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Individual and contextual correlates of physical activity among a clinical sample of United States Veterans

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Abstract

Rationale: Veterans, especially those using U.S. Department of Veterans Affairs (VA) healthcare, have poorer health than the general population. In addition, Veterans using VA services are more likely than non-VA users to be physically inactive. Little is known about physical activity correlates among Veterans. To identify targets for health promotion interventions, understanding barriers to and facilitators of physical activity in this population is critical.

Methods: This study examined individual-, social-, and perceived neighborhood-level associations of meeting weekly physical activity recommendations (150 min/week of combined leisure and transportation activity) based on the International Physical Activity Questionnaire (IPAQ) among $N = 717$ patients from VA Puget Sound, Seattle Division using a mailed survey sent

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Conflict of interest statement

The authors declare there are no conflicts of interest.

Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.socscimed.2015.07.034>.

2012–2013 (response rate = 40%). Independent associations were identified with direct estimation of relative risks using generalized linear models (dichotomous outcome), and linear regression (continuous outcome), including variables associated in bivariate tests ($p < .05$).

Results: Most participants were male, Caucasian, and unemployed, and had an annual income \$40,000. Over two-thirds (69.9%) reported meeting physical activity recommendations. Fewer days of limitations due to physical or mental health (Relative Risk (RR) = 0.99 per day; 95% Confidence Interval (CI) = 0.98, 0.99; $p = .01$), others doing physical activity with the Veteran (RR = 1.18; 95% CI = 1.04, 1.33; $p = .01$), receiving ideas from others regarding physical activity (RR = 1.14; 95% CI = 1.01, 1.29; $p = .03$) and better perceived neighborhood aesthetics (RR = 1.14; 95% CI = 1.06, 1.24; $p = .001$) were associated with meeting physical activity recommendations. Findings were comparable for total weekly physical activity, but lower depression symptom severity was also associated with increased physical activity.

Conclusion: This study identified individual and contextual correlates of physical activity among VA-using Veterans. Targeting these factors will be important in promoting physical activity in order to address the disproportionate disease burden facing U.S. Veterans. Existing VA interventions targeting physical activity may need to be adapted to account for the influence of contextual factors.

Keywords

Veterans; Physical activity; Neighborhood; Social support

1. Introduction

Veterans face disproportionate disease burden across a host of health indicators (Agha et al., 2000; Hoerster et al., 2012b; Lehavot et al., 2012). This includes overweight/obesity, with only 28% of VA-using Veterans having normal weight compared with 43% in the general adult population (Nelson, 2006). A primary approach to addressing overweight/obesity is physical activity (Institute of Medicine, 2012). Veterans may have unique barriers to physical activity, including a high burden of mental health conditions (Hoerster et al., 2012b; Lehavot et al., 2012), which can affect physical activity engagement (Chwastiak et al., 2011). In order to better promote physical activity among Veterans, it is important to identify barriers and facilitators of physical activity.

Ecological models extend traditional behavioral models to acknowledge and address the impact of contextual factors on behavior, including health-related behaviors (Sallis et al., 2008). As specified in “The Ecological Model of Active Living” (Sallis et al., 2006), physical activity is thought to be affected by factors at multiple levels of influence, including intrapersonal, social-cultural environment, and perceived physical environment characteristics. Given the complex contributors to physical activity, comprehensive interventions to improve physical activity and related chronic diseases can maximize effectiveness by including complementary strategies at these multiple levels (Sallis et al., 2008). Evidence from observational studies of Veterans suggests that demographic characteristics, health status, psychiatric conditions, somatic symptoms, fatigue, and use of VA care are associated with lower physical activity (Bouldin and Reiber, 2012; Chasens et

al., 2009; Chwastiak et al., 2011; Hoerster et al., 2012a; Littman et al., 2009). These prior studies of Veterans have focused on identifying important clinical correlates, but have not identified contextual factors that influence physical activity, which may differ from those in non-Veterans. To expand our understanding of Veterans' physical activity facilitators and barriers, the current study examined individual and contextual correlates of physical activity among Veterans.

2. Methods

2.1. Sample

The present study used data from a survey mailed August–September of 2012 to 1997 Veterans from VA Puget Sound, Seattle Division. Veterans were identified based on administrative data and were randomly selected from two clinic populations (half from PTSD specialty care and half from primary care) based on having had at least one visit in fiscal year 2011 (10/2010–9/2011). Veterans were recruited from these two clinics to ensure adequate representation of Veterans with PTSD, a focus of the parent survey study. We sent reminder letters to those who did not return surveys as of October 2012 and re-mailed surveys to 1221 non-responders in March of 2013, followed by a reminder call. Veterans received \$10 in VA canteen coupons for completing the survey. All recruited Veterans had a residential address with a King County zip code.

