initial in-home assessment: events related to consequences of prior health risk or change in economic or health-related factors. Consequences of prior health risk included occurrence of a major illness or overnight hospitalization (i.e., occurrence and number of times and days). Change in economic or health-related factors included loss of food stamps (i.e., receiving food stamps at baseline and not at 1 year), loss of drug coverage (i.e., having government or supplemental drug coverage at baseline and having neither at 1 year), or increased drug use (i.e., taking a greater number of unique prescription medications at 1 year than at baseline).

**Proximate Factors at 1-Year Assessment**

In addition to being asked the same food-sufficiency questions as at the baseline, participants were asked three questions that measured the perceived adequacy of economic resources (Mitchell, Mathews, Hunt, Cobb, & Watson, 2001): (a) Do you worry about having enough money in the future?; (b) Do you have trouble making ends meet?; and (c) Do you not have enough money for little extras? From
the summary score (range = 0–3), I constructed a dichotomous inadequate economic resource variable: 0 = fewer than two inadequate economic resource items and 1 = two or three items.

**Statistical Analysis**

I performed all statistical analyses by using Stata, version 8 (Stata Corporation, 2003). Unadjusted logistic regression models (univariate analyses) examined the association (odds ratio) of each of the baseline fundamental factors with diabetes status. Because of a potential statistical issue with multiple testing, I used a conservative Bonferroni correction (alpha rejection region/number of tests to be conducted) to reduce the Type 1 error rate for each individual test from 0.05 to 0.004 (Kleinbaum, Kupper, Muller, & Nizam, 1998).

I estimated multivariate logistic regression models, using a three-category nominal dependent variable, to evaluate the relationship between baseline fundamental factors and increasingly severe levels of food insufficiency at baseline and 1 year. In the first model (food-sufficiency status at baseline), I simultaneously entered all baseline characteristics to adjust for sample characteristics. I used backward elimination strategy, which sequentially removes statistically nonsignificant variables, to obtain the “best” set of independent variables (Kleinbaum et al., 1998). In the second regression model (food-sufficiency status at 1 year), I added baseline food-sufficiency status to the independent variables in the first model to adjust for level of food sufficiency at baseline. I present regression results in terms of odds ratios for being RFI or being FI relative to being FS, along with their 95% confidence intervals.

Finally, I used two multivariate logistic regression models (backward elimination strategy) to examine the relationship of diabetes status, intervening events, and heightened food insufficiency status at 1 year. In Model 1, the dependent variable was diminished food sufficiency (DFS), which I defined by the negative change in level of food sufficiency between baseline and 1 year: from FS to RFI or FI, and from RFI to FI. In Model 2, the dependent variable was DFS/PFI—DFS at 1 year or PFI (persistent food insufficiency), which was food insufficiency at both baseline and 1 year.

**Results**

**Sample Characteristics and Diabetes Status**

The baseline in-home assessment was completed by 99% (n = 345) of the 348 individuals who were recruited (122, or 35.4%, reported diabetes); 268 completed both baseline and 1-year assessments (70.5% homebound with diabetes vs 81.6% without, p < .05); and those who did not participate in the second assessment included 10% (n = 35) nursing home residents, 8% (n = 28) decedents, and 4% (n = 14) lost to follow-up. Proportionally more homebound older adults with diabetes than those without diabetes became nursing home residents or decedents between data-collection points (24.6% vs 14.8%, p = .024). The average length of continuous receipt of home-delivered meals prior to baseline assessment did not differ significantly by diabetes presence (without diabetes = 33.6 ± 28.4 months; with diabetes = 30.8 ± 26.9 months). For the entire sample of 268 homebound older adults who completed both comprehensive in-home assessments, more than 30% reported the diagnosis of diabetes. As shown in Table 1 (univariate analyses), study participants with diabetes were more likely than not to be Black, younger (aged 60–74 years), have government medication coverage (significant prior to Bonferroni correction), receive food stamps, participate in one or more other food-assistance program, or take eight or more different prescription medications each day. Considering that only 12 participants (4.5%) were between 60 and 64 years of age, proportional differences in medication use (compared with that of adults 65 years of age or older) were not meaningful (data not shown).

