

Health Impacts of Health System Implementation of a Food-as-Medicine Strategy

Sarah D. Ronis, MD, PhD; Holly Hartman, PhD; Ian J. Neeland, MD; Anne Leach, MS, RDN, LD; and Celina Cunanan, MSN, APRN-CNM

FOOD SECURITY, DEFINED as access by members of a household at all times to enough food to support an active and healthy life, requires ready availability of nutritionally adequate and safe foods and assured ability to acquire foods in socially acceptable ways (that is, without resorting to emergency food supplies, scavenging, stealing, or other coping strategies).¹ As such, food insecurity, or the limited or uncertain availability of nutritionally adequate and safe foods, is a major social determinant of health.²⁻⁵ More than 1 in 10 US households were reported to be food insecure in 2022, a statistically significant increase compared with pre-COVID-19 pandemic levels, with the highest rates of food insecurity in households with children (17.3%), Black (22.4%) and Hispanic (20.8%) heads of household, and those with incomes below the federal poverty level (36.7%).¹ Those with food insecurity have greater risk of chronic illness, including 2.5 times greater odds of obesity,⁶ 1.5 times greater risk of cardiovascular mortality,⁷ and more than twice the risk of diabetes.⁸ Importantly, food insecurity adversely impacts the management of chronic conditions, as food-insecure individuals may engage in coping strategies that are counterproductive to the management of their chronic illness.^{3,6,9} For example, a food-insecure patient with hypertension and obesity may struggle to adhere to Dietary Approaches to Stop Hypertension guidelines because of reliance on less-expensive and more shelf-stable canned vegetables over fresh produce, maximizing dietary quantity at the expense of quality.³

In response to this growing need, clinical Food-as-Medicine interventions have emerged in recent years to directly connect clinical settings to food access.¹⁰ These include connecting patients to supplemental nutrition benefits, such as the Special Supplemental Nutrition Program for Women, Infants, and Children; Supplemental Nutrition Assistance Program; and Temporary Assistance for Needy Families¹¹; produce prescriptions for free or discounted fresh produce to be redeemed at a grocery store food pantry or farmers' market¹²; medically tailored grocery (MTG) programs, wherein a health care professional, considering the patient's unique medical needs and goals, selects foods to be provided to the patient

ABSTRACT

Objectives: To describe a regional health system's experience with medically tailored groceries (MTG), focusing on program reach and effectiveness as determined by observed within-person changes in cardiometabolic measures.

Study Design: Case study including individuals aged 18 to 79 years referred by an ambulatory health care provider to a single regional health system's MTG program from April 2020 through September 2023.

Methods: Demographics, clinical characteristics, and cardiometabolic measures (blood pressure [BP], weight, body mass index [BMI], and hemoglobin A_{1c} [HbA_{1c}]) were abstracted from electronic health records. Descriptive and bivariate analyses evaluated differences in demographics and comorbid conditions among those who ever vs never used the Food for Life Market. Weighted linear mixed-effect models evaluated the expected change in outcomes from baseline to recent measure, accounting for demographics, time between measures, and attributed market location.

Results: A total of 2259 adults received referrals to the MTG program (median, 1 referral; range, 1-7; 3184 total referrals). Of those referred, 1397 (61.8%) ever attended; MTG users were significantly older than nonusers (median age, 52.9 vs 38.3 years; $P < .001$). MTG program attendance was associated with favorable changes in market attendees vs nonusers in diastolic BP (-0.54 vs -0.51 mm Hg; $P = .04$) and BMI (0.20 vs 0.23 ; $P = .02$) after 3 years from baseline, after accounting for confounders. No significant differences were observed in systolic BP, HbA_{1c}, or weight.

Conclusions: An unincubated MTG intervention demonstrated modest impacts on key cardiometabolic measures. Future efforts to colocate MTG sites with clinical settings may enhance program uptake and impact on cardiometabolic measures.

from a clinic or pantry and prepared at home¹³; and/or medically tailored meal (MTM) programs, wherein prepared meals are delivered directly to patients' homes.¹⁴⁻¹⁶ MTG programs, in particular, have proven attractive to health systems in terms of potential reach, acceptability, flexibility, and lower costs than MTM for staffing, storage, and distribution.¹⁷ However, data are limited regarding the impact of MTG on population health when implemented by a regional health system. Therefore, the purpose of this article is to describe one regional health system's experience with MTG as a population health strategy, focusing on reach and effectiveness as determined by observed within-person changes over time in blood pressure (BP), weight, body mass index (BMI), and hemoglobin A_{1c} (HbA_{1c}).

An MTG intervention offered by a single regional health system was not only widely adopted with substantial reach but was also well accepted by patients, with modest but statistically significant impacts on key cardiometabolic measures influenced by adequate nutrition. Future research should focus on addressing the limitations of the program and how to implement changes to increase exposure and impact of the MTG intervention.

METHODS

DESIGN AND SETTING

This retrospective observational case study included all adults referred by an ambulatory health care provider to University Hospitals Health System's ("University Hospitals") MTG program, the Food for Life Market (FFLM), from the launch of an electronic referral process in April 2020 through September 2023. University Hospitals is located in Northeast Ohio with

a service area covering 15 counties. The first FFLM opened in October 2018 in 1 of the system's urban-located ambulatory care facilities, with 3 additional locations added over the following 18 months. At the time of data abstraction in September 2023, FFLMs were active in 4 locations (2 in Cuyahoga County, 1 in Portage County, and 1 in Ashtabula County). FFLM locations are appointment-only and include space for one-on-one consultation plus a storelike area with available pantry-stable food items arrayed on shelving units and perishables in refrigerator cases.

To identify those eligible for FFLM, patients are screened as part of routine care using the 2-item Hunger Vital Sign.¹⁸ Those with a positive screen are eligible for electronic referral to their preferred location by their treating clinician. Each referral permits the patient to select a week's worth of groceries for up to 4 household members once per month for up to 6 months as a supplement to other food-related resources. After the 6-month referral period expires, patients who again indicate food insecurity on the Hunger Vital Sign are eligible for rereferral, with no limit to the number of referral episodes. Like any other medical referral, patients schedule their market appointments at a day, time, and location that is convenient for them. Each location is staffed at least 3 days per week by a registered dietitian. Food is provided to each market by the regional food bank serving the county in which it is located, with no substantial differences in inventory among sites. Staff, facilities, and related program costs are funded by University Hospitals as part of its community benefit strategy.

At each market visit, the dietitian reviews with the patient their particular medical conditions that may influence food selection, discusses nutrition goals, provides dietary education, and supports the patient in composing a medically tailored grocery bag that accounts for their preferences. Often, the dietitian will coach the patient regarding food preparation, providing recipes that use the selected foods and address medical and nutrition goals. The dietitian will then schedule with the patient their next market visit. Each market encounter is documented in the patient's electronic health record (EHR), capturing the needs, goals, and recommendations discussed during the appointment.

