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Patient, facility, and environmental factors associated with obesity treatment in US Veterans

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Abstract

Background: Identifying patient-, facility-, and environment-level factors that influence the initiation and retention of comprehensive lifestyle management interventions (CLMI) for urban and rural Veterans could improve obesity treatment and reach at Veterans Affairs (VA) facilities.

Aims: This study identified factors at these various levels that predicted treatment engagement, retention, and weight management among urban and rural Veterans.

Methods: A retrospective cohort study of 631,325 Veterans was designed using VA databases to identify Veterans with class II and III obesity during 2015–2017. Primary outcomes were initiation of CLMI, bariatric surgery, or obesity pharmacotherapy within 1 year of index date. Secondary outcomes included treatment retention and successful weight loss. Generalized linear mixed models were used to evaluate the relationships between factors and obesity-related outcomes, with rurality differences assessed through interaction terms.

Results: Patient characteristics associated with increased odds of initiating CLMI included female sex ($p < 0.001$), black race ($p < 0.001$), sleep apnea ($p < 0.001$), mood disorder ($p < 0.001$), and use of medications associated with weight loss ($p < 0.001$) or weight gain ($p < 0.001$). Facility use of telehealth was associated with greater odds of CLMI initiation in urban Veterans ($p < 0.001$) but lower retention in both populations ($p = 0.003$). Routine consideration of pharmacotherapy was associated with higher CLMI initiation. Environmental characteristics associated with increased odds of CLMI initiation included percent of population foreign born (OR = 1.03 per 10% increase; $p < 0.001$), percent black ($p < 0.001$), and high walkability index ($p < 0.001$). The relationship between total population and CLMI initiation differed by rurality, as greater population was associated with lower odds of CLMI initiation in urban areas (OR: 0.99 per 1000 population; $p < 0.001$), but higher odds in rural areas (OR:1.01, $p = 0.01$). Veterans in the south were less likely to initiate CLMI and had lower retention ($p < 0.001$).

Conclusion: Treatment and retention of CLMI among Veterans remain low, highlighting areas for improvement to expand its reach both urban and rural Veterans.

KEYWORDS
obesity treatment, rural population, veterans Affairs

1 | INTRODUCTION

The disease of obesity among Veterans served by the Veterans Health Administration (VHA) has a prevalence of 41% across the 140 VHA facilities.[1] The negative cardiometabolic consequences of obesity are amplified in patients with class II and III obesity (BMI >35 kg/m^2 and BMI >40 kg/m^2, respectively).[2] Furthermore, obesity-related medical expenses have been shown to cost the U.S. healthcare system more than $147 billion USD annually, emphasizing the importance of obesity prevention and treatment.[3]

Since 2006, the VHA has offered MOVE!, an evidence-based comprehensive lifestyle modification intervention (CLMI) to all Veterans with a body mass index (BMI) of ≥25 kg/m^2. MOVE! is currently the largest health care-delivered weight loss intervention in the United States.[4] The program consists of 8–16 in-person or telemedicine and individual or group sessions aimed at fostering the use of self-management strategies, dietary changes, and increased physical activity.[4] MOVE! also offers pharmacotherapy and bariatric surgery. Staffing requirements for MOVE! typically include a physician champion, program coordinator, and an interdisciplinary staff though not all programs contain all roles.

Despite years of implementation, participation in the MOVE! program continues to be low, and varies between 0.05% and 16% of eligible Veterans.[4] Though sustained engagement in MOVE! has shown a modest improvement in short-term weight loss, only a few participants engage in the full program.[5] A 2016 review concluded that MOVE! participation was associated with modest short-term weight loss, with 12-month weight loss ranging from −0.13 kg to −3.3 kg.[6] More recently, Hung et al. demonstrated an average 1.4% body weight loss over 12 months – substantially lower than the 5% weight loss that is considered clinically significant.[7] The program's relatively modest success may partly be due to low retention rates. Only 9% of MOVE! participants in the study had 12 or more CLMI visits in the 12 months following enrollment – the minimum recommended level of engagement. Indeed, participants with 12+ visits in one year lost an average 2.8% of their weight after 12 months, more than twice as much as participants with <12 visits. Other studies have found similarly low engagement rates.[5,8–10] Higher CLMI participation has been consistently associated with greater weight change.[6,11] Veterans who had 1 to 5 CLMI visits showed similar odds of weight loss, but additional visits significantly improved outcomes. Specifically, the relative odds of achieving clinically relevant weight loss were 17%, 53%, 84%, and 121% higher for Veterans with 6–9, 10–13, 14–17, and 18 or more CLMI contacts, respectively, compared to those with only 1 contact.[11] Some studies suggest that TeleMOVE! may improve retention. Rutledge et al. found more frequent CLMI participation among Veterans engaged in TeleMOVE! Moreover, 26.6% of TeleMOVE! participants lost 5% or more bodyweight compared to only 12% of regular CLMI participants.[12]

Weight loss strategies including weight loss pharmacotherapy and bariatric surgery are under-utilized at the VHA, despite the strong evidence of their effectiveness and support by multiple professional society guidelines.[13–18] Despite their availability, use of weight loss pharmacotherapy through 2019 was very low within MOVE!, with only 1.1% of eligible Veterans receiving any weight loss medications within 1 year of MOVE! enrollment.[19] Importantly, this study did not include the newer class of obesity pharmacotherapies approved since 2021.[19] The use of bariatric surgery to treat adults with severe obesity is also low. Fewer than 0.1% of Veterans with severe obesity underwent bariatric surgery–a utilization rate nearly 20 times lower than that for nonveterans.[20]

Factors contributing to low levels of MOVE! engagement include limited availability of staff and facilities as well as patient-specific factors such as socioeconomic status.[6,21] Staffing and curriculum content across local MOVE! programs vary, reflecting differences in Veterans' needs and resource allocations. This variability contributes to the wide disparities observed in MOVE! participation and retention across facilities as well as in the use of obesity pharmacotherapy and bariatric surgery.[6,22] Use of obesity pharmacotherapy may also be impeded due to restrictive criteria for approval and follow-up processes,[23,24] limited provider experience, and concern about adverse reactions.[25] Bariatric surgery may be underutilized due to limited referring provider knowledge about guidelines for bariatric surgery, long travel distances, delayed referrals, difficulties meeting preoperative requirements, and lack of available providers or appointments.[20,26] Barriers to treatment may be particularly pronounced for rural Veterans, partly due to environmental factors such as greater geographic distance to treatment providers and community resources, limited access to specialty care, fewer physicians experienced in obesity pharmacotherapy or bariatric surgery, lower population density and diversity, limited internet availability, and higher poverty rates.[27] Current data suggest that people living in rural and highly rural localities have higher rates of obesity and sedentary lifestyle as compared to those living in urban areas. Additionally, a recent study demonstrated that rural veterans had a higher odds of both current and lifetime depression and experience more episodes of binge drinking compared to their urban counterparts which may further impede further weight loss efforts.[28–31] A recent retrospective study by Robinson et al. demonstrated that rural Veterans had lower initiation rates in MOVE!, and lower use of pharmacotherapy and bariatric surgery than non-rural patients.[32] While the previous study highlighted disparities in weight loss treatment initiation among Veterans in urban, rural, and highly rural areas, the current study examines a wider range of factors influencing MOVE! engagement and outcomes. It integrates patient characteristics, facility-level practices, and environmental factors to predict both initiation and retention in MOVE! as well as other related outcomes. Additionally, this study explores the nuanced interactions between urban-rural status and these variables, providing actionable insights for improving program reach and effectiveness in these populations.

