

PHYSICAL ACTIVITY IN RELATION TO DEPRESSIVE SYMPTOMS
IN BLACK U.S. ADULTS: RESULTS FROM
THE NATIONAL SURVEY OF AMERICAN LIFE

by

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A Dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Nursing)
in The University of Michigan
2009

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To Mom and Dad
and Dorisa

ACKNOWLEDGEMENTS

I would like to thank the co-chairs of my committee, Drs. Carolyn Sampsel and Kimberlee Gretebeck. Dr. Sampsel's decades of experience have been instrumental in her role modeling and helping me establish long-term career goals. Dr. Gretebeck has provided expertise in physical activity and countless hours of mentoring as a research associate on her study. Drs. Sampsel and Gretebeck have provided outstanding team effort in their guidance, patience and enthusiasm. They are largely responsible for encouraging me to obtain external funding, complete this dissertation and lay the foundation for a research career. I am enormously indebted to both.

I wish to expressly thank Dr. David Ronis for his repeated statistical guidance, particularly through his chemotherapy. Dr. Harold Neighbors introduced me to the National Survey of American Life and helped form my thinking on mental health in general and in minority populations. I am grateful to both for their gentle and kind direction.

This accomplishment would not be possible without the financial assistance I've received from the the Rackham Merit Fellowship and the National Institutes of Health. Specifically, the National Institute of Nursing Research provided assistance through an Individual National Research Service Award, Grant # 1F31NR010669-01 (PI: Torres) which funded this study, and the Women's Health Disparities Interdisciplinary Training Grant # 5T32NR007965-05 (PI: Sampsel), which funded a year of coursework. Additional coursework in translational research was funded through the Michigan Institute for Clinical and Health Research, Clinical and Translational Service Award,

Grant # UL1RR024986 (PI: Clauw), Multidisciplinary Clinical Researchers in Training Year-Long Program, Grant # 5T32RR023257-03 (PI: Kang), and Multidisciplinary Clinical Researchers in Training Summer Practicum, Grant # 1T32RR023257-01(PI: Kang).

On a personal note, I'd like to thank my partner Tim for his constant support through almost two decades of higher education. I had the privilege of helping Tim train for and then crew his first 100 mile race at Western States. After running continuously for 29 hours, 39 minutes, and 9 seconds, Tim has shown me that all things are possible with education, perseverance, hard work and enormous good fortune. I am lucky to have too many friends to name, but I thank them for sharing in my laughter and tears, particularly the Ann Arbor running community.

I would like to acknowledge my parents who have been married for over 40 years. My dad's teachings in spirituality helped me find my path. My mom instilled in me the importance of higher education when she told me at the age of 5 that I would go to college. I have achieved what our grandparents could not imagine.

I end my acknowledgements with thanks to the participants who volunteered to be part of the National Survey of American Life, and faculty and staff at the University of Michigan. It is my hope that this study will add to the body of literature aiming to promote health and prevent disease.

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ABSTRACT

PHYSICAL ACTIVITY IN RELATION TO DEPRESSIVE SYMPTOMS IN BLACK U.S. ADULTS: RESULTS FROM THE NATIONAL SURVEY OF AMERICAN LIFE

by

Elisa Rosee Torres

Co-Chairs: Carolyn Sampsel and Kimberlee Gretebeck

A report of the Surgeon General revealed Blacks are underrepresented in mental health research (USDHHS, 2001). The purpose of the current study is to investigate the relation between physical activity (PA) and depressive symptoms in Black U.S. adults. Various mechanisms by which PA are proposed to decrease depressive symptoms are explored, including biological, psychological, social, cultural, seasonal and geographical factors. Since the exact mechanism of action is unknown, PA may not decrease depressive symptoms in all populations. A systematic literature review performed to determine the effects of PA on depressive symptoms in Black adults found inconclusive results, partly due to convenience sampling, predominantly female samples, and lack of reported guidance by theory. A secondary data analysis was subsequently performed on the National Survey of American Life (n=4,716), guided by Stokols' Social Ecology of Health Promotion. Multiple regression for complex samples examined the relationship between PA and depressive symptoms while controlling for personal (sex, age, body

mass index, disability, family history of depression and perceived discrimination) and environmental factors (ethnic origin, household income, region of country, neighborhood safety). Three separate analyses were performed for each type of PA, with a Bonferroni correction of $p < .0167$ test for significance. Depressive symptoms were associated with sports/exercise in women ($b = -.40$, $R^2 = .22$) and men ($b = -.73$, $R^2 = .17$) and walking in women ($b = -.28$, $R^2 = .22$). In contrast to sports/exercise and walking, gardening/yardwork was significantly correlated with increased age in women ($r = .22$) and men ($r = .03$). Family history of depressive symptoms was associated with depressive symptoms in women but not men. Longitudinal studies are needed to establish causality. Validation of self-report measures is recommended, such as DNA analyses for genetic factors. Consideration should be given to differentiating among leisure, transportation, occupation and household PA to avoid collapsing all types of PA into one variable. Studies should examine gardening and yard work separately, paying particular attention to whether this type of PA increases with age. PA measurements should include intensity, frequency, duration and type in order to compare results to national PA guidelines. Better measurements of the environment are needed.

CHAPTER I INTRODUCTION

Randomized trials have found physical activity effective in decreasing depressive symptoms (Baker et al., 2007; Brenes et al., 2007; Dunn, Trivedi, Kampert, Clark, & Chambliss, 2005; Knubben et al., 2007; Mather et al., 2002; Penninx et al., 2002; Singh, Clements, & Singh, 2001). Non-White participants have rarely been included in such trials (Brenes et al.; Dunn et al.; Penninx et al.), supporting a report of the U.S. Surgeon General which concluded that ethnic minorities are underrepresented in mental health research (U.S. Department of Health & Human Services [USDHHS], 1999). Although physical activity is hypothesized to decrease depressive symptoms through biological, psychological and social mechanisms (Brosse, Sheets, Lett, & Blumenthal, 2002; Craft & Perna, 2004; Dishman et al., 2006; Fox, 1999; North, McCullagh, & Tran, 1990; Paluska & Schwenk, 2000; Scully, 1998; Singh & Singh, 2000; Yeung, 1996), the exact mechanism of action is unknown.

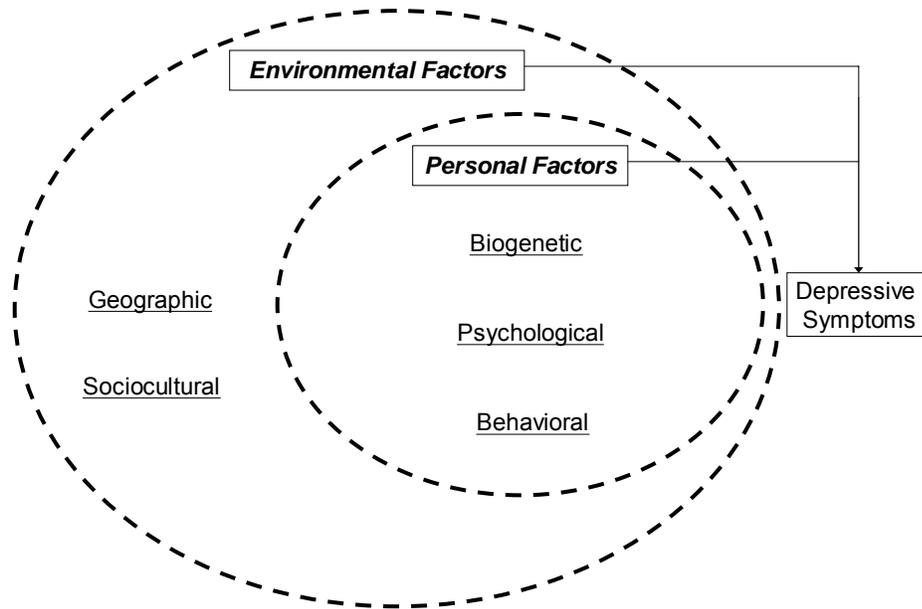
Few studies examining physical activity effects on depressive symptoms report guidance by a theory. Theory is important in guiding and generating explanations which are systematic and controllable by factual evidence that can be used in the organization and classification of knowledge (Carper, 1978). Theories that take into consideration multiple levels of influence are recommended to guide the investigation of physical activity effects on depressive symptoms in Black adults. For example, ecological models can address factors within the individual factors such as biological and psychological, as well as environmental factors such as social. Ecological models are one of the most commonly used theories for the study of physical activity behavior (Adams et al., 2006;

Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003; Bull, Eakin, Reeves, & Kimberly, 2006; Duncan & Mummery, 2005; Ebbeling et al., 2007; Giles-Corti, Timperio, Bull, & Pikora, 2005; Grzywacz & Marks, 2001; Hutzler, 2007; King, Stokols, Talen, Brassington, & Killingsworth, 2002; King, Satariano, Marti, & Zhu, 2008; Limstrand, 2008; Orleans, Kraft, Marx, & McGinnis, 2003; Resnick et al., 2007; Robertson-Wilson, Leatherdale, & Wong, 2008; Sallis, Bauman, & Pratt, 1998; Sallis et al., 2006; Satariano & McAuley, 2003; Swinburn, Egger, & Raza, 1999), including in the Black population (Eyler et al., 2002; Fleury & Lee, 2006; Kumanyika et al., 2007; Walcott-McQuigg, Zerwic, Dan, & Kelley, 2001). Ecological models are becoming more common in the literature related to depressive symptoms (Ailey & Miller, 2004; Corcoran & Franklin, 2002; Eachus et al., 1996; Gunnell, Peters, Kammerling, & Brooks, 1995; Miller et al., 2006; Wilson, Chen, Taylor, McCracken, & Copeland, 1999; Zimmerman & Bell, 2006).

The most common types of ecological models cited in the physical activity and/or depressive symptoms literature include those by Bronfenbrenner, McLeroy, Stokols, Sallis and King (Bronfenbrenner, 1979; King et al., 2002; McLeroy, Bibeau, Steckler, & Glanz, 1988; Sallis et al., 2006; Stokols, 1992). Sallis and King draw heavily from Bronfenbrenner, McLeroy, and Stokols. Bronfenbrenner's (1979) Ecological Systems Theory proposed different systems as nested within each other, similar to Russian Dolls. While Bronfenbrenner's Ecological Systems Theory yields a holistic model, it is more conceptual than methodological, requiring operationalization of its concepts, namely the microsystem, mesosystem, exosystem, and macrosystem. McLeroy, Bibeau, Steckler, & Glanz (1988) adapted Bronfenbrenner's work by introducing intrapersonal factors, interpersonal processes and primary groups, institutional factors, community factors and public policy. However, McLeroy et al. (1988) made it clear that the purpose of an ecological model is to focus attention on the environmental causes of behavior and to identify environmental interventions.

Stokols' (1992) Social Ecology of Health Promotion proposes efforts to promote human well-being should be based on an understanding of the dynamic interplay among diverse environmental and personal factors, rather than on analyses that focus exclusively on environmental, biological, or behavioral factors. Within personal factors, Stokols discusses biogenetic, psychological and behavioral. Within environmental factors, Stokols outlines sociocultural, technological and geographic, among others. Stokols operationalized each category. Figure 1 depicts personal factors nested within environmental factors as predictors of depressive symptoms, while providing the categories under each factor. Stokols' Social Ecology of Health Promotion has not been extensively researched, compared to other ecological models such as Bronfenbrenner. However, the few studies conducted show promise (Schneider, Randoll, & Buchner, 2006; Woods, Montgomery, Herring, Gardner, & Stokols, 2006). For example, risk factors for back pain revealed differences between women and men when Stokols' factors were taken into account (Schneider et al.). Psychological risk factors for back pain were significantly more common in women while behavioral, technological and sociocultural risk factors for back pain were significantly more common in men (Schneider et al.). Whereas Bronfenbrenner requires operationalization of the microsystem, mesosystem, exosystem, and macrosystem, Stokols has already operationalized personal factors such as psychological and behavioral variables, and environmental factors such as technological and sociocultural variables. In another study, there were significant associations between receiving a prostate-specific antigen blood test and/or digital rectal exam in Black U.S. men and personal factors (talking with personal physician about screening and/or self-initiated appointment for screening) and environmental factors (tv, radio, posters, brochures and handouts) (Woods et al.). Whereas McLeroy focuses on environmental causes of behavior, Stokols emphasizes personal and environmental factors.

Figure 1. Stokols' Social Ecology of Health Promotion



Stokols' Social Ecology of Health Promotion is the guiding conceptual model throughout this document. The mechanisms by which physical activity reduces depressive symptoms are explored, with suggestions for future directions. Since the exact mechanism of action is unknown, physical activity may not exert antidepressant effects in all populations. A systematic literature review was conducted to determine the possible effects of physical activity on depressive symptoms in Black adults. Based on the results of the systematic literature review, a secondary analysis on the National Survey of American Life (NSAL) database was performed which examined physical activity in relation to depressive symptoms in Black U.S. adults.

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CHAPTER II PHYSICAL ACTIVITY EFFECTS ON DEPRESSIVE SYMPTOMS: MECHANISMS OF ACTION

Almost thirty years of randomized trials have shown physical activity effective in decreasing depressive symptoms in nonclinical (King, Taylor, & Haskell, 1993; McCann & Holmes, 1984; McNeil, LeBlanc, & Joyner, 1991) and clinical settings (Dooyne et al., 1987; Greist et al., 1979; Klein et al., 1984; Martinsen, Hoffart, & Solberg, 1989; Veale et al., 1992). These classic studies have been recently criticized for poor quality (Lawlor & Hopker, 2001). Subsequently, randomized trials which followed CONSORT reporting guidelines (Moher D. Schulz KF. Altman DG. CONSORT GROUP [Consolidated Standards of Reporting Trials], 2001) have continued to find physical activity effective in reducing depressive symptoms in individuals diagnosed with depression (Dunn, Trivedi, Kampert, Clark, & Chambliss, 2005; Knubben et al., 2007; Mather et al., 2002; Singh, Clements, & Singh, 2001) or had scores indicative of depression (Brenes et al., 2007) and in healthy community samples (Baker et al., 2007; Penninx et al., 2002).

