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RESEARCH ARTICLE

Additional Chronic Conditions as Barriers to Depression Management Among Adults Living with HIV

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ABSTRACT

Introduction: An estimated 20% to 30% of people living with HIV (PLHIV) suffer from depression. While the collaborative care model (CCM) is an evidence-based intervention designed to reduce depression, little is known of the impact of additional chronic conditions (ACC) on depression management and CCM response among PLHIV.

Methods: A retrospective cohort study was conducted among 412 PLHIV enrolled in CCM at a large urban community hospital in Cuyahoga County, Ohio, between July 1, 2015, and June 30, 3017. Study participants were identified as clinically depressed at enrollment with at least two PHQ-9 measurements within a year of enrollment. Additional chronic conditions were studied to assess their association with depression treatment response or remission during the study period. Multivariable logistic regression was used to model response and remission considering ACC while adjusting for demographic, program-related, and clinical measures.

Results: Depression outcomes were no different based on the presence or number of ACC. Study participants age 50 years or over with obesity (aOR: 0.15; 95% CI: 0.04-0.64) or heart disease (aOR: 0.15; 95% CI: 0.03-0.84) were less likely to achieve remission. Participants irrespective of age with musculoskeletal disease (MSD) were less likely to achieve remission compared to others without MSD (aOR: 0.48; 95% CI: 0.25-0.93).

Conclusion: Strategies that address obesity may be necessary adjuncts to successfully treating depression among older adults with HIV, while barriers posed by heart disease or MSD should be further investigated.

Keywords: HIV; Depression; Chronic conditions; Obesity; Retrospective cohort study

INTRODUCTION

In 2020, there were over 25 000 persons currently living with diagnosed HIV (PLHIV) in the state of Ohio. Among Ohio counties, Cuyahoga—deemed a priority county for HIV intervention by the Ending the HIV Epidemic: A Plan for America (EHE) initiative—has the highest rate of PLHIV at 421.9 per 100 000 persons.[1] Although HIV infection was largely considered a death sentence in the early days of the epidemic (circa 1980s), today PLHIV who are adherent to HIV antiretroviral therapy (ART) can significantly improve their life expectancy and quality of life.[2–6] However, an estimated 20% to 30% of PLHIV suffer from depression, a condition which is largely undertreated and known to complicate the management of HIV.[7–10] Several studies have linked depression in PLHIV to low adherence to ART and missed medical appointments as well as to lower rates of viral suppression and higher rates of HIV-specific mortality.[11–14] Moreover, a cohort study of US veterans showed that the relationship between depressive symptoms and mortality was modified by HIV status where, in stratified analyses, depression was associated with significantly higher rates of

mortality among the HIV-infected but not among the HIV-uninfected.[15]

Collaborative care models (CCM) for depression have been initiated to address depression and mental health issues in HIV clinics.[16] Key components of CCM include routine screening for depression, measurement based care, care coordination, and case consultation of the care coordinator with psychiatry. The aim of these efforts is to improve HIV treatment adherence and HIV-related outcomes. Unfortunately, depression often is not the only health condition faced by PLHIV, as they are at an increased risk of developing other noninfectious chronic conditions such as dyslipidemia, hypertension, obesity, diabetes, and cardiovascular disease.[17,18] Additionally, depression among PLHIV is often linked with substance abuse.[19,20] Therefore, achieving the desired effect via treatment for depression may be hampered when individuals are comanaging HIV and depression while dealing with other health challenges. A cross-sectional study showed that an increased number of chronic conditions among older adults living with HIV was correlated with higher rates of depression. However, the authors were unable to show how rates of depressive symptoms were impacted by the number or presence of specific chronic conditions over time.[21] A similar study examined chronic conditions among PLHIV focusing exclusively on prevalence among those who are at least 50 years of age.[22] To date, no other study has examined the impact of additional chronic conditions (ACC) on depressive symptoms over time for PLHIV across the adult age spectrum. This study attempts to investigate the impact of the presence, number, and/or type of ACC on depression treatment outcomes over time among adult PLHIV diagnosed with depression.

