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Physical Activity and Depression Symptom Profiles in Young Men and Women With Major Depression

Charlotte McKercher, PhD, George C. Patton, PhD, Michael D. Schmidt, PhD, Alison J. Venn, PhD, Terence Dwyer, MD, and Kristy Sanderson, PhD

Objective: This study explored whether young adults with major depression who are physically active differ in their depression symptom profile from those physically inactive. **Methods:** Analyses included data from 950 (47.6%) men and 1045 women (mean [standard deviation] age = 31.5 [2.6] years) participating in a national study. Participants reported leisure physical activity (International Physical Activity Questionnaire) and ambulatory activity (pedometer steps per day). Diagnosis and symptoms of major depression were assessed using the Composite International Diagnostic Interview. **Results:** Prevalence of major depression was 5.5% ($n = 52$) for men and 11.6% ($n = 121$) for women. Interactions between physical activity and sex were observed for depressed mood, appetite changes, vacillating thoughts, and suicidality (all, $p < .050$). Among those with major depression, physically active men were significantly less likely to endorse the presence of insomnia (prevalence ratio [PR] = 0.78, 95% confidence interval [CI] = 0.63–0.96), fatigue (PR = 0.82, 95% CI = 0.69–0.99), and suicidality (PR = 0.69, 95% CI = 0.49–0.96) compared with inactive men. Physically active women were significantly less likely to endorse hypersomnia (PR = 0.50, 95% CI = 0.27–0.95), excessive/irrational guilt (PR = 0.76, 95% CI = 0.59–0.97), vacillating thoughts (PR = 0.74, 95% CI = 0.58–0.95), and suicidality (PR = 0.43, 95% CI = 0.20–0.89) compared with inactive women. Associations were adjusted for age, physical health, educational attainment, depression severity, and other depressive symptoms. **Conclusions:** Among adults with major depression, those physically active seem to differ in their depression symptom profile from those physically inactive. **Key words:** depression, depressive symptoms, physical activity, population based.

BMI = body mass index; **DSM-IV** = Diagnostic and Statistical Manual of Mental Disorder; Fourth Edition; **IPAQ** = International Physical Activity Questionnaire; **SF-12v2** = Short-Form Survey.

INTRODUCTION

Observational research indicates that regular physical activity is associated with reduced risk of depression and depressive symptoms (1). Intervention studies also indicate the beneficial effects of physical activity on depressive symptoms comparable with antidepressants (2). However, previous studies have examined the association between physical activity and global depressive symptoms only. Physical inactivity and depression are both accompanied by changes in psychological and physiological functioning including anhedonia, fatigue, and psychomotor activity. Observed associations may therefore be caused by the inclusion of physical inactivity–related characteristics in depression diagnosis. This has implications for an individuals' likelihood of endorsing certain diagnostic criterion to reach a diagnostic threshold and attain a clinical diagnosis. It is important to clarify therefore whether associations are caused by the inclusion of physical inactivity–related characteristics in the diagnostic system or whether those who are physically active are, in fact, different in their depression symptom profile from those who are physically inactive.

Research examining associations between physical activity and specific depressive symptoms is sparse. Intervention studies indicate that increased exercise may be beneficial in improving depressed mood (3,4), sleep problems, negative self-worth, and concentration difficulties (4). Furthermore, exercise withdrawal (i.e., induced physical inactivity) has been found to precipitate altered sleep patterns as well as increases in depressed mood (5,6) and fatigue (5). Finally, observational studies indicate inverse associations between sports participation (7,8), physical activity (9,10), and suicidal behavior. It remains unclear therefore whether physical inactivity is associated with all depressive symptoms, or whether there is specificity to type of symptom. Clarifying which symptoms covary with physical activity may enhance our understanding of the protective mechanisms involved and inform the use of physical activity interventions for depression.

To our knowledge, no studies have examined associations between physical activity and individual Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) (11) depressive symptoms. Using a population-based cohort, we have previously demonstrated inverse associations between physical activity and prevalence of depression in young adults (12). Current analyses examine the prevalence of individual depressive symptoms in physically active and physically inactive young adults diagnosed as having major depression. We hypothesized that depressive symptoms corresponding to characteristics of physical inactivity, such as anhedonia, fatigue, and psychomotor changes, would differentiate those physically active from those physically inactive.

METHOD

Participants

The Childhood Determinants of Adult Health study is a 20-year follow-up of 8498 children (age, 7–15 years) who participated in the 1985 Australian Schools Health and Fitness Survey (13). Sampling procedures and data collection protocols have been described previously (14). Briefly, a nationally representative sample of 109 schools was selected with probability proportional to enrolment. Approximately 20 years later, 6840 (81%) of the baseline

From the Menzies Research Institute Tasmania (C.M., M.D.S., A.J.V., K.S.), University of Tasmania, Hobart, Australia; Department of Kinesiology (M.D.S.), University of Georgia, Athens, Georgia; Department of Paediatrics (G.C.P.), University of Melbourne, Melbourne, Australia; and Murdoch Childrens Research Institute (G.C.P., T.D.), Melbourne, Australia.

Address correspondence and reprint requests to Charlotte McKercher, PhD, Menzies Research Institute Tasmania, University of Tasmania, Private Bag 23, Hobart TAS 7000, Australia. E-mail: Charlotte.McKercher@utas.edu.au

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sample were traced and 5170 (61%) enrolled and provided follow-up data. Of these, 2410 attended a study clinic and 2070 completed the main exposure and outcome measures used in the current analysis. Those currently pregnant (n = 75) were excluded, leaving data from 1995 clinic attendees. Figure 1 illustrates the recruitment and retention of cohort participants. A subsample of 1681 clinic attendees (84.3%) additionally completed a 7-day pedometer diary.

There were no significant differences at baseline (1985) between those who did and those who did not provide a pedometer diary at follow-up in depressed mood (8.9% versus 8.2%, p = .64) and total past-week physical activity (424 versus 459 min/wk, p = .10). The study was approved by the Southern Tasmania Health and Medical Human Research Ethics Committee, and all participants provided written informed consent.

Measures

Participants were sent questionnaires before attending a clinic where height and weight were measured, the Composite International Diagnostic Interview (CIDI) was completed, and pedometers were issued.

