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Systematic Review of Behavioral Health Homes Impact on Cardiometabolic Risk Factors for Adults with Serious Mental Illness

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Abstract

Objective—This systematic review examined the impact of health homes on cardiometabolic risk in adults with serious mental illness.

Methods—The Preferred Reporting Items for Systematic Reviews and Meta-Analyses procedures were used to conduct the systematic review. Databases were searched for peer-reviewed articles published between 1946 and August 2018 that compared health homes to a control condition (e.g., usual care, secondary data analyses using matched samples). Participants, interventions, comparisons, outcomes, and study design criteria were used to assess study eligibility. Studies were assessed for methodological quality using the *Quality Assessment of Before and After Studies With No Control Group,* and the *Quality Assessment of Controlled Intervention Studies*.

Results—Eighteen studies (i.e., eleven observational, four quasi-experimental, three randomized controlled trials) reported on 17 health homes. Most studies reported increases in receipt of screening for cardiometabolic risk factors and service use. There was a modest reduction in selected cardiometabolic risk factors among people with serious mental illness, but clinical outcomes varied widely among studies.

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Declaration of interests

We declare no competing interests.

Discussion—Health homes are associated with increased rates of cardiometabolic screening and service use. However, improvement in cardiometabolic risk factors varied across the studies and the clinical significance of these reductions is not clear. Peer support and self-management training may represent strategies to improve cardiometabolic risk factors.

Conclusions—Co-location of services may not be enough to significantly impact cardiometabolic risk factors. Health homes may have a greater impact on clinical outcomes if they include: standardized screening; peer support and self-management training; intervention components that target interdependent risk factors.

Keywords

serious mental illness; cardiometabolic outcomes; peer support; behavioral health home

Introduction

People with serious mental illness (SMI) comprise 4–6% of the population[1] and have a reduced life expectancy of 11–30 years compared to the general population[2–5]. This disparity in mortality is mainly due to high prevalence of cardiovascular disease, obesity, and tobacco use[6]. A critical strategy to improve health and impact early mortality rates in persons with SMI has been the creation of "health homes,"[7] which aim to better coordinate care and improve the physical health of people with SMI by integrating primary healthcare within community-based behavioral healthcare[8] – sometimes referred to as "reverse integration."

Improved integration of the organization, financing, and delivery of primary care and behavioral health services has the potential to address longstanding *systemic* barriers to accessing care for people with SMI[7]. For instance, health homes may facilitate navigation of the primary care and mental health systems, diminish denial of treatment due to the complexity of conditions, offer parallel, not disjointed treatment, and improve comprehensive screening and assessment. The promise of health homes to improve care and outcomes has stimulated numerous national and state initiatives[7,8].

Systematic reviews[9,10] and evaluations[7,11] of behavioral health homes have consistently noted that they lead to increased receipt of preventive care, but the impact on cardiometabolic risk factors has been variable[7,9–11]. Our objective was to systematically review the peer-reviewed published literature on health homes to examine their impact on cardiometabolic risk factors among adults with SMI, including examination of strategies that seem to produce the best clinical outcomes, with the eventual goal of informing potential reforms of federal and state healthcare policies, health plans, and provider systems for adults with SMI.

Methods

Search Strategy

We followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) procedures[12]. Our search strategy protocol was published in the PROSPERO

International prospective register of systematic reviews (Registration number: CRD42017056169). We searched the following databases for peer-reviewed articles from 1946 to August 2018 (we included available high-quality electronic reference databases beginning in 1946 to identify early health home models): CINAHL, Cochrane Central, PubMed, Medline, PsycINFO, and Web of Science. The following search terms were used for SMI: schizophrenia, disorder with psychotic features, psychotic, schizophrenia spectrum disorder, paranoia, serious mental disease, serious psychotic illness, persistent mental illness, persistent mental disease, schizoaffective disorder, bipolar disorder, serious mental illness, severe mental illness. These terms were used in combination with the following terms for behavioral health homes: co-location, health home, medical health home, behavioral health home, integrated care, primary care and mental healthcare. Each term was entered as a keyword and assigned the corresponding Medical Subject Heading term. To identify articles not included in our original search, we reviewed reference lists of studies that met inclusion criteria, prior systematic reviews, and searched Google Scholar by using different combinations of the terms.

Study Selection Criteria

Studies were evaluated by the first two authors (KLF, PRD), who independently screened titles and abstracts. We piloted our title and abstract review protocol on 10 references to ensure at least 80% concordance/agreement before reviewing the entire set of titles and abstracts. These authors independently reviewed and rated all full text articles meeting inclusion criteria. Discrepancies in ratings were resolved following discussion and arrival at consensus by these authors. As stated by PRISMA guidelines[12], we used the participants, interventions, comparisons, outcomes, and study design (PICOS) criteria[13] to assess study eligibility.

Participants—Studies that included individuals age ≥18 years with either a schizophrenia spectrum disorder (schizophrenia or schizoaffective disorder) or bipolar disorder were included.

Intervention—Behavioral health homes were defined as models in which primary care services were integrated into a mental health setting. This review focused only on this type of health home versus those focused on substance use treatment or primary care facilities with embedded mental health care.

Comparisons—All included studies were required to have a comparison condition. All study comparison conditions were considered eligible, including other behavioral health home interventions, minimal interventions, usual care, pre/post studies with an experimental or quasi-experimental comparison condition, or secondary data analyses using matched samples (treated versus non-treated samples). Any study without a comparison condition was excluded, including case studies, qualitative studies, and pre/post studies *without* an experimental or quasi-experimental comparison condition.

Outcomes—The outcomes of interest included the following: impact on service utilization (i.e., primary care use, emergency department use, and hospital admissions); receipt of

preventive screenings (i.e., laboratory and physical measures of cardiometabolic risk factors); and impact on cardiometabolic risk factors (i.e., objective measures of blood pressure, blood glucose, body mass index, LDL cholesterol, HDL cholesterol, total cholesterol, triglycerides, cigarette use, and diagnosis of heart disease or hypertension). Studies that did not include at least one of the outcomes were excluded. Subjective measures such as self-reported health status were not included as outcomes.

Study design—We included studies with randomized controlled trials, pre-post designs with experimental or quasi-experimental comparison conditions, and secondary data analyses if there was a comparison condition and if outcomes were relevant to the effectiveness of the behavioral health home interventions. Research protocols, letters to the editor, review articles, pharmacological studies, and theoretical articles were excluded. Articles that were not peer-reviewed were excluded in this systematic review. We recognize that evaluations of health homes have been reported in non-peer reviewed venues such as white papers, government reports, and contracted narratives; however, we chose to include only models that were tested with sufficient scientific rigor to merit publication in a peer-reviewed journal.

Data Extraction

Relevant data from included studies were extracted in duplicate by two of the authors (PRD and MCL) using a standardized data collection tool. Prior to data extraction, the two reviewers piloted the data collection tool on five included articles to identify and reconcile any unintended omissions of data. The first author (KLF) approved the final set of data and resolved any of the remaining data discrepancies. Extracted study data included study design, sample size, sociodemographic characteristics of the sample, study length, comparison group (control group) type, physical location of health home intervention (e.g., community mental health center, Veteran's Administration), health home model description, and study outcomes.

