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Association Between Receipt of a Medically Tailored Meal Program and Health Care Use

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IMPORTANCE Whether interventions to improve food access can reduce health care use is unknown.

OBJECTIVE To determine whether participation in a medically tailored meal intervention is associated with fewer subsequent hospitalizations.

DESIGN, SETTING, AND PARTICIPANTS A retrospective cohort study was conducted using near/far matching instrumental variable analysis. Data from the 2011-2015 Massachusetts All-Payer Claims database and Community Servings, a not-for-profit organization delivering medically tailored meals (MTMs), were linked. The study was conducted from December 15, 2016, to January 16, 2019. Recipients of MTMs who had at least 360 days of preintervention claims data were matched to nonrecipients on the basis of demographic, clinical, and neighborhood characteristics.

INTERVENTIONS Weekly delivery of 10 ready-to-consume meals tailored to the specific medical needs of the individual under the supervision of a registered dietitian nutritionist.

MAIN OUTCOMES AND MEASURES Inpatient admissions were the primary outcome. Secondary outcomes were admission to a skilled nursing facility and health care costs (from medical and pharmaceutical claims).

RESULTS There were 807 eligible MTM recipients. After matching, there were 499 MTM recipients, matched to 521 nonrecipients for a total of 1020 study participants (mean [SD] age, 52.7 [14.5] years; 568 [55.7%] female). Prior to matching and compared with nonrecipients in the same area, health care use, health care cost, and comorbidity were all significantly higher in recipients. For example, preintervention mean (SD) inpatient admissions were 1.6 (6.5) in MTM recipients vs 0.2 (0.8) in nonrecipients ($P < .001$), and mean health care costs were $80 617 ($312 337) vs $16 138 ($68 738) ($P < .001$). Recipients compared with nonrecipients were also significantly more likely to have HIV (21.9% vs 0.7%, $P < .001$), cancer (37.9% vs 11.3%, $P < .001$), and diabetes (33.7% vs 7.0%, $P < .001$). In instrumental variable analyses, MTM receipt was associated with significantly fewer inpatient admissions (incidence rate ratio [IRR], 0.51; 95% CI, 0.22-0.80; risk difference, −519; 95% CI, −360 to −678 per 1000 person-years). Similarly, MTM receipt was associated with fewer skilled nursing facility admissions (IRR, 0.28; 95% CI, 0.01-0.60; risk difference, −913; 95% CI, −689 to −1457 per 1000 person-years). The models estimated that, had everyone in the matched cohort received treatment owing to the instrument (and including the cost of program participation), mean monthly costs would have been $3838 vs $4591 if no one had received treatment owing to the instrument (difference, −$753; 95% CI, −$1225 to −$280).

CONCLUSIONS AND RELEVANCE Participation in a medically tailored meals program appears to be associated with fewer hospital and skilled nursing admissions and less overall medical spending.

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Invited Commentary
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Following an appropriate diet is a cornerstone of maintaining health and managing illness. However, dietary adherence is difficult for those with complex medical conditions. These difficulties are compounded for socioeconomically vulnerable individuals. This population often faces food insecurity, that is, lack of or uncertainty about access to nutritious food owing to cost,[1] and other barriers to dietary adherence that include physical disability that impedes food shopping, areas with low retail food access (food deserts), and lack of time to prepare appropriate meals. Although the association between these factors and poor health is clear,[2-7] how best to intervene is not apparent.

One emerging strategy to address both food insecurity and these additional barriers in medically complex individuals is medically tailored meal (MTM) delivery. The MTM program involves the home delivery of meals prepared under the supervision of registered dietitian nutritionists to meet the specific nutritional needs of the individual. By helping to improve nutrition, MTMs may improve health and thus lower health care use and cost. Alternatively, it is conceivable that MTM delivery provides limited measurable value given the challenging circumstances of potential recipients. These issues often include poverty and attendant health-related social needs, such as lack of adequate housing and transportation,[8,9] which MTM delivery may not address. In a prior study of individuals dually eligible for Medicare and Medicaid, a research group found that MTM delivery participation was associated with lower health care use.[9] However, because of the restricted study sample, questions about generalizability remained unanswered, along with questions about the sensitivity of the results to possible unmeasured confounding.