A total of 193 Veterans were excluded from the study following the survey mailing because they were deceased, or had an erroneous or out-of-state mailing address, leaving 1804 possible respondents. We received surveys from 717 (response rate = 40%). The VA Puget Sound, Seattle Division Institutional Review Board approved this study and a waiver of consent.

2.2. Measures

Measure selection was guided by “The Ecological Model of Active Living” so that potential physical activity correlates were measured at the intrapersonal, social-cultural environment, and perceived physical environment levels of influence (Sallis et al., 2006).

2.2.1. Intrapersonal measures—The survey collected information on age, sex, race/ethnicity (non-Hispanic White, non-Hispanic Black, and Other), marital status, educational attainment, employment status, and annual household income. We measured past-week pain interference using a single item asking participants who endorsed experiencing chronic pain (yes vs. no pain that has persisted for more than 3 months) to rate its interference with daily activities on a scale from 0 to 10; those who denied chronic pain received a zero score for this measure. Days of functional limitations due to mental health or physical health concerns/problems was assessed by asking “During the past 31 days, for about how many days did poor physical or mental health keep you from doing your usual activities, such as self-care, work, or recreation?” (Centers for Disease Control and Prevention (CDC), 2014a). Mental health symptoms were past-month post-traumatic stress disorder (PTSD) symptoms, assessed with the PTSD Checklist-Military Version (PCL-M; score range: 17–85) (National Center for PTSD, 2014), and depressive symptoms in the past two weeks, assessed with the

Patient Health Questionnaire-8 (PHQ-8; score range: 0–24) (Kroenke et al., 2009). PCL-M and PHQ-8 symptom severity scores were summed; higher scores indicate worse symptoms.

2.2.2. Social-cultural environment measures—Overall social support was assessed with the ENRICH Social Support Instrument (ESSI) (Mitchell et al., 2003; Vaglio et al., 2004). Responses across items were summed; higher scores reflect greater perceived social support (range: 8–34). Neighborhood social cohesion and trust was assessed with a five-item scale (items averaged), where higher scores indicate better cohesion and trust (range: 1–5) (Sampson et al., 1997). Social support for physical activity was assessed using three variables that were created for this study, informed by prior work (Hoerster et al., 2011; Sallis et al., 1987). Participants were asked how much in the past 30 days, others: (1) did physical activity with them; (2) encouraged them to do physical activity; and/or (3) shared ideas on physical activity with them. Because participants were asked these questions separately for family, friends, another Veteran, and neighbors, their responses to each were recoded “*often and very often*” for any social support type (family, friends, another Veteran, and neighbors) versus “*sometimes, rarely, and never*,” yielding three dichotomous measures of social support for physical activity.

2.2.3. Perceived physical environment measures—Perceived neighborhood characteristics were assessed using items from some domains of the Neighborhood Environment Walkability Scale-Abbreviated (NEWS-A): infrastructure and safety for walking; aesthetics; traffic hazards; and crime (Cerin et al., 2006). Item scores were averaged within each domain (ranges: 1–4). Higher scores for infrastructure and safety for walking and aesthetics reflect better walkability. Higher scores for traffic hazards and crime reflect worse hazards and crime.

2.2.4. Physical activity—Total weekly physical activity was calculated by summing the total weekly minutes (based on the multiplicative of days and duration responses) of walking, moderate, and vigorous leisure and transportation physical activity as reported on the long form International Physical Activity Questionnaire (IPAQ), a widely used measure with acceptable reliability and validity (Craig et al., 2003). Standard IPAQ data cleaning procedures were used (International Physical Activity Questionnaire (IPAQ), 2005); as a result, physical activity values were truncated for 93 participants, and another 8 participants were excluded from analyses because their responses were considered invalid due to being extreme outliers. For the study’s primary analyses, the measure of total physical activity was dichotomized to reflect meeting versus not meeting physical activity recommendations (≥ 150 vs. <150 weekly minutes of physical activity) (CDC, 2014b), a level of activity that has been shown to have important health and longevity benefits (Arem et al., 2015).