Methodological Quality Assessment

All included studies were assessed for methodological quality using two National Heart, Lung, and Blood Institute Quality Assessment (NHLBI) tools that are commonly used and include instructions for their interpretation, the *Quality Assessment of Before and After (Pre-Post) Studies With No Control Group*[14] and the *Quality Assessment of Controlled Intervention Studies* tool.[14] The former tool includes 12 discrete criteria, while the latter has 14. Examples of study criteria, which are rated as yes or no, include clarity of hypotheses, representativeness of the sample, sample size power calculations, blinding of assessment procedures, etc. After rating the study-specific criteria, a methodological quality rating of low risk of bias (good quality), moderate risk of bias (medium quality), or high risk of bias (poor quality) was assigned independently by two authors (PRD and MCL). Disagreements were resolved through consultation with a third reviewer (KLF).

Results

The search strategy identified 7,101 citations. Of these, 1,729 citations were duplicates. A total of 5,372 titles and abstracts were reviewed, and 5,323 ineligible studies were excluded. The full text of the remaining 49 articles were assessed further for inclusion criteria, and 18 articles met criteria and were included for analysis (see Figure 1 in the online supplement).

This systematic review identified 18 studies that reported on 17 behavioral health homes (i.e., eleven observational, four quasi-experimental designs, and three randomized controlled trials). As detailed below, studies examined health home models in community mental health centers, outpatient mental health settings, a community mental health center and federally-qualified health center partnership, and an inpatient unit. Included studies reported on service utilization, receipt of preventive screenings for cardiometabolic risk factors (i.e., laboratory and physical measures), and changes in cardiometabolic risk factors.

Methodological Quality Assessment

Eleven studies were categorized as low risk of bias (good)[15–25], six studies were categorized as moderate risk of bias (medium quality)[26–31], and one study was rated as high risk of bias (poor quality)[32] (Table 1). The most common causes for methodological quality concerns among studies were: failure to report baseline characteristics, lack of blinding of assessors, unclear description of the intervention and/or its delivery, no mention of statistical power, and infrequent or single assessment of outcomes.

The eligible studies were divided into two categories, health home studies conducted in a Veteran's Administration (VA) health home and those conducted in non-VA health homes, because the VA had already integrated primary care providers and behavioral health workers prior to the formal establishment of behavioral health homes[8]. Additionally, the VA represents a single integrated health system that does not have distinct funding streams, thus limiting the administrative and financial barriers to integrated care compared to non-VA systems. Seven studies were conducted in a VA[16,20,21,23,24,27,30], four studies were conducted in community mental health centers[15,22,25,31], two studies were conducted in outpatient mental health settings[19,26], three studies were conducted in the context of a community mental health center and federally-qualified health center partnership[17,28,32], and one study was conducted in an inpatient unit[29].

Service Utilization

A total of ten studies reported changes in service utilization[15–18,22–27], of which, eight were identified as low risk of bias (good quality)[15–18,22–25], and two were categorized as medium risk of bias (medium quality)[26,27]. Four studies were conducted in the VA[16,23,24,27], two studies were conducted in outpatient mental health settings[18,25], three studies were conducted in a community mental health center[15,22,25], and one study was conducted in a combination of a community mental health center and a federally-qualified health center[17]. In Table 2 below, we have listed the results separately by VA and non-VA health homes and present the methodological quality of the studies in parentheses to assist readers in discerning the results. The black bar in the table indicates studies that reported on an

outcome of interest. We plotted our results for each intervention, based on methodological quality, and distributed them by outcome. The effect and quality of the studies varied greatly. The footnote details the outcomes of the studies including the following: "*" represents statistically significant results; "(−)" represents a negative finding; "(+/−)" represents the effect was not replicated in a second sample; and "(−/−)" represents there was improvement but no difference compared to the control; "(o/o)" represents no improvement in either group.

Primary care utilization

VA health homes—One study conducted within a VA found a significant increase in primary care use[16], and two studies found non-significant improvement in primary care use (i.e., 2.3 more visits over 18-months of follow-up[23] and 1.74 more visits over 6-months of follow-up) (good quality) [24].

Non-VA health homes—Compared with usual care, participants in the health home intervention group had a greater likelihood of having a primary care provider (71.2% vs. 51.9%, p=0.003)[15]; however, the frequency of visits was not reported. The same research group found in a later study (good quality) that, compared with usual care, primary care visits in the health home increased from a mean of 0.93 to a mean of 1.73 (versus 0.65 to 0.86 in the usual care group). The group-by-time interaction for this increase in visits was statistically significant (p<0.001)[17].

Emergency department utilization

VA health homes—Emergency department (ED) utilization results were not consistent across studies. One study (good quality) found that participants in the health home intervention group had fewer emergency department visits compared to the control group (4.3 mean days +/− 7 compared to 5.0 mean days+/−6; non-statistically significant)[23]. Another study (good quality) found a statistically significant increase in emergency department among participants in the health home intervention group compared to the control condition (p<.05)[24]. A third study (medium quality) found no difference between the intervention and control groups on emergency department visits[27].

Non-VA health homes—One study (good quality) showed a significant decrease in ED utilization in the health home intervention group compared to a control condition[19]; however, the results were not replicated in a subsequent trial[19]. Another study (medium quality) found the health home intervention group had 42% fewer emergency department visits compared to the control[26].

Psychiatric hospitalizations

VA health homes—One study (medium quality) found no difference between the intervention and control groups on inpatient psychiatric admissions[27].

Non-VA health homes—Decrease in psychiatric hospitalizations were not consistent across studies in non-VA health homes. One study (good quality) showed a decrease in the proportion of participants with an inpatient hospital admission (p=.04) in one Primary

Behavioral Health Care Integration (PBHCI) clinic, but not in the other[22]. Another study (good quality) found that psychiatric hospitalizations declined for health home participants (. 22 to .10) and remained stable for participants in the control group (.145 and .147) (p=.002 between groups)[25].

Medical hospitalizations

VA health homes—In one study (good quality), the average length of medical hospital stay decreased from 8.75 days to 6.0 days for people with SMI in the health home group (non-statistically significant)[24].

Non-VA health homes—Medical hospitalization outcomes were null or negative across studies. One study (good quality) found *no* significant differences in medical hospitalization utilization in the health home versus the control group[25]. Another study (good quality) found that hospital stays due to chronic health conditions *increased* significantly in the intervention group compared to the control group[19].

Outpatient medical services

VA health homes—Not applicable—none of the identified studies included this outcome in a VA health home.

Non-VA health homes—In one study (good quality), a higher proportion of participants in the health home compared to the control group engaged in outpatient medical services following program enrollment (p<.003, clinic 1; p<.001, clinic 2)[22]. In another study (medium quality), the health home group had a 50% increase in routine medical care compared to the usual care group[26].

Screening for Cardiometabolic Risk Factors

A total of twelve studies reported changes in screening for cardiometabolic risk factors[15–18,20,21,23,25–27,29,32] (see Table 3). Among these, eight studies were classified as having low risk of bias (good quality)[15–18,20,21,23,25], three studies were categorized as having a medium risk of bias (medium quality)[26,27,29], and one study was categorized as having a high risk of bias (poor quality)[32]. Five studies were conducted at a VA[16,20,21,23,27], one study was conducted in an inpatient mental health setting[29], two studies were conducted in outpatient mental health settings[18,26], two studies were conducted in community mental health centers[15,25], and two studies were conducted in the context of a partnership between a community mental health center and a federally-qualified health center[17,32].