In this study, we sought to understand the association between MTM delivery participation and subsequent health care use and cost in a broader population—the state of Massachusetts as reflected in the Massachusetts All-Payer Claims Database (MA-APCD). We further sought to minimize the potential limitation of unmeasured confounding by using an instrumental variable strategy combined with careful matching. Based on prior work,[9] we hypothesized that MTM delivery participation would be associated with lower use of particularly expensive health care, such as inpatient admissions, and thus also be associated with lower health care expenditures.

Key Points

Question Is participating in a medically tailored meal delivery program for medically and socially complex adults associated with fewer inpatient admissions?

Findings In this cohort study of 1020 adults that used a combined instrumental variable analysis and matching approach, participation in a medically tailored meal delivery program was associated with approximately half the number of inpatient admissions.

Meaning For medically and socially complex adults, participating in a medically tailored meal delivery program may reduce inpatient admissions, although cautious interpretation is warranted because intervention receipt was not randomized.

Methods

Study Design

This study used an incident-user matched cohort design in which individuals who did and did not receive MTMs were matched on the basis of preintervention period demographic, health care use, and area-level (eg, neighborhood poverty) data. Our analytic strategy used a type of instrumental variable analysis termed near/far matching, which combines matching with traditional instrumental variable analysis to filter a larger cohort down to its most informative pairs—those who are as similar as possible on demographic and clinical factors but differ in the amount of encouragement to participate in the intervention that they received.[10-14] The instrumental variable that metaphorically encouraged participation was the distance an individual lived from Community Servings, a not-for-profit food and nutrition organization that delivers MTMs to individuals with serious medical illness.

Study Setting and Participants

We linked data at the individual level from the 2011-2015 MA-APCD and the service delivery records of Community Servings. To preserve participant privacy, the Massachusetts Center for Health Information and Analysis, which oversees the MA-APCD, conducted a deterministic link, using name, date of birth, sex, and address to determine MTM receipt. Then, a deidentified analytic data set was created. Community Servings was the only MTM delivery program operating in Massachusetts during the study period.

Institutional review board approval was obtained from the Massachusetts Department of Public Health, the Human Subjects Research Committee at Partners Health Care, and the Office of Human Research Ethics at the University of North Carolina at Chapel Hill, with waiver of informed consent.

To be eligible for the study, individuals had to be 18 years or older, have a home address within 100 km of Community Servings (approximately the delivery radius for the program), and be captured in the MA-APCD at least 360 days before the index date. The index date was the date of enrollment in the MTM delivery program for intervention recipients and a randomly assigned date for nonrecipients. The study was conducted from December 15, 2016, to January 16, 2019.

MTM Program

Each week, the MTM program delivered 10 meals tailored to a recipient's specific medical needs. A registered dietitian nutritionist could choose up to 3 among 17 dietary tracks (eg, appropriate for diabetes and end-stage renal disease). No outreach was made to recruit participants as part of the intervention. Instead, individuals were referred for MTM delivery by a clinician (eg, a primary care physician or social worker) on the basis of both nutritional and social risk. This procedure means that a clinician certified that the individual both had a clinical condition that required medically tailored meals and faced substantial social barriers, such as poverty or food

insecurity, to following an appropriate diet, and that the individual was at substantial risk of clinical deterioration. The clinician and potential recipient then completed an enrollment packet (eAppendix in the Supplement), which was sent to intervention program staff for review. Any person living in the delivery area could apply, so applications came from numerous clinics and health care systems. Key considerations for enrollment were clinical need and the inability of the individual to meet their nutritional needs and follow a medically appropriate diet in the absence of program participation (eg, owing to an income level that prevented purchase of health foods, or mobility limitations secondary to clinical conditions that prevented cooking for oneself). Meals were provided at no cost to the recipients.

Community Servings received funding to support the MTM program from philanthropy supplemented by the Ryan White Act funds for persons living with HIV. Meal receipt continued until the individual chose to withdraw or no longer needed MTMs (eg, owing to an improvement in social circumstances). Meals are delivered in person, but there is not a home-visiting or meal-sharing component to the intervention, unlike some other nutritional assistance programs, such as Meals on Wheels.

