

Physical Activity Type and Psychosocial Factors as Predictors of Mental Distress in U.S. College Students

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Abstract

Background

Mental health disorders, including depression and anxiety, remain among the most pressing challenges facing U.S. college students, driven by academic pressures, social stressors, and lifestyle disruptions. Physical activity has been proposed as a preventive measure, yet whether its benefits varied by activity type, frequency, and duration, whether any such associations persisted after adjustment for psychosocial burden, remained unclear. This study tested whether physical activity type was independently associated with self-reported poor mental health days, and whether psychosocial factors (stress, loneliness, depression history, life satisfaction) accounted for significantly greater variance than physical activity behavior.

Methods

Using 2023 Behavioral Risk Factor Surveillance System (BRFSS) data, 1,862 U.S. college students aged 18–24 were identified after applying inclusion criteria and excluding three physical activity categories with insufficient sample sizes. The primary outcome was self-reported poor mental health days in the past 30 days (MENTHLTH, 0–30, continuous) and a binary indicator of frequent mental distress (≥ 14 days; CDC definition). Key independent variables included physical activity type, frequency, session duration, total weekly minutes, strength-training frequency, depression diagnosis, life satisfaction, emotional support, loneliness, stress, and socioeconomic indicators. Welch's one-way ANOVA, Kruskal–Wallis, and TukeyHSD post-hoc tests examined differences across activity types. Nested multiple linear regression models (Models 0–5) and a parallel binary logistic regression examined predictors of poor mental health. Heteroscedasticity-consistent (HC3) standard errors were used for inference. Survey-weighted sensitivity analyses were conducted using LLCPWT sampling weights.

Results

Welch's ANOVA confirmed significant differences in poor mental health days across PA types ($F(7, 148.09) = 8.34, p < 0.0001; \eta^2 = 0.032$). TukeyHSD identified three significant pairwise differences, all versus walking: running/jogging ($\Delta = -3.63$ days, $p < 0.0001, d = 0.46$), weight lifting ($\Delta = -2.88$ days, $p < 0.0001, d = 0.35$), and other activities ($\Delta = -2.37$ days, $p < 0.001, d = 0.28$). PA modality variables (frequency, duration, total minutes, strength frequency) did not significantly improve model fit beyond PA type and demographics (LRT $p = 0.341$). Adding psychosocial factors produced a significant jump in explained variance ($R^2: 0.079 \rightarrow 0.443$, LRT $p < 0.0001$). In the full model (Model 5; adjusted $R^2 = 0.433$), stress, loneliness, depression diagnosis, and life satisfaction were the dominant predictors. Only running/jogging remained significant among PA types after full adjustment ($\beta = -1.14, p < 0.01$). Binary logistic regression (Nagelkerke $R^2 = 0.434$) confirmed that students who never or rarely felt stressed had

94–95% lower odds of frequent distress; running/jogging was the only PA type associated with significantly lower odds (OR = 0.61, 95% CI [0.38, 0.95], $p < 0.05$).

Conclusion

Using the only nationally representative U.S. dataset with detailed physical activity type data for college students, this study found that psychosocial burden, particularly stress, loneliness, and depression history, vastly outweighed exercise behavior in explaining mental distress. Running/jogging was the sole physical activity type independently protective after full psychosocial and socioeconomic adjustment. These findings reframe physical activity as a valuable but secondary lever within broader campus wellness strategies that must foreground stress management and social connectedness.

Background

Mental health disorders are a growing public health concern globally, with rising prevalence of depression, anxiety, and stress-related conditions across all age groups (World Health Organization, 2021). College students are disproportionately affected: academic pressure, financial stress, social transitions, and the neurological changes of early adulthood combine to elevate risk for clinician-recognized disorders and subclinical distress alike (Beiter et al., 2015; Liu et al., 2017; Deng et al., 2022). Mental health symptoms in this population are associated with impaired academic performance, strained relationships, and diminished quality of life, and conditions that emerge during college years frequently persist into adulthood (Tosevski et al., 2010; Aarons et al., 2008). Despite growing awareness, many students face persistent barriers to accessing professional mental health care, including financial constraints, stigma, and limited service availability (Liu et al., 2017).