Physical Activity

Participants completed the International Physical Activity Questionnaire (IPAQ) (15), which assesses the frequency and duration of moderate- and vigorous-intensity leisure physical activity in the previous 7 days. The IPAQ demonstrates very good levels of repeatability and fair to moderate validity when compared with data from accelerometers (16).

Following detailed instructions, participants wore a pedometer (Yamax Digiwalker SW-200) for 7 days and kept a pedometer diary. Ambulatory activity (mean steps per day) over the wear period was calculated for each participant with at least four valid days of measurement. Pedometers have shown evidence of reliability (17) and convergent and discriminative validity (18).

Diagnostic Assessment

Major depression and depressive symptoms based on DSM-IV diagnostic criteria for the previous 12 months were assessed using the CIDI-Auto (version 2.1) (19). The CIDI-Auto includes a list of dichotomous symptom items that separately operationalize the nine DSM-IV criteria for major depression. For compound diagnostic criterion, individual symptom components are also assessed. DSM-IV organic exclusion and diagnostic hierarchy rules were used in making diagnoses. Diagnosis of major depression requires endorsement of at least one of the two core symptoms of depression (depressed mood, anhedonia), together with at least three associated criteria, to give a total of five or more diagnostic criteria. Owing to the skip logic embedded in the computerized CIDI-Auto, analyses were by necessity restricted to those who endorsed at least one of these core symptoms. These participants were then assessed for the presence of the other seven diagnostic criteria. This subsample who met the diagnostic criteria for a diagnosis of major depression (n = 173) comprised the analysis sample.

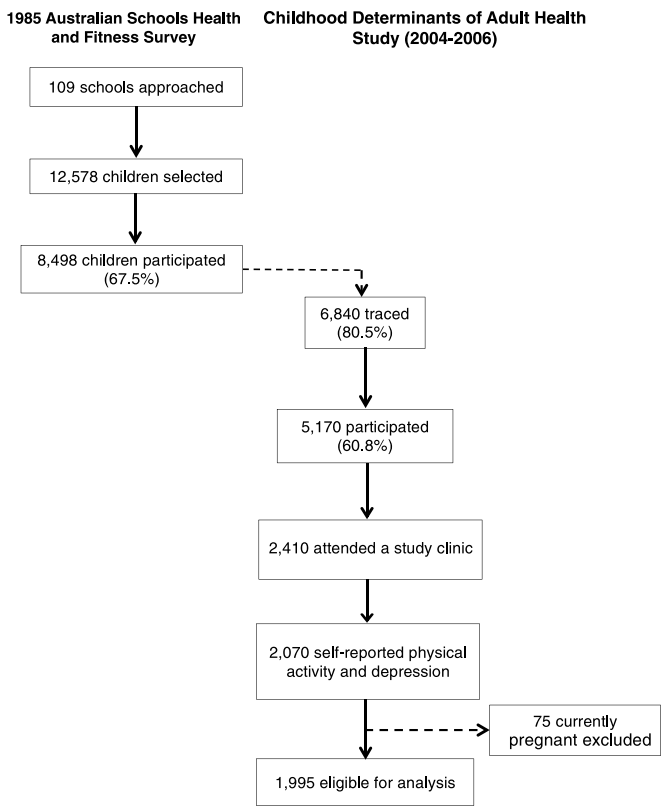

Figure 1. Flowchart of recruitment and retention of cohort participants.

Sociodemographic and Health Information

Age, sex, marital status, educational attainment, main source of income, current occupation, smoking status, and number of live births (women only) were collected by self-report. Physical health status was assessed using the physical health component summary scale of the Short-Form Survey (SF-12v2). Symptom severity was assessed using the mental health component summary (MCS) scale of the SF-12v2 as a proxy measure, with lower scores indicating increased severity (20). Body mass index (BMI; in kilograms per meter squared) using objectively measured height and weight was calculated and categorized according to standard BMI cut-points (21).

Statistical Analysis

To examine potential reporting bias due to depression, Spearman correlations were used to assess associations between leisure physical activity and ambulatory activity (steps per day). To identify sex differences in the association between physical activity and depressive symptoms, we calculated interaction terms for participants endorsing each symptom. Similarly, Pearson correlations were used to examine associations between symptom severity (SF-12 MCS) and physical activity. Differences between physical activity groups (inactive versus active) for each depressive symptom were assessed using χ^2 or Fisher exact tests, as appropriate.

Associations between physical activity and each individual depressive symptom were examined using a two-step approach. First, to compare the prevalence of depressive symptoms between physical activity groups, physical activity was categorized using approximate sex-specific tertile cut-points. Given the skewness of the leisure physical activity variable, categories of leisure physical activity were defined as inactive (0 min/wk) and active (>0 min/wk), with inactivity corresponding to the lowest tertile of physical activity. To retain comparability between physical activity variables, categories of ambulatory activity (steps per day) were similarly defined as inactive (<7500 steps/d) and active (≥7500 steps/d) for men, and inactive (<6800 steps/d) and active (≥6800 steps/d) for women, with inactivity corresponding to the lowest tertile. For brevity, "inactive" refers to those with nil leisure physical activity and low ambulatory activity. Using those inactive as the reference group, prevalence ratios (PR) and 95% confidence intervals (CI) for each individual depressive symptom from each physical activity domain were then estimated using Poisson regression. Second, to examine associations between increasing durations of physical activity and each symptom, we calculated β values and 95% CI using leisure physical activity and ambulatory activity (both log-transformed) as continuous variables. Analyses were conducted by sex because of the known differences in physical activity (22) and depressive etiology (23) between men and women, as well as overall. Potential covariates were based on a bivariate association (p < .25) and retained in the model if the exposure coefficient varied by 10% or greater (24). Variables identified a priori as potential confounders of the association between physical activity and depression are described previously. Covariates included in the final models are displayed in table footnotes. Because individual depressive symptoms may be influenced by the presence of other depressive symptoms (e.g., anhedonia may lead to a loss of appetite), models were additionally adjusted for symptoms identified in univariable analyses as being significantly different between physical activity groups, per a previous analytical approach (25). Because different symptoms tend to be endorsed at different levels of depression severity (26), all models were additionally adjusted for depression severity (number of diagnostic criteria met).