METHODS

In July of 2015, a large urban community hospital in Cuyahoga County, Ohio, implemented CCM to improve the identification and treatment of depression within its HIV clinic. The current study was developed to retrospectively examine changes in depression among patients enrolled in the first year of the intervention who had at least 12 months of follow-up and at least 2 clinic visits documented within the electronic health record (EHR) where depression was assessed. During the 2-year observation period of July 1, 2015, to June 30, 2017, a total of 594 HIV patients screened positive for depression. Of these patients, 416 met criteria for participation with 4 missing either chart review data or program data. For the remaining 412 patients, we evaluated depression outcomes for their first year of enrollment.

The Patient Health Questionnaire (PHQ-9), a 9-item scale (range 0-27), was used to screen for the presence and severity of depression. Individuals who score below 10 on the PHQ-9 are identified as having either minimum/normal (0-4) or mild (5-9) depression; while individuals who score 10 or above are identified as screening positive for either moderate (10-14), moderately severe (15-19), or severe (20-27) depression. Study inclusion requires a positive screen for depression at baseline (ie, a PHQ-9 score ≥ 10 indicative of either moderate, moderately severe, or severe depression). Suggested treatment for study participants, who screened positive for depression, include counseling and/or antidepressant medication to address depressive symptoms. At 1-year follow-up, study participants were identified as achieving a treatment response (50% reduction in PHQ-9 score); remission in depressive symptoms (PHQ-9 score < 5), which assumes a treatment response; or neither remission nor a treatment response.

The study exposure variables consist of 9 specific ACC: diabetes (type 1 or type 2), obesity (body mass index >30), liver disease, cancer, heart disease, hypertension, chronic obstructive pulmonary disease (COPD), musculoskeletal disease (MSD), and kidney disease. A tenth variable ("other ACC") consisting of other conditions such as hyperlipidemia, asthma, Crohn disease, and/or arthritis was also examined. The presence or absence of each condition was manually verified in the medical record. These 10 dichotomous variables represent the presence or absence of specific chronic condition(s). Additionally, an "any ACC" variable was created to determine the presence or absence of at least 1 ACC, and an "ACC Count" variable was created to capture the total number of additional chronic conditions for a patient.

Potential confounders and effect modifiers include baseline age (adults age 18 and over); gender (Male, Female); race/ethnicity (White/non-Hispanic, Black/non-Hispanic, and Other) where "Other" largely consists of Hispanic ethnicity; and substance abuse history (Yes, No) reflecting a history of marijuana, crack cocaine, opiates, methamphetamine, or alcohol abuse. Information was also available on mental health medication use and prescription adherence (Yes, adherent; Yes, non-adherent; or No) as well as the presence or absence of psychiatric disorders including posttraumatic stress, generalized anxiety disorder, panic disorder, and/or personality disorder as psychiatric disorders (Yes, No). Additionally, assessments were made regarding a participant's engagement in CCM using an engagement measure defined as the number of appointments kept plus the number of phone calls completed minus the number of appointments missed within a 12-month period. Participants with expressed disinterest in program engagement and/or engagement scores within the range 0 to 2 were identified as being "Not Engaged" in care; whereas participants with scores within the 3 to 6 range or the 7 and higher range were identified as being "Somewhat Engaged" or "Very Engaged" in care, respectively. Furthermore, baseline HIV viral load (measured as either "Detected" or "Not Detected or less than 200") and baseline PHQ-9 depression score were captured.

The prevalence of at least 1 ACC and specific ACC was determined across the entire sample and by participant characteristics at baseline with significant differences identified using Fisher exact tests. Characteristics that were shown to be statistically significant at the 0.10 level for at least 1 ACC were included in multivariate models. Ordinal logistic regression was subsequently employed to initially conduct multivariate analyses modeling improvement in

depressive symptoms using 3 mutually exclusive ordinal categories (remission > response but not remission > neither remission nor a response). However, after it was determined that our proposed model violated the assumption of proportional odds, an assumption that the effects of independent variables are constant for each increase in the level of the outcome,[23] we chose to perform 2 binary logistic regression analyses by modeling response (PHQ-9 reduction ≥ 50%) and remission (PHQ-9 < 5) separately. Each of the 10 ACC variables were included in models adjusted for age, gender, ethnicity, substance abuse history, psychiatric disorders, mental health medication use, engagement in care, baseline viral load, and baseline PHQ-9 depression score. In addition, models substituting the 10 ACC variables with either the presence/absence of ACC or the number of ACC were developed to determine their potential impact on depressive symptoms. These alternative models used the same set of control variables. While age was operationalized as a continuous variable within models across all patients, an age cut-point of 50 years was used in age-stratified models to assess the adjusted effect on response and remission for younger (age 18-49) and older (age 50+) adults separately. The proposed, revised and final statistical models are displayed in Figure 1.