2 | MATERIALS AND METHODS

This is a retrospective analysis using secondary data of 631,325 urban and rural VA patients with class II and class III obesity using the VHA national patient databases available through the VA Informatics and Computing Infrastructure (VINCI). The project received Human Subjects Research approval from the University of Iowa (IRB #201910848) and the Iowa City VA Medical Center Institutional Review Board. All data management and analyses were conducted on VINCI. Patient data sources included the VA Corporate Data Warehouse, inpatient and outpatient encounter data, pharmacy, along with geocoded enrollment information from the VA Planning Systems and Support Group (PSSG), VHA Vital Signs file, and VHA Vital Status File.

Inclusion and exclusion criteria are shown in Figure 1. Briefly, VA patients ≥18 years with at least two weight and height measurements during 2015–2017 who had class II or III obesity were identified. These patients were selected because of their increased propensity to develop obesity-related metabolic complications. Patients ≥80 years were excluded due to unknown benefits of weight loss programs in older patients.[33,34] Patients were also excluded if they received obesity treatment (MOVE! initiation and/or weight loss pharmacotherapy) during the 12 months prior to the index date (defined as the start of the second year with class II or III obesity), had <1 year of VA healthcare enrollment prior to the index date, had missing residential information for determining rurality, or resided outside the 50 states and District of Columbia. Finally, a small number of patients with pre-existing gastrointestinal ulcer or palliative status were excluded as they may not have been suitable candidates for some weight loss treatments.

2.1 | Patient, facility, and environmental factors

The same patient level variables were used in this study as in a previous study by Robinson et al.[32] In both studies, patients were categorized as urban or rural based on Rural-Urban Commuting Area (RUCA) codes assigned to patient residence census tract.[35] Other patient variables included demographics (age, sex, and self-reported race), select comorbid conditions based on Elixhauser & Charlson algorithms,[36] an overall measure of comorbidity defined by Gagne et al.,[37] and use of medications associated with weight gain or weight loss. These medications are tabulated in Robinson et al. for reference.[32]

Facility variables included VHA facility complexity,[38] annual volume of CLMI group and individual in-person behavioral therapy sessions, annual volume of CLMI telehealth sessions, and the percent of total CLMI encounters by telehealth as derived from VHA administrative data. Additionally, characteristics of CLMI programs at

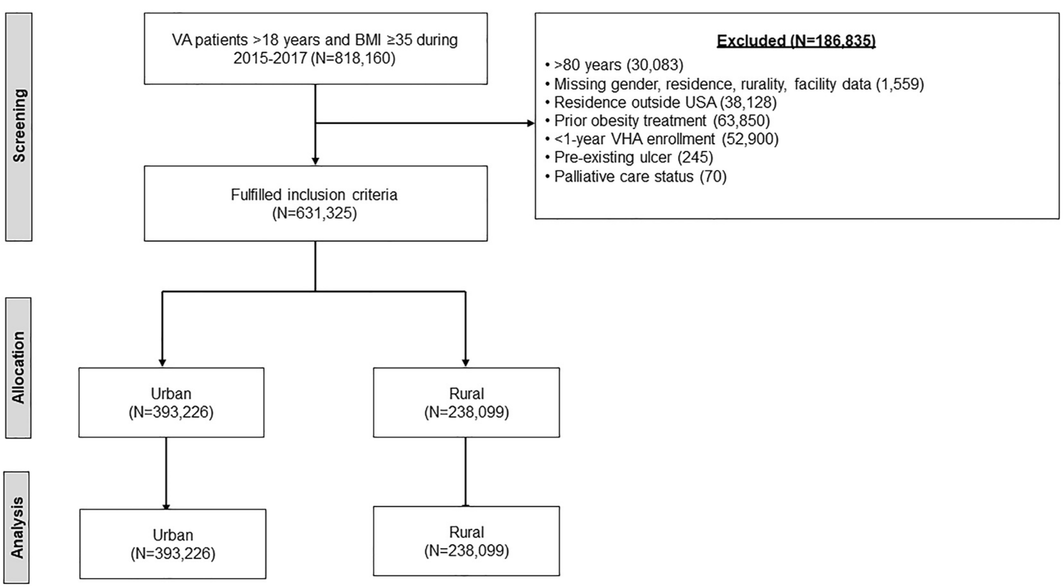

FIGURE 1 Inclusion criteria included VA patients >18 years old with at least two weight and height measurements during 2015–2017 who had Class II and Class III obesity. VHA, Veterans health administration.

each facility were assessed by the 2017 VA healthcare analysis and information group (HAIG) survey. Factor analysis was used to evaluate the correlation structure among facility and CLMI program characteristics due to the large number of available variables. Nine latent factors accounted for 74% of the total variance represented by facility variables.

The option of defining variables representing each latent factor based on linear combinations of observed variables was considered. Ultimately, a single variable was selected to represent each factor to preserve the scale and interpretability of specific facility and CLMI program characteristics. The observed facility characteristic that best represented each latent factor was chosen for analysis; in most cases, this was the variable with the highest loading factor (i.e., most related to the latent factor). For example, total facility patients, total patients enrolled in CLMI, and total CLMI encounters all reflect alternative measures of facility patient volume and are correlated. The variable for inclusion was selected based on factor loading value, relationship to outcomes, and collinearity with other selected variables (See Table A1 for description of the nine facility factors). Variables selected to represent the nine facility latent factors included: MOVE! patient volume, percent of MOVE! encounters delivered by telehealth, individual MOVE! encounters offered, MOVE! maintenance programming offered, CLMI coordinators available ≥21 h per week, use of pharmacotherapy routinely considered, availability of a pharmacist with weight management expertise, no limits imposed on pharmacotherapy refills, and availability of bariatric surgery.