2.3. Statistical analyses

Descriptive and bivariate analyses were performed in SAS Version 9.4. Variables significantly ($p < .05$) associated with physical activity in bivariate t-tests for continuous variables and Chi-Square tests for categorical variables were simultaneously included in a multivariable regression analysis to identify factors independently associated with meeting versus not meeting weekly physical activity recommendations. We directly estimated

relative risks using generalized linear models (GLM; log link, Poisson distribution) (Zou, 2004) because meeting recommended physical activity levels was not rare (i.e., more than 10% endorsed meeting recommendations (Zhang and Yu, 1998)) and thus odds ratios from logistic regression models would overestimate the relative risk. Thus, we present the more useful and interpretable summary measure, relative risk (Holcomb et al., 2001; Sinclair and Bracken, 1994). In secondary analyses, variables significantly associated with total weekly physical activity in bivariate correlations for continuous variables and ANOVAs for categorical variables were simultaneously included in a multivariable linear regression model.

Because of missing data combinations, 316 respondents were excluded from the complete case multivariable analysis for meeting vs. not meeting physical activity recommendations and 365 were missing from the complete case secondary multivariable linear regression analyses for total weekly physical activity. To address the missing data in the multivariable models, we employed multiple imputation by chained equations in Stata Version 13 for multivariable analyses, imputing only the outcome and variables that were statistically significantly associated with the outcome in bivariate associations, with 10 imputations run for each model (Royston and White, 2011; Rubin, 1987; Van Buuren et al., 1999). Multiple imputation-based multivariable regression results are presented, rather than complete-case analyses, because there were minor differences between complete-case versus multiple imputation regression models.

To provide further understanding of factors associated with physical activity among Veterans, interactions—adjusting for all variables associated at the bivariate level—were tested between all intrapersonal variables and the social-cultural and perceived physical environment variables that were included in the regression models. Because this approach involved running 20 separate multivariable analyses for the dichotomous outcome and 24 for the continuous outcome, a more stringent p -value ($p < .001$) was set for identifying significant interactions to avoid Type I error. Lastly, to assess the impact of non-response bias, we examined whether sample characteristics differed between survey respondents and non-respondents based on administrative data.

3. Results

Over two-thirds (69.9%) of respondents reported engaging in at least 150 min of weekly physical activity. The average minutes of weekly physical activity was 529.7 (Standard Deviation (SD) = 611.2). Sample characteristics are presented in Table 1. The majority of participants were male, Caucasian, unemployed, and had at least some college education, and an annual income of \$40,000 or less. Characteristics for those with no missing data on the secondary outcome were comparable so they are not presented.

3.1. Associations with meeting physical activity recommendations

In bivariate analyses, Veterans meeting physical activity recommendations had fewer days of functional limitations due to physical or mental health concerns/problems, lower depression symptoms, and more favorable perceived neighborhood aesthetics (Table 1). In addition, Veterans who were male, employed, and had higher income and greater social support for

physical activity were also more likely to meet physical activity recommendations (Table 1). In the multivariable analysis ($F(12, 3233.4) = 8.46, p < .001$), fewer days of functional limitations due to physical or mental health concerns/problems, others doing physical activity with the Veteran, receiving ideas from others regarding physical activity, and better perceived neighborhood aesthetics were each significantly and independently associated with increased likelihood of meeting physical activity recommendations (Table 2). Variables associated at the bivariate level but not in multivariable analyses were sex, employment status, income, depression symptom severity, and receiving encouragement from others regarding physical activity.

3.2. Associations with total weekly physical activity

In bivariate analyses, higher minutes of weekly physical activity was associated with lower pain, days of limitations due to physical or mental health, and depression; being employed part- or full-time (vs. being unemployed and under 65 years of age); higher general social support, neighborhood social cohesion and trust, and all three types of support for physical activity; and better perceived neighborhood aesthetics (Table 3). In the multivariable analysis ($F(11, 377.4) = 7.32, p < .001$), greater minutes of weekly physical activity was associated with fewer days of functional limitations due to physical or mental health concerns/problems, lower depression symptoms, others doing physical activity with the Veteran, receiving encouragement from others regarding physical activity, and better perceived neighborhood aesthetics (Table 4). Variables associated at the bivariate level but not in multivariable analyses were employment status, pain, general social support, neighborhood social cohesion, and receiving ideas from others regarding physical activity.

3.3. Interaction testing

No significant interactions between intrapersonal and social-cultural variables, nor between intrapersonal and perceived physical environment variables, were detected.

3.4. Non-response bias

The study sample differed from non-responders on age, race/ethnicity, marital status, and PTSD diagnosis status but did not differ on gender (Supplementary Table 1).

4. Discussion

This study identified individual and contextual correlates of physical activity among Veterans who use VA care. This was a relatively active sample with 70% reporting that they meet physical activity recommendations, a rate slightly higher than the general US population, where 62% meet activity recommendations based on self-reported total physical activity (Tucker et al., 2011).