DATA SOURCES

Data for these analyses were obtained via our health system's ambulatory EHR system. Included for analysis were all patients aged 18 to 79 years referred at least once to at least 1 FFLM from April 2020 through September

2023 by a provider using the ambulatory EHR system. These analyses include all patients referred from primary care, ambulatory specialty clinics, outpatient obstetrician-gynecologist (ob-gyn) practices, and urgent care sites, but they exclude any self-referrals or those from inpatient units or emergency departments, as they use a different referral process not captured in the ambulatory EHR. All study protocols and procedures, including waiver of signed consent, were approved by the University Hospitals Institutional Review Board.

Although the fixed-effects model indicated smaller increases in BMI and greater decreases in DBP among those who attended the market over longer periods, it is unclear whether these changes are clinically meaningful. Nevertheless, our data reflect clinical impacts resulting from real-world, unincentivized implementation of MTG as part of routine clinical care. The lessons to be learned regarding program acceptability, feasibility, adoption, and reach are notable and may be used to guide other Food-as-Medicine interventions in varied health systems.

MEASURES

The primary exposure of interest was market attendance, where *ever attended* was defined as patients with 1 or more documented market visits following any referral, and *never attended* was defined as patients with no documented market visits despite 1 or more referrals.

Outcomes of interest included within-person change in the following cardiometabolic measures: systolic

BP (SBP), diastolic BP (DBP), HbA_{1c}, weight in kg, and BMI in kg/m². For each outcome, 2 time points were abstracted: the baseline measure was defined based on the clinical encounter with the date closest to the first referral to the market, and the recent measure was defined based on the clinical encounter closest to the date of data abstraction (August 13, 2023).

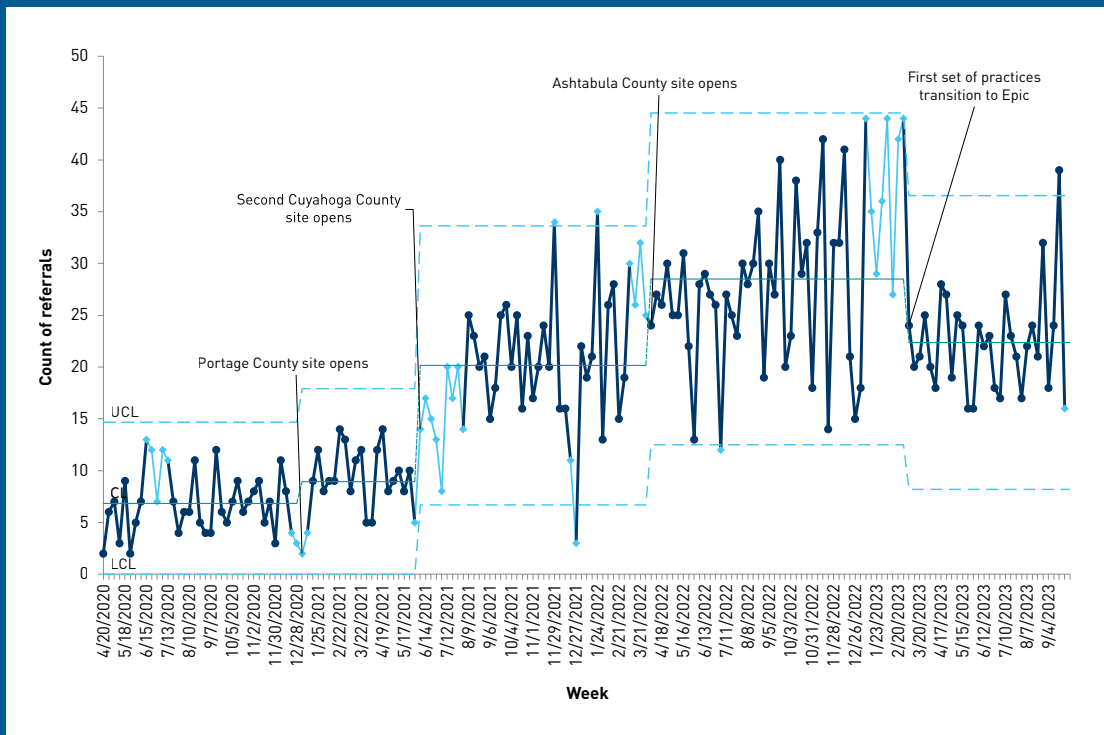
Covariates included patient sex, age, race, and ethnicity as documented in the EHR. County of residence was based on the patient's home zip code. Referral source was based on the encounter location from which the first FFLM referral was placed, grouped according to specialty (primary care, including internal medicine, medicine-pediatrics, and family medicine practices; ob-gyn practices; ambulatory adult specialty practices such as cardiology, nephrology, neurology; and other, including pediatrics, psychiatry, and urgent care sites). Comorbid conditions were defined based on the first 3 digits of the *International Statistical Classification of Diseases, Tenth Revision* codes included on the patient's EHR active problem list.

ANALYSES

Descriptive statistics (frequencies and percentages) were used to describe the study population, with Shapiro-Wilk tests for normality applied to assess distribution of cardiometabolic measures. Bivariate analyses (χ^2 or Kruskal-Wallis rank sum test, as appropriate) were conducted to evaluate differences in demographics and comorbid conditions among those who ever vs never used the market. To account for observed age differences between those who visited the market and those who did not and expected confounding of comorbid condition prevalence by age, we applied inverse propensity weighting to the data set prior to multivariable modeling. We used the weighted data set to construct linear mixed-effect models to evaluate the expected change in outcomes from baseline to recent measure, with time measured as the difference in years between baseline and recent measure, and including a random effect for each person nested within a random effect for residential location. We assumed that patients residing in Cuyahoga County would most likely attend 1 of the 2 Cuyahoga County markets, those in Portage County would attend the Portage County market, etc. For those residing in other counties, we assigned them to the market location closest to their residence as the crow flies. The model was:

$$\text{Outcome} \sim \text{Demographics} + \text{Time} \times \text{Market Attendance} + (\text{Person} | \text{Location})$$

FIGURE. Systemwide Referrals to Market, April 2020 to September 2023: Statistical Process Control Chart^a



LCL, lower confidence limit; UCL, upper confidence limit.

^aThe first Cuyahoga County site opened for paper/manual referrals in 2018, with transition to an electronic referral process in the ambulatory electronic health record shared by system ambulatory practices. In March 2023, a subset of primary care practices transitioned into Epic, with the remainder of system sites making the transition in October 2023. Light blue solid line indicates mean count of referrals per during the time period (centerline). Light blue points indicate weeks in which the count of referrals relative to the centerline triggered 1 or more control chart rules indicating special cause variation.