Neighborhood and environmental variables were obtained from three sources: (1) the United States Department of Agriculture (USDA) Food Access Research Atlas,[39] an open-access repository featuring various food access indicators; (2) the Social Deprivation Index[40] and component variables derived from the American Community Survey (ACS); and (3) the U.S. Environmental Protection Agency (EPA) Walkability Index. This national geographic resource assesses block groups and ranks them according to relative walkability. Additionally, driving time and distance from patient residence to the nearest VHA primary and tertiary care sites were obtained from VHA Provider Systems and Support Group (PSSG) files. Using the same factor analysis approach described above, 14 underlying factors representing 76% of the variance in 33 neighborhood measures were identified (Table A2). Selected variables included poverty rate (based on federal poverty level), total population, percent Black, percent foreign-born, percent White, percent high needs population, EPA walkability index (summarized to census tract level), low access tract at 1 and 20 miles based on USDA Food Access Research Atlas, percent unemployed, census region, mean distance in miles to nearest VA tertiary care center, number of seniors (≥65 years), and median household income (ranked into quartiles). Low access at 1 and 20 miles indicates individuals living more than 1 mile (in urban areas) or more than 20 miles (in rural areas) from the nearest supermarket, supercenter, or large grocery store. The percentage of population with high needs reflects population percentages of seniors, children under the age of 5 and women of child-bearing ages (age 15–44).[41]

2.2 | Outcomes

Primary outcomes were (1) initiation of CLMI, (2) bariatric surgery, or (3) pharmacotherapy within 1 year of index date. Secondary outcomes included treatment retention and successful weight loss. Treatment retention was defined as ≥12 consecutive weeks of CLMI encounters. Successful weight loss was defined as losing ≥5% of the initial body weight 12 months after initiating MOVE! Greater than 12 weeks was chosen as an outcome as this is consistent with VA Department of Defense Practice Guidelines and a recent systematic review showing greater weight loss in patients participating in CLMI programs with more than 12 compared to <12 sessions.[42]

2.3 | Statistical analysis

Patient, facility and environment characteristics were compared between rural and urban Veterans using a *t*-test for continuous variables and a chi-square test for categorical variables, with $p < 0.05$ indicating statistical significance. Treatment initiation, retention, and successful weight loss were compared between urban and rural patients using logistic regression estimated as a generalized linear mixed model with random intercepts for each patient's assigned facility as identified in the VA Primary Care Management Module, a resource that identifies the site of each patient's assigned primary care physician. All analyses were conducted using SAS version 9.4.

3 | RESULTS

3.1 | Patient, facility, and environmental factors

The total study population consisted of 631,325 Veterans: 393,226 urban and 238,099 rural. Mean age of the urban and rural groups was 57.7 and 60.2 years, respectively. Across both groups, most patients were male, non-Hispanic White, and older than 55 years. The most common medical comorbidities included hypertension, diabetes, sleep apnea, and depression (Table 1). Rural patients had greater proportions of most comorbidities compared with urban patients, although most differences were small despite their statistical significance. Over half of the studied population were taking medications that could cause weight gain.

Among facility characteristics, CLMI coordinators were available >21 h/week at >50% of VA facilities across groups. Facilities treating rural patients had lower MOVE! patient volume (11,600 vs. 14,400), slightly higher percentage of CLMI delivered by telehealth (36.3% vs. 34.0%), and were more likely to offer individual CLMI sessions (58.3% vs. 52.1%). Additionally, pharmacotherapy was routinely considered in similar proportions at facilities treating urban (37.9%) and rural (37.0%) patients, but a pharmacist with pharmacotherapy expertise was more likely to be present at facilities treating urban patients (32.9%) compared to facilities treating rural patients (24.2%). Similarly, bariatric surgery was more likely to be available at

TABLE 1 Characteristics of urban and rural patients.

	Urban	Rural	*p*-value
Demographics			
All patients	393,226	238,099	
Age (years), mean (SD)	57.7 (12.5)	60.2 (11.6)	<0.001
Length of enrollment (years), mean (SD)	10.15 (5.0)	10.33 (4.9)	<0.001
Sex, N (%)			
Male	352,088 (89.5)	221,161 (93.1)	<0.001
Female	41,138 (10.5)	16,333 (6.9)	
Race and Ethnicity, N (%)			
White, non-Hispanic	242,089(61.6)	193,820 (81.4)	<0.001
Black, non-Hispanic	96,162(24.5)	21,471 (9.0)	<0.001
Other (Hispanic or other non-White)	35,087 (8.9)	10,506 (4.4)	<0.001
Unknown	19,888(5.1)	12,239 (5.1)	0.13
Comorbidities, N (%)			
Alcohol use disorder	26,133 (6.7)	12,253 (5.1)	<0.001
Substance use disorder	17,328 (4.4)	5969 (2.5)	<0.001
Congestive heart failure	20,483 (5.2)	13,621 (5.7)	<0.001
Chronic obstructive pulmonary disease	59,645 (15.2)	40,990 (17.2)	<0.001
Coronary artery disease	59,749 (15.2)	44,780 (18.8)	<0.001
Depression	82,429 (21.0)	47,934 (20.1)	<0.001
Diabetes			
Diabetes mellitus (any)	160,032 (41.5)	104,473 (43.9)	<0.001
Uncomplicated	116,891 (29.7)	74,475 (31.3)	<0.001
Complicated	46,141 (11.7)	29,968 (12.9)	<0.001
Hypertension (any)	264,333 (67.2)	168,865 (70.9)	<0.001
Uncomplicated	251,864 (64.1)	161,723 (67.9)	<0.001
Complicated	12,469 (3.2)	7142 (3.0)	0.001
Ischemic stroke	12,922 (3.3)	8243 (3.5)	0.001
Liver disease	13,414 (3.4)	6560 (2.8)	<0.001
Peripheral vascular disease	16,969 (4.3)	11,672 (4.9)	<0.001
Renal failure	25,056 (6.4)	14,334 (6.0)	<0.001
Sleep apnea	107,069 (27.2)	64,604 (27.1)	0.431
Tobacco use	51,106 (13.0)	34,325 (14.4)	<0.001
Pharmacologic variables, N (%)			
Using medications associated with weight gain	212,435 (54.0)	134,915 (56.7)	<0.001
Using medications associated with weight loss[a]	100,399 (25.5)	63,075 (26.5)	<0.001

[a]Use of medications associated with weight loss, excluding pharmacologic treatment for weight loss as part of MOVE!.

facilities treating urban versus rural patients (89% and 79.6% respectively). Urban patients were more likely to be treated in facilities with the highest complexity (47.8% and 32.2% respectively; Table 2)

Among environmental factors, Veterans living in rural areas were likely to have a greater distance to tertiary care centers compared with urban-dwelling Veterans. Rural Veterans also had a lower median household income, lower percentage non-employed, and lower

TABLE 2 Characteristics of facilities serving rural and urban patients.

Facility characteristic	Urban	Rural	*p*-value
Number of patients	393,226	238,099	
Facility MOVE! characteristics			
Patients enrolled in MOVE!/1000 primary care patients, mean (SD)	14.4 (9.6)	11.6 (8.5)	<0.001
Percent CLMI encounters by telehealth, mean (SD)	34.0 (39.3)	36.3 (46.1)	<0.001
Individual CLMI offered, N (%)	204,999 (52.13)	138.705 (58.3)	<0.001
CLMI coordinator >21 h/week, N (%)	241,951 (61.53)	147.144 (61.8)	0.03
Facility use of pharmacotherapy			
Pharmacotherapy routinely considered, N(%)	149,186 (37.9)	87,978 (37.0)	<0.001
PharmD obesity pharmacotherapy expert: Yes, N(%)	125,434 (31.9)	57,544 (24.2)	<0.001
No	216,409 (55.0)	132,726 (57.8)	
Unknown	51,383 (13.1)	42,829 (18.0)	
Refill limit for obesity pharmacotherapy, N(%)	116,921 (29.7)	70,265 (29.5)	<0.001
Facility provides bariatric surgery, N(%)	350,134 (89.0)	189,590 (79.6)	<0.001
Facility complexity[a], N(%)			
1a (high complexity)	187,827 (47.8)	76,547 (32.2)	<0.001
1b	74,458 (18.9)	34,609 (14.5)	
1c	74,217 (18.9)	60,091 (25.2)	
2–3 (low complexity)	56,724 (14.4)	66,852 (28.1)	

Abbreviation: CLMI, comprehensive lifestyle modification intervention.

walkability index. A disproportionate number of rural Veterans resided in the Midwest (29.6%) compared with urban Veterans (19.3%; Table 3).