While the sample self-reported being very active overall, among those not meeting physical activity recommendations, the median number of weekly physical activity minutes was 30 (data not shown), far below the level that will result in physical activity benefits (CDC, 2014b; Institute of Medicine, 2012). Indeed, 45% of those not meeting physical activity recommendations reported zero weekly minutes of leisure or transportation-related physical

activity (data not shown). Veterans who are inactive or engaging in suboptimal levels of activity will need to be targeted to improve overall health. Identifying correlates of physical activity is thus an important step towards designing optimal physical activity interventions for inactive or sub-optimally active Veterans. This may be particularly important for VA given that VA's nationally-delivered MOVE! weight loss program has shown only modest weight loss outcomes, especially for those with psychiatric conditions (Hoerster et al., 2014; Kahwati et al., 2011).

In this study's analyses, which included important demographic factors related to physical activity, intrapersonal, social-cultural environment, and one perceived physical environment measure were associated with the study's two physical activity outcomes. Specifically, lower functional limitations, and better social support for physical activity and neighborhood aesthetics were associated with both outcomes, and lower depression symptom severity was associated with higher total physical activity. Unlike prior research in the general population (Bauman et al., 2012), demographic characteristics (i.e., age, sex, race/ethnicity, educational attainment, employment status, and income) were not associated with physical activity in this study, which is a promising finding given that these factors are not, or not easily, modifiable. Instead, this study's findings indicate that physical activity promotion efforts likely need to target modifiable factors at multiple levels of influence to be effective among Veterans. Findings are consistent with "The Ecological Model of Active Living" (Sallis et al., 2006) and prior research in the general population demonstrating the importance of individual and contextual factors in facilitating and interfering with physical activity (Bauman et al., 2012; Mozaffarian et al., 2012).

4.1. Intrapersonal level of influence

Higher functional limitations were associated with reduced physical activity based on both physical activity outcomes in our sample, consistent with previous reports (Brown et al., 2004; Hillsdon et al., 2005; Seeman and Chen, 2002). U.S. Veterans have more functional limitations than the general population, and VA-users are the most severely affected (Hoerster et al., 2012b; Lehavot et al., 2012; Peterson et al., 2004; Rogers et al., 2004). This was true in the current study sample, with the average days of functional limitations being 7.5, compared with 2.3 days in the general adult population (Centers for Disease Control and Prevention (CDC), 2011). These findings are important in light of the increased costs associated with functional decline (Fried et al., 2001). Physical activity is considered a key component of health promotion and disease prevention guidelines, and has demonstrated efficacy as both a primary and secondary prevention tool for functional decline and disability (Berk et al., 2006; Brach et al., 2004; Morey et al., 2009; Pahor et al., 2014). However, many Veterans report physical comorbidities (e.g., health problems, chronic pain) that may limit regular physical activity participation (Das et al., 2005; Dominick et al., 2006; Spelman et al., 2012), high-lighting the need for effective, evidence-based programs that promote physical activity and preserve physical functioning. Although chronic pain has been cited as a physical activity barrier for Veterans previously (Buis et al., 2011), chronic pain interference was not associated with physical activity in the present study, suggesting that broader physical limitations should be the focus when promoting physical activity among

Veterans, especially among older Veterans. Even modified physical activity is effective in reducing morbidity (Stevenson and Topp, 1990).

Depression was associated with reduced total physical activity in the present study, consistent with prior research (Roshanaei-Moghaddam et al., 2009), including among Veterans (Hoerster et al., 2012a). Contrary to expectations based on prior research (Hall et al., 2015), PTSD symptom severity was not associated with reduced physical activity, indicating that perhaps depression is a more important mental health factor to target when developing physical activity interventions for Veterans. Physical activity should be assessed among those with depression to determine whether physical activity intervention is indicated. This will be especially important to do given that physical activity interventions are shown to reduce depressive symptoms (Conn, 2010).

4.2. Social-cultural environment level of influence

While previous research has demonstrated that social support is an important facilitator of physical activity in the general population (Bauman et al., 2002), this is, to our knowledge, the first study to demonstrate this association among Veterans. In the present sample, Veterans who reported others did physical activity with them or provided ideas about physical activity were significantly more likely to meet physical activity recommendations. Likewise, Veterans who reported others did physical activity with them or encouraged them to be physically active reported significantly higher physical activity. Integrating social support into interventions targeting physical activity among Veterans may enhance efficacy. One social support-based intervention delivery mechanism recently implemented in VA is the peer support model of care, wherein paid Veterans in recovery from mental health conditions support physical and mental health behavioral change in other Veterans (Chinman et al., 2008, 2010). Expansion of the existing peer support model may be one strategy to facilitate physical activity among Veterans. It is important to note that marital status, general social support, and neighborhood cohesion were not independently associated with physical activity in the present study. Thus, while social support is important, it appears critical that promoting social support in physical activity interventions for Veterans should specifically involve encouraging, providing ideas related to, and engaging together in physical activity.