VA health homes—Two studies examined preventive healthcare[16– 27]. Preventive healthcare as defined by the U.S. Preventive Services Task Force guidelines includes blood pressure screening, mammogram, pap smear, chlamydia and gonorrhea screening, cholesterol screening, colorectal cancer screening, diabetes screening, and HIV screening[17]. In one study (good quality), compared to usual care, participants in the health home group had a statistically significant increase in receipt of preventive healthcare[16]. By contrast, one study (medium quality) found no difference between the intervention and control groups on preventive health screenings[27].

Other studies (good quality) also found statistically significant increases for the health home groups compared to control groups in foot exams among people with diabetes[21], and screenings for the following conditions: colorectal cancer, alcohol misuse[21,23], lipids, glucose, body mass index, blood pressure[20], breast cancer, prostate cancer, tobacco use, and major depressive disorder[23].

Non-VA health homes—Multiple studies (good quality) found that the health home group compared to the control group was associated with significant improvements in receipt of preventive services ($p<.001$; Cohen's $d=1.2$, large effect[17]; 58.7% vs. 21.8%, $p<0.001$)[15].

Two studies found that the health home group as compared to the control was associated with non-statistically significant improvements in the following screenings: blood pressure, cholesterol, blood glucose, hypertension, high-risk cholesterol (poor quality)[32], physical examinations, diabetes, and hypertension (medium quality)[26].

Other studies found mixed results for individual screenings[25, 29]. One study (good quality) found increases in HbA1c screening but *not* in lipid monitoring in the health home group[25]. Another study (medium quality) found increases in the control group (i.e., treatment as usual) compared to the health home group in screening for hemoglobin A1c tests, glucose, and lipids[29].

One study (good quality) demonstrated variable results[18]. In wave 1 of implementation of a PBHCI program, participants experienced statistically significant improvement in glucose/HbA1c screening (OR=0.22, 95% confidence interval: 0.12–0.33, $p<.05$), but these results were not replicated in the wave 2 sample. Further, the PBHCI program showed statistically significant improvement in low-density lipoprotein/cholesterol screening (OR=0.21, 95% confidence interval: 0.12–0.30, $p<.05$) for participants taking antipsychotics in only one of the two waves[18].

Two studies (good quality) found null results[18, 25]. One study found HbA1c monitoring was not impacted in two waves of the health home intervention[18]. Another study found no significant differences in metabolic monitoring among participants with diabetes in the health home and control groups[25].

Cardiometabolic Risk Factor Outcomes

A total of six studies reported changes in cardiometabolic risk factor outcomes[17,21,28,30–32] (see Table 4), of which, two studies were identified as low risk (good quality)[17,21], three studies were categorized as medium risk (medium quality)[28,30,31], and one study was categorized as high risk (poor quality)[32]. Four studies were conducted in the VA[21,30], one study was conducted in a community mental health center,[31] and three studies were conducted in a partnership between a community mental health center and a federally-qualified health center[17,28,32].

VA health homes—Studies that examined changes in cardiometabolic risk factors produced mixed results[21, 30]. One study (good quality) found statistically significant

improvements in blood pressure control for the health home group but also found that these participants were less likely to have well-controlled glycosylated hemoglobin (i.e., HbA1c) <9% (OR=.69, p<.05)[21]. Another study (medium quality) found statistically significant improvements in body mass index, triglycerides, blood pressure control, and LDL cholesterol[30] for the health home versus the control group. Yet, in this study there were no statistically significant changes in high-density lipoprotein cholesterol or HbA1c in the health home or control groups[30].

Non-VA health homes—Two studies (medium quality) produced statistically significant improvements in weight[31], LDL cholesterol[28,31], systolic and diastolic blood pressure[31], HDL cholesterol[28,31], total cholesterol[28], and cigarette use[31]. However, the remaining studies produced mixed results[17, 32]. One study (good quality) found statistically significant improvements in systolic blood pressure but no difference between groups on other cardiometabolic outcomes, including diastolic blood pressure, total and LDL cholesterol levels, blood glucose level, HbA1c level, and Framingham risk score[17]. Another study (poor quality) found a significant reduction in hypertension yet an increase in prediabetes or diabetes in the health home versus the control group (p=.01)[32].

Strategies to Augment Clinical Improvement

Four studies described an enhanced health home model, which included self-management training (e.g., medical self-management, stress management)[15,17,18,31], peer support[31], coaching on how to interact more effectively with providers (i.e., self-advocacy)[15], coordinated care between primary and mental health care providers[15], and action planning to promote health behavior change[15].

Discussion

Behavioral health homes may improve the lives of adults with serious mental illness, but co-location of services may not be enough to impact cardiometabolic risk factors, which are responsible for high rates of morbidity and early mortality. This systematic review identified 18 studies that reported on 17 behavioral health homes. Most of the studies reviewed suggested that health homes were effective in increasing screening and service use among adults with serious mental illness. Findings were mixed as to the effectiveness of health homes in improving cardiometabolic risks. Potential strategies that may enhance clinically significant improvement in cardiometabolic risk factors include peer support and illness self-management training.

In theory, increased service utilization to address cardiometabolic risk factors could reduce health care costs in the long-run, but the impact on costs is likely to be modest in the absence of dedicated efforts to improve health behaviors, given that health behaviors are estimated to proportionally contribute four times more to premature death (40%) than differences in healthcare (10%)[33]. Improving integration and receipt of health services alone, without engaging people with a lived experience of SMI in health behavior change activities is unlikely to result in significant and lasting improvements in health and long-term reductions in costs.

This systematic review found that screening for cardiometabolic risk factors in health homes has improved since a previous evaluation of health homes conducted by the RAND Corporation[7], which included four studies demonstrating statistically significant changes in screening[15,17, 20,21] and four finding non-statistically significant improvements in screening [16,23,26,32]. Few studies identified in this systematic review found increases in some but not all cardiometabolic screenings [25]; no differences in cardiometabolic screening between treatment groups[27]; or negative results (where screening increased in the control group, not the behavioral health home)[29]. Variation in outcomes across reviewed studies may be due to non-standardization of health home screening practices. Standardized screening practices could better enable providers to identify and address problems using a population health approach.

Findings were mixed with regard to the impact of health homes on improvement in cardiometabolic risk factors. Health home models have often targeted discrete modifiable risk factors versus composite risk factors. For example, some health homes have targeted dietary practices such as salt reduction to impact blood pressure. Individuals with SMI commonly present with *multiple* cardiometabolic risk factors and general medical conditions[6]. The potential to widely impact excess morbidity and mortality rates for adults with SMI is limited when health homes target only one a few discrete risk factors. In addition, studies largely reported statistically significant reductions, but did not report on the proportions of individuals achieving clinically significant reductions or normalized values in key parameters such as BMI, blood pressure, lipids, and HbA1c. One study that used a multi-component approach in which the health home required: physical examinations, screening tests, vaccinations, and education on exercise, self-examination, smoking, nutrition, and weight[15] resulted in positive cardiometabolic outcomes based on a composite scale (i.e., Framingham Cardiovascular Risk Scores were significantly better for the health home intervention group [6.9%] compared to the control group, 9.8%, p=0.02, N=100])[15]. Morbidity and mortality risk are impacted by numerous, interacting, modifiable factors that are biological (e.g., chronic health conditions), psychological (e.g., depressive or anxiety symptoms), behavioral (e.g., physical inactivity, tobacco use), and social (e.g., isolation, loneliness). Interventions targeting interdependent risk factors using a “whole person” approach may positively impact *multiple* cardiometabolic risk factors and *multiple* indicators of health status. One such intervention (not included in this review) is Integrated Illness Management and Recovery (I-IMR), which teaches people with serious mental illness about multiple chronic physical health conditions, as well as serious mental illnesses including schizophrenia and bipolar disorder, how physical and mental health relate to each other, and how to better manage them together. I-IMR also provides training on obtaining social support, and how to improve health behaviors (e.g., exercise, diet, smoking cessation[34].