**Food-Sufficiency Status**

Between the baseline and 1-year assessment, the proportion of the total sample who were RFI or who were FI increased from 41.8% to 54.9%. Figure 2 shows that most of the observed change occurred among homebound participants with diabetes; the 1-year increase in RFI or FI among homebound participants without diabetes was 7 percentage points (from 41% to 48%); and for participants with diabetes, the increase was 24 percentage points (from 44% to 68%). Specifically, 19% of participants without diabetes and 34% of those with diabetes reported diminished food sufficiency (p = .009). At the same time, stability (i.e., no 1-year change), which I determined by summation of the number of participants with no change in food-sufficiency status (total of diagonal), indicated that 60% of those with diabetes and 70% of those without diabetes reported no change in food-sufficiency status during the 1-year period; that is, they remained FS, RFI, or FI. The most stable category for homebound older adults without diabetes was FS; almost three fourths of these participants who were FS at baseline remained so 1 year later. For homebound older adults with diabetes, a similar proportion (almost 73%) of individuals who were FI at baseline remained so at 1 year. Table 2 (multivariate analyses) shows the characteristics that increased the odds for RFI and FI (compared with FS) at baseline and 1 year later. For homebound older adults with diabetes (compared with those without diabetes), the odds were increasingly greater for RFI and FI at 1 year, after I adjusted for baseline food-sufficiency status.
In addition, the odds for RFI at 1 year were greater for Blacks, younger persons, or homebound older adults with a low income.

**Intervening Events and Inadequacy of Economic Resources**

Table 3 shows intervening events and adequacy of economic resources by diabetes status. At the 1-year assessment, proportionately more persons with diabetes reported occurrence of hospitalization or major illness in the 12 months since baseline or perceived inadequacy of economic resources. The number of hospitalizations and number of days hospitalized did not differ by diabetes status. A multivariate model (data not shown) examined the determinants of inadequate economic resources. Baseline factors that were independently associated with inadequate economic resources included having a low income, being married, being 60 to 74 years of age, and suffering from comorbidity. Drug coverage and medication use were not statistically significant.

**Heightened Food Insufficiency at 1 Year**

More than 23% of the individuals in the sample reported having DFS at the 1-year evaluation. Another 7.1% (n = 19) reported having PFI; thus, these individuals were FI at both assessments. Table 4 shows that, independent of intervening events or inadequate economic resources, the odds of experiencing heightened food insufficiency (DFS or DFS/PFI) were almost two times greater for participants with diabetes. Although increased medication use or inadequate economic resources increased the likelihood for either model for heightened food insufficiency, the effect of increased medication use was greater on DFS (Model 1), whereas the effect of inadequate economic resources was considerably greater on DFS/PFI (Model 2).
Healthful nutrition is critical in the day-to-day management of diabetes, glycemic control, and prevention of diabetes-related complications among an older population. For more vulnerable older adults, dietary adherence may be particularly difficult. As depicted in the economic-context model (Figure 1), such adults simultaneously face the complex demands of managing their diabetes (or other chronic conditions) and dealing with competing needs for limited resources (e.g., food, medications, heating and cooling, medical care, and transportation; see Schoenberg & Drungle, 2001; Sharkey, 2003). Although prior studies of adults with diabetes have identified a variety of barriers for self-care behaviors that reduce dietary adherence, only limited data are available that evaluate the influence of economic conditions as a potential challenge to dietary change and adherence (Dye, Haley-Zitlin, & Willoughby, 2003; Murata et al., 2004; Nelson et al., 2001; Schoenberg & Drungle; Wen et al., 2004). By modeling the influence of economic factors on healthful eating in the NAFS and focusing on food-sufficiency status as an outcome, this study contributes to prior research by examining the relationship between diabetes and heightened food insufficiency over time among a vulnerable and growing home-bound population.

### Discussion

Diabetes have identified a variety of barriers for self-care behaviors that reduce dietary adherence, only limited data are available that evaluate the influence of economic conditions as a potential challenge to dietary change and adherence (Dye, Haley-Zitlin, & Willoughby, 2003; Murata et al., 2004; Nelson et al., 2001; Schoenberg & Drungle; Wen et al., 2004). By modeling the influence of economic factors on healthful eating in the NAFS and focusing on food-sufficiency status as an outcome, this study contributes to prior research by examining the relationship between diabetes and heightened food insufficiency over time among a vulnerable and growing home-bound population.