4.3. Perceived physical environment level of influence

To our knowledge, the current study is the first to demonstrate that perceived neighborhood characteristics influence physical activity among Veterans. Perceived aesthetics was associated with both physical activity outcomes in this Veteran sample. Neighborhood aesthetics are often found to be associated with physical activity in the general population (Bauman et al., 2012; Cain et al., 2014; Cerin et al., 2014). While the larger-scale built environment can be difficult to modify in the short-term, aesthetic features are one of the more changeable “microscale” environment correlates of activity (Cain et al., 2014). Veterans working in their communities to organize neighborhood clean-ups, tree-plantings, and/or building maintenance could capitalize on improving social cohesion and improve neighborhood aesthetics, both of which can increase physical activity.

Infrastructure and safety, crime, and traffic hazards were not significantly associated with Veterans' physical activity in this sample. Crime has been an inconsistent correlate of physical activity (Bauman et al., 2012; Evenson et al., 2012) while traffic safety and infrastructure for walking have commonly been found to be associated with physical activity (Sallis et al., 2012). However, studies in the general population may not apply uniformly to Veterans, who in this sample had on average lower socioeconomic status and were often disabled. The null perceived neighborhood findings suggest that more research is needed among Veterans to a) identify optimal mechanisms for measuring the perceived neighborhood environment; b) understand the impact of objectively measured neighborhood features on physical activity; and c) intervene on neighborhood correlates interfering with physical activity.

4.4. Type of physical activity

The primary objective of this study was to examine whether or not Veterans met recommendations for physical activity (CDC, 2014b). Consistent with national guidelines and previous research, we conceptualized physical activity as an umbrella term, which included both transportation and leisure physical activities (CDC, 2014b; Tucker et al., 2011). However, other studies in the general population have examined these activity domains separately, and report that correlates of transportation- and leisure-based physical activity differ (Bauman et al., 2012). For example, in one study, factors like streetscape characteristics (e.g., sidewalk presence and quality) and proximity to destinations (e.g., services and shops) were correlates of transportation-based physical activity, and neighborhood aesthetics was associated with leisure physical activity (Cain et al., 2014). Thus, in exploratory analyses we examined whether the patterns of association differed when transportation-based activity was removed from the outcome. Results were comparable in these exploratory analyses, with lower functional limitations, social support for physical activity, and more favorable perceived neighborhood aesthetics independently associated with increased likelihood of meeting physical activity recommendations through leisure-based activity (data not shown). A similar pattern of results was observed when correlates of total weekly minutes of leisure physical activity were examined (data not shown). However, only perceived neighborhood aesthetics was associated with total weekly minutes of transportation-based activity (data not shown).

Findings illustrate that perceived neighborhood aesthetics have a widespread impact on Veterans' physical activity, regardless of activity type. Neighborhood aesthetics has been shown in many studies to positively impact adults' physical activity (Bauman et al., 2012; Cain et al., 2014; Cerin et al., 2014). The present findings underscore the importance of bringing more awareness to this issue in the Veteran population and increasing resources to areas in need of aesthetic improvements to potentially increase physical activity.

Identifying more comprehensive correlates of transportation-based physical activity among Veterans will be important, especially because transportation-based activity was an important contributor to the high number of Veterans meeting physical activity recommendations in this sample; removing such activity from the outcome reduced the percent of Veterans meeting recommendations by 23% (data not shown).

4.5. Limitations and strengths

Because this is a cross-sectional study, the direction of associations cannot be determined. PTSD symptom severity was not associated with physical activity in this sample. The literature on the association between PTSD and physical activity has been inconsistent, with several but not all prior studies finding an association between PTSD and activity (Hall et al., 2015). The lack of association in the present study may be related to non-response bias. Having a PTSD diagnosis was more common among non-responders than among responders (see Supplementary Table 1). It is possible that non-response was correlated with how much physical activity Veterans with PTSD (but not those without) engaged in, potentially resulting in non-response bias. It also could be that the IPAQ physical activity measure used in the present study yields different data for Veterans with PTSD than measures used in prior studies among Veterans with PTSD. No published studies have validated physical activity measures in this Veteran sub-population (Hall et al., 2015). Moreover, few studies that used psychometrically sound physical activity measures have found an association between PTSD and physical activity, and no published studies examining the association between PTSD and physical activity have used objective measures of activity. Thus, this is an important area for future study. In addition, the focus of the parent survey study was PTSD; therefore, this sample has an overrepresentation of Veterans with PTSD. In summary, this study's results may not be generalizable to all Veterans, particularly those with PTSD. However, it is noted that PTSD status was not a moderator of the relationships of socio-demographic characteristics with meeting physical activity guidelines in exploratory interaction testing.