We reviewed residual plots and QQ plots to confirm normality of the error terms of each model and used the F-test with Kenward-Roger approximation to test the hypothesis for each model that the expected change in outcome measure was equal between those who did and did not attend the market.

Subgroup analyses were conducted following the same procedures, focusing on those with comorbid conditions of particular interest to payers: chronic kidney disease, diabetes, and pregnancy. Analyses were completed using R 4.0.3 and R Studio 1.4.1103 (R Foundation for Statistical Computing).

RESULTS

PROGRAM REACH

In total, 2259 individuals aged 18 to 79 years were referred to the FFLM from April 2020 to September

2023 (median, 1 referral; range, 1-7; 3184 total referrals placed during the study period) (Figure). Referred patients had a median age of 49 years at first referral, predominately identifying as Black or African American (67%) and non-Hispanic (98%), with referrals most often originating from primary care offices (48.2%) and for patients residing in Cuyahoga County (68.3%). The most common comorbidities included hypertension (53.3%), overweight/obesity (44.5%), hyperlipidemia (39.3%), and type 2 diabetes (29.5%). Only 8.4% of referred patients had chronic kidney disease, and 26% had a pregnancy-related diagnosis. Of those referred, 1397 had ever attended the FFLM (514 once, 197 twice, and 679 for 3 or more visits), whereas 862 had never attended. Those who attended the market had their first encounter a mean (SD) of 4 (13.1) weeks from the date of first referral. We observed

TABLE 1. Unweighted (Raw) Demographic and Clinical Characteristics of Patients Aged 18-79 Years Referred to Market

Characteristic	Overall	Never attended	Market user	P
n	2259	862	1397	
Age in years, median (IQR)	48.77 (31.33-61.96)	38.27 (26.10-57.23)	52.90 (36.08-63.57)	<.001
Age categories in years, n (%)				<.001
18-29	509 (22.5)	289 (33.5)	220 (15.7)	
30-39	354 (15.7)	163 (18.9)	191 (13.7)	
40-49	314 (13.9)	112 (13.0)	202 (14.5)	
50-59	426 (18.9)	108 (12.5)	318 (22.8)	
60-69	452 (20.0)	134 (15.5)	318 (22.8)	
70-79	204 (9.0)	56 (6.5)	148 (10.6)	
Male, n (%)	682 (30.2)	265 (30.7)	417 (29.8)	.688
Race, n (%)				.806
Black or African American	1520 (67.3)	587 (68.1)	933 (66.8)	
White	44 (1.9)	16 (1.9)	28 (2.0)	
Other ^a	695 (30.8)	259 (30.0)	436 (31.2)	
Ethnicity: not Hispanic or Latino, n (%)	2212 (97.9)	842 (97.7)	1370 (98.1)	.635
Comorbid conditions, ^b n (%)				
Asthma	498 (22.0)	154 (17.9)	344 (24.6)	<.001
Chronic kidney disease	189 (8.4)	55 (6.4)	134 (9.6)	.009
Coronary artery disease	268 (11.9)	70 (8.1)	198 (14.2)	<.001
Hyperlipidemia	888 (39.3)	260 (30.2)	628 (45.0)	<.001
Hypertension	1203 (53.3)	340 (39.4)	863 (61.8)	<.001
Overweight/obese BMI	1005 (44.5)	311 (36.1)	694 (49.7)	<.001
Pregnancy	588 (26.0)	322 (37.4)	266 (19.0)	<.001
Thyroid disease	346 (15.3)	97 (11.3)	249 (17.8)	<.001
Type 1 diabetes	45 (2.0)	25 (2.9)	20 (1.4)	.023
Type 2 diabetes	666 (29.5)	191 (22.2)	475 (34.0)	<.001
Referral source, n (%)				<.001
Primary care	1082 (48.2)	319 (37.3)	763 (54.9)	
Ambulatory specialty	550 (24.5)	195 (22.8)	355 (25.5)	
Ob-gyn	526 (23.4)	301 (35.2)	225 (16.2)	
Other	101 (4.5)	47 (5.4)	54 (3.8)	
County of residence, n (%)				.032
Ashtabula	42 (1.9)	13 (1.5)	29 (2.1)	
Cuyahoga	1543 (68.3)	609 (70.6)	934 (66.9)	
Other	184 (8.1)	78 (9.0)	106 (7.6)	
Portage	490 (21.7)	162 (18.8)	328 (23.5)	

TABLE 1. (Continued) Unweighted (Raw) Demographic and Clinical Characteristics of Patients Aged 18-79 Years Referred to Market

Characteristic	Overall	Never attended	Market user	P
Cardiometabolic measures				
SBP in mm Hg, median (IQR)				
Baseline	125 (115-139)	122 (113-135)	128 (117-141)	<.001
Recent	126 (115-138)	124 (114-135)	127 (116-139)	<.001
DBP in mm Hg, median (IQR)				
Baseline	79 (72-85)	78 (71-84)	80 (72-86)	.001
Recent	79 (72-85)	78 (72-84)	79 (72-85)	.133
Hemoglobin A _{1c} in %, median (IQR)				
Baseline	5.90 (5.40-6.90)	5.75 (5.30-6.80)	5.90 (5.40-7.00)	.009
Recent	5.90 (5.40-6.80)	5.70 (5.30-6.62)	5.90 (5.50-6.90)	<.001
Weight in kg, median (IQR)				
Baseline	86.18 (69.85-106.14)	83.46 (66.00-102.13)	87.68 (71.69-107.96)	<.001
Recent	86.36 (70.36-106.14)	84.37 (67.60-102.97)	88.00 (71.67-108.00)	.001
BMI in kg/m ² , median (IQR)				
Baseline	30.87 (24.98-38.18)	29.65 (24.11-36.14)	31.58 (25.63-39.20)	<.001
Recent	31.17 (25.29-38.25)	30.11 (24.64-37.09)	31.94 (26.01-38.87)	<.001

BMI, body mass index; DBP, diastolic blood pressure; ob-gyn, obstetrics-gynecology; SBP, systolic blood pressure.

*Other race: American Indian or Alaska Native (n=1), Asian (n=2), declined (n=1), multiracial (n=3), other (n=8), unknown (n=11).

^bDefined based on first 3 digits of *International Statistical Classification of Diseases, Tenth Revision* codes included in patient's electronic health record problem list: asthma (J45), chronic kidney disease (N18), coronary artery disease (I25), hyperlipidemia (E78), hypertension (I10-I13, I15), overweight/obese BMI (E66), pregnancy (O00-O48), thyroid disease (E00-E07), type 1 diabetes (E10), type 2 diabetes (E11).

no difference in attendance according to sex, race, or ethnicity. Patients referred from primary care settings or ambulatory specialty services were more likely than those from ob-gyn or other settings to attend the market. Notably, those who attended the market were significantly older than those who did not, and market users had greater prevalence of most comorbid conditions, pregnancy excepted. Those residing in Portage County were significantly more likely to attend the FFLM compared with other locations (Table 1).