TABLE 1. Characteristics of Participants With Major Depression

	Overall (n = 173)	Men (n = 52)	Women (n = 121)
Age, M (SD), y	31.4 (2.6)	31.5 (2.9)	31.4 (2.5)
Educational attainment, *n* (%)			
University	67 (38.7)	17 (32.7)	50 (41.3)
Diploma/Vocational	51 (29.5)	20 (38.5)	31 (25.6)
Year 12 or less	55 (31.8)	15 (28.8)	40 (33.1)
Short-Form Survey, version 2, M (SD)			
Mental Health Component Summary	37.7 (11.0)	38.2 (11.8)	37.6 (10.6)
Physical Health Component Summary	54.4 (9.3)	55.6 (8.2)	53.8 (9.7)
Missing, *n*	5	2	3
Overweight/Obese, *n* (%)	35 (20.2)	10 (19.2)	25 (20.7)
Depression severity[a], M (SD)	6.54 (1.24)	6.56 (1.24)	6.54 (1.25)
Leisure physical activity, M (SD), min/wk	130 (199)	163 (269)	115 (158)
Inactive, *n* (%)	53 (30.6)	39 (32.2)	14 (26.9)
Ambulatory activity, M (SD), steps/d	8223 (2983)	8843 (3344)	7923 (2761)
Inactive, *n* (%)	54 (37.5)	36 (37.1)	18 (38.3)
Missing, *n*	29	5	24

M = mean; SE = standard deviation.
[a] Number of diagnostic criteria met.

Overweight/obesity in women was hypothesized to be a mediating (27) rather than a confounding factor and was examined separately.

Analyses were performed using Stata/IC version 12.0 (Statacorp, 2011), with statistical comparisons treated as significant at $\alpha = .05$ (two tailed). Owing to the exploratory nature of the analysis, no adjustments were made for multiple testing (28).

RESULTS

In total, 1995 participants (950 men, 1045 women) completed the IPAQ and the depression module of the CIDI. Overall, 5.5% of men (n = 52) and 11.6% of women (n = 121) met the diagnostic criteria for major depression. For the subsample who returned a pedometer diary (n = 1,681), prevalence of major depression was 5.9% for men (n = 47) and 10.9% for women (n = 97). Leisure physical activity and ambulatory activity were significantly associated for both cases (n = 149; $r = 0.18$, $p = .03$) and noncases (n = 1532; $r = 0.10$, $p < .001$), suggesting that physical activity reported via the IPAQ was not substantially biased by depression. There were no significant differences in prevalence of major depression between those who did and those who did not return a pedometer diary for both men (n = 52; 5.9% versus 3.2%; $p = .12$) and women (n = 121; 10.9% versus 15.2%; $p = .12$).

Characteristics of participants with major depression (n = 173) are displayed in Table 1. Mean (standard deviation) symptom severity (SF-12 MCS) score was 37.7 (11.0), which is substantially lower than population norms (20). Regarding depression severity, around half of participants (48.1% men, 47.1% women) met the recommended criterion for severe major depression (i.e., endorsed 7 or more diagnostic criteria) (29).

Table 2 displays interaction terms, Pearson correlations, and the proportion of those diagnosed as having major depression who endorsed each depressive symptom by leisure physical activity group.

There were no significant interactions between sex and leisure physical activity; however, there was nonsignificant trend for a suicide plan ($\beta = -0.35$, $p = .060$). Higher levels of symptom severity (SF-12 MCS) were associated with lower activity for depressed mood, fatigue, feelings of worthlessness, and suicidality overall and with appetite increase in men and thoughts of death in women (all, $p < .050$). For those reporting no past-week leisure physical activity, a lower proportion of men endorsed anhedonia, whereas a higher proportion of women reported a suicide plan (both, $p < .050$). No participants endorsed *attempting* suicide in the past 12 months or worthlessness/guilt caused by being impaired by depression.

Table 3 displays interaction terms, Pearson correlations, and the proportion of those diagnosed as having major depression who endorsed each depressive symptom by ambulatory activity group.

Significant interactions between sex and ambulatory activity were observed for depressed mood, appetite changes, vacillating thoughts, and suicidality (all, $p < .050$). Higher symptom severity (SF-12 MCS) was associated with lower ambulatory activity for psychomotor changes overall including agitation in men ($p < .01$) as well as retardation and suicidality in women (both, $p < .050$). For participants reporting lower ambulatory activity, a higher proportion endorsed depressed mood, loss of appetite, vacillating thoughts, indecisiveness, and suicidality (all, $p < .050$). Of note, a significantly higher proportion of both inactive men and women endorsed having a suicide plan.

Using those physically inactive as the reference group, adjusted PR and standardized β values with corresponding 95% CI between physical activity domains and individual depressive

symptoms were estimated for the analysis sample overall (Table 4) and for men (Table 5) and women (Table 6) separately.

For all participants with major depression, those reporting any leisure physical activity in the past week were less likely to report concentration difficulties/indecision ($p = .048$) compared with those reporting nil leisure activity. Nonsignificant trends were observed for objective psychomotor agitation ($p = .060$) and excessive/irrational guilt ($p = .050$). Inverse associations were observed between increasing durations of leisure physical activity and excessive/irrational guilt ($p = .025$) and death/suicidal thoughts ($p = .029$). Those reporting higher ambulatory activity were less likely to endorse fatigue, concentration difficulties/indecision (both, $p < .050$), and a suicide plan ($p < .01$) compared with the inactive group. Increasing durations of ambulatory activity were inversely associated with weight/appetite changes, objective psychomotor agitation (all, $p < .050$), and a suicide plan ($p < .001$).

For men with major depression, those reporting any leisure physical activity were less likely to report insomnia, fatigability, death/suicidal thoughts, and thoughts of death compared with those reporting nil leisure activity (all, $p < .050$). An inverse association was observed between increasing durations of leisure physical activity and fatigue ($p = .02$), with nonsignificant trends observed for insomnia ($p = .070$), death/suicidal thoughts ($p = .060$), and thoughts of death ($p = .060$). Those reporting higher ambulatory activity were less likely to endorse fatigability and more likely to endorse worthlessness/guilt than men reporting lower ambulatory activity (both, $p < .050$). Although nonsignificant, higher active men were around 80% less likely to endorse a suicide plan compared with low active men

TABLE 2. Descriptive Statistics for Depressive Symptoms and Leisure Physical Activity

