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Meal Delivery Programs Reduce The Use Of Costly Health Care In Dually Eligible Medicare And Medicaid Beneficiaries

ABSTRACT Delivering food to nutritionally vulnerable patients is important for addressing these patients' social determinants of health. However, it is not known whether food delivery programs can reduce the use of costly health services and decrease medical spending among these patients. We sought to determine whether home delivery of either medically tailored meals or nontailored food reduces the use of selected health care services and medical spending in a sample of adults dually eligible for Medicare and Medicaid. Compared with matched nonparticipants, participants had fewer emergency department visits in both the medically tailored meal program and the nontailored food program. Participants in the medically tailored meal program also had fewer inpatient admissions and lower medical spending. Participation in the nontailored food program was not associated with fewer inpatient admissions but was associated with lower medical spending. These findings suggest the potential for meal delivery programs to reduce the use of costly health care and decrease spending for vulnerable patients.

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Social determinants of health, such as lack of access to nutritious food, are recognized as factors associated with high costs of health care.[1–3] Approximately 13 percent of US households report food insecurity, meaning that they lack "consistent, dependable access to enough food for active, healthy living."[4] Food insecurity is associated with poor health and increased use of "big-ticket" health services, such as emergency department (ED) visits and inpatient admissions.[5–12] Proposed mechanisms of this association include poor dietary quality leading to increased disease complications, making trade-offs between food and medication purchases that impair chronic disease management, and increased stress that worsens mental health.[13] Perhaps for these reasons, food insecurity is associated with $77 billion in excess health care expenditures each year.[14]

Lack of access to nutritious food may be a particular problem for people who are dually eligible for Medicare and Medicaid.[15] These individuals qualify for Medicaid on the basis of low income and for Medicare through either adjudicated disability or age. Vulnerability from both medical issues and poverty that dually eligible patients face has led to support for services, such as meal programs, that were uncommon in fee-for-service systems.[3,16] However, it is not yet known whether meal programs improve vulnerable patients' health care use.

In this study we sought to determine the impact of two types of home-delivered meal interventions, which had different program costs and target populations, on health care use and spending. Because there is an association between food insecurity and greater use of the ED, we hypothesized that the interventions would reduce participants' ED visits.[5–8] Second-

arily, we hypothesized that participation in one of the meal programs would reduce the use of other big-ticket services (inpatient admissions and emergency transportation, such as transportation by ambulance), along with associated medical spending.

Study Data And Methods

STUDY POPULATION AND SAMPLE SELECTION The study sample was drawn from members of Commonwealth Care Alliance (CCA), and the primary data source for this study was CCA health care claims. CCA is a not-for-profit community-based health plan that manages and administers care for adults (people older than age twenty-one) who are dually eligible for Medicaid and Medicare.[17] CCA uses capitated payments to provide enhanced primary care and care coordination programs. All CCA members with at least six months of continuous enrollment in one of the two meal delivery programs in the period January 1, 2014–January 1, 2016, were eligible for this study. We randomly selected CCA members who, during the same time period, did not receive either meal program, as a control group. For participants, the index date was the date they began receiving the meals; for the control group, it was a randomly selected date. To have sufficient data for matching, we required twelve months of enrollment in CCA before the index date (see online appendix exhibit A1).[18] Participants were followed until either the end of their membership in CCA or the end of the study period (June 30, 2016). Participants who stopped their meal program were analyzed as part of their meal program group.

The Partners Human Research Committee provided human subjects approval for this project.

MEAL DELIVERY PROGRAMS We studied two meal programs. The first was a medically tailored meals program that provided meals customized to participants' medical needs. Each week the program delivered to participants' homes five days' worth of lunches, dinners, and snacks. A registered dietitian tailored the meals to participants' medical needs across seventeen dietary tracks (for example, diabetes, renal, soft, and so on), with combinations of up to three tracks permitted. The second was a Meals on Wheels–type nontailored food program. It also delivered nutritious meals but did not tailor them to participants' medical needs. It provided five days' worth of prepared lunches and dinners each week, usually delivered daily.

Enrollment in either program was determined by an authorizing clinician. Authorization required a determination that the member was at nutritional risk (for example, he or she had significant weight change, food scarcity, or medical issues that required a specific diet). There was no specific guidance for clinicians as to whether the member should receive the medically tailored meal or the nontailored food program.

