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Uptake of Preventive Services Among Patients With and Without Multimorbidity

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Abstract

Introduction—Patients with multiple chronic conditions (multimorbidity) are commonly seen in primary care practices and often have suboptimal uptake of preventive care owing to competing treatment demands. The complexity of multimorbidity patterns and their impact on receiving preventive services is not fully understood. This study identifies multimorbidity combinations associated with low receipt of preventive services.

Methods—This was a retrospective cohort study of U.S. community health center patients aged 19 years. Electronic health record data from 209 community health centers for the January 1, 2014–December 31, 2017 study period were analyzed in 2018–2019. Multimorbidity patterns included: “physical only,” “mental health only,” and “physical and mental health” multimorbidity patterns, with “no multimorbidity” as a reference category. Electronic health record–based preventive ratios (number of months services were up-to-date/total months the patient was eligible for services) were calculated for the 14 preventive services. Negative binomial regression models assessed the relationship between multimorbidity physical/mental health patterns and the preventive ratio for each service.

Results—There was a variation in receipt of preventive care between multimorbidity groups: Individuals with “mental health only” multimorbidity were less likely to be up-to-date with cardiometabolic and cancer screenings compared with the “no multimorbidity” group or groups with physical health conditions, and the “physical only” multimorbidity group had low rates of depression screening.

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Conclusions—This study provided critical insights into receipt of preventive service among adults with multimorbidity using a more precise method for measuring up-to-date preventive care delivery. Findings would be useful to identify target populations for future intervention programs to improve preventive care.

INTRODUCTION

Preventive care is critical in improving population health, and can potentially decrease long-term healthcare spending.¹ However, only 8% of U.S. adults aged 35 years and older receive all recommended preventive services.² There is a growing number of people living with multiple chronic conditions—defined as having two or more concurrent chronic conditions, and referred to as multimorbidity.³ Competing treatment demands may lead to suboptimal uptake of preventive care among individuals with multimorbidity.^{4–6} However, previous studies show inconsistent findings regarding the impact of chronic conditions on utilization of preventive care: Some showed a negative association with receipt of preventive care,^{7,8} whereas others found a positive relationship even after controlling for age and number of visits.^{9–11} Different methods to define multimorbidity and type and number of conditions included contribute to such inconsistency.

Mental health conditions pose additional challenges to adequate preventive care provision,^{12,13} especially with the fragmentation of care in the U.S. healthcare system.¹⁴ Individuals with mental health conditions are likely to have more chronic conditions,^{15,16} and the evidence concerning appropriate receipt of preventive services among patients with mental illness is mixed.¹⁷ Some studies have shown that people with mental health conditions are less likely to receive preventive care,^{12,18,19} whereas others have found no differences in receipt of preventive services between patients with or without mental health conditions.²⁰

Additionally, it is unclear how specific combinations or patterns of chronic conditions may impede the provision of high-quality, appropriate preventive services. More evidence is needed to understand utilization of preventive care by multimorbidity patterns, as multimorbidity poses unique challenges to patients^{21,22} and care providers,²³ and may affect adequate receipt of preventive services.

Moreover, to better understand the impact of competing demands from different combination of physical and mental health conditions, more nuanced measures of preventive care receipt are needed. For instance, preventive ratios estimate the proportion of time a patient was “up-to-date” for a given preventive service.²⁴ This measure was used previously to assess delivery of preventive care in community health centers (CHCs).^{24,25}

Therefore, the purpose of this study is to evaluate receipt of preventive services overall and by types of services among patients with different combinations of physical and mental health conditions compared with no multimorbidity group. Authors hypothesize that individuals with “mental health only” multimorbidity will be less up-to-date with preventive services compared with those with no multimorbidity, and presence of physical health comorbidity will be associated with higher preventive care.

METHODS

The authors conducted a retrospective cohort study of adults, aged 19 years, receiving care at one of 209 clinics from 59 CHCs in the U.S. between January 1, 2014 and December 31, 2017. Low-income and uninsured individuals are at higher risk of having multimorbidity²⁶ and comprise a large proportion of CHC patients.²⁷ The authors utilized electronic health record (EHR) data from the OCHIN, Inc. community health information network. OCHIN is a nonprofit organization that provides a fully hosted instance of the Epic® EHR to safety net clinics.^{28–30} Detailed information about OCHIN and its EHR database is available elsewhere.^{28,29} Clinics that were not “live” on the EHR throughout the study period or that were unlikely to provide preventive care services to adult patients, and those providing <100 total ambulatory visits or serving a population with <20% adults, were excluded. Data were analyzed in 2018–2019.