Among the studies reviewed here, health homes that included elements of peer support and training on self-management skills showed the greatest reduction in cardiometabolic risk factors[17,31]. Building on previous evaluations of health homes[7,9], systematic reviews[9,10] , and the Interim Report to Congress on the Medicaid Health Home State Plan Option[11], our review used a systematic approach and identified potential strategies to promote health behavior change including self-management training[15,17,31], and peer support[31] , which have

not traditionally been included in health home models[7] in spite of evidence showing that these approaches help people with SMI to better manage chronic conditions. For example, I-IMR compared to usual care increased medical and psychiatric self-management skills and reduced hospitalizations among people with SMI[34]. If health homes are to have a greater impact on clinical outcomes, peer support and illness self-management training may need to be included as core components. Including these types of evidence-based interventions within behavioral health homes would require the development of new financing mechanisms as well as a shift in the culture of behavioral health settings, which have not traditionally embraced medical illness management as a core responsibility.. Future research on the impact of peer support and self-management and the integration of these services within health homes is needed.

We acknowledge several limitations of this review. First, the lack of longitudinal outcomes in the included studies prevented us from assessing the persistence of reduced cardiometabolic risk factors over time. Further research is needed to determine how to sustain clinical improvements, especially among Medicaid beneficiaries, as long-term risk reduction is critical to reduce mortality risk and control Medicaid costs. Second, although participant age ranged greatly across the studies, from 18–75 years, the average age was 47 years, indicating that our findings may not generalize to particular cohorts of people with serious mental illness, such as older adults or young adults. Older adults with serious mental illness in particular are at greater risk of developing medical co-morbidity, resulting in excess medical hospitalizations, nursing home placement, and mortality[2–5]. This highlights an important area of future research focused on examining access to primary care within mental health services among adults with serious mental illness or potentially within other service settings. Third, because few studies met our inclusion criteria, we cannot reliably distinguish which health home intervention features contributed to positive changes in cardiometabolic risk factors. The current literature suggests that the design and components of health home vary considerably across programs. Additional research specifically examining the impact of components such as peer support and illness self-management training in health homes is needed. Finally, given the variability in the types of health homes currently available, future work comparing health homes with different organizational structures is warranted.

Conclusions

To our knowledge, this is the first systematic review of peer-reviewed studies of behavioral health homes designed for adults with SMI that examined service utilization, screening, and clinical outcomes. Earlier reviews did not examine changes in cardiometabolic risk factors[11], did not target people with SMI [9], and included non-peer-reviewed studies that lacked methodological rigor[7,10,11]. Our findings indicate that if health homes are to have a greater impact on clinical outcomes, several enhancements may be necessary. First, standardization of screening practices across health homes models may help providers to identify and address health problems using a population health approach. Second, targeting clinically significant thresholds for reduced cardiometabolic risk factors will help to provide benchmarks for clinical management and for comparing the effectiveness of different approaches. Third, the addition of self-management skill development and peer support may

improve clinical outcomes by improving critical health behaviors outside of the health home clinical encounter. Including self-management skill development and peer support as core components of health homes may especially advance impacts on cardiometabolic outcomes. Finally, morbidity and mortality are influenced by a myriad of interacting modifiable risk factors. Targeting multiple interdependent risk factors may produce better results than focusing on only one or two. However, this will require coordination between multiple provider systems and disciplines.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Health homes are associated with increased rates of cardiometabolic screening and service use.
- Improvement in cardiometabolic risk factors varied across the studies and the clinical significance of these reductions is not clear.
- Co-location of services may not be enough to significantly impact cardiometabolic risk factors.
- Health homes may have a greater impact on clinical outcomes if they include: standardized screening; peer support and self-management training; intervention components that target interdependent risk factors.

Table 1.

Behavioral health homes for people with serious mental illness

Study	Setting	Sample Demographics		Description of BHH Model	Comparison	Outcomes
Studies with a low level of bias (good quality)						
Breslau et al. 2018a (18) Observational/ secondary data analysis	OP	**Wave 1 N= 19,724** PBHCI group (N = 6712) **Age, mean (SD)** 43.41 (10.94) **Gender, N(%)** Male 2385 (35.5) **Race, N(%)** White 1965 (29.2) African-American 2272 (33.8) Latino 1733 (25.8) Asian 61 (0.91) Other 681 (10.1) **Mental health diagnosis** Serious mental illness 2197 (32.73%) **No IC group (N = 13,012)** **Age, mean (SD**) 43.28 (11.09) **Gender, N(%)** Male 4120 (31.6) **Race, N(%)** White 4241 (32.5) African-American 4214 (32.6) Latino 2725 (20.9) Asian 278 (2.1) Other 1554 (11.9) **Mental health diagnosis** Serious mental illness 3794 (29.16%)	**Wave 2 N= 13,395** **PBHCI group (N = 1881)** **Age, mean (SD**) 45.93 (10.91) **Gender, N(%)** Male 707 (37.59) **Race, N(%)** White 484 (25.73) African-American 664 (35.30) Latino 410 (21.80) Asian 26 (1.38) Other 297 (15.79) **Mental health diagnosis** Serious mental illness 895 (47.58%) **No IC group (N = 11,514)** **Age, mean (S D)** 44.81 (11.14) **Gender, N(%)** Male 3847 (33.4) **Race, N(%)** White 3637 (31.5) African-American 3888 (33.7) Latino 2357 (20.4) Asian 250 (2.1) Other 1382 (12.0) **Mental health diagnosis** Serious mental illness 3691 (32.06%)	Primary Behavioral Health Care Integration (PBHCI) program; implementation of the PBHCI program varied across the clinics	Propensity score matched persons with serious mental illness that were never enrolled in the intervention.	Hospital stays due to chronic health conditions increased significantly in the intervention group in comparison to the control group in both waves (OR = 1.21; wave 1; OR: 1.33, wave 2). Emergency room visits for behavioral health conditions decreased significantly in comparison to the control condition in wave 1 (OR = 0.89), but there was no change in wave 2. No additional significant differences in utilization in the intervention and control were identified.
Breslau et al., 2018b (19) Observational/ secondary data analysis	OP	Same as Breslau et al. 2018a	Same as Breslau et al. 2018a	Primary Behavioral Health Care Integration (PBHCI) program; implementation of the PBHCI program varied across the clinics	Propensity score matched persons with serious mental illness that were never enrolled in the intervention.	The PBHCI program showed statistically significant improvement low-density lipoprotein/cholesterol screening (OR=0.21, 95% confidence interval: 0.12–0.30, $p<.05$) for participants taking antipsychotics in one of the two research waves. [16] In wave 1, the PBHCI program showed statistically significant improvement in Glucose/ HbA1c screening (OR=0.22, 95% confidence interval: 0.12–0.33, $p<.05$), but these results were not replicated in the wave 2 sample.