	Overall				Men			Women		
Symptoms	$n = 173$, β value[a]	$n = 173$, r^b	Inactive ($n = 53$), %	Active ($n = 120$), %	$n = 52$, r^b	Inactive ($n = 14$), %	Active ($n = 38$), %	$n = 121$, r^b	Inactive ($n = 39$), %	Active ($n = 82$), %
Depressed mood	0.02	0.19*	88.7	90.8	0.22	92.9	89.5	0.17	87.2	91.5
Loss of interest	−0.02	0.15	86.8	87.5	0.28	71.4	94.7*	0.09	92.3	84.2
Weight/Appetite changes	−0.02	0.13	81.1	76.7	0.11	71.4	73.7	0.13	84.6	78.1
Loss of appetite	−0.13	0.08	56.6	50.0	−0.18	50.0	63.2	0.21	59.0	43.9
Increase in appetite	0.13	0.21	35.9	34.2	0.64*	28.6	15.8	0.10	38.5	42.7
Weight loss	0.16	−0.01	24.5	30.0	−0.13	14.3	23.7	0.04	28.2	32.9
Weight gain	0.14	0.31*	24.5	25.8	0.66	14.3	15.8	0.20	28.2	30.5
Sleep disturbance	−0.05	0.12	94.3	87.5	0.18	100.0	92.1	0.08	92.3	85.4
Insomnia	−0.06	0.09	88.7	79.2	0.17	100.0	81.6	0.04	84.6	78.1
Hypersomnia	−0.01	0.17	37.7	39.2	0.01	21.4	42.1	0.22	43.6	37.8
Psychomotor difficulties	0.03	0.01	26.4	31.7	−0.12	21.4	36.8	−0.03	28.2	29.3
Psychomotor retardation	0.05	0.18	32.1	38.3	0.18	21.4	42.1	0.14	35.9	36.6
Objective psychomotor retardation	−0.05	0.13	20.8	22.5	0.02	14.3	29.0	0.03	23.1	19.5
Psychomotor agitation	0.14	−0.05	18.9	28.3	0.27	21.4	31.6	−0.25	18.0	26.8
Objective psychomotor agitation	0.38	−0.17	9.4	19.2	−0.10	7.1	15.8	−0.22	10.3	20.7
Fatigability	−0.01	0.18*	90.6	87.5	0.18	100.0	86.8	0.18	87.2	87.8
Worthlessness/Guilt	0.15	0.1	37.7	46.7	0.15	28.6	39.5	0.09	41.0	50.0
Feelings of worthlessness	−0.02	0.21*	66.0	64.2	0.33	57.1	65.8	0.14	69.2	63.4
Excessive/Irrational guilt	−0.08	0.11	73.6	61.7	0.21	64.3	60.5	0.06	76.9	62.2
Concentration difficulties/indecision	−0.01	0.14	100.0	95.8	0.17	100.0	92.1	0.12	100.0	97.6
Vacillating thoughts	0.03	0.09	73.6	77.5	0.08	85.7	76.3	0.09	69.2	78.1
Indecisiveness	−0.04	0.08	84.9	75.0	0.08	85.7	68.4	0.07	84.6	78.1
Death/Suicidal thoughts	−0.08	0.24*	54.7	47.5	0.22	71.4	50.0	0.25	48.7	46.3
Thoughts of death	0.02	0.26*	50.9	50.0	0.19	71.4	44.7	0.31*	43.6	52.4
Suicidal ideation	−0.11	0.24	32.1	27.5	0.49	21.4	31.6	0.17	35.9	25.6
Suicide plan	−0.35	0.18	22.6	14.2	0.43	14.3	21.1	0.12	25.6	11.0*

Leisure physical activity: inactive (0 min/wk) and active (>0 min/wk).

* $p < .05$.

[a] β Values for interaction between sex (men = 0, women = 1) and leisure physical activity (inactive = 0, active = 1).

[b] Pearson correlations between symptom severity (Short-Form Survey Mental Component Summary) and leisure physical activity.

TABLE 3. Descriptive Statistics for Depressive Symptoms and Ambulatory Activity

Symptoms	Overall				Men			Women		
	$n = 144$, β value[a]	$n = 144$, r^b	Inactive ($n = 54$), %	Active ($n = 90$), %	$n = 47$, r^b	Inactive ($n = 18$), %	Active ($n = 29$), %	$n = 97$, r^b	Inactive ($n = 36$), %	Active ($n = 61$), %
Depressed mood	−0.08*	0.11	96.3	84.4*	0.09	94.4	89.7	0.10	97.2	82.0*
Loss of interest	0.05	0.17	83.3	90.0	0.17	88.9	86.2	0.18	80.6	91.8
Weight/Appetite changes	−0.01	0.08	81.5	75.6	0.03	88.9	65.5	0.11	77.8	80.3
Loss of appetite	−0.22*	0.11	61.1	43.3*	−0.10	72.2	51.7	0.31	55.6	39.3
Increase in appetite	0.29*	−0.03	29.6	38.9	0.23	22.2	17.2	−0.09	33.3	49.2
Weight loss	0.05	0.28	24.1	22.2	0.08	27.8	13.8	0.38	22.2	26.2
Weight gain	0.19	0.10	22.2	25.6	−0.05	16.7	13.8	0.13	25.0	31.2
Sleep disturbance	−0.002	0.14	87.0	88.9	0.10	94.4	93.1	0.16	83.3	86.9
Insomnia	−0.01	0.12	81.5	80.0	0.07	94.4	79.3	0.15	75.0	80.3
Hypersomnia	−0.11	0.19	40.7	33.3	0.11	38.9	34.5	0.21	41.7	32.8
Psychomotor difficulties	−0.09	0.36*	31.5	27.8	0.32	38.9	31.0	0.35	27.8	26.2
Psychomotor retardation	−0.11	0.39**	44.4	34.4	0.46	50.0	31.0	0.36*	41.7	36.1
Objective psychomotor retardation	−0.18	0.39*	27.8	18.9	0.42	38.9	17.2	0.42	22.2	19.7
Psychomotor agitation	−0.13	0.43**	29.6	24.4	0.69**	38.9	27.6	0.20	25.0	23.0
Objective psychomotor agitation	0.11	0.50*	13.0	16.7	0.71	11.1	17.2	0.37	13.9	16.4
Fatigability	−0.05	0.12	94.4	84.4	0.14	100.0	82.8	0.11	91.7	85.3
Worthlessness/Guilt	−0.001	0.06	42.6	43.3	−0.08	22.2	44.8	0.13	52.8	42.6
Feelings of worthlessness	−0.05	0.10	68.5	61.1	0.08	77.8	58.6	0.12	63.9	62.3
Excessive/Irrational guilt	0.00	0.17	64.8	67.8	0.11	50.0	72.4	0.19	72.2	65.6
Concentration difficulties/indecision	−0.02	0.13	100.0	94.4	0.10	100.0	89.7	0.14	100.0	96.7
Vacillating thoughts	−0.13*	0.08	85.2	68.9*	0.12	77.8	75.9	0.03	88.9	65.6*
Indecisiveness	−0.08	0.13	87.0	72.2*	0.04	77.8	69.0	0.17	91.7	73.8*
Death/Suicidal thoughts	−0.25*	0.12	59.3	37.8*	−0.08	72.2	41.4*	0.33*	52.8	36.1
Thoughts of death	−0.14	0.14	55.6	41.1	−0.09	66.7	37.9	0.35*	50.0	42.6
Suicidal ideation	−0.34*	0.07	37.0	18.9*	0.03	38.9	17.2	0.13	36.1	19.7
Suicide plan	−1.21**	0.04	31.5	4.4***	−0.07	33.3	6.9*	0.26	30.6	3.3***

