Lifestyle Factors and Depressive Symptoms Among Permanent Supportive Housing Residents

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LIST OF ABBREVIATIONS

BA- Behavioral Activation

BIC- Bayesian Information Criterion

CBT- Cognitive-Behavioral Therapy

DALYs- Disability Adjusted Life Years

FPL- Federal Poverty Level

IPT- Interpersonal Therapy

MDD- Major Depressive Disorder

MDE- Major Depressive Episode

m.chat- Mobile Community Health Assistance for Tenants

NIH- National Institutes of Health

NIMH- National Institute of Mental Health

PHQ-9- Patient Health Questionnaire

PSH- Permanent Supportive Housing

PST- Problem-Solving Therapy

RCTs- Randomized Controlled Trials

TLFB- Timeline Follow-Back

SMD- Standardized Mean Difference

USDHHS- U.S. Department of Health and Human Services

WHO- World Health Organization

YLDs- Years Lived with Disabilities

YLLs- Years of Life Lost

CHAPTER ONE

Introduction

In the United States, 549,928 individuals experienced homelessness on a single night in 2016, and about one fifth of individuals experiencing homelessness, or 77,486 people, experienced chronic patterns of homelessness (Henry, Watt, Rosenthal, Shivji, & Associates, 2016). Chronically homeless individuals are people with a disability who have been continuously homeless for at least one year or who experienced at least four episodes of homelessness with a combined time of 12 months of homelessness in the past three years (Henry et al., 2016). Individuals with a history of adult homelessness are more likely to have poor health outcomes compared with individuals without a history of adult homelessness (Oppenheimer, Nurius, & Green, 2016). Permanent supportive housing (PSH) is an approach to address chronic homelessness (Henry et al., 2016; Kertesz, Baggett, O'Connell, Buck, & Kushel, 2016) by providing housing and supportive services to formerly homeless individuals (Henry et al., 2016). In addition, the housing and supportive services that PSH provides addresses social determinants of health, which may improve health outcomes, thus reducing health disparities (Henwood, Cabassa, Craig, & Padgett, 2013).

Depression is prevalent among individuals entering PSH (Henwood, Lahey, Rhoades, Winetrobe, & Wenzel, 2018) and has a significant influence on health and quality of life (Mokdad et al., 2018). In a recent study, over half (53.7%) of PSH residents had depression near entry into housing, and it was the most common mental health condition reported (Henwood et al., 2018). This prevalence rate is more than three times the prevalence of depression among families living below the Federal Poverty Level (FPL) (15.8%) and nearly seven times greater

than the prevalence of depression among the general population (8.1%) (Brody, Pratt, & Hughes, 2018). Depression is associated with increased morbidity, mortality (Lepine & Briley, 2011; Mokdad et al., 2018), and healthcare utilization (Egede, 2007), negatively affects employment (Banerjee, Chatterji, & Lahiri, 2017; Lepine & Briley, 2011), and reduces compliance with health care treatment (DiMatteo, Lepper, & Croghan, 2000). In addition, other chronic health conditions are prevalent among individuals entering PSH, including hypertension, diabetes, and chronic obstructive pulmonary disease (Henwood et al., 2018). When individuals with depression experience co-morbidities, functional disability, health care utilization (Egede, 2007), and the economic burden of depression increases (Greenberg, Fournier, Sisitsky, Pike, & Kessler, 2015). These factors underscore the need to reduce the prevalence of depression among PSH residents to improve their overall health and quality of life.

A clinical diagnosis for Major Depressive Disorder (MDD) is based on the presence and severity of nine depressive symptoms, length of time these symptoms are experienced, and the etiology of the condition (American Psychiatric Association [APA], 2013). Reducing and preventing the development of depressive symptoms is key to reducing the prevalence of depression among PSH residents. Therefore, identifying modifiable lifestyle factors that contribute to depressive symptoms can elucidate a method for early intervention, prevention, and treatment for depression. Many lifestyle behaviors appear to be risk factors for depressive symptoms, including diet quality, physical inactivity, alcohol use, and tobacco use (Berk, Sarris, Coulson, & Jacka, 2013; Sarris, O'Neil, Coulson, Schweitzer, & Berk, 2014).

Beyond these behaviors, individuals' thoughts, beliefs, and their social environment can affect depressive symptoms (Greenberger & Padesky, 2016). Cognitive-behavioral therapy (CBT) is based on the assumption that thoughts, beliefs, behaviors, moods, physical reactions,

the environment, and life events are interconnected and affect each other (Greenberger & Padesky, 2016). Behavioral activation (BA) is a treatment approach that is incorporated in CBT and emphasizes activity scheduling to increase participation in activities that are perceived as enjoyable and personally fulfilling (Martell, Dimidjian, & Herman-Dunn, 2013). Activity scheduling is an effective approach to reduce depressive symptoms (Cuijpers, van Straten, & Warmerdam, 2007). In addition, according to Urie Bronfenbrenner's Bioecological Systems Theory, lifestyle behaviors and health outcomes are affected by the multiple systems that interact, involving the interaction of individual biological, psychological, cognitive, and genetic factors with sociocultural factors (Bronfenbrenner, 1979). Therefore, the influence of lifestyle factors on depressive symptoms should be analyzed within the context of individuals' perception of social support and satisfaction with leisure activities.

Previous studies have evaluated the effect of lifestyle behaviors on depressive symptoms, but many limitations complicate the ability to translate findings to PSH residents. For example, inconsistent results and methods between studies complicate the ability to draw firm conclusions. In addition, very few studies assessed the effect of lifestyle factors on depressive symptoms among PSH residents, so the effect of lifestyle behaviors on depressive symptoms in this population is unclear. Furthermore, it is not clear if the effect of lifestyle behaviors on depressive symptoms depends on the level of perceived social support. Finally, it is not clear if PSH residents with moderate to severe depressive symptoms would be interested in working on lifestyle factors.

Significance of the Study

Psychotherapy and medication for depression tend to focus on treatment rather than prevention and are typically implemented at the individual rather than the population level,

limiting the capacity of these approaches to reduce the prevalence of depression. In addition, treatment from psychotherapy alone may only be effective for individuals with mild to moderate depression (U.S. Department of Health and Human Services [USDHHS], National Institutes of Health [NIH], & National Institute of Mental Health [NIMH], 2015), and antidepressant medication may only be effective for individuals with very severe depression (Fournier et al., 2010). Furthermore, the effectiveness of psychotherapy and medication in reducing the prevalence of depression is limited by factors that reduce access to and utilization of these mental health services. Prominent factors that reduce access to mental health services among low-income populations include cost of care and insurance coverage (Goodman, Pugach, Skolnik, & Smith, 2013; Rowan, McAlpine, & Blewett, 2013). Additional factors that reduce the effectiveness of psychotherapy and medication for depression include noncompliance with medication use (Sansone & Sansone, 2012) and a variety of psychological and sociocultural factors that reduce people's willingness to utilize psychotherapy among low-income populations (Goodman et al., 2013; Goodman, Geiger, & Wolf, 2016; Hodgkinson, Godoy, Beers, & Lewin, 2017; Levy & O'Hara, 2010). Therefore, effective strategies are needed to create efficacious interventions and expand coverage of health care for depression.

There are many benefits to implementing lifestyle interventions to reduce the prevalence of depression. For example, lifestyle factors can be influenced as a preventive and treatment strategy by population and individual level interventions to reduce the prevalence of depression. As an individual level treatment approach, a lifestyle intervention could be implemented in combination with psychotherapy or medication to enhance the effect of these approaches on depressive symptoms or as an alternative treatment method (Berk et al., 2013; Jacka, Mykletun, & Berk, 2012). As a population level preventive and treatment approach to reduce depressive

symptoms, lifestyle behaviors could be influenced by multiple levels of influence to enhance the effect of lifestyle interventions on depressive symptoms. Levels of influence that affect lifestyle behaviors includes the intrapersonal, interpersonal, organizational, community, physical environment, and public policy levels (Sallis, Owen, & Fisher, 2008). In addition, lifestyle interventions can reduce the prevalence of multiple chronic diseases (World Health Organization [WHO], 2014), so participating in a lifestyle intervention could be encouraged for multiple reasons. This could reduce the stigma of receiving treatment for depressive symptoms and provide an alternative option for treatment for those without access to psychotherapy or antidepressant medication. Finally, modifying lifestyle factors may be more affordable than psychotherapy and antidepressant medication for individuals with depressive symptoms; individuals can modify many lifestyle factors with little to no monetary expenses (Sarris et al., 2014).

Evidence from previous studies suggests that changes in lifestyle behaviors can prevent and treat depression (Berk et al., 2013; Jacka et al., 2012; Josefsson et al., 2014; Knapen, Vancampfort, Morien, & Marchal, 2015). Meta-analyses reviewing physical activity interventions indicate that an increase in physical activity can prevent and reduce depressive symptoms (Josefsson et al., 2014; Knapen et al., 2015; Rebar et al., 2015). Analyses of dietary patterns are less consistent, but many studies indicate that dietary interventions and consumption of nutritious foods can prevent and reduce depressive symptoms (Lai et al., 2014; Opie, O'Neil, Itsiopoulos, & Jacka, 2015). Tobacco and alcohol use are additional lifestyle behaviors that may contribute to the development of depressive symptoms (Berk et al., 2013; Esmaeelzadeh et al., 2018; Sarris et al., 2014).

There are many limitations among previous studies that evaluated the relationship between lifestyle factors and depressive symptoms. First, findings from previous studies that evaluated the effect of lifestyle factors on depressive symptoms among the general population or other sub-populations, including those with few co-morbid conditions and without a history of homelessness, may not be generalizable to PSH residents. This population has a history of homelessness and tends to have multiple comorbidities, differentiating them from the general population. Second, inconsistent results among high quality studies make it difficult to draw firm conclusions regarding the effect of lifestyle factors on depressive symptoms. Third, the methodology varied significantly between studies, making it difficult to translate the findings into practice.

In addition, the effect of lifestyle behaviors on depressive symptoms may be confounded by factors not measured in previous studies. For instance, there is strong evidence that social support is associated with depressive symptoms (Gariépy, Honkaniemi, & Quesnel-Vallee, 2016). Therefore, social support may confound the effect of lifestyle factors on depressive symptoms. Additionally, health coaches and mental health professionals are among many sources of social support having a direct influence on depressive symptoms within interventions (Holmes, Yang, Aryal, Walters, 2018). However, social support was rarely included as a covariate in observational studies, and this factor may have differed between the control and treatment groups in randomized controlled trials (RCTs) in previous studies that evaluated the effect of lifestyle behaviors on depressive symptoms. Furthermore, BA includes participating in enjoyable and personally fulfilling activities and is an effective treatment approach to reduce depressive symptoms (Cuijpers, van Straten, & Warmerdam, 2007). Because leisure activities often coincide with lifestyle behaviors, the perception of leisure activities as satisfying activities

may confound the effect of lifestyle behaviors on depressive symptoms. Including satisfaction with leisure activities and perceived social support as potential confounding variables will provide more insight on the influence of lifestyle behaviors on depressive symptoms.

Furthermore, it is possible that the effect of lifestyle behaviors on depressive symptoms depends on perceptions of social support. According to Urie Bronfenbrenner's Bioecological Systems Theory, behavior can be explained by an interaction of the individual and many additional systems surrounding the individual, including relationships, the social system, culture, and resources within the community (Bronfenbrenner, 1979). Furthermore, sociocultural factors can interact with individuals' behaviors and biological processes (Bronfenbrenner, 1979). For example, people with a high level of perceived social support may have a more conducive environment to reduce depressive symptoms. Therefore, the influence of healthy lifestyle behaviors on depressive symptoms may be more pronounced, and the influence of health risk behaviors may be mitigated among individuals with a high level of perceived social support. Alternatively, the influence of healthy lifestyle behaviors on depressive symptoms may be mitigated, and the influence of health risk behaviors may be more pronounced among individuals with lower levels of perceived social support. Therefore, including social support as a modifying variable will provide more insight on the influence of lifestyle factors on depressive symptoms.

Finally, previous studies did not compare the interest in changing lifestyle factors between individuals with different severity levels of depression. Because depression often includes a loss of interest in activities and a depressed mood (APA, 2013), people with more depressive symptoms may have more negative evaluations of a behavior and their ability to overcome barriers to change behaviors. According to the Theory of Planned Behavior, these factors affect people's intention to change a behavior (Montano & Kasprzyk, 2008). Therefore,

intention to change a behavior may differ among PSH residents with different severity levels of depression. In addition, there are multiple stages of change that people progress through prior to taking action (Prochaska, Colleen, & Kerry, 2008). Expressing interest in changing a behavior in the next month indicates that an individual is in the preparation stage of change (Prochaska et al., 2008). Participants in the preparation stage of change are often recruited for action-oriented individual-level interventions because they are interested in changing behaviors in the near future (Prochaska et al., 2008). On the other hand, people who do not intend to change a lifestyle factor are likely in the precontemplation or contemplation stages of change and do not intend to act in the next month. Strategies to help participants progress toward action differ based on their current stage of change (Prochaska et al., 2008). Therefore, knowing the lifestyle factors chosen to change at the first coaching visit among PSH residents with different severity levels of depression will be useful to inform the strategies to implement in future interventions designed to reduce the prevalence of depression among this population.