Study Population

Among eligible CHCs, authors included patients with two or more ambulatory visits: One or more visits prior to January 1, 2014 were needed to identify “established” patients with a documented medical history to assess chronic condition at the beginning of the study, and one or more visits during the 2014–2017 period.

Measures

The authors used preventive ratios to estimate the proportion of time a patient was up-to-date for a given preventive service.^{24,25} A preventive ratio is the total person-months covered in a given time period divided by the total person-months eligible for a particular service (Figure 1). For example, if an influenza vaccination was administered to a patient on the day it was due, that individual was considered up-to-date for this service 100% of the eligible time (1 year). The preventive ratio ranges from 0% to 100%. In situations of competing demand, delivery of preventive care might be delayed, thus the preventive ratio can more accurately capture the timeliness of service receipt. For example, if a patient received an influenza vaccination 3 months after it was due, a binary measure would report that the patient received the vaccination while the preventive ratio will indicate that the person was “up-to-date” 9 of the 12 months (75%).

The authors measured preventive ratios for 14 services based on U.S. Preventive Services Task Force grade A and B recommendations and Centers for Disease Control and Prevention immunization recommendations.^{31,32} They also used a combined preventive index, which aggregates the average of all individual preventive ratios to assess overall receipt of preventive services.^{24,25} Services due and received were identified through diagnosis and procedure codes, lab/imaging/scanned test results, and longitudinal “health maintenance” records. Services that were ordered but not verified as received were not counted. For each preventive service, individuals were identified as “due” based on sex and age eligibility. Detailed information about measure-by-measure definitions is available elsewhere.²⁵

Chronic conditions are from historical problem list records and medical diagnosis codes prior to January 1, 2014. The list of chronic conditions was based on Centers for Medicare

and Medicaid Services Chronic Conditions Data Warehouse algorithm³³ and included 29 chronic conditions categories with an individual prevalence of 1% in the study population to increase the epidemiological interest.³⁴ Mental health conditions included: depression, anxiety/post-traumatic stress disorder, attention-deficit/hyperactivity disorder, alcohol use disorder, substance use disorder, group with mental disabilities, and other mental health conditions group. A full list of physical chronic conditions can be found in Table 1 and Appendix Table 1. Individuals were categorized into four mutually exclusive groups: “no multimorbidity” group (zero to one chronic condition), “physical only” multimorbidity group (two or more physical chronic conditions), “mental health only” multimorbidity group (two or more mental health diseases, and no physical comorbidity), and “physical and mental health” multimorbidity group.

Covariates shown to affect preventive care delivery included^{35–37}: patients’ sex, race/ethnicity, preferred spoken language, age as of the study start, insurance type, rural location, smoking status, BMI, established with a primary care provider, number of ambulatory visits during the study period, and continuity of care. Missing/unknown data were included an “unknown” category in the analysis. Continuity of care was measured with the usual provider continuity index,³⁸ which is the percentage of visits with the established primary care provider among all office visits during study period. The authors did not adjust for number of chronic conditions as it would have been correlated with the main independent variable (e.g., no multimorbidity group would be perfectly correlated with zero chronic conditions) and would have produced unstable regression coefficients. The authors did not differentiate groups by number of conditions but instead evaluated different multimorbidity patterns.

Statistical Analysis

Frequencies and percentages for categorical variables and mean and SD for continuous variables for each group were calculated. The authors calculated unadjusted mean and SD of the preventive ratio for individual preventive services and combined preventive index among the four groups. The mean preventive ratio represents the average percentage of months study patients were “covered” for a given service, of the total months eligible, from 2014 to 2017. To assess the association between different multimorbidity patterns and preventive ratios, they utilized negative binomial regression models accounting for overdispersion.