Physical activity is one of the most widely studied and feasible preventive strategies. A robust evidence base links regular exercise to reductions in depression, anxiety, and perceived stress, as well as improvements in sleep, cognitive function, and overall psychological well-being (Peluso & Guerra de Andrade, 2005; Biddle, 2016; Kim et al., 2021; Grasdalsmoen et al., 2020). However, the mental health benefits of exercise are not uniform across activity types. Aerobic exercise such as running is strongly associated with mood improvement, resistance training with reduced anxiety and enhanced self-confidence, and higher-effort modalities with greater reductions in depressive symptoms relative to lower-effort activities (Goldstein et al., 2020; Kim et al., 2021). Despite this evidence, fewer studies have examined how exercise type, session frequency and duration, and the socioeconomic context in which activity occurred, jointly shaped mental health outcomes in college students.

This study addressed that gap using the 2023 BRFSS — the first and, to date, only cycle of this nationally representative survey to simultaneously capture physical activity type (EXTRACT12), session duration, and total weekly minutes for a large college-student sample. Prior studies examining PA type and mental health in this population have either relied on small convenience samples, lacked psychosocial covariates, or were unable to test whether exercise-type differences persist after adjustment for stress,

loneliness, and depression history. This study directly tests both limitations. Two hypotheses were examined: (1) that different physical activity types are differentially associated with poor mental health days among U.S. college students aged 18–24; and (2) that psychosocial factors (stress, loneliness, depression history, life satisfaction) account for significantly more variance in mental health outcomes than physical activity type, frequency, or duration.

Methods

Data Source

This study utilized data from the 2023 Behavioral Risk Factor Surveillance System (BRFSS; Centers for Disease Control and Prevention, 2023), a nationally representative health survey conducted via random-digit-dialed telephone interviews of U.S. adults by the CDC. The 2023 BRFSS was the first cycle to classify specific physical activity types (EXTRACT12), session duration (PADUR1_), and total weekly minutes (MINAC12). The 2023 BRFSS excluded data from Kentucky and Pennsylvania due to insufficient sample size. Participants were aged 18–24 and self-identified as college or graduate students. The original dataset comprised approximately 433,000 respondents; after inclusion/exclusion criteria and listwise deletion, the final analytic sample comprised 1,862 observations. Three physical activity categories with insufficient sample sizes were excluded: household activities ($n = 3$), aerobics ($n = 13$), and elliptical/EFX machine exercise ($n = 14$). All participants reported past-month physical activity (EXERANY2; binary: Yes/No); this variable served solely as an inclusion criterion and was not included in any analyses.

Variables

Physical activity type was classified under EXTRACT12; exercise frequency under PAFREQ1_; session duration under PADUR1_; total weekly minutes under MINAC12; and strength-training frequency under STRFREQ_. Depression history was captured by ADDEPEV3 (binary: Yes/No). Demographic variables included age (AGE80), sex (SEX), and race/ethnicity (IMPRACE). Socioeconomic status was measured via household income (INCOMG1) and binary hardship indicators (SDHEMPLOY, FOODSTMP, SDHBILLS, SDHUTILS, SDHTRNSP; binary: Yes/No). Psychosocial covariates included life satisfaction (LSATISFY, 4-point scale), emotional support adequacy (EMTSUPRT, 5-point scale), loneliness (SDLONELY, 5-point), and stress frequency (SDHSTRE1, 5-point scale). The primary outcome was MENTHLTH (continuous, 0–30 days) and a binary frequent mental distress indicator (MENTHLTH_BIN: ≥ 14 days).