Ambulatory activity: physically inactive (<7500 steps/d) and physically active (≥7500 steps/d) for men, physically inactive (<6800 steps/d) and physically active (≥6800 steps/d) for women.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

[a] β values for interaction between sex (men = 0, women = 1) and ambulatory activity (steps per day) (inactive = 0, active = 1).

[b] Pearson correlations between symptom severity (Short-Form Survey Mental Component Summary) and ambulatory activity.

($p = .070$). Likewise, increasing durations of ambulatory activity were inversely associated with having a suicide plan ($p < .01$). Increasing activity was also associated with weight/appetite changes including loss of appetite (both, $p < .050$).

For women with major depression, those reporting participation in some past-week leisure physical activity were less likely to endorse excessive/irrational guilt and a suicide plan compared with those reporting nil leisure activity (both, $p < .050$). Increasing durations of leisure activity were associated with anhedonia ($p = .020$), excessive/irrational guilt ($p = .008$), and having a suicide plan ($p = .015$) Those reporting higher ambulatory activity were significantly less likely to endorse hypersomnia, vacillating thoughts, indecisiveness (all, $p < .050$), and a suicide plan ($p < .001$) compared with women reporting lower ambulatory activity. Increasing durations of ambulatory activity were associated with hypersomnia ($p = .020$), objective psychomotor agitation ($p < .050$), and a suicide plan ($p = .001$), with a nonsignificant trend for vacillating thoughts ($p = .060$).

The addition of overweight/obesity had minimal impact on associations between physical activity domains and depressive symptoms for women (data not shown).

DISCUSSION

Using two different measures of physical activity, we compared the depression symptom profiles of physically active and inactive young men and women with major depression. Key strengths include multiple physical activity assessment, analysis of depressive symptoms using a validated diagnostic

TABLE 4. Associations Between Physical Activity and Depressive Symptoms for Participants With Major Depression[a]

Symptoms	Leisure Physical Activity (n = 168)			Ambulatory Activity (n = 139)		
	%	PR (95% CI)[b]	β Value (95% CI)[b]	%	PR (95% CI)[b]	β Value (95% CI)[b]
Depressed mood	90.5	1.05 (0.94–1.17)	0.01 (−0.01 to 0.03)	89.2	0.92 (0.84–1.01)	−0.10 (−0.21 to 0.002)
Loss of interest	88.1	1.00 (0.90–1.12)	−0.01 (−0.03 to 0.01)	88.5	1.09 (0.96–1.24)	0.10 (−0.10 to 0.26)
Weight/appetite changes	77.4	0.95 (0.81–1.11)	−0.01 (−0.04 to 0.02)	77.0	0.99 (0.82–1.18)	−0.23 (−0.42 to −0.04)*
Loss of appetite	50.6	0.86 (0.65–1.15)	−0.03 (−0.09 to 0.02)	48.2	0.76 (0.53–1.08)	−0.49 (−0.90 to −0.08)*
Increase in appetite	35.7	0.98 (0.64–1.51)	0.004 (−0.08 to 0.09)	36.7	1.59 (0.99–2.54)	0.25 (−0.41 to 0.92)
Weight loss	28.6	1.22 (0.73–2.10)	0.04 (−0.06 to 0.14)	23.0	1.00 (0.55–1.82)	−0.05 (−0.81 to 0.72)
Weight gain	26.2	1.16 (0.68–1.98)	0.04 (−0.07 to 0.14)	22.2	1.60 (0.89–2.85)	0.24 (−0.60 to 1.08)
Sleep disturbance	89.3	0.95 (0.87–1.04)	−0.01 (−0.03 to 0.01)	87.8	1.04 (0.92–1.18)	−0.06 (−0.17 to 0.05)
Insomnia	81.6	0.90 (0.79–1.03)	−0.02 (−0.05 to 0.01)	79.9	1.03 (0.86–1.22)	−0.04 (−0.21 to 0.13)
Hypersomnia	38.1	1.13 (0.75–1.72)	0.03 (−0.05 to 0.11)	35.3	0.74 (0.45–1.23)	−0.44 (−1.01 to 0.13)
Psychomotor difficulties	29.8	1.34 (0.86–2.10)	0.10 (−0.02 to 0.14)	28.8	1.18 (0.71–1.97)	0.47 (−0.17 to 1.12)
Psychomotor retardation	35.7	1.25 (0.86–1.83)	0.03 (−0.04 to 0.10)	37.4	1.05 (0.70–1.56)	0.13 (−0.43 to 0.68)
Objective psychomotor retardation	21.4	1.17 (0.69–1.97)	0.04 (−0.06 to 0.14)	21.6	0.82 (0.42–1.58)	−0.06 (−0.75 to 0.64)
Psychomotor agitation	25.0	1.57 (0.83–2.99)	0.06 (−0.05 to 0.18)	25.9	0.95 (0.52–1.73)	0.71 (−0.02 to 1.44)
Objective psychomotor agitation	16.1	2.36 (0.97–5.76)	0.12 (−0.02 to 0.26)	15.1	2.03 (0.83–4.96)	1.47 (0.22 to 2.72)*
Fatigability	88.1	0.97 (0.86–1.08)	−0.01 (−0.03 to 0.01)	87.8	0.87 (0.78–0.98)*	−0.10 (−0.23 to 0.03)
Worthlessness/Guilt	44.1	1.26 (0.87–1.82)	0.05 (−0.02 to 0.12)	43.2	0.97 (0.64–1.46)	0.11 (−0.41 to 0.63)
Feelings of worthlessness	64.3	1.00 (0.80–1.28)	−0.02 (−0.06 to 0.03)	63.3	0.99 (0.78–1.29)	−0.07 (−0.37 to 0.22)
Excessive/Irrational guilt	64.9	0.81 (0.66–1.00)	−0.05 (−0.09 to −0.01)*	66.2	1.03 (0.80–1.32)	0.07 (−0.24 to 0.38)
Concentration difficulties/indecision	97.6	0.96 (0.92–0.99)*	−0.003 (−0.008 to 0.002)	97.1	0.94 (0.89–0.99)*	−0.06 (−0.13 to 0.02)
Vacillating thoughts	76.2	1.07 (0.89–1.29)	0.01 (−0.02 to 0.05)	74.8	0.86 (0.72–1.04)	−0.10 (−0.30 to 0.11)
Indecisiveness	78.0	0.90 (0.77–1.05)	−0.02 (−0.05 to 0.01)	77.7	0.87 (0.73–1.03)	−0.16 (−0.35 to 0.03)
Death/Suicidal thoughts	49.4	0.81 (0.63–1.05)	−0.06 (−0.11 to −0.01)*	45.3	0.83 (0.61–1.14)	−0.13 (−0.55 to 0.28)
Thoughts of death	50.0	0.92 (0.72–1.19)	−0.03 (−0.08 to 0.02)	46.0	0.95 (0.70–1.29)	0.01 (−0.40 to 0.42)
Suicidal ideation	29.2	0.92 (0.58–1.45)	−0.04 (−0.12 to 0.05)	25.9	0.73 (0.42–1.27)	−0.19 (−0.90 to 0.52)
Suicide plan	16.7	0.60 (0.32–1.14)	−0.11 (−0.24 to 0.02)	14.4	0.16 (0.05–0.51)**	−1.21 (−1.80 to −0.62)***