While research consistently points to a relationship between physical activity and depressive symptoms, the mechanisms underlying the antidepressant effects of physical activity remain unclear (Craft & Perna, 2004). Several biological, psychological and social mechanisms have been proposed. Few studies examining the effects of physical activity on depressive symptoms report guidance by a theory. A theory is an internally consistent group of relational statements that presents a systematic view about a phenomenon that is useful for description, explanation, prediction or prescription (Walker

& Avant, 2005). Ecological theories offer an integrative and broad understanding of the methods by which biological, psychological, sociocultural and physical environmental factors together affect well-being (Stokols, 2000). Personal and environmental factors as outlined in the Social Ecology of Health Promotion (Stokols, 1992) will serve as a guide in the examination of the mechanisms of action by which physical activity reduces depressive symptoms, including suggestions for future directions.

Personal Factors

Biogenetic

Amine hypothesis

The monoamine hypothesis of depression was introduced over 30 years ago and proposes that the underlying biological basis for clinical depression is a deficiency of central noradrenergic, serotonergic and/or dopaminergic systems (Delgado, 2000). Physical activity activates monoamines, specifically norepinephrine (Russo-Neustadt & Chen, 2005; Waters et al., 2005), serotonin (Chaouloff, 1997) and dopamine (Waters et al., 2005) in animal models, and norepinephrine (Davy, Johnson, & Seals, 1995; Dela, Mikines, Von Linstow, & Galbo, 1992; Deschenes et al., 1998; Poehlman & Danforth, 1991) and dopamine (Mazzeo, 1991) in humans. Physical activity may also increase phenylacetic acid concentration in urine, which reflects phenylethylamine, an endogenous neuroamine that has been linked to the regulation of clinical depression (Szabo, Billett, & Turner, 2001). The relationship of monoamines and clinical depression may be modulated in part by a gene-environment interaction (Holtzheimer, 2006). Although the monoamine deficiency hypothesis fueled the creation of a wide variety of antidepressant medications, it has fallen short of explaining some important clinical observations, such as the fact that chronic treatment (often 3-4 weeks) is required before

the full range of therapeutic effects of antidepressants appear, or why monoamine depletion does not produce clinical depression in healthy individuals (Russo-Neustadt & Chen, 2005). Nevertheless, these increased levels of neurotransmitter can begin to alter gene expression, which in turn leads to plastic changes within the brain (Russo-Neustadt & Chen, 2005).

Genetic hypothesis

Rodent studies have found physical activity enhances the expression of protein brain derived neurotrophic factor (BDNF) (Russo-Neustadt & Chen, 2005; Zheng et al., 2006), which is capable of producing an antidepressant response itself and may enhance the function of monoamine systems disordered in clinical depression (Russo-Neustadt & Chen, 2005). BDNF seems to play an important role in augmenting neuronal growth, protection and survival; in modulating neuronal transmission; in activity-directed synaptic remodeling; and adult neurogenesis (Russo-Neustadt, 2003; Russo-Neustadt & Chen, 2005). Messenger ribonucleic acid (mRNA) carries the particular sequence of the gene from the nucleus to cytoplasm where it can be translated into protein structure (National Human Genome Research Institute [NHGRI], n.d.). BDNF mRNA is an antecedent of the protein BDNF and gives an indication of the amount of BDNF in a particular region (NHGRI, n.d.). Physical activity reversed the effects of chronic unpredictable stress on hippocampal BDNF mRNA in rats (Zheng et al., 2006). Physical activity in the form of voluntary running by itself (Zheng et al., 2006) and in combination with antidepressant medication (Russo-Neustadt, Beard, & Cotman, 1999) showed significant increases in rat hippocampal BDNF mRNA expression levels in as little as six hours (Oliff, Berchtold, Isackson, & Cotman, 1998) to two days (Russo-Neustadt, Beard, Huang, & Cotman, 2000; Russo-Neustadt, Alejandre, Garcia, Ivy, & Chen, 2004) with effects enhanced one and two weeks later (Russo-Neustadt et al., 2004). Physical

activity with and without antidepressant medication produced significant changes where antidepressant medication alone failed (Russo-Neustadt et al., 2004). In addition, the combination of physical activity and antidepressant medication may accelerate as well as increase the amount of BDNF transcription (Russo-Neustadt et al., 2000), leading to rapid and sustained increases in hippocampal BDNF mRNA expression (Russo-Neustadt et al., 2004) over antidepressant medication alone.

In humans, physical activity has been shown to increase serum BDNF in healthy young adults (Ferris, Williams, & Shen, 2007; Tang, Chu, Hui, Helmeste, & Law, 2008; Winter et al., 2007) and middle-age adults with multiple sclerosis (Castellano & White, 2008; Gold et al., 2003; Schulz et al., 2004). One bout of high-intensity anaerobic physical activity (Ferris et al., 2007; Rojas Vega et al., 2006; Winter et al., 2007), high-intensity aerobic physical activity (Ferris et al., 2007), and moderate-intensity aerobic physical activity (Gold et al., 2003; Tang et al., 2008; Winter et al., 2007) has been shown to increase serum BDNF. In addition, eight weeks of moderate-intensity training for 30 minutes, two (Schulz et al., 2004) and three times per week (Castellano & White, 2008) increased serum BDNF at 4 (Castellano & White, 2008) and 8 weeks (Schulz et al., 2004) of training. However, none of these studies reported depressive symptoms. It is unclear if an increase in serum BDNF as a result of physical activity contributes to a decrease in depressive symptoms.

Just as physical activity changes the expression of BDNF in rodents, physical activity could theoretically change the expression of certain genes associated with monoamines, which could potentially result in a decrease in depressive symptoms. For example, a dopaminergic candidate gene associated with unipolar depression is *DRD4 Gene on Chromosome 11p15* (Lopez Leon et al., 2005). A dopamine candidate gene associated with increased risk for early-onset (before 30 years) recurrent major depression is *DYT1 Gene on Chromosome 9q34* (Heiman et al., 2004). A serotonin

transporter gene associated with various forms of clinical depression is *SLC6A4 Gene on Chromosome 17q* (Caspi et al., 2003; Hoefgen et al., 2005; Ogilvie et al., 1996; Taylor et al., 2005; Willeit et al., 2003). Future studies should consider genetic factors in addition to BDNF in the mechanism of action, such as dopaminergic candidate genes and serotonin transporter genes.

Endorphin hypothesis

Interest in endorphins has gradually receded (Singh & Singh, 2000) since the early 1990s (Fox, 1999) due to conflicting evidence regarding the effects of physical activity on endorphins. Physical activity was largely thought to increase β -endorphin levels (Goldfarb, 1997; Schwarz & Kindermann, 1992; Thorén, 1990). However, the increase in β -endorphin levels has not been associated with a statistically significant decrease in depressive symptoms (Hatfield, Goldfarb, Sforzo, & Flynn, 1987). It is the decrease in β -endorphin levels as a result of physical activity which has been attributed to lower depressive symptoms (Lobstein, Ismail, & Rasmussen, 1989; Lobstein, Rasmussen, Dunphy, & Dunphy, 1989; Lobstein & Rasmussen, 1991), although not all studies have been able to confirm a link between β -endorphins and depressive symptoms (Williams & Getty, 1986). Methodological problems may have accounted for conflicting results as measured plasma concentrations of endorphins may not accurately reflect central nervous system levels (Morgan, 1985; North, McCullagh, & Tran, 1990; Paluska & Schwenk, 2000; Thorén, 1990). Current use of positron emission tomography scans which can take into account other opioid receptors such as μ , δ , and κ , have found reductions in opioid receptor availability in prefrontal and limbic/paralimbic brain structures after two hours of endurance running in humans (Boecker et al., 2008). Thus, the endorphin hypothesis shows potential.

Thermogenesis hypothesis

The thermogenesis hypothesis suggests that body temperature elevations are responsible for improvement in mood following physical activity (Craft & Perna, 2004; Fox, 1999; Paluska & Schwenk, 2000; Yeung, 1996). However, research has focused on symptoms of anxiety, not depression.

Cardiovascular fitness hypothesis

The antidepressant effect of physical activity could be mediated by cardiovascular fitness levels (Armstrong & Edwards, 2004; Blumenthal et al., 1999; Fox, 1999; North et al., 1990). However, improvement in fitness is not always concurrent with a decrease in depressive symptoms in older adults (Pollock et al., 1998). In addition, decreases in depressive symptoms have been found from a single physical activity session (North et al., 1990), while fitness is mainly determined by physical activity patterns over recent weeks or months (Blair, Cheng, & Holder, 2001). On the other hand, fitness is a complex term comprising morphologic, muscular, cardiorespiratory, motor and metabolic components (Blair et al., 2001). When fitness is discussed in reference to the antidepressant effects of physical activity, only the cardiorespiratory component has been emphasized. In addition, cardiorespiratory fitness is measured differently across studies, for example total treadmill time, heart rate, maximum oxygen uptake, and work load at heart rate 150 beats/min divided by body weight in kilograms (Blair et al., 2001). Thus, there is insufficient evidence to determine if any type of fitness mediates the antidepressant effects of physical activity.

Hypothalamic-Pituitary-Adrenocortical (HPA) Axis hypothesis

A review by Holsboer & Barden (1996) outlined considerable evidence that HPA dysregulation is causally implicated in the onset of clinical depression. Stressful environmental challenges are accompanied by central elaboration of catecholamines

and by increased levels of glucocorticoids secreted from the adrenals after hypothalamic activation of corticotropin releasing hormone and adrenocorticotrophic hormone from the pituitary. In clinical depression, the adaptive response appears to be defective, leaving the HPA system altered until therapeutic interventions begin to be effective (Holsboer & Barden, 1996). The time course of these neuroendocrine actions on HPA activity and, more specifically, on corticosteroid receptors follows closely that of clinical improvement, supporting the hypothesis that a causal link between HPA activity and antidepressant effects exists (Holsboer & Barden, 1996).

Physical activity in the form of voluntary running reduced the increase of circulating cortisone effects of chronic unpredictable stress in rats (Zheng et al., 2006). Long-term voluntary physical activity in mice (by allowing access to a running wheel) increased adrenal size, increased tyrosine hydroxylase mRNA expression in the adrenal medulla, attenuated the corticosterone response to a mild psychological stressor, augmented corticosterone response to restraint stress, and decreased corticotrophin-releasing factor mRNA expression in the hypothalamic paraventricular nucleus (Droste et al., 2003). Whereas antidepressant medication by itself had no effect, physical activity in combination with antidepressant medication had a synergistic effect, influencing both adrenal structure and function (Droste et al., 2003).

Comorbid illnesses

Depressive symptoms with comorbid illness are common (World Health Organization [WHO], 2005). Physical activity has been shown to be effective in reducing depressive symptoms in individuals who have 2-5 additional illnesses (Brenes et al., 2007; Singh, Clements, & Fiatarone, 1997; Singh et al., 2001; Singh et al., 2005), including cardiovascular disease (Motl et al., 2005) such as hypertension (Baker et al., 2007; Kamioka et al., 2006; Motl et al., 2005; Penninx et al., 2002), cerebrovascular

accidents (Motl et al., 2005; Tsang, Fung, Chan, Lee, & Chan, 2006), heart disease (Penninx et al., 2002), and hyperlipidemia (Kamioka et al., 2006; Motl et al., 2005); diabetes (Motl et al., 2005; Penninx et al., 2002; Tsang et al., 2006); arthritis (Motl et al., 2005; Penninx et al., 2002; Tsang et al., 2006) such as osteoarthritis (Baker et al., 2007; Kamioka et al., 2006); cancer (Motl et al., 2005; Tsang et al., 2006); osteoporosis (Kamioka et al., 2006); Parkinson and others (Tsang et al., 2006). Future research should examine the mechanism by which physical activity reduces depressive symptoms in healthy populations and in individuals with additional comorbid illnesses.

Psychological Effects

Distraction hypothesis

It has been posited that distraction from daily worries may account for the antidepressant effect of physical activity (Brosse, Sheets, Lett, & Blumenthal, 2002; Craft & Perna, 2004; Morgan, 1985; North et al., 1990; Paluska & Schwenk, 2000; Yeung, 1996). However, results did not support the distraction hypothesis for acute (Yeung, 1996) or chronic physical activity (Craft, 2005; North et al., 1990). Although physical activity is known to increase positive affect (Yeung, 1996), positive affect is diminished in depressed patients and is not augmented by distraction activities (Craft & Perna, 2004). The diminished capacity to experience positive affect is an essential distinguishing symptom in clinical depression (Craft & Perna, 2004). Thus, although theoretically plausible, there is currently minimal empirical support for the distraction hypothesis accounting for the antidepressant effect of physical activity.

Self-efficacy hypothesis

Perceived self-efficacy refers to beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments (Bandura, 1997). A

low sense of self-efficacy may contribute to depressive symptoms (Bandura, 1997). Likewise, greater self-efficacy has been associated with less severe symptoms of depression (Maciejewski, Prigerson, & Mazure, 2000). Extensive research has documented the relationship between physical activity and self-efficacy (King, Stokols, Talen, Brassington, & Killingsworth, 2002). A quasi-experimental study found support for coping self-efficacy in clinically depressed individuals (Craft, 2005). However, in randomized controlled trials there is conflicting evidence on the influence of self-efficacy when physical activity was shown to decrease depressive symptoms. No change in self-efficacy measures were found at the end of a 10 week trial of high-intensity progressive resistance training compared to attention control group (Singh et al., 1997). Conversely, significant improvement in self-efficacy was seen over an 8 week progressive resistance training, regardless of high or low intensity, although self-efficacy at baseline did not predict antidepressant scores (Singh et al., 2005). Individuals who engaged in high-intensity progressive resistance training for 10 weeks followed by 10 weeks of unsupervised physical activity had increased self-efficacy for jogging at 20 weeks compared to a lecture only control group (Singh et al., 2001). However, there was no significant effect of treatment assignment on other self-efficacy perceptions such as walking, climbing, lifting, or push-ups (Singh et al., 2001). A 16 week qigong exercise intervention increased self-efficacy for dealing with novel or demanding situations (Tsang et al., 2006). Finally, when physical activity did not result in decreased depressive symptoms due to noncompliance, self-efficacy did not increase (Baker et al., 2007). Conflicting results may be due to the measurement of different types of self-efficacy. It should also be noted that all of the randomized studies found that addressed self-efficacy in physical activity were conducted in older adults diagnosed with some form of clinical depression, such as major depressive disorder, minor depressive disorder or dysthymic disorder.