3.2 | Unadjusted outcomes

Unadjusted analysis indicated that rural Veterans were less likely to: initiate CLMI, be prescribed weight loss medications, and undergo bariatric surgery ($p < 0.001$, $p < 0.001$, $p = 0.04$ respectively). There was no difference in CLMI retention or successful weight loss by rurality (Table 4).

3.3 | Predictors for CLMI initiation

Patient, facility, and environmental predictors of CLMI initiation are illustrated in Table 5. The relative odds of initiating CLMI decreased by 10% for every 10 years of age among urban patients, and by 15% for rural patients. Female gender was associated with higher odds of CLMI initiation, with slightly higher relative odds of initiating CLMI among rural women compared to urban women (OR: 1.60 vs. 1.49, respectively). Black patients in urban or rural settings were more likely to initiate MOVE! compared to White non-Hispanic patients. Rural Black patients had higher relative odds of initiating CLMI than urban Black patients (OR:1.49 vs. 1.30, respectively). Overall, higher comorbidity as measured by the Gagne comorbidity score was associated with higher odds of initiating CLMI (OR:1.06; 95% CI, 1.04–1.07), with no difference in the effect of comorbidity by rurality. Having a mood disorder or sleep apnea was associated with higher odds of initiating CLMI among both rural and urban patients, with higher relative odds among rural patients compared to urban patients (OR:1.33 vs. 1.23; OR:1.50 vs. 1.38 respectively). Prior substance use disorder and use of medications known to be associated with weight loss or weight gain were also associated with higher odds of initiating CLMI. Tobacco use, diabetes, renal disease, coronary artery disease, and heart failure were associated with lower odds of CLMI initiation, with no difference between urban and rural patients. Receiving primary care in a facility where pharmacotherapy was routinely considered for obesity treatment was associated with higher odds of CLMI initiation (OR = 1.15) and did not differ by rurality. The percentage of CLMI encounters delivered by telehealth was also associated with higher odds of CLMI initiation for urban patients (OR = 1.03 per 10% increase) but not for rural patients.

Five environmental characteristics were associated with CLMI initiation. Residence in a tract with a high percentage of foreign-born or Black residents was associated with higher odds of CLMI initiation (OR: 1.03 and 1.02 per 10% increase, respectively; $p < 0.001$), and did not differ by rurality. The walkability index was also associated with CLMI initiation, with a 1-unit increase in the index associated with a 1% increase in the likelihood of initiating CLMI for both urban and rural patients. Residing in a census tract designated as having low access to food was associated with lower odds of initiating CLMI for both rural and urban patients. The likelihood of initiating CLMI

TABLE 3 Characteristics of rural and urban patients' residential environments.

Environment/Neighborhood Characteristic	Urban, N(%)	Rural, N(%)	*p*-value
Number of patients	393,226	238,099	
Census tract population characteristics			
Total population in 2010, mean (SD)	5271 (2630)	4698 (1864)	<0.001
Number seniors (>65 years), mean (SD)	664 (635)	721 (323)	<0.001
Percent black, mean (SD)	17.6 (23.9)	7.4 (14.6)	<0.001
Percent foreign born, mean (SD)	11.2 (10.5)	3.5 (4.6)	<0.001
Percent White, mean (SD)	68.5 (25.3)	85.7 (26.6)	<0.001
Percent ≤100% of federal poverty level), mean (SD)	16.7 (12.0)	16.5 (8.8)	<0.001
Median Family income, mean (SD)	$63,431 (25,880)	$56,550 (15,799)	<0.001
Percent with high needs, mean (SD)	41.0 (5.7)	40.5 (4.6)	
Percent non-unemployed, mean (SD)	9.5 (5.6)	8.7 (4.7)	
Reside in census tract with low food access at 1 and 20 miles[a], N (%)	195,827 (49.8)	55,715 (23.4)	<0.001
Walkability index, mean (SD)	9.36 (3.4)	5.81 (2.3)	<0.001
Miles to nearest VA tertiary care, mean (SD)	78.1 (67.5)	132.3 (84.7)	<0.001
Region, N (%)			<0.001
Midwest	76,062 (19.3)	70,580 (29.6)	
Northeast	50,667 (12.9)	26,582 (11.2)	
South	182,834 (46.5)	105,210 (44.2)	
West	83,663 (21.3)	35,727 (15.0)	

Abbreviation: VA, veterans affairs.

[a]1 mile, urban; 20 miles, rural.

TABLE 4 Unadjusted outcomes.

	Urban, N(%)	Rural, N(%)	Odds Ratio[a] (rural vs. urban)
All patients	393,226	238,099	
Obesity Treatment			
Initiated CLMI	24,677 (6.3)	10,675 (4.5)	0.72 (0.70–0.73; $p < 0.001$)
Pharmacotherapy	1100 (0.3)	481 (0.2)	0.79 (0.70–0.89; $p < 0.001$)
Bariatric surgery	95 (0.024)	39 (0.016)	0.68 (0.47–0.98; $p = 0.04$)
Among patients who initiated CLMI			
CLMI retention ≥12 weeks	2422 (9.9)	1076 (10.1)	1.01 (0.93–1.10; $p = 0.8$)
Successful weight loss at 12 months[b]	3515 (14.2)	1541 (15.4)	1.00 (0.94–1.07; $p = 0.96$)

[a]Odds ratios estimated using generalized linear mixed models controlling for facility as random effects.

[b]Successful weight loss was defined as losing ≥5% of initial weight 12 months after initiating MOVE! The results exclude 2346 urban and 890 rural dwelling Veterans with no BMI available 12 months after initiating MOVE!.

Abbreviation: CLMI, comprehensive lifestyle modification intervention.

decreased by 1% per 1000 population in urban centers and increased by 1% per 1000 population in rural centers. Finally, CLMI initiation differed significantly by census region, with the highest relative likelihood in the Midwest (OR = 1.16), and lowest likelihood in the South (OR = 0.90).

3.4 | Predictors of pharmacologic obesity treatment

Older age was linked to a decreased use of pharmacologic obesity treatment in both urban and rural patients (OR: 0.76; OR: 0.69 respectively; Table 6). Female sex and history of alcohol use disorder,

TABLE 5 Predictors of CLMI initiation.