We observed 1.33 times greater odds of attending the market for every 10-year increase in age at referral. Application of inverse propensity weights by age resulted in a data set balanced at baseline for demographics, with suggestion of greater market use by those with most chronic conditions, especially hypertension, overweight/obesity, and type 2 diabetes (eAppendix Table 1 [eAppendix available at ajmc.com]).

PROGRAM EFFECTIVENESS

Market attendance was associated with improvement in some cardiometabolic risk factors. In multivariable analyses accounting for demographics, market location, and time between baseline and recent measures, market users had a larger decrease in DBP compared with those who did not attend the market (expected change over 3 years, -0.54 vs -0.51 mm Hg; $P = .044$) and smaller increases in BMI (expected change over 3 years, 0.20 vs 0.23 ; $P = .016$). We observed no significant differences in change from baseline according to market attendance in SBP, HbA_{1c}, or weight (Table 2).

In subgroup analyses (see eAppendix), multivariable models found that among those with kidney disease, there was a significant difference between those who attended the market and those who did not in expected change from baseline in DBP, weight, and BMI after 3 years. Those who attended the market had a larger decrease in DBP (-2.55 vs

TABLE 2. Linear Mixed-Effect Model: Expected Change in Outcome Measures at 3 Years^a From Baseline

Measure	Attended	Never attended	Difference	P
SBP (mm Hg)	-0.09	-0.37	0.28	.594
DBP (mm Hg)	-0.54	-0.51	-0.03	.0438*
HbA _{1c} (%)	0.08	-0.02	0.09	.3843
Weight (kg)	0.49	0.41	0.08	.0611
BMI (kg/m ²)	0.2	0.23	-0.03	.0164*

BMI, body mass index; DBP, diastolic blood pressure; HbA_{1c}, hemoglobin A_{1c}; SBP, systolic blood pressure.

* $P < .05$.

^aExcept HbA_{1c}, for which average observation time was 1.5 years.

-2.02 mm Hg; $P = .02$), a smaller decrease in weight (-3.16 vs -3.29 kg; $P < .0001$), and a smaller decrease in BMI (-0.87 vs -1.04; $P < .0001$) than those who did not.

Among pregnant patients, multivariable models found a statistically significant difference in expected change after 3 years from baseline among market users vs nonusers in all outcomes. Those who attended the market had a larger increase in DBP (3.02 vs 1.92 mm Hg; $P = .0002$), SBP (1.68 vs 1.21 mm Hg; $P = .003$), and HbA_{1c} (0.31% vs 0.04%; $P = .006$) compared with those who never attended. Notably, those who attended the market had a smaller increase in weight (3.69 vs 4.39 kg; $P < .0001$) and in BMI (1.33 vs 1.54; $P < .0001$).

Among those with diabetes, multivariable models found a statistically significant difference in expected change after 3 years from baseline between market users vs nonusers in all outcomes except SBP. Patients with diabetes who attended the market had a smaller decrease in DBP (-0.94 vs -1.58 mm Hg; $P = .008$), HbA_{1c} (-0.18% vs -0.20%; $P = .0295$), weight (-1.97 vs -2.30 kg; $P < .0001$), and BMI (-0.57 vs -0.62; $P = .0002$) than those who never attended the market. These differences were modest and likely not clinically significant.

In terms of market use, among those who ever attended the market, 514 (37%) only attended once, 197 (14%) attended twice, 369 (27%) attended 3 to 7 times, and 310 (22%) attended 8 or more times. Those in Cuyahoga County were less likely to attend multiple times compared with those in Portage or Ashtabula counties. However, in inverse-propensity weighted mixed-effect models, we did not observe a clear dose-response relationship between the number of times a person attended the market and the change in outcomes in which higher market attendance correlated with better outcomes.

DISCUSSION

In this retrospective observational cohort of adult patients referred to an MTG intervention (FFLM) embedded within

a regional health care system, within-person changes in documented biometric outcomes (SBP, DBP, HbA_{1c}, weight, BMI) were small. Although the fixed-effects model indicated smaller increases in BMI and greater decreases in DBP among those who attended the market over longer periods, it is unclear whether these changes are clinically meaningful. Nevertheless, our data reflect clinical impacts resulting from real-world, unincorporated implementation of MTG as part of routine clinical care. The lessons to be learned regarding program acceptability, feasibility, adoption, and reach are notable and may be used to guide other Food-as-Medicine interventions in varied health systems.

Referral volumes were substantial, with growth over time as more markets came online and more clinicians became aware of patients' need for food supports and the system-based resources to address that need. Ultimately, more than 2200 unique adults were referred to FFLM from a wide range of practices for several reasons, with some patients receiving as many as 7 referrals to the program in a 3-year period. With food insecurity increasing over time, particularly as access to pandemic-era government supports wanes, it is reassuring to observe that the referral process (screening using a simple 2-question Hunger Vital Sign and placement of electronic referral to the program following the same process as any other in-system medical referral) was widely adopted throughout the entire system within a short period, showing the acceptability and feasibility of the market referral process.

The majority of patients referred to the market did attend at least once. However, we observed differences in market attendance according to residential location, with patients in Cuyahoga County and those in counties without FFLM locations attending the market less often than those patients in Portage and Ashtabula counties. As an entirely urban county, many Cuyahoga County residents rely on public transit, with both FFLM locations on

the east side of the county and not necessarily colocated with the site of their referring practice. By contrast, both the Portage and Ashtabula locations are housed within the same regional medical centers where referring practices are located. Convenience and proximity to the market may be driving differences in market uptake. Indeed, transportation is a frequently cited barrier to use of MTG interventions,^{19,20} and familiarity with a particular location is a motivator for similar place-based interventions,²¹ leveraging a trusted and familiar location to overcome patient reticence or stigma in accessing services.²² Based on these data, we anticipate that selection of future FFLM sites will prioritize colocation with the clinical sites from which patients are referred.


LIMITATIONS

Several limitations merit comment. Our data reflect the experience of this particular MTG model within a single health system, and thus, our findings may not be generalizable to other settings or programs. Because we relied on EHR data, clinical measures did not correspond in all cases to specific timing of market encounters, and our inclusion of a heterogeneous population defined only by their shared self-report of food insecurity elided individual-level considerations or goals for BP or weight management. As described here and in the literature, there is likely misallocation of comorbid conditions as we were limited to active problems on the patient's problem list (which may not have been up to date). For example, for patients with pregnancy on their problem list, we were unable to attribute market exposure to specific pregnancy episodes. Given notable difference in market attendance by these patients, further work should be conducted prospectively to evaluate barriers and facilitators to their uptake of the FFLM model during pregnancy and postpartum periods. Similarly, the market intervention addressed a single week's groceries for the month and thus supplemented rather than replaced other food resources to which participants may have had access. Furthermore, despite the emphasis on dietitian-led education, the market intervention did not necessarily influence other behaviors or aspects of patients' lifestyles. Therefore, we cannot strictly attribute market exposure as causal of our observed differences in DBP, weight, and BMI for market users. Finally, these analyses did not account for nutrient intake resulting from foods distributed by the market. Thus, future analyses addressing food quality will be needed to explore the mechanisms by which market exposure may influence cardiometabolic markers.