Additional psychological hypotheses

Multiple psychological factors have been examined as potential mediators in the effects of physical activity on depressive symptoms. Physical activity resulted in improvements in personal well-being, general health, perceived benefit, and several components of self-concept (social relationship, daily tasks, leisure and physical well-being) (Tsang et al., 2006). Morale increased, particularly attitude toward aging (Singh et al., 1997; Singh et al., 2001). Life satisfaction, dysfunctional attitudes (Blumenthal et al., 1999), perceived stress (King et al., 1993) and self-esteem (Blumenthal et al., 1999; Motl et al., 2005) improved, with self-esteem predicting depressive symptoms (Motl et al., 2005). Quality of life improved (Antunes, Stella, Santos, Bueno, & de Mello, 2005; Singh et al., 1997; Singh et al., 2005). Oddly, even when physical activity did not result in statistically reduced depressive symptoms, quality of life and perceived health still improved (Paw, van Poppel, Twisk, & van Mechelen, 2004). Future studies should continue to isolate psychological factors which may help explain the reduction in depressive symptoms as a result of physical activity.

Environmental Factors

Sociocultural

Social support hypothesis

The positive effects of social support on mental health have long been established (Blazer, 2005; Bruce, 2002; Harris, 2001; Jorm, 1995; Kawachi & Berkman, 2001; Lin & Peek, 1999; Lépine & Bouchez, 1998; Paykel, 1994; Vilhjalmsson, 1993), with few exceptions (Piccinelli & Wilkinson, 2000). Aspects of social support have been suggested as the primary mechanism of physical activity action in clinical depression (Singh & Singh, 2000). Physical activity has been shown to increase social support (Liu-

Ambrose, 2005; Schoster, 2005). Some have proposed that social support is more important at the beginning of a physical activity program because it is an external motivator, while its effect may diminish as the rewards of physical activity become internalized (North et al., 1990). Others have proposed that social support in mildly depressed individuals is equipotent to physical activity (Singh et al., 1997; Singh & Singh, 2000). It has been argued that physical activity retained its antidepressant effects when participants exercised individually in rooms by themselves (Dunn et al., 2005), suggesting social support alone is not required for physical activity to decrease depressive symptoms in those diagnosed with Major Depressive Disorder (Singh et al., 1997; Singh & Singh, 2000). This was confirmed by a meta-analysis which did not support the social support hypothesis as the only mediator in the antidepressant effects of physical activity (North et al., 1990). Although implicit, the discussion has focused on emotional support (House, 1981) received during physical activity in a group setting, suggesting that depressive symptoms were affected in a positive manner by the social interaction between study participants. In addition, instrumental support in the form of tangible aid (Israel, 1982) and emotional social support (House, 1981) in the form of motivation may assist in adopting and maintaining a physical activity regimen. Thus, although emotional social support is not necessary for physical activity to exert its antidepressant effects, the addition of instrumental and emotional social support may enhance adherence to a physical activity regimen, thereby indirectly exerting antidepressant effects.

Sociocultural issues

Interventions examining the effect of physical activity on depressive symptoms have mostly been conducted in Western societies. The most common types of physical activity reported include weight-bearing physical activities (Mather et al., 2002) such as

walking/jogging (Babyak et al., 2000; Blumenthal et al., 1999; Dimeo, Bauer, Varahram, Proest, & Halter, 2001; Doyne et al., 1987; King et al., 1993; Martinsen, Medhus, & Sandvik, 1985; McCann & Holmes, 1984; McNeil et al., 1991; Penninx et al., 2002) or running (Greist et al., 1979; McCann & Holmes, 1984; Veale et al., 1992) on a treadmill (Dimeo et al., 2001; Dunn et al., 2005), in a shopping mall (McNeil et al., 1991; Motl et al., 2005), or in a facility or home environment (King et al., 1993; McNeil et al., 1991; Penninx et al., 2002); cycling on a stationary bike (Dunn et al., 2005) or cycle ergometry (Antunes et al., 2005; Babyak et al., 2000; Baker et al., 2007); aerobic weight training (Brenes et al., 2007), low-intensity resistance training (Brenes et al., 2007; Paw et al., 2004; Doyne et al., 1987; Martinsen et al., 1989; Motl et al., 2005; Penninx et al., 2002; Singh et al., 2005), high-intensity progressive resistance training (Baker et al., 2007; Singh et al., 1997; Singh et al., 2001; Singh et al., 2005), functional training (Paw et al., 2004), balance training (Baker et al., 2007), and flexibility training (Martinsen et al., 1989; Motl et al., 2005; Veale et al., 1992) including yoga (Veale et al., 1992) in a gym (Baker et al., 2007; Motl et al., 2005; Singh et al., 2001), training facility (Antunes et al., 2005; Penninx et al., 2002; Singh et al., 2001; Singh et al., 2005) or home environment (Penninx et al., 2002; Singh et al., 2001).

Few interventions have been conducted in non-Western societies using culturally specific types of physical activity. For example, Tai Chi was effective in reducing depressive symptoms in clinically depressed older adults at the end of a three month intervention in Hong Kong (Chou et al., 2004). Qigong was effective in reducing depressive symptoms after the 16 week intervention in older adults in Hong Kong (Tsang et al., 2006). Hot spa bathing combined with stretching, indoor and outdoor walking, sponge tennis, underwater physical activity in a spa pool, prevention physical activities for knees and back pain, and rhythmic physical activity was partially effective in maintaining a reduction in depressive symptoms after 1 year follow-up in healthy middle-

age and elderly women in Japan (Kamioka et al., 2006). More research should be done taking into account varying cultural characteristics since the cultures individuals come from shape their mental health and affect the types of mental health services they use (USDHHS, 2001).

Geographic

There is scarce mention of the environment in the literature on the antidepressant effects of physical activity. Prospective observational studies have found physical activity remained predictive of depressive symptoms while controlling for neighborhood issues such as crime (Strawbridge, Deleger, Roberts, & Kaplan, 2002), and geographic region of residence such as South or West in the U.S. (Wise, Adams-Campbell, Palmer, & Rosenberg, 2006) and urban or rural in Australia (Brown, Ford, Burton, Marshall, & Dobson, 2005). Geographic location is particularly important with respect to seasonal affective disorder, a type of depression which may be caused by latitude, climate, social and cultural influences and genetic factors (Mersch, Middendorp, Bouhuys, Beersma, & van den Hoofdakker, 1999). Latitude values indicate the angular distance between the Equator and points north or south of it on the surface of the Earth (Nationalatlas.gov, 2007). Significantly high correlations have been found between prevalence and latitude of seasonal affective disorder in North America; the higher the latitude, the higher the prevalence (Mersch et al., 1999). In addition, the climate, such as winter months, may predispose individuals to depressive symptoms (Mersch et al., 1999). Future studies should consider if geographic factors have any impact on mechanism by which physical activity decreases depressive symptoms.

Conclusion

Although thirty years of randomized trials have shown physical activity effective

in decreasing depressive symptoms, the exact mechanism of action is still unknown and few studies reported guidance by theory. Personal and environmental factors outlined in the Social Ecology of Health Promotion (Stokols, 1992) guided in the examination of the mechanisms by which physical activity decreases depressive symptoms. Future studies should examine biogenetic factors such as norepinephrine, dopamine and serotonin, as well as the genetic expression of BDNF, dopaminergic candidate genes and serotonin transporter genes. Research with regard to the endorphins in humans and hypothalamic-pituitary-adrenocortical (HPA) axis in rodents is promising. There is not definitive data to support or refute the thermogenesis or cardiovascular fitness hypotheses. Psychological variables should be further explored, including morale, self-esteem and specific types of self-efficacy, although there is minimal empirical support for the distraction hypothesis. Aspects of the environment, such as social support, culturally tailored types of physical activity, neighborhood issues, region of country, latitude and climate may potentially interact with the mechanism by which physical activity decreases depressive symptoms. Depressive symptoms in healthy individuals and those diagnosed with depression or having other comorbid illnesses should be evaluated separately as they may require different doses of physical activity.

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CHAPTER III
PHYSICAL ACTIVITY EFFECTS ON DEPRESSIVE SYMPTOMS IN BLACK ADULTS:
A SYSTEMATIC REVIEW OF THE LITERATURE

Randomized trials which followed CONSORT reporting guidelines (Moher D. Schulz KF. Altman DG. CONSORT GROUP (Consolidated Standards of Reporting Trials), 2001) have found physical activity effective in decreasing depressive symptoms in individuals who were diagnosed with depression (Dunn, Trivedi, Kampert, Clark, & Chambliss, 2005; Knubben et al., 2007; Mather et al., 2002; Singh, Clements, & Singh, 2001), individuals who had scores indicative of depression (Brenes et al., 2007), and in healthy community samples (Baker et al., 2007; Penninx et al., 2002). Many of these studies did not report race (Baker et al., 2007; Knubben et al., 2007; Mather et al., 2002; Singh et al., 2001), possibly because they were not conducted in the U.S. When race was reported, there was no identification of the non-White group (Brenes et al., 2007; Penninx et al., 2002) or small numbers of ethnic minorities that precluded analyses of race/ethnicity effects (Dunn et al., 2005). Thus, it is not surprising that a report of the U.S. Surgeon General concluded ethnic minorities are underrepresented in mental health research (U.S. Department of Health & Human Services [USDHHS], 1999).

Physical activity is hypothesized to decrease depressive symptoms through psychological, social, cultural, seasonal and geographical factors (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009a). Since the mechanism of action is unknown, physical activity may not exert antidepressant effects on everyone. The purpose of this systematic literature review was to determine the effects of physical activity on depressive symptoms in Black adults.

Methods

Research literature was abstracted by conducting an on-line computer search of MEDLINE using OVID software, ISI Web of Science, and PubMed. Inclusion criteria included race-specific results in quantitative studies where the effects of physical activity on depressive symptoms could be ascertained. No time restriction was placed on publication date. Healthy adults and those with any diagnosis were included. All types of physical activity were included regardless of dosage or duration, as well as any method of measuring depressive symptoms. Papers published in peer-reviewed journals up to March 5, 2009 were located using the following key words in OVID (includes title, original title, abstract, name of substance word, and subject heading word), topics in ISI Web of Science (all citation databases, including Science, Social Sciences, and Arts & Humanities), and in PubMed (limiting search to humans); exercise or physical activity and depress*, dysthmi*, or seasonal affective disorder and Black or African American. Asterisks were used to include all words with a certain term. A further hand search of reference lists of eligible studies was conducted.

Results

Figure 1 summarizes the process of inclusion of the studies for review and analysis. Of the 182 non-duplicating articles found, 170 were excluded for a variety of reasons. Several were not quantitative studies in peer-review journals. Specifically, three were either qualitative (Kramer, 2007) or case studies (Fitzgerald, 1981; Hamilton, Rosenthal, Berwick, & Nadas, 1978). Eight were unrelated reviews, conference abstracts, methods papers, or other non-data based articles (Belza & Warms, 2004; Hayes et al., 2000; Hogan et al., 2008; Malcomson, Dunwoody, & Lowe-Strong, 2007; Mant et al., 2004; McKinlay & Link, 2007; Walker et al., 2004; Yang, 1996).

Several studies were excluded due to unrelated sample. Three comprised non-

human subjects (Jessen, Dmi'el, Choshniak, Ezra, & Kuhnen, 1998; Rogers et al., 2000; Spangenberg, Augustsson, Dahlborn, Essen-Gustavsson, & Cvek, 2005). Eleven either did not stratify results related to physical activity and depressive symptoms by race (Blanchard, Rodgers, Courneya, Daub, & Black, 2002; Choi & McDougall, 2007; Dong, Sanchez, & Price, 2004; Gary, 2006; Jerome et al., 2009; Resnick, Luisi, & Vogel, 2008; Santiago & Coyle, 2004; Saydah, Brancati, Golden, Fradkin, & Harris, 2003; Stack & Murthy, 2008; Vickers, Nies, Patten, Dierkhising, & Smith, 2006), or did not include a sample specific to the Black U.S. population (Parker & Crawford, 2007). Eighteen comprised children (Annesi, 2004; M. M. Black, 2003a; M. M. Black, 2003b; Dowda, Pfeiffer, Dishman, & Pate, 2007; Hales et al., 2006; McCann, Voris, Simon, & Wells, 1989; Moore et al., 2007; Thapar, Strong, Miller, Leatherbury, & Salehbbhai, 1978; Young-Hyman, 2006) and/or adolescent samples (Ammouri, Kaur, Neuberger, Gajewski, & Choi, 2007; Dishman et al., 2006a; Fisher, Juszczak, & Friedman, 1996; Halpern, 2005; Neumark-Sztainer, Story, Hannan, Tharp, & Rex, 2003; Nollen, 2006; Perron, Gotham, & Cho, 2008; Setiloane, 2004; Storch et al., 2007).