The authors then performed univariable and multivariable models for each preventive service, controlling for EHR-based covariates. They did not control for clinic-level characteristics because they believe that the rich collection of patient-level characteristics included in the model already accounted for heterogeneity across clinics. Recognizing that preventive care delivery varies by practice setting,³⁹ they accounted for nesting of patients within clinics by robust cluster-adjusted SE adjustment. The prevalence of multimorbidity combinations varies by age group,⁴⁰ thus for sensitivity analysis the authors performed regression models for each age group individually. In addition, they performed regression models with different reference categories such as “physical only” multimorbidity group and “no chronic condition” group to compare the “mental health only” group to groups without any mental health diagnoses. Unadjusted and adjusted rate ratios and 95% CIs were

calculated. Statistical significance was considered at the $\alpha < 0.05$ level. All analyses were conducted using Stata, version 15. This study was approved by the Oregon Health & Science University IRB.

RESULTS

Overall, the study sample included 301,665 patients, with mean age of 45 years, 62.5% women, 29.9% with Medicaid insurance and 33.1% uninsured (Table 1). More than 50% of patients had two or more chronic conditions. About 40% had one or more mental health conditions, and among patients with multimorbidity, mental health diagnoses were prevalent (65%). A “physical only” pattern was identified in 18.1% of patients; 30.5% had a combination of physical and mental health multimorbidity, and 4.1% had “mental health only” pattern. Table 1 shows the characteristics of the four study groups. Patients in “physical only” and “physical and mental health” groups tended to be older and had more chronic conditions and office visits than the “no multimorbidity” and the “mental health only” groups. Individuals in the “mental health only” group were more likely to be white, have Medicaid insurance coverage, and be a current smoker than individuals in the other groups.

Table 2 shows percentage of person-time covered for each of the services across different multimorbidity patterns. Overall, the combined preventive index was $< 50\%$ and varied from 33.9% (“no multimorbidity” group) to 46.3% (“physical only” group). Patients with no multimorbidity had lower preventive ratios compared with study groups with physical health conditions, except in chlamydia screening (31.0%). Patients with “mental health only” pattern had lower preventive ratios for diabetes and lipid screenings, all cancer screenings, chlamydia and abdominal aortic aneurysm screening, and pneumonia vaccination compared with the “no multimorbidity” group.

Patients with a “physical only” pattern had higher preventive ratios for diabetes, lipid, and cancer screenings, as well as influenza and pneumonia vaccinations relative to other groups. Patients with a “physical and mental health” pattern had higher preventive ratios for substance use, depression, hepatitis C, and abdominal aortic aneurysm screening compared with other groups.

After adjusting for covariates, there was no significant difference between “no multimorbidity” and “mental health only” groups in receipt of preventive care overall; however, people with physical comorbidities were more up-to-date with overall preventive care, compared with former groups (Table 3). The association between preventive ratios and multimorbidity patterns varied across preventive services, though the magnitudes of associations were small. Among individuals in the “mental health only” group, there was 12% less person-time covered for diabetes screening (rate ratio=0.88, 95% CI=0.85, 0.92), 3% less for blood pressure screening (rate ratio=0.97, 95% CI=0.96, 0.98), and 9% less for lipid screening (rate ratio=0.91, 95% CI=0.87, 0.95) compared with the “no multimorbidity” group. Additionally, individuals in the “mental health only” group had between 7% and 31% less person-time covered compared with the “physical health only” group for the same services (Appendix 3), and between 3% and 5% less compared to “no chronic condition”

group, except a non-significant difference for lipid screening (Appendix Table 5). Patients in “mental health only” group were less likely to be up-to date with cervical, breast, and colorectal cancer screenings, chlamydia screening (rate ratio=0.91, 95% CI=0.85, 0.98), and pneumonia vaccination (rate ratio=0.79, 95% CI=0.65, 0.96) compared with the “no multimorbidity” group. For HIV, hepatitis C, and depression screenings, the “mental health only” group was more up-to-date than the “no multimorbidity” group, whereas there were no observed differences for influenza vaccination, substance use, and abdominal aortic aneurysm screenings. Individuals in the “physical only” group were less likely to receive HIV (rate ratio=0.72, 95% CI=0.64, 0.80), chlamydia (rate ratio=0.79, 95% CI=0.72, 0.87), and cervical cancer (rate ratio=0.91, 95% CI=0.89, 0.94) screenings than the “no multimorbidity” group. There was no observed difference for substance use and depression screenings for the “physical only” group compared to the no multimorbidity group.