Study	Setting	Sample Demographics		Description of BHH Model	Comparison	Outcomes
						HbA1c monitoring was not impacted in either wave.
Druss et al., 2001 (16) RCT	VA OP	**Total N=120** **Integrated Care n=59** **Age, mean (SD)** 45.7 (8.4) **Gender, N(%)** Male 59 (100) **Race, N(%)** White 45 (76.3) **Mental Health Diagnosis** Schizophrenia 13 (22.0); Post-traumatic Stress Disorder 19 (32.2); Major Affective Disorder 7 (11.9); Substance Use Disorder 15 (25.4); Other 5 (8.5); Severe Psychiatric Illness 47 (79.7)	**Usual Care n=61** **Age, mean (SD)** 44.8 (8.0) **Gender, N(%)** Male 60 (98.4) **Race, N (%)** White 39 (63.9) **Mental Health Diagnosis** Schizophrenia 12 (19.7); Post-traumatic Stress Disorder 16 (26.2); Major Affective Disorder 9 (14.8); Substance Use Disorder 18 (29.5); Other 6 (9.8); Severe Psychiatric Illness 44 (72.1)	Primary care services provided within a VA mental health clinic by a multidisciplinary team co-located within the VA mental health clinic. Team consisted of a full-time nurse practitioner and nurse case manager, and part-time family practitioner and administrative assistant. Staff provided education, preventive services, and communication and coordination between primary care and mental health providers.	Usual care; participants were provided referral to VA general medicine, located adjacent to the mental health clinic	Participants in the health home intervention group clinic were significantly more likely to have had a primary care visit and also had a greater average number of primary care visits compared to participants in usual care. Participants in the health home were significantly more to receive preventive healthcare.
Druss et al., 2010 (15) RCT	CMHC	**Total N=407 Case Management n=205** **Age mean (SD)** 47.0 (8.1) **Gender, N(%)** Male 302 (74.2) **Race, N(%)** African-American 156 (76.5) Latino 4 (2.0) **Mental Health Diagnosis** Schizophrenia/ Schizoaffective Disorder 75 (36.6); Bipolar Disorder 22 (10.7); Post-Traumatic Stress Disorder 11 (5.4; Depression 94 (45.9); Co-occurring Substance Use Disorder 50 (24.4%)	**Usual Care (Control) n=202** **Age mean (SD)** 46.3 (8.1) **Gender, N(%)** Male 110 (54.4) **Race, N(%)** African-American 159 (78.7) Latino 2 (1.0) **Mental Health Diagnosis** Schizophrenia/ Schizoaffective Disorder 69 (34.2); Bipolar Disorder 30 (14.9); Post-Traumatic Stress Disorder 9 (4.5) Depression 85 (42.1); Other 1 (0.5); Co-occurring Substance Use Disorder 53 (26.2%)	Registered nurse provided medical education, information on medical care providers, and information on appointments. Motivational interviewing was used to monitor their readiness to change, support self-management skills, coaching participants to interact more effectively with providers, and developing action plans to promote health behavior change. registered nurses also enrolled uninsured participants in entitlement programs and coordinated care between primary and mental health care providers.	Usual care; participants were provided with a list with contact information to contact local primary care medical clinics	At 12-month follow-up, the health home intervention group received 58.7% of recommended preventive services (i.e., physical examinations, screening tests, vaccinations, and education), compared to 21.8% in the usual care group (p<0.001). Specifically for screening, individuals in the health home intervention group had more than twice as many screening tests (50.4% vs. 21.6%, (F1,361=105.93, p<0.001). The health home intervention group had a higher likelihood of having a primary care provider (71.2% vs. 51.9%, p=0.003). Among participants with laboratory data (N=100), Framingham Cardiovascular Risk Scores were significantly better for intervention group (6.9%) compared to the control group (9.8%) (p=0.02).
Druss et al., 2017 (17) RCT	CMHC; FQHC	**Total N=447** **Behavioral Health Home n=224** **Age, mean (SD)** 47.26 (9.7) **Gender N(%)** Male 80 (36) **Race, N(%)** White 122 (54) African-American 95 (42) Other 7 (3)	**Usual Care n=223** **Age, mean (SD)** 47.12 (9.6) **Gender, N(%)** Male 81 (39) **Race, N(%)** White 129 (58) African-American 84 (38) Other 10 (4)	Clinic staff included a part-time nurse practitioner with prescribing authority and a full-time nurse care manager, both supervised by an FQHC medical director. A treat-to-target approach was used for the cardiometabolic risk factors, with weekly supervision meetings focusing on patients whose test results were not within normal	Usual care; participants provided with summary of findings from laboratory tests and were encouraged to make follow-up appointment with a medical provider.	Compared with usual care, primary care visits in the health home intervention group increased from a mean of 0.93 to a mean of 1.73 (0.65 to 0.86 in the usual care group). The group-by-time interaction was statistically significant (p<0.001). Compared with usual care, the health home intervention group was associated with significant

Study	Setting	Sample Demographics		Description of BHH Model	Comparison	Outcomes
		Mental Health Diagnosis Schizophrenia/ Schizoaffective Disorder 49 (22%); Bipolar Disorder 108 (48%); Depression 66 (29%); Anxiety 1 (0%)	**Mental Health Diagnosis** Schizophrenia/Schizoaffective Disorder 40 (18%); Bipolar Disorder 122 (55%); Depression 58 (26%); Anxiety 2 (1%); Substance Use 1 (0%)	range for blood pressure, glucose level, or cholesterol level. The care manager provided health education for lifestyle factors (e.g., smoking, diet) and logistical support to ensure that participants were able to attend their medical appointments. Both providers attended weekly rounds at the CMHC to facilitate integration with the mental health team.		improvements in use of preventive services (p<.001; Cohen's *d*=1.2, large effect). For most cardiometabolic outcomes, both groups demonstrated improvement, although there were no statistically significant differences between the two groups over time on diastolic blood pressure, total and LDL cholesterol levels, blood glucose level, HbA1c level, or on the Framingham risk score. There were modest statistically significant differential improvements in systolic blood pressure (improvements of 4.9 points and 3.1 points, respectively; *p*=0.04).
Kilbourne, et al., 2011a (20) Observational/ Cross-sectional	VA OP	**Total N=40,600** **Age, mean (SD)** 55 (11.6) **Gender, N(%)** Male (91) **Race, N(%)** African-American (26) **Mental Health Diagnosis** No report of specific serious mental illness diagnosis or physical health diagnosis	Detailed sample in non-co-located sites was not included in manuscript.	The health home intervention group co-located general medical care within the mental health clinic.	VA participants that did not receive care at a co-located facility	Participants in the health home intervention group were more likely to receive all cardiometabolic tests, including diabetes, blood pressure, BMI, and cholesterol screening (OR=1.26, 95% confidence interval: 1.18–1.35, *p*<.001).
Kilbourne, et al., 2011b (21) Observational/ Cross-sectional	VA OP	**Total N=7514** **Age, mean (SD)** Not reported **Gender, N(%)** Not reported **Race, N(%)** Not reported **Mental Health Diagnosis** Serious Mental Illness 7514 (100%)	Detailed sample in non-co-located sites was not included in manuscript.	The health home intervention group co-located general medical care within the mental health clinic.	VA participants that did not receive care at a co-located facility	Participants in the health home intervention group compared with those without colocation were more likely to receive foot exams (OR=1.87, *p*<.05), colorectal cancer screenings (OR=1.54, *p*<.01), and alcohol misuse screenings (OR=2.92, *p*<.01). They were also more likely to have their blood pressure controlled (<140/90 mmHg; OR=1.32, *p*<.05) but less likely to have glycosylated hemoglobin <9% (OR=.69, *p*<.05).
Krupski et al., 2016 (22) Observational/ Secondary data analysis	CMHC	**Clinic 1 N=746** **PBHCI N=373** **Age mean (SD)** 47.60 (11.12) **Gender, N(%)** Male 256 (68) **Race, N(%)** American Indian/Alaskan Native 6 (2) Asian 18 (5) African-American 137 (37) Hispanic 10 (3) Multiracial 9 (2) Native Hawaiian 1 (0) Other 5 (1)	**Clinic 2 N=778** **PBHCI N=389** **Age mean (SD)** 46.00 (10.18) **Gender, N(%)** Male 265 (68) **Race, N(%)** American Indian/Alaskan Native 9 (2) Asian 12 (3) African-American 110 (28) Hispanic 15 (4)	A primary care physician and nurse care managers were embedded within a community mental health center. Staff screening and referral services for prevention and treatment, care management, additional prevention and wellness services.	Propensity score matched persons with serious mental illness that were never enrolled in the intervention.	A higher proportion of participants in the health home intervention group engaged in outpatient medical services following program enrollment (*p*<.003, clinic 1; *p*<.001, clinic 2) compared to the control condition. Health home intervention group clinic 1 was associated with a decrease in the proportion of participants with an inpatient hospital admission (*p*=.04).