	Urban OR (95% CI; *p*-value)	Rural OR (95% CI; *p*-value)
Patient characteristics		
Demographics		
Age per 10 years	0.90 (0.89–0.92; $p < 0.001$)	0.85 (0.83–0.86; $p < 0.001$)
Female	1.49 (1.43–1.54; $p < 0.001$)	1.60 (1.50–1.71; $p < 0.001$)
Race		
Black non-Hispanic[a]	1.30 (1.25–1.35; $p < 0.001$)	1.49 (1.40–1.59; $p < 0.001$)
Other non-white	1.11 (1.07–1.16; $p < 0.001$)	
Length of VHA enrollment	0.996 (0.993–0.998; $p < 0.001$)	
Comorbidities		
Gagne comorbidity score	1.06 (1.04–1.07; $p < 0.001$)	
Tobacco use	0.88 (0.85–0.91; $p < 0.001$)	
Diabetes	0.84 (0.82–0.87; $p < 0.001$)	
Renal disease	0.84 (0.80–0.89; $p < 0.001$)	
Coronary artery disease	0.92 (0.89–0.95; $p < 0.001$)	
Heart failure	0.88 (0.83–0.94; $p < 0.001$)	
Substance use disorder	1.23 (1.17–1.29; $p < 0.001$)	
Mood disorder	1.23 (1.19–1.26; $p < 0.001$)	1.33 (1.27–1.39; $p < 0.001$)
Sleep apnea	1.38 (1.34–1.42; $p < 0.001$)	1.50 (1.44–1.56; $p < 0.001$)
Use of meds associated with weight loss[b]	1.33 (1.30–1.37; $p < 0.001$)	
Use of meds associated with weight gain	1.27 (1.24–1.30; $p < 0.001$)	
Facility characteristics		
Pharmacotherapy routinely considered	1.15 (1.00–1.34; $p = 0.05$)	
Percent MOVE! by telehealth (per 10%)	1.03 (1.01–1.04; $p < 0.001$)	1.01 (0.99–1.03; $p = 0.15$)
Environmental characteristics		
Percent of population foreign born (per 10%)	1.03 (1.01–1.04; $p < 0.001$)	
Percent of population black (per 10%)	1.02 (1.01–1.03; $p < 0.001$)	
Walkability index	1.01 (1.01–1.02; $p < 0.001$)	
Total population (per 1000)	0.99 (0.98–0.99; $p < 0.001$)	1.01 (1.00–1.03; $p = 0.01$)
Census region (Ref: "National Average")		
Midwest	1.16 (1.10–1.22; $p < 0.001$)	
Northeast	0.97 (0.91–1.04; $p = 0.40$)	
South	0.90 (0.86–0.93; $p < 0.001$)	
West	1.00 (0.94–1.06; $p = 0.90$)	

[a]White race was used as a reference to calculate odds ratios.

[b]Use of medications associated with weight loss, excluding pharmacologic treatment for weight loss as part of MOVE!.

Abbreviations: 95% CI, 95% confidence interval; CLMI, comprehensive lifestyle modification intervention; OR, odds ratio; VHA, Veterans Health Administration.

substance use disorder, sleep apnea, coronary artery disease, diabetes, and prior use of medications associated with weight gain and weight loss were associated with an increased odds of being prescribed pharmacotherapy. There were no facility characteristics that predicted the use of pharmacotherapy. The odds of initiating pharmacotherapy increased with increasing percent of the population foreign born (OR:1.10, $p < 0.001$ per 10% increase in foreign born), whereas the odds decreased with increased percent of the population living in poverty (OR: 0.94, $p = 0.02$ per 10% increase in poverty rate).

TABLE 6 Predictors of obesity pharmacotherapy initiation.

	Urban OR (95% CI; p-value)	Rural OR (95% CI; p-value)
Patient characteristics		
Age per 10 years	0.76 (0.72–0.80; $p < 0.001$)	0.69 (0.63–0.75; $p < 0.001$)
Female	1.68 (1.43–1.98; $p < 0.001$)	
Comorbidities		
Tobacco use	0.73 (0.63–0.85; $p < 0.001$)	
Alcohol use disorder	1.62 (1.35–1.95; $p < 0.001$)	
Substance use disorder	1.56 (1.26–1.93; $p < 0.001$)	
Sleep apnea	1.37 (1.23–1.52; $p < 0.001$)	
Coronary artery disease	1.15 (1.02–1.30; $p = 0.03$)	
Diabetes – Any	2.18 (1.93–2.46; $p < 0.001$)	
With complication	1.83 (1.57–2.13; $p < 0.001$)	
Prior use of medications associated with weight gain	2.29 (1.98–2.64; $p < 0.001$)	
Prior use of medications associated with weight loss[a]	2.07 (1.84–2.33; $p < 0.001$)	
Facility characteristics	*None*	
Environmental characteristics		
Percent foreign born (per 10%)	1.10 (1.04–1.17; $p = 0.001$)	
Poverty rate (100% of federal poverty level)	0.94 (0.90–0.99; $p = 0.02$)	

[a]Use of medications associated with weight loss, excluding pharmacologic treatment for weight loss as part of MOVE!.

TABLE 7 Predictors of bariatric surgery.

	Urban OR (95% CI; p-value)	Rural OR (95% CI; p-value)
Patient characteristics		
Age per 10 years	0.85 (0.73–0.98; $p = 0.03$)	
Female	2.55 (1.68–3.87; $p < 0.001$)	
Comorbidities		
Hypertension	0.85 (0.55–1.33; $p = 0.49$)	0.37 (0.19–0.72; $p = 0.004$)
Sleep apnea	1.16 (0.74–1.84; $p = 0.52$)	2.32 (1.22–4.43; $p = 0.01$)
Facility characteristics	*None*	
Environmental characteristics		
Distance to nearest VA tertiary care (per 10 miles)	0.90 (0.85–0.96; $p < 0.001$)	0.97 (0.93–1.02; $p = 0.27$)

Abbreviation: VA, Veterans Affairs.

3.5 | Predictors for bariatric surgery

Older age was associated with lower odds of bariatric surgery (OR: 0.85, $p = 0.03$; Table 7). Females in both rural and urban settings were more likely to undergo bariatric surgery than males ($p < 0.001$). Patients with hypertension were significantly less likely to receive bariatric surgery in rural areas, though this result was not significant in urban patients. There were no facility characteristics that predicted the likelihood of receiving bariatric surgery. A greater distance from a VA tertiary care center among urban-dwelling patients was associated with a lower likelihood of receiving bariatric surgery ($p < 0.001$). Surprisingly, distance to nearest VA tertiary center was not related to the receipt of bariatric surgery for rural patients.

3.6 | Predictors for CLMI retention

Female gender, older age, and having sleep apnea were all associated with higher odds of CLMI retention, with no difference in the effect for rural and urban patients. Tobacco use was associated with lower CLMI retention. Treatment at a facility that routinely considered pharmacotherapy treatment for obesity was associated with higher retention (OR = 1.35), while increasing percent of CLMI encounters delivered by telehealth was associated with lower retention (OR = 0.96 per 10% increase in the proportion of CLMI encounters via telehealth). Retention also differed by region, with patients residing in the South having the lowest likelihood of completing 12 weeks of CLMI. These results are illustrated in Table A3.