OUTCOMES The primary outcome was ED visits (regardless of whether the patient was admitted as an inpatient or discharged home), obtained through health care claims (January 1, 2014, to June 30, 2016). Secondary outcomes included inpatient admissions and use of emergency transportation—a high-cost component of care in this population. In addition, we examined medical spending (expressed as inflation-adjusted 2016 dollars), using claims for five service categories where nutrition programs might plausibly affect expenditure:[13] inpatient, outpatient, ED, pharmacy, and emergency transportation.

DATA EXTRACTION From CCA data, we extracted information on age, race/ethnicity, sex, primary language (English or non-English), type of CCA plan (One Care or Senior Care Options), and the start and end (if any) of CCA enrollment. We examined a risk score (from the Centers for Medicare and Medicaid Services' Hierarchical Condition Category risk-adjustment model),[19] and medication classes for prescriptions filled in the prior year. We used *International Classification of Diseases*, Ninth Revision (ICD-9), and *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision (ICD-10), diagnosis codes in claims data to create a comorbidity index (range: −2 to 26) following the method of Joshua Gagne and colleagues.[20,21] In addition, we used information about participants' area of residence, as indicated by their ZIP code, based on data from the Census Bureau's American Community Survey[22] and from the Dartmouth Atlas of Health Care.[23] (For more details, see the "Data Extraction" section of the appendix.)[18]

STATISTICAL ANALYSIS Participation in the two food programs did not occur at random, which is a major source of confounding in this study. To account for this, we used a nonparametric approach called coarsened exact matching[24–27] (see the "Coarsened Exact Matching" section of the appendix).[18] This approach seeks to balance relevant sociodemographic, clinical, and pre-intervention health care characteristics that would lead to treatment between the treated and untreated groups, using only pre-intervention data. The approach leads to matched groups that are similar not only in their mean values of covariates, but also across the entire distribution of values (which is important for analyzing health care use, as a small number of cases can contribute a large portion of the total outcome). We

This study extends our knowledge of the effects of providing home-delivered meals on health outcomes.

created two cohorts using coarsened exact matching—one of people who received the medically tailored meals program and similar participants who received no meal intervention, and the other of people who received the nontailored food program and similar participants who received no meal intervention. Owing to the relatively small sample size and substantial differences between those who received the two types of programs, we were unable to compare the two intervention groups with each other.

After creating the matched cohorts, to account for any imbalance between the groups still present after matching, we conducted regression-adjusted analyses using generalized linear models. For "count" outcomes, we used a generalized linear model with a negative binomial distribution and log link. The models included demographic and clinical variables along with medical spending in the twelve months before the index date (to account for regression to the mean—an analysis-of-covariance approach)[28] and the index date (to account for secular trends). To analyze monthly post-intervention medical spending, we used a generalized linear model with a gamma distribution and a log link.[29] We express differences in post-intervention medical spending between the groups in terms of both that spending itself (the gross difference) and spending net of intervention costs (the net difference). Intervention costs were calculated by summing the paid claims for the services and dividing by the participant's follow-up time (number of months) to calculate an average per person monthly cost.

We conducted several sensitivity analyses to check the robustness of the results. First, we sought to determine whether differences could be due to a triggering event, such as an inpatient admission, and we conducted analyses in a sample that matched based on these events (see the "Statistical Analysis" section of the appendix).[18] Next, we ran the same models on the entire (unmatched) sample. After that, we forced a very close match on pre-intervention medical spending, with less emphasis on other factors, and then conducted gamma regression analyses as described above. Finally, to check whether changes might have been related to other social support services (for example, personal care assistants or home health aides), we examined the use of these services in the period sixty days before and sixty days after the index date and during the entire post-index period.

All models used robust confidence intervals for inference. Analyses were conducted in SAS, version 9.4, and Stata/SE, version 14.2.

LIMITATIONS The findings of this study should be interpreted considering several limitations. First, as noted above, entry into the meal delivery programs was not randomized. Though we accounted for measured factors that could influence program entry, we could not exclude unmeasured confounding—for example, by stigma associated with program participation.

Second, the study sample was drawn from a population of people dually eligible for Medicare and Medicaid who were participating in a health insurance program specifically designed for people with high levels of medical and social complexity. These participants were more diverse than state averages and highly concentrated in urban areas. It is unclear how these results might generalize to different populations.

Third, we did not have data on who was offered, but declined, participation in either program.

Fourth, we present our results using an intention-to-treat analysis strategy. However, this might have biased our results to the null, since including those who discontinued the intervention could have diluted the association between the intervention and changes in utilization.

Finally, we could not assess how concurrent interventions that did not result in health care claims might have affected results.