With respect to missingness, complete data were available on all variables except race/ethnicity for which a value was missing for just 1 patient. Consequently, case-wise deletion was chosen as our strategy for handling missing data in multivariable models. Statistical significance in models was determined based on a *P* value cutoff of 0.05, and SAS Software version 9.4 was used to conduct all statistical analyses for the study.

RESULTS

The mean age of CCM participants at baseline was 43 years with 31.3% age 50 and over. Overall, 72.6% of participants were male, and 89.3% were either Black or White race/ethnicity. Additionally, 42.2% of participants had a prior history of substance abuse or a psychiatric disorder, while 69.4% were prescribed mental health medication. At baseline, 24.0% of study participants were diagnosed with severe depression and 76.9% had an undetectable HIV viral load. Moreover, the number of specific ACC ranged from 0 to 7 for participants with 28.4% having 3 or more documented ACC. The set of CCM characteristics examined across study participants is shown in Table 1.

Overall, 73.8% of participants had at least 1 ACC. Individuals who are age 50 or over, female, and/or prescribed mental health medication were more likely to have at least 1 ACC. Additionally, individuals with an undetectable HIV viral load at baseline were more likely to have at least 1 ACC.

With regard to specific ACC, prevalence varied with MSD being the most prevalent (28.9%) and kidney disease being the least prevalent (4.4%). In most instances the prevalence of each condition was significantly higher for individuals age 50 or over. Overall, the prevalence of MSD was nearly twice as high among females compared to males (43.4% vs 23.4%) and higher for participants with documented psychiatric disorders versus participants without disorders (35.5% vs 23.5%). The prevalence of obesity was 3 times higher for females compared to males (43.4% vs 14.0%) and significantly higher for participants prescribed mental health medication and/or with an undetectable HIV viral load at baseline.

The prevalence of liver disease was twice as high for participants with either severe or moderately severe depression compared to participants with moderate depression (14.5% and 15.2% vs 7.1%), and the prevalence of heart disease was significantly higher for individuals prescribed mental health medication compared to others not prescribed medication. For both COPD and cancer, prevalence varied significantly by race/ethnicity with a lower prevalence of COPD for participants of Black race compared to others of non-Black race. Additionally, a total of 187 participants (45.3%) who were identified as having other ACC exhibited significant variation in prevalence by gender and baseline HIV viral load

Proposed Ordinal Logistic Regression Models [a]

1. $\text{Logit}\,[P(Y \geq \text{REM or } Y \geq \text{RSP} \mid \text{ACC, CHAR})] = \beta_0 + \sum\beta_{ACC} + \sum\beta_{CHAR}$
2. $\text{Logit}\,[P(Y \geq \text{REM or } Y \geq \text{RSP} \mid \text{ACC, CHAR})] = \beta_0 + \beta_{ACC\_YN} + \sum\beta_{CHAR}$
3. $\text{Logit}\,[P(Y \geq \text{REM or } Y \geq \text{RSP} \mid \text{ACC, CHAR})] = \beta_0 + \beta_{ACC\_CNT} + \sum\beta_{CHAR}$