In sum, depression is prevalent among PSH residents (Brody et al., 2018) and has a significant influence on health and quality of life (Egede, 2007; Lepine & Briley, 2011; Mokdad et al., 2018). Psychotherapy and medication are limited in their ability to reduce the prevalence of depression because these approaches tend to focus on treatment rather than prevention, are typically implemented at the individual rather than the population level, and have many barriers that reduce the effectiveness and access to these approaches (Goodman et al., 2013; Levy & O'Hara, 2010; Sansone & Sansone, 2012; Srimongkon, Aslani, & Chen, 2018). Lifestyle modification is being considered as a preventive and treatment approach to reduce the prevalence of depression (Berk et al., 2013; Jacka et al., 2012). However, many limitations reduce the ability to determine if lifestyle changes influence depressive symptoms among PSH residents and their

interest in setting goals to change lifestyle factors. The results of this study will determine the influence of four lifestyle behaviors (i.e., vegetable/fruit intake, physical activity, tobacco use, and alcohol use) on depressive symptoms among PSH residents within the context of perceived social support and satisfaction with leisure activities. In addition, the results of this study will determine the lifestyle factors that PSH residents with different severity levels of depression were intending to change within the next month at their first coaching visit. This will provide meaningful evidence to apply in the development of future lifestyle interventions to reduce depressive symptoms among PSH residents.

Problem Statement

There are three aims of this study. First, the purpose of this study is to determine if four lifestyle behaviors (i.e., vegetable/fruit intake, physical activity, tobacco use, and alcohol use) predict depressive symptoms within the context of perceived social support and satisfaction with leisure activities. Second, the purpose is to include perceived social support as a modifying variable to determine if the effect of lifestyle factors on depressive symptoms depends on the level of perceived social support. Third, the purpose is to determine the initial lifestyle domains (i.e., diet, exercise, substance use, social support, and recreation/leisure) activated among PSH residents with different baseline severity levels of depressive symptoms. This information will be useful to apply in the development of future interventions designed to reduce depressive symptoms among PSH residents.

CHAPTER TWO

Literature Review

Burden of Depression

The WHO and Healthy People 2020 recognize depression as a high-priority public health issue and emphasize population-based approaches to reduce the prevalence of depression (USDHHS & Office of Disease Prevention and Health Promotion [ODPHP], 2019b; WHO, 2019). A population's overall health is measured by disability-adjusted life years (DALYs), which reflects the number of years lost due to poor health (Murray et al., 2012). Data from the Global Burden of Disease Study 2016 captured the number of DALYs attributed to non-communicable diseases (NCDs), communicable diseases, and injuries (Mokdad et al., 2018). DALYs are a combined total of years of life lost (YLLs) and years lived with disability (YLDs) (Murray et al., 2012). In 2016, 80.6% of global YLDs were attributed to NCDs with the greatest amount (18.7%) of YLDs attributed to mental and substance use disorders (Vos et al., 2017). Among mental and substance use disorders, the greatest proportion of global YLDs (29.4%) were attributed to depressive disorders. In addition, the majority (77.1%) of global YLDs from depressive disorders were attributed to MDD, which was greater than any other disorder in this category (Vos et al., 2017). In the United States, there was a 16.7% increase in DALYs and 27% increase in YLDs attributed to MDD between 1990 and 2016 (Mokdad et al., 2018). In 2016, MDD ranked as the 9th leading cause of DALYs and the 2nd leading cause of YLDs out of 333 causes evaluated (Hay et al., 2017; Mokdad et al., 2018; Vos et al., 2017).

Furthermore, MDD results in substantial economic costs (Greenberg, Fournier, Sisitsky, Pike, & Kessler, 2015). Between 2005 and 2010, the economic burden of MDD in the United

States increased from $173.2 billion to $210.5 billion (Greenberg et al., 2015). The economic burden of depression captures excess costs from major depression and comorbid conditions among individuals with MDD compared with individuals without MDD (Greenberg et al., 2015). In 2010, the majority (62%) of total costs were due to comorbid conditions (Greenberg et al., 2015). Among the costs from comorbid conditions, 9% were due to other mental health disorders and 29% were due to non-mental health disorders (Greenberg et al., 2015). In addition, 45% of the total costs were due to direct costs, 50% were due to workplace costs, and 5% were due to suicide-related costs (Greenberg et al., 2015). Between 2005 and 2010, direct costs increased by 27.5%, workplace costs by 18.2%, and suicide-related costs by 2.7% (Greenberg et al., 2015). The majority (71.6%) of direct costs were due to medical services, reaching $70.7 billion in 2010 (Greenberg et al., 2015). Among medical services, $38.2 billion were due to outpatient services and $20.6 billion were due to inpatient services (Greenberg et al., 2015). Direct costs were 1.7 times greater among individuals covered by Medicaid compared with private insurance (Ivanova et al., 2011). Because PSH residents are often covered by Medicaid, direct costs may be greater among individuals with MDD in this population as well.

Brody, Pratt, and Hughes (2018) analyzed data from the National Health and Nutrition Examination Survey to determine the prevalence of depression among adults in the United States between 2013 and 2016. Overall, between 2015-2016, 8.1% of adults over the age of 20 had depression, which differed by sex, age, ethnicity, and income level (Brody et al., 2018). The prevalence increased incrementally as family income levels decreased; the prevalence was 3.5% among families at or above 400% of the FPL, 7.8% among families at 200-400% of the FPL, 10.9% among families at 100-200% of the FPL, and 15.8% among families living below the FPL (Brody et al., 2018). The prevalence of depression among families living below the FPL was

nearly twice the prevalence of depression among all adults (Brody et al., 2018). A recent report indicated that the majority (53.7%) of PSH residents had depression near entry into housing (Henwood et al., 2018). This was more than three times the prevalence of families living below the FPL and nearly seven times greater than the general population (Brody et al., 2018), underscoring the need to reduce the prevalence of depression among PSH residents. Reducing the prevalence of depression in this population will improve their overall health and quality of life (Vos et al., 2017; Mokdad et al., 2018) and contribute to reduced economic costs (Greenberg et al., 2015).

Treatment for Depression

The NIMH and the WHO recommend psychotherapy and medication for the treatment of depression (NIMH, 2017, November; USDHHS, NIH, & NIMH, 2015; WHO, 2019). Psychotherapy addresses individual level factors, including thoughts, feelings, and behaviors (USDHHS et al., 2015). Common forms of psychotherapy include CBT, Interpersonal Therapy (IPT), and Problem-Solving Therapy (PST) (USDHHS et al., 2015). CBT helps people change negative thought patterns, IPT focuses on improving relationships, and PST helps people develop solutions to cope with stressful experiences (USDHHS et al., 2015). Psychotherapy is provided in a variety of delivery formats, including face-to-face, video conferencing, and computer programs (USDHHS et al., 2015). Although psychotherapy may be sufficient to treat mild to moderate depression, antidepressant medication is often necessary to treat severe depression (USDHHS et al., 2015) and is frequently utilized in combination with psychotherapy (NIMH, 2017). Many medications are available to treat depression, including selective serotonin reuptake inhibitors, serotonin and norepinephrine reuptake inhibitors, tricyclic antidepressants, and

monoamine oxidase inhibitors (USDHHS et al., 2015). However, antidepressant medication may only be effective for individuals with very severe depression (Fournier et al., 2010).

The majority (71.3%) of adults who screen positive for depression in the United States do not seek professional help (Andrews, Sanderson, Corry, & Lapsley, 2000; Olfson, Blanco, & Marcus, 2016). Among individuals below the FPL, only 30.1% of individuals who screened positive for depression received treatment (Olfson et al., 2016). Although cost of care and lack of health insurance are primary barriers to treatment among individuals living below the FPL, many additional factors reduce the effectiveness of psychotherapy and antidepressant medication (Goodman et al., 2013; Hodgkinson et al., 2017). For example, many people who live below the FPL may not receive psychotherapy because of stigma (Levy & O'Hara, 2010), other psychological barriers (Levy & O'Hara, 2010), sociocultural contexts, and practical barriers, including lack of transportation and schedule conflicts (Goodman et al., 2013; Levy & O'Hara, 2010). Additionally, noncompliance with antidepressant medication is common (Sansone & Sansone, 2012). In a recent review, nearly half of psychiatric and primary care patients discontinued use at six months (Sansone & Sansone, 2012). Many factors contribute to nonadherence with antidepressant medications, including adverse reactions, dose and timing requirements, uncertainty about the effectiveness of treatment, and self-stigma (Srimongkon et al., 2018). Given these barriers, effective strategies are needed to create efficacious interventions and expand coverage of health care for depression.

Healthy People 2020 is a national initiative to improve the health of all Americans (USDHHS & ODPHP, 2019a). Two of the objectives in Healthy People 2020 are to increase the proportion of adults who receive treatment for major depressive episodes (MDEs) and to reduce the proportion of adults with MDEs (USDHHS & ODPHP, 2019b). Dietary intake, physical

activity, tobacco use, and alcohol use seem to be risk factors for depression and affect biological mechanisms that contribute to depressive symptoms (Berk et al., 2013; Jacka et al., 2012; Sarris et al., 2014). Therefore, lifestyle modification, including modification of dietary intake, physical activity, tobacco use, and alcohol use, may be an effective preventative (Berk et al., 2013) and treatment strategy to reduce the burden of depression (Sarris et al., 2014).

Lifestyle Modification Among PSH Residents

Because PSH traditionally emphasizes mental rather than physical health, few lifestyle interventions have been implemented or evaluated among PSH residents (Henwood, Cabassa, Craig, & Padgett, 2013). In an analysis of 5,532 homeless adults in Boston, Massachusetts, 65.7% were either overweight or obese with a BMI ≥ 25, which was similar to the general population (Koh, Hoy, O'Connell, & Montgomery, 2012). Many chronic diseases are prevalent among homeless populations as well, including heart disease, diabetes, and chronic obstructive pulmonary disease (Spence-Almaguer et al., 2013). Similar behaviors contribute to obesity and chronic diseases in this population, including low vegetable and fruit intake, high consumption of energy-dense foods, insufficient physical activity, and tobacco use (Kendzor et al., 2017; Kim et al., 2008). Because PSH residents have a history of chronic homelessness (Henry et al., 2016), many of these behaviors likely persist among PSH residents. Lifestyle modification is a recommended approach to reduce the prevalence of obesity and many chronic diseases (WHO, 2014), and it is a promising approach to treat (Sarris et al., 2014) and prevent depressive symptoms (Berk et al., 2013; Jacka et al., 2012). However, the effect of lifestyle factors on depressive symptoms among PSH residents is unclear.

Lifestyle Factors

Dietary Patterns

A variety of nutrients can impact depressive symptoms (Dog, 2010; Lopresti, Hood, & Drummond, 2013). Because these factors can interact and have a synergistic effect on depressive symptoms, overall dietary patterns have been analyzed. Studies that had similar dietary characteristics tend to be grouped together and analyzed separately in reviews and meta-analyses. Common categories for dietary patterns included the "Healthy Diet," "Mediterranean Diet," and "Western Diet." Among the dietary patterns analyzed in meta-analyses, the Mediterranean diet had the most consistent evidence, supporting this dietary pattern as a potential approach to reduce depressive symptoms (Lassale et al., 2018; Psaltopoulou et al., 2013; Shafiei, Salari-Moghaddam, Larijani, & Esmaillzadeh, 2019).

Healthy Diet. Common foods within the healthy dietary pattern included fruit, vegetables, and lean proteins, and these foods are recommended by the United States Dietary Guidelines 2015-2020 (USDHHS, 2015a). Overall, there is a trend towards lower risk of depression with greater adherence to a healthy dietary pattern. Lai et al. (2014) evaluated 13 studies, including nine cross-sectional studies and four cohort studies. The healthy dietary pattern was associated with a lower odds of having depression, which was statistically significant (OR = 0.84; 95% CI: 0.76, 0.92; $P < 0.001$) (Lai et al., 2014). In addition, Lassale et al. (2018) included 20 longitudinal and 21 cross-sectional studies in the most recent meta-analysis that grouped dietary patterns by the measures of dietary intake. There were three cohort studies and four cross-sectional studies that analyzed a healthy dietary pattern based on a Healthy Eating Index (Lassale et al., 2018). Results from the cohort studies found a lower risk of developing depression with a high compared with a low diet score (OR = 0.76; 95% CI: 0.57, 1.02), but it was not statistically

significant (Lassale et al., 2018). However, results from the cross-sectional studies found an inverse association between the healthy diet and depression (OR = 0.53; 95% CI: 0.38, 0.75), which was statistically significant (Lassale et al., 2018).

Western Diet. Common foods within the Western diet included refined grains, high-fat, high-sugar, and processed foods (Lai et al., 2014). These foods are limited in the United States Dietary Guidelines 2015-2020 (USDHHS, 2015a). Overall, there is weak evidence suggesting an increased risk of depression with greater consumption of Western foods. Two systematic reviews assessed the Western dietary pattern, but the results were inconclusive because significant and non-significant results were found among high-quality studies (Quirk et al., 2013; Rahe et al., 2014). Lai et al. (2014) conducted a meta-analysis and grouped together studies that assessed the Western pattern of eating. The Western dietary pattern was associated with a higher odds of depression, but it was not statistically significant (OR = 1.17; 95% CI: 0.97, 1.41; $P = 0.094$). Because there were only three studies that analyzed Western dietary patterns, there was likely insufficient power to detect a significant result (Lai et al., 2014). The effects of the Western pattern of eating remain inconclusive. There is some indication that consumption of trans fatty acids (Sanchez-Villegas et al., 2011) and fast food have a more significant impact on depressive symptoms compared with refined carbohydrates and sugars (Sanchez-Villegas et al., 2012).