Study Results

For the analyses of the medically tailored meals program, we included 133 participants who received the meals and 1,002 matched controls. For the analyses of the nontailored food program, we included 624 participants who received the intervention and 1,318 matched controls. In these cohorts, demographic characteristics of the intervention and control groups were generally similar, both for mean values and across the distribution of covariates (see exhibit 1 and appendix exhibits A2a and A2b).[18]

Very few patients were lost to follow-up: 99.5 percent (1,129 of 1,135) of the participants in the medically tailored meals program cohort and 96.6 percent (1,875 of 1,942) of those in the nontailored food program cohort were enrolled

EXHIBIT 1

Sociodemographic and clinical characteristics of participants in the Commonwealth Care Alliance medically tailored meals and nontailored food programs and matched controls

	Medically tailored meals program		Nontailored food program	
	Control ($n = 1,002$)	Intervention ($n = 133$)	Control ($n = 1,318$)	Intervention ($n = 624$)
Mean age, years (SD)	57.9 (5.4)	57.4 (8.4)	73.1 (5.9)	73.5 (7.5)
Female (%)	53.49	55.64	63.78	60.74
Race/ethnicity (%)				
Non-Hispanic white	35.22	37.59	12.50	12.50
Non-Hispanic black	13.78	20.30	0.80	0.80
Hispanic	8.27	8.27	28.53	28.53
Asian, other, multiple, or declined to answer	42.73	33.84	58.17	58.17
Non-English primary language (%)	34.98	27.07	46.86	52.88
Insurance product (%)				
One Care	78.04	81.95	22.55	20.03
Senior Care Options	21.96	18.05	77.45	79.97
Spending in 12 months before intervention				
Mean	$5,475	$11,251	$5,095	$5,446
SD	3,849	8,553	3,887	5,619
Risk score[a]				
Mean	1.42	1.40	1.54	1.53
SD	0.44	0.69	0.43	0.54
Comorbidity index[b]				
Mean	0.26	0.26	0.17	0.17
SD	0.25	0.39	0.26	0.32
Rural ZIP Code Tabulation Area (%)				
Mean	0.24	0.00	0.38	0.48
SD	0.45	0.00	0.98	1.32
Households in ZCTA living in poverty (%)				
Mean	16.06	16.26	17.96	17.86
SD	3.24	5.14	5.38	6.66
Medicare beneficiaries in ZIP code with primary care provider visit in past 12 months (%)				
Mean	80.50	79.48	80.97	80.97
SD	1.00	1.06	1.22	1.52
Prescribed medications (%)				
Insulin	10.24	18.80	13.71	15.71
Antihypertensive	52.62	59.40	68.11	70.35
Other cardiovascular disease medication	26.14	29.32	40.22	40.22
Anticoagulant	4.42	4.51	6.65	7.05
Proton pump Inhibitor	30.39	48.12	40.01	43.27
Antiretroviral	0.75	0.75	0.89	1.12
Phosphate binder	0.11	0.00	0.75	0.32
Inhaler	15.18	30.08	17.69	19.55
Oral steroids	15.09	25.56	16.37	14.90
Antibiotics	33.22	45.11	36.75	30.61

SOURCE Authors' analysis of data from Commonwealth Care Alliance. **NOTES** Multivariate imbalance was assessed using the L1 statistic (0.97 in the medically tailored meal group and 0.96 in the nontailored food group after matching). Detailed information on balance is in appendix exhibits A2a and A2b (see note 18 in text). SD is standard deviation. [a]Risk score as derived from the CMS-HCC Risk Adjustment Model (see note 19 in text). The range in the sample was 0.20–12.03, with higher values indicating worse health. [b]Score as derived from the Gagne comorbidity index (see note 20 in text). The range in the sample is −2–23, with higher scores indicating worse health.

in CCA through the end of the study period (details of meal program participation are in appendix exhibit A3).[18] Owing to a later start within the study period for the medically tailored meals recipients, average post-index follow-up time there was 19.1 (standard deviation: 5.8) months for those who received meals and 23.0 (SD: 2.0) months for their controls. Average post-index follow-up time in the nontailored food program cohort was 23.6 (SD: 5.1) months

for those who received meals and 24.3 (SD: 2.6) months for their controls. In the analyses of the medically tailored meals program, mean per person counts of ED, inpatient, and emergency transportation use were 1.8, 0.3, and 1.2, respectively. In the analyses of the nontailored food program, mean per person counts were 1.3, 0.4, and 1.0, respectively.