Analysis

All analyses were conducted in R 4.2.2. Welch's ANOVA was the primary test for PA type differences (robust to heteroscedasticity confirmed by Levene's test); the Kruskal–Wallis test served as a nonparametric sensitivity check; TukeyHSD identified significant pairwise differences. Effect sizes were

quantified as η^2 (ANOVA), ϵ^2 (Kruskal–Wallis), and Cohen’s d (pairwise). Six nested linear regression models (Models 0–5) used MENTHLTH as the continuous outcome; sequential likelihood ratio tests assessed incremental fit. A parallel binary logistic regression used MENTHLTH_BIN as the outcome. Heteroscedasticity was confirmed (Breusch–Pagan BP = 163.13, $p < 0.0001$); HC3 robust standard errors were used for inference. Standardized β coefficients were computed via `lm.beta`. Walking was specified as the reference category for physical activity type in all regression models because it was the most frequently reported activity ($n = 645$, 34.6%) and exhibited the widest distributional range across the mental health outcome. Walking provides a maximally informative and valid baseline against which higher-intensity activities can be compared.

Results

Descriptive Statistics

The analytic sample comprised 1,862 college students (Table 1). The cohort was 54.6% male, 43.0% female, and 2.5% nonbinary or another gender identity. The majority identified as White, non-Hispanic (57.1%), followed by Hispanic (15.8%), Asian non-Hispanic (10.5%), Black non-Hispanic (9.3%), other race non-Hispanic (6.2%), and American Indian/Alaskan Native non-Hispanic (1.0%). Approximately 23.8% reported a depression diagnosis. Walking (34.6%), weight lifting (21.0%), and running/jogging (18.4%) were the most common activity types. Most participants reported being satisfied (62.5%) or very satisfied (31.5%) with life. The mean age was 20.46 years ($SD = 1.83$) and the mean number of poor mental health days was 6.77 ($SD = 8.12$; Table 2).

Table 1
Descriptive Statistics for Categorical Variables on Self-Reported Mental Health and Physical Activity Among U.S. College Students (n = 1,862) from BRFSS (2023)

Characteristic	n	%
Sex		
Male	1,016	54.6
Female	800	43.0
Nonbinary / Other	46	2.5
Race/Ethnicity		
White, Non-Hispanic	1,064	57.1
Black, Non-Hispanic	173	9.3
Asian, Non-Hispanic	196	10.5
Hispanic	294	15.8
Other/Multiracial	135	7.3
Annual Household Income		
< \$15,000	202	10.8
\$15,000 – \$25,000	223	12.0
\$25,000 – \$35,000	233	12.5
\$35,000 – \$50,000	244	13.1
\$50,000 – \$100,000	509	27.3
\$100,000 – \$200,000	295	15.8
≥ \$200,000	156	8.4
Depression Diagnosis		
Yes	443	23.8
No	1,419	76.2
Physical Activity Type		
Walking	645	34.6
Running or jogging	342	18.4
Weight lifting	391	21.0
Note. 'Not sure' and 'Refused' responses were excluded.		

Characteristic	n	%
Sex		
Other	329	17.7
Bicycling	62	3.3
Calisthenics	50	2.7
Yoga/Pilates/Tai Chi	26	1.4
Gardening/yard work	17	0.9
Life Satisfaction		
Very satisfied	587	31.5
Satisfied	1,163	62.5
Dissatisfied	104	5.6
Very dissatisfied	8	0.4
Emotional Support		
Always	680	36.5
Usually	769	41.3
Sometimes	303	16.3
Rarely	75	4.0
Never	35	1.9
Loneliness		
Always	36	1.9
Usually	116	6.2
Sometimes	658	35.3
Rarely	722	38.8
Never	330	17.7
Stress (past 30 days)		
Always	103	5.5
Usually	247	13.3
Sometimes	570	30.6
Note. 'Not sure' and 'Refused' responses were excluded.		

Characteristic	n	%
Sex		
Rarely	484	26.0
Never	458	24.6
Socioeconomic Hardship Indicators		
Job loss or reduced hours – Yes	285	15.3
Received food stamps – Yes	130	7.0
Unable to pay bills – Yes	109	5.9
Utility service threatened – Yes	58	3.1
Transportation barrier – Yes	151	8.1
Note. 'Not sure' and 'Refused' responses were excluded.		

Table 2
Descriptive Statistics for Continuous Variables (n = 1,862)

Variable	Mean	SD
Age (years)	20.46	1.83
Poor mental health days (past 30 days)	6.77	8.12
PA frequency (sessions/week)	4.23	3.17
Session duration (minutes)	77.50	60.26
Total PA minutes/week (MINAC12)	249.71	426.26
Strength training frequency (sessions/week)	2.55	2.50
Note. Total PA Minutes per Week (MINAC12) reflects CDC adjustment and capping rules; it does not equal the value of frequency × duration.		