Study	Setting	Sample Demographics		Description of BHH Model	Comparison	Outcomes
		White 184 (49) **Mental health diagnosis** Serious mental illness (100%) **Comparison N=373** **Age mean (SD)** 47.55 (13.15) **Gender, N(%)** Male 270 (72) **Race, N(%)** American Indian/Alaskan Native 6 (2) Asian 20 (5) African-American 152 (41) Hispanic 7 (2) Multiracial 11 (3) Other 6 (2) White 168 (45) **Mental health diagnosis** Serious mental illness (100%)	Multiracial 6 (2) Native Hawaiian 1 (0) White 229 (59) **Mental health diagnosis** Serious mental illness (100%) **Comparison N=373** **Age mean (SD)** 47.00 (11.31) **Gender, N(%)** Male 261 (67) **Race, N(%)** American Indian/Alaskan Native 10 (3) Asian 10 (3) African-American 124 (32) Hispanic 22 (6) Multiracial 5 (1) White 208 (53) **Mental health diagnosis** Serious mental illness (100%)			
McGuire et al., 2009 (23) Observational/ Pre-post	VA OP	**N=260 Homeless Veterans** **Age, mean (SD)** 45.8 (7.0) **Gender, N(%)** Male 259 (99) **Race, N(%)** African American 130 (50) **Mental Health Diagnosis** Bipolar Disorder 20%; Depression 42% Post-Traumatic Stress Disorder 17%; Schizophrenia 13%; Substance abuse (drug) 48%; Alcohol Use Disorder 45%	Same as original sample	Participants were screened and referred to the health home intervention group (i.e., primary and mental health care services co-located within the VA Mental Health Outpatient Center) within the same day. Case managers provided short-term assistance for participants. Primary care providers included a primary care physician and three advance practice register nurses.	Pre-integration of primary care services within the VA Mental Health Outpatient Center; Medical center was .5 miles from mental health facility and the wait for appointments was approximately two months	The health home intervention group had fewer days to primary care enrollment (.3 mean days +/−1.8 compared to 53.2 mean days+/−1.7), received significantly more prevention services including tobacco use screening, depression screening, colorectal cancer screening, breast cancer screening, alcohol abuse screening (.57 +/− .1 compared to .44 s+/−.1)and primary care significantly more visits (2.3 more visits over 18-months of follow-up), and significantly fewer emergency department visits compared to the demonstration group (control) (4.3 mean days +/− 7 compared to 5.0 mean days+/−6).
O'Toole et al., 2011 (24) Quasi-experimental	VA PCMH	**Total N=457** **Age, mean, (SD)** Not reported; Adults aged 65 year + = 167 (36.5%) **Gender, N(%)** Male 312 (68.2) **Race, N(%)** Not reported **Mental Health Diagnosis** Serious Mental Illness 74 (16.1%)	Same as original sample	The traditional patient-centered medical home model with the addition of special clinic team to manage participants with serious mental illness. Clinic team tailored access and care to address population-specific needs, and provided intensive RN and social work case management with small case loads. Staff were also trained on specific cultural competencies.	Pre-implementation of the patient-centered medical home	For participants with serious mental illness, primary care visits increased from 64.9% (1.30 visits) to 82.4% (3.04 visits) from pre-implementation of the patient-centered medical home to full implementation of the patient-centered medical home. Average length of hospital stay decreased from 8.75 days to 6.0 days. However, there was also an increase

Study	Setting	Sample Demographics		Description of BHH Model	Comparison	Outcomes
						in emergency department use among people with SMI (p<.05).
Teppers et al., 2018 (25) Quasi-experimental/ Secondary data analysis	CMHC	**Behavioral Health Home N=424** **Age, mean** 48 **Gender, N(%)** Male 224 (53) **Race, N(%)** White (64) African-American (22) Hispanic (2) Asian (2) **Mental health condition** Psychotic disorder 87%; Bipolar disorder 13%	**Control N=1,521** **Age, mean** 50 **Gend er, N(%)** Male 745 (49) **Race, N(%)** White (59) African-American (18) Hispanic (8) Asian (2) **Mental health condition** Bipolar Disorder 37%	Health home services included on-site medical care and chronic disease screening, health promotion, support for care coordination and transitions, and opportunities for peers to engage with one another such as social functions and educational workshops. Electronic health records included alerts for patient transitions through emergency departments or inpatient units, and provided a registry for monitoring patients' health status and service delivery, and discharge.	Usual care included an psychopharmacology and individual or group psychotherapy, use of primary care or specialty services. Electronic health records offered modest information to track health care utilization.	Psychiatric hospitalizations declined for health home participants (.22 to . 10) and remained stable for participants in the control group (. 145 and .147) (p=.002 between groups); no differences in medical hospitalizations. Health home participants were more likely to receive HbA1c screening; however, there were no differences between groups in lipid monitoring. No significant differences in metabolic monitoring among participants with diabetes.
Studies with a medium level of bias (medium quality)						
Boardman et al. 2006 (26) Quasi-experimental	OP	**Total N=76** **Experimental Group n=39** **Age, mean, (SD)** Not reported **Age range** 20–69 years **Gender, N(%)** Male 14 (37) **Race, N(%)** Not reported **Mental Health Diagnosis** Serious mental illness (100%)	**Usual Care (control) n=37** **Age, mean, (SD)** Not reported **Age range** 20–69 years **Gender, N(%)** Male 9 (25) **Race, N (%)** Not reported **Mental Health Diagnosis** Serious mental illness (100%)	Primary care was co-located within a mental health outpatient clinic. Primary health care was provided by a nurse practitioner including a physical examination, laboratory tests, referral for additional tests, and on-going follow-up. Mental health and substance abuse counseling, psychopharmacology, and case management were also provided on-site. The nurse practitioner communicated with other care providers	Usual care	The health home intervention group reported a 42% lower number of emergency department visits, routine medical care increased by 50%, 70% greater incidence of physical examinations, and notable increases in healthcare screens (i.e., diabetes, hypertension) compared to the usual care group.
Scharf et al., 2016 (28) Quasi-experimental	CMHC; FQHC	**Total N=791** **Primary and Behavioral Health Integration Clinics n=322** **Age, mean (SD)** 42 (12) **Gender, N(%)** Male 601 (75.9) **Race, N(%)** White 231 (71) African-American 51 (16) Latino 15 (5) Other 25 (8) **Mental Health Diagnosis** Anxiety 33 (10%); Bipolar Disorder 79 (25%); Schizophrenia 91 (28%); Major Depressive Disorder 85 (26%)	**Control n=469** **Age, mean (SD)** 45 (12) **Gender, N(%)** Male 162 (34.5) **Race, N (%)** White 393 (84) African-American 21 (4) Latino 17 (4) Other 38 (8) **Mental Health Diagnosis** Anxiety 54 (12%); Bipolar Disorder 97 (21%); Schizophrenia 120 (26%); Major Depressive Disorder 143 (30%)	Primary and Behavioral Health Integration Clinic include (1) screening and referral for general medical illness prevention and treatment, (2) registry and tracking system for general medical needs and outcomes, (3) care management, and (4) prevention and wellness support.	Usual care	Participants in the intervention group had better outcomes for cholesterol: mean reductions in total cholesterol was greater by 36 mg/dL (p<.01), mean reductions in low-density lipoprotein cholesterol was greater by 35 mg/dL (p<.001), and mean increases in high-density lipoprotein cholesterol was greater by 3 mg/dL (p<.05).
Tatreau et al., 2016 (29)	IP	**Integrated care group=N=220**	**TAU=N=232**	A locked inpatient unit included an embedded medical team. The team	A locked inpatient unit that provided treatment as	Significantly more physical health screenings were ordered in the