CONCLUSIONS

An MTG intervention offered by a single regional health system was not only widely adopted with substantial reach but also well accepted by patients, with modest but statistically significant impacts on key cardiometabolic measures influenced by adequate nutrition. Future research should focus on addressing the limitations of the program (eg, reducing barriers to enrollment and retention, translating and tracking of food market exposure to adequate nutritional intake, and optimizing outreach for underserved/marginalized groups) and how to implement changes to increase exposure and impact of the MTG intervention. Based on these preliminary findings, health systems should consider integrating Food-as-Medicine interventions into their strategy to promote population health.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the contributions of Dr Margaret Larkins Pettigrew, the University Hospitals (UH) Food for Life Market Dietitians, the participating University Hospitals Health System clinicians, and the patients and families, as well as Elizabeth Ruttenberg of the UH Center for Equity Diversity and Inclusion, the Greater Cleveland Food Bank, the Akron Canton Regional Food Bank, and Sodexo for their support of the UH Food for Life Market program. 

Author Affiliations: University Hospitals Rainbow Center for Child Health & Policy (SDR), Cleveland, OH; Department of Pediatrics (SDR), Department of Population and Quantitative Health Sciences (HH), and Department of Medicine (IJN), Case Western Reserve University School of Medicine, Cleveland, OH; University Hospitals Harrington Heart & Vascular Institute (IJN), Cleveland, OH; Clinical and Community Nutrition, Sodexo Healthcare at University Hospitals (AL), Cleveland, OH; University Hospitals Office of Community Impact, Equity, Diversity and Inclusion (CC), Cleveland, OH. **Source of Funding:** Funding for this research was provided by the University Hospitals Office of Community Impact, Equity, Diversity and Inclusion.

Author Disclosures: Dr Hartman received payment for her involvement as a biostatistician in the preparation of this manuscript. Dr Neeland is a consultant for Boehringer Ingelheim, Eli Lilly, and Novo Nordisk; has a grant pending from the National Institutes of Health; and has participated in speaker bureaus for Bayer, Boehringer Ingelheim, and Eli Lilly. The remaining authors report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

Authorship Information: Concept and design (SDR, AL, CC); acquisition of data (CC); analysis and interpretation of data

(SDR, HH, IJN); drafting of the manuscript (SDR, HH, IJN); critical revision of the manuscript for important intellectual content (SDR, HH, IJN, AL, CC); statistical analysis (HH); provision of study materials or patients (AL); administrative, technical, or logistic support (CC); and supervision (CC).

Send Correspondence to: Sarah D. Ronis, MD, PhD, University Hospitals, 11100 Euclid Ave, MS 6036, Cleveland, OH 44106. Email: sarah.ronis@UHhospitals.org.

REFERENCES

- Rabbitt MP, Hales LJ, Burke MP, Coleman-Jensen A. Household Food Security in the United States in 2022. US Department of Agriculture Economic Research Service. October 2023. Accessed April 28, 2024. https://ers.usda.gov/sites/default/files/_laserfiche/publications/107703/ERR-325.pdf?v=26604
- Johnson KT, Palakshappa D, Basu S, Seligman H, Berkowitz SA. Examining the bidirectional relationship between food insecurity and healthcare spending. *Health Serv Res.* 2021;56(5):864-873. doi:10.1111/1475-6773.13641
- Marpadga S, Fernandez A, Leung J, Tang A, Seligman H, Murphy EJ. Challenges and successes with food resource referrals for food-insecure patients with diabetes. *Perm J.* 2019;23:18-097. doi:10.7812/tpp/18-097
- Eder M, Henninger M, Durbin S, et al. Screening and interventions for social risk factors: technical brief to support the US Preventive Services Task Force. *JAMA.* 2021;326(14):1416-1428. doi:10.1001/jama.2021.12825
- Norris K, Jilcott Pitts S, Reis H, Haynes-Maslow L. A systematic literature review of nutrition interventions implemented to address food insecurity as a social determinant of health. *Nutrients.* 2023;15(15):3464. doi:10.3390/nu15153464
- Briggs R, Rowden H, Lagojda L, Robbins T, Randeve HS. The lived experience of food insecurity among adults with obesity: a quantitative and qualitative systematic review. *J Public Health (Oxf).* 2024;46(2):230-249. doi:10.1093/pubmed/fdae016
- Sun Y, Liu B, Rong S, et al. Food insecurity is associated with cardiovascular and all cause mortality among adults in the United States. *J Am Heart Assoc.* 2020;9(19):e014629. doi:10.1161/JAHA.119.014629
- Kirby JB, Bernard D, Liang L. The prevalence of food insecurity is highest among Americans for whom diet is most critical to health. *Diabetes Care.* 2021;44(6):e131-e132. doi:10.2337/dc20-3116
- Gany F, Melnic I, Wu M, et al. Food to overcome outcomes disparities: a randomized controlled trial of food insecurity interventions to improve cancer outcomes. *J Clin Oncol.* 2022;40(31):3603-3612. doi:10.1200/JCO.21.02400
- De Marchis EH, Torres JM, Benesch T, et al. Interventions addressing food insecurity in health care settings: a systematic review. *Ann Fam Med.* 2019;17(5):436-447. doi:10.1370/afm.2412
- Keith-Jennings B, Llobrera J, Dean S. Links of the Supplemental Nutrition Assistance Program with food insecurity, poverty, and health: evidence and potential. *Am J Public Health.* 2019;109(12):1636-1640. doi:10.2105/AJPH.2019.305325
- Hager K, Du M, Li Z, et al. Impact of produce prescriptions on diet, food security, and cardiometabolic health outcomes: a multisite evaluation of 9 produce prescription programs in the United States. *Circ Cardiovasc Qual Outcomes.* 2023;16(9):e009520. doi:10.1161/CIRCOUTCOMES.122.009520
- Sharma V, Sharma R. Food is Medicine initiative for mitigating food insecurity in the United States. *J Prev Med Public Health.* 2024;57(2):96-107. doi:10.3961/jpmph.23.505
- Mozaffarian D, Fleischhacker S, Andrés JR. Prioritizing nutrition security in the US. *JAMA.* 2021;325(16):1605-1606. doi:10.1001/jama.2021.1915
- Fischer L, Bodrick N, Mackey ER, et al. Feasibility of a home-delivery produce prescription program to address food insecurity and diet quality in adults and children. *Nutrients.* 2022;14(10):2006. doi:10.3390/nu14102006
- Berkowitz SA, Delahanty LM, Terranova J, et al. Medically tailored meal delivery for diabetes patients with food insecurity: a randomized cross-over trial. *J Gen Intern Med.* 2019;34(3):396-404. doi:10.1007/s11606-018-4716-z
- Peters A, Hughes R IV, Brown J. Food is Medicine: the road to universal coverage. *Health Affairs Forefront.* April 9, 2024. doi:10.1377/forefront.20240404.727722
- Makelarski JA, Abramsohn E, Benjamin JH, Du S, Lindau ST. Diagnostic accuracy of two food insecurity screeners recommended for use in health care settings. *Am J Public Health.* 2017;107(11):1812-1817. doi:10.2105/ajph.2017.304033
- Schlosser AV, Joshi K, Smith S, Thornton A, Bolen SD, Trapl ES. "The coupons and stuff just made it possible": economic constraints and patient experiences of a produce prescription program. *Transl Behav Med.* 2019;9(5):875-883. doi:10.1093/tbm/ibz086
- Crusan A, Roozen K, Godoy-Henderson C, Zamarripa K, Remache A. Using community-based participatory research methods to inform the development of medically tailored food kits for Hispanic/Latine adults with hypertension: a qualitative study. *Nutrients.* 2023;15(16):3600. doi:10.3390/nu15163600
- Glover J, Samir N, Kaplun C, et al. The effectiveness of place-based interventions in improving development, health and wellbeing outcomes in children aged 0–6 years living in disadvantaged neighbourhoods in high-income countries – a systematic review. *Wellbeing Space Soc.* 2021;2:100064. doi:10.1016/j.wss.2021.100064
- Bruckner HK, Westbrook M, Loberg L, Teig E, Schaeffbauer C. "Free" food with a side of shame? combating stigma in emergency food assistance programs in the quest for food justice. *Geoforum.* 2021;123:99-106. doi:10.1016/j.geoforum.2021.04.021