In sensitivity analyses, regression analyses stratified by age group revealed similar findings (Appendix Table 4).

DISCUSSION

Overall, preventive ratios were low in groups with and without multimorbidity for multiple preventive services. Results from this study are similar to clinic-level analyses, which also showed low rates of preventive care.²⁵ Patients with physical health conditions were more likely to be up-to-date on preventive care than those with “no multimorbidity” or those with “mental health conditions only”. In fact, those with no multimorbidity had the lowest overall preventive index and those in the “mental health only” group were less likely to be up-to-date on a number of preventive ratios. The findings show the value of using preventive ratios over combined a preventive index when comparing these patient populations, as the ratios provided more information about which specific screenings are lacking for each population group.

Although there was no significant difference between “no multimorbidity” and “mental health only” groups for combined preventive index, using preventive ratios allowed the authors to identify subgroups of patients with lower rates of time covered for certain services. Individuals with “mental health only” multimorbidity were less likely to be up-to-date with cardiometabolic and cancer screenings compared with the “no multimorbidity” group or groups with physical conditions. Previous studies have shown that patients with mental health conditions receive fewer preventive care services.^{12,19,41,42} One potential explanation might be that competing demands for individuals with mental health diagnoses such as psychiatric treatment may become a priority during time-limited office visit, resulting in delayed delivery of preventive care. However, other explanations may exist: For instance, mental illness can be a barrier to care when patients decline preventive care or are not in a position to follow through with advised care. The fragmentation of care in the U.S. further disadvantages populations with mental health conditions who have been shown to receive lower overall quality of care.⁴³ This finding is especially concerning given that some patients with mental health conditions receive antipsychotic medications, which are associated with higher rates of cardiovascular and metabolic disorders; thus, timely

preventive screening for cardiovascular and metabolic disorders is critical in these patients.^{44,45}

Interestingly, findings highlighted that the presence of physical conditions was associated with higher rates of preventive care among patients with co-occurring mental health conditions. Individuals in the “physical and mental health” group were more up-to-date with preventive care than the “mental health only” group, though not as up-to-date as the “physical health only” group, despite individuals in the “physical and mental health” group having, on average, more office visits than other groups. Though individuals with physical conditions were older and had more office visits than the “mental health only” group, similar findings were observed in age-stratified sensitivity analysis, and after controlling for number of visits (Appendix Table 4). Patients with physical conditions, whether or not they have mental health disorders, may require more monitoring to manage their conditions, especially cardiovascular disease, which likely aids in receiving guideline-concordant services.

There was no difference with regards to depression screening between the “physical health only” and “no multimorbidity” groups, though the preventive ratio were relatively low. Multimorbidity may lead to the development of mental health disorders such as anxiety and depression.⁴⁶ Timely screening and treatment for mental health disorders among individuals with physical multimorbidity could improve management of complex multimorbidity cases.

In addition to the explanations of fragmented services and competing demands, a recent qualitative study reported that there was a misconception and negative bias among providers regarding delivery of preventive care to patients with serious mental health conditions.⁴⁷ Findings from this study and other similar studies suggest the need for interventions to improve preventive care for all patients, especially those with mental health diagnoses. Patients with mental health conditions may benefit from embedding behavioral health providers into primary care settings⁴⁸ or embedding preventive care delivery at mental health clinics.^{48,49} Primary care providers might also benefit from additional education about preventive services among patients with mental health comorbidities, and the potential for implicit bias.

This study used EHR data and included a large sample of CHC patients to evaluate the proportion of time up-to-date on various preventive services over 4 years. This approach allowed the authors to capture receipt of preventive care in a consistent manner, especially for services provided on an annual basis. This study included a large percentage of uninsured patients and patients with a significant chronic condition burden, especially with higher mental health and substance abuse burden, who often are less well represented in the other studies.