Revised and Final [b] **Binary Logistic Regression Models**

1. $\text{Logit}\,[P(Y = \text{REM} \mid \text{ACC, CHAR})] = \beta_0 + \sum\beta_{ACC} + \sum\beta_{CHAR}$
2. $\text{Logit}\,[P(Y = \text{REM} \mid \text{ACC, CHAR})] = \beta_0 + \beta_{ACC\_YN} + \sum\beta_{CHAR}$
3. $\text{Logit}\,[P(Y = \text{REM} \mid \text{ACC, CHAR})] = \beta_0 + \beta_{ACC\_CNT} + \sum\beta_{CHAR}$
4. $\text{Logit}\,[P(Y = \text{RSP} \mid \text{ACC, CHAR})] = \beta_0 + \sum\beta_{ACC} + \sum\beta_{CHAR}$
5. $\text{Logit}\,[P(Y = \text{RSP} \mid \text{ACC, CHAR})] = \beta_0 + \beta_{ACC\_YN} + \sum\beta_{CHAR}$
6. $\text{Logit}\,[P(Y = \text{RSP} \mid \text{ACC, CHAR})] = \beta_0 + \beta_{ACC\_CNT} + \sum\beta_{CHAR}$

REM: remission; RSP response; ACC: additional chronic conditions; CHAR: participant characteristics; Logit: natural logarithm of odds; P: conditional probability; Y: study outcome; β_0: model intercept; $\sum\beta_{ACC}$: parameter estimates for the set of chronic conditions; β_{ACC_YN}: parameter estimate for the presence of at least 1 additional chronic condition; β_{ACC_CNT}: parameter estimate for the count of additional chronic conditions; $\sum\beta_{CHAR}$: parameter estimates for the set of participant characteristics.

[a] In ordinal logistic regression, the proportional odds assumption requires that the effects (or odds ratios) derived from modeling "REM" versus "not REM" and "REM or RESP" versus "neither" are the same.

[b] Final models include both overall and age-stratified models.

Figure 1. Proposed, Revised and Final Statistical Models

Table 1. CCM Participant Characteristics (N = 412)

Characteristic	n (%)
Age: Mean (SD)	42.7 (11.92)
Age category	
18-49	283 (68.7)
50+	129 (31.3)
Gender	
Male	299 (72.6)
Female	113 (27.4)
Race/Ethnicity	
White (non-Hispanic)	170 (41.4)
Black (non-Hispanic)	197 (47.9)
Other	44 (10.7)
Substance abuse history	
Yes	174 (42.2)
No	238 (57.8)
Psychiatric disorder [a]	
Yes	186 (45.1)
No	226 (54.9)
Mental health medication use	
Yes, adherent	219 (53.1)
Yes, non-adherent	67 (16.3)
No	126 (30.6)
Engagement in care coordination	
Not engaged	194 (47.1)
Somewhat engaged	133 (32.3)
Very engaged	85 (20.6)
Baseline HIV viral load	
Detected	95 (23.1)
Not detected or less than 200	317 (76.9)
Baseline PHQ-9 score: mean (SD)	15.9 (4.60)
Baseline PHQ-9 severity	
Moderate [10-14]	196 (47.6)
Moderately severe [15-19]	117 (28.4)
Severe [20-27]	99 (24.0)
Additional chronic conditions (ACC)	
None	108 (26.2)
1	108 (26.2)
2	79 (19.2)
3+	117 (28.4)

PHQ-9 = Patient Health Questionnaire (9-Item).
[a] Psychiatric disorders include posttraumatic stress, generalized anxiety, panic, and/or personality disorders.

status. The prevalence of any or specific ACC by CCM participant characteristics is shown in Table 2.

After 1 year of follow-up, 168 participants (40.8%) responded to treatment as noted by at least a 50% reduction in their follow-up PHQ-9 score. Of these, 91 (22.1%) achieved remission as noted by a PHQ-9 score below 5. The remaining 244 participants (59.2%) neither achieved response nor remission for depression. Overall, rates of follow-up depression status were not significantly different for participants based on the presence or absence of ACC nor were they significantly different based on ACC burden (ie, the total number of specific ACC).

In multivariable analyses modeling a treatment response versus nonresponse, there were no significant differences between individuals with or without specific ACC after adjusting for age, gender, ethnicity, substance abuse history, psychiatric disorders, mental health medication use, engagement in care, baseline HIV viral load, baseline PHQ-9 score, and the remaining specific ACC.