ANOVA: Physical Activity Type and Mental Health

Figure 1 presents the distribution of poor mental health days by activity type, ordered by group median. Walking showed the widest spread, spanning the full 0–30-day range, while running/jogging and gardening/yard work showed more compact, lower-distress distributions. Levene’s test confirmed heteroscedasticity across groups ($F(7, 1854) = 6.01, p < 0.0001$); accordingly, Welch’s ANOVA was used as the primary test and confirmed significant differences in mean poor mental health days ($F(7, 148.09) = 8.34, p < 0.0001; \eta^2 = 0.032$, small effect). The Kruskal–Wallis test corroborated this finding ($\chi^2(7) = 57.39, p < 0.0001; \varepsilon^2 = 0.031$). The Durbin–Watson statistic ($DW = 2.03, p = 0.49$) confirmed residual independence.

TukeyHSD post-hoc comparisons (Table 3; Fig. 2) identified three statistically significant pairwise differences, all relative to walking as the reference. Running/jogging was associated with 3.63 fewer poor mental health days (95% CI [- 5.26, - 2.01], $p < 0.0001$, $d = 0.46$), weight lifting with 2.88 fewer days (95% CI [- 4.43, - 1.32], $p < 0.0001$, $d = 0.35$), and other activities with 2.37 fewer days (95% CI [- 4.02, - 0.73], $p < 0.001$, $d = 0.28$). All effect sizes were small. No other pairwise comparisons were significant after family-wise correction, including calisthenics versus walking ($p = 0.09$). Because these observations were cross-sectional, reverse causation cannot be ruled out.

Table 3

TukeyHSD Pairwise Comparisons: Significant Differences in Poor Mental Health Days by PA Type (Reference: Walking)

Comparison	Mean Diff. (days)	95% CI	p (adjusted)	Cohen's d	Magnitude
Running or jogging – Walking	-3.63	[- 5.26, - 2.01]	$p < 0.0001$	0.46	Small
Weight lifting – Walking	-2.88	[- 4.43, - 1.32]	$p < 0.0001$	0.35	Small
Other – Walking	-2.37	[- 4.02, - 0.73]	$p < 0.001$	0.28	Small
Note. p-values adjusted for family-wise error (Tukey method). Cohen's d interpretation: small < 0.50, medium < 0.80, large ≥ 0.80 . No other pairwise comparisons survived correction.					

Linear Regression: Nested Model Comparison

Model Comparison and Evaluation

Six nested linear regression models were constructed with incremental predictor addition (Appendix A). Models 0 and 1 explained minimal variance ($R^2 = 0.059$ and 0.032 , respectively). Adding PA modality variables in Model 3 did not significantly improve fit over Model 2 (LRT: $F(4) = 1.13$, $p = 0.341$), indicating that frequency, duration, total minutes, and strength frequency contributed negligible independent variance once PA type and demographics were controlled. Adding psychosocial factors in Model 4 produced the largest improvement (LRT: $F(22) = 53.94$, $p < 0.0001$), with R^2 rising from 0.079 to 0.443 . Adding SES indicators in Model 5 produced a modest but significant further improvement (LRT: $F(5) = 2.52$, $p = 0.028$). Although Model 4 was favored by AIC (12,078.3), Model 5 is reported as the primary model given its theoretical completeness: the inclusion of socioeconomic hardship indicators reflects the study's goal of examining psychosocial and structural determinants of mental health jointly, and the marginal AIC difference does not meaningfully outweigh the added explanatory scope.

Regression Coefficients and Predictor Strength

The full model (Model 5) was statistically significant ($F(46, 1815) = 31.84$, $p < 0.0001$) with an adjusted R^2 of 0.433 . Figure 3 presents standardized effect sizes for all predictors. Full coefficients are reported in

Appendix B.