Mediterranean Diet. The Mediterranean dietary pattern includes high consumption of fruits, vegetables, whole grains, nuts, and seeds, low to moderate consumption of lean proteins and red wine, low intake of red meats and processed foods, and olive oil as the main source of fat (Willett et al., 1995). The United States Dietary Recommendations provide specific recommendations for the Mediterranean dietary pattern based on caloric intake for vegetables, fruits, grains, dairy, protein (i.e., seafood, meats, poultry, eggs, nuts, seeds, soy products), oils,

and a limit on calories from all other foods (USDHHS, 2015b). Overall, there is strong evidence indicating that there is a reduced risk of depression with greater adherence to a Mediterranean dietary pattern.

Meta-analyses have been conducted focusing exclusively on the Mediterranean diet. A recent meta-analysis included 14 observational studies (Shafiei et al., 2019). Results from the four cohort studies were not statistically significant, but the combined effect sizes from the nine cross-sectional studies found a reduced risk of depression with greater adherence to the Mediterranean diet (pooled OR = 0.72; 95% CI = 0.60,0.87) (Shafiei et al., 2019). In addition, in a previous meta-analysis of the Mediterranean dietary pattern and depression risk by Psaltopoulou et al. (2013), moderate to high adherence to a Mediterranean diet was protective against depression. The pooled effect estimate was 0.68 (95% CI = 0.54, 0.86) for high adherence and 0.77 (95% CI = 0.62, 0.95) for moderate adherence (Psaltopoulou et al., 2013). Similarly, Lassale et al. (2018) included four cohort studies in their meta-analysis that evaluated the effect of the Mediterranean dietary pattern. Overall, they found a protective effect among the four longitudinal cohort studies (overall RR = 0.67; 95% CDI = 0.55, 0.82) when comparing individuals with the highest adherence to individuals with the lowest adherence to the Mediterranean diet (Lassale et al., 2018).

Vegetables and Fruit. High intake of vegetables and fruit is consistently included among healthy diets and the Mediterranean diet. There is consistent evidence that these foods can reduce the risk of depression. Two meta-analyses evaluated the association of vegetable and fruit intake on the risk of depression. Saghafian et al. (2018) evaluated 18 studies and found a reduced risk for depression when comparing the highest with the lowest fruit intake in cohort studies (pooled RR = 0.83; 95% CI = 0.71, 0.98) and cross-sectional studies (pooled RR = 0.76; 95% CI = 0.63,

0.92). Similar results were found when comparing the highest with the lowest vegetable intake in cohort studies (pooled RR=0.86; 95 % CI = 0.75, 0.98) and cross-sectional studies (pooled RR=0.75; 95 % CI = 0.62, 0.91). Total fruit and vegetable intake was also associated with reduced risk of depression (pooled RR = 0.80; 95% CI = 0.65, 0.98) (Saghafian et al., 2018). Similarly, Liu, Yan, Li, & Zhang (2016) included 10 studies that evaluated fruit intake and found an inverse association with fruit intake (pooled RR = 0.86; 95% CI = 0.81, 0.91) and with vegetable intake (pooled RR = 0.89; 95% 0.83, 0.94). Vitamin C, beta-cryptoxanthin, and antioxidants present in vegetables and fruits may explain the reduction in depressive symptoms (Payne, Steck, George, & Steffens, 2012). Vegetables and fruits may be key foods in dietary patterns that are associated with reduced depressive symptoms.

Physical Activity

Treatment Effect. Many meta-analyses have been conducted to determine the treatment effect of exercise on depression. Overall, the effect of physical activity on depressive symptoms ranged between moderate to high with no clear difference based on frequency, dose, and duration of physical activity between studies. Krogh, Hjorthoj, Speyer, Gluud, and Nordentoft (2017) analyzed 35 RCTs measuring depression as a continuous variable and found that exercise significantly reduced depression severity compared with the control condition (Standardized Mean Difference (SMD) = -0.66; 95% CI: -0.86, -0.46; $P<0.001$) (Krogh, Hjorthoj, Speyer, Gluud, & Nordentoft, 2017). This effect size corresponded with a difference of 4.1 points (95% CI: -5.3, -2.9) on the 17-item Hamilton Depression Rating Scale, suggesting a moderate antidepressant effect (Krogh et al., 2017). However, excluding trials to those with less than high risk of bias found no significant difference (Krogh et al., 2017). These inconsistencies reduce

confidence in the primary outcomes and highlight the potential effect of bias on the validity of the results (Krogh et al., 2017).

Similarly, Schuch et al. (2016) pooled results from 25 RCTs, and found a large, significant reduction in depressive symptoms among the exercise group compared with the control group (SMD = 0.98, 95% CI = 0.68, 1.28, $P<0.0001$). After adjusting for publication bias, the effect size increased, indicating a greater reduction in depressive symptoms among the exercise group (SMD = 1.11; 95% CI: 0.79, 1.43) (Schuch et al., 2016). Significant results did not depend on the frequency or duration of physical activity (Schuch et al., 2016). However, a subgroup analysis indicated that aerobic exercise interventions had a stronger effect on depression compared with the initial pooled results that included resistance only and mixed types of exercise (SMD = 1.14, 95% CI = 0.46, 1.81) (Schuch et al., 2016).

Josefsson et al. (2014) pooled results from 13 RCTs analyzing the effect of physical activity interventions on depressive symptoms and found a significantly large overall effect, and a moderate effect among studies with high methodological quality. Finally, a meta-meta-analysis of 92 studies found a medium effect of physical activity on depression (SMD = -0.50; 95% CI: -0.93, -0.06) (Rebar et al., 2015). In addition, a meta-analysis of 16 RCTs comparing treatment approaches found a similar efficacy for physical activity alone and CBT compared with a combined approach in reducing depressive symptoms (Bernard et al., 2018).

Recent meta-analyses focused on populations recruited by mental health services for the treatment of major depression. Morres et al. (2019) conducted a meta-analysis that included 11 RCTs and found a large antidepressant effect (g=-0.79; 95% CI: -1.01, -0.57; $P<0.00$), deeming it an effective antidepressant intervention (Morres et al., 2019). Participants were between 18 and 65 years of age, received a referral or clinical diagnosis of major depression, and were recruited

by mental health services (Morres et al., 2019). The aerobic exercise interventions were an average of 45 minutes in duration, at moderate intensity, with a frequency of three times per week, for 9.2 weeks (Morres et al., 2019). There was not any publication bias found and the heterogeneity between studies was low and not statistically significant (Morres et al., 2019).

Beland et al. (2019) conducted a meta-analysis to evaluate the effect of aerobic exercise on depressive symptoms among patients with major non-communicable diseases, including cardiovascular diseases, respiratory diseases, cancer, and type 2 diabetes. Pooling results from 24 studies, aerobic exercise alleviated depressive symptoms among participants with non-communicable diseases compared with usual care (SMD = 0.50; 95% CI = 0.25, 0.76), and the effect size was greater among patients with cardiovascular disease (SMD = 0.67; 95% CI = 0.35, 0.99) (Beland et al., 2019). However, there were high levels of heterogeneity between the studies (Beland et al., 2019). Subgroup analyses for duration of sessions, frequency, and length of intervention were not statistically significant, indicating that any aerobic exercise is better than none (Beland et al., 2019).

Protective Effect. In addition to treating depression, physical activity can prevent the development of depression. Many studies have been conducted to elucidate the protective effect of exercise for depression. Schuch et al. (2018) conducted the first meta-analysis of prospective studies, providing evidence that physical activity can protect against the development of depression. Pooling results from 49 prospective studies, those with high levels of physical activity had a lower odds of developing depression (adjusted OR = 0.83; 95% CI = 0.79, 0.88) (Schuch et al., 2018). A protective effect was found among youths, adults, and elderly persons and geographic regions in subgroup analyses (Schuch et al., 2018). Variations in the definition of low or high physical activity preclude the ability to determine optimal dose, frequency, or

duration (Schuch et al., 2018). However, a subgroup analysis suggested that at least 150 minutes per week of moderate to vigorous physical activity reduced the odds of developing depression (adjusted OR = 0.78; 95% CI = 0.617, 0.986, P = 0.038) (Schuch et al., 2018).

Tobacco Use

There is strong evidence that smoking tobacco increases the odds of having depression. In a review of 78 cross-sectional studies, current smokers had an increased odds of having depression compared with never smokers (OR = 1.50, 95% CI = 1.39, 1.60) and former smokers (OR = 1.76, 95% CI = 1.48, 2.09) (Luger, Suls, & Vander Weg, 2014). Similarly, in a meta-analysis of 25 studies, current smokers had a greater odds of having depression compared with never smokers (OR = 1.85; 95% CI = 1.65, 2.07) (Taylor et al., 2014). Also, in a meta-analysis of 36 studies, pooled results indicated an association between depression and tobacco use (OR = 1.65; 95% CI: 1.43, 1.92) (Esmaeelzadeh et al., 2018).

There is also evidence that depression increases the odds of using tobacco. Tobacco use increases the odds of having depression (OR = 1.87; 95% CI = 1.23, 2.85) and depression increases the odds of using tobacco (OR = 1.22; 95% CI = 1.09, 1.37), indicating a bi-directional relationship (Esmaeelzadeh et al., 2018). There is some evidence indicating the potential of smoking cessation interventions to reduce depressive symptoms. A systematic literature review and meta-analysis was conducted to evaluate smoking cessation interventions among smokers who have depression (Secades-Villa, Gonzalez-Roz, Garcia-Perez, & Becona, 2017). The studies that evaluated the effect of the smoking cessation intervention on depressive symptoms indicate that they do not increase depressive symptoms but rather have the potential to mitigate depressive symptoms (Secades-Villa et al., 2017).

Alcohol Use

There is a large body of evidence indicating that alcohol abuse or dependence is a risk factor for major depression (Berk et al., 2013). These two conditions commonly co-occur, and it is likely that there is a bi-directional relationship between alcohol use disorders and major depression (Boden & Fergusson, 2011). Environmental and social factors may increase both alcohol use disorders and major depression (Boden & Fergusson, 2011). However, the association persisted among many studies controlling for these variables, indicating that there may be a causal relationship between these two conditions, and treating either of these conditions may improve the other (Boden & Fergusson, 2011).

In addition, low to moderate alcohol consumption may have a different effect on depressive symptoms than heavy consumption (Bellos et al., 2013, 2016; Berk et al., 2013). While heavy drinking may be associated with an increased prevalence of depression, low to moderate consumption of alcohol may be associated with a reduced prevalence (Bellos et al., 2013) and reduced incidence of depression (Bellos et al., 2016). These results remained after controlling for chronic diseases and sociodemographic variables, reducing the likelihood that these factors affected the outcome (Bellos et al., 2013, 2016).

In fact, low to moderate consumption of wine is included in the Mediterranean dietary pattern (Willett et al., 1995) and is often associated with reduced depressive symptoms (Lassale et al., 2018; Psaltopoulou et al., 2013; Shafiei et al., 2019). Low to moderate consumption of wine, defined as 1 to 2 glasses per day in the Mediterranean diet, may have a health promoting effect (Pavlidou et al., 2018). For example, wine may reduce depressive symptoms due to the presence of antioxidants and polyphenols (Vauzour, 2012) and their anti-inflammatory effects among other beneficial actions (Bouayed, 2010). In a recent study on dietary polyphenol intake,

wine was one of the major sources of polyphenols that had an inverse association with depressive symptoms (Godos, Castellano, Ray, Grosso, & Galvano, 2018).

Leisure Activities

CBT is an evidence-based approach for treating depression (Greenberger, 2016). This approach integrates concepts from cognitive therapy and BA (Martell et al., 2013). Cognitive therapy focuses on changing thoughts about situations to influence feelings and behaviors (Martell et al., 2013). BA was later included alongside cognitive therapy, focusing on changing behaviors to improve feelings (Martell et al., 2013). Principles of BA recognize that behaviors will have a different effect based on outcomes of the behavior and events or thoughts surrounding the behavior (Martell et al., 2013). This results in a "trial-and-error" approach to finding activities that are naturally reinforcing (Martell et al., 2013).

Participation in leisure activities, including individual hobbies or social activities, can have a direct effect on depressive symptoms (Goodman et al., 2016). Goodman, Geiger, & Wolf (2016) assessed the association of depressive symptoms with the frequency of participating in leisure activities, including social, solitary, and physical activity, among unemployed and employed populations (Goodman et al., 2016). All three categories of leisure activities were associated with depressive symptoms, but the strength of the effect differed depending on the type of activity (Goodman et al., 2016). When the three categories of recreational activities were compared, social activities had the strongest effect while exercise had the weakest effect on depressive symptoms (Goodman et al., 2016).

Many factors may mediate the effect of leisure activities on depressive symptoms. For instance, leisure activities may influence depressive symptoms by increasing the amount of structured time and routines in the day or by providing a sense of purpose in life (Goodman,

Geiger, & Wolf, 2017). In addition, activities may reduce depressive symptoms by serving as a distraction from ruminating thoughts (Morrow & Nolen-Hoeksema, 1990). Morrow and Nolen-Hoeksema (1990) found that activities that are active and distracting compared with passive and self-focused have a greater influence on depressive affect.