Study	Setting	Sample Demographics		Description of BHH Model	Comparison	Outcomes
Obervational / cross sectional		**Age, mean (SD)** 36.1 (14.3) **Gender, N(%)** Male=146 (66) **Race, N(%)** White 93 (42) Black 109 (50) Asian 2 (1) Other 16 (7) Hispanic 6 (3) **Mental Health Diagnosis** Schizophrenia spectrum disorder 144 (65%); Bipolar disorder 69 (31%); Depression 35 (16%); Autism 11 (5%)	**Age, mean (SD)** 38.8 (14.5) **Gender, N(%)** Male 150 (65) **Race, N (%)** White 141 (61) Black 67 (29) Asian 1 (.4) Other 23 (10) Hispanic 6 (3) **Mental Health Diagnosis** Schizophrenia spectrum disorder 187 (81%); Bipolar disorder 101 (44%); Depression 58 (25%); Autism 2 (1%)	included a physician's assistant supervised by a physician.	usual medical care. In this model medical care is provided by resident psychiatrists supervised by attending psychiatrist. A hospitalists is available as needed for consultation regarding medical issues.	control group (i.e., hemoglobin A1c tests, 56% vs. 16%, p <.001, glucose, 99% vs. 66%, p < .001, and lipids, 61% vs. 20%, p < .001) compared to the health home intervention group.
Pirraglia et al., 2012 (30) Obervational / Pre-post	VA, OP	**Total N=97 Veterans** **Age, mean, (SD)** 55.3, 10 **Gender, N(%)** Male 92 (95) **Race, N(%)** White 83 (86) **Mental Health Diagnosis** Schizophrenia 23 (24%); Schizoaffective Disorder 24 (25%); Psychosis, not otherwise specified 4 (4%); Bipolar Disorder 14 (14%); Major Depressive Disorder 36 (37%); Alcohol Abuse/ Dependence 41 (42%); Substance Abuse/Dependence 28 (29%)	Same as original sample	A primary care clinic staffed by one primary care physician and patient care assistant, co-located and integrated in the VA mental health outpatient program. The integrated clinic uses open-access scheduling and primary care visits are scheduled to co-occur with mental health care visits.	1 year pre-enrollment in the integrated clinic	Compared to the control group participants in the health home intervention group had significantly improved goal attainment for blood pressure, low-density lipoprotein cholesterol, triglycerides and body mass index; there was not statistically significant changes for high-density lipoprotein cholesterol or HbA1c.
Putz et al., 2015 (31) Obervational / Pre-post	CMHC	**Total N=169** **Age, mean (SD**) 46.3 (12.04) **Gender, N(%)** Male 61 (36) **Race, N(%)** White 154 (91.1) African-American 11 (6.5) American Indian 4 (2.4) **Mental Health Diagnosis** Primary psychotic disorder (42%) Primary mood/anxiety disorder (41.4%) Borderline personality disorder/ADHD/intermittet explosive disorder/other (10.7%)	Same as original sample	Participants were referred by their mental health provider to this collaborative care program that included a clinical social worker, physician specializing in metabolic diseases, a family nurse practitioner, two nurse care managers, a peer support specialist, a part-time wellness coach, and an office assistant. Participants received a physical health assessment, was assigned a medical case manager, and was offered enrollment in wellness programs (e.g., diabetes support, weight-loss support, tobacco cessation, physical activity instruction, stress management, medical self-management, and/or peer support.	The control condition was a baseline measurement of study participants.	At six-month follow-up, significant decreases were found in the following risk factors in the health home intervention group: (1) weight among participants whom were overweight and obese at baseline (t(92) = 4.189, p < .001); (2) HDL and low-density lipoprotein cholesterol among at-risk for participants with cardiovascular disease (t(37) = −2.58, p=0.016); (3) cigarette use among baseline cigarette smokers (t (37) = 2.648, p=0.012); and (4) systolic blood pressure decreased at six-months: t(7) D 4.997, p< 0.002 and diastolic blood pressure decreased at six-months: t(15) D 3.96, p <0.001.

Study	Setting	Sample Demographics		Description of BHH Model	Comparison	Outcomes
Snyder et al., 2008 (27) Obervational / ecological	VA PC	**Total *N*=46** **Psychiatry Primary Medical Care *n*=23** **Age, mean (SD)** 52.2 (7.5) **Gender, N(%)** Male 46 (100) **Race, N(%)** Not reported **Mental Health Diagnosis** Bipolar Disorder 12 (52.2%); Schizophrenia 9 (39.1%); Schizoaffective Disorder 1 (4.3%); Delusional Disorder 1 (4.3%)	**Usual Care (control) *n*=23** **Age, mean (SD)** 51.8 (8.5) **Gender**, **N(%)** Male 23 (100) **Race, N(%)** Not reported **Mental Health Diagnosis** Bipolar Disorder 12 (52.2%); Schizophrenia 8 (34.8%); Schizoaffective Disorder 3 (13%)	Medical school residents provide primary and psychiatric care for participants within a VA medical center	Usual care defined as treatment in the VA Mental Health Clinics and primary care treatment in a general medical ambulatory clinic by staff or trainees	There was no difference between the health home intervention group and control group on preventative health screenings, emergency department visits or inpatient psychiatry.
Studies with a high level of bias studies (poor quality)						
Gilmer et al. 2016 (32) Obervational / ecological	Model 1: Mobile health teams; Model 2: CMHC; FQHC	**Total N= 1941** **Low integration homes: n=649** **Age, mean, (SD)** Not reported **Gender** Not reported **Race, N(%)** Not reported **Mental Health Diagnosis** Serious mental illness 649 (100%)	**High integration homes: n=1292** **Age, mean, (SD)** Not reported **Gender** Not reported **Race, N(%)** Not reported **Mental Health Diagnosis** Serious mental illness 100% (1292)	Model 1: Integrated mobile health teams paired supportive housing with an Assertive Community Treatment model for mental health care and federally qualified health centers for general medical care, provided by mobile team; Model 2: Integrated clinics paired community mental health centers with federally qualified health centers	Models were compared based on level of integration	Highly integrated programs were associated with greater improvement in screening rates for blood pressure, cholesterol, blood glucose and reduced risk of hypertension, high-risk cholesterol, and prediabetes/ diabetes compared to less integrated programs. In the highly integrated group, there was a significant reduction in hypertension yet an increase in prediabetes or diabetes (p=.01).