Limitations

Although use of EHR data had many advantages, such as avoiding recall bias, it may also have some limitations in capturing enrollment continuity within CHCs such as preventive care received at different sites or missing historical data on preventive care. However, studies suggest overall good agreement between EHR data and other sources⁵⁰ and that CHC

patients, especially with chronic conditions, are more likely to remain in CHCs than patients from other settings.⁵¹

Individuals with mental health conditions may seek services in community mental health clinics, where they may receive some preventive care potentially underestimating the preventive ratios. Patients with less frequent visits may have undiagnosed conditions, thus leading to underestimation of the proportion of patients with multimorbidity. These results maybe not be generalizable to all CHC patients or to patients receiving care outside CHCs. Nonetheless, previous evidence comparing delivery of preventive care in CHCs and Kaiser Permanente found a similar association with mental health conditions and preventive care delivery in both care settings.²⁰ The authors were not able to control for individual preferences and risk factors, patients' education level, patient–provider relationships, severity of chronic conditions, or site-level characteristics (e.g., ZIP code–level poverty rates), which may affect access to preventive care. Future studies are needed to further evaluate how unique combinations of chronic conditions affect delivery of preventive care.

CONCLUSIONS

This study provides critical insights into receipt of preventive service among adults with multimorbidity using a more precise method for measuring up-to-date preventive care delivery. There was a variation in receipt of preventive care between multimorbidity groups: Individuals with “mental health only” multimorbidity were less likely to be up-to-date with cardiometabolic and cancer screenings compared with the “no multimorbidity” group or groups with physical conditions, and the “physical only” multimorbidity group had low rates of depression screening as compared with other groups. This study identified vulnerable populations for future interventions to improve preventive care delivery.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Definition of the preventive ratio.
Source: Hatch BA et al. Use of a Preventive Index to Examine Clinic-Level Factors Associated With Delivery of Preventive Care. *Am J Prev Med.* 2019;57(2):241–249.

Table 1.

Characteristics of the Study Patients, Overall and by Group

Characteristic	All patients	0–1 chronic conditions	2 chronic conditions		
			Physical health only	Mental health only	Physical and mental health
Study population, n (%)	301,665	142,872 (47.4)	54,556 (18.1)	12,282 (4.1)	91,955 (30.5)
Age, years, mean (SD)	45 (16)	38 (14)	57 (15)	36 (12)	49 (14)
Female, n (%)	188,500 (62.5)	92,281 (64.6)	31,904 (58.5)	7,594 (61.5)	56,721 (61.7)
Race/Ethnicity, n (%)					
Non-Hispanic white	165,476 (54.9)	68,988 (48.3)	27,604 (50.6)	8,787 (71.1)	60,097 (65.4)
Non-Hispanic black	41,439 (13.7)	18,499 (13.0)	9,684 (17.8)	1,093 (8.9)	12,163 (13.2)
Hispanic	72,951 (24.2)	44,102 (30.9)	13,230 (24.3)	1,736 (14.1)	13,883 (15.1)
Other	21,799 (7.2)	11,283 (7.9)	4,038 (7.4)	741 (6.0)	5,737 (6.2)
English-language preference, n (%)	23,3441 (77.4)	102,455 (71.7)	4,0697 (74.6)	11,100 (89.8)	79,189 (86.2)
Insurance status, n (%)					
Medicaid	90,304 (29.9)	42,149 (29.5)	10,607 (19.4)	5,400 (43.7)	32,148 (35.0)
Medicare	4,7241 (15.7)	7,730 (5.4)	16,779 (30.8)	927 (7.5)	21,805 (23.7)
Private	51,559 (17.1)	29,139 (20.4)	9,817 (18.0)	1,340 (10.8)	11,263 (12.3)
Uninsured	99,815 (33.1)	56,292 (39.4)	15,303 (28.1)	4,202 (34.0)	24,018 (26.1)
Other	12,746 (4.2)	7,562 (5.3)	2,050 (3.8)	488 (4.0)	2,646 (2.9)
Rural location, n (%)	86,004 (28.5)	42,076 (29.5)	17,153 (31.4)	2,889 (23.4)	23,886 (26.0)
Number of chronic conditions, mean (SD)	2.2 (2.2)	0.4 (0.5)	3.2 (1.4)	2.5 (0.9)	4.4 (2.0)
Smoking status, n (%)					
Never	151,627 (50.3)	84,246 (59.0)	33,175 (60.8)	3,456 (28.0)	30,750 (33.5)
Current	75,290 (25.0)	25,522 (17.9)	5,233 (9.6)	6,399 (51.8)	38,136 (41.5)
Former	58,628 (19.4)	19,747 (13.8)	15,057 (27.6)	2,098 (17.0)	21,726 (23.7)
Unknown	16,120 (5.3)	13,357 (9.4)	1,091 (2.0)	404 (3.3)	1,268 (1.4)
Number of office visits during 2014–2017, mean (SD)	12.9 (22.5)	9.2 (12.9)	14.6 (16.1)	13.3 (26.7)	17.7 (33.3)
Having PCP by January 1, 2014	259,442 (86.0)	109,892 (76.9)	50,250 (92.1)	11,433 (92.5)	87,867 (95.6)
Usual provider continuity index over 2014–2017, mean (SD)	50.5 (34.4)	41.2 (35.9)	61.5 (30.2)	47.4 (33.5)	58.9 (30.0)