Most studies were excluded due to methodological issues. Three combined depression with anxiety (Bazargan, 1996; Shih, Hootman, Kruger, & Helmick, 2006) and other moods (Grimm et al., 1997). Since the purpose of this review was to determine the effects of physical activity on depressive symptoms, depressive symptoms had to be the dependent or outcome variable. Six studies had physical activity as the dependent variable and were excluded (Damush, Plue, Bakas, Schmid, & Williams, 2007; Jorna, Ball, & Salmon, 2006; Kaplan, Lazarus, Cohen, & Leu, 1991; Sarkisian, Prohaska, Wong, Hirsch, & Mangione, 2005; Simonsick, Guralnik, & Fried, 1999; Wing et al., 2004). Four were unable to isolate the effects of physical activity from other interventions (Jenkins et al., 2003; Lane-Tillerson, Davis, Killion, & Baker, 2005; Rimmer, Silverman, Braunschweig, Quinn, & Liu, 2002; Rubin et al., 2008). Thirty-nine

had no measurement of physical activity (Andresen et al., 2006; Baker, Bodner, & Allman, 2003; Black, Hershey, Hartlein, Carl, & Perlmutter, 2005; Blazer, Hybels, & Fillenbaum, 2006; Burdette, Wadden, & Whitaker, 2006; Chaiamnuay et al., 2007; Choi & Morrow-Howell, 2007; Chowdhury, Balluz, & Strine, 2008; Doninger, Fink, & Utset, 2005; Everson-Rose et al., 2005; Franks, Lichtenberg, & MacNeill, 2003; Goldman et al., 2008; Haley et al., 1995; Iezzoni, McCarthy, Davis, & Siebens, 2001; Jayadevappa et al., 2007; Koenig et al., 1997; Koenig, 1998; Leveille, Fried, McMullen, & Guralnik, 2004; Li, 2005; Lim, Wood, & Miller, 2008; Lombardi & Ulbrich, 1997; Malmstrom, Wolinsky, Andresen, Miller, & Miller, 2005; McCracken, Matthews, Tang, & Cuba, 2001; Mehta et al., 2007; Melnyk et al., 2004; Miles, Gillespie, & Holditch-Davis, 2001; Mosley-Williams, Lumley, Gillis, Leisen, & Guice, 2002; Nelson, Fernandez, Livingston, Knapp, & Katona, 2004; Peel et al., 2005; Pells, 2007; Post et al., 1977; Sarkisian, Shunkwiler, Aguilar, & Moore, 2006; Sibbitt et al., 2002; Stump, Clark, Johnson, & Wolinsky, 1997; Williams, Baker, & Allman, 2005; Won et al., 1999; Woods et al., 1997; Yochim, Kerkar, & Lichtenberg, 2006; Zule, Lam, & Wechsberg, 2003). Examples of measures other than physical activity include physical functioning (Koenig, 1998; Mehta et al., 2007; Won et al., 1999), physical performance (Baker et al., 2003; Everson-Rose et al., 2005; Leveille et al., 2004; Malmstrom et al., 2005), physical health (Koenig et al., 1997), mobility (Blazer et al., 2006; Iezzoni et al., 2001; Peel et al., 2005), motor activity (Post et al., 1977), physical limitations (Chowdhury et al., 2008; Yochim et al., 2006) and physical dependency (Nelson et al., 2004). Fifteen had no measurement of depressive symptoms (Amoako, Skelly, & Rossen, 2008; Bakx et al., 1995; Dawson et al., 2008; Gold et al., 2005; Golightly & Dominick, 2005; Gulati et al., 2005; Headley, Claiborne, Lottes, & Korba, 1996; Honda, Goodwin, & Neugut, 2005; Janisse, Nedd, Escamilla, & Nies, 2004; Montanes, Lawless, Black, Oakley, & Hughes, 1982; Nelson et al., 1975; Rademacher, Black, & Ulrich, 2008; Starling, Liu, & Sullivan, 2001; van der Merwe et al.,

1996; Wells et al., 1997). For example, mood (Janisse et al., 2004), psychosocial adjustment (Amoako et al., 2008), psychological distress (Honda et al., 2005), ST wave depression from an EKG was measured (Bakx et al., 1995; Gold et al., 2005; Gulati et al., 2005), instead of depressive symptoms. Rarely, neither physical activity nor depressive symptoms were measured (Buchanan & Selmon, 2008; Cataldo, 2005; Gaston-Johansson, Ohly, Fall-Dickson, Nanda, & Kennedy, 1999; Jones, Moulton, Moulton, & Roach, 1999; Ohmoto, 1996).

Finally, sixty studies were excluded as the relationship between physical activity and depressive symptoms was undeterminable (Allen, Scott, Stewart, & Young, 2004; Avis et al., 2003; Avis & Colvin, 2007; Baltrus, Lynch, Everson-Rose, Raghunathan, & Kaplan, 2005; Barnes, Mendes de Leon, Wilson, Bienias, & Evans, 2004; Blazer, Hays, & Salive, 1996; Bromberger et al., 2005; Broome, 2001; Buist et al., 2000; Cashion, Holmes, Arheart, Acchiardo, & Hathaway, 2005; Cauley et al., 2005; Chang, Hahn, Teutsch, & Hutwagner, 2001; Chesla et al., 2004; Cowan, Meiser, Giles, Lindeman, & Gaff, 2008; Davidson, Jonas, Dixon, & Markovitz, 2000; DeLellis et al., 2004; Dunlop et al., 2005; Everhart et al., 1989; Felton, Parsons, & Bartoces, 1997; Fitzgerald, Link, Litman, Trivison, & McKinlay, 2007; Friedman, Freeman, Munoz, Jampel, & West, 2007; Gold et al., 2007; Guo, North, Gorden-Larsen, Bulik, & Choi, 2007; Halkitis et al., 2008; Hamm, Bazargan, & Barbre, 1993; Jonas & Mussolino, 2000; Jones, 2008; Kinar, Cuppett, & Berg, 2002; Kupelian, Link, Rosen, & McKinlay, 2008; Laumann et al., 2007; Lee et al., 2005; Levenstein, Smith, & Kaplan, 2001; Link et al., 2008; Litman et al., 2007; Markovitz et al., 1996; Mehta & Jain, 1995; Mussolino, 2005; Neggers, Goldenberg, Cliver, & Hauth, 2006; Peters & Lumley, 2007; Raikonen, Matthews, & Kuller, 2001; Rhee et al., 2008; Robbins, Hirsch, Whitmer, Cauley, & Harris, 2001; Sammel et al., 2003; Schootman et al., 2006; Schootman et al., 2007; Schulz et al., 2008; Setse et al., 2008; Sowers et al., 2008; Spangler, Konen, & McGann, 1993;

Stewart, Richards, Brayne, & Mann, 2001; Taylor et al., 2003; Wadley et al., 2007; Walker, Cooney, & Riggs, 1999; Whitney et al., 1998; Wilcox, Bopp, Oberrecht, Kammermann, & McElmurray, 2003; Yancey et al., 2004; Yancey et al., 2006; Yancy, Olsen, Westman, Bosworth, & Edelman, 2002; Zonana-Nacach et al., 2000; Zutshi, Hull, Bast, & Hammel, 2007). Usually physical activity and depressive symptoms were both covariates in a regression with a different outcome.

Studies reviewed (n=12) were assessed and listed in Table 1, which summarizes the samples, designs, methods and key findings. The studies reviewed comprised 7 cross-sectional (Artinian, Washington, Flack, Hockman, & Jen, 2006; Bopp, Wilcox, Oberrecht, Kammermann, & McElmurray, 2004; Farmer et al., 1988; Malebo, 2007; Orr et al., 2006; Patil, 2008; Siegel et al., 2000), 3 prospective observational (Knox et al., 2006; Nelson et al., 2008; Walker et al., 2004), 1 combination cross-sectional and longitudinal (Wise et al., 2006), and 1 experimental (Izquierdo-Porrera, Powell, Reiner, & Fontaine, 2002). Ten of the 12 studies included convenience sampling. Most of the studies had majority female samples; 9 were more than 70% female, 7 were 100% female. Only one study from 1988 used a nationally representative sample (Farmer et al., 1988). Of the two studies that specifically addressed the effects of physical activity on depressive symptoms, one study excluded those who reported physician-diagnosed depression (Wise et al., 2006), while another excluded adults with selected self-reported health conditions that may increase the risk of depressive symptoms (Farmer et al., 1988). All of the studies used an established measure of depressive symptoms. Nine studies measured depressive symptoms with the Center for Epidemiologic Studies Depression Scale (CESD), a self-report scale developed for epidemiologic studies at the National Institute of Mental Health (Radloff, 1977). Each study measured physical activity differently.

Seven of the studies found a significant inverse relationship between physical

activity and depressive symptoms (Farmer et al., 1988; Knox et al., 2006; Malebo, 2007; Orr, James, Garry, & Newton, 2006; Patil, 2008; Siegel, Yancey, & McCarthy, 2000; Wise, Adams-Campbell, Palmer, & Rosenberg, 2006). Two studies specifically addressed the effects of physical activity on depressive symptoms and found an inverse association between physical activity and depressive symptoms in Black women and men (Farmer et al., 1988; Wise et al., 2006). Specifically, for Black women the odds ratio of depressive symptoms was larger for low levels of physical activity apart from recreation, while for Black men the odds ratio of depressive symptoms was larger for low levels of physical activity in recreation (i.e. exercise) after adjustment for several confounders (Farmer et al., 1988). In addition, an inverse association was observed between adult vigorous physical activity and depressive symptoms in Black women (Wise et al., 2006). However, walking for exercise was not associated with depressive symptoms in multivariate analyses (Wise et al., 2006).

Although a broad range of ages were sampled, 18-90 years, no clear determination can be made regarding age and the relationship between physical activity and depressive symptoms in Black adults. Physical activity was sometimes related to depressive symptoms in young adults (Malebo, 2007; Orr et al., 2006), but not always (Walker et al., 2004), sometimes related in middle age (Knox et al., 2006) and middle to old age (Nelson et al., 2008), and occasionally related to older adults (Patil, 2008), but usually not (Artinian et al., 2006; Bopp et al., 2004). Studies which included adults of all ages usually found a significant relationship between physical activity and depressive symptoms (Farmer et al., 1988; Siegel et al., 2000; Wise et al., 2006).

The relationship between BMI, physical activity and depressive symptoms is not clear. Wise et al. (2006) stratified analyses by BMI (<30 vs. 30+) and found the odds of depressive symptoms in Black women who engaged in vigorous physical activity five hours or more per week versus none were slightly stronger in nonobese than obese

women, but the associations were not statistically different. Wise et al. also found walking for exercise was weakly inversely associated with depressive symptoms among obese women, but no association was found among nonobese women.

Discussion

No firm conclusion can be drawn concerning the effects of physical activity on depressive symptoms in Black adults. There are many possible sources for heterogeneity demonstrated in this literature. Convenience sampling resulted in mostly female samples. Only two studies specifically addressed the effects of physical activity on depressive symptoms. Future studies designed to examine the effects of physical activity on depressive symptoms in Black adults should be based on representative samples, with a particular focus on adequate numbers of men.

Most of the reviewed studies measured depressive symptoms with the CESD, a widely recognized tool with established reliability and validity. A majority of the studies used the original 20 item questionnaire (Artinian et al., 2006; Farmer et al., 1988; Knox et al., 2006; Nelson et al., 2008; Orr et al., 2006; Siegel et al., 2000; Walker et al., 2004; Wise et al., 2006) with Cronbach alphas ranging from .84 to .93 (Artinian et al., 2006; Nelson et al., 2008; Siegel et al., 2000; Walker et al., 2004). Another measurement of depressive symptoms in the reviewed articles was the Geriatric Depression Scale (Bopp et al., 2004; Patil, 2008). Both studies reported good psychometrics for the Geriatric Depression Scale in previous studies (Bopp et al., 2004; Patil, 2008). However, neither study used the original version (Bopp et al., 2004; Patil, 2008). Only one study reported the Cronbach alpha for their study, which was quite low (.41 to .49) (Bopp et al., 2004). Future studies should continue to use an established measure of depressive symptoms and continue to report psychometrics with subsequent studies.

In contrast to the established measurement of depressive symptoms, each of the

reviewed studies measured physical activity differently, which may account for the conflicting results. Intensity refers to how much work is being performed or the magnitude of the effort required to engage in physical activity (Centers for Disease Control and Prevention [CDC], 2008). Reviewed articles measured intensity as moderate (Artinian et al., 2006), vigorous (Siegel et al., 2000; Wise et al., 2006) and through energy expenditure such as metabolic equivalents (Knox et al., 2006) and kilocalories (Nelson et al., 2008; Walker et al., 2004). Frequency is typically measured as the number of times an activity is performed (CDC, 2008). Reviewed articles measured frequency as number of times weekly (Patil, 2008; Siegel et al., 2000) and number of days in last 30 days (Artinian et al., 2006). One study measured the attendance rate at a structured program by dividing the number of sessions attended by the total possible number of sessions offered (Izquierdo-Porrera et al., 2002). Duration is commonly measured as the length of time in which an activity is performed (CDC, 2008). Reviewed articles measured duration by at least 20 minutes (Patil, 2008; Siegel et al., 2000), at least 30 minutes per day (Artinian et al., 2006), hours per week (Bopp et al., 2004) or average number of hours per week (Wise et al., 2006). Various types of physical activity were measured, such as leisure-time physical activity (Nelson et al., 2008; Siegel et al., 2000), fun and fitness (Orr et al., 2006), strength training (Bopp et al., 2004), intentional cardiovascular workout (Patil, 2008), recreational and nonrecreational (Farmer et al., 1988), walking (Wise et al., 2006) and daily activities such as cleaning and gardening (Knox et al., 2006). Recall varied from seven days (Walker et al., 2004), last 30 days (Artinian et al., 2006) or over previous year (Knox et al., 2006; Wise et al., 2006). Only three studies measured physical activity with a questionnaire which demonstrated reliability and validity in previous studies (Bopp et al., 2004; Malebo, 2007; Nelson et al., 2008). All three used a different questionnaire and only one reported reliability and validity of the physical activity measurement in their results section (Malebo, 2007).

Finally, only one study accounted for seasonal physical activity, specifically summer and winter participation (Malebo, 2007). Future studies should use physical activity measurements which have demonstrated reliability and validity in previous studies, and continue to report reliability and validity measures in subsequent studies. Established physical activity measurements which include intensity, frequency, duration and type should be utilized. None of the studies in this review appear to be theoretically based. Since physical activity is hypothesized to decrease depressive symptoms through biological, psychological, social, cultural, seasonal and geographical factors (Torres, Sampelle, Gretebeck, Ronis, & Neighbors, 2009a), theories that take into consideration multiple levels of influence are recommended to guide the investigation of physical activity and depressive symptoms in Black adults. Ecological models such as Stokols' (1992) Social Ecology of Health Promotion can address factors within the individual as well as environmental factors and guides the subsequent recommendations.

Social Ecology of Health Promotion

The Social Ecology of Health Promotion focuses on personal and environmental factors that play either an etiologic or moderating role in human health (Stokols, 1992).

Personal factors

Personal factors were further defined as biogenetic, psychological, and behavioral (Stokols, 1992). Examples of biogenetic factors include genetics, sex, age, disabling injuries. Although Stokols did not include body mass index (BMI), such a variable would fit in this category as well.

A typical factor within individuals which may influence the impact of physical activity on depressive symptoms is genetics. For example, rodent studies have found physical activity enhances the expression of protein brain derived neurotrophic factor

(BDNF) (Russo-Neustadt & Chen, 2005; Zheng et al., 2006), which is capable of producing an antidepressant response itself and may enhance the function of monoamine systems disordered in clinical depression (Russo-Neustadt & Chen, 2005). In humans, physical activity has been shown to increase serum BDNF in healthy young adults (Ferris, Williams, & Shen, 2007; Tang, Chu, Hui, Helmeste, & Law, 2008; Winter et al., 2007) and middle-age adults with multiple sclerosis (Castellano & White, 2008; Gold et al., 2003; Schulz et al., 2004). However, none of these studies reported depressive symptoms. It is unclear if an increase in serum BDNF resulting from physical activity leads to a decrease in depressive symptoms. Just as physical activity changes the expression of BDNF, physical activity could theoretically change the expression of certain genes associated with depressive symptoms, such as dopaminergic candidate genes and serotonin transporter genes, which could potentially result in a decrease in depressive symptoms. None of the reviewed studies accounted for genetic factors. Future studies should account for genetic factors in the relationship between physical activity and depressive symptoms by including genetic tests such as family history, assaying the biochemistry, chromosomal analysis and/or measuring mutations at the DNA level (CDC, 2009).