Furthermore, thoughts about events or experiences can affect the emotional, behavioral, and physical responses (Greenberger & Padesky, 2016). BA is an effective treatment approach that increases participation in activities that are perceived as enjoyable and personally fulfilling (Cuijpers et al., 2007). Perceiving leisure activities that coincide with health behaviors as satisfying could confound the effect of a health behavior on depressive symptoms. For example, physical activity and vegetable or fruit intake may have a greater effect on reducing depressive symptoms if they coincide with enjoyable social activities. Leisure time activities might also include activities other than health behaviors, including reading, gardening, or going to museums. Therefore, satisfaction with leisure activities may have a direct effect on depressive symptoms or be associated with lifestyle factors, confounding the effect of lifestyle factors on depressive symptoms.

Social Support

Many types of social support can have a direct impact on depressive symptoms (Gariépy et al., 2016). Types of social support include emotional support, instrumental support, informational support, and appraisal support (House, Umberson, & Landis, 1988). Emotional support involves expressions of empathy, love, trust, and a sense of caring (House et al., 1998). Instrumental support includes tangible aid and services (House et al., 1998). Informational support includes advice and suggestions (House et al., 1998). Appraisal support includes feedback and affirmations, which are useful for self-evaluation (House et al., 1988). To qualify

as social support, these types of support need to be provided with the intention of being helpful and in the context of respect for autonomous decision-making (Heaney & Israel, 2008).

Aspects of social support can be provided by a single person or many different people (Heaney & Israel, 2008). A systematic review was conducted to elucidate the type and source of support that was associated with depression among various life stages (Gariépy et al., 2016). The final selection included 100 studies over a period of 27 years (1988-2015) and indicated that greater levels of social support are associated with reduced depressive symptoms among each age group (Gariépy et al., 2016). The majority (89%) of the 36 studies that included adults had significant outcomes, indicating that social support was associated with a reduced odds of depression (pooled OR = 0.74, 95% CI 0.72 to 0.76) and depressive symptoms (pooled beta coefficient = -0.01, 95% CI -0.02 to -0.01) (Gariépy et al., 2016). Similar results were found among the 33 studies that focused on adults over the age of 50 (Gariépy et al., 2016). The majority (94%) of these studies had significant outcomes as well, indicating that social support was associated with a reduced odds of depression (pooled OR = 0.56, 95% CI 0.55 to 0.57) and depressive symptoms (pooled beta coefficient -0.11, 95% CI -0.13 to -0.08) (Gariépy et al., 2016). The sources of social support assessed in these studies were primarily from spouses, children, family, and friends (Gariépy et al., 2016). Among adults, spouses and friends were the primary sources of social support evaluated among studies that had significant outcomes (Gariépy et al., 2016).

Additionally, many aspects of social support are often exchanged between health care professionals and clients. For example, in the Mobile Community Health Assistance for Tenants (m.chat) program, the coaching interaction included motivational interviewing and solution-focused brief therapy to encourage behavior change (Walters, Spence-Almaguer, Hill, &

Abraham, 2015). Because motivational interviewing is provided in a manner that expresses empathy (Miller & Rollnick, 2012), this approach is an example of emotional support (House et al., 1988). Furthermore, the exchange of information, advice, and suggestions is an example of informational support (House et al., 1988), and the feedback provided for self-evaluation purposes (Walters et al., 2015) is an example of appraisal support (House et al., 1988). In this way, health care professionals may be a prominent source of social support and confound the effects of lifestyle factors on depressive symptoms among studies evaluating these effects. In addition, it is possible that the effects of health behaviors on depressive symptoms depend on the individual's level of perceived social support (Holmes et al., 2018). Social factors often interact with individual level factors that influence health outcomes (Bronfenbrenner, 1979), including cognitive factors, behaviors, and biological processes (Bronfenbrenner, 1979). Therefore, the influence of lifestyle factors on depressive symptoms may depend on individuals' level of perceived social support. Including social support as a potential confounding and modifying variable will provide more insight on the effect of lifestyle behaviors on depressive symptoms.

Intention

People with different severity levels of depression may have different intentions to change lifestyle factors than people without depression. According to the Theory of Planned Behavior, attitude towards a behavior, subjective norm, and perceived behavioral control influence behavioral intention, predicting behavior change (Montano & Kasprzyk, 2008). Attitude toward the behavior includes the individual's belief and evaluation of the attributes and outcome of the behavior (Montano & Kasprzyk, 2008). Subjective norms include the individual's belief regarding others' approval or disapproval of the behavior and motivation to comply with those individuals (Montano & Kasprzyk, 2008). Perceived behavioral control

includes the perception of facilitators or barriers to performing the behavior and the impact of those factors on facilitating or inhibiting the behavior (Montano & Kasprzyk, 2008). Because clinical depression includes a depressed mood or loss of interest or pleasure in activities (APA, 2013), people with more depressive symptoms may have more negative evaluations of behaviors, others' attitudes toward behaviors, and their ability to overcome barriers to change behaviors. This could result in different attitudes toward a behavior, subjective norm, or perceived behavioral control and may consequently influence their intention to change a lifestyle factor.

The transtheoretical model indicates multiple stages of change that people progress through based on their readiness to change (Prochaska et al., 2008). Three stages precede action: precontemplation, contemplation, and preparation (Prochaska et al., 2008). The precontemplation stage of change is described as no intention to act within the next six months, contemplation is described as intending to act within the next six months, and preparation is described as intending to act within the next thirty days and taking some steps in that direction (Prochaska et al., 2008). For example, individuals could take a step in the direction of acting by setting a goal to act within the next thirty days, indicating that they are in the preparation stage of change.

Knowing participants' stage of change for a range of lifestyle factors can inform future treatment approaches. According to the transtheoretical model, the processes of change can help people progress through the stages of change toward action (Prochaska et al., 2008). For example, consciousness raising, dramatic relief, and environmental reevaluation are strategies relevant to the precontemplation and contemplation stages of change, which may not be necessary to help people move from preparation to action (Prochaska et al., 2008). However, self-reevaluation helps people move from the contemplation or preparation stage of change toward action (Prochaska et al., 2008). In addition, people with more depressive symptoms may

be less interested in setting goals to change lifestyle factors that have a strong influence on depressive symptoms. Therefore, an ecological, population-based approach may be necessary to initiate changes in these lifestyle factors. For example, an ecological, population-based approach could be integrated with individual treatment methods to support changes in lifestyle factors, focusing on the environmental settings and policy changes (Sallis et al., 2008).

Gaps in the Literature

Depression is prevalent among PSH residents (Henwood et al., 2018) and has a significant effect on health and quality of life (Egede, 2007; Henwood et al., 2018; Lepine & Briley, 2011; Mokdad et al., 2018). There is increasing evidence that lifestyle factors can influence depressive symptoms, but inconsistent results and significant heterogeneity among studies reduces the ability to generalize results. In addition, few studies were conducted among populations similar to PSH residents, and thus the influence of lifestyle behaviors on depressive symptoms in this population is not clear. Furthermore, most analyses did not consider the effect of lifestyle behaviors within the context of satisfaction with leisure activities and perceived social support. Perceived social support and satisfaction with leisure activities may confound the effects of lifestyle behaviors on depressive symptoms, and perceived social support may modify the effects of lifestyle factors on depressive symptoms. Ultimately, evaluating these factors will provide a better understanding of the effect of lifestyle factors on depressive symptoms among PSH residents.

Very few studies have assessed the effects of lifestyle factors on depressive symptoms among PSH residents. In a previous analysis, the association between changes in diet quality, physical activity, and social support with changes in depressive symptoms was assessed among PSH residents (Holmes, Yang, Aryal, & Walters, 2018). A subsequent analysis assessed the

influence of Western food intake and nutritious food intake on depressive symptoms among PSH residents over one year (Holmes, Aryal, Nandy, & Walters, 2018). However, the modifying effect of social support was not evaluated in each of these analyses. Because sociocultural factors often interact with individual level factors that influence health outcomes, including behaviors and biological processes (Bronfenbrenner, 1979), perceived social support may modify the effect of lifestyle factors on depressive symptoms.

Also, previous studies have not compared the goals set among PSH residents with different severity levels of depression. Knowing their intention to set goals within the lifestyle domains will help determine the lifestyle factors they prioritize changing. Indicating their interest in changing a lifestyle factor within the next month indicates that they are in the preparation stage of change. Because different behavior change strategies are relevant to each stage of change (Prochaska et al., 2008), knowing their intention to change lifestyle factors will help inform the strategies applied to influence lifestyle factors among this population.

CHAPTER THREE

Methodology

Intervention Description

The m.chat program was a technology-assisted health coaching program in Fort Worth, Texas. There were three goals of the program: 1) Implement a health coaching program to improve the quality of life of PSH residents, targeting changes in alcohol/drug use, depression, and criminal justice admissions. 2) Measure outcomes at baseline and key follow-up points. 3) Test the efficacy of a cell phone component as an adjunct to the in-person health coaching program on project outcomes. The health coaching program supported participants in making changes in the following biopsychosocial domains: dietary intake, physical activity, substance use, medication compliance, social support, recreation/leisure activities, and my chat.

There were three main components of m.chat: in-person health coaching, specialized coaching software, and the provision of "Chat Bucks" wellness incentives. In-person coaching utilized motivational interviewing and solution-focused brief therapy. Each health coaching session occurred monthly and was approximately 45-60 minutes in duration. An automated health coaching system was provided along with in-person coaching to facilitate the coaching interaction. In addition, a subset of participants were randomized to receive a cellphone and phone based app, which provided daily assessments, strategies, and reminders about their goals. Participants could receive up to 60 "Chat Bucks", equivalent to $60, when they completed health coaching visits and up to 15 "Chat Bucks" per month for completing phone assessments. Coaches helped participants redeem their "Chat Bucks" for pre-approved wellness items.

Research staff screened participants over the phone or in person to determine their eligibility for the program. The screening assessment included questions regarding demographics, insurance status, mental health symptoms, depressive symptoms, and substance use and were conducted over the phone and in person. After verifying eligibility, participants met in person with a member of the research team for their baseline assessment. The baseline assessment included questions regarding quality of life, family and social relationships, leisure activities, social support, physical activity, dietary intake, medication adherence, substance use, legal status, and biological measurements. Follow-up assessments occurred in person every six months for a maximum of 36 months. The follow-up assessments included questions regarding quality of life, family and social relationships, depressive symptoms, leisure activities, social support, physical activity, dietary intake, medication adherence, substance use, legal status, and biological measurements. Participants received $25 or $35 upon completing the baseline and follow-up assessments, depending on the location of the visit. Informed consent was obtained from all participants. This program was approved by the Institutional Review Board of the University of North Texas Health Science Center.

Procedures

Study Design

This study is a secondary data analysis of data collected from the m.chat program. Data from the screening, baseline, six-month, and twelve-month assessments were utilized. Demographic information was collected from the screening assessment and was included in the models as time-constant variables. PHQ-9 scores, the measure for depressive symptoms, were collected from the screening, six-month, and twelve-month assessments and were included in the model as time-varying variable. Vegetable/fruit intake, physical activity, alcohol use, tobacco

use, social support, and satisfaction with leisure activities were collected from the baseline, six-month, and twelve-month assessments and were included in the model as time-varying variables.

Data Collection

Screening questions were most often conducted by phone. Baseline and follow-up visits occurred in person at the participants' residence or a public location convenient to the participant and were approximately 90 minutes in duration. The assessments were conducted by trained members of the research team and consisted of structured interviews with questions prompted by the computer. Visual aids were provided to assist participants with answering questions. Data was collected and stored in a password-protected online storage system, Efforts to Outcome. Regular newsletters, appointment reminders, birthday cards, phone calls, text messages, and emails were sent to participants to retain enrollment and active participation in the program. Data was collected between November 2014 and September 2017.

Participants

Sampling Method and Recruitment. Convenience sampling was used to recruit participants from six housing agencies in Fort Worth, Texas. Participants were recruited using a variety of methods, including in-person announcements, flyers, letters, word-of-mouth, phone calls, and emails. Recruitment efforts occurred at a variety of locations, including support or treatment groups, agency waiting rooms, PSH premises, provider meetings, and community events. In addition, flyers and letters were available for agency personnel to refer participants, and some agencies provided demographic contact information to the research team to recruit participants. Participants were provided incentives to refer others to the program. They received 10 "Chat Bucks" if the person they referred was eligible and completed the baseline assessment.

Inclusion and Exclusion Criteria. Participants were eligible to receive services from the program if they were English-speaking adults 18 years or older, current PSH residents, Medicaid-enrolled or Medicaid-eligible (i.e., low-income and uninsured), and self-reported symptoms of a mental health condition within the past year. Symptoms of a mental health condition included the following: prescribed medication for psychological or emotional problems, experienced hallucinations, received a pension for a psychiatric disability, or reported at least moderate levels of depression (PHQ-9 > 9). Participants were excluded from the program if they did not meet the eligibility requirements.