PR = prevalence ratio; CI = confidence interval.
* $p < .05$.
** $p < .01$.
*** $p < .001$.
[a] PRs and 95% CIs calculated using those inactive as the reference group. β Values and 95% CI calculated using physical activity (log-transformed) as a continuous variable.
[b] PR and β values with corresponding 95% CI for each symptom calculated using Poisson regression models adjusted for age, physical health, educational attainment, depression severity, and other symptoms.

instrument, measured height and weight, and examination of a range of potential confounders. Among those with major depression, active men were less likely to endorse the presence of insomnia, fatigue, and suicidality and more likely to endorse worthlessness/guilt compared with inactive men. Active women were less likely to endorse hypersomnia, excessive/irrational guilt, vacillating thoughts, indecisiveness, and suicidality compared with inactive women. Associations remained significant after adjustment for sociodemographic and health characteristics, depression severity, and the influence of other depressive symptoms. Of note, inverse associations between physical activity and suicidality were consistent across sex and physical activity assessment. Increasing durations of physical activity were associated with decreased symptom severity over a range of symptoms including fatigue, sleep disturbance, psychomotor changes, worthlessness/guilt, and suicidality.

Owing to the inclusion of characteristics related to physical inactivity in the diagnostic system, we expected certain depressive symptoms (i.e., anhedonia, fatigue, and psychomotor difficulties) to discriminate between inactive and active participants. High endorsement of certain symptoms (e.g., anhedonia and depressed mood) limited our ability to detect significant differences between physical activity groups. Significant associations between physical activity and fatigue were consistently observed across physical activity domains in men; however, no significant differences were observed between physical activity and fatigue

TABLE 5. Associations Between Physical Activity and Depressive Symptoms for Men With Major Depression[a]