The association between physical activity and depressive symptoms may be confounded by type of physical activity, sex, age, BMI and disability. For Black women, the inverse relationship with depressive symptoms was larger for physical activity apart from recreation, while for Black men the relationship with depressive symptoms was larger for physical activity in recreation after adjustment for several confounders (Farmer et al., 1988). In addition, although adults age 18-90 years were sampled, no clear determination can be made regarding age and the relationship between physical activity and depressive symptoms in Black adults. Although walking for exercise was weakly inversely associated with depressive symptoms among obese but not obese women in

one study (Wise et al., 2006), the relationship between BMI, physical activity and depressive symptoms is unclear in Black women and not known in Black men. Finally, the effectiveness of physical activity in decreasing depressive symptoms in Black adults with other illnesses or the disability which results from those illnesses has not been well studied. This suggests the need to consider different types of physical activity, stratify results by sex and perhaps young, middle and older adults and BMI, and include Black adults with disabilities that may increase the risk of depressive symptoms.

Psychological factors have been hypothesized as part of the mechanism by which physical activity decreases depressive symptoms (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009). However, of the two studies which specifically addressed the possible effects of physical activity on depressive symptoms in Black adults (Farmer et al., 1988; Wise et al., 2006), none included psychological factors. Future studies should include psychological variables such as self-esteem and self-efficacy.

Environmental factors

Environmental factors were further defined as sociocultural and geographic (Stokols, 1992). Examples of sociocultural factors that may confound the relationship between physical activity and depressive symptoms include socioeconomic status of individuals and groups, social support and culture (Stokols, 1992). Physical activity remained predictive of depressive symptoms in Black U.S. adults, even after controlling for education, employment status, occupation and income (Farmer et al., 1988; Wise et al., 2006).

Most reviewed studies have focused solely on factors within individuals with little consideration for the social context. Mental illness and less severe mental health problems should be understood in a social context since social environments can increase or decrease the likelihood of exposure to certain types of stressors (USDHHS,

1999). For example, the positive effects of social support on mental health have been established (Blazer, 2005; Bruce, 2002; Harris, 2001; Jorm, 1995; Kawachi & Berkman, 2001; Lin & Peek, 1999; Lépine & Bouchez, 1998; Paykel, 1994; Vilhjalmsson, 1993). Future studies examining the effects of physical activity on depressive symptoms in Black U.S. adults should control for social support and examine the possible interaction between physical activity and social support on depressive symptoms. Whenever possible, general measures of support that have meaning across a variety of situations should be combined with measures that capture the unique dynamic of support related to physical activity, depressive symptoms, and the combination of physical activity and depressive symptoms (Depner, Wethington, & Ingersoll-Dayton, 1984; O'Reilly, 1988). In addition, it is essential to distinguish between social network and social support (Bowling, 1997; Cohen, 1988; House & Kahn, 1985; Hutchinson, 1999; Israel, 1982; Israel & Rounds, 1987; O'Reilly, 1988; Tardy, 1985). Social network is the existence or quantity and structure of social relationships, while social support is the functional content of relationships (House & Kahn, 1985).

A Surgeon General's expert panel concluded that the cultures that patients come from shape their mental health and affect the types of mental health services they use (USDHHS, 2001). Reviewed studies have not addressed cultural characteristics or intra-group ethnic heterogeneity (House & Williams, 2000; Williams, Yu, Jackson, & Anderson, 1997; Williams & Jackson, 2000). For example, approximately 2.4 million or 8% of U.S. Blacks are foreign born (U.S. Census Bureau [USCB], 2005). Sixty percent of foreign born Blacks living in the U.S. are from the Caribbean (McKinnon & Bennett, 2005). The lifetime prevalence of major depressive disorder (MDD) in Black U.S. adults of Caribbean ancestry has been estimated at 13%, compared to 10% in Black U.S. adults without Caribbean ancestry (Williams et al., 2007). The 12-month rate of MDD was 10.9% for Black U.S. adults of Caribbean ancestry born in the U.S., compared to

2% for Black U.S. adults born in the Caribbean (Williams et al., 2007). Future studies should account for intra-group ethnic heterogeneity, partly by taking into account different cultures within the same ethnic group and levels of acculturation for immigrants.

Examples of geographic factors which may confound the relationship between physical activity and depressive symptoms include regions of country and neighborhood factors. In the only reviewed study which addressed region of country, vigorous physical activity was most common in the West and least common in the South (Wise et al., 2006). Region of country is also an important component of seasonal affective disorder. Seasonal affective disorder is a type of depression which may be caused by latitude, climate, social and cultural influences and genetic factors (Mersch, Middendorp, Bouhuys, Beersma, & van den Hoofdakker, 1999). Latitude values indicate the angular distance between the Equator and points north or south of it on the surface of the Earth (Nationalatlas.gov, 2007). Significantly high correlations have been found between prevalence and latitude of seasonal affective disorder in North America; the higher the latitude, the higher the prevalence (Mersch et al., 1999). In addition, the climate, such as winter months, may predispose individuals to depressive symptoms (Mersch et al., 1999). None of the reviewed studies addressed seasonal affective disorder, but it is reasonable to design future studies to include such risk factors.

Another example of the impact of geographical location is neighborhood factors. In an article that did not stratify results by race, individuals who reported neighborhood concerns related to crime, traffic, noise, trash and litter, night lighting or availability of public transportation had 1.4 times the odds of incident depression, and almost 3 times the odds of prevalent depression (Strawbridge, Deleger, Roberts, & Kaplan, 2002). None of the reviewed articles included a measurement of neighborhood factors. Future studies should include aspects of the physical environment, such as the neighborhood safety.

There are limitations of this systematic review. While physical activity and other forms of antidepressant treatments may offer some protection against stress, in some cases alleviating the cause of the stress may be a more effective and ethical solution than simply offering different treatment or coping methods. Another limitation is that theses, proceedings and textbooks were not reviewed. Nor were researchers and sponsoring organizations contacted for unpublished results. Thus, this systematic review is at risk of overestimating the effect of physical activity on depressive symptoms (Jadad, Moher, & Klassen, 1998). However, the results of this review found only about half of the eligible studies found a significant inverse relationship between physical activity and depressive symptoms in Black adults, suggesting that publication bias, or the favoring of positive results, was not an issue. There is little empirical evidence to recommend blinding reviewers to the study authors, institutions, sponsorship, publication year and journal or study results (Jadad et al., 1998). Hence, the reviewer was not blinded. Data combination for meta-analysis was inappropriate (Moher, Jadad, & Klassen, 1998) due to differences in how physical activity and depressive symptoms were measured, as well as varied statistical measures, including t-tests, one way analysis of variance, correlation, odds ratio, regression and percentages.

Strengths of this review include a focused clinical question developed a priori, clear and concise selection criteria, and assessment of quality (Klassen, Jadad, & Moher, 1998). The quality of the studies (Jadad et al., 1998) was assessed by focusing on methodological aspects including design, generalizability, various measurements of physical activity and depressive symptoms, and theoretical guidance, as well as the inclusion of potential confounders such as depression diagnosis and treatment, genetic factors, intra-group ethnic heterogeneity, the social context and aspects of the environment.

In summary, although randomized trials have found physical activity effective in

decreasing depressive symptoms, few studies included sufficient numbers of Black participants to extrapolate this conclusion to Black adults. This integrated literature review has shown varying results on the effects of physical activity on depressive symptoms in Black adults. Heterogeneity may account for the divergent results. Future studies should include representative samples of Black women and men, use established measures of depressive symptoms and physical activity, and report psychometrics. Physical activity measures should include intensity, frequency, duration and type. Studies should incorporate a theory which considers multiple levels of influence, such as Stokols' Social Ecology of Health Promotion which considers personal and environmental factors. Relevant personal factors include genetics, sex, age, disability, BMI and psychological factors. Appropriate environmental factors include socioeconomic status of individuals and groups, social support and network, intra-group ethnic heterogeneity, region of country, latitude, climate and neighborhood factors. This study is a first step in the inclusion of many (though not all) key variables.

Figure 2. Process of Inclusion for Review

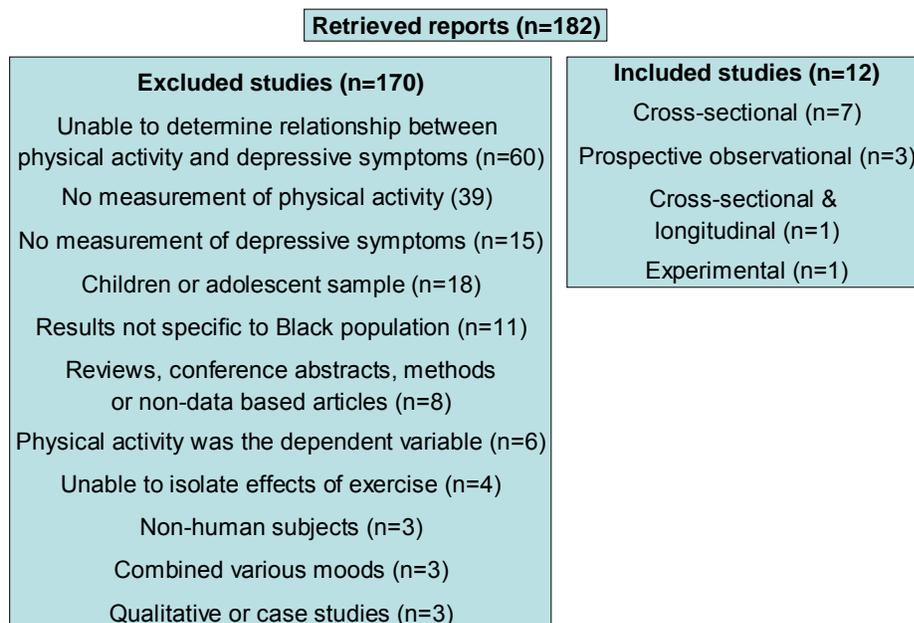


Table 1. Summary studies of physical activity and depressive symptoms in Black adults

Authors	n	Subject Selection	Gender	Age	Design	Physical Activity Measurement	Psychological Instrument	Key Findings on physical activity & depressive symptoms variables
Artinian et al. (2006)	245	convenience	100% female	61 years (SD, 12.7 years)	Cross-sectional	Assessment of physical activity was determined by two one-item measures.	20 item CESD, scored differently than original	Non-significant relationship between depressive symptoms and # of days within last 30 of moderate-intensity activity: $F_{1,241}=3.13$ ($p>.05$)
Bopp et al. (2004)	42	convenience	100% female	70.59 ± 9.21 years	Cross-sectional	Physical Activity Scale for the Elderly, only asked about strength training participation (yes/no and hours/week)	5 item version of the Geriatric Depression Scale, with one of the items removed to improve internal consistency	Non-significant correlation between strength training participation and depression
Farmer et al. (1988)	155	Stratified random sampling	56.8% female, 43.2%	25-77	Cross-sectional	Current recreational & nonrecreational	20 item CESD	The adjusted odds ratio for depressive symptoms was

		(NHANES I)	male			physical activity		16.5 in men with little or no physical activity in recreation, and 19.2 in women with little or no activity apart from recreation.
Izquierdo-Porrera et al.+ (2002)	46 out of 48 (96%) participants were Black	convenience	83% female	29-83	Experimental	Attendance in physical activity church program	20 item CESD	Attendance in physical activity intervention was not correlated with depressive symptoms ($r=.16$, $p>.05$)
Knox et al. (2006)	2,637	Random & convenience	56% female, 44% male	33-45	Prospective observational	METS from strenuous physical activities to daily activities such as cleaning & gardening over previous year	20 item CESD	The adjusted predictor of # of depressive episodes was $\beta=-28.40$, $SE=7.61$, $p=.0002$ for physical activity.
Malebo, et al. (2007)	293	convenience	52% male, 48% female	20-35	Cross-sectional	Physical Activity Index measured 5 categories of activity, namely intensity, duration, frequency, summer participation,	General Health Questionnaire depression subscale	Fewer depressive symptoms in sports participants compared to non-sport participants ($t= -1.84$, $p=.07$, small effect size).

						and winter participation		
Nelson et al. (2008)	186	Random	100% women	35-47 at baseline, followed for 8 years	Prospective observational	Kilocalories of leisure-time physical activity per week were calculated from the Paffenbarger Physical Activity Questionnaire and categorized into the top third (≥ 1450 kcal/wk), the middle third (< 1450 to 644 kcal/wk), and the bottom third (< 644 kcal/wk) of reported current activity.	20 item CESD	Physical activity at any level was not related to depressive symptoms among African American women (top third OR = 0.04, CI = -1.87, 1.94; middle-third OR = 0.05, CI = -1.53, 1.63. The lowest physical activity tertile was used as the reference group.)
Orr et al.+ (2006)	922	convenience	pregnant patients	18-20+	Cross-sectional	Physical activity for fun & fitness before and during pregnancy	20 item CESD	Proportionately more women with lower levels of depressive symptoms engaged in

								physical activity during pregnancy (65.9%) than those with higher levels of depressive symptoms (51.8%).
Patil et al. (2008)*	74	Convenience	81.1% female	60-95	Cross-sectional	estimate the number of times weekly that they physical activity (intentional cardiovascular workout) for at least 20 consecutive minutes	15 item Geriatric Depression Scale	Correlation between physical activity and depressive symptoms was $-.29$, $p < .01$ (two-tailed)
Siegel et al. (2000)	378	convenience	Women in Los Angeles, CA	adults	Cross-sectional	Leisure-time physical activity was operationalized as "no physical activity" (scored as 1), "only light physical activity/weekly," "vigorous physical activity at least 20 min once or twice weekly," and	20 item CESD	Physical activity predicted depressive symptoms ($\beta = -0.15$, $p < .01$), holding education, income, marital status, and pounds overweight constant.

						“vigorous physical activity at least 20 min three or more times weekly” (scored as 4).		
Walker et al. (2004)+	100	convenience	Women post-partum	22.40 □3.75	Prospective observational	7-day physical activity recall, kcal/kg/d	20 item CESD	Non-significant correlation between depressive symptoms and physical activity ($r = -.078$).
Wise et al.+ (2006)	35,224	convenience	100% women	21-69	Cross-sectional and Prospective observational	Vigorous physical activity during high school; average # of hours spent each week during the past year in walking for physical activity & vigorous physical activity	20 item CESD	Compared with women who were never active, the adjusted OR of depressive symptoms for women who were active in high school but inactive in adulthood, inactive in high school but active and adulthood, and always active was 0.90 (0.85-0.96), 0.83 (0.77-0.91), and 0.76 (0.71-0.82) respectively.