Measurements

Depressive Symptoms. Depressive symptoms were measured during the screening and follow-up visits by the PHQ-9 (Kroenke, Spitzer, & Williams, 2001). Nine questions were asked to determine if participants had been bothered by the following problems in the previous two weeks: 1) having little interest or pleasure in doing things 2) feeling down depressed, or hopeless 3) having trouble falling or staying asleep, or sleeping too much 4) feeling tired or having little energy 5) poor appetite or overeating 6) feeling bad about yourself or that you are a failure or have let yourself or your family down 7) trouble concentrating on things, such as reading the newspaper or watching television 8) moving or speaking so slowly that other people could have noticed, or being so fidgety or restless that you have been moving around a lot more than usual 9) thoughts that you would be better off dead, or of hurting yourself. Answers to each question were measured on a Likert scale ranging from “not at all” to “nearly every day.” The scores for each question ranged from 0 to 3 and were summed to provide an overall score ranging from 0 to 27. Higher scores indicate greater depressive symptoms. The PHQ-9 is considered a valid and

reliable measure of depression severity (Kroenke et al., 2001). The PHQ-9 score ≥ 10 had a sensitivity of 88% and specificity of 88% for major depression. Scores for levels of depression severity were given for none (PHQ-9 = 0-4), mild (PHQ-9 = 5-9), moderate (PHQ-9 = 10-14), moderately severe (PHQ-9 = 15-19), and severe depressive symptoms (PHQ-9 = 20-27) (Kroenke et al., 2001).

Vegetables and Fruit. Two questions were asked regarding vegetables and fruit intake: 1) "How many servings of fruit did you eat each day?" and 2) "How many servings of vegetables did you eat each day?" Answers to each of these questions were "2 or less," "3-4," and "5 or more" and were ranked from 1 to 3. The scores from each question were summed to create a score ranging from 2 to 6. Higher scores indicated greater consumption of fruits and vegetables.

Physical Activity. Physical activity was measured by the Global Physical Activity Questionnaire (GPAQ) (WHO, 2018). Items measured the typical amount of moderate and vigorous physical activity per week from work, travel, and recreational activities. Based on guidelines from the WHO, minutes per week in physical activity were converted into metabolic equivalents (METs) to determine if a participant achieved the minimum recommendation of 600 MET-minutes per week (WHO, 2018). MET scores were determined by multiplying minutes of moderate activity by four and minutes of vigorous activity by eight. A categorical variable was created to reflect low (<600 MET-minutes per week) and high (≥ 600 MET-minutes per week) physical activity. The GPAQ is considered an acceptable measure of moderate-to-vigorous physical activity (Bull, Maslin, & Armstrong, 2009; Cleland et al., 2014). Moderate agreement was found between the GPAQ and accelerometer for MVPA (r=0.48) (Cleland et al., 2014) and moderate-strong agreement with the International Physical Activity Questionnaire when tested in nine countries (Kappa = 0.67 to 0.73; r= 0.67 to 0.81) (Bull et al., 2009).

Social Support. Social support was measured by a modified version of the Interpersonal Support Evaluation List (ISEL) (Heitzmann & Kaplan, 1988). Participants were asked to think about the past month and rate nine items. Three items measured tangible social support: 1) "If I were sick, I could easily find someone to help me with daily chores." 2) "I could easily find someone who could give me a ride if I needed one." 3) "I could easily find someone to loan me $10 if I needed it." Three items measured appraisal social support: 1) "I can easily find someone to help me think through problems." 2) "I can easily find someone to help me sort through my finances." 3) "I can easily find someone to give me advice when I need it." Three items measured a feeling of belonging: 1) "When I want to socialize, I have a group of friends I can spend time with." 2) "When I feel lonely, I have people I can talk to." 3) "I have a group of friends who include me in their activities." Answers to each question were measured on a Likert scale ranging from "occasionally" to "almost always." The scores for each answer ranged from 1 to 5 and were summed to provide an overall social support score ranging from 9 to 45. Higher scores indicated greater social support. Social support was converted to a binary variable indicating high or low social support, reflecting those above or below the median value at the three timepoints.

Satisfaction with Leisure Activities. Satisfaction with leisure activities was measured by a modified version of the Meaningful Activity Participation Assessment (MAPA) (Eakman, Carlson, & Clark, 2010). Participants were asked to consider leisure time activities such as watching T.V., reading the paper or magazines, tending house plants or gardening, hobbies, going to museums, and going to the movies. Two items were included: 1) "Overall, how satisfied are you with your leisure time activities?" 2) "Overall, how much would you like a change in your leisure time activities?" Answers to each question were measured on a Likert scale ranging

from “hardly ever” to “almost always.” The scores for each answer ranged from 1 to 5 and were summed to provide an overall score for satisfaction with leisure activities ranging from 2 to 10. Higher scores indicated greater satisfaction with leisure activities.

Tobacco Use. Participants were asked if they currently smoke cigarettes or use other forms of tobacco. If participants answered “yes” they were considered a tobacco user, and if participants answered “no” they were considered a non-user.

Alcohol Use. Alcohol use was measured by the Timeline Follow-Back (TLFB). Participants indicated the number of standard drinks consumed on each day during the previous 90 days. Anchor dates (e.g., holidays, life events, birthdays) were used to help participants recall patterns of alcohol consumption. The TLFB is considered an acceptable measure of alcohol use (Grant, Tonigan, & Miller, 1995; Tonigan, Miller, & Brown, 1997). Alcohol use was categorized as none, moderate, and high intake based on recommendations from the Dietary Guidelines (USDHHS, 2015a). None was defined as no alcohol intake within the past month. Moderate intake was defined as greater than zero and no more than one standard drink on any day for women and greater than zero and no more than two standard drinks on any day for men in the past thirty days. High intake was defined as consuming greater than one standard drink on any day for women and consuming greater than two standard drinks on any day for men in the past thirty days.

Covariates. Covariates in the model were collected from the baseline interview and included age in years, sex, race, and visit. Race has seven categories: White, Alaska Native, Asian, Black/African American, Native American, Pacific Islander, and other. Race was converted to a dichotomous variable: white and all other races. Visit included three categories: screening/baseline, six-month, and twelve-month visits.

Hypotheses

Objective 1. To determine if lifestyle behaviors, social support, and satisfaction with leisure activities predict depressive symptoms.

H_1 Vegetable/fruit intake predicts depressive symptoms, controlling for physical activity, tobacco use, alcohol use, social support, satisfaction with leisure activities, age, sex, race, and visit.

H_2 Physical activity predicts depressive symptoms, controlling for vegetable/fruit intake, tobacco use, alcohol use, social support, satisfaction with leisure activities, age, sex, race, and visit.

H_3 Tobacco use predicts depressive symptoms, controlling for vegetable/fruit intake, physical activity, alcohol use, social support, satisfaction with leisure activities, age, sex, race, and visit.

H_4 Alcohol use predicts depressive symptoms, controlling for vegetable/fruit intake, physical activity, tobacco use, social support, satisfaction with leisure activities, age, sex, race, and visit.

H_5 Social support predicts depressive symptoms, controlling for vegetable/fruit intake, physical activity, tobacco use, alcohol use, satisfaction with leisure activities, age, sex, race, and visit.

H_6 Satisfaction with leisure activities predicts depressive symptoms, controlling for vegetable/fruit intake, physical activity, tobacco use, alcohol use, social support, age, sex, race, and visit.

Objective 2. To determine if social support modifies the effects of the lifestyle behaviors and satisfaction with leisure activities on depressive symptoms.

H_1 Social support modifies the effect of vegetable/fruit intake on depressive symptoms, controlling for physical activity, tobacco use, alcohol use, satisfaction with leisure activities, age, sex, race, and visit.

H_2 Social support modifies the effect of physical activity on depressive symptoms, controlling for vegetable/fruit intake, tobacco use, alcohol use, satisfaction with leisure activities, age, sex, race, and visit.

H_3 Social support modifies the effect of tobacco use on depressive symptoms, controlling for vegetable/fruit intake, physical activity, alcohol use, satisfaction with leisure activities, age, sex, race, and visit.

H_4 Social support modifies the effect of alcohol use on depressive symptoms, controlling for vegetable/fruit intake, physical activity, tobacco use, satisfaction with leisure activities, age, sex, race, and visit.

H_5 Social support modifies the effect of satisfaction with leisure activities on depressive symptoms, controlling for vegetable/fruit intake, physical activity, tobacco use, alcohol use, age, sex, race, and visit.

Statistical Procedures

Analysis. Data was analyzed using SAS 9.4. A longitudinal analysis was conducted using data collected at three timepoints, corresponding with the screening/baseline, six-month, and twelve-month assessment visits. The independent variables are time-varying and include vegetable/fruit intake, physical activity, tobacco use, alcohol use, social support, and satisfaction with leisure activities. The covariates are time-constant in the model and include age, sex, race, and visit. The dependent variable is a continuous measure of depressive symptoms and is time-varying.

Inference and Modeling. The unstructured and parameterized covariance models were compared. The covariance model with the best fit was determined by the likelihood ratio test for nested models and Bayesian information criterion (BIC) for non-nested models. Models were compared with and without social support and satisfaction with leisure activities to evaluate these factors as potential confounding variables. In addition, social support was evaluated as a potential modifier of the effect of lifestyle behaviors and satisfaction with leisure activities on depressive symptoms. When included in the interaction terms, vegetable/fruit intake and satisfaction with leisure activities were mean-centered by subtracting the mean value from each participant's value for the respective predictors.

Analysis of Intention

Participants' interest in changing lifestyle factors was determined by the domains activated at their first coaching visit. Health coaches activated health domain(s) if the participant indicated they were interested in working on the health area: diet, exercise, substance use, social support, recreation/leisure, medication adherence, and my chat. The categories for medication adherence and my chat were combined to create a category for all other health areas. Participants were categorized as individuals with moderate (PHQ-9 = 10-14), moderately severe (PHQ-9 = 15-19), and severe depressive symptoms (PHQ-9 = 20-27). The percent of participants who activated each health domain was calculated (i.e., diet, exercise, substance use, recreation/leisure, social support, and other) by severity of depressive symptoms.

CHAPTER FOUR

Results

Baseline Characteristics

Fifty-two percent of participants were Black/African American (52%), 42% White, 4% Other, 1% Native American, 1% Pacific Islander, 1% Alaska Native, and 1% Asian. Fifty percent of the participants were female, and fifty percent were male. Participants had a mean age of 50 (SD = 9).

Table 1. *Baseline Characteristics of Participants*

Sex, n(%)	
Female	212 (50)
Male	208 (50)
Age, M(SD)	50 (9)
Race, n(%)	
Black/African American	218 (52)
White	175 (42)
Other	16 (4)
Native American	6 (1)
Pacific Islander	1 (1)
Alaska Native	1(1)
Asian	1(1)

Predictors of Depressive Symptoms

Models were compared using the likelihood ratio test for nested models and BIC for non-nested models. The random intercept model had the best fit when social support and satisfaction with leisure activities were included in the model. The effects of each lifestyle factor on depressive symptoms was assessed, adjusting for age, sex, race, and visit (Table 2). Compared with heavy alcohol consumption, moderate alcohol consumption predicted a statistically significant decrease in depressive symptoms (b=-1.54, p=.01). The difference in depressive

symptoms between non-consumers and heavy consumers of alcohol approached statistical significance with non-consumers of alcohol having lower depressive symptoms than heavy consumers of alcohol (*b*=-.76, *p*=.07). In addition, satisfaction with leisure activities and social support were statistically significant predictors of depressive symptoms. Increased satisfaction with leisure activities predicted lower depressive symptoms (*b*=-.83, *p*<.0001), and high social support predicted a decrease in depressive symptoms compared with low social support (*b*=-1.86, *p*<.0001). Tobacco use was a marginally statistically significant predictor of depressive symptoms (*b*=.92, *p*=.05). Vegetable and fruit intake (*b*=-.06, *p*=.79) and physical activity (*b*=-.39, *p*=.25) were not statistically significant predictors of depressive symptoms. Among the covariates, increased age predicted lower depressive symptoms (*b*=-.07, *p*=.01), and the six-month follow-up visit (*b*=-3.69, *p*<.0001) and twelve-month follow-up visit (*b*=-3.33, *p*<.0001) predicted lower depressive symptoms compared with the baseline visit. Race and sex were not statistically significant predictors of depressive symptoms. The intraclass correlation coefficient for this model was 0.45.

Table 2. *The Effect of Lifestyle Factors on Depressive Symptoms*

Predictor	*b*	*SE*	Lower 95% CI	Upper 95% CI	*p*
Intercept	21.85	1.68	18.56	25.14	<.0001
Vegetable/fruit Intake	-0.06	0.21	-0.47	0.35	0.79
Physical Activity					
High (≥ 150 METs/wk)	-0.39	0.34	-1.06	0.28	0.25
Low (<150 METs/wk)	Ref				
Tobacco Use	0.92	0.47	-0.01	1.84	0.05
Alcohol Use					
None	-0.76	0.43	-1.60	0.07	0.07
Moderate	**-1.54**	**0.61**	**-2.74**	**-0.34**	**0.01**
Heavy	Ref				
Satisfaction with Leisure Activities	**-0.83**	**0.09**	**-1.01**	**-0.66**	**<.0001**
Social Support					
High	**-1.86**	**0.38**	**-2.60**	**-1.12**	**<.0001**
Low	Ref				
Race (White)	0.72	0.47	-0.21	1.65	0.13

Predictor	*b*	*SE*	Lower 95% CI	Upper 95% CI	*p*
Sex (Female)	0.08	0.48	-0.86	1.01	0.87
Age (Years)	**-0.07**	**0.03**	**-0.12**	**-0.02**	**0.01**
Visit					
Follow-up 2	**-3.33**	**0.35**	**-4.01**	**-2.65**	**<.0001**
Follow-up 1	**-3.69**	**0.33**	**-4.33**	**-3.05**	**<.0001**
Baseline	Ref				

Note: b = beta, *SE* = Standard Error, CI = Confidence Interval, *p* = probability, coefficients in bold are statistically significant (*p*<.05).