Note: Chronic conditions were defined using the Chronic Condition Data Warehouse (CCW) algorithm created by the Center for Medicare and Medicaid Services. Physical conditions include: hypertension, hyperlipidemia, obesity, diabetes, ulcer/gastroesophageal reflux disease, chronic pain, asthma, arthritis, thyroid disease, anemia, cancer, migraine headache, chronic obstructive pulmonary disease, chronic heart disease, chronic kidney disease, hepatitis, liver disease cerebrovascular disease, vision impairment, hearing Impairment, dysrhythmia, HIV/AIDS. Mental conditions include: depression, anxiety/PTSD, substance abuse, alcohol-related disease/abuse, attention deficit hyperactivity disorder, other mental health diagnosis group, and mental disability group.

“Unknown” category for Race/Ethnicity variable were included in “Other” category given low number of observations.

PCP, primary care provider; PTSD, post-traumatic stress disorder.

Table 2.

Eligible Patients for Each Preventive Service and Percentage of Patient-Time Covered by Each Service

Preventive service	Eligible population	Preventive ratio, mean (SD)				
		No MM	Physical health only	Mental health only	Physical and mental health	All
Combined preventive index	301,665	33.9 (17.3)	46.3 (19.3)	37.5 (17.5)	44.9 (19.2)	39.6 (19.2)
Cardiovascular screening						
Blood pressure screening	301,665	82.6 (26.9)	83.8 (23.7)	87.2 (23.5)	84.2 (23.8)	83.5 (25.4)
Diabetes screening	152,791	36.6 (33.8)	64.7 (33.8)	33.7 (31.7)	58.2 (34.7)	51.7 (36.2)
Lipid screening	175,454	54.3 (45.2)	86.2 (30.9)	51.1 (45.3)	82.2 (34.1)	73.5 (40.2)
Cancer screening						
Cervical cancer screening	156,065	52.5 (40.5)	54.0 (41.4)	50.7 (40.1)	52.4 (41.0)	52.5 (40.7)
Breast cancer screening	74,583	32.5 (37.0)	46.3 (38.7)	28.9 (35.1)	41.8 (37.6)	40.1 (38.1)
Colorectal cancer screening	131,996	26.4 (36.9)	42.5 (41.6)	23.3 (35.6)	39.4 (41.5)	36.1 (40.7)
Infectious disease screening						
HIV screening	268,970	17.7 (37.1)	8.6 (27.4)	20.8 (39.4)	14.2 (34.0)	15.5 (35.2)
Hepatitis C screening	107,959	4.7 (19.2)	6.2 (22.2)	10.9 (29.2)	12.3 (30.9)	8.4 (25.9)
Chlamydia screening	25,974	31.0 (33.8)	28.6 (33.6)	28.9 (34.0)	29.4 (34.1)	30.6 (33.9)
Influenza vaccine	301,665	12.6 (22.4)	32.2 (34.5)	13.9 (23.0)	29.2 (33.2)	21.3 (29.8)
Pneumonia vaccine	54,669	31.3 (41.9)	54.1 (44.9)	24.6 (39.4)	50.1 (45.0)	47.5 (45.2)
Other services						
Substance screening	301,665	21.6 (26.8)	34.8 (32.0)	27.6 (28.5)	36.2 (32.0)	28.7 (30.3)
Depression screening	301,665	17.4 (21.7)	24.8 (24.1)	29.5 (27.1)	33.3 (28.4)	24.1 (25.5)
Abdominal aortic aneurysm screening	11,518	8.9 (25.4)	15.7 (33.3)	6.2 (22.6)	16.5 (33.9)	14.5 (32.1)