3.7 | Predictors for successful weight loss

Older age, female sex, diabetes, and use of medications linked to weight gain were associated with lower odds of successful weight loss relative to younger age, male sex, no diabetes, and no use of medications linked to weight gain (Table A4). Black race was associated with higher odds of successful weight loss relative to White non-Hispanic patients. No facility characteristics were associated with successful weight loss. Total population was the only environmental variable associated with weight loss as the likelihood of successful weight loss increased by 2% per 1000 population in urban and rural areas.

4 | DISCUSSION

This study is one of the first to identify patient, facility, and environmental predictors of CLMI initiation and retention in both urban and rural VA populations. Overall, the study revealed several predictors of CLMI initiation, obesity pharmacotherapy, bariatric surgery enrollment, weight loss >5%, and CLMI retention. While patient age, sex, and comorbidities play a dominant role in determining obesity treatment, retention, and successful weight loss, some influential facility and environment factors were noted.

Younger Veterans and male Veterans were less likely to initiate or continue MOVE! though male Veterans had greater odds of successful weight loss. Additionally, male Veterans were less likely to be prescribed pharmacotherapy or undergo bariatric surgery. This finding is partly in line with previous reports. Men with obesity, despite being at an increased risk of chronic disease, are less likely than women to attempt weight loss.[43] Additionally, men are underrepresented in the weight loss treatment literature, though they have an equivalent prevalence of obesity as women.[44] This fact may not hold true across races. Several reasons may account for the less engagement of male Veterans in CLMI. Educating male patients regarding their health risk status, including weight, may help MOVE! initiation; however, this approach has limitations.[45] Male patients may feel that worrying about weight challenges their self-identity and masculinity, a phenomenon found among several studies in males within the civilian population, and heightened among Veterans.[45,46] This feeling of ostracization can result in a lack of social support for males in weight loss interventions. Providers must challenge the norms surrounding masculinity steeped in military culture to truly engage male Veterans within MOVE! programming.[47] Within this, having providers that are knowledgeable about MOVE! may help recruitment and retention of patients in CLMI interventions. A recent study by Arigo et al. demonstrated that physicians and physician assistants demonstrated limited subjective knowledge of MOVE! relative to dieticians and behavioral health providers.[48] Having a physician champion was shown to increase the implementation of healthcare programs and could be a viable strategy to increase the recruitment of patients to MOVE!.[48,49]

Regarding access to treatment, facility use of telehealth did not help improve MOVE! initiation in rural patients as much as it did for urban patients, though it still had a favorable impact on MOVE! initiation in both groups. These data point to factors other than healthcare access that may be impeding the initiation of MOVE! in rural patients, such as culture regarding obesity/dietary habits, financial barriers, and time constraints, among others.[50] Future qualitative and quantitative studies should aim to delineate factors that preferentially contribute to greater or lesser CLMI initiation and retention among rural Veterans, beyond simply “distance to care.” Additionally, results indicated that as facility reliance on telehealth for CLMI encounters increased, patient retention decreased among both urban and rural Veterans. This finding could possibly be confounded by patient initiative as those who are attending in-person appointments may be more motivated to continue attending as opposed to virtual visits that may be easier to skip. Thus, having occasional in-person follow-ups for MOVE! may be beneficial to augment MOVE! retention. Taken together, the findings of this study should not undermine the importance of facilitating access to telehealth among rural Veterans. As MOVE! is a multi-factorial, behavioral intervention that demands greater commitment than seeking other types of healthcare (e.g., primary care), it may require a mixture of in-person and telehealth modalities to facilitate initiation and retention among both urban and rural Veterans.

A recent study demonstrated that low access to broadband Internet was spatially clustered in the southeast, southwest, and northern plains regions of the U.S..[51] This study indicates that Veterans receiving care from VHA facilities located in the southern U.S. were less likely to initiate or continue CLMI. Thus, increasing the availability and access to telehealth in the south may improve CLMI initiation among Veterans. Previous studies have shown that telemedicine is an effective method to provide MOVE! to Veterans, though these studies did not stratify by rurality.[52,53] Furthermore, emerging evidence promotes utilizing multicomponent behavioral interventions via downloadable mobile applications to deliver weight loss interventions.[54] The MOVE!® Coach mobile application was developed to increase population reach and promote support of in-person services. It also helps patients set goals and assist lifestyle management from their smartphone. Notwithstanding, a significant barrier to telehealth is the limited availability of broadband Internet access. Thus, it will be important to work with local stakeholders to increase Internet access in these areas to increase the reach of MOVE! to the south, and explore other potential barriers to healthcare access for Veterans living in the south.

Lastly, routine consideration of obesity treatment by pharmacotherapy positively predicted CLMI initiation and retention in both urban and rural-dwelling Veterans. Notably, the cohort consists of veterans with class II or III obesity, increasing the likelihood of pharmacotherapy use. Indeed, restrictions on the use of pharmacotherapy in the VA have eased since 2016.[24] Previously, pharmacotherapy was seldom used in the VA due to inadequate physician training, VA system formulary restrictions, safety concerns, and high comorbidity burden.[32] Furthermore, clinician attitudes surrounding treatment by pharmacotherapy must evolve toward treating obesity as a medical problem rather than solely as a behavioral problem. In contrast, the awareness of the general public regarding the efficacy of pharmacotherapy seems to have slowly shifted, especially with the recent FDA approval of medications for weight loss including Semaglutide and Tirzeptide.[55] The availability of pharmacotherapy, in addition to lifestyle intervention, has been shown to increase reach in two configurational analyses of all VHA facilities that provide MOVE!.[22,56] Thus, incorporating pharmacotherapy in all MOVE! programs and communicating these treatments as an option to Veterans will be an important step toward increasing the accessibility of MOVE! Additionally, provider education surrounding weight loss pharmacotherapy will be an important next step to increase MOVE! engagement, and to increase CLMI initiation and retention.

Several limitations need to be considered when interpreting the results of this study. First, the population was not diverse and included primarily White, male, and middle-aged Veterans. Veterans also tend to be sicker than the general population.[57] Because the study included a large population with severe obesity and a heavy burden of comorbidities requiring close monitoring and social support, generalizability to the general population may be limited. However, the studied population aligns with the demographic characteristics of the VA system clientele, which is a sizable minority and an important stratum of U.S. society. Second, the recent introduction of new obesity pharmacotherapies such as Semaglutide and Tirzepatide are not reflected in the time period of this study. Results pertaining to factors related to pharmacotherapy treatment initiation may differ in recent years. Third, factors regarding provider bias and futility in helping patients participate in the MOVE! program could not be captured in the analysis. Fourth, the ACS 5-year population estimates are subject to sampling error, which has two main causes: (1) the smaller the sample size, the larger the margin of error; and (2) the more diverse a population, the greater the margin of error with respect to specific characteristics in the population.[58] While rural populations are generally not as diverse as urban populations, the smaller populations in rural areas suggest larger margins of error in ACS estimates for rural census tracts. Uncertainty in the ACS was not accounted for in this study's analysis. Finally, the study reflects services provided by the VA or paid through a VA Care in the Community program. Services paid by private insurance or other non-VHA sources are not captured. Nevertheless, the major strengths of the study include a large patient sample with representation from all major regions of the U.S., availability of detailed patient-level data on weight loss, program retention, pharmaceuticals, and comorbidities, availability of environmental indicators assigned to individual patient census tracts, and inclusion of a large number of treatment providers.