eAppendix Table 1. Summary of weighted demographic data

	Overall	Never Attended	Market User
n	4477	2250	2227
Age in years -- median [range]	49.27 [18.01-79.92]	49.29 [18.01-79.92]	49.26 [18.01-79.90]
Sex = male (%)	1410 (31.5)	773 (34.4)	637 (28.6)
Race (%)			
Black or African American	2914 (65.1)	1387 (61.6)	1528 (68.6)
White	1477 (33.0)	826 (36.7)	651 (29.2)
Other*	86 (1.9)	37 (1.7)	49 (2.2)
Ethnicity = Not Hispanic or Latino (%)	4385 (97.9)	2201 (97.8)	2183 (98.0)
Comorbid conditions** (%)			
Asthma	959 (21.4)	400 (17.8)	558 (25.1)
Chronic Kidney Disease	389 (8.7)	197 (8.8)	191 (8.6)
Coronary Artery Disease	535 (11.9)	263 (11.7)	272 (12.2)
Hyperlipidemia	1770 (39.5)	864 (38.4)	906 (40.7)
Hypertension	2372 (53.0)	1099 (48.8)	1273 (57.2)
Overweight/Obese BMI	1932 (43.2)	833 (37.0)	1099 (49.4)
Pregnancy	1164 (26.0)	632 (28.1)	532 (23.9)
Thyroid disease	679 (15.2)	314 (13.9)	366 (16.4)
Type 1 Diabetes Mellitus	92 (2.0)	57 (2.5)	35 (1.6)
Type 2 Diabetes Mellitus	1315 (29.4)	618 (27.5)	697 (31.3)

*other race = American Indian or Alaska Native (1), Asian(2), Declined(1), Multi-racial(3), Other(8), Unknown(11)

** defined based on first 3 digits of ICD-10 codes included in patient's AEMR problem list: asthma-J45; chronic kidney disease-N18; coronary artery disease-I25; hyperlipidemia-E78; hypertension-I10-I13, I15; overweight/obese BMI-E66; Pregnancy-O00-O48; Thyroid disease-E00-E07; Type 1 Diabetes-E10; Type 2 Diabetes-E11

eAppendix Table 2. Unweighted (raw) Demographic and Clinical Characteristics of Patients with Chronic Kidney Disease Referred to Market

	n	Overall	Never Attended	Market User	p-value
Age in years -- median [IQR]		189 63.83 [54.91, 70.87]	54 63.35 [53.86, 70.71]	135 63.95 [55.23, 71.06]	0.66
Age categories - n (%)					0.858
	18-29y	6 (3.2)	3 (5.5)	3 (2.2)	
	30-39y	8 (4.2)	2 (3.6)	6 (4.5)	
	40-49y	17 (9.0)	6 (10.9)	11 (8.2)	
	50-59y	42 (22.2)	12 (21.8)	30 (22.4)	
	60-69y	65 (34.4)	17 (30.9)	48 (35.8)	
	70-79y	51 (27.0)	15 (27.3)	36 (26.9)	
Sex = male (%)		76 (40.2)	26 (47.3)	50 (37.3)	0.269
Race (%)					0.297
	Black or African American	115 (60.8)	30 (54.5)	85 (63.4)	
	White	72 (38.1)	25 (45.5)	47 (35.1)	
	Other*	2 (1.1)	0 (0.0)	2 (1.5)	
Ethnicity = Not Hispanic or Latino (%)		184 (97.4)	55 (100.0)	129 (96.3)	0.341
Comorbid conditions** (%)					
	Asthma	43 (22.8)	11 (20.0)	32 (23.9)	0.699
	Coronary Artery Disease	51 (27.0)	11 (20.0)	40 (29.9)	0.228
	Hyperlipidemia	131 (69.3)	38 (69.1)	93 (69.4)	1
	Hypertension	174 (92.1)	48 (87.3)	126 (94.0)	0.206
	Overweight/Obese BMI	92 (48.7)	21 (38.2)	71 (53.0)	0.091
	Pregnancy	3 (1.6)	1 (1.8)	2 (1.5)	1
	Thyroid disease	51 (27.0)	10 (18.2)	41 (30.6)	0.117
	Type 1 Diabetes Mellitus	8 (4.2)	3 (5.5)	5 (3.7)	0.891
	Type 2 Diabetes Mellitus	108 (57.1)	24 (43.6)	84 (62.7)	0.025
Referral source					0.209
	Primary Care	105 (56.1)	27 (50.0)	78 (58.6)	
	Ambulatory Specialty	68 (36.4)	21 (38.9)	47 (35.3)	
	OB/Gyn	5 (2.7)	2 (3.7)	3 (2.3)	