The present study sample also differed from non-responders on age, race/ethnicity, and marital status (see Supplementary Table 1). These were the available administrative variables with which to examine non-response bias, but there are likely other unmeasured factors that may be leading to bias in this study's sample and thus findings. Responders and non-responders did not differ on gender. While it is possible that the analysis was underpowered to detect differences in gender, 87% of responders and non-responders were male, so there is likely no meaningful difference in response based on gender. In summary, the degree to which non-response impacted the findings is unknown and the study's results should be considered in light of this limitation.

All measures in the present study were self-report, which can lead to bias. In particular, people tend to overestimate their physical activity engagement (Troiano et al., 2008; Tucker et al., 2011). As such, future studies of physical activity correlates among Veterans should incorporate objective clinical measures (e.g., clinician-administered mental health symptom assessment) and device-based (e.g., accelerometer) physical activity assessment. Objective physical activity measurement will also help to more accurately identify moderate-to-vigorous levels of activity engagement, important given that the CDC recommendations are for 150 min of *weekly moderate-to-vigorous* activity (CDC, 2014b).

We included walking in the physical activity totals because a) this was an older sample with the average age being 61 years; b) walking is a popular and healthy way for older adults to participate in exercise (CDC, 2013); and c) walking has been shown to be the most common way that individuals meet physical activity recommendations, with important health benefits (Arem et al., 2015). Moreover, longevity is improved for individuals who engage in activity,

even among those not achieving the weekly 150-min threshold (Arem et al., 2015). Doing so meant that individuals meeting physical activity recommendations were not necessarily limited to those achieving moderate or vigorous physical activity. Due to mailed survey space restrictions, we also did not assess occupational and household activity, which are part of the long form IPAQ assessment. Thus, future studies in Veterans should include comprehensive and objective physical activity measures.

We were unable to measure all components of “The Ecological Model of Active Living” (Sallis et al., 2006) in the current study, including objectively-measured built environment characteristics like street connectivity, and proximity of destinations and recreation facilities (Bauman et al., 2012). However, measures of perceived neighborhood characteristics are widely used and psychometrically sound. Future studies should comprehensively examine the correlates specified in the model (Sallis et al., 2006) among Veterans. We also were unable to examine potential mediators in our study because of the cross-sectional design (Maxwell and Cole, 2007). Future studies employing longitudinal models will allow for testing mediation, which will identify clearer targets for interventions. In the present study, we did not detect interactions between factors at different levels of the ecological model. To inform policy, future longitudinal research should examine interactions between levels of the ecological model, which may provide more specific intervention directions for Veterans, given that various environmental or social factors may differentially affect people with diseases or disability. Notwithstanding these limitations, this study provides important and novel preliminary data on individual and contextual correlates of physical activity among VA-using Veterans.

4.6. Conclusions

To our knowledge, this study is the first to comprehensively evaluate individual and contextual correlates of physical activity among VA-using Veterans. Correlates identified are modifiable and situated at multiple levels of influence. The VA healthcare system typically takes an individual-level approach to healthcare delivery. However, the current study’s findings underscore the importance of advising clinicians to also assess and address social- and neighborhood-level influences on physical activity among Veterans, and reinforce the importance of developing interdisciplinary efforts to address this complex problem.

Future behavioral intervention planning that incorporates factors beyond the individual can maximize the impact of physical activity interventions, and “The Ecological Model of Active Living” (Sallis et al., 2006) provides a useful guide to planning such interventions. More effectively promoting physical activity among Veterans via these modifiable pathways will be an essential step in improving VA interventions like the MOVE! weight management program (Kahwati et al., 2011) and ultimately, the health of U.S. Veterans.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Sample characteristics and bivariate associations with meeting physical activity recommendations (≥ 150 min of weekly PA) among Veterans.