In negative binomial regression analyses, participation in the medically tailored meals program was associated with fewer ED visits (adjusted incidence rate ratio: 0.30; 95% confidence interval: 0.20, 0.45), inpatient admissions (aIRR: 0.48; 95% CI: 0.26, 0.90), and uses of emergency transportation (aIRR: 0.28; 95% CI: 0.16, 0.51) (exhibit 2, appendix exhibits A4–A7).[18] Participation in the nontailored food program was associated with fewer ED visits (aIRR: 0.56; 95% CI: 0.47, 0.68) and uses of emergency transportation (aIRR: 0.62; 95% CI: 0.49, 0.78), but not with fewer inpatient admissions (aIRR: 0.88; 95% CI: 0.69, 1.11) (the full models are in appendix exhibits A8–A10).[18]

In gamma regression models that examined average monthly medical expenditures after the index date, participation in the medically tailored meals program was associated with lower medical spending, compared to not participating (difference: –$570; 95% CI: –931, –208) (exhibit 3, appendix exhibit A11).[18] Participation in the nontailored food program was also associated with lower medical spending (difference: –$156; 95% CI: –308, –5) (appendix exhibit A12).[18] The average monthly program costs per participant were $350 for the medically tailored meals program and $146 for the nontailored food program (data not shown). Subtracting the program costs from the estimated savings yielded a net savings of $220 for the medically tailored meals program and $10 for the nontailored food program.

We found that the results of our main analyses were robust across a number of sensitivity analyses. As an illustration, matching based on a triggering event rather than pre-intervention medical spending did not substantially alter the results (exhibit 4). Other sensitivity analyses included using the entire (unmatched) cohort, in which results for the medically tailored meals program were qualitatively unchanged and results for the nontailored food program results were also similar—except that the reduction in medical spending was no longer significant ($p = 0.05$), and reductions in inpatient admissions were significant ($p = 0.001$). Sensitivity analyses that forced a very close match on costs again favored receipt of medically tailored meals (difference in cost: –$706; $p < 0.0001$) (appendix exhibits A13 and A14).[18] We did not find significant differences in the use of, or costs associated with, other supportive programs (such as home health aide or personal care assistant services) between either intervention group and its matched controls (appendix exhibit A15).[18] Ad-

EXHIBIT 2

Estimated absolute and relative changes in use of selected health care services, by intervention

	Mean event count					
	Intervention group		Matched control group			
	Number	(95% CI)	Number	(95% CI)	Incidence rate ratio	(95% CI)
EMERGENCY DEPARTMENT VISITS						
Medically tailored meals program	0.63	(0.39, 0.88)	2.10****	(1.73, 2.47)	0.30****	(0.20, 0.45)
Nontailored food program	0.90	(0.74, 1.06)	1.59****	(1.31, 1.88)	0.56****	(0.47, 0.68)
INPATIENT ADMISSIONS						
Medically tailored meals program	0.27	(0.08, 0.46)	0.56**	(0.34, 0.78)	0.48**	(0.26, 0.90)
Nontailored food program	0.43	(0.33, 0.53)	0.49	(0.38, 0.60)	0.88	(0.69, 1.11)
EMERGENCY TRANSPORTATION EVENTS						
Medically tailored meals program	0.46	(0.19, 0.72)	1.60****	(1.12, 2.09)	0.28	(0.16, 0.51)
Nontailored food program	1.06	(0.73, 1.39)	1.70****	(1.15, 2.24)	0.62****	(0.49, 0.78)

SOURCE Authors' analysis of data from Commonwealth Care Alliance (CCA). **NOTES** The exhibit presents estimated absolute number of events ("count"), absolute difference in number of events between groups ("difference"), and relative differences (incidence rate ratio), with associated confidence intervals (CIs) and *p* values. Estimates from negative binomial models adjusted for receipt of medically tailored meals program, index year, spending in 12 months before intervention, risk score, comorbidity index, CCA enrollment year, insurance product, age, age squared, percent of ZIP Code Tabulation Area (ZCTA) that was rural, percent of households in ZCTA living in poverty, non-Hispanic white, non-Hispanic black, Hispanic, female, prescribed medication classes before the intervention (see exhibit 1), percent of Medicare beneficiaries in ZIP code with primary care provider visit in past twelve months, English as primary language, and follow-up time. The count represents the estimated difference over the follow-up period. *p* values for comparison of intervention with matched controls. **$p < 0.05$ ****$p < 0.001$

EXHIBIT 3

Estimated average monthly medical spending per person, by intervention and in control groups

	Intervention group	Matched control group	Gross difference	Net difference
Medically tailored meals program	$ 843	$1,413	–$570***	–$220
Nontailored food program	$1,007	$1,163	–$156**	–$10