Outcomes

In our conceptual framework,[15] receipt of MTMs was most likely to affect health over the short term by providing necessary nutrition (concurrently reducing the consumption of medically inadvisable foods) and by freeing resources that could be used for medications or other expenses that may have associations with improved health, such as rent or transportation. For example, a previous study of this intervention demonstrated a large increase in diet quality when individuals were receiving the meals.[16] We hypothesized that these benefits would help to prevent acute exacerbations of chronic conditions and allow for more consistent adherence to outpatient management plans. Therefore, the primary outcome of this study was inpatient admissions, which we hypothesized would be reduced with receipt of the intervention. Secondary outcomes were admission to a skilled nursing facility (because these largely reflect postacute care after an inpatient admission, lower inpatient admissions should also lead to lower skilled nursing facility admissions), and total health care costs (the sum of combined medical and pharmaceutical claims), expressed on a per-person per-month basis.

Our original protocol included a separate examination of emergency department visit rates, but the deidentified analytic data set limited our ability to identify unique emergency department visits, so we could not conduct these analyses. We used the consumer price index to inflation-adjust all spending to 2017.[17] To account for intervention costs, we added $350 per month for each MTM recipient, which is the approximate per-person cost of program operation (including dietary tailoring, food, and delivery). For all outcomes, we winsorized the upper percentiles to reduce the influence of outliers.[18] We conducted sensitivity analyses without winsorization.

Covariates

We examined data on a number of covariates that could confound the association between MTM receipt and health care use (eMethods, eTable 1, eFigure 1 in the Supplement). All covariate data came from the preindex period. These covariates included age (years), sex, and insurance type (commercial, Medicare, Medicaid, or other, including uninsured), which were consistently available from the MA-APCD. Furthermore, data on race/ethnicity (categorized as non-Hispanic white, non-Hispanic black, Hispanic, Asian, other, or multiracial), and disability status were provided for some records and used when available; otherwise, we created a category indicating that data were not provided. For comorbidities, we used the Gagne index.[19] In addition, we created indicators for specific comorbidities that frequently prompt MTM receipt (HIV infection, cancer, end-stage renal disease, diabetes, and congestive heart failure).[19] For patterns of health care use, we created counts of inpatient admissions, skilled nursing facility admissions, home health visits, and total medical and pharmaceutical costs. To account for the possibility that a triggering event may have led to MTM receipt, we developed an indicator of inpatient admission within 6 months of the index date. To account for area-level socioeconomic status, we used data from the American Community Survey[20] to calculate the percentage of individuals living in poverty within the zip code tabulation area of the study participant. Finally, to summarize the large number of *International Classification of Diseases, Ninth Revision* diagnosis codes and medications associated with medical, procedural, and pharmaceutical claims, we used the high-dimensional propensity score approach of Schneeweiss et al[21] and used the high-dimensional propensity score as an additional matching variable.

Statistical Analysis

Our major concern was to address the potential for confounding introduced by nonrandom assignment to the intervention. To do this we used near/far matching[12,14] and constructed to a matched cohort that was as similar as possible on relevant sociodemographic and clinical characteristics, but differed in whether an individual was encouraged or discouraged to receive the intervention based on an instrumental variable. In this study, the instrumental variable was the geographic distance between Community Servings' single location and the centroid of an individual's zip code tabulation area (owing to privacy concerns, data on smaller geographic areas were not available). Those living closer are subtly encouraged to enroll. Further details of this instrumental variable approach, and instrument testing, are provided in the eMethods, eTable 2, and eTable 3 in the Supplement.

For matching, after preprocessing we conducted an optimal nonparametric match using Mahalanobis distance and a simulated annealing optimization algorithm.[14] This technique enabled us to achieve the best balance on the potential confounders while maximizing the difference in distance from Community Servings. We used standardized mean difference (SMD) as a metric of balance.

Once the matched cohort was identified, we conducted analyses using the 2-stage residual inclusion approach to

instrumental variable analyses.[22] We fit a first-stage logistic model that predicts receipt of MTM using distance and the above-mentioned covariates. Next, the residuals, defined as the difference between the observed and predicted values from the first-stage model, were calculated. Third, the second-stage model was fit by regressing the outcome on receipt of the intervention, along with the residuals from the first-stage model and the other covariates. For event outcomes (inpatient and skilled nursing facility admissions), we fit Poisson regression models. For the spending outcome, we fit log-link γ regression models, selecting γ regression after conducting modified Park tests.[23] All models were adjusted for covariates to account for residual imbalance after matching and for the index date to account for secular trends. Our analyses followed the intention-to-treat approach whereby individuals who enrolled in the intervention continued to be analyzed as part of the intervention even if they stopped participating.

