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Physical Activity Effects on Depressive Symptoms in Black Adults

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Abstract

Objectives—Randomized trials found physical activity (PA) effective in decreasing depressive symptoms. Few studies included Black participants. The purpose of this systematic literature review was to determine the effects of PA on depressive symptoms in Black adults.

Methods—Articles were abstracted by conducting a computer and hand search of eligible studies.

Results—Eight of 13 studies found a significant inverse relationship between PA and depressive symptoms in Black adults. Sources for the heterogeneity were explored.

Conclusion—Future studies should include representative samples of Black adults, incorporate a theory which considers multiple levels of influence, account for genetic factors in the etiology of depressive symptoms, include individuals diagnosed with depression and with health conditions which may increase the risk of depressive symptoms, account for intra-group ethnic heterogeneity, measure and differentiate between social support and social network, consider aspects of the physical environment and use standardized measurements of PA.

Keywords

exercise; depression; African American; systematic review; Stokols' Social Ecology of Health Promotion

INTRODUCTION

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 with clinical depression (Brenes et al., 2007; Dunn, Trivedi, Kampert, Clark, & Chambliss, 2005; Knubben et al., 2007; Mather et al., 2002; Singh, Clements, & Singh, 2001) 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

specification of groups classified as "non-White" (Brenes et al., 2007; Penninx et al., 2002) or the small numbers of ethnic minorities 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 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; N. A. Singh & Fiatarone Singh, 2000; Yeung, 1996). Since the mechanism of action is unknown, physical activity may not exert antidepressant effects in 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 of the relationship between physical activity and depressive symptoms. No time restriction was placed on publication date. Healthy adults and those with clinical depression were included, such as Major or Minor Depressive Disorder and dysthymia. Individuals with mood disorders in addition to clinical depression were excluded. Studies focused on non-diagnostic depressive symptoms were included. All types of physical activity were included regardless of dosage. Quantitative studies published in peer-reviewed journals through August 27, 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. In OVID, the subheading African Continental Ancestry Group was included in the search, while Black or African American was in ISI Web of Science and PubMed. 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 identified for review and analysis. Of the 195 non-duplicating articles found, 182 were excluded for a variety of reasons. Several were not quantitative studies in peer-review journals. Many were excluded due to unrelated sample such as nonhuman subjects or children. Often studies were excluded due to methodological issues such as combining depression with other mood disorders, or measuring concepts similar to but not identical to physical activity, such as physical health or mobility. Since the purpose of this review was to determine the effects of physical activity on depressive symptoms, depressive symptoms had to be the dependent variable. Finally, studies were excluded if the relationship between physical activity and depressive symptoms was undeterminable, such as when physical activity and depressive symptoms were both covariates in a regression with a different outcome.

Studies reviewed (n=13) were assessed and listed in Table 1, which summarizes the samples, designs, methods and key findings. Eight of the studies found a significant inverse relationship between physical activity and depressive symptoms (Farmer et al., 1988; Knox et al., 2006; Malebo, van Eeden, & Wissing, 2007; Orr, James, Garry, & Newton, 2006; Patil, Johnson, & Lichtenberg, 2008; Siegel, Yancey, & McCarthy, 2000; Wilbur et al.,

2009; Wise, Adams-Campbell, Palmer, & Rosenberg, 2006). The studies reviewed comprised 7 cross-sectional (Artinian, Washington, Flack, Hockman, & Jen, 2006; Bopp, Wilcox, Oberrecht, Kammermann, & McElmurray, 2004; Farmer et al., 1988; Malebo et al., 2007; Orr et al., 2006; Patil et al., 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 2 experimental (Izquierdo-Porrera, Powell, Reiner, & Fontaine, 2002; Wilbur et al., 2009). Ten of the 13 studies used convenience sampling. Most of the studies had majority female samples; 10 were more than 70% female and 8 were 100% female. Only 1 study from 1988 used a nationally representative sample (Farmer et al., 1988). About half of the studies specified exclusion criteria based on health and/or capacity to participate in physical activity, such as the presence of disabilities (Farmer et al., 1988; Izquierdo-Porrera et al., 2002; Knox et al., 2006; Nelson et al., 2008; Walker et al., 2004; Wilbur et al., 2009). One study excluded those with mental illness (Artinian et al., 2006) while another excluded those who reported physician-diagnosed depression (Wise et al., 2006). All of the studies used an established measure of depressive symptoms. Ten 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.