5 | CONCLUSION

There are several patient-, facility-, and environmental-specific factors that contribute to MOVE! participation. This study revealed that male Veterans were less likely to initiate and stay in the MOVE! program and pursue pharmacotherapy or bariatric surgery, and that patients living in the southern U.S. were less likely to initiate or continue MOVE! Furthermore, telehealth did not help improve MOVE! initiation in rural patients as much as it did for urban patients, though it still had a favorable impact on CLMI initiation in both groups. Additionally, as MOVE! telehealth increased, patient retention decreased among both urban and rural Veterans. The findings of this study emphasize the importance of tailoring interventions to different populations (e.g., male Veterans) to ensure equitability. Additionally, several modifiable factors can potentially increase successful participation and retention in the MOVE! program, including targeting the male population, increasing the opportunities for education of providers, and improving opportunities to engage and retain patients in MOVE! through telehealth.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest statement.

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APPENDIX

TABLE A1 Factor loading characteristics of US census tracts.

	Factor													
Census tract variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11***	**12**	**13**	**14**
1. Walkability index	0.151	**−0.870**	0.167	−0.089	−0.119	0.040	0.045	−0.055	−0.078	0.082	0.119	−0.139	0.030	−0.002
2. Total population	−0.131	0.054	0.119	−0.045	−0.070	**−0.886**	−0.141	0.002	−0.022	0.028	0.058	−0.029	0.085	−0.070
3. Low income and low access tract measured at 1 mile for urban areas and 20 miles	0.357	0.071	−0.054	0.003	0.035	−0.028	0.002	−0.023	0.055	−0.041	0.036	0.054	**0.773**	0.000
4. Mean distance to nearest VA primary care	−0.051	0.251	−0.076	−0.009	0.258	0.008	0.010	0.092	0.083	−0.099	−0.079	0.831	−0.032	0.023
5. Mean distance to nearest VA tertiary care	0.017	0.154	−0.068	−0.035	0.126	0.003	0.002	0.951	0.044	−0.071	−0.009	0.106	−0.014	−0.008
6. Mean travel time to nearest VA primary care	−0.046	0.067	−0.022	0.024	0.095	0.018	0.009	0.227	0.006	0.013	−0.045	**0.897**	0.021	0.013
7. Mean travel time to nearest VA tertiary care	−0.002	0.095	−0.041	0.003	0.087	0.002	−0.009	**0.960**	0.014	−0.023	−0.002	0.197	−0.008	−0.006
8. Low income census tract	0.826	−0.054	0.072	0.001	0.009	0.039	0.006	−0.025	0.059	−0.041	0.015	0.053	0.115	0.013
Tract poverty rate (<100% of federal poverty level)	**0.935**	−0.023	0.024	0.003	0.011	0.048	−0.011	0.008	−0.081	0.016	0.018	−0.010	−0.010	0.002
9. Tract median family income	−0.795	−0.097	−0.032	−0.030	−0.040	−0.035	−0.052	−0.035	**−0.396**	0.021	0.074	−0.032	0.017	0.000
10. Low food access tract at 1 mile for urban areas and 20 miles for rural areas	−0.162	0.140	−0.062	0.028	0.017	−0.139	−0.016	−0.006	−0.095	0.040	0.079	−0.044	0.813	−0.062
11. Low food access tract at 20 miles	−0.020	−0.022	0.041	−0.034	**0.838**	0.048	0.045	0.095	−0.019	0.029	−0.028	−0.006	0.235	0.027
12. Low food access tract at 10 miles	0.016	0.168	−0.103	−0.011	0.705	−0.039	−0.055	−0.016	0.088	−0.069	−0.007	0.172	−0.317	−0.025
13. Low access, population at 10 miles, share	0.009	0.142	−0.074	−0.016	0.834	0.042	−0.028	0.012	0.071	−0.054	−0.020	0.161	−0.208	−0.011
14. Low access, population at 20 miles, share	−0.018	−0.021	0.041	−0.033	0.848	0.067	0.048	0.108	−0.020	0.030	−0.029	0.019	0.216	0.023
15. Number of seniors age 65+, number	−0.231	0.075	−0.073	0.022	−0.014	−0.640	0.578	−0.008	0.036	−0.087	−0.048	0.023	0.014	**−0.292**
16. Percent population white	−0.528	0.190	−0.197	0.060	0.022	−0.023	0.111	0.066	0.062	−0.747	−0.081	0.051	0.001	−0.009
17. Social deprivation index	0.888	−0.148	0.192	−0.022	−0.022	0.015	0.002	0.020	0.189	0.114	0.074	−0.016	0.007	0.031

TABLE A1 (Continued)

	Factor													
Census tract variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11***	**12**	**13**	**14**
18. Percent of population seniors age 65+	−0.190	0.077	−0.159	0.047	0.066	0.014	0.846	−0.008	0.059	−0.124	−0.119	0.068	−0.046	−0.173
19. Percent of population black	0.472	−0.079	−0.209	0.173	−0.035	0.041	−0.042	−0.080	−0.038	**0.770**	0.025	−0.036	0.010	−0.007
20. Percent impacted by crowding	0.392	−0.065	0.708	−0.223	0.009	−0.032	−0.118	0.004	0.016	0.036	−0.057	−0.004	−0.050	0.006
21. Percent high school drop out	0.676	0.075	0.540	−0.004	0.021	−0.012	−0.074	−0.029	0.084	0.007	−0.036	0.069	−0.066	−0.009
22. Percent foreign born	0.088	−0.314	**0.818**	−0.135	−0.051	−0.052	−0.013	−0.071	−0.063	0.132	0.090	−0.052	−0.034	0.006
23. Percent of households with no car	0.559	−0.351	0.099	0.163	−0.009	0.068	0.167	0.015	−0.139	0.249	−0.072	−0.110	−0.132	0.014
24. Percent of population with high needs (age ≥65 years, children, child-bearing aged women)	0.142	−0.063	−0.045	−0.005	−0.022	0.058	**0.847**	0.003	0.046	0.026	0.030	−0.046	0.024	−0.051
25. Percent Hispanic	0.283	−0.070	0.794	−0.226	−0.029	−0.041	−0.117	−0.020	0.040	−0.090	0.116	−0.031	0.020	0.006
26. Percent English language speakers	0.304	−0.184	0.846	−0.040	−0.011	−0.043	−0.004	−0.029	−0.033	−0.031	0.024	−0.033	−0.043	0.003
27. Percent not employed	0.611	−0.035	−0.054	−0.052	−0.009	0.035	0.013	−0.019	−0.020	0.263	−0.018	−0.021	−0.009	−0.012
28. Percent rental occupancy	0.648	−0.383	0.176	−0.065	−0.069	0.081	0.029	0.048	0.013	0.153	0.109	−0.142	0.012	0.030
29. Percent single parent households	0.756	−0.167	0.039	0.033	−0.068	0.051	−0.113	0.027	0.068	0.272	0.027	−0.104	0.057	0.030
30. Percent unemployed	0.355	−0.026	0.043	−0.056	−0.028	0.013	−0.003	−0.005	0.007	−0.016	0.013	−0.023	−0.002	0.005
31. Region: Midwest	0.012	0.040	−0.240	**0.751**	0.003	0.052	−0.052	−0.041	0.050	−0.095	−0.166	−0.011	0.019	0.015
32. Region: Northeast	−0.052	−0.078	−0.040	**0.841**	−0.035	0.006	0.057	0.000	−0.070	0.008	−0.139	−0.057	−0.016	0.008
33. Region: South	0.087	0.248	−0.069	**0.765**	−0.034	−0.019	0.026	−0.065	0.055	0.112	0.172	0.081	0.021	−0.031