To express the results of these models on the absolute (risk difference) and relative (risk ratio) scale, we used recycled predictions,[24] which standardizes the estimates over the observed distribution of covariates. To obtain 95% CIs, we used a nonparametric bootstrap of the entire process (both the first- and second-stage models), with 1000 replications.[22] We also conducted sensitivity analyses using the E-value approach. This approach quantifies the strength of association that an unmeasured confounder would need to have with both the treatment and outcome in order to render the observed treatment-outcome association null.[25,26]

For descriptive analyses, the *P* value was determined using unpaired *t* tests for continuous variables or χ^2 tests for categorical variables. A 2-tailed *P* value <.05 was taken to indicate statistical significance. All statistical analyses were conducted in SAS, version 9.4 (SAS Institute Inc), and R, version 3.4.2 (R Foundation for Statistical Computing).

Results

Participants

There were 1706 MTM program recipients in the MA-APCD, of whom 991 were incident recipients (58.1%). Among incident recipients, 807 individuals (81.4%) had the requisite 360 days of preindex follow-up to permit matching. Before matching, intervention recipients and nonrecipients differed substantially even when restricted to the age- and sex-matched subset residing in the same areas (**Table 1**). For example, mean (SD) preindex costs were $80 617 ($312 337) in MTM recipients vs $16 138 ($68 738) in nonrecipients (*P* < .001), mean (SD) inpatient admissions were 1.6 (6.5) vs 0.2 (0.8) in nonrecipients (*P* < .001), and mean comorbidity index was 5.2 (4.2) vs 0.9 (2.1) in nonrecipients (*P* < .001) (possible range from −1 to 26, with higher numbers indicating greater burden of comorbidity). Recipients were also significantly more likely to have cancer (306 [37.9%] vs 5860 [11.3%], *P* < .001) and diabetes (272 [33.7%] vs 3609 [7.0%], *P* < .001), compared with nonrecipients.

Following matching, there were 509 encouraged individuals (those living closer to Community Servings, regardless of whether they received the intervention) and 511 discouraged individuals. The matched cohort was more balanced, with SMD less than 0.2 for all covariates (**Table 2**). Postindex follow-up was similar for both groups, with a mean (SD) of 21.4 (12.8) months in recipients vs 22.1 (12.5) months in nonrecipients (*P* = .41). Among recipients, the mean (SD) duration of receipt was 12.4 (10.6) months and the median duration was 9.0 (interquartile range, 6.0-18.0) months.

Health Care Use

In the matched cohort, there were 1242 inpatient admissions and 1213 skilled nursing admissions over 1822.1 person-years of follow-up. In instrumental variable analysis combined with matching and intervention, receipt was associated with significantly fewer inpatient admissions (incidence rate ratio [IRR], 0.51; 95% CI, 0.22-0.80). In absolute terms, this translates to fewer estimated admissions per 1000 person-years (−519; 95% CI, −360 to −678) had everyone in the matched cohort been encouraged into treatment by the instrument compared with no one being encouraged into treatment. Similarly, intervention receipt was associated with fewer skilled nursing facility admissions (IRR, 0.28; 95% CI, 0.01-0.60; absolute reduction, −913; 95% CI, −689 to −1457 per 1000 person-years). Most skilled nursing admissions (880 [72.5%] of 1213) came from individuals with an inpatient admission.

Sensitivity analyses using nonwinsorized outcomes were similarly in favor of intervention participation, without any qualitative differences compared with the main analyses (eTable 4 in the Supplement). Sensitivity analyses also revealed that it would require strong unobserved confounding to render the treatment-outcome association null (eFigure 2 and eTable 5 in the Supplement).