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. 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). However, in studies including specific age groups, physical activity was sometimes related to depressive symptoms in young adults (Malebo et al., 2007; Orr et al., 2006), but not always (Walker et al., 2004), often related in middle age (Knox et al., 2006; Wilbur et al., 2009) and middle to old age (Nelson et al., 2008), and occasionally related in older adults (Patil et al., 2008), but usually not (Artinian et al., 2006; Bopp et al., 2004).

The relationship between body mass index (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 had a weak inverse relationship 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 often resulted in mostly female samples. Only three 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; Wilbur et al.,

2009; Wise et al., 2006) with Cronbach alphas ranging from .71 to .93 (Artinian et al., 2006; Nelson et al., 2008; Siegel et al., 2000; Walker et al., 2004; Wilbur et al., 2009). Another measurement of depressive symptoms in the reviewed articles was the Geriatric Depression Scale (Bopp et al., 2004; Patil et al., 2008). Although both reported good psychometrics for the Geriatric Depression Scale in previous studies, neither study used the original version (Bopp et al., 2004; Patil et al., 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], 2009). 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, 2009). Reviewed articles measured frequency as number of times weekly (Patil et al., 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). Another study calculated adherence to walking frequency as the percentage of the prescribed minimum of 68 walks completed during the adoption phase of the intervention (Wilbur et al., 2009). Duration is commonly measured as the length of time in which an activity is performed (CDC, 2009). Reviewed articles measured duration by at least 20 minutes (Patil et al., 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 et al., 2008), recreational and nonrecreational (Farmer et al., 1988), walking (Wilbur et al., 2009; 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 et al., 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 et al., 2007). Only one study reported validating self-report data (Wilbur et al., 2009). Specifically, heart rate monitors and an automated telephone response system was reported (Wilbur et al., 2009). Finally, only one study accounted for seasonal physical activity, specifically summer and winter participation (Malebo et al., 2007). Future studies should use physical activity measurements which have demonstrated reliability and validity in previous studies, continue to report psychometrics in subsequent studies, and validate self-report measures. Established physical activity measurements which include intensity, frequency, duration and type should continue to be utilized. Although this review did not support a recommendation regarding period of recall, recommendations have been made for relatively short reporting intervals (no longer than three months), with the possible exception of advanced age where long term memory may be better preserved than recent recollections of activity patterns (Shepard, 2003).

Only one of the studies in this review reported guidance by a theory or conceptual model (Wilbur et al., 2009). Since physical activity is hypothesized to decrease depressive

symptoms through biological, psychological and social mechanisms (Brosse et al., 2002; Craft & Perna, 2004; Dishman et al., 2006; Fox, 1999; North et al., 1990; Paluska & Schwenk, 2000; Scully, 1998; Singh & Fiatarone Singh, 2000; Yeung, 1996), theories or models 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 Model 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 and disabling injuries. Although Stokols did not include 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, 2007).

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 aged 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 had a weak inverse association 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 remains 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 disability which results from those illnesses has not been well studied. This suggests the need to investigate the effects of different types of physical activity, stratify results by sex, age (perhaps by

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 (Brosse et al., 2002; Craft & Perna, 2004; Fox, 1999; North et al., 1990; Paluska & Schwenk, 2000; Scully, 1998; Singh & Fiatarone Singh, 2000; Yeung, 1996). However, of the three studies which specifically addressed the possible effects of physical activity on depressive symptoms in Black adults (Farmer et al., 1988; Wilbur et al., 2009; Wise et al., 2006), none included psychological factors. Future studies should include psychological variables such as self-efficacy.

Environmental factors

Environmental factors were delineated 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; Wilbur et al., 2009; 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; D. R. Williams, Yu, Jackson, & Anderson, 1997; D. R. Williams & Jackson, 2000). For example, approximately 2.4 million or 8% of U.S. Blacks are foreign born (U.S. Census Bureau, 2005). Sixty percent of foreign born Blacks living in the U.S. are from the Caribbean (McKinnon & Bennett, 2005, August). The 12-month rate of Major Depressive Disorder 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 regional differences and neighborhood

characteristics. 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 in the United States (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). For example, 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 geographic factors is neighborhood characteristics. In the only reviewed study which addressed neighborhood characteristics, adherence to walking remained predictive of depressive symptoms while controlling for neighborhood deterioration and crime (Wilbur et al., 2009). Additional neighborhood characteristics which affect physical activity and depressive symptoms include animals, traffic, noise, trash and litter, night lighting, sidewalk conditions, public walking tracks and trails, and availability of public transportation (Gallagher et al., 2010; Strawbridge, Deleger, Roberts, & Kaplan, 2002). Future studies should include aspects of the physical environment, such as the neighborhood characteristics.