In similar analyses modeling remission versus nonremission across all participants, differences were identified for individuals with MSD or obesity where individuals with MSD were one-half as likely of achieving remission compared to others without MSD (aOR: 0.48; 95% CI: 0.25-0.93), and individuals with obesity were one-third as likely of achieving remission compared to others without obesity (aOR: 0.37; 95% CI: 0.17-0.83). In age-stratified models of remission, differences were only apparent among individuals within the 50 or over age group. Specifically, participants with obesity were significantly less likely of achieving remission compared to other participants without obesity (aOR: 0.15; 95% CI: 0.04-0.64), and individuals with heart disease were significantly less likely of achieving remission compared to others without heart disease (aOR: 0.15; 95% CI: 0.03-0.84). In effect, older adults without obesity or without heart disease were at least 6 times more likely of achieving remission compared to older adults with obesity or heart disease. The impact of ACC on treatment response and remission overall and by age group is shown in Table 3.

DISCUSSION

For CCM participants, the burden of specific ACC had no significant impact on rates of treatment response during the 1-year follow-up period. However, for CCM participants with specific ACC such as obesity, heart disease and/or MSD, we found significantly lower rates of remission (the more stringent outcome) during follow-up. Among these findings, lower rates of remission were not realized within the 18 through 49 age group. This study is unique in that it investigates the impact of ACC on depressive symptoms among CCM enrollees jointly diagnosed with HIV and depression. In contrast to a cross-sectional study, which revealed a positive correlation between the number of chronic conditions and depression, our longitudinal study did not find such an association.[21] Moreover, our finding that obesity reduces the likelihood of remission during the 1-year follow-up period, differs from that of a CCM study of depression management, which found no associations between patient BMI and 6-month depression treatment outcomes.[24] Perhaps the findings of the 2 studies would have been more in parallel had the follow-up been the same and both investigations restricted to the study of PLHIV. Unfortunately, we can only speculate about this possibility.

Our finding of significantly lower rates of remission among adults with MSD is unique in that no other studies of depression management among PLHIV have alluded to this relationship in the past. Although one might surmise such an outcome for MSD considering the positive association between obesity and MSD,[25–27] our results indicate that MSD significantly reduces the likelihood of remission even after adjusting for other ACC, including obesity. Similar to MSD, our finding of significantly lower remission rates among adults age 50 or over with heart disease is unique and may be an artifact of this study as heart disease among younger adults appears to have an opposite, albeit insignificant, effect on remission.

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Table 2. Prevalence of Additional Chronic Conditions (ACC) by CCM Participant Characteristics (N = 412)