### Table 2. Adjusted Odds Ratios for Risk and Presence of Food Insufficiency at Baseline and 1 Year

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline</th>
<th>1 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Risk of Food Insufficiency</td>
<td>Food Insufficient</td>
</tr>
<tr>
<td>Diabetes</td>
<td>0.81 (0.41, 1.58)</td>
<td>0.53 (0.19, 1.47)</td>
</tr>
<tr>
<td>Black race</td>
<td>1.69 (0.91, 3.14)</td>
<td>3.84*** (1.44, 10.28)</td>
</tr>
<tr>
<td>Aged 60–74 years</td>
<td>1.98* (1.05, 3.77)</td>
<td>5.12*** (1.99, 13.15)</td>
</tr>
<tr>
<td>Low education</td>
<td>2.27*** (1.22, 4.24)</td>
<td>2.31 (0.90, 5.94)</td>
</tr>
<tr>
<td>Low income</td>
<td>1.52 (0.80, 2.91)</td>
<td>1.62 (0.56, 4.72)</td>
</tr>
<tr>
<td>Comorbidity</td>
<td>1.38 (0.75, 2.51)</td>
<td>4.26** (1.42, 12.85)</td>
</tr>
<tr>
<td>No drug coverage</td>
<td>2.23*** (1.15, 4.31)</td>
<td>2.36 (0.85, 6.59)</td>
</tr>
<tr>
<td>Take ≥ 8 medications</td>
<td>1.80 (0.91, 3.54)</td>
<td>2.92* (1.10, 7.76)</td>
</tr>
<tr>
<td>Pseudo $R^2$ of model (%)</td>
<td>13.0</td>
<td>29.2</td>
</tr>
</tbody>
</table>

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**a**Odds Ratios (relative to being food sufficient) and 95% confidence intervals are derived from multivariate nominal logistic regression (backward elimination procedure).

**b**Odds Ratios (relative to being food sufficient at 1-year assessment) and 95% confidence intervals are derived from multivariate nominal logistic regression (same variables as baseline model), with adjustment for baseline food sufficiency status.

**c**Assessed at baseline only.
bound older population known to be difficult to recruit and retain in research studies (Sharkey, 2002). This evaluation is particularly important, given that nutrition interventions for the management of diabetes may not be enough to ensure a healthy diet and prevent diabetes-related outcomes without the continual availability of affordable healthy foods.

In this study, not only did food-sufficiency status diminish over time for the entire sample, but this status became or remained worse for older adults with diabetes; this observation remained even after I took into consideration intervening events that may influence the adequacy of economic resources. More specifically, proportionately more homebound elders with diabetes (than without) experienced diminished food insufficiency (1-year negative change in level of food sufficiency) or persistent food insufficiency (food insufficiency at baseline and 1 year later). This observation is of special concern for older persons with diabetes, given that prior studies found that the risk or presence of food insufficiency was associated with diet and health; that is, lowest levels of nutrient intake from food, increased burden of multiple chronic conditions, increased risk for restricting prescription-medications use, or higher physician utilization were seen in these individuals (Nelson et al., 2001; Sharkey, 2003; Sharkey et al., 2005). Because increased out-of-pocket costs and poor dietary adherence may both lead to poorer clinical outcomes in individuals with diabetes (Karter et al., 2003; Murata et al., 2004), the economic-context model and the study results suggest that food-sufficiency status is likely linked to out-of-pocket costs (and economic conditions) and poor dietary adherence.

Because greater proportions of homebound elders with diabetes experienced a reduction in their level of food sufficiency between the first and second in-home assessment, this study utilized two strategies to evaluate whether this relationship was independent of other factors. First, I examined the association of baseline fundamental factors with food-sufficiency status 1 year later, after adjustment for baseline food-sufficiency status. With respect to 1-year level of food sufficiency, having diabetes progressively increased the odds for RFI or FI. This progression occurred despite continued receipt of home-delivered meals and may be a consequence of worsening personal financial conditions (e.g., greater out-of-pocket expenses) that are due to the shifting of health costs to individuals (e.g., copays), increased costs for basic needs (e.g., food, utilities, and transportation), or intervening and perhaps unexpected events (e.g., hospitalizations or loss of drug or food-stamp coverage). In the second approach, I considered intervening events and perceived inadequacy of economic resources—indicators of increasing demands on economic resources or worsening financial conditions—as determinants of heightened food insufficiency. I used two definitions of heightened food insufficiency: (a) DFS between baseline and 1 year, and (b) a composite (DFS/PFI) of either DFS or PFI (FI at both assessments). Regardless of definition,

### Table 3. One-Year Intervening Events and Perceived Inadequate Economic Resources by Diabetes Status

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Sample (n = 268, %)</th>
<th>Diabetes Absent (n = 186, %)</th>
<th>Diabetes Present (n = 82, %)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consequences of prior health riska</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospitalization</td>
<td>43.7</td>
<td>38.7</td>
<td>54.9</td>
<td>.014</td>
</tr>
<tr>
<td>Major illness</td>
<td>47.0</td>
<td>40.9</td>
<td>61.0</td>
<td>.002</td>
</tr>
<tr>
<td>Economic change</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss of drug coverageb</td>
<td>7.8</td>
<td>8.1</td>
<td>7.3</td>
<td>1.000</td>
</tr>
<tr>
<td>Loss of food stampsb</td>
<td>6.0</td>
<td>4.3</td>
<td>9.8</td>
<td>.096</td>
</tr>
<tr>
<td>Health-related change</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased medication useb</td>
<td>45.7</td>
<td>45.7</td>
<td>40.2</td>
<td>.407</td>
</tr>
<tr>
<td>Adequacy of economic resourcesa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>54.8</td>
<td>48.9</td>
<td>68.3</td>
<td>.003</td>
</tr>
</tbody>
</table>

Note: Table data were calculated by cross tabulations using \( \chi^2 \) statistic and Fisher’s exact test.