Note: Rotated Factor Pattern using Quartermax Rotation. Variables selected for multivariable models are bolded, italicized, and highlighted in gray. No variable was selected to represent Factor 11 due to collinearity with other selected variables.

TABLE A2 Factor loading characteristics of VA Hospital and MOVE! programs.

	Factor								
Facility and MOVE! program characteristics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. Facility performs bariatric surgery	0.361	0.060	**0.753**	−0.102	−0.067	0.050	0.184	−0.088	0.019
2. Total facility patients	**0.852**	0.068	0.218	−0.063	0.017	0.028	−0.007	−0.131	−0.061
3. Number MOVE! encounters (total/1000)	0.772	0.183	0.025	0.068	−0.133	−0.110	0.134	0.225	0.081
4. Number MOVE! encounters by telehealth (/1000)	0.336	0.156	0.067	0.003	0.829	0.012	0.049	0.064	0.049
5. Percent of MOVE! by telehealth	−0.146	0.049	−0.003	0.008	**0.910**	0.106	0.004	−0.092	−0.082
6. Number of persons with 1 or more MOVE! encounters	0.854	0.099	0.188	−0.026	0.264	−0.140	0.032	0.064	−0.067
7. Facility complexity level 1b*	0.133	−0.052	0.108	−0.150	0.157	−0.154	0.786	0.037	−0.111
8. Facility complexity level 1c*	−0.204	−0.091	0.687	0.159	0.090	−0.062	−0.440	0.056	0.003
9. Facility complexity level 2–3 (lowest)*	−0.448	−0.058	−0.794	0.130	−0.038	0.045	−0.101	0.039	0.075
10. Bariatric surgery is considered	0.103	0.290	0.028	0.304	0.056	0.003	0.412	−0.541	0.087
11. Be Active and MOVE! is offered	0.425	0.016	−0.093	0.088	−0.049	0.030	0.171	0.524	0.266
12. Maintenance programming is offered	0.053	0.257	0.089	0.291	−0.348	0.007	**0.525**	0.108	0.053
13. MOVE coordinator available ≥ 21 h/week	0.095	0.276	0.238	0.024	0.002	−0.100	0.097	**0.628**	−0.201
14. MOVE! individual sessions offered	−0.046	0.073	0.107	−0.162	−0.083	−0.127	−0.109	−0.102	**0.843**
15. Pharmacotherapy is considered	0.183	0.785	−0.015	−0.065	0.140	−0.054	0.097	−0.189	0.086
16. Pharmacist with weight management expertise NOT available	−0.077	−0.077	−0.004	−0.002	0.058	**0.916**	−0.076	−0.013	−0.068
17. Pharmacist with weigh management expertise is available	0.095	0.240	0.001	0.079	−0.062	−0.870	0.035	0.041	0.016
18. Physician champion available	0.057	0.153	0.558	−0.035	0.028	0.031	0.129	0.256	0.235
19. Refill limit for weight management medications = None	0.041	0.074	−0.067	**0.883**	−0.067	−0.011	−0.027	−0.046	−0.085
20. Refill limit for weight management medications = Yes	0.106	0.162	0.048	−0.872	−0.044	0.086	0.031	0.002	0.056
21. TeleMove! (home Move! by telehealth) is offered	0.178	0.076	0.073	0.349	0.261	0.143	0.262	0.146	0.372
22. Weight-loss medication prescriber is available	0.004	0.769	0.164	−0.178	0.047	−0.242	0.064	0.120	−0.031
23. Weight loss medications are routinely considered	0.145	**0.817**	0.011	0.145	−0.003	−0.048	−0.068	0.161	0.037

Note: Rotated Factor Pattern using Quartermax Rotation. Variables selected for multivariable models are bolded, italicized and highlighted in gray. Facility complexity was not included in multivariable models due to high collinearity with other variables more representative of specific MOVE! program characteristics.

TABLE A3 Predictors of CLMI retention.

	OR (95% CI; *p*-value)
Patient characteristics	
Demographics	
Age per 10 years	1.32 (1.28–1.37; $p < 0.001$)
Female	1.31 (1.18–1.46; $p < 0.001$)
Comorbidity	
Tobacco use	0.80 (0.71–0.89; $p < 0.001$)
Sleep apnea	1.22 (1.13–1.31; $p < 0.001$)
Facility characteristics	
Pharmacotherapy routinely considered	1.35 (1.08–1.69; $p = 0.008$)
Percent MOVE! by telehealth (per 10%)	0.96 (0.94–0.99; $p = 0.003$)
Environmental characteristics	
Region	
Midwest	1.09 (0.95–1.24; $p = 0.22$)
Northeast	1.16 (0.98–1.37; $p = 0.09$)
South	0.78 (0.70–0.88; $p < 0.001$)
West	1.01 (0.87–1.18; $p = 0.85$)

Abbreviations: 95% CI, 95% confidence interval; CLMI, comprehensive lifestyle modification intervention; OR, odds ratio.

TABLE A4 Predictors of weight loss[a].

Patient characteristics	OR (95% CI; *p*-value)
Age (per 10 years)	0.91 (0.88–0.94; $p < 0.001$)
Female	0.86 (0.78–0.94; $p < 0.001$)
Black race (relative to white and other non-white)	1.14 (1.05–1.22; $p < 0.001$)
Comorbidities	
Diabetes	0.81 (0.76–0.87; $p < 0.001$)
Prior use of medications associated with weight gain	1.17 (1.09–1.25; $p < 0.001$)
Facility characteristics	None
Environmental characteristics	
Total population (per 1000)	1.02 (1.01–1.03; $p = 0.005$)

[a]Successful weight loss was defined as >5% body weight loss.