Health Care Costs

In instrumental variable analysis combined with matching, participation in the intervention was associated with lower health care costs. The models estimated that, had everyone in the matched cohort been encouraged into treatment (and including the cost of program participation), mean monthly costs would have been $3838 vs $4591 if no one had been encouraged into treatment (relative risk of mean per person per month expenditures difference, 0.84; 95% CI, 0.67-0.998; risk difference, −$753; 95% CI, −$1225 to −$280). This difference represents approximately 16% lower health care costs. Sensitivity analyses using nonwinsorized outcomes were more strongly in favor of intervention participation (eTable 4 in the Supplement). The point estimate for the reduction in medical costs related to inpatient and skilled nursing facility visits was $712 (95% CI, $1930 lower to $505 higher) per month, which is consistent with lower use of these services as the main source of the estimated reduction in total expenditures.

Discussion

In this study using MA-APCD data, we found that participation in an MTM delivery program was associated with fewer inpatient admissions, and with fewer skilled nursing facility

Table 1. Demographic and Clinical Characteristics of the Unmatched Sample

Characteristic	Overall (N = 52 533)	Community Servings Participation Status			
		Did Not Participate (n = 51 726)	Participated (n = 807)	P Value[a]	SMD
Distance from Community Servings, mean (SD), km[b]	24.0 (14.1)	24.1 (13.9)	16.7 (19.4)	<.001	0.44
Age, mean (SD), y	52.3 (14.5)	52.3 (14.5)	51.1 (14.8)	.02	0.08
Female, No. (%)	32 230 (61.4)	31 800 (61.5)	430 (53.3)	<.001	0.17
Race/ethnicity, No. (%)					0.80
Non-Hispanic white	5280 (10.1)	5103 (9.9)	177 (21.9)		
Non-Hispanic black	1110 (2.1)	982 (1.9)	128 (15.9)		
Hispanic	498 (0.9)	453 (0.9)	45 (5.6)	<.001	
Multiracial or other	173 (0.3)	158 (0.3)	15 (1.9)		
Information not provided	45 472 (86.6)	45 030 (87.1)	442 (54.8)		
Insurance, No. (%)					0.89
Other	13 994 (26.6)	13 893 (26.9)	101 (12.5)		
Private	18 940 (36.1)	18 842 (36.4)	98 (12.1)	<.001	
Medicare	8142 (15.5)	7980 (15.4)	162 (20.1)		
Medicaid	11 457 (21.8)	11 011 (21.3)	446 (55.3)		
Disability status indicator, No. (%)	1791 (3.4)	1656 (3.2)	135 (16.7)	<.001	0.67
Experienced triggering event, No. (%)[c]	2943 (5.6)	2637 (5.1)	306 (38.0)	<.001	0.87
No. of visits in past 12 mo, mean (SD)					
Inpatient	0.2 (1.1)	0.2 (0.8)	1.6 (6.5)	<.001	0.31
Skilled nursing facility	0.3 (3.6)	0.3 (3.6)	0.5 (3.0)	.12	0.06
Home health	1.6 (19.4)	1.4 (18.0)	16.7 (61.0)	<.001	0.34
Total health care costs in past 12 mo, mean (SD), $	17 129 (78 816)	16 138 (68 738)	80 617 (312 337)	<.001	0.29
Comorbidity index, mean (SD)[d]	1.0 (2.2)	0.9 (2.1)	5.2 (4.2)	<.001	1.28
HIV-positive, No. (%)	541 (1.0)	364 (0.7)	177 (21.9)	<.001	0.71
History, No. (%)					
Cancer	6166 (11.7)	5860 (11.3)	306 (37.9)	<.001	0.65
End-stage renal disease	3547 (6.8)	3244 (6.3)	303 (37.5)	<.001	0.82
Diabetes	3881 (7.4)	3609 (7.0)	272 (33.7)	<.001	0.70
Congestive heart failure	3706 (7.1)	3426 (6.6)	280 (34.7)	<.001	0.74
% Living in poverty in zip code tabulation area, mean (SD)	10.2 (7.7)	10.0 (7.5)	19.9 (8.8)	<.001	1.21

Abbreviation: SMD, standardized mean difference.

[a] *P* value determined using *t* tests for continuous variables or χ^2 test for categorical variables.

[b] Community Servings, a not-for-profit organization delivering medically tailored meals.

[c] An inpatient visit in the 6 months immediately before the index date.