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 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 resulted in 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, & Kiassen, 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 region of the country and neighborhood characteristics.

CONCLUSION

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 systematic 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, report psychometrics and validate self-report measures. 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 characteristics.

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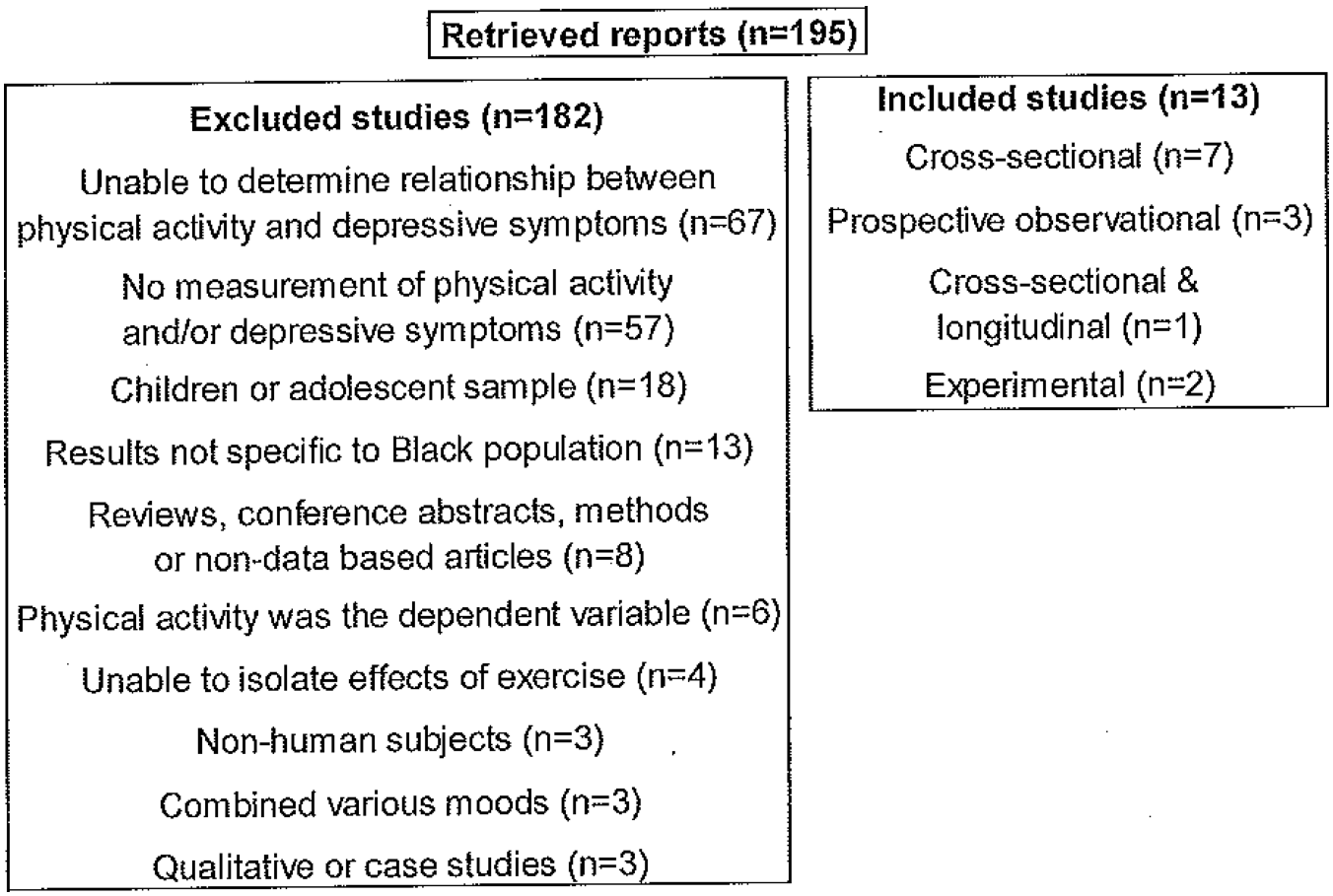

Figure 1.
Process of Inclusion for Review.