Exposure was determined at time of 1-year in-home assessment.

Change from baseline to 1-year assessment.

### Table 4. Determinants of Heightened Food Insufficiency at 1 Year

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1: Diminished FSa</th>
<th>Model 2: Diminished FS and PFIb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>Adjusted p</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1.96 (1.06, 3.65)</td>
<td>.033</td>
</tr>
<tr>
<td>Increased medication use</td>
<td>2.47 (1.35, 4.51)</td>
<td>.003</td>
</tr>
<tr>
<td>Inadequate economic resourcesa</td>
<td>3.28 (1.69, 6.33)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Notes: FS = food sufficiency; PFI = persistent food insufficiency; RFI = risk of becoming food insufficient.

Odds Ratios of diminished FS (negative change in level of food sufficiency between baseline and 1 year: from FS to RFI or FI and from RFI to FI), relative to no change or improved food sufficiency status and 95% confidence intervals are derived from multivariate logistic regression (backward elimination procedure).

Odds Ratios of diminished FS (negative change in level of food sufficiency between baseline and 1 year) or PFI—being food insufficient at both baseline and 1 year—relative to all others and 95% confidence intervals are derived from multivariate logistic regression (backward elimination procedure).
participants with diabetes were almost two times as likely to report heightened food insufficiency as persons without diabetes, independent of intervening events or inadequacy of economic resources. In addition, the perception of having inadequate economic resources increased the odds for both definitions of heightened food insufficiency, with a greater influence on a composite DFS/PFI than DFS alone. Because perceived inadequacy of economic resources was associated with having a low income, being married (e.g., health-related expenses of the spouse were not measured), and suffering from comorbidity (but not medication use or drug coverage), the results suggest that, in light of the conceptual model, this proximate factor may describe overall financial condition and help healthcare providers and others understand how fundamental factors interrelate and contribute to diminished food sufficiency or persistent food insufficiency over time.

These findings are especially important in light of certain contextual factors. First, all participants received the traditional home-delivered-meals service—one meal a day for each of the five weekdays. Thus, it is possible that these results underestimate the relationship between diabetes and food sufficiency among characteristically similar older adults who do not regularly receive home-delivered meals as a result of meals service unavailability (e.g., waiting lists, service limited to fewer meals, geographic location, or inadequate community resources, including financial or lack of volunteers; see Ponza et al., 1996). Second, the traditional “school-lunch” model of home-delivered-meals service may no longer be sufficient to prevent inadequate nutrient intakes, especially among individuals with diabetes. Homebound older adults, especially individuals who receive home-delivered meals, report a proportionally greater prevalence of diabetes and other nutrition-related chronic conditions than does the overall older adult population. Furthermore, these individuals rely on home-delivered meals for a greater proportion of daily intake to meet long-term nutritional needs (Ponza et al.; Sharkey et al., 2002; U.S. Department of Health and Human Services, 2004). Third, meal programs that assess nutritional risk and function seldom collect detailed information on diabetes status, medication use, or food-sufficiency status, because such data collection is not part of OAANP reporting requirements (Administration on Aging, 2000). Finally, a paradigm shift in diabetes care has occurred from a traditional approach that is reactive, fragmented, and focused on the individual to a new chronic care model, which incorporates community resources and policies to support self-management (Norris & Olson, 2004). Concomitantly, a paradigm shift within OAANP also has occurred that holds service providers to greater accountability to demonstrate effectiveness and document program outcomes that recognize that dietary modification is part of the disease prevention-and-management process—especially for diseases that are highly prevalent among older persons, such as diabetes.

**Strengths and Limitations of the Study**

The present study has several particular strengths. First, using a conceptual model of the influence of individuals’ economic context, in this evaluation I examined the influence of intervening events, perceived adequacy of income, and diabetes status on declining food sufficiency over time among OAANP homebound participants; this is a methodology not typically utilized in this context. Second, using two waves of data from the North Carolina NAFS provided a breadth of clinical, nutritional, and social information often not found in food-insufficiency studies of older persons, such as detailed information on the burden of diseases, medication use from visual inspection, a three-level indicator of food-insufficiency severity that included forced-resource decisions, and intervening events. Finally, two multivariate regression approaches allowed for an examination of the association between diabetes status and food-sufficiency status at two time points and provided possible explanations for heightened food insufficiency over 1 year.