								<p>Results mostly held when stratifying by age and BMI. Compared with women who reported no vigorous physical activity, the adjusted OR of depressive symptoms for women reporting <1, 1, 2, 3-4, and 7 hr or more per week was .89, .85, .74, .72, and .75 respectively (p<.001). Results held when stratifying by age, but not BMI. Similar results were not found for walking.</p>
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CHAPTER IV
PHYSICAL ACTIVITY IN RELATION TO DEPRESSIVE SYMPTOMS IN BLACK U.S.
ADULTS: RESULTS FROM THE NATIONAL SURVEY OF AMERICAN LIFE

Physical activity has been found to decrease depressive symptoms in individuals who were diagnosed with depression (Dunn, Trivedi, Kampert, Clark, & Chambliss, 2005; Knubben et al., 2007; Mather et al., 2002; Singh, Clements, & Singh, 2001), had scores indicative of depression (Brenes et al., 2007) and in healthy community samples (Baker et al., 2007; Penninx et al., 2002), per randomized trials which followed CONSORT reporting guidelines (Moher D. Schulz KF. Altman DG. CONSORT GROUP (Consolidated Standards of Reporting Trials), 2001). No identification of the non-White group (Brenes et al., 2007; Penninx et al., 2002) or small numbers of ethnic minorities (Dunn et al., 2005) make it difficult or impossible to draw conclusions in the Black population. Physical activity is believed to decrease depressive symptoms through biological, psychological, social, cultural and geographical mechanisms (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009a). Since the mechanism of action is unknown, physical activity may not exert antidepressant effects on everyone. A systematic literature review performed to determine the effects of physical activity on depressive symptoms in Black adults found inconclusive results due to heterogeneity (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009b). In addition, few studies reported guidance by theory.

This study attempted to address short-comings found through the literature review by including representative samples of Black women and men and incorporating a theory which considers multiple levels of influence. Since sex affects biological

vulnerability, exposure to health risks, experiences of disease and disability, and access to medical care and public health services (World Health Organization (WHO), 2005), results will be stratified by sex. Stokols (1992) Social Ecology of Health Promotion takes into consideration multiple levels of influence by addressing personal and environmental factors and guides the current analysis. There are three specific aims of this study. The first is to test the relationship between PA and depressive symptoms. The second is to examine the separate effects of personal and environmental factors on the relationship between PA and depressive symptoms. The third is to examine the combined effects of personal and environmental factors on the relationship between PA and depressive symptoms.

Methods

The National Survey of American Life (NSAL) includes a nationally representative sample of African-American and Caribbean Black adults (Heeringa et al., 2004). Interviewing started in early 2001 and was completed in the spring of 2003. The sample and sampling method is extensively described in Heeringa et al. (2004) and is briefly summarized here. Inclusion criteria in the NSAL incorporated U.S. adults in the two target groups who were age 18 and older with no upper age limit, resided in households located in the contiguous 48 states, were able to complete the interview in English and consented to participate in the study. The African-American survey population included only Black adults who did not identify ancestral ties in the Caribbean. The Caribbean Black survey population was limited to Black adults who self-identified as being of Caribbean ancestry. Institutionalized persons such as individuals in prisons, jails, nursing homes and long-term medical or dependent care facilities were excluded. While military personnel living in civilian housing were eligible for the study,

residents of housing located on a military base or military reservation were excluded.

Heeringa et al. (2004) describe a four stage national area probability sampling with special supplement for Caribbean Black adults. Primary stage sampling comprised a stratified probability sample of U.S. households with two domains based on the 1990 census proportions of African-American households. The first domain included all census block households in which 10% or more of 1990 census households were reported to be African-American. The second domain included all census block groups in which the 1990 census reported <10% density for African-American households. Second stage sampling included area segments formed by linking geographically continuous census blocks. Third stage included a systematic random sample of housing units which were contacted in person by an interviewer. If the interviewer reported that one or more eligible adults lived at the sample housing unit address, the interviewer prepared a complete list of household members and proceeded to randomly select a respondent for the study interview, comprising the fourth stage. Once a respondent was randomly selected from a sequential listing of eligible household members using the Kish selection procedure, no substitutions were allowed (Pennell et al., 2004). Supplemental sampling was restricted to census geographic areas that exceeded a minimum population density for Caribbean Blacks. Pretesting of questionnaires and training of interviewers was described extensively in Pennell et al. Oral consent was obtained prior to initiating the interview (Pennell et al., 2004). There was race/ethnic matching of interviewers and respondents, with face-to-face interviews lasting on average 2 hours and 20 minutes (Pennell et al., 2004). The response rate was 70.7% for the African American and 77.7% for the Caribbean Black sample (Jackson et al., 2004). Individuals meeting the Diagnostic and Statistical Manual IV criteria for major depressive disorder or dysthymia (292) or missing values on the dependent variable

depressive symptoms (23) were excluded from the current analysis, resulting in a sample size of 4,693. Institutional Review Board (IRB) approval at the University of Michigan was granted for the NSAL (Pennell et al., 2004) and prior to data analysis for the current study.

Dependent Variable: Depressive Symptoms

The Center for Epidemiologic Studies Depression (CES-D) Scale is a self-report scale developed for epidemiologic studies at the National Institute of Mental Health (Radloff, 1977) and is one of the most widely used survey indicators of depressive symptomatology. The original 20-item CES-D was modified to 12 items (Roberts & Sobhan, 1992), which was the scale used in the National Survey of American Life. The 12-item CES-D scale included items in sentence form such as “I had crying spells” and “I enjoyed life.” Responses were rated on a four point rating scale according to the amount of time the respondent felt like this during the past week, from (0) none of the time through (3) most of the time. The total score was obtained through a possible range from 0 to 36, with higher scores indicating more symptoms (Radloff, 1977). Depressive symptoms were measured continuously as opposed to a categorical approach which risks the loss of much information (Tabachnick & Fidell, 2007). The CES-D has demonstrated reliability and validity in a wide range of settings among diverse adult Black samples. For example the alpha ranged from .77 in a HIV high-risk social environment (Morrison, DiClemente, Wingood, & Collins, 1998) to .96 in young adults (Areán & Miranda, 1997) and caregivers (Knight, Silverstein, McCallum, & Fox, 2000). Significant positive correlations were found between the CES-D and the Profile of Mood States (POMS)-Short Form ($r = .78, p < .0001$), POMS Depression Subscale ($r = .80, p < .0001$) and the Bradburn Negative Affect Scale ($r = .74, p < .0001$) in cancer

survivors (Conerly, Baker, Dye, Douglas, & Zabora, 2002), demonstrating convergent validity (Waltz, Strickland, & Lenz, 2005). The correlation of the CES-D with the Bradburn Positive Affect scale was negative in cancer survivors ($r = -.49, p < .0001$) (Conerly et al., 2002), suggesting discriminant validity (Waltz et al., 2005). The sensitivity of the CES-D in the identification of depressive symptoms in psychiatric patients was 71% compared to depressive disorders confirmed with the Structured Clinical Interview for DSM-III-R (Baker, Velli, Friedman, & Wiley, 1995). For this study, the alpha was .764 for women and .700 for men.

Independent Variable: Physical activity

Physical activity was measured with three questions pertaining to how often the respondent engaged in sports/physical activity, walking and gardening/yard work. Three separate analyses were run for each type of physical activity. Four rating scale responses were available with scores ranging from (1) often to (4) never. Scores were recoded (0) never, (1) rarely, (2) sometimes and (3) often, with higher scores indicating more physical activity. The three questions came from the Americans' Changing Lives questionnaire and have been used with Blacks across the adult lifespan (House et al., 2000; Lantz et al., 1998; Lantz et al., 2001; Robert & Reither, 2004). No reported psychometrics have been found. Criterion-related validity refers to scores correlating highly with scores on the criterion (Polit & Beck, 2004). Increasing physical activity in general is usually associated with decreasing age and disability, and increasing income (National Center for Health Statistics (NCHS), 2005; NCHS, 2007). Criterion-validity was assessed in this study by correlating the three different types of physical activity with age, income and disability and comparing results to the literature (Polit & Beck, 2004; Waltz et al., 2005).

Covariates

Personal Factors

Biogenic

Sex was assessed by interviewer identifying respondent as male (1) or female (2). Age was assessed by asking the date of birth of the respondent and measured continuously. Body mass index (BMI) was assessed by self-report weight and height and calculated as follows: $BMI = \text{weight (kg)} / \text{height squared (m}^2\text{)}$ (National Heart, Lung, and Blood Institute, 2000). BMI was measured continuously. Disability was measured from a subset of items in the World Health Organization's Disability Assessment Schedule II mobility domain (Rehm et al., year). Respondents who said that their physical or mental health was not excellent or whose health had changed for the worse in the past year were administered 3 items detailing the number of days in the past 30 days that the respondents' symptoms caused difficulty in mobility. None (1), mild (2), moderate (3), severe (4) and can't do (5) were first scored as 0, 0.25, 0.50, 0.75, and 1.0, respectively. Then, scores were transformed to 0 to 100 scale where 0 = no impairment and 100 = complete impairment. Respondents who were not asked these questions owing to excellent health were given a score of 0. Psychometric testing from 21 sites in 19 countries found confirmatory factor analysis average loadings were .81-.83 and Cronbach's alpha was .84-.86 (Rehm et al., year). For this study, the alpha was .683 for women and .772 for men. Respondents were asked if they had a family history of depression and was measured dichotomously as (0) no or (1) yes.

Psychological

Perceived discrimination was measured with the Everyday Discrimination Scale,

which measures chronic, routine, and relatively minor experiences of unfair treatment (Williams, Yu, Jackson, & Anderson, 1997). This scale consists of ten items and measures encounters with discrimination in the respondent's day-to-day life. A representative item includes "How often have you been treated with less courtesy than others?" Responses are scored on a six-point rating scale ranging from (1) almost every day to (6) never. Scores were measured continuously and reverse coded so higher scores indicate more discrimination. Cronbach's alpha has ranged from .82 to .88 (Banks, Kohn-Wood, & Spencer, 2006; Schulz et al., 2006a; Schulz et al., 2006b). Cronbach's alpha for this study was .880 for women and .895 for men.

Environmental Factors

Sociocultural

Socioeconomic status was measured by household income. Household income was assessed by asking how much all household members received in the previous year. If respondents did not give an answer, they were referred to a chart and asked to identify a letter which corresponded with a given income range (i.e., (M) \$10,000-\$10,999). The chart also had the options of (A) less than \$0 (loss) and (B) \$0 (none). Income was measured continuously. The income questions have been used extensively in the Black population, including the National Survey of Black Americans from 1979 to 1992 and the Detroit Area Study, 1995. Ethnic origin was measured categorically as (1) African-American and (2) Black Caribbean.

Geographic

Neighborhood safety was measured by two questions related to theft or assault and drug selling/use. Responses were scored on a five and four point rating scale

ranging from neighborhood safety being a problem (1) nearly often or very serious to (4-5) never or not serious at all. The average of the scores was measured continuously ranging from 1-4.5 so that higher scores indicate more neighborhood safety. No reported psychometrics found. Cronbach alpha for this study was .732 for women and .694 for men.

Region of the country (Northeast, Midwest, South and West) was ascertained by comparing the state the respondent lived in with the Census Bureau Regions (U.S. Census Bureau (USCB), n.d.). Dummy coding was utilized, with the West as the reference group.

Analysis

Descriptive statistics were used in SPSS 16.0 to summarize the data. All other analyses were performed in STATA 10.0. Weights were constructed by the original statisticians associated with the study design and methodology (Heeringa & Berglund, 2007). Three weights were used in all analyses: an overall weight incorporated unequal probabilities of selection, nonresponse, and poststratification; a variable accounting for the strata in a stratified sample design; and a variable accounting for the clusters in a clustered sample design (ICPSR Summer Program in Quantitative Methods of Social Research, 2008). All complex survey analyses were conducted using a software program (Faul & Erdfelder, 1992; StataCorp, 2007) with the Taylor Series Linearization Approach for estimating variance in a complex sample.

Validity of the physical activity measures were tested with correlation for complex samples examining the relationship between sports/physical activity, walking and gardening/yard work with age, income and disability. Reliability was assessed with the Cronbach's alpha. T-tests and Chi-square for complex samples were used to determine

if there was a statistically significant difference between women and men on descriptive statistics. Simple and multiple linear regression for complex samples were used to examine if the three types of physical activity was associated with depressive symptoms while controlling for personal and/or environmental factors. Three separate analyses were performed for each type of physical activity, with a Bonferroni correction of $p < .0167$ test for significance. Using multiple regression with an alpha of .0167, power calculations were conducted to establish the adequacy of the sample size to provide at least 80% power to detect medium sized squared multiple correlation coefficients, taking into account the number of predictor variables (13), and the inflation of error terms due to the complex survey sampling design. The definition of a medium sized squared multiple correlation is $R^2 = .13$, visible to the naked eye (Cohen, 1988). Based on results calculated by GPOWER software (Faul & Erdfelder, 1992), with a simple random sample this would require 185 subjects. The complex clustered survey design with 108 primary sampling units increases the number of subjects needed. There is a functional relationship between the size of a simple random sample and the size of a complex sample that will yield the same precision (Kish, 1965): $n(\text{eff}) = n / \text{DEFF}$, where $n(\text{eff})$ is the size for a simple random sample, n is the size of the complex sample and DEFF is the design effect. The design effect is the ratio of the variance of the estimator based on the complex design to the variance of the estimator based on a simple random sample of the same size (Kalton, 1983). The formula for DEFF is (Kish, 1965): $\text{DEFF} = 1 + (b - 1) \times \text{ICC}$, where b is the average size of the clusters and ICC is intraclass correlation. In this sample, $b = 4693 / 108$, or the total sample / # of primary sampling units, which equals 43.45. With this sampling design, the ICC could be as high as 0.2. Thus, $\text{DEFF} = 1 + (43.45 - 1) \times .2 = 8.49$. Since $n(\text{eff}) = n / \text{DEFF}$, $n(\text{eff}) \times \text{DEFF} = 185 \times 8.49 = 1570.65$. Thus, 1,571 is the needed sample size. Since the actual sample size is 4,693,

2960 women and 1733 men, power was sufficient.