The unstructured covariance pattern had the best fit when social support and satisfaction with leisure activities were not included in the model. The effects of vegetable and fruit intake, physical activity, tobacco use, and alcohol use on depressive symptoms was assessed, adjusting for age, sex, race, and visit (Table 3). Compared with heavy alcohol consumption, moderate alcohol consumption predicted a statistically significant decrease in depressive symptoms (*b*=-1.29, *p*=.04). Similarly, compared with heavy alcohol consumption, non-consumption of alcohol predicted a statistically significant decrease in depressive symptoms (*b*=-1.00, *p*=.03). Tobacco use was a statistically significant predictor of depressive symptoms (*b*=1.25, *p*=.01). Vegetable and fruit intake (*b*=-.08, *p*=.70) and physical activity (*b*=-.41, *p*=.23) were not statistically significant predictors of depressive symptoms. Among the covariates, increased age predicted lower depressive symptoms (*b*=-.09, *p*=.003), and the six-month follow-up visit (*b*=-4.31, *p*<.0001) and twelve-month follow-up visit (*b*=-3.89, *p*<.0001) predicted lower depressive symptoms compared with the baseline visit. Race and sex were not statistically significant predictors of depressive symptoms. Compared with the model that included satisfaction with leisure activities and social support as potential confounding variables, the effect of vegetable and fruit intake and physical activity remained similar and not statistically significant. However, the effect of non-consumption of alcohol compared with heavy alcohol consumption along with tobacco use did not remain statistically significant in the model that included social support and

satisfaction with leisure activities as predictors, indicating that social support and satisfaction with leisure activities may confound the effects of these two lifestyle factors.

Table 3. *The Effect of Lifestyle Behaviors on Depressive Symptoms*

Predictor	*b*	*SE*	Lower 95% CI	Upper 95% CI	*p*
Intercept	17.20	1.79	13.68	20.72	<.0001
Vegetable/fruit Intake	-0.08	0.21	-0.50	0.33	0.70
Physical Activity					
High (≥ 150 METs/wk)	-0.41	0.35	-1.09	0.27	0.23
Low (<150 METs/wk)	Ref				
Tobacco Use	**1.25**	**0.51**	**0.25**	**2.24**	**0.01**
Alcohol Use					
None	**-1.00**	**0.45**	**-1.88**	**-0.12**	**0.03**
Moderate	**-1.29**	**0.63**	**-2.52**	**-0.06**	**0.04**
Heavy	Ref				
Race (White)	1.03	0.53	-0.01	2.07	0.05
Sex (Female)	-0.20	0.53	-1.25	0.85	0.71
Age (Years)	**-0.09**	**0.03**	**-0.15**	**-0.03**	**.003**
Visit					
Follow-up 2	**-3.89**	**0.34**	**-4.55**	**-3.23**	**<.0001**
Follow-up 1	**-4.31**	**0.35**	**-5.00**	**-3.63**	**<.0001**
Baseline	Ref				

Note: b = beta, *SE* = Standard Error, CI = Confidence Interval, *p* = probability, coefficients in bold are statistically significant ($p<.05$).

When the interaction terms were included in the model, total vegetable and fruit intake (b=.23, p=.45), physical activity (b=-.30, p=.52), and tobacco use (b=1.11, p=.08) were not statistically significant predictors of depressive symptoms (Table 4). In addition, there was not a statistically significant difference in depressive symptoms when non-consumption of alcohol was compared with heavy consumption of alcohol (b=-.95, p=.08). However, moderate alcohol use predicted a decrease in depressive symptoms when compared with heavy alcohol use (b=-2.22, p=.01). The interaction of social support with vegetable and fruit intake, physical activity, tobacco use, alcohol use, and satisfaction with leisure activities was not statistically significant ($p>.05$). Therefore, social support was not a statistically significant modifier of the effect of the lifestyle behaviors and satisfaction with leisure activities on depressive symptoms. Among the

covariates, increased age predicted lower depressive symptoms (*b*=-.07, *p*=.01), and the six-month follow-up visit (*b*=-3.72, *p*<.0001) and twelve-month follow-up visit (*b*=-3.36, *p*<.0001) predicted lower depressive symptoms compared with the baseline visit. Race and sex were not statistically significant predictors of depressive symptoms. The intraclass correlation coefficient for this model was 0.46.

Table 4. *Predictors of Depressive Symptoms with Social Support as a Modifying Variable*

Predictor	*b*	*SE*	Lower 95% CI	Upper 95% CI	*p*
Intercept	21.24	1.85	17.62	24.87	<.0001
Vegetable/fruit Intake	0.23	0.30	-0.36	0.82	0.45
Physical Activity					
High (≥ 150 METs/wk)	-0.30	0.46	-1.20	0.61	0.52
Low (<150 METs/wk)	Ref				
Tobacco Use	1.11	0.63	-0.13	2.35	0.08
Alcohol Use					
None	-0.95	0.54	-2.02	0.11	0.08
Moderate	**-2.22**	**0.81**	**-3.80**	**-0.63**	**0.01**
Heavy	Ref				
Satisfaction with Leisure Activities	**-0.83**	**0.12**	**-1.06**	**-0.60**	**<.0001**
Social Support					
High	**-1.89**	**0.94**	**-3.75**	**0.04**	**0.05**
Low	Ref				
Race (White)	0.75	0.48	-0.19	1.68	0.12
Sex (Female)	0.07	0.48	-0.87	1.01	0.89
Age (years)	**-0.07**	**0.03**	**-0.12**	**-0.02**	**0.01**
Visit					
Follow-up 2	**-3.36**	**0.35**	**-4.05**	**-2.66**	**<.0001**
Follow-up 1	**-3.72**	**0.33**	**-4.38**	**-3.06**	**<.0001**
Baseline	Ref				
Social Support * Vegetable/fruit Intake	-0.52	0.40	-1.31	0.27	0.19
Social Support * Physical Activity	-0.13	0.65	-1.41	1.14	0.84
Social Support * Tobacco Use	-0.41	0.79	-1.96	1.14	0.60
Social Support * Alcohol Use					
Social Support * No Alcohol Use	0.42	0.76	-1.07	1.91	0.58
Social Support * Moderate Alcohol Use	1.45	1.15	-0.82	3.72	0.21
Social Support * Heavy Alcohol Use	Ref				
Social Support * Satisfaction with Leisure Activities	-0.004	0.17	-0.33	0.33	0.98

Note: b = beta, *SE* = Standard Error, CI = Confidence Interval, *p* = probability, coefficients in bold are statistically significant (*p*<.05).

Intention to Change Lifestyle Factors

Among participants with moderate depressive symptoms, 61% of participants selected diet, 55% exercise, 39% substance use, 39% other, 26% social support, and 17% recreation/leisure. A similar rank order was found among participants with moderately severe and severe depressive symptoms. Among participants with moderately severe depressive symptoms, 52% selected diet, 52% exercise, 41% substance use, 36% other, 28% social support, and 22% recreation/leisure. Among participants with severe depressive symptoms, 51% selected diet, 47% exercise, 34% substance use, 32% other, 28% social support, and 27% recreation/leisure. A greater percent of participants with moderate depressive symptoms activated the diet and exercise domains compared with participants who had moderately severe or severe depressive symptoms. However, a greater percent of participants with moderately severe and severe depressive symptoms activated the recreation/leisure domain compared with participants who had moderate depressive symptoms. Also, a greater percent of participants with moderate and moderately severe depressive symptoms activated the substance use domain compared with participants with severe depressive symptoms.

Table 5. *Activated Domains at First Coaching Visit by Severity of Depressive Symptoms, n (%)*

Health Domain	Moderate (n = 101)	Moderately Severe (n = 88)	Severe (n = 79)
Diet	62 (61)	46 (52)	40 (51)
Exercise	56 (55)	46 (52)	37 (47)
Substance Use	39 (39)	36 (41)	27 (34)
Social Support	26 (26)	25 (28)	22 (28)
Recreation/Leisure	17 (17)	19 (22)	21 (27)
Other	39 (39)	32 (36)	25 (32)

CHAPTER FIVE

Discussion

Summary

In the adjusted models, greater social support and satisfaction with leisure activities predicted lower depressive symptoms. In addition, moderate alcohol consumption predicted lower depressive symptoms compared with heavy alcohol consumption. However, no alcohol consumption did not predict a statistically significant difference in depressive symptoms compared with heavy alcohol consumption. In addition, total vegetable and fruit intake, physical activity, and tobacco use were not statistically significant predictors of depressive symptoms. The effect of vegetable/fruit intake and physical activity on depressive symptoms was not statistically significant in the models with and without social support and satisfaction with leisure activities included as predictors. However, the statistical significance of the effect of tobacco use and alcohol use on depressive symptoms varied between the models with and without social support and satisfaction with leisure activities included as predictors, indicating that these factors are potential confounding variables. Also, the interaction of the lifestyle factors with social support was not statistically significant. Therefore, the influence of the lifestyle factors on depressive symptoms did not depend on the participants' level of social support.

Vegetables and Fruit

In this study, there was not enough evidence to conclude that total vegetable and fruit intake predicted depressive symptoms. Some studies reported similar results (Liu et al., 2016; Saghafian et al., 2018). For example, a cross-sectional study conducted among males and females from 16 countries in Europe did not find a statistically significant association between

depression and daily fruit intake (Allgower, Wardle, & Steptoe, 2001). Similarly, cross-sectional studies conducted among males and females in Finland (Hintikka et al., 2005) and Hong Kong (Woo et al., 2006), and a cohort study in Taiwan (Chi, Wan & Tsai, 2016) did not find a statistically significant reduced risk of depression among individuals who consumed greater amounts of fruits or among individuals consuming greater amounts of vegetables. When considering combined vegetable and fruit intake, two studies did not find a statistically significant reduced risk of depression among participants who had greater total vegetable and fruit intake (Aihara, Minai, Aoyama, & Shimanouchi, 2011; Verger, Lions, & Ventelou, 2009).

Additionally, a few studies found a significantly reduced odds of having depression among people who consumed greater amounts of fruits and a non-significant outcome among people who consumed greater amounts of vegetables. For example, Sanchez-Villegas et al. (2009) and Mihrshahi, Dobson, and Mishra (2015) conducted cohort studies and found a reduced odds of developing depression among participants with greater consumption of fruit, but there was not a statistically significant outcome for vegetables. Therefore, the effects of vegetables and fruits on depression may differ. However, pooled results from meta-analyses that included these studies indicated a statistically significant reduced risk for depression among people in the highest category of fruit intake compared with the lowest category of fruit intake and among people in the highest category of vegetable intake compared with the lowest category of vegetable intake (Liu et al., 2016; Saghafian et al., 2018). In addition, pooled results from the meta-analysis conducted by Saghafian et al. (2018) indicated a statistically significant lower risk for depression among people who consumed greater amounts of total vegetables and fruit.

Differences in outcomes between individual studies could be due to differences in the measurement of the exposure or outcome, differences in the populations studied, and differences

in the covariates included in the analyses. For example, vegetables and fruits were measured as individuals in the highest quintile compared with the lowest quintile for consumption of vegetables and fruits (Sanchez-Villegas, 2009), at least two servings of vegetables or fruits per day (Hintikka et al., 2005; Mihrshahi et al., 2015), or daily consumption of vegetables or fruits (Allgower et al., 2001; Verger et al., 2009). Additionally, populations varied by age groups, countries, and sample size (Liu et al., 2016; Saghafian et al., 2018). Finally, there were a total of sixty possible covariates included throughout the studies in the meta-analysis by Saghafian et al. (2018). Differences in adjustment for these variables may partially explain differences in study outcomes.

Rather than focusing on specific nutrients or foods, many studies included vegetables and fruits as nutritious components of dietary patterns. Studies were categorized as "Healthy" or the "Mediterranean" dietary pattern within meta-analyses and included vegetable and fruit intake as part of diet quality scores or indexes (Lai et al., 2014; Lassale et al., 2018; Psaltopoulou et al., 2013; Shafiei et al., 2019). For example, studies that calculated diet scores with the USDA Healthy Eating Index or the Alternative Healthy Eating Index included points for total fruit intake and total vegetable intake within the diet score (Guenther, Reedy, & Krebs-Smith, 2008; McCullough et al., 2002). Pooled results from most studies found a statistically significant reduced risk for having depression among people with greater adherence to a "Healthy" (Lai et al., 2014; Lassale et al., 2018) or "Mediterranean" dietary pattern (Psaltopoulou et al., 2013; Shafiei et al., 2019). However, pooled results from some cohort studies did not report statistically significant outcomes. For example, Shaafiei et al. (2019) pooled results from four cohort studies and did not find a statistically significant greater risk for developing depression with greater adherence to the Mediterranean diet. Similarly, Lassale et al. (2018) pooled results from three

cohort studies and did not find a statistically significant lower risk of developing depression among participants with a high compared with low diet score.

Dietary patterns are often assessed to reflect overall nutrient intake and diet quality. Nutrients that may influence depressive symptoms include omega-3 polyunsaturated fatty acids, vitamin D, vitamin B_6, vitamin B_{12}, folate, iron, zinc, magnesium (Dog, 2010), and vitamin C (Payne et al., 2012). These nutrients are present in a variety of foods in different amounts (NIH, 2019). Many nutrients, including vitamin D, iron, zinc, and magnesium are only found in a few types of vegetables or fruits (NIH, 2019). For example, vitamin D is found in mushrooms, iron and magnesium are present in spinach and legumes, and zinc can be found in beans (NIH, 2019). Vitamin B_{12} is not found naturally in vegetables and fruits (NIH, 2019). However, it is present in fish, meat, poultry, and dairy products (NIH, 2019). Therefore, variation in foods consumed among participants and variations in food included in the measurement of dietary intake may contribute to different study outcomes.