Symptoms	Leisure Physical Activity (n = 50)			Ambulatory Activity (n = 45)		
	%	PR (95% CI)[b]	β Value (95% CI)[b]	%	PR (95% CI)[b]	β Value (95% CI)[b]
Depressed mood	92.0	1.06 (0.88–1.27)	0.006 (−0.03 to 0.04)	93.3	1.04 (0.86–1.26)	−0.04 (−0.20 to 0.12)
Loss of interest	88.0	1.30 (0.94–1.80)	0.03 (−0.03 to 0.09)	86.7	1.08 (0.82–1.42)	0.15 (−0.14 to 0.45)
Weight/Appetite changes	72.0	1.09 (0.78–1.51)	0.01 (−0.05 to 0.07)	73.3	0.79 (0.57–1.10)	−0.49 (−0.86 to −0.10)*
Loss of appetite	58.0	1.28 (0.74–2.20)	0.004 (−0.09 to 0.10)	57.8	0.75 (0.44–1.27)	−0.64 (−1.14 to −0.14)*
Increase in appetite	20.0	0.54 (0.15–1.98)	−0.001 (−0.29 to 0.29)	20.0	1.18 (0.34–4.11)	−0.05 (−1.22 to 1.12)
Weight loss	20.0	0.83 (0.20–3.40)	−0.06 (−0.29 to 0.17)	17.8	0.64 (0.10–3.94)	0.38 (−1.37 to 2.13)
Weight gain	16.0	1.02 (0.25–4.16)	0.12 (−0.23 to 0.47)	15.6	1.63 (0.39–6.69)	0.09 (−1.21 to 1.39)
Sleep disturbance	94.0	0.88 (0.75–1.03)	−0.02 (−0.05 to 0.01)	93.3	1.03 (0.83–1.27)	0.06 (−0.11 to 0.22)
Insomnia	86.0	0.78 (0.63–0.96)*	−0.04 (−0.08 to 0.002)	84.4	0.85 (0.64–1.14)	−0.12 (−0.38 to 0.15)
Hypersomnia	38.0	1.90 (0.59–6.11)	0.09 (−0.09 to 0.27)	37.8	1.16 (0.51–2.65)	0.45 (−0.59 to 1.49)
Psychomotor difficulties	32.0	1.45 (0.47–4.48)	0.05 (−0.13 to 0.24)	33.3	0.74 (0.30–1.83)	0.63 (−0.77 to 2.02)
Psychomotor retardation	34.0	1.79 (0.63–5.10)	0.08 (−0.08 to 0.25)	35.6	0.65 (0.27–1.55)	0.28 (−1.35 to 0.78)
Objective psychomotor retardation	24.0	2.03 (0.58–7.11)	0.15 (−0.06 to 0.37)	24.4	0.42 (0.09–1.90)	−0.08 (−1.70 to 1.53)
Psychomotor agitation	30.0	1.03 (0.34–3.14)	−0.01 (−0.21 to 0.02)	33.3	0.64 (0.27–1.51)	0.48 (−0.80 to 1.76)
Objective psychomotor agitation	14.0	1.20 (0.14–10.70)	−0.05 (−0.34 to 0.24)	15.6	0.56 (0.11–2.98)	0.49 (−2.14 to 3.12)
Fatigability	90.0	0.82 (0.69–0.99)*	−0.05 (−0.10 to −0.01)*	88.9	0.83 (0.69–0.99)*	−0.20 (−0.43 to 0.04)
Worthlessness/Guilt	36.0	1.86 (0.74–4.67)	0.12 (−0.03 to 0.27)	35.6	2.66 (1.11–6.35)*	0.81 (−0.67 to 2.29)
Feelings of worthlessness	64.0	1.17 (0.70–1.95)	0.03 (−0.06 to 0.12)	66.7	0.86 (0.54–1.35)	−0.29 (−0.70 to 0.12)
Excessive/irrational guilt	60.0	0.87 (0.53–1.42)	−0.02 (−0.12 to 0.07)	62.2	1.68 (0.95–2.98)	0.42 (−0.30 to 1.14)
Concentration difficulties/indecision	96.0	0.97 (0.91–1.03)	0.002 (−0.007 to 0.01)	95.6	0.93 (0.85–1.03)	−0.08 (−0.22 to 0.05)
Vacillating thoughts	80.0	0.99 (0.74–1.33)	0.01 (−0.03 to 0.06)	77.8	0.99 (0.71–1.37)	−0.002 (−0.34 to 0.34)
Indecisiveness	74.0	0.82 (0.58–1.16)	−0.02 (−0.08 to 0.04)	73.3	0.96 (0.64–1.43)	−0.21 (−0.58 to 0.17)
Death/Suicidal thoughts	56.0	0.69 (0.49–0.96)*	−0.07 (−0.15 to 0.004)	53.3	0.87 (0.56–1.35)	−0.23 (−0.72 to 0.27)
Thoughts of death	52.0	0.63 (0.43–0.92)*	−0.08 (−0.16 to 0.002)	48.9	0.86 (0.53–1.40)	−0.34 (−0.83 to 0.15)
Suicidal ideation	28.0	1.04 (0.35–3.10)	−0.02 (−0.21 to 0.17)	24.4	0.63 (0.20–2.00)	−0.31 (−1.79 to 1.16)
Suicide plan	18.0	0.90 (0.43–0.92)	−0.05 (−0.27 to 0.17)	15.6	0.16 (0.02–1.16)	−1.35 (−2.25 to −0.46)**

PR = prevalence ratio; CI = confidence interval.

* $p < .05$.

** $p < .01$.

[a] PRs and 95% CIs calculated using those inactive as the reference group. β Values and 95% CI calculated using physical activity (log-transformed) as a continuous variable.

[b] PR and β values with corresponding 95% CI for each symptom calculated using Poisson regression models adjusted for age, physical health, depression severity, and other symptoms.

in women. In addition, no significant associations were observed between physical activity and psychomotor difficulties in men. It may be that a minimal threshold of physical activity intensity is required for physical activity to influence psychomotor changes in young men. Observed sex differences may be reflective of symptom profiles for major depression differing between men and women (26). Furthermore, the physical activity measures used may have been insufficiently sensitive to detect significant differences between physical activity groups.

The current analysis suggests that the correspondence in characteristics between physical activity and depression does not fully account for the well-documented association observed in the literature. Indeed, a striking finding was that leisure and ambulatory activity were characterized by decreased endorsement of suicidal symptoms in both men and women, with associations remaining significant after adjustment for overweight/obesity in women and depression severity. These findings are consistent with and extend several population-based studies indicating significant inverse associations between sports participation and suicidal ideation in adolescents (8,30), and physical activity and suicidal behavior in adolescents (9) and college students (7,10). A novel finding was that increasing durations of both leisure and ambulatory activity were inversely associated with having a suicide plan in young women. This is in contrast to previous research indicating that moderate to high levels of physical activity were positively associated with risk of suicide ideation/plans in female college students (7). This finding did not seem to be accounted for by BMI and weight perception, leading the authors to speculate that female undergraduate college students (aged ≥18 years) at risk for suicidal behavior may have been

TABLE 6. Associations Between Physical Activity and Depressive Symptoms for Women With Major Depression[a]