Results

All variables were examined through various SPSS programs for accuracy of data entry, missing values, and fit between their distributions and the assumptions of multivariate analysis (Tabachnick & Fidell, 2007). The variables were examined separately for women and men. Sixteen women and seven men were missing values on the dependent variable and were excluded, leaving 2960 women and 1733 men (total N = 4,693). The group mean for women and/or men were substituted on sports/physical activity, BMI, perceived discrimination and neighborhood safety, since all had missing values on less than 5% of the cases. Linearity, normal distribution and homoscedasticity were assessed interposing the normal curve on a histogram of the standardized residuals and evaluating plotted values on a normal probability plot (Munro, 2001) and found to be satisfactory. Family history of depression had 8% of its cases missing in women and 11% missing in men. The mean (for each group) was inserted for missing values so that all cases were analyzed. A dummy variable was created with complete cases = 0 and missing cases = 1, and used as another variable in analysis (Tabachnick & Fidell, 2007).

Values that were more than 1.5 interquartile ranges from the upper and lower edges of the box in a boxplot were considered outliers (Munro, 2001). Boxplots revealed outliers in the following variables in women and men respectively; 16 and 15 in depressive symptoms, 2 and 4 in walking, 8 and 7 in age, 15 and 15 in BMI, 53 and 51 in disability, 18 and 16 in perceived discrimination, 36 and 32 in household income. The cutoff for outliers in women and men respectively were as follows; 23 and 20 for depressive symptoms, 0 and 0 for walking, 86 and 88 for age, 44.91 and 39.53 for BMI,

0.56 and 0.28 for disability, 57 and 53 for perceived discrimination, \$88,000 and \$105,000 for income. Analyses were performed with and without the outliers in the distribution. Since most of the results were the same with and without the outliers, the outliers were ignored and results were reported including outliers (Munro, 2001) with a few exceptions which are noted. One exception was the disability variable. Since 80% of women and 85 of men reported no disability, any disability was an outlier. Thus, all of the disability scores remained in the analysis.

For grouped data, the assumption of homoscedasticity is the same as the assumption of homogeneity of variance (Tabachnick & Fidell, 2007). F_{max} is the ratio of the largest cell variance to the smallest. If the sample sizes are relatively equal (within a ratio of 4 to 1 or less for the largest to smallest cell size), an F_{max} as great as 10 is acceptable. Departures from normality were evaluated by from inspection of the difference between frequencies expected under the normal distribution (the superimposed curve) and obtained frequencies. Disability was obviously positively skewed. For the two groups, $F_{max} = .123/.131 = .942$. Since the F_{max} is well below this criterion, there is no concern about violation of homogeneity of variance or of homogeneity of variance-covariance matrices (Tabachnick & Fidell, 2007). If the relationships are linear and the dependent variable is normally distributed for each value of the independent variable, then the distribution of the residuals should be approximately normal (Munro, 2001). This was assessed by interposing the normal curve on a histogram of the standardized residuals and evaluating plotted values on a normal probability plot (Munro, 2001) and found to be satisfactory. Multicollinearity was assessed and determined not to be an issue. None of the independent variables had intercorrelations of .85 or higher (Polit, 1996). Also, none of the tolerances approached zero (Polit, 1996; Tabachnick & Fidell, 2007).

The validity of the physical activity measures was assessed with correlations (Table 2). Sports/physical activity was significantly related to age, income and disability. Walking was also significantly related to age, income and disability in women, but not men. While gardening/yard work was significantly related to age, income and disability, it was positively associated with age. Reliability was assessed with the Cronbach's alpha which ranged from .68 to .90 for depressive symptoms, perceived discrimination, disability and neighborhood safety (Table 3).

Table 2. Assessing validity: Correlations for Complex Samples

	age		income		disability	
	W†	M†	W	M	W	M
Sports/ physical activity	-.15*	-.32*	.15*	.15 *	-.16*	-.24*
Walking	-.13*	-.03	-.01	.00	-.18*	-.06
Gardening/ yardwork	.22*	.03*	.08*	.16*	-.08*	-.09*

† W=women, M=men *p<.0167

Table 3. Assessing reliability: Cronbach's alpha

	W†	M†
Depressive symptoms	.76	.70
Perceived Discrimination	.88	.90
Disability	.68	.77
Neighborhood safety	.73	.69

† W=women, M=men

Compared to men, women reported statistically significantly higher depressive symptoms, family history of depression, BMI, disability and lower physical activity regardless of type and income (Table 4). Black U.S. adults were more likely to identify as African-American (69-72%) and live in the South (55-56%).

Table 4. Sample Characteristics

	Mean (CI)		t	p
	Women N=2960	Men N=1733		
Age	42 (41-43)	42 (40-43)	1.0	.3179
BMI	29.2 (29.0-29.5)	27.9 (27.5-28.2)	56.3	<.0001
Perceived Discrimination	52.0 (51.5-52.5)	54.3 (53.3-55.2)	23.2	<.0001
Household Income *	32,625 (30,423-34,827)	42,035 (38,556-45,513)	40.9	<.0001
Disability	4.8 (4.1-5.4)	3.6 (2.9-4.3)	5.8	.0197
Neighborhood safety	3.1 (3.0-3.2)	3.1 (3.0-3.2)	1.7	.1992
Physical Activity				
Sports/exercise	1.6 (1.5-1.7)	1.9 (1.9-2.0)	36.6	<.0001
Walk	2.1 (2.0-2.2)	2.2 (2.2-2.3)	7.9	.0070
Garden/yard work	1.0 (0.9-1.1)	1.5 (1.4-1.6)	170.8	<.0001
Depressive Symptoms	6.8 (6.44-7.17)	6.0 (5.58-6.42)	15.9	.0002
	(%)		χ^2	p
Family History of Depression				
Yes	25	20	48.9	<.0001
Ethnic Origin			3.2	.0815
Black-Caribbeans	28	31		
African-Americans	72	69		
Region of Country			1.9	.1426
Northeast	19	18		
Midwest	17	15		
South	55	56		
West	9	11		

*top coded at \$200,000

A significant association was found between depressive symptoms and sports/physical activity in women ($b = -.50$) and men ($b = -.76$), as well as gardening/yardwork in women ($b = -.44$) and men ($b = -.45$), but not walking, with 1-3% of the variance explained (Table 5). When personal factors were controlled for, depressive symptoms were only significantly associated with sports/physical activity in women ($b = -.53$) and men ($b = -.84$). Explained variance increased to 17% in women and 14% in men. When environmental factors were controlled for, depressive symptoms remained significantly associated with sports/physical activity in women ($b = -.35$) and men ($b = -.63$) and were also significantly associated with walking for women ($b = -.31$). Although depressive symptoms were significantly associated with gardening/yardwork in women ($b = -.28$) and men ($b = -.34$), this relationship was no longer significant when outliers on depressive symptoms and income were excluded. Explained variance ranged between 7-9%. When personal and environmental factors were controlled for, depressive symptoms remained significantly associated with sports/physical activity in women ($b = -.40$) and men ($b = -.73$) and were also significantly associated with walking for women ($b = -.28$). Explained variance was 22% in women and 17% in men.

Table 5. Associations between three different types of physical activity and depressive symptoms with various adjustments: The National Survey of American Life

Model	Adjustment	Women			Men		
		b†	95% CI†	R ²	b	95% CI	R ²
1	Sports/exercise	-.50*	-0.74, -0.26	.01	-.76*	-1.06, -0.47	.03
	Walking	-.20	-0.46, 0.63	.00	.11	-0.20, 0.42	.00
	Gardening/yard work	-.44*	-0.66, -0.21	.01	-.45*	-0.69, -0.20	.01
2±	Sports/exercise	-.53*	-0.76, -0.31	.17	-.84*	-1.12, -0.56	.14
	Walking	-.18	-0.43, 0.07	.16	.10	-0.17, 0.36	.11
	Gardening/yard work	-.10	-0.31, 0.10	.16	-.25	-0.52, 0.01	.11
3±±	Sports/exercise	-.35*	-0.59, -0.12	.08	-.63*	-0.94, -0.32	.09
	Walking	-.31*	-0.55, -0.08	.07	.08	-0.22, 0.38	.07
	Gardening/yard work	-.28*	-0.47, -0.08	.07	-.34*	-0.59, -0.08	.08
4±±±	Sports/exercise	-.40*	-0.63, -0.18	.22	-.73*	-1.02, -0.44	.17
	Walking	-.28*	-0.51, -0.05	.22	.10	-0.16, 0.36	.15
	Gardening/yard work	.02	-0.17, 0.20	.21	-.20	-0.46, 0.06	.15

† b, beta coefficient; 95% CI, 95% confidence interval

* p<.0167

±Adjusted for personal factors, i.e. age, body mass index, disability, family history of depression and perceived discrimination

±±Adjusted for environmental factors, i.e. ethnic origin, household income, region of country, neighborhood safety

±±±Adjusted for personal and environmental factors, i.e. age, body mass index, disability, family history of depression, perceived discrimination, ethnic origin, household income, region of country, neighborhood safety

Tables 6-7 show which independent variables were most important in explaining depressive symptoms by descending relative importance in women and men.

Sports/exercise, age, perceived discrimination, disability, household income and neighborhood safety were important in both sexes, while family history of depression was only significant in women. Ethnic origin, BMI and region of the country were not significant in either sex.

Table 6. Simultaneous Multiple Linear Regression for Depressive Symptoms in Women by descending t-values (N=2,960)

Females	Coefficient	S.E.*	t	p	95% C.I.**
Age	-0.06	-8.05	-8.05	≤0.001	-0.07, -0.04
Perceived discrimination	0.15	7.77	7.77	≤0.001	0.11, 0.19
House hold income	-0.00	-7.76	-7.76	≤0.001	-0.00, -0.00
Disability	0.07	6.21	6.21	≤0.001	0.05, 0.10
Family history of depression	1.72	4.19	4.19	≤0.001	0.90, 2.54
Neighborhood safety	-0.43	-3.80	-3.80	≤0.001	-0.66, -0.20
Sports/exercise	-0.40	-3.63	-3.63	≤0.001	-0.63, -0.18
Ethnic origin	0.77	1.98	1.98	0.05	-0.01, 1.55
Northeast	0.43	0.77	0.77	0.45	-0.70, 1.56
Midwest	0.35	0.53	0.53	0.56	-0.96, 1.66
South	0.24	0.40	0.40	0.69	-0.96, 1.43
BMI	0.00	0.09	0.09	0.93	-0.05, 0.05

*S.E., Standard Error; **C.I., Confidence Interval

Table 7. Simultaneous Multiple Linear Regression for Depressive Symptoms in Men by descending t-values (N=1,733)

Males	Coefficient	S.E.*	t	p	95% C.I.**
Perceived discrimination	0.09	.02	5.96	≤0.001	0.06, 0.12
Age	-0.04	.01	-5.67	≤0.001	-0.06, -0.03
Sports/exercise	-0.73	.15	-5.01	≤0.001	-1.02, -0.44
House hold income	-0.00	.00	3.75	≤0.001	-0.00, -0.00
Disability	0.05	.01	3.62	≤0.001	0.02, 0.08
Neighborhood safety	-0.64	.18	-3.55	≤0.001	-1.00, -0.28
Family history of depression	0.70	.35	1.99	0.05	-0.01, 1.41
Midwest	1.26	.67	1.88	0.07	-0.06, 0.04
Ethnic origin	-1.19	.66	-1.80	0.08	-2.52, 0.14
South	0.62	.45	1.38	0.17	-0.28, 1.52
BMI	-0.01	.03	-0.37	0.71	-0.06, 0.04
Northeast	-0.14	.50	-0.28	0.78	-1.15, 0.87

*S.E., Standard Error; **C.I., Confidence Interval

Discussion

There appears to be a relationship between physical activity and depressive symptoms in the Black population (Farmer et al., 1988; Wise, Adams-Campbell, Palmer, & Rosenberg, 2006). This study added to the research by including a representative sample of Black U.S. adults and guidance by theory. Our results differed between women and men and the type of physical activity measured.

Compared to men, women reported more depressive symptoms and less physical activity regardless of type, which corresponds with the literature (National Center for Health Statistics (NCHS), 2005; WHO, 2005). Women tended to have higher BMIs and report more disability than men, which also corresponds with the literature (NCHS, 2005). Sports/physical activity was inversely associated with depressive symptoms in Black women and men, which coincides with much of the literature (Farmer et al., 1988; Knox et al., 2006; Malebo, 2007; Orr, James, Garry, & Newton, 2006; Patil, 2008; Siegel, Yancey, & McCarthy, 2000; Wise et al., 2006). The mechanism of action is unknown, but biological, psychological, social and environmental hypotheses have been proposed (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009a).

Walking was inversely associated with depressive symptoms in Black women, but not associated with depressive symptoms in Black men in any of the models. These results may coincide with Farmer et al. (1988) who found for Black men, the adjusted odds ratio for depressive symptoms was larger for physical activity in recreation (i.e. sports/exercise), while for Black women the adjusted odds ratio for depressive symptoms was larger for activity apart from recreation (i.e. walking). Since men are typically more physically active than women (NCHS, 2005), perhaps men in general are more fit and require intensities higher than walking to derive benefits. This could also explain how walking may prevent or delay the onset of disability in women but not men, resulting in a decrease in depressive symptoms in women but not men. However, although the antidepressant effect of physical activity could be mediated by cardiovascular fitness levels (K. Armstrong & Edwards, 2004; Fox, 1999; North, McCullagh, & Tran, 1990), improvement in fitness is not always concurrent with a decrease in depressive symptoms (Pollock et al., 1998). In addition, the present study did not differentiate walking for physical activity from walking for other purposes, such as transportation, occupation or household physical activity (Sallis et al., 2006). Increasing physical activity in general is usually associated with younger age, less disability and higher income (National Center for Health Statistics (NCHS), 2005; National Center for Health Statistics (NCHS), 2007), which coincides with the current results related to walking in women but not men. Perhaps male respondents in this sample were uncertain on how to categorize walking for exercise versus walking for other purposes.