Continuous variables		Total sample (N = 635) ^a		<150 min PA (N = 191)		150 min PA (N = 444)		^b p-value
		Mean (SD)		Mean (SD)		Mean (SD)		
Intrapersonal (possible range)								
Age (25–97) ^c		60.9 (13.3)		61.4 (13.8)		60.7 (13.1)		0.54
Pain interference (0–10)		4.0 (3.5)		4.4 (3.6)		3.8 (3.4)		0.07
Days of functional limitations (0–31)		7.5 (10.0)		10.8 (11.5)		6.1 (8.9)		<0.001
PTSD symptom severity (17–85)		44.3 (20.6)		45.8 (21.3)		43.7 (20.3)		0.26
Depression symptom severity (0–24)		9.2 (7.2)		10.9 (7.6)		8.5 (6.9)		<0.001
Social environment								
General social support (8–34)		23.2 (7.7)		22.3 (7.9)		23.6 (7.6)		0.06
Neighborhood cohesion/trust (1–5)		3.1 (1.0)		3.1 (1.0)		3.2 (0.9)		0.19
Perceived physical environment								
Infrastructure and safety (1–4)		2.7 (0.8)		2.6 (0.8)		2.7 (0.8)		0.27
Aesthetics (1–4)		3.0 (0.7)		2.7 (0.8)		3.1 (0.7)		<0.001
Traffic hazards (1–4)		2.4 (0.7)		2.4 (0.7)		2.4 (0.7)		0.26
Crime (1–4)		1.9 (0.9)		1.9 (0.9)		1.8 (0.8)		0.21
Categorical variables		N (%)		%		%		^d p-value
Intrapersonal								
Sex								0.03
Male		536 (85.9)		28.5		71.5		
Female		88 (14.1)		39.8		60.2		
Race/ethnicity								
Non-Hispanic White		437 (73.0)		30.7		69.3		0.29
Non-Hispanic Black		58 (9.7)		20.7		79.3		
Other		104 (17.4)		30.8		69.2		
Relationship status								
Married/living with SO		316 (51.7)		27.2		72.8		0.15

	Total sample (N = 635) ^a		<150 min PA (N = 191)		150 min PA (N = 444)		^b p-value
Continuous variables	Mean (SD)		Mean (SD)		Mean (SD)		
Not married or living with SO	295 (48.3)		32.5		67.5		
Educational attainment							0.30
High school graduate	122 (19.8)		33.6		66.4		
>High school	493 (80.2)		28.8		71.2		
Employment status							0.03
Part- or Full-time	131 (21.9)		22.9		77.1		
Unemployed, Age <65	245 (41.0)		35.9		64.1		
Unemployed, Age 65	222 (37.1)		28.8		71.2		
Household income							0.03
<\$20,000	186 (31.2)		37.1		62.9		
\$20,001–\$40,000	177 (29.7)		29.9		70.1		
\$40,001–\$80,000	162 (27.2)		26.5		73.5		
>\$80,000	71 (11.9)		19.7		80.3		
<i>Social environment</i>							
Others did PA with them							<0.001
Yes	142 (25.6)		10.6		89.4		
No	412 (74.4)		38.4		61.7		
Others shared ideas about PA with them							<0.001
Yes	187 (32.6)		15.0		85.0		
No	386 (67.4)		39.1		60.9		
Others provided encouragement for PA							<0.001
Yes	246 (42.9)		18.3		81.7		
No	328 (57.1)		40.2		59.8		

Abbreviations: PA = Physical Activity; SD = Standard Deviation; PTSD = Post-traumatic Stress Disorder; SO = Significant Other.

^aSample size based on the number of Veterans with data on the outcome (150 min of weekly PA); multiple imputation not used for descriptive and bivariate tests.

^bBased on t-test.

^cAge range for the sample.

^dBased on chi-square test.

Table 2

Multivariable associations with meeting physical activity recommendations (150 min of weekly PA) among Veterans ($N = 717$).^a

Variables	Relative risk	CI
Intrapersonal		
Female vs. Male	0.85	0.72, 1.00
Unemployed, Age <65 vs. Part- or Full-time	0.90	0.79, 1.03
Unemployed, Age 65 vs. Part- or Full-time	0.88	0.78, 1.00
\$20,001–\$40,000 vs. < \$20,000	1.05	0.92, 1.19
\$40,001–\$80,000 vs. < \$20,000	1.05	0.92, 1.19
>\$80,000 vs. < \$20,000	1.06	0.91, 1.23
Days of functional limitations (per each additional day) ^{**}	0.99	0.98, 0.99
Depression severity (per point increase in severity)	1.00	0.99, 1.00
Social environment		
Others did PA with them: yes vs. no ^{**}	1.18	1.04, 1.33
Others shared ideas about PA with them: yes vs. no [*]	1.14	1.01, 1.29
Others provided encouragement for PA: yes vs. no	1.13	0.99, 1.28
Perceived physical environment		
Aesthetics (per point increase in rating) ^{***}	1.14	1.06, 1.24

Abbreviations: CI = Confidence Interval; PA = Physical Activity.