	Any ACC		MSD		Hypertension		Obesity		Liver disease		Diabetes		Heart disease		COPD		Cancer		Kidney disease		Other [b]	
	n (%)		n (%)		n (%)		n (%)		n (%)		n (%)		n (%)		n (%)		n (%)		n (%)		n (%)	
Overall	304 (73.8)		119 (28.9)		118 (28.6)		91 (22.1)		46 (11.2)		43 (10.4)		39 (9.5)		26 (6.3)		25 (6.1)		18 (4.4)		187 (45.4)	
Characteristic																						
Age category																						
18-49 years	188 (66.4)	*	67 (23.7)	*	67 (23.7)	*	58 (20.5)		24 (8.5)	*	19 (6.7)	*	17 (6.0)	*	6 (2.1)	*	11 (3.9)	*	8 (2.8)	*	116 (41.0)	*
50+ years	116 (89.9)		52 (40.3)		51 (39.5)		33 (25.6)		22 (17.1)		24 (18.6)		22 (17.1)		20 (15.5)		14 (10.9)		10 (7.8)		71 (55.0)	
Gender																						
Male	209 (69.9)	*	70 (23.4)	*	78 (26.1)	#	42 (14.0)	*	32 (10.7)		27 (9.0)		27 (9.0)		18 (6.0)		21 (7.0)		13 (4.3)		124 (41.5)	*
Female	95 (84.1)		49 (43.4)		40 (35.4)		49 (43.4)		14 (12.4)		16 (14.2)		12 (10.6)		8 (7.1)		4 (3.5)		5 (4.4)		63 (55.8)	
Race/Ethnicity																						
White (non-Hispanic)	129 (75.9)		49 (28.4)		44 (25.9)		33 (19.4)		22 (12.9)		10 (5.9)	*	14 (8.2)		17 (10.0)	*	15 (8.8)	*	8 (4.7)		84 (49.4)	
Black (non-Hispanic)	145 (73.6)		56 (28.8)		65 (33.0)		50 (25.4)		19 (9.6)		27 (13.6)		21 (10.7)		6 (3.1)		5 (2.5)		10 (5.1)		85 (43.2)	
Other	30 (68.8)		14 (31.8)		9 (20.9)		8 (18.2)		5 (11.4)		6 (13.7)		4 (9.1)		3 (6.8)		5 (11.4)		0 (0.0)		18 (40.9)	
Substance abuse history																						
Yes	128 (73.6)		54 (31.0)		52 (29.9)		31 (17.8)	#	23 (13.2)		12 (6.9)	#	16 (9.2)		10 (5.7)		14 (8.0)		6 (3.4)		78 (44.8)	
No	176 (73.9)		65 (27.3)		66 (27.7)		60 (25.2)		23 (9.7)		31 (13.0)		23 (9.7)		16 (6.7)		11 (4.6)		12 (5.0)		109 (45.8)	
Psychiatric disorder [a]																						
Yes	141 (75.8)		66 (35.5)	*	56 (30.1)		48 (25.8)		24 (12.9)		20 (10.8)		19 (10.2)		9 (4.8)		14 (7.5)		8 (4.3)		85 (45.7)	
No	163 (72.1)		53 (23.5)		62 (27.4)		43 (19.0)		22 (9.7)		23 (10.2)		20 (8.9)		17 (7.5)		11 (4.9)		10 (4.4)		102 (45.1)	
Mental health medication use																						
Yes, adherent	172 (78.5)	*	71 (32.4)		65 (29.7)		58 (26.5)	*	28 (12.8)		25 (11.4)		23 (10.5)	*	14 (6.4)		16 (7.3)		9 (4.1)		111 (50.7)	#
Yes, non-adherent	51 (76.1)		20 (29.9)		23 (34.3)		15 (22.4)		8 (11.9)		6 (9.0)		10 (14.9)		4 (6.0)		4 (6.0)		4 (6.0)		26 (38.8)	
No	81 (64.3)		28 (22.2)		30 (23.8)		18 (14.3)		10 (7.9)		12 (9.5)		6 (4.8)		8 (6.3)		5 (4.0)		5 (4.0)		50 (39.7)	
Engagement in care coordination																						
Not engaged	142 (73.2)		59 (30.4)		57 (29.4)		47 (24.2)		19 (9.8)		20 (10.3)		18 (9.3)		15 (7.7)		15 (7.7)		9 (4.6)		92 (47.4)	
Somewhat engaged	99 (74.4)		35 (26.3)		34 (25.6)		27 (20.3)		16 (12.0)		17 (12.8)		13 (9.8)		6 (4.5)		6 (4.5)		5 (3.8)		61 (45.9)	
Very engaged	63 (74.1)		25 (29.4)		27 (31.8)		17 (20.0)		11 (12.9)		6 (7.1)		8 (9.4)		5 (5.9)		4 (4.7)		4 (4.7)		34 (40.0)	
Baseline HIV viral load																						
Detected	61 (64.2)	*	22 (23.2)		20 (21.1)	#	14 (14.7)	*	10 (10.5)		9 (9.5)		9 (9.5)		3 (3.2)		4 (4.2)		3 (3.2)		34 (35.8)	*
Not Detected or Less than 200	243 (76.7)		97 (30.6)		98 (30.9)		77 (24.3)		36 (11.4)		34 (10.7)		30 (9.5)		23 (7.3)		21 (6.6)		15 (4.7)		153 (48.3)	
Baseline PHQ-9 severity																						
Moderate [10-14]	150 (76.5)		52 (26.5)		56 (28.6)		39 (19.9)		14 (7.1)	*	23 (11.7)		17 (8.7)		10 (5.1)		15 (7.7)		10 (5.1)		91 (46.4)	
Moderately severe [15-19]	85 (72.6)		38 (32.5)		34 (29.1)		28 (23.9)		17 (14.5)		12 (10.3)		15 (12.8)		10 (8.5)		4 (3.4)		5 (4.3)		53 (45.3)	
Severe [20-27]	69 (69.7)		29 (29.3)		28 (28.3)		24 (24.2)		15 (15.2)		8 (8.1)		7 (7.1)		6 (6.1)		6 (6.1)		3 (3.0)		43 (43.4)	