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Table 1

Summary of 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 PA & depressive symptoms variables
Artinian et al. (2006)	245	Convenience	female	61 years (SD, 12.7 years)	Cross-sectional	Assessment of PA 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	female	70.59 ±9.21 years	Cross-sectional	PA 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	57% female	25–77	Cross-sectional	Current recreational & nonrecreational PA	20 item CESD	Adjusted odds ratio for depressive symptoms was 16.5 in men with little or no PA 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%)	Convenience	83% female	29–83	Experimental	Attendance in PA church program	20 item CESD	Attendance in PA intervention was not correlated with depressive symptoms (r=.16, p>.05)
Knox et al. (2006)	2,637	Random & convenience	56% female	33–45	Prospective observational	METS from strenuous PA to daily activities such as cleaning & gardening over previous year	20 item CESD	The adjusted predictor of # of depressive episodes was B=−28.40, SE=7.61, p=.0002 for PA.

Authors	n	Subject Selection	Gender	Age	Design	Physical Activity Measurement	Psychological Instrument	Key Findings on PA & depressive symptoms variables
Malebo, et al. (2007)	293	Convenience	52% male	20–35	Cross-sectional	PA Index measured 5 categories of activity: intensity, duration, frequency, summer participation, and winter 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)
Nelson et al. (2008)	186	Random	female	35–47 at baseline, followed for 8 years	Prospective observational	Kilocalories of leisure-time PA per week were calculated from the Paffenbarger PA Questionnaire and categorized into the top third (≥ 1450 kcal/wk), middle third (< 1450 to 644 kcal/wk), and bottom third (< 644 kcal/wk) of reported current activity	20 item CESD	PA 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 PA tertile was used as the reference group.)
Orr et al. (2006)	922	Convenience	pregnant women	18–20+	Cross-sectional	PA for fun & fitness before and during pregnancy	20 item CESD	Proportionately more women with lower levels of depressive symptoms engaged in PA 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	Estimated number of times weekly of PA (intentional cardiovascular workout) for at least 20 consecutive minutes	15 item Geriatric Depression Scale	Correlation between PA and depressive symptoms was −.29, p<01 (two-tailed)

Authors	n	Subject Selection	Gender	Age	Design	Physical Activity Measurement	Psychological Instrument	Key Findings on PA & depressive symptoms variables
Siegel et al. (2000)	378	Convenience	female	adults	Cross-sectional	Leisure-time PA operationalized as “no PA”, “only light PA/weekly,” “vigorous PA at least 20 min once or twice weekly,” and “vigorous PA at least 20 min three or more times weekly”	20 item CESD	PA predicted depressive symptoms (B = −0.15, p<.01), holding education, income, marital status, and pounds overweight constant
Walker et al. (2004)	100	Convenience	post-partum	22.40 ±3.75	Prospective observational	7-day PA recall, kcal/kg/d	20 item CESD	Non-significant correlation between depressive symptoms and PA (r = −.078)
Wilbur et al. (2009)	278	Convenience	female	48.5 (SD 6.0)	Quasi-experimental	Adherence to walking frequency calculated as the percentage of the prescribed minimum of 68 walks completed during the adoption phase of the intervention	20 item CESD	Higher walking adherence was predictive of lower depressive symptoms at 24 weeks (B = −.023, p = .036)
Wise et al. (2006)	35,224	Convenience	female	21–69	Cross-sectional and prospective observational	Vigorous PA during high school; average # of hours spent each week during the past year in walking for PA & vigorous PA	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, 0.83, and 0.76 respectively. Compared with women who reported no

Authors	n	Subject Selection	Gender	Age	Design	Physical Activity Measurement	Psychological Instrument	Key Findings on PA & depressive symptoms variables
								vigorous PA, the adjusted OR of depressive symptoms for women reporting <1, 1, 2, 3–4, and 7 hr or more/week was .89, .85, .74, .72, and .75 respectively (p<.001).

PA=physical activity