Note: Each estimate is adjusted for all other variables in Table 2.

^{*} $p < .05$;

^{**} $p < .01$;

^{***} $p < .001$.

^a Sample size based on multiple imputation, performed for the outcome and variables associated with the outcome in bivariate analyses.

Table 3

Bivariate associations with total weekly minutes of physical activity among Veterans ($N = 556$).^a

Continuous variables ^b	Correlation with total PA	P-value (<i>r</i>)
Intrapersonal		
Age	−0.06	0.14
Pain interference	−0.13	<0.01
Days of functional impairment	−0.23	<0.001
PTSD symptom severity	−0.07	0.13
Depression symptom severity	−0.18	<0.001
Social environment		
General social support	0.10	0.03
Neighborhood social cohesion and trust	0.10	0.02
Perceived physical environment		
Infrastructure and safety for walking	0.05	0.22
Aesthetics	0.23	<0.001
Traffic hazards	−0.07	0.12
Crime	−0.06	0.17
Categorical variables		
PA minutes Mean (SD)		
p-value (ANOVA)		
Intrapersonal		
Sex		
Male	545.6 (621.2)	0.10
Female	425.6 (538.2)	
Race/ethnicity		
Non-Hispanic White	529.2 (620.2)	0.87
Non-Hispanic Black	509.9 (505.3)	
Other	561.7 (632.1)	
Marital status		
Married/living with SO	557.4 (629.2)	0.32
Not married or living with SO	505.4 (589.4)	

Continuous variables ^b	Correlation with total PA	P-value (<i>r</i>)
Educational attainment		0.78
High school graduate	515.3 (643.5)	
>High school	533.8 (600.9)	
Employment status		0.03
Part- or Full-time ^c	637.4 (605.8)	
Unemployed, Age <65 ^c	453.6 (602.0)	
Unemployed, Age 65	527.4 (605.4)	0.45
Annual household income		
<\$20,000	508.3 (618.7)	
\$20,001–\$40,000	486.8 (554.3)	
\$40,001–\$80,000	563.1 (646.1)	
>\$80,000	615.8 (646.0)	
<i>Social environment</i>		
Others did PA with them		<0.001
Yes	778.7 (639.9)	
No	445.8 (590.2)	
Others shared ideas about PA with them		<0.001
Yes	689.2 (621.6)	
No	451.2 (606.0)	
Others provided encouragement for PA		<0.001
Yes	687.0 (678.1)	
No	418.4 (552.1)	

Abbreviations: PA = Physical Activity; *SD* = Standard Deviation; PTSD = Post-Traumatic Stress Disorder; SO = Significant Other.

^aSample size based on the number of Veterans with data on the outcome (total weekly minutes of PA); multiple imputation was not used for descriptive and bivariate tests. The N for these analyses is smaller than those presented in Table 1 because Veterans could have missing data on some components of the PA measure (e.g., walking for transportation) but report 150 min of PA based on other components. To have data on the total PA outcome, Veterans had to report their activity for all components of the PA measure.

^bSample characteristics and variable ranges are presented in Table 1.

^cSignificant difference is between these two groups.

Table 4

Multivariable associations with total weekly physical activity among Veterans ($N = 717$).^a

	Diff	CI
Intrapersonal		
Unemployed, Age <65 vs. Part- or Full-time	-104.8	-245.7, 36.1
Unemployed, Age 65 vs. Part- or Full-time	-126.1	-270.6, 18.3
Pain interference (per point increase in severity)	-0.9	-15.4, 13.7
Days of functional limitations (per point increase in severity)**	-7.6	-13.4, -1.9
Depression severity (per point increase in severity)*	-9.1	-18.1, -0.2
Social environment		
General social support (per point increase in amt.)	-5.7	-14.2, 2.7
Neighborhood cohesion/trust (per point increase in amt.)	-18.4	-89.0, 52.3
Others did PA with them: yes vs. no*	166.8	0.3, 333.3
Others shared ideas about PA with them: yes vs. no	32.8	-100.5, 166.2
Others provided encouragement for PA: yes vs. no*	169.8	9.5, 330.0
Perceived physical environment		
Aesthetics (per point increase in rating)***	146.0	69.9, 222.2

Abbreviations: Diff = Difference in minutes of physical activity; CI = Confidence Interval; amt = amount; PA = Physical Activity. Note: Each estimate is adjusted for all other variables in Table 4.

* $p < .05$;

** $p < .01$;

*** $p < .001$.

^aSample size based on multiple imputation, performed for the outcome and variables associated with the outcome in bivariate analyses.