MSD: musculoskeletal disease; COPD: chronic obstructive pulmonary disease; PHQ-9: patient health questionnaire (9-Item)
Fisher exact tests were used to compare prevalence rates.
P Values: p < 0.05 (*), p < 0.10 (#).
[a] Psychiatric disorders include posttraumatic stress, generalized anxiety, panic, and/or personality disorders.
[b] Other ACC include hypercholesterolemia, asthma, arthritis, and/or Crohn disease.

Although our study has important findings, we recognize that it also has some limitations. Detail beyond the presence or absence of ACC, such as length of time with illness at baseline or illness severity, was not available for all patients and thus not factored into analyses to assess their impact on outcomes. Additionally, patients varied in the timing and number of PHQ-9 scores provided during follow-up with a minimum of 1 additional measurement required post-baseline to calculate a change in status. To offset this variation, we added engagement in care, which considers the number of planned visits kept and measurements taken, as a control variable in multivariable models. Due to the complications involved in testing and interpreting a massive number of combinations of chronic disease presentations, the impact of joint illness (eg, diabetes and cancer) on response and remission was not considered in multivariable models. Thus, we were limited to considering the impact of each ACC individually on outcomes in light of other potential confounding factors, which included the presence or absence of other specific ACC. Instead, we used the number of ACC as a general assessment of the impact of joint illness or comorbidity on depression management.

Although we chose to stratify our analyses by age group, based on a desire to compare results in the older age group to other studies that exclusively studied individuals age 50 or over, stratification based on gender and/or ethnicity was not carried out. This was primarily due to concerns of sample size and over testing, thus prohibiting us from evaluating differences in response and remis-

Table 3. The Impact of Additional Chronic Conditions (ACC) on Depression Outcomes

	Response[b]						Remission[c]					
	Overall		Ages 18-49		Ages 50+		Overall		Ages 18-49		Ages 50+	
ACC [a]	aOR	95% CI	aOR	95% CI	aOR	95% CI	aOR	95% CI	aOR	95% CI	aOR	95% CI
MSD	0.69	(0.42-1.16)	0.83	(0.43-1.61)	0.74	(0.30-1.81)	0.48	(0.25-0.93)	0.46	(0.18-1.19)	0.69	(0.24-1.99)
Hypertension	1.18	(0.71-1.98)	1.48	(0.76-2.87)	0.85	(0.33-2.22)	1.34	(0.72-2.51)	1.80	(0.77-4.21)	1.50	(0.51-4.39)
Obesity	0.63	(0.35-1.13)	0.88	(0.42-1.84)	0.38	(0.13-1.14)	0.37	(0.17-0.83)	0.62	(0.22-1.76)	0.15	(0.04-0.64)
Liver disease	0.94	(0.48-1.87)	1.21	(0.48-3.04)	0.74	(0.23-2.39)	1.26	(0.55-2.90)	1.64	(0.52-5.12)	0.71	(0.17-2.99)
Diabetes	1.30	(0.62-2.74)	0.72	(0.24-2.22)	2.81	(0.74-9.46)	1.35	(0.55-3.33)	0.84	(0.20-3.45)	1.68	(0.42-6.66)
Heart disease	0.81	(0.38-1.76)	1.30	(0.42-4.04)	0.57	(0.18-1.86)	0.53	(0.19-1.47)	1.64	(0.41-6.57)	0.15	(0.03-0.84)
COPD	0.44	(0.17-1.14)	0.28	(0.02-3.56)	0.54	(0.16-1.79)	1.18	(0.41-3.41)	1.00	(0.06-16.13)	1.52	(0.41-5.63)
Cancer	1.17	(0.46-2.96)	1.71	(0.43-6.76)	0.72	(0.18-2.92)	2.07	(0.75-5.73)	4.56	(0.88-23.52)	1.26	(0.26-6.00)
Kidney disease	0.92	(0.33-2.60)	0.45	(0.08-2.45)	1.60	(0.34-7.51)	0.95	(0.29-3.18)	0.36	(0.04-3.36)	1.53	(0.28-8.23)
Other [d]	0.92	(0.59-1.44)	0.74	(0.42-1.31)	1.95	(0.80-4.80)	0.84	(0.48-1.46)	0.57	(0.27-1.21)	1.37	(0.51-3.68)