Note: Community mental health center=CMHC; Federally Qualified Health Center=FQHC; Primary care=PC; Veterans Administration=VA; Mental health outpatient=OP; Patient-Centered Medical Home=PCMH; Inpatient psychiatric unit=IP; Randomized control trial= RCT

Table 2.

Impact of behavioral health homes on service utilization

Study	Service Utilization					
Studies with a low level of bias (good quality)						
	ER Visits	**PC Visits**	**Hospital Stays**	**Psychiatric Hospital Stays**	**Medical Hospital Stay**	**Inpatient Psychiatry**	**OP Medical Services**
Breslau et al. 2018a (18)	*(+/−) R		*(−) R				
Breslau et al., 2018b (19)							
Druss et al., 2001 VA (16)		* R					
Druss et al., 2010 (15)							
Druss et al., 2017 (17)		* R					
Kilbourne et al., 2011a VA (20)							
Kilbourne et al., 2011b VA (21)							
Krupski et al., 2016 (22)			* R				* R
McGuire et al., 2009 VA (23)	* R	* R					
O'Toole et al., 2011 VA (24)	*(−) R						
Teppers et al., 2018 (25)				* R	(o/o) R		
Studies with a medium level of bias (medium quality)						
Boardman et al. 2006 (26)	R	R					
Scharf et al., 2016 (28)							
Tatreau et al., 2016 (29)							
Pirraglia et al., 2012 VA (30)							
Putz et al., 2015 (31)							
Snyder et al., 2008 VA (27)	(−/−) R					(−/−) R	
Studies with a high level of bias studies (poor quality)						
Gilmer et al. 2016 (33)							

Note: The "R" indicates a study reported on the selected outcome.

* represents statistically significant results

"(−)' represents a negative finding; "(+/−)" represents the effect was not replicated in a second sample; and "(−/−)" represents there was improvement but no difference compared to the control; "(o/o)" represents no improvement in either group; ER=Emergency Room; PC=Primary Care; OP=Outpatient

Table 3.

Impact of behavioral health homes on screening for cardiometabolic risk

Study	Screening for Cardiometabolic Risk Factors									
Studies with a low level of bias (good quality)										
	Preventative Services [a]	**Diabetes (HbA1c, glucose, foot exam)**	**BP**	**BMI**	**Cholesterol**	**Colorectal Cancer**	**Alcohol Misuse**	**Depression**	**Tobacco Use**	**Physical Exams**
Breslau et al. 2018a (18)										
Breslau et al., 2018b (19)		**(o/o) R**	*(+/−) **R**		*(+/−) **R**					
Druss et al., 2001 VA (16)	* **R**									
Druss et al., 2010 (15)	* **R**									
Druss et al., 2017 (17)	* **R**		* **R**							
Kilbourne et al., 2011a VA (20)		* **R**	* **R**	* **R**	* **R**					
Kilbourne et al., 2011b VA (21)		* **R**				* **R**	* **R**			
Krupski et al., 2016 (22)										
McGuire et al., 2009 VA (23)						* **R**	* **R**	* **R**	* **R**	
O'Toole et al., 2011 (24) VA										
Teppers et al., 2018 (25)		**R**			**(−/−) R**					
Studies with a medium level of bias (medium quality)										
Boardman et al. 2006 (26)		**R**	**R**							**R**
Scharf et al., 2016 (28)										
Tatreau et al., 2016 (29)		*(−) **R**			*(−) **R**					

Study	Screening for Cardiometabolic Risk Factors																			
Studies with a low level of bias (good quality)																				
	Preventative Services [a]		**Diabetes (HbA1c, glucose, foot exam)**		**BP**		**BMI**		**Cholesterol**		**Colorectal Cancer**		**Alcohol Misuse**		**Depression**		**Tobacco Use**		**Physical Exams**
Pirraglia et al., 2012 (30) VA																				
Putz et al., 2015 (31)																				
Snyder et al., 2008 (27) VA	**(−/−) R**																			
Studies with a high level of bias studies (poor quality)																				
Gilmer et al. 2016 (33)			**R**		**R**				**R**											

Note: The “R” indicates that a study reported on the selected outcome.

* statistically significant results

(−), negative finding; (+/−), effect not replicated in a second sample; (−/−), improvement, but no difference compared with the control; (o/o), no improvement in either group. BP, blood pressure; BMI, body mass index; VA, U.S. Department of Veterans Affairs.

Table 4.

Impact of behavioral health homes on cardiometabolic risk factors

Study	Cardiometabolic Risk Factor Outcomes																							
Studies with a low level of bias (good quality)																								
	BP control		**Diastolic BP**		**Systolic BP**		**Heart Disease Risk**		**TC**		**HDL**		**LDL**		**Cigarette Use**		**BMI/ Weight**		**Hypertension**		**HbA1c**		**Blood Glucose**		**Triglyceride**
Breslau et al., 2018a (18)																								
Breslau et al., 2018b (19)																								
Druss et al., 2001 VA (16)																								
Druss et al., 2010 (15)							* **R**																	
Druss et al., 2017 (17)			(−/−) **R**		* **R**		(−/−) **R**		(−/−) **R**				(−/−) **R**								(−/−) **R**		(−/−) **R**		
Kilbourne et al., 2011a VA (20)																								
Kilbourne et al., 2011b VA (21)	* **R**																				*(−) **R**				
Krupski et al., 2016 (22)																								
McGuire et al., 2009 (23) VA																								
O'Toole et al., 2011 (24) VA																								
Teppers et al., 2018 (25)																								

Study	Cardiometabolic Risk Factor Outcomes																					
Studies with a low level of bias (good quality)																						
	BP control		**Diastolic BP**		**Systolic BP**		**Heart Disease Risk**		**TC**		**HDL**		**LDL**		**Cigarette Use**		**BMI/ Weight**		**Hypertension**		**HbA1c**		**Blood Glucose**		**Triglyceride**
Studies with a medium level of bias (medium quality)																						
Boardman et al., 2006 (26)																						
Scharf et al., 2016 (28)									* **R**		* **R**		* **R**									
Tatreau et al., 2016 (29)																						
Pirraglia et al., 2012 (30) **VA**	* **R**										(−/−) **R**		* **R**				* **R**				(−/−) **R**				* **R**
Putz et al., 2015 (31)			* **R**		* **R**						* **R**		* **R**		* **R**		* **R**								
Snyder et al., 2008 (27) **VA**																						
Studies with a high level of bias studies (poor quality)																						
Gilmer et al. 2016 (33)																			* **R**				*(−) **R**		

Note: The “R” indicates a study reported on the selected outcome.

* represents statistically significant results

“(−)” represents a negative finding; “(+/−)” represents the effect was not replicated in a second sample; and “(−/−)” represents there was improvement but no difference compared to the control; “(o/o)” represents no improvement in either group; ER=Emergency Room; PC=Primary Care; OP=Outpatient; BP=Blood Pressure; TC=Total Cholesterol; HDL= High-density Lipoprotein; LDL= Low-density Lipoprotein