Gardening/yardwork was significantly related to depressive symptoms while controlling for environmental factors in women and men, but not when outliers were excluded on depressive symptoms and income. If gardening/yardwork is eventually shown to be effective in decreasing depressive symptoms, gardening/yardwork may still

not be an appropriate intervention for individuals with higher depressive symptoms (over 23 for women and 20 for men). Correlation results showed a significant positive relationship between gardening/yardwork and income in women ($r = .08$) and men ($r = .16$). This suggests that those with higher income are more likely to participate in gardening/yardwork than those with lower income. Perhaps those with higher income are more likely to own a home and have access to a garden or yard. If gardening/yardwork is shown to be effective in decreasing depressive symptoms, it will have to be more accessible, perhaps through community gardens (Armstrong, 2000; Armstrong, 2000; Johnson & Smith, 2006; Lombard, Forster-Cox, Smeal, & O'Neill, 2006; Twiss et al., 2003).

Gardening/yardwork was not associated with depressive symptoms in Black women and men while controlling for personal and environmental factors. Gardening may be thought of as a hobby while yard work may be thought of as a chore. Gardening has been considered a moderately to very pleasant activity and has been associated with happiness (Onishi et al., 2006). Conversely, yard work has not been inversely associated with depressive symptoms (Izquierdo-Porrera, Powell, Reiner, & Fontaine, 2002). Future studies should separate gardening from yardwork. In addition, unlike other forms of physical activity, gardening/yard work was positively associated with age in women ($r = .22$) and men ($r = .03$) with a significance of $p < .0167$. Izquierdo et al. (2002) found similar correlations between calories expended during yard work and age ($r = .22$) in a predominantly Black female convenience sample. Like income, perhaps those with increased age are more likely to own a home and have access to a garden or yard. Those with increased age may also have more time to garden or tend a yard, particularly if they are retired. If future studies confirm these findings, gardening or yardwork may be an additional method of increasing and maintaining physical activity

with age.

The national recommendations for adults are a minimum of 150 minutes a week of moderate intensity or 75 minutes per week of vigorous intensity aerobic physical activity, or an equivalent combination of moderate and vigorous intensity aerobic physical activity, and moderate or high intensity muscle strengthening activities involving all major muscle groups on two or more days a week (U.S. Department of Health & Human Services [USDHHS], 2008). Unfortunately, since the current study did not measure intensity or duration, it is difficult to compare the current results to the national recommendations.

Personal factors explained more variance in depressive symptoms than environmental factors in women (16-17% vs. 7-8%) and men (11-14% vs. 7-9%). This may be due to inadequate measures of the environment. Although the current study included four regions of country, other recommendations include measuring latitude and climate (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009a; Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009b), which takes into account risk factors for seasonal affective disorder (Mersch, Middendorp, Bouhuys, Beersma, & van den Hoofdakker, 1999). In addition, although the current study included neighborhood safety, other appropriate measures could include animals, traffic, noise, trash and litter, night lighting, sidewalk conditions, public walking tracks and trails, and availability of public transportation (Gallagher et al., in press; Strawbridge, Deleger, Roberts, & Kaplan, 2002).

There were additional interesting findings beyond those in the specific aims. Age, disability, perceived discrimination, household income and neighborhood safety were all significantly related to depressive symptoms while holding all other variables constant in women and men. However, when high-end outliers of depressive symptoms,

age, BMI, and income were excluded from analyses, disability was no longer significantly related to depressive symptoms while holding all other variables constant in men. This suggests the significant relationship between disability and depressive symptoms in men is confounded by increased age, BMI, and/or income.

The relative importance of the independent variables differs between women and men. For example, in women age, perceived discrimination, household income, disability, family history of depression and neighborhood safety all appeared to be more important than sports/exercise. This is in contrast to men, where only perceived discrimination and age appeared more important than sports/exercise in predicting depressive symptoms. In addition to biological factors, these results point to the importance of socially constructed factors in relation to depressive symptoms (WHO, 2005).

Family history of depression was also significantly related to depressive symptoms in women, but not men. Since family history of depression had 8% of its cases missing in women and 11% missing in men, a dummy variable was created with complete cases vs. missing cases, and used as another variable in analysis (Tabachnick & Fidell, 2007). However, the dummy variable was not significant in any of the models (results not shown). Could women have a genetic predisposition to depressive symptoms that men don't have? Future studies are needed to address this question.

Generalization of these results are limited to community-dwelling Black U.S. adults who self-identified as African American or of Caribbean descent, lived in the contiguous states, spoke and understood English and were not clinically depressed. This study attempted to address short-comings found in previous literature by including representative samples of Black women and men, incorporating a theory, and stratifying results based on types of physical activity. Depressive symptoms were significantly

related to sports/physical activity in Black women and men, and walking in women. Longitudinal studies are needed to establish causality. Future studies should also include Black U.S. adults diagnosed with Major Depressive Disorder and/or dysthymia. Validation of self-report measures is recommended, such as height and weight for BMI, DNA analyses for genetic factors, and accelerometers for physical activity. Consideration should be given to differentiating among leisure, transportation, occupation and household physical activity, and not collapse all types of physical activity into one variable. Additional studies should examine gardening and yard work separately, paying particular attention to whether this type of physical activity increases with age. Physical activity measurements should include intensity, frequency, duration and type in order to compare results to national physical activity guidelines. Reliability and validity for measures should be reported. More and better measurements of the environment are needed. Physical activity decreases depressive symptoms in the White population (Baker et al., 2007; Brenes et al., 2007; Dunn et al., 2005; Knubben et al., 2007; Mather et al., 2002; Penninx et al., 2002; Singh et al., 2001). Future studies should continue to examine this relationship in the Black population.

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CHAPTER V CONCLUSION

This thesis provides new insights into the relationship between physical activity and depressive symptoms in Black U.S. adults. A systematic literature review of 182 articles found 12 relevant articles, 7 of which found an inverse relationship and only 2 studies which specifically addressed the effects of physical activity on depressive symptoms in Black adults (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009b). The current study adds to the small body of research by including a representative sample of Black U.S. women and men, guidance by a Stokols' Social Ecology of Health Promotion and assessment of reliability and validity of measures (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009c).

Sports/exercise was inversely associated with depressive symptoms in Black women and men (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009c). Although the current study was cross-sectional, randomized trials in the White population has shown exercise effective in decreasing depressive symptoms in clinical (Brenes et al., 2007; Doyne et al., 1987; Dunn, Trivedi, Kampert, Clark, & Chambliss, 2005; Greist et al., 1979; Klein et al., 1984; Knubben et al., 2007; Martinsen, Hoffart, & Solberg, 1989; Mather et al., 2002; Singh, Clements, & Singh, 2001; Veale et al., 1992) and nonclinical (Baker et al., 2007; King, Taylor, & Haskell, 1993; McCann & Holmes, 1984; McNeil, LeBlanc, & Joyner, 1991; Penninx et al., 2002) settings. If sports/exercise is effective in decreasing depressive symptoms in Black adults, the most likely mechanisms include changing the expression of certain genes such as BDNF, dopamine and serotonin;

releasing endorphins; regulating the hypothalamic-pituitary-adrenocortical axis; and increasing certain types of self-efficacy and social support (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009a). Age, perceived discrimination, household income, disability and neighborhood safety in women and men, and family history of depression in women are important factors which may confound the relationship between physical activity and depressive symptoms (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009c).

Walking was inversely associated with depressive symptoms in Black women, but not Black men (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009c). Men may be more fit than women in general, and require intensities higher than walking to derive benefits. Conversely, women may not require as high intensities than men because of a genetic predisposition to depressive symptoms. Family history of depression was related to depressive symptoms in Black women, but not Black men (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009c). Perhaps walking changes the expression of certain genes in women but is not at a high enough intensity to cause a change in men. Black women also reported higher rates of obesity than Black men (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009c). In previous studies of a convenience sample of all Black women which stratified results by BMI, walking for exercise was weakly associated with depressive symptoms among obese women, but not nonobese women (Wise, Adams-Campbell, Palmer, & Rosenberg, 2006). Perhaps physical activity regardless of intensity interacts with obesity, which could explain how walking may decrease depressive symptoms in women but not men.

Just as there are certain types of physical activity that are more acceptable to certain cultures such as tai chi and qigong in the Chinese (Chou et al., 2004; Tsang, Fung, Chan, Lee, & Chan, 2006), hot spa bathing in the Japanese (Kamioka et al.,

2006), and yoga in India (Vedamurthachar et al., 2006), there may be certain types of physical activity that are more acceptable to women compared to men. Unlike women, men have historically been socialized to engage in sports/exercise. For example, in the ancient Olympic Games, married women were not allowed to participate in the athletic contests and were barred from watching male athletic competition, with a penalty of death (University of Pennsylvania Museum of Archeology and Anthropology, 2007). The marathon was first introduced in the Modern Olympic Games of 1896 in Athens (University of Pennsylvania Museum of Archeology and Anthropology, 2007). However, women were not allowed to run the marathon distance in the Olympic Games until the 1984 Summer Olympics in Los Angeles (Vertinsky, 2000). Thus, sports/exercise but not walking may be seen as an acceptable form of physical activity by men, while any type of available physical activity may be appreciated by women.

Gardening/yardwork was positively correlated with age (Torres, Sampsel, Gretebeck, Ronis, & Neighbors, 2009c). This is one of the few types of physical activities which have been found to increase with age. If future studies confirm this finding in the Black population, this may be an effective way to increase physical activity in older adults. Although gardening/yardwork was also positively correlated with income, access may be increased with community gardens (Armstrong, 2000; Armstrong, 2000; Johnson & Smith, 2006; Lombard, Forster-Cox, Smeal, & O'Neill, 2006; Twiss et al., 2003). In addition to increasing physical activity, community gardens have been shown to increase access to fresh fruits and vegetables in urban (Armstrong, 2000; Johnson & Smith, 2006; Twiss et al., 2003) and rural areas (Armstrong, 2000; Armstrong, 2000; Lombard et al., 2006), contribute to positive income through saving money on food otherwise purchased at stores and/or selling produce at a farmer's market (Armstrong, 2000; Lombard et al., 2006), reduce or delay the risk of diabetes and other

cardiovascular diseases (Armstrong, 2000; Lombard et al., 2006), and promote opportunities to organize around other important issues in the community (Armstrong, 2000; Twiss et al., 2003).

Like community gardens, physical activity has an impact on more than depressive symptoms. A Surgeon General's report on physical activity and health (U.S. Department of Health & Human Services [USDHHS], 1996) concluded that regular moderate physical activity substantially reduces the risk of dying of coronary heart disease, the nation's leading cause of death, and decreases the risk for stroke, colon cancer, diabetes, and high blood pressure. It also helps to control weight; contributes to healthy bones, muscles, and joints; reduces falls among older adults; helps to relieve the pain of arthritis; reduces symptoms of anxiety; and is associated with fewer hospitalizations, provider visits, and medications. This has important implications for individuals with comorbid illnesses.

Although the current study excluded individuals diagnosed with Major Depressive Disorder or dysthymia, studies in the clinically depressed White population have found physical activity often reduced depressive symptoms by at least 50% (Blumenthal et al., 1999; Dunn et al., 2005; Martinsen, Medhus, & Sandvik, 1985; Singh, Clements, & Fiatarone, 1997; Singh et al., 2001), similar to antidepressant medication (Williams et al., 2000). Whereas more than 90% of antidepressant medication trials have only been of 6 to 8 weeks duration (Williams et al., 2000), physical activity has been found to maintained a reduction in depressive symptoms for up to five years (Motl et al., 2005). Part of the reason for such short trials is that the drop-out rates for antidepressant medications are high. Approximately 20% of antidepressant medication studies reported drop-out rates exceeding 40% (Williams et al., 2000), as opposed to 6-26% reported in physical activity studies (Babyak et al., 2000; Blumenthal et al., 1999; Dunn et al., 2005;

Penninx et al., 2002; Singh et al., 2001). Significantly more participants taking a selective serotonin reuptake inhibitor (SSRI) compared to those receiving a placebo discontinued treatment because of adverse events (Williams et al., 2000). Drop-outs due to adverse events were statistically significantly higher for first-generation tricyclic antidepressants (16%) than SSRIs and reversible inhibitors of monoamine oxidase A (5%) (Williams et al., 2000). Common adverse events with SSRIs include diarrhea, headache, insomnia, and nausea (Williams et al., 2000). Adverse events that were significantly more common for tricyclic antidepressants than for SSRIs were blurred vision, constipation, dizziness, dry mouth, tremors, and urinary disturbance (Williams et al., 2000). In addition, estimates of sexual dysfunction from antidepressant medication range from small to 80% (Rosen, 1999). Conversely, there was either no statistical difference between physical activity and control groups with respect to adverse events (Dunn et al., 2005) or fewer adverse events in the physical activity group compared to the control group (Singh et al., 2001) and antidepressant medication group (Blumenthal et al., 1999).

In addition to side-effects, stigma has been associated with individuals not taking their antidepressant medication as prescribed (Ayalon, 2005; Sirey et al., 2001). Black U.S. adults are even less likely than White U.S. adults to find antidepressant medications acceptable treatment (Cooper et al., 2003). In addition, nearly two-thirds of Black Americans who met criteria for a 12-month DSM-IV disorder did not seek some form of mental health services in the previous year (Neighbors et al., 2007). Stigma surrounding the receipt of mental health treatment is among the many barriers that discourage people in general and Black U.S. adults in particular from seeking treatment (Cooper-Patrick, Ford, Mead, Chang, & Klag, 1997). If future studies demonstrate physical activity is effective in decreasing depressive symptoms in the Black population

suffering from clinical depression as it is in the White population, physical activity could serve as an adjunct to current therapies which are associated with significant side-effects and stigma.

It is important to emphasize that while physical activity and other forms of antidepressants may offer some protection against stress, in some cases alleviating the cause of the stress may be a more effective and ethical solution, than simply offering different treatment or coping methods. Perceived discrimination, adequate income and neighborhood safety may have to be addressed before physical activity or any other medical intervention is a viable option. As social environments can increase or decrease the likelihood of exposure to certain types of stressors (USDHHS, 1999), future studies should address social networks as well. Emphasis on personal responsibility should not replace system blame and social change perspectives (Neighbors, Braithwaite, & Thompson, 1995).

Finally, children, adolescents and individuals from varying ethnicities and cultures should be included in studies addressing mental health. Fortunately, with datasets such as an adolescent version of the National Survey of American Life and the National Latino and Asian American Study, such studies are now possible. The importance of providing culturally appropriate self-management tools is recognized in HealthyPeople 2010. Specific objectives include developing an operational mental health plan that addresses cultural competence and providing early detection and intervention for mental health problems (USDHHS, 2001). In addition, this study addresses National Institute of Nursing Research's goals of promoting health, preventing disease and improving quality of life with self-management of symptoms (National Institute of Nursing Research , 2006).

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