MSD: musculoskeletal disease, COPD: chronic obstructive pulmonary disease; aOR: adjusted odds ratio; CI: confidence interval.
All models adjust for gender, ethnicity, substance abuse history, psychiatric disorder, mental health medication use, engagement in care, baseline HIV viral load, baseline PHQ-9 score, and other ACC. Overall models also adjust for age.
[a] The reference category for each aOR estimate and 95% CI is the absence of the corresponding condition.
[b] Response refers to a PHQ-9 score reduction ≥50% (Reference = "No response").
[c] Remission refers to a PHQ-9 score <5, which implies Response (Reference = "No remission").
[d] Other ACC include hypercholesterolemia, asthma, arthritis, and/or Crohn disease.

sion for subgroups of individuals based on these characteristics alone or jointly with age. Lastly, the results of our study are limited to individuals enrolled in evidence-based CCM programs where proactive efforts are made to manage depression for the purposes of reducing morbidity and premature mortality. Consequently, the results of this study may not be generalizable to depressed PLHIV with additional chronic conditions who are not enrolled in these programs.

Despite these limitations, our findings clearly suggest that obese individuals within our CCM program face challenges managing depression as participants with obesity were less likely to achieve remission. Unfortunately, recent studies have linked weight gain to ART.[28–30] This poses a dilemma to PLHIV who must adhere to ART regimens to sustain life but struggle with health issues such as depression resulting from their ART-related weight gain. Behavioral activation interventions, which have been shown to successfully address issues of depression and obesity may be useful for obese PLHIV in CCM programs.[31,32]

Similar to obesity, MSD affects physical mobility, a factor which might partially explain lower rates of remission among adults diagnosed with MSD. Nevertheless, the significance of these lower rates, as well as those among adults age 50 or over with heart disease, will require further investigation. Overall, it is evident that management of multiple chronic conditions can become extremely complex given their combined impact on a person's physical and mental wellbeing and on the various therapies and interventions required to control each condition. This is of particular importance for PLHIV suffering from depression and other chronic conditions who, at the least, must remain adherent to ART to extend their length of life. To that end, barriers to ART adherence among PLHIV that involve comanaging depression and other chronic conditions must be fully investigated in areas such as Cuyahoga County, Ohio, that have been severely burdened with the HIV/AIDS epidemic.

PUBLIC HEALTH IMPLICATIONS

Drastic decreases in HIV/AIDS-related mortality and corresponding increases in life expectancy have been realized among PLHIV since the advent of ART. More people today are living with the HIV virus than ever before. Nevertheless, quality and duration of life remain an issue, as PLHIV have a higher prevalence of comorbidity compared to HIV-naïve persons, comorbidity increases with age, and comorbidity burden is associated with increased mortality. This is of relevance considering that 50% of PLHIV today are over the age of 50, and 70% of PLHIV are expected to be over the age of 50 by year 2030.[33] Given these realities, public health is faced with the challenge of ensuring that members of this growing, older PLHIV population remain in care and remain virally suppressed.

Treat, 1 of the 4 pillars of the EHE, involves establishing support for retention in care and adherence to HIV medication to prevent AIDS-related mortality among PLHIV and transmission of the HIV virus to others. The findings of this study, conducted in 1 of EHE's high-priority counties, suggest it is harder for older adult PLHIV with chronic conditions such obesity or heart disease to experience remission of depressive symptoms. The generalizability of these results should be investigated in studies of other EHE high-priority areas; and if validated, public health programs that target PLHIV should seek to identify these subpopulations for the purpose of assessing their mental health as it relates to retention in HIV care and ART adherence.

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