Several limitations to this study are acknowledged. Food-sufficiency data, a measure of resources, did not include information on duration and frequency; as a result, this study was unable to differentiate between acute and chronic risk for, or presence of, food insufficiency. This issue is a recurring concern with studies of food insufficiency in elderly persons (Nord, Andrews, & Winicki, 2002). Additional limitations included measurement of most study variables through self-report only, and absence of information on spouse, actual out-of-pocket costs for medications, and intervening events. Furthermore, lack of data on duration of diabetes, history of glycemic control, or diabetes-related complications must be acknowledged as study limitations.

Despite these limiting factors, this study furthers knowledge about the greater vulnerability of homebound older adults with diabetes for worsening food sufficiency over time. With the recent enactment of the Medicare Modernization Act, only the passage of time will tell whether prescription-drug coverage—assuming no increase in other out-of-pocket expenses—will lessen diminished or persistent food insufficiency. Regardless, the OAANP home-delivered-meal service is a critical component of community resources and provides food assistance for low-income, minority, and food-insufficient home-
bound older adults (Millen, Ohls, Ponza, & McCool, 2002; Ponza et al., 1996). For many older adults, the home-delivered meal may prevent more severe and chronic food insufficiency. However, despite these intentions of the OAANP, this study shows that food insufficiency remains highly prevalent and increases over time, especially for homebound older adults who are expected to make necessary diet choices in order to optimally manage their diabetes.

Implications of the Study

Considering that continual risk or presence of food insufficiency is an unfavorable environmental condition that may counter diabetes self-management, the findings of this study have several implications for managing the care of chronic illness, such as diabetes, among the growing homebound older population who are living longer in the community with a greater burden of chronic disease, increased income constraints, and need for long-term food assistance.

Of particular significance, this research has implications for providers and planners of health care and nutrition services to older adults with diabetes. Limited economic resources clearly influence choices for day-to-day diabetes care (Hunt et al., 1998). Additionally, diminished food sufficiency poses a significant barrier to utilization of published care guidelines for diabetes, because of the strong association of food insufficiency to poor diet quality (including lower consumption of fruits and vegetables and low intakes of essential nutrients; see Rose & Oliveira, 1997; Sharkey et al., 2002). Given these factors, health care providers should attempt to identify high-risk older adults—those who have diabetes and are at risk of food insufficiency—and should develop community linkages and strategies that integrate nutrition with a diabetes care plan. The goal is to support a multidisciplinary chronic care model to improve diabetes management and outcomes in the context in which older persons live (ADA, 2003). For providers and planners of nutrition services to older adults, this process will involve the following: (a) viewing OAANP activities as part of a chronic care model that supports improved disease management and helps older individuals remain independent and in their own homes; (b) increased funding and program targeting to improve unfavorable environmental conditions (i.e., persistent RFI or FI) that may counter diabetes self-management; (c) incorporation of multiple food-insufficiency items in assessments and reassessments that recognize issues related to absence of food, forced scarce-resource decisions, access and availability of food (e.g., transportation, grocery shopping, and meal preparation), and food choice (e.g., “right foods for health”; Wolfe et al., 2003); (d) monitor changes in food-sufficiency status and economic and health-related circumstances in program participants; and (e) target interventions that seek to ameliorate difficulty with continually securing healthy foods. Interventions may include referrals to appropriate programs for food, utility, pharmacy, housing, and transportation assistance. Other interventions may involve increasing meals to targeted, high-risk participants through the provision of more than one meal per day, more than 5 days per week, and improvement in meal nutrient density through the use of fortified food products. Nutrition education should teach low-cost dietary alternatives and provide assistance in developing strategies for controlling food costs within a healthy diet (Hunt et al.). Finally, policy makers of health and social service programs servicing older adults should recognize the challenge to individual, family, and community resources for diabetes support among particularly vulnerable groups. Specifically, the issues related to homebound older adults who are in a minority group, economically disadvantaged, or lack food sufficiency should be addressed. Such efforts should include consideration of food-sufficiency data as decisions are made regarding funding for home- and community-based services and food and nutrition programs. Ultimately, it may be more cost effective to ensure food sufficiency—and hence reduce disease progression and disease-related complications—in this population than to provide extra medical service alone (Nelson, Brown, & Lurie, 1998).

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