County of Residence	Other	9 (4.8)	4 (7.4)	5 (3.8)	0.712
	County C	2 (1.1)	1 (1.8)	1 (0.7)	
	County A	123 (65.1)	33 (60.0)	90 (67.2)	
	Other	19 (10.1)	7 (12.7)	12 (9.0)	
	County B	45 (23.8)	14 (25.5)	31 (23.1)	
Cardiometabolic Measures					
SBP (mmHg - median [IQR])					
	Baseline	125 [115, 139]	122 [113, 135.25]	128 [117, 141]	<0.001
	Recent	126 [115, 138]	124 [114, 135]	127 [116, 139]	<0.001
DBP (mmHg -median [IQR])					
	Baseline	79 [72, 85]	77.50 [71, 84]	80.00 [72, 86]	0.001
	Recent	79 [72, 85]	78 [72, 84]	79 [72, 85]	0.133
Hemoglobin A1C (% - median [IQR])					
	Baseline	5.90 [5.40, 6.90]	5.75 [5.30, 6.80]	5.90 [5.40, 7.00]	0.009
	Recent	5.90 [5.40, 6.80]	5.70 [5.30, 6.62]	5.90 [5.50, 6.90]	<0.001
Weight (kg - median [IQR])					
	Baseline	86.18 [69.85, 106.14]	83.46 [66.00, 102.13]	87.68 [71.69, 107.96]	<0.001
	Recent	86.36 [70.36, 106.14]	84.37 [67.60, 102.97]	88.00 [71.67, 108.00]	0.001
BMI (kg/m ² - median [IQR])					
	Baseline	30.87 [24.98, 38.18]	29.65 [24.11, 36.14]	31.58 [25.63, 39.20]	<0.001
	Recent	31.17 [25.29, 38.25]	30.11 [24.64, 37.09]	31.94 [26.01, 38.87]	<0.001

*other race = American Indian or Alaska Native (1), Asian(2), Declined(1), Multi-racial(3), Other(8), Unknown(11)

** defined based on first 3 digits of ICD-10 codes included in patient's AEMR problem list: asthma-J45; chronic kidney disease-N18; coronary artery disease-I25; hyperlipidemia-E78; hypertension-I10-I13, I15; overweight/obese BMI-E66; Pregnancy-O00-O48; Thyroid disease-E00-E07; Type 1 Diabetes-E10; Type 2 Diabetes-E11

Abbreviations: OB/Gyn – Obstetrics & Gynecology, SBP – systolic blood pressure, DBP – diastolic blood pressure, BMI – body mass index

eAppendix Table 3. Linear Mixed Effect Model: Expected Change in Outcome Measures among Patients with Chronic Kidney Disease at 3 years^a from Baseline

	Attended	Never Attended	Difference	p-value	sig
SBP (mm Hg)	-2.71	-2.54	-0.17	0.1437	
DBP (mm Hg)	-2.55	-2.02	-0.53	0.0246	*
A1C (% , 1.5 year)	-0.08	-0.19	0.11	0.1570	
Weight (kg)	-3.16	-3.29	0.13	0.0000	*
BMI	-0.87	-1.04	0.18	0.0005	*

^aexcept A1C, for which average observation time was 1.5 years

eAppendix Table 4. Unweighted (raw) Demographic and Clinical Characteristics of Pregnant Patients Referred to Market

		Overall	Never Attended	Market User	p-value
	n	588	322	266	
Age in years -- median [IQR]		28.08 [22.60, 33.21]	27.02 [21.89, 32.55]	28.97 [24.25, 33.95]	0.001
Age categories - n (%)					0.245
	18-29y	343 (58.3)	200 (62.1)	143 (53.8)	
	30-39y	197 (33.5)	100 (31.1)	97 (36.5)	
	40-49y	43 (7.3)	20 (6.2)	23 (8.6)	
	50-59y	4 (0.7)	2 (0.6)	2 (0.8)	
	60-69y	1 (0.2)	0 (0.0)	1 (0.4)	
Race (%)					0.216
	Black or African American	528 (89.8)	295 (91.6)	233 (87.6)	
	White	16 (2.7)	6 (1.9)	10 (3.8)	
	Other*	44 (7.5)	21 (6.5)	23 (8.6)	
Ethnicity = Not Hispanic or Latino (%)		581 (98.8)	319 (99.1)	262 (98.5)	0.799
Comorbid conditions** (%)					
	Asthma	127 (21.6)	55 (17.1)	72 (27.1)	0.005
	Chronic Kidney Disease	3 (0.5)	1 (0.3)	2 (0.8)	0.868
	Hyperlipidemia	48 (8.2)	19 (5.9)	29 (10.9)	0.04
	Hypertension	116 (19.7)	46 (14.3)	70 (26.3)	<0.001
	Overweight/Obese BMI	238 (40.5)	112 (34.8)	126 (47.4)	0.003
	Thyroid disease	47 (8.0)	17 (5.3)	30 (11.3)	0.012
	Type 1 Diabetes Mellitus	10 (1.7)	8 (2.5)	2 (0.8)	0.195
	Type 2 Diabetes Mellitus	61 (10.4)	25 (7.8)	36 (13.5)	0.032
Referral source					0.001
	Primary Care	91 (15.5)	40 (12.4)	51 (19.2)	
	Ambulatory Specialty	24 (4.1)	7 (2.2)	17 (6.4)	
	OB/Gyn	460 (78.2)	271 (84.2)	189 (71.1)	
	Other	13 (2.2)	4 (1.2)	9 (3.4)	
County of Residence					0.035
	County C	2 (0.3)	0 (0.0)	2 (0.8)	

	County A	541 (92.0)	303 (94.1)	238 (89.5)	
	Other	29 (4.9)	15 (4.7)	14 (5.3)	
	County B	16 (2.7)	4 (1.2)	12 (4.5)	
Cardiometabolic Measures					
SBP (mmHg - median [IQR])					
	Baseline	118 [109, 127]	117 [109, 125]	119 [109, 130]	0.113
	Recent	120 [112, 130]	119 [111, 128]	120.5 [113, 132]	0.067
DBP (mmHg -median [IQR])					
	Baseline	75 [70, 82]	75 [70, 81]	76 [69, 84]	0.397
	Recent	78 [72, 84]	77 [72, 83]	79 [72, 84]	0.12
Hemoglobin A1C (% - median [IQR])					
	Baseline	5.40 [5.10, 5.80]	5.30 [5.10, 5.70]	5.40 [5.10, 5.90]	0.582
	Recent	5.30 [5.10, 5.80]	5.30 [5.00, 5.70]	5.40 [5.10, 5.90]	0.124
Weight (kg - median [IQR])					
	Baseline	82.56 [63.83, 103.42]	78.25 [61.21, 98.43]	88.91 [70.31, 107.50]	<0.001
	Recent	85.73 [69.06, 107.44]	82.00 [66.41, 102.00]	92.99 [73.03, 108.95]	<0.001
BMI (kg/m ² - median [IQR])					
	Baseline	31.48 [24.78, 38.77]	29.44 [24.01, 36.24]	33.47 [27.10, 40.53]	<0.001
	Recent	32.65 [26.47, 39.94]	31.05 [25.74, 38.42]	34.67 [27.59, 41.52]	<0.001