Symptoms	Leisure Physical Activity (n = 118)			Ambulatory Activity (n = 94)		
	%	PR (95% CI)[b]	β Value (95% CI)[b]	%	PR (95% CI)[b]	β Value (95% CI)[b]
Depressed mood	89.8	1.10 (0.96–1.26)	0.03 (−0.001 to 0.05)	87.2	0.91 (0.78–1.06)	−0.08 (−0.21 to 0.06)
Loss of interest	88.1	0.89 (0.78–1.01)	−0.03 (−0.07 to −0.01)*	89.4	1.15 (0.93–1.42)	0.12 (−0.10 to 0.34)
Weight/Appetite changes	79.7	0.92 (0.77–1.11)	−0.01 (−0.05 to 0.03)	78.7	1.07 (0.93–1.42)	−0.12 (−0.40 to 0.17
Loss of appetite	32.2	0.73 (0.51–1.06)	−0.06 (−0.14 to 0.02)	43.6	0.82 (0.46–1.47)	−0.39 (−1.07 to 0.28)
Increase in appetite	42.4	1.12 (0.71–1.77)	0.01 (−0.08 to 0.10)	44.7	1.67 (0.91–3.07)	0.42 (−0.38 to 1.21)
Weight loss	47.5	1.25 (0.70–2.24)	0.04 (−0.07 to 0.15)	25.5	2.47 (0.87–6.96)	0.40 (−0.57 to 1.37)
Weight gain	30.5	1.14 (0.65–2.01)	0.02 (−0.09 to 0.12)	29.8	1.18 (0.60–2.34)	0.10 (−0.70 to 0.91)
Sleep disturbance	87.3	0.96 (0.85–1.09)	−0.01 (−0.03 to 0.01)	85.1	1.06 (0.85–1.32)	−0.16 (−0.34 to 0.02)
Insomnia	79.7	0.95 (0.78–1.15)	−0.02 (−0.06 to 0.02)	77.7	1.27 (0.92–1.75)	0.04 (−0.23 to 0.32)
Hypersomnia	38.1	0.90 (0.56–1.44)	−0.02 (−0.12 to 0.08)	34.0	0.50 (0.27–0.95)*	−0.89 (−1.66 to −0.13)*
Psychomotor difficulties	28.8	1.12 (0.66–1.89)	0.03 (−0.08 to 0.14)	26.6	1.47 (0.62–3.50)	0.25 (0.44 to 0.95)
Psychomotor retardation	36.4	1.10 (0.71–1.71)	0.01 (−0.08 to 0.10)	38.3	1.01 (0.55–1.85)	0.13 (−0.50 to 0.77)
Objective psychomotor retardation	20.3	0.92 (0.48–1.75)	−0.02 (−0.16 to 0.11)	20.2	1.03 (0.42–2.53)	−0.08 (0.91 to 0.75)
Psychomotor agitation	22.9	1.63 (0.73–3.62)	0.09 (−0.07 to 0.24)	22.3	1.89 (0.76–4.75)	1.03 (−0.08 to 2.13)
Objective psychomotor agitation	16.9	2.31 (0.83–6.43)	0.17 (−0.02 to 0.36)	14.9	3.95 (0.88–17.75)	1.11 (0.01–2.21)*
Fatigability	87.3	0.99 (0.86–1.16)	0.02 (−0.03 to 0.03)	87.2	0.87 (0.74–1.01)	−0.03 (−0.16 to 0.11)
Worthlessness/Guilt	47.5	1.30 (0.85–2.01)	0.05 (−0.04 to 0.13)	46.8	0.75 (0.45–1.26)	0.09 (−0.50 to 0.68)
Feelings of worthlessness	64.4	1.03 (0.78–1.36)	−0.02 (−0.08 to 0.04)	61.7	1.35 (0.88–2.07)	0.26 (−0.23 to 0.75)
Excessive/irrational guilt	66.9	0.76 (0.59–0.97)*	−0.07 (−0.12 to −0.02)**	68.1	0.80 (0.59–1.08)	−0.04 (−0.36 to 0.28)
Concentration difficulties/indecision	98.3	0.97 (0.93–1.01)	−0.001 (−0.01 to 0.003)	97.9	0.96 (0.90–1.02)	−0.02 (−0.10 to 0.03)
Vacillating thoughts	74.6	1.16 (0.92–1.47)	0.02 (−0.03 to 0.07)	73.4	0.74 (0.58–0.95)*	−0.25 (−0.52 to 0.01)
Indecisiveness	79.7	0.92 (0.77–1.10)	−0.02 (−0.06 to 0.02)	79.8	0.80 (0.65–0.99)*	−0.12 (−0.36 to 0.12)
Death/Suicidal thoughts	46.6	0.88 (0.62–1.23)	−0.06 (−0.13 to 0.02)	41.5	0.79 (0.50–1.25)	−0.10 (−0.74 to 0.54)
Thoughts of death	49.2	1.14 (0.80–1.61)	0.002 (−0.07 to 0.07)	44.7	0.99 (0.66–1.50)	0.24 (−0.33 to 0.81)
Suicidal ideation	29.7	0.83 (0.50–1.37)	−0.07 (−0.17 to 0.03)	26.6	0.77 (0.40–1.49)	−0.17 (−0.97 to 0.64)
Suicide plan	16.1	0.43 (0.20–0.89)*	−0.21 (−0.37 to −0.04)*	13.8	0.09 (0.03–0.28)**	−1.67 (−2.67 to −0.66)**

PR = prevalence ratio; CI = confidence interval.
* $p < .05$.
** $p < .01$.
[a] PRs and 95% CIs calculated using those inactive as the reference group. β Values and 95% CI calculated using physical activity (log-transformed) as a continuous variable.
[b] PR and β values with corresponding 95% CI for each symptom calculated using Poisson regression models adjusted for age, physical health, educational attainment, depression severity, and other symptoms.

using physical activity as a coping strategy. The older age and community-based nature of the current cohort may account for the different finding.

Several limitations should be considered when interpreting these results. The use of questionnaires may have contributed to imprecision in assessment of leisure physical activity and depressive symptoms. However, the IPAQ has demonstrated acceptable measurement properties (16), and diagnostic interviews for depression, including the CIDI, have been shown to improve standardization of diagnosis and eliminate clinician bias (31). Furthermore, differences in depression prevalence at follow-up were observed in both men and women between those who did and those who did not return a pedometer diary. Although not statistically significant, the magnitude of these differences may be clinically important and because the direction varied by sex may constitute an important source of bias.

Owing to the skip logic embedded in the computerized CIDI-Auto, analyses were restricted to those who met the diagnostic threshold for major depression. Future studies should examine differences in depressive symptoms across the population as a whole, not just those meeting the diagnostic threshold. No adjustment was made for multiple statistical testing, thereby increasing the risk of type I errors (28). However, correction for multiple test procedures increases the risk of type II errors (32), and the novelty of this analysis provides some justification. Current findings require replication using a larger cohort with capacity to adjust for multiple comparisons. Future studies should also include a validated depression rating scale to enable

a more in-depth examination of associations between physical activity and symptom severity. Finally, the cross-sectional design precludes any conclusions regarding causality.

In summary, young men and women with clinical depression who are physically active seem to have a different depressive symptom profile from those who are physically inactive. The effects of physical activity were apparent across a wide range of depressive symptoms, suggesting that observed associations between physical inactivity and depression are not merely caused by the epiphenomenon of shared characteristics. Associations were generally consistent across the two analytical approaches lending added assurance to these inferences. Indeed results suggest that physical activity may have particular benefits in reducing levels of sleep disturbance and suicidality. Given that suicide is one of the significant causes of death in young adults worldwide (33), clarifying the efficacy of physical activity in suicide prevention during this critical life stage would be an important advance in public health. Further examination of associations between physical activity and depressive symptoms within a larger population-based cohort may assist in clarifying these associations.

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