Note: Preventive index and preventive ratios were defined at a patient-level, covering the entire study period. Preventive ratio estimates the proportion of time a patient was up-to-date for a given preventive service. Preventive ratio is the total person-months covered in a given time period divided by the total person-months eligible for a particular service (e.g., if a patient was eligible for blood pressure screening all 48 months, and was covered for it 12 of those months, they would have been covered for 25% of the time [preventive ratio=25%]). Averaging all patient preventive ratios give the mean preventive ratio for each service. The preventive ratio ranges from 0–100%.

MM, multimorbidity.

Table 3.

Association Between Multimorbidity Patterns and Receipt of Preventive Services Comparing to No Multimorbidity Group: Multivariate Regression Models

Preventive service	No multimorbidity	Physical health only ARR (95% CI)	Mental health only ARR (95% CI)	Physical and mental health ARR (95% CI)
Combined preventive index	ref	1.11 *** (1.09, 1.13)	1.00 (0.98, 1.01)	1.06 *** (1.05, 1.08)
Cardiovascular screening				
Blood pressure screening	ref	1.04 *** (1.03, 1.05)	0.97 *** (0.96, 0.98)	0.98 *** (0.97, 0.99)
Diabetes screening	ref	1.28 *** (1.25, 1.31)	0.88 *** (0.85, 0.92)	1.18 *** (1.15, 1.21)
Lipid screening	ref	1.27 *** (1.24, 1.30)	0.91 *** (0.87, 0.95)	1.26 *** (1.23, 1.29)
Cancer screening				
Cervical cancer screening	ref	0.91 *** (0.89, 0.94)	0.92 *** (0.89, 0.96)	0.92 *** (0.89, 0.94)
Breast cancer screening	ref	1.02 (0.97, 1.08)	0.81 *** (0.73, 0.90)	0.96 *** (0.92, 1.00)
Colorectal cancer screening	ref	1.12 *** (1.07, 1.18)	0.87 *** (0.80, 0.95)	1.15 *** (1.09, 1.21)
Infectious disease screening				
HIV screening	ref	0.72 *** (0.64, 0.80)	1.16 *** (1.05, 1.29)	1.04 (0.92, 1.16)
Hepatitis C screening	ref	1.20 *** (1.05, 1.36)	1.54 *** (1.27, 1.86)	1.70 *** (1.49, 1.95)
Chlamydia screening	ref	0.79 *** (0.72, 0.87)	0.91 *** (0.85, 0.98)	0.85 *** (0.81, 0.90)
Influenza vaccine	ref	1.28 *** (1.22, 1.34)	1.01 (0.96, 1.06)	1.30 *** (1.24, 1.35)
Pneumonia vaccine	ref	1.18 *** (1.13, 1.24)	0.79 *** (0.65, 0.96)	1.20 *** (1.14, 1.27)
Other services				
Substance screening	ref	0.97 (0.91, 1.03)	1.02 (0.96, 1.08)	0.99 (0.93, 1.05)
Depression screening	ref	0.97 (0.92, 1.02)	1.33 *** (1.26, 1.41)	1.20 *** (1.14, 1.26)
Abdominal aortic aneurysm screening	ref	1.15 (0.93, 1.42)	1.13 (0.39, 3.33)	1.31 *** (1.06, 1.63)

Note: Boldface indicates statistical significance (* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$). Negative binomial models were conducted to assess the association between type of multimorbidity patterns and preventive ratios for each service separately. The regression models were adjusted for: age, gender, race/ethnicity, primary language, insurance type, rural location, smoking status at the beginning of the study, number of office visits during study period, presence of established primary care provider at the beginning of the study, and usual provider continuity index. Results are presented as an exponentiated β -coefficients or rate ratios (RR) and 95% CI.

ARR, adjusted rate ratio