*other race = American Indian or Alaska Native (1), Asian(2), Declined(1), Multi-racial(3), Other(8), Unknown(11)

** defined based on first 3 digits of ICD-10 codes included in patient's AEMR problem list: asthma-J45; chronic kidney disease-N18; coronary artery disease-I25; hyperlipidemia-E78; hypertension-I10-I13, I15; overweight/obese BMI-E66; Pregnancy-O00-O48; Thyroid disease-E00-E07; Type 1 Diabetes-E10; Type 2 Diabetes-E11

Abbreviations: OB/Gyn – Obstetrics & Gynecology, SBP – systolic blood pressure, DBP – diastolic blood pressure, BMI – body mass index

eAppendix Table 5. Linear Mixed Effect Model: Expected Change in Outcome Measures among Pregnant Patients at 3 years^a from Baseline

	Attended	Never Attended	Difference	p-value	sig
SBP (mm Hg)	3.02	1.92	1.10	0.0002	*
DBP (mm Hg)	1.68	1.21	0.47	0.0027	*
A1C (% , 1.5 year)	0.31	0.04	0.27	0.0058	*
Weight (kg)	3.69	4.39	-0.70	0.0000	*
BMI	1.33	1.54	-0.21	0.0000	*

^aexcept A1C, for which average observation time was 1.5 years

eAppendix Table 6. Unweighted (raw) Demographic and Clinical Characteristics of Patients with Diabetes Referred to Market

	n	Overall	Never Attended	Market User	p-value
Age in years -- median [IQR]		666	191	475	
		58.21 [48.66, 65.45]	56.66 [45.46, 65.48]	58.65 [50.03, 65.40]	0.075
Age categories - n (%)					0.1
	18-29y	30 (4.5)	13 (6.8)	17 (3.6)	
	30-39y	62 (9.3)	21 (11.0)	41 (8.6)	
	40-49y	93 (14.0)	32 (16.8)	61 (12.8)	
	50-59y	192 (28.8)	45 (23.6)	147 (30.9)	
	60-69y	200 (30.0)	59 (30.9)	141 (29.7)	
	70-79y	89 (13.4)	21 (11.0)	68 (14.3)	
Sex = male (%)		243 (36.5)	80 (41.9)	163 (34.3)	0.081
Race (%)					<0.001
	Black or African American	387 (58.1)	89 (46.6)	298 (62.7)	
	White	6 (0.9)	0 (0.0)	6 (1.3)	
	Other*	273 (41.0)	102 (53.4)	171 (36.0)	
Ethnicity = Not Hispanic or Latino (%)		654 (98.2)	189 (99.0)	465 (97.9)	0.544
Comorbid conditions** (%)					
	Asthma	165 (24.8)	42 (22.0)	123 (25.9)	0.339
	Chronic Kidney Disease	108 (16.2)	24 (12.6)	84 (17.7)	0.132
	Coronary Artery Disease	146 (21.9)	40 (20.9)	106 (22.3)	0.776
	Hyperlipidemia	463 (69.5)	129 (67.5)	334 (70.3)	0.541
	Hypertension	542 (81.4)	149 (78.0)	393 (82.7)	0.191
	Overweight/Obese BMI	404 (60.7)	97 (50.8)	307 (64.6)	0.001
	Pregnancy	61 (9.2)	25 (13.1)	36 (7.6)	0.037
	Thyroid disease	143 (21.5)	36 (18.8)	107 (22.5)	0.347
Referral source					<0.001
	Primary Care	419 (62.9)	99 (51.8)	320 (67.4)	
	Ambulatory Specialty	170 (25.5)	57 (29.8)	113 (23.8)	
	OB/Gyn	45 (6.8)	19 (9.9)	26 (5.5)	
	Other	32 (4.8)	16 (8.4)	16 (3.4)	

County of Residence					0.005
	County C	20 (3.0)	6 (3.1)	14 (2.9)	
	County A	381 (57.2)	89 (46.6)	292 (61.5)	
	Other	59 (8.9)	20 (10.5)	39 (8.2)	
	County B	206 (30.9)	76 (39.8)	130 (27.4)	
Cardiometabolic Measures					
SBP (mmHg - median [IQR])					
	Baseline	131 [120, 144]	129 [118, 140.50]	132 [120, 145]	0.129
	Recent	130 [119, 144]	128 [118, 140]	131 [120, 144]	0.113
DBP (mmHg -median [IQR])					
	Baseline	80 [73, 86]	79 [73, 86]	80 [73, 86]	0.424
	Recent	79 [72, 85]	78 [72, 84]	79 [72, 85]	0.279
Hemoglobin A1C (% - median [IQR])					
	Baseline	7.25 [6.30, 9.20]	7.60 [6.50, 10.05]	7.20 [6.20, 8.80]	0.003
	Recent	7.10 [6.30, 8.50]	7.20 [6.30, 8.75]	7.10 [6.20, 8.50]	0.138
Weight (kg - median [IQR])					
	Baseline	97.98 [82.10, 115.78]	97.64 [83.69, 112.41]	97.98 [81.65, 117.94]	0.727
	Recent	95.26 [78.74, 113.40]	95.98 [78.87, 111.83]	94.55 [78.47, 114.31]	0.994
BMI (kg/m ² - median [IQR])					
	Baseline	34.39 [29.44, 41.73]	34.30 [29.14, 40.17]	34.62 [29.58, 42.05]	0.261
	Recent	34.00 [28.47, 40.23]	33.15 [28.02, 39.44]	34.11 [28.67, 40.81]	0.327

*other race = American Indian or Alaska Native (1), Asian(2), Declined(1), Multi-racial(3), Other(8), Unknown(11)

** defined based on first 3 digits of ICD-10 codes included in patient's AEMR problem list: asthma-J45;chronic kidney disease-N18; coronary artery disease-I25; hyperlipidemia-E78; hypertension-I10-I13, I15; overweight/obese BMI-E66; Pregnancy-O00-O48; Thyroid disease-E00-E07; Type 1 Diabetes-E10; Type 2 Diabetes-E11

eAppendix Table 7. Linear Mixed Effect Model: Expected Change in Outcome Measures among Patients with Diabetes at 3 years^a from Baseline

	Attended	Never Attended	Difference	p-value	sig
SBP (mm Hg)	-0.52	-0.95	0.43	0.3663	
DBP (mm Hg)	-0.94	-1.58	0.64	0.0080	*
A1C (% , 1.5 year)	-0.18	-0.20	0.02	0.0295	*
Weight (kg)	-1.97	-2.30	0.34	0.0000	*
BMI	-0.57	-0.62	0.05	0.0002	*

^aexcept A1C, for which average observation time was 1.5 years