[d] Range, −1 to 26, with higher numbers indicating greater burden of comorbidity.

admissions. Individuals who received MTMs were substantially more ill than the overall population: 37.9% had cancer diagnoses and 33.7% had diabetes. It is unlikely that similar results would be seen were the intervention applied to a healthier population, as the risk of admission or high health care costs, even in the absence of intervention, would be substantially lower. Furthermore, intervention recipients were those with clinical, nutritional, and social risk factors that interacted to produce a high short-term risk of clinical deterioration if they did not receive nutritional intervention. Although these risk factors are a common combination, we caution against overgeneralizing the results of this study to other contexts. For example, programs to reduce hospital readmissions or reduce health care costs among individuals with high past-year costs often include those with heterogeneous reasons for use of health care services. Because health care use in many of these cases may not be driven by the combination of clinical, nutritional, and social risk factors that MTM programs address, we would not expect to see the results observed in this study when applied to a more heterogeneous population. When considering how best to improve health care use, we think it is necessary to understand the drivers of that use and develop specific interventions to address those specific drivers.

This study is consistent with prior literature and expands our knowledge regarding the associations between MTM and health care use. A previous study found associations with reduced use and cost that were similar in magnitude, but that study was restricted to Medicare-Medicaid dual eligibles.[9] The present study adds information on a broader segment of the population and, to the extent that the instrumental variable assumptions are met, adds robustness against unmeasured confounding. Other studies of meal delivery programs have found associations with reduced nursing home admissions,[27] reduced 30-day readmission rates,[28] and improved heart failure symptoms.[29] Furthermore, studies of the Supplemental Nutrition Assistance Program have shown associations with lower health care use and cost, supporting the idea of food insecurity as a modifiable risk factor for adverse health care use.[10,30,31] Following the success of an earlier pilot program,[32]

Table 2. Demographic and Clinical Characteristics of the Matched Sample

Characteristic	Overall (N = 1020)	Encouragement Status[a]			
		Discouraged (n = 511)	Encouraged (n = 509)	*P* Value[b]	SMD
Participated in Community Servings, No. (%)[c]	499 (48.9)	227 (44.4)	272 (53.4)	.01	0.18
Distance from Community Servings, mean (SD), km	17.2 (16.5)	23.7 (18.0)	10.7 (11.7)	<.001	0.86
Age, mean (SD), y	52.7 (14.5)	52.6 (15.0)	52.8 (14.0)	.82	0.01
Female, No. (%)	568 (55.7)	285 (55.8)	283 (55.6)	.90	0.02
Race/ethnicity, No. (%)				.42	0.12
Non-Hispanic white	243 (23.8)	121 (23.7)	122 (24.0)		
Non-Hispanic black	138 (13.5)	77 (15.1)	61 (12.0)		
Hispanic	46 (4.5)	23 (4.5)	23 (4.5)		
Multiracial or other	17 (1.7)	11 (2.2)	6 (1.2)		
Information not provided	576 (56.5)	279 (54.6)	297 (58.3)		
Insurance, No. (%)				.37	0.11
Other	119 (11.7)	54 (10.6)	65 (12.8)		
Private	114 (11.2)	51 (10.0)	63 (12.4)		
Medicare	213 (20.9)	108 (21.1)	105 (20.6)		
Medicaid	574 (56.3)	298 (58.3)	276 (54.2)		
Disability status indicator, No. (%)	180 (17.6)	93 (18.2)	87 (17.1)	.53	0.07
Experienced triggering event, No. (%)[d]	272 (26.7)	135 (26.4)	137 (26.9)	.91	0.01
No. of visits in past 12 mo, mean (SD)					
Inpatient	1.0 (1.9)	1.0 (2.0)	0.91 (1.7)	.43	0.05
Skilled nursing facility	0.5 (3.7)	0.3 (1.5)	0.7 (5.1)	.11	0.10
Home health	15.4 (64.3)	17.0 (66.3)	13.8 (62.2)	.42	0.05
Total health care costs in past 12 mo, mean (SD), $	54 470 (73 081)	54 280 (75 590)	54 661 (70 546)	.93	0.01
Comorbidity index, mean (SD)[e]	4.23 (4.1)	4.17 (4.3)	4.29 (4.0)	.64	0.02
HIV-positive, No. (%)	165 (16.2)	88 (17.2)	77 (15.1)	.41	0.06
History, No. (%)					
Cancer	382 (37.5)	183 (35.8)	199 (39.1)	.31	0.07
End-stage renal disease	286 (28.0)	139 (27.2)	147 (28.9)	.60	0.04
Diabetes	278 (27.3)	132 (25.8)	146 (28.7)	.34	0.06
Congestive heart failure	293 (28.7)	143 (28.0)	150 (29.5)	.65	0.03
% Living in poverty in zip code tabulation area, mean (SD)	19.0 (9.7)	19.2 (10.2)	18.7 (9.3)	.37	0.06

Abbreviation: SMD, standardized mean difference.