SOURCE Authors' analysis of data from Commonwealth Care Alliance. **NOTES** Spending is in inflation-adjusted 2016 dollars. Estimates from gamma regression models adjusted for the factors listed in the notes to exhibit 2. Gross difference represents the estimated difference in health care spending by intervention status. Net difference represents the estimated difference in health care expenditures, accounting for the cost of the intervention. *p* values test the null hypothesis that the difference in gross spending between intervention and matched controls is equal to zero. **$p < 0.05$ ***$p < 0.01$

justing for supportive services use and cost did not substantially alter the estimates of cost savings, which remained in favor of the intervention programs (appendix exhibit A16).[18]

Discussion

We found that participating in either a medically tailored meals intervention or a nontailored food intervention for at least six months was associated with significant reductions in ED visits, compared with visits among similar participants who did not receive an intervention. These programs were also associated with lower use of other big-ticket health services. Sensitivity analyses conducted on the entire unmatched cohort were generally similar to the matched analyses, and we did not see evidence that regression to the mean, use of other social supports, or a triggering event explained these findings.

The medically tailored meals and nontailored food interventions were used in different populations. In general, the former was used in a younger group with higher rates of disability, while the latter was used in an older group whose members were less likely to use English as their primary language. Information regarding these programs may be useful to policy makers and payers, particularly to the extent that the populations they are providing care for are similar to these groups. The medically tailored meals program may be particularly useful for those who are sicker and disabled. The nontailored food program may be a useful, and less expensive, way to improve health care use for people who are older but otherwise relatively healthy. For both programs, the overall reductions in ED visits are large enough to be clinically meaningful. Though we did not conduct a formal cost-effectiveness analysis in this study, the lower estimated spending suggests that these programs may offer savings to payers or at least be cost-neutral, while reducing unplanned and disruptive events such as ED visits and emergency transportation. Thus, the programs are likely to be beneficial for both patients and health care systems.

This study extends our knowledge of the effects of providing home-delivered meals on health outcomes. Few prior studies have examined the impact of medically tailored meals, but one study that did, in a different patient population, found cost savings associated with the meals.[30] With regard to the delivery of nontailored food, prior studies have suggested that home-delivered meals decrease nursing home admissions, but these studies were limited by their ecological design.[31,32] Furthermore, a recent systematic review of home-delivered meal interventions found that most studies were cross-sectional and did not examine health care use or spending, as this study did.[33]

This study suggests several directions for future work. Randomized evaluation for this type of intervention is feasible, and given our promising findings, that would be an important next step. It will also be important to confirm these findings in larger samples and in different settings, to evaluate the results' generalizability. Our results also support the overall approach of increasing the integration between health care and social services sectors.[16,34,35]

This study had several key strengths. We used detailed assessment of pre-intervention data across several domains (clinical, claims-based, demographic, social, and geographical), which helped minimize confounding related to inter-

EXHIBIT 4

Estimated changes in utilization and spending based on matching using pre-intervention services (triggering events)

	Incidence rate ratio	(95% CI)
EMERGENCY DEPARTMENT VISITS		
Medically tailored meals program	0.36***	(0.24, 0.56)
Nontailored food program	0.54***	(0.42, 0.68)
INPATIENT ADMISSIONS		
Medically tailored meals program	0.41**	(0.19, 0.90)
Nontailored food program	0.81	(0.60, 1.10)
EMERGENCY TRANSPORTATION EVENTS		
Medically tailored meals program	0.18***	(0.08, 0.38)
Nontailored food program	0.52***	(0.39, 0.69)
	Average monthly spending	**(95% CI)**
DIFFERENCE IN GROSS SPENDING		
Medically tailored meals program	–$802***	(–1,363, –242)
Nontailored food program	–$228**	(–380, –76)

SOURCE Authors' analysis of data from the Commonwealth Care Alliance. **NOTES** Spending is in inflation-adjusted 2016 dollars. Estimates from negative binomial models adjusted for the factors listed in the notes to exhibit 2. **$p < 0.05$ ***$p < 0.01$

vention assignment. Our data were also longitudinal, and the participants were racially and ethnically diverse. Finally, the results were robust to several sensitivity analyses.

Conclusion

Home-delivered meals—in particular, those tailored to recipients' medical needs—show promise for helping curtail the use of selected costly health services in adults dually eligible for Medicare and Medicaid, a medically and socially complex population for whom effective interventions can be hard to come by. While further, preferably randomized, evaluations are needed, this study suggests that meal delivery may be an important way to improve the health of vulnerable patients. ■

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