Physical Activity

In this study, achieving at least 150 METs per week in physical activity was not a statistically significant predictor of depressive symptoms. This outcome is similar to results from many individual studies. For example, the majority of cohort studies included in a meta-analysis by Schuch et al. (2018) to evaluate the effect of physical activity on incident depression did not report a statistically significant outcome. Similarly, many RCTs included in meta-analyses evaluating the effect of physical activity on depression did not have statistically significant outcomes (Beland et al., 2019; Bernard et al., 2018; Josefsson et al., 2014; Krogh et al., 2017; Morres et al., 2019; Rebar et al., 2015; Schuch et al., 2016). However, pooled results reported in meta-analyses that included these studies indicated a significant effect of physical activity on

depression. For example, many pooled results from RCTs that evaluated the effect of physical activity on depression found a statistically significant reduction in the risk for depression among the intervention group (Beland et al., 2019; Bernard et al., 2018; Josefsson et al., 2014; Krogh et al., 2017; Morres et al., 2019; Rebar et al., 2015; Schuch et al., 2016). In addition, a significant protective effect was found when results from 36 cohorts were pooled (Schuch et al., 2018).

Many factors may explain the differences in study outcomes and null effects. For example, the effect of structured exercise and leisure time activity may be different than total physical activity from travel, work, and recreation. Two cohort studies measured leisure-time physical activity rather than total physical activity (Schuch et al., 2018). In addition, RCTs measured the intervention effects of structured exercise regimes rather than total daily physical activity (Josefsson et al., 2014; Krogh et al., 2017). Because physical activity seems to influence depressive symptoms by affecting physiological processes (Lopresti et al., 2013), total physical activity is expected to have a stronger effect than leisure activity alone. However, measures of total physical activity may be less reliable or valid than supervised exercise regimes. Physical activity measured in observational studies is often self-reported (Schuch et al., 2018), so it is susceptible to recall bias. On the other hand, physical activity measured in RCTs was often supervised (Josefsson et al., 2014), improving the validity and reliability of the measure.

Additionally, differences in the dose, frequency, duration, and type of physical activity varied between studies and participants, potentially contributing to differential effects on depressive symptoms. For example, the frequency of sessions ranged from two to five sessions per week, duration ranged from 20 to 60 minutes per session, intensity was unreported or near 80% max heart rate, and type of activity included aerobic and nonaerobic exercise (Josefsson et al., 2014). There may be an optimal combination of these factors to reduce depressive symptoms.

Achieving 150 METs per week is recommended to prevent many chronic diseases, including cardiovascular disease, diabetes, and cancer (WHO, 2018). Assessing the effects of 150 METs per week on depressive symptoms helps determine if achieving this amount of physical activity could prevent depressive symptoms as well. Pooled results from a few studies indicated that there was a reduction in the odds of developing depression among participants who achieved 150 METs per week of moderate or vigorous physical activity compared with individuals who did not achieve 150 METs per week of moderate or vigorous physical activity (Schuch et al., 2018). However, some individuals may experience beneficial effects at lower doses of physical activity, providing a potential intervention for individuals limited in the type or intensity of physical activity that they are able to achieve. Additionally, the environment may affect the influence of physical activity on depressive symptoms. Physical activity that occurs in nature may increase the effect of physical activity on depressive symptoms (Berk et al., 2013).

Tobacco Use

Tobacco use was a statistically significant predictor of depressive symptoms when social support and satisfaction with leisure activities were not included in the model as predictors. However, tobacco use was a marginally statistically significant predictor of depressive symptoms when social support and satisfaction with leisure activities were included as predictors in the model. Similarly, in a sample of US Black adults (Klonoff & Landrine, 2001), US primary care patients (Brown, Madden, Palenchar, & Cooper-Patrick, 2000), US chronic pain patients (Fishbain et al., 2007), and US older adults (Haas, Eng, Dowling, Schmitt, & Hall, 2005), there was not a statistically significant relationship between depression and smoking. However, pooled results from three meta-analyses indicated an increased odds of having depression among tobacco users (Esmaeelzadeh et al., 2018; Luger et al., 2014; Taylor et al., 2014).

Nicotine is a component in tobacco that is hypothesized to influence depressive symptoms (Picciotto, Brunzell, & Caldarone, 2002). Nicotine is found in tobacco products and targets neuronal nicotinic acetylcholine receptors (Picciotto et al., 2002). These receptors regulate stimulatory, inhibitory, and modulatory neurotransmitters, affecting depressive symptoms through many mechanisms (Picciotto et al., 2002). The effect of nicotine on depression is complex because nicotine can act as a depressant or anti-depressant (Picciotto et al., 2002). In addition, the exposure and the route of transmission may affect the influence of nicotine on depressive symptoms (Picciotto et al., 2002). Nicotine may have antidepressant effects with short durations of tobacco use, but nicotine withdrawal can result in depression among participants with a history of chronic tobacco use (Picciotto et al., 2002). Among chronic users, tobacco use can be seen as a state of persistent withdrawal with short periods of intoxication (Berk et al., 2013). Additional components of tobacco may contribute to depressive symptoms by inducing an inflammatory response (Nunes et al., 2012). Participants' smoking history, duration of use, and type of tobacco use was not evaluated in my analysis. These factors contribute to individual differences and may affect the odds of depression among tobacco users and non-users.

Alcohol Use

Moderate alcohol consumption predicted lower depressive symptoms compared with heavy alcohol consumption. However, there was not a statistically significant difference in depressive symptoms between non-consumers of alcohol and heavy alcohol consumers. Similarly, light to moderate alcohol consumption was associated with a reduced prevalence (Bellos et al., 2013) and incidence of depression in two recent studies (Bellos et al., 2016). In addition, moderate alcohol consumption is included in the Mediterranean dietary pattern (Willett et al., 1995). For example, studies categorized moderate alcohol consumption as a dichotomous

variable with 5-25 grams per day for females and 10-50 grams per day for males (Adjibade et al., 2018) or less than seven glasses of wine per week (Estruch et al., 2013) within indexes for the Mediterranean dietary pattern. A reduced prevalence of depression was found among people with greater adherence to the Mediterranean dietary pattern (Lassale et al., 2018; Psaltopoulou et al., 2013; Shafiei et al., 2019). This outcome may be attributed in part to moderate alcohol consumption, providing additional evidence that a reduction in depressive symptoms could be attributed to moderate alcohol consumption.

Many properties of alcohol may influence depressive symptoms. The antioxidants and polyphenols present in red wine may reduce depressive symptoms by their neuroprotective (Vauzour, 2012) and anti-inflammatory effects (Bouayed, 2010). However, most analyses of moderate alcohol consumption or the Mediterranean dietary pattern on depression did not differentiate between red wine and other alcoholic beverages, so additional properties of alcohol and mechanisms may explain the protective effects. For example, moderate alcohol consumption may reduce depressive symptoms by acting on gamma-aminobutyric receptors, neurotransmitters, and hormonal systems that reinforce alcohol consumption (Bellos et al., 2016) and regulate emotions (Mohler, 2012).

Reverse-causality may explain the relationship between alcohol consumption and depressive symptoms because depressive symptoms could have been present prior to the thirty days when alcohol consumption was reported. Therefore, the presence of depressive symptoms may affect individuals' level of alcohol consumption. Interestingly, there was not a statistically significant difference between non-consumers and heavy consumers of alcohol. The null finding was found when comparing non-consumers of alcohol with heavy users. It is still possible that there is no difference in depressive between non-consumers and moderate consumers of alcohol.

The null effect found when comparing non-consumers of alcohol with heavy consumers may be due to confounding from unmeasured variables, including past alcohol history or the presence of chronic diseases and medication use that contraindicate alcohol use (Filmore, Stockwell, Chikritzhs, Bostrom, & Kerr, 2007). However, the intake of alcohol could influence the presence of chronic diseases (Pavlidou et al., 2018), so moderate alcohol consumption may also reduce the presence of chronic diseases, mediating the relationship between moderate alcohol consumption and depressive symptoms. Future interventions among PSH residents that reduce consumption of alcohol from heavy to moderate alcohol consumption may be effective in reducing depressive symptoms in this population.

Social Support

An increase in perceived social support predicted a reduction in depressive symptoms. Similar results were found among many studies. For example, Moak and Agrawal (2010) used data from a representative sample of 34,653 U. S. adults who completed the National Epidemiological Survey on Alcohol and Related Conditions. In this analysis, an increase in perceived interpersonal social support was associated with a reduced prevalence of MDD, controlling for gender, age, ethnicity, and living below the poverty line (OR = 1.32; 95% CI = 1.21, 1.43) (Moak & Agrawal, 2010). Similarly, Teo, Choi, and Valenstein (2013) evaluated the effect of social relationships on depression among a nationally representative cohort of 4,642 American adults. Over a period of ten years, there was an increased risk of depression among participants with a lack of social support (OR = 1.79; 95% CI = 1.37-2.35) and lower quality relationships (OR = 2.60; 95% CI = 1.84-3.69) (Teo, Choi, & Valenstein, 2013). In addition, in a review of 100 studies, the majority of studies reported a reduced risk of depression among

individuals who had greater levels of social support across multiple age groups and geographical regions (Gariépy et al., 2016).

Social support is multi-dimensional and includes instrumental, information, and emotional aspects of social support (House et al., 1998). Two processes can explain the effect of social support on depressive symptoms. Social support can reduce depressive symptoms indirectly by buffering the effects of stress on psychological processes (Cohen & Wills, 1985). In this way, increased perceived social support can improve individuals' coping abilities and reduce the negative physiological responses to a stressful event (Cohen & Wills, 1985). In addition, social support can reduce depressive symptoms by having a direct effect on physiological processes irrespective of exposure to a stressful event (Cohen & Wills, 1985). For example, having people to talk to and a group to spend time with demonstrates the level of integration into a support system. A greater level of integration into a support system can increase a sense of belonging, improving psychological wellbeing. These two processes may be related; increased integration into a support system may reduce the number of stressful events experienced (Moak & Agrawal, 2010). Although social factors can interact with individual factors to influence biological mechanisms and health outcomes (Bronfenbrenner, 1979), social support did not interact with the effects of lifestyle factors on depressive symptoms in this analysis. This indicates that the effect of lifestyle behaviors does not depend on the individual's level of perceived social support. Social support may have an additive rather than multiplicative interactive effect with other lifestyle factors on depressive symptoms.

Satisfaction with Leisure Activities

Increased satisfaction with leisure activities predicted a reduction in depressive symptoms. Therefore, increasing participation in satisfying activities may be an effective

treatment for depression among PSH residents. Participating in enjoyable activities is a common component of activity scheduling, which is an effective treatment for depression (Cuijpers et al., 2007). Both social and solitary activities may be perceived as satisfying activities and have an effect on depressive symptoms (Goodman et al., 2016). In a meta-analysis by Cuijpers et al. (2007), activity scheduling was found to have similar effects on depression as other psychological treatments, including cognitive therapy. For example, Comas-Diaz (1981) compared activity scheduling with cognitive therapy among a group of low-income women. Both treatments significantly reduced depression with no significant difference between the treatment groups (Comas-Diaz, 1981). Similarly, activity scheduling was compared with cognitive treatment and a control condition among twenty-five adults in Australia (Wilson, Goldin, Charbonneau-Powis, 1983). Cognitive therapy and activity scheduling had a significant effect on depressive symptoms, and there was not a significant difference between these treatment approaches (Wilson et al., 1983). Activity scheduling was effective in reducing depressive symptoms among multiple populations, including young adults (Taylor & Marshall, 1977) and dementia patients (Teri, Logsdon, Uomoto, & McCurry, 1977).

Activity scheduling was developed as a treatment approach for depression to support participants in monitoring and making connections between their daily activities and mood (Lewinsohn, Biglan, & Zeiss, 1976). In this way, they learn to increase participation in enjoyable activities and receive positive reinforcement (Lewinsohn et al., 1976). This treatment approach was developed due to the connection found between the frequency of participation in enjoyable activities and mood (Lewinsohn & Graf, 1973) and the association between the variety and frequency of participation in enjoyable activities (MacPhillamy & Lewinsohn, 1974). For example, Pressman et al. (2009) reported a correlation between increased participation in

enjoyable activities and depressive symptoms among 1,399 adults. Additionally, increased participation in enjoyable activities buffered the effects of stressful life events on negative and positive affect (Pressman et al., 2009). Therefore, participation in enjoyable activities may reduce depressive symptoms by buffering the effects of stressful life events.

Pressman et al. (2009) reported that participants with lower education and lower income reported less frequent participation in enjoyable activities. Individuals with a lower socioeconomic status may have significant barriers to participating in enjoyable activities. Ciro and Smith (2015) evaluated barriers to participation in meaningful activities among low-income housing residents. Barriers mentioned by participants included cost, available transportation, low awareness of activities available, functional disabilities, and the lack of interest in activities provided (Ciro & Smith, 2015). Interventions that reduce barriers to participate and provide leisure activities specific to participants' interest may be more effective in increasing satisfaction with leisure activities and reducing depressive symptoms. For example, Jung, Park, & Kim (2018) compared the effects of a customized leisure activity program to the existing leisure activity program. The customized leisure activities were individualized based on interviews with the clients. Participants in the customized leisure activity group experienced a statistically significant reduction in depressive symptoms while the control group did not experience a statistically significant change in depressive symptoms. In addition, the customized leisure activity group reported a significant increase in satisfaction with leisure activities after participation in the program. Customized activities included reading, walking, writing, learning a new task, and playing a game (Jung, Park, Kim, 2018). A client-centered intervention that facilitates participation in customized leisure activities may reduce depressive symptoms and increase satisfaction with leisure activities.