[a] Encouraged indicates individuals who lived closer to Community Servings; discouraged indicates individuals who lived farther away.

[b] *P* value from *t* tests for continuous variables or χ^2 test for categorical variables.

[c] Community Servings, a not-for-profit organization delivering medically tailored meals.

[d] An inpatient visit in the 6 months immediately prior to the index date.

[e] Range −1 to 26, with higher numbers indicating greater burden of comorbidity.

California recently announced a large-scale food-is-medicine demonstration project that will examine the health effects of medically tailored meals, and results are expected in 2020.

Our study has several implications for health policy. Medicaid programs in several states have piloted MTM delivery in various settings, and Medicare Advantage recently made changes that could allow coverage for some meal delivery programs.[33] For wide-scale implementation of MTM delivery to be successful, however, further research is needed. First, benefits of MTM participation should be established in large-scale randomized clinical trials. Second, because MTM delivery is a relatively expensive intervention, it will be necessary to target the intervention to those most likely to benefit. Individuals whose needs can be met with less-intensive activities (eg, navigation into the Supplemental Nutrition Assistance Program or community resources such as food pantries) may not require MTMs. Conversely, individuals with high health care expenditures that are not driven by nutrition are unlikely to benefit. A rigorous evidence base that elucidates when MTM programs are needed will be necessary for efficient use of health care resources. Ultimately, a range of options that vary in cost and level of service provided may be needed.

Limitations

The results of this study should be interpreted in light of several limitations. All instrumental variables rely on certain untestable assumptions. In this case, we assume that living closer to Community Servings does not affect health except via increasing the chance of program participation. Next, the association estimates of this study, which apply to a particular cohort of those at substantial clinical and nutritional risk, likely do not apply to the general population of high health care users, who may have other, potentially nonmodifiable, drivers for their health care use and costs. Furthermore, as in all instrumental variable analyses, the results are relevant for the marginal patient who might be encouraged to use the MTM program by the instrument (the local average treatment effect),

and should not be interpreted as the effect for all patients (the average treatment effect). The former is typically larger than the latter.

Next, although we know that individuals in the control group did not receive MTMs, we were unable to determine whether they received other nutrition interventions, such as Meals on Wheels or the Supplemental Nutrition Assistance Program. Furthermore, they may have received other enabling or supportive services that may not generate health care claims (eg, case management), which could bias the observed association to the null. In addition, because this study relied on claims data, measurement error regarding matching factors could have influenced the results, although we do not expect this association to be differential. Next, this study was able to examine only the association between intervention receipt as a whole and the study outcomes, rather than examining the individual components. Thus, even if there is a causal association between the intervention and the outcomes, we do not know what specific components (eg, the provision of food, the medically tailored preparation of the food, or any social connection provided by home delivery) of the intervention are responsible for the findings. In addition, we did not have data on individuals who were offered referral to the intervention but declined, which is another reason to be cautious when generalizing the results observed in this study and not to regard the results as an estimate of the average treatment effect (the effect that would be seen were the program applied to the entire eligible population). In addition, the study used data only from Massachusetts; thus, it is unclear whether the results would generalize to other states with different levels of insurance and services.

Conclusions

Receipt of MTMs appeared to be associated with meaningfully lower downstream medical events compared with nonreceipt. As the focus of health care in the United States turns to population health, the ability to intervene on health-related social needs will become increasingly important for improving both health and the value of health care. Medically tailored meal programs represent promising interventions and deserve further study as we seek to improve health for all Americans, particularly the most vulnerable.

ARTICLE INFORMATION

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Author Contributions: Dr Berkowitz had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Concept and design: Berkowitz, Terranova, Waters, Hsu.
Acquisition, analysis, or interpretation of data: Berkowitz, Terranova, Randall, Cranston, Hsu.
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