Intention to Change Lifestyle Factors

At their first coaching visit, participants were asked what lifestyle factor they would like to work on. A menu of options was presented that included diet, exercise, substance use, social support, and recreation/leisure. The rank order was the same for the behaviors chosen among participants with moderate, moderately severe, and severe depressive symptoms. Over half of participants with moderate (61%), moderately severe (52%), and severe (51%) depressive symptoms indicated they were interested in setting diet goals. This was the most common lifestyle factor that participants indicated interest in working on. Exercise was the second most common lifestyle factor that participants indicated they were interested in working on with moderate (55%), moderately severe (52%), and severe (51%) depressive symptoms. Over one third of participants with moderate (39%), moderately severe (41%) and severe (34%) depressive symptoms were interested in working on their substance use. Social support and recreation/leisure were the least common lifestyle factors that participants were interested changing. Slightly over one fourth of participants with moderate (26%), moderately severe (28%), and severe (28%) depressive symptoms were interested in working on social support. Participants with severe depressive symptoms expressed greater interest in working on recreation/leisure activities (27%) compared with participants with moderately severe (22%) or moderate (17%) depressive symptoms.

A variety of factors may explain participants' preference to work on diet, exercise, and substance use rather than social support or recreation/leisure activities. According to the Theory of Planned Behavior, intention to change a behavior can be explained by participants' attitudes toward the behavior, subjective norms, and their perceived behavioral control (Godin & Kok, 1996; Montano & Kasprzyk, 2008). For example, participants may choose to work on a health

area because they have a positive attitude toward changing these behaviors and believe that changes in these behaviors will result in positive health outcomes. Additionally, participants may feel pressured by other people's belief that they should work on the health area (Godin & Kok, 1996; Montano & Kasprzyk, 2008). Finally, participants may choose to work on the health area because they have greater perceived control over these behaviors and perceive fewer barriers to changing these behaviors (Godin & Kok, 1996; Montano & Kasprzyk, 2008).

Intention to work on these behaviors may change over time. As participants make progress in working on diet or exercise, they may gain self-efficacy and motivation to change additional lifestyle factors later in the program, including substance use, social support, and recreation/leisure activities. This is more likely to occur if participants believe that working on one lifestyle factor supports working on the second lifestyle factor (Fleig et al., 2015). For example, participants who are working on improving their dietary intake are more likely to begin working on physical activity as well if they believe working on dietary intake supports improvements in physical activity. Alternatively, participants may believe that improvements in a lifestyle factor can compensate for other health risk behaviors (Knäuper, Rabiau, Cohen, & Patriciu, 2004). For example, participants may believe that improvements in dietary intake can compensate for low physical activity, reducing their intention to work on physical activity.

While coaches suggested areas to work on, participants could make their own decision regarding the areas chosen. However, the coaching intervention was designed to motivate participants to initiate behavior changes. Therefore, these results are a best representation of PSH residents' intention to work on lifestyle factors after participating in their first coaching session. Because participants tended to prioritize working on diet, exercise, and substance use, narrowing the menu of options to social support and leisure activities could be a method to increase

selection of these lifestyle factors. However, the percent of participants at risk in each category is not clear. Therefore, it is possible that participants did not choose to work on social support or leisure activities because they had high levels of perceived social support and satisfaction with leisure activities. Also, the health domains could be modified in future interventions to focus on subcategories that have the potential to reduce depressive symptoms. For instance, the broad categories of diet, exercise, or substance use could be narrowed to focus on vegetable and fruit intake, moderate to vigorous physical activity, smoking cessation, and reducing heavy alcohol consumption.

Limitations

There are many limitations to consider with the analyses. First, because participants were restricted to PSH residents in Fort Worth, Texas, these results may be specific to PSH residents in this area. For example, these results may not be generalizable to PSH residents who live in different geographical locations. Second, the participants were enrolled in a technology-assisted health coaching program. Evaluation of participants' interest in changing lifestyle factors may differ from PSH residents who are not participating in a health coaching program. Also, it is not clear if components of the health coaching program affected the outcome of the analyses. Third, vegetable and fruit intake, social support, and satisfaction with leisure activities were measured by modified questionnaires. These modified questionnaires have not been compared with a previously validated or gold standard measure, potentially affecting the accuracy of the results. Fourth, the model included three timepoints to evaluate the effects of lifestyle factors on depressive symptoms over a period of one year. All 420 participants' data was utilized. However, missing data from participants may bias the results toward or away from the null hypotheses if data is not missing at random.

Recommendations

In this study, the influence of multiple lifestyle factors on depressive symptoms was assessed, controlling for age, race, sex, and visit. Vegetable and fruit consumption was not a statistically significant predictor of depressive symptoms. Increased vegetable and fruit intake may not be sufficient to reduce depressive symptoms in this population. The nutrients of vegetables and fruit vary (NIH, 2012) and may interact with additional foods consumed within a dietary pattern. Vegetables and fruits may contribute to a reduction in depressive symptoms when included in a dietary pattern. Although vegetables and fruits were measured within indexes for the healthy dietary pattern and Mediterranean dietary pattern in previous studies, there is more evidence supporting the effect of the Mediterranean dietary pattern on depressive symptoms (Lassale et al., 2018; Psaltopoulou et al., 2013; Shafiei et al., 2019). Further research is needed to have a better understanding of the mechanisms in which dietary intake influences depressive symptoms and to decipher an optimal dietary pattern. Future research should evaluate the effect of dietary intake on depressive symptoms among PSH residents. Dietary intake interventions should be tailored for PSH residents and evaluated to determine their effect on depressive symptoms among this population.

Achieving 150 METs per week in physical activity did not predict depressive symptoms when compared with PSH residents who did not achieve 150 METs per week. Physical activity may influence depressive symptoms at a variety of doses, frequencies, and intensities. In this analysis, physical activity was limited to moderate and vigorous physical activity, but it is possible that light intensity physical activity has an influence on depressive symptoms as well. Future research should evaluate the effect of light intensity physical activity on depressive symptoms among PSH residents. In addition, RCTs focused on the effects of structured exercise

programs (Beland et al., 2019; Josefsson et al., 2014; Krogh et al., 2017; Morres et al., 2019; Schuch et al., 2016). Increasing structured exercise often reflects an increase in leisure time physical activity. In this study, physical activity was total moderate and vigorous activity from work, travel, and recreation. Structured exercise may be more similar to leisure time activity and have a different effect on depressive symptoms than total physical activity. Future research should evaluate the effects of a structured exercise program and leisure time physical activity on depressive symptoms among PSH residents.

Tobacco use did not predict depressive symptoms among PSH residents compared with non-users. The role of nicotine on depressive symptoms is complex and may have antidepressant effects when consumed and induce depressive symptoms during periods of withdrawal (Berk et al., 2013; Picciotto et al., 2002). It is possible that the effect of cigarette smoking on depressive symptoms varies from overall tobacco use. In addition, participants' history of tobacco use and frequency of current tobacco use may influence the effect of tobacco use on depressive symptoms. Future research should compare the effect of cigarette smoking with other types of tobacco use. In addition, future research should evaluate the effect of participants' history of tobacco use, frequency of use, and smoking cessation interventions on depressive symptoms among PSH residents.

Compared with heavy alcohol consumption, moderate alcohol consumption predicted a reduction in depressive symptoms among PSH residents. In addition, no alcohol consumption did not predict a reduction in depressive symptoms compared with heavy alcohol consumption. Past alcohol history or the presence of chronic diseases and medication use that contraindicate alcohol use (Filmore et al., 2007) may confound the effect of alcohol use on depressive symptoms. However, alcohol intake may influence the presence of chronic diseases (Pavlidou et al., 2018),

so the presence of chronic diseases may mediate the relationship between alcohol consumption and depressive symptoms. While there was not enough evidence to conclude that there was a difference in depressive symptoms between non-consumers of alcohol and heavy consumers, a reduction in alcohol intake from heavy to moderate alcohol consumption may reduce depressive symptoms among PSH residents. In addition, moderate alcohol consumption may have health promoting effects (Pavlidou et al., 2018). Most studies evaluated the effect of alcohol abuse or dependence on depressive symptoms rather than the level of alcohol consumption (Berk et al., 2013; Boden & Fergusson, 2011). Furthermore, red wine has unique properties (Bouyed, 2010; Vauzour, 2012) that may explain a different effect on depressive symptoms compared with other types of alcoholic beverages. However, few research studies differentiated between the type of alcohol consumed when evaluating the effect of alcohol consumption on depressive symptoms. More research is needed to evaluate the influence of moderate alcohol consumption on depressive symptoms compared with no alcohol consumption and heavy alcohol consumption. Future research should differentiate between the type of alcohol consumed and effects of no, moderate, and heavy alcohol consumption on depressive symptoms. Alcohol intake interventions that aim to lower alcohol use from heavy to moderate alcohol use should be tailored for PSH residents and evaluated to determine the effect of the intervention on depressive symptoms among this population.

Social support and satisfaction with leisure activities predicted depressive symptoms, controlling for vegetable and fruit intake, physical activity, tobacco use, alcohol use, age, sex, race, and visit. Future health policies and interventions among PSH residents should aim to facilitate participants' involvement in satisfying leisure activities and help them develop supportive relationships to reduce depressive symptoms in this population. In this study, less

than 30% of PSH residents with moderate, moderately severe, or severe depressive symptoms chose to work on social support or recreation/leisure activities at the end of their first coaching visit. These lifestyle factors were chosen to work on less often than diet, exercise, substance use, or other health domains. Additional research is needed to assess the reasons why the majority of participants with moderate to severe depressive symptoms did not choose to work on social support or satisfaction with leisure activities at their first coaching visit. It is possible that participants did not choose to work on these lifestyle factors because they already had high levels of social support or satisfaction with leisure activities. However, it is also possible that PSH residents preferred to work on other lifestyle factors when given the choice; more participants may be interested in working on social support and recreation/leisure activities if these are the only factors that the intervention addresses. In addition, participants may have chosen to work on social support or recreation/leisure activities later in the program. Further research is needed to determine the lifestyle factors participants chose to work on throughout the program and how these decisions changed over time.

Because the stage of change among participants who did not choose to work on social support and recreation/leisure activities is unclear, future research is needed to assess PSH residents' readiness to work on social support and recreation/leisure activities. In addition, future research should evaluate the factors that influence their decision to work on social support and recreation/leisure activities to inform the development of future interventions. For example, individual factors that influence this decision could include participants' attitude toward the behavior, subjective norms, and perceived behavioral control (Godin & Kok, 1996; Montano & Kasprzyk, 2008). The social or physical environments may be contributing factors that affect social support (Giurgescu et al., 2015; Wang, Chen, Shen, & Morrow-Howell, 2018) and

satisfaction with leisure activities (Ciro & Smith, 2015) and should be evaluated as well. Knowledge of factors influencing PSH residents' decision to work on social support or recreation/leisure activities can help tailor future intervention approaches.

Future interventions could target environmental and individual factors, incorporating an ecological intervention approach to increase perceived social support and satisfaction with leisure activities. Public health interventions could increase participants' social support by providing group activities or individual support directly, working with participants to leverage sources of support within their social network, or facilitating supportive connections between participants and community members. Public health interventions could increase participants' satisfaction with leisure activities by increasing available opportunities for leisure activities. For example, participants could work with health coaches to find activities that they enjoy and can participate in more often. Activities could include reading, writing, cooking, sports, hobbies, playing a musical instrument, gardening, volunteering at a local organization, or spending time with others. Participation in these activities could be facilitated by community events, local organizations or clubs, and shared resources such as areas to play sports or a community garden. Coaches could work with participants in person or through technology-assisted interventions. Future interventions should aim to increase social support and satisfaction with leisure activities as they relate to lifestyle behaviors during the process of changing lifestyle behaviors. This approach is recommended to modify lifestyle behaviors, social support, and satisfaction with leisure activities at the same time to reduce depressive symptoms. Further research is needed to evaluate lifestyle interventions and health policies that aim to reduce depressive symptoms by increasing perceived social support and satisfaction with leisure activities among PSH residents.

Conclusions

In conclusion, moderate alcohol consumption predicted lower depressive symptoms compared with heavy alcohol consumption among PSH residents. In addition, high compared with low satisfaction with leisure activities predicted lower depressive symptoms, and high compared with low social support predicted lower depressive symptoms. Tobacco use was a marginally statistically significant predictor of depressive symptoms. Total vegetable and fruit intake and physical activity were not statistically significant predictors of depressive symptoms. Social support was not a statistically significant modifier of the effect of lifestyle factors on depressive symptoms. Participants with moderate, moderately severe, and severe depressive symptoms were most interested in working on diet, exercise, and substance use and least interested in working on social support and recreation/leisure activities. Lifestyle interventions designed to reduce depressive symptoms among PSH residents should aim to increase PSH residents' social support and satisfaction with leisure activities. An ecological approach may be necessary to influence social support and satisfaction with leisure activities among PSH residents.

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