Gender identity was significantly associated with mental health outcomes. Females reported 1.15 more poor mental health days than males ($\beta = 1.15$, $SE = 0.331$, $p < 0.001$; $\beta^* = 0.070$), and nonbinary or other-gender students reported 2.79 more days ($\beta = 2.79$, $SE = 1.237$, $p < 0.01$; $\beta^* = 0.053$). Age was not significant. Asian, non-Hispanic students reported 1.28 fewer days than White, non-Hispanic peers ($\beta = -1.28$, $p < 0.01$).

Among physical activity types, only running or jogging was significantly associated with fewer poor mental health days relative to walking after full adjustment ($\beta = -1.14$, $SE = 0.431$, $p < 0.01$; $\beta^* = -0.054$). Calisthenics approached but did not reach significance ($\beta = -1.63$, $p = 0.107$) and was not interpreted as a protective activity. All PA modality variables (frequency, duration, total minutes, strength frequency) were non-significant (all $p > 0.20$).

Students without a depression diagnosis reported 3.83 fewer poor mental health days than those with a diagnosis ($\beta = -3.83$, $SE = 0.449$, $p < 0.0001$; $\beta^* = -0.201$). Life satisfaction exhibited a dose-response gradient: compared with very satisfied students, those satisfied reported 1.11 more days ($p < 0.01$), those dissatisfied 4.32 more days ($p < 0.0001$), and those very dissatisfied 7.22 more days ($p < 0.01$). Loneliness showed a consistent gradient; those who never felt lonely reported 5.58 fewer days than those always lonely ($p < 0.0001$; $\beta^* = -0.263$).

Stress was the strongest predictor. Compared with students always stressed, those usually stressed reported 4.82 fewer days ($p < 0.0001$), sometimes stressed 8.89 fewer ($p < 0.0001$), rarely stressed 10.88 fewer ($p < 0.0001$), and never stressed 11.45 fewer days ($p < 0.0001$; $\beta^* = -0.608$, the largest standardized effect in the model). Among SES variables, only food stamps showed a significant association (not receiving food stamps: $\beta = 1.65$, $p < 0.01$). This direction indicates that students not receiving food stamps reported more poor mental health days than those who did, a counterintuitive finding that was not robust to survey weighting (weighted $p = 0.068$) and should be interpreted with caution (see Discussion).

Logistic Regression: Frequent Mental Distress

The binary logistic model predicting frequent mental distress (≥ 14 poor mental health days) achieved a Nagelkerke pseudo- R^2 of 0.434, comparable to the OLS adjusted R^2 . Figure 4 presents odds ratios for key predictors. Students without a depression diagnosis had 67% lower odds of frequent distress (OR = 0.334, 95% CI [0.247, 0.453], $p < 0.0001$). Students who rarely or never felt stressed had 94–95% lower odds compared with those always stressed (Rarely: OR = 0.058; Never: OR = 0.049; both $p < 0.0001$). Life dissatisfaction was associated with nearly sixfold higher odds of frequent distress (OR = 5.845, 95% CI [3.022, 11.441], $p < 0.0001$). Running/jogging was the only physical activity type with significantly lower odds versus walking (OR = 0.606, 95% CI [0.379, 0.954], $p < 0.05$). Females had 39% higher odds than males (OR = 1.394, $p < 0.05$), and nonbinary/other-gender students had more than threefold higher odds (OR = 3.067, $p < 0.01$).

Survey-Weighted Sensitivity Analysis

Survey-weighted estimates (LLCPWT) were directionally consistent with unweighted Model 5 estimates for 46 of 47 predictors. Notable divergences were observed for Hispanic ethnicity (unweighted: $\beta = -0.34$, $p = 0.416$; weighted: $\beta = -1.53$, $p < 0.01$) and job loss (unweighted: $p = 0.191$; weighted: $\beta = -1.77$, $p < 0.01$), suggesting underrepresentation of these groups in the unweighted analytic sample. Food stamps association diminished to non-significance under weighting ($p = 0.068$). Core psychosocial predictors (stress, loneliness, depression, life satisfaction) were robust across both specifications. VIF confirmed no multicollinearity (all $\text{GVIF}^{\frac{1}{2}}D < 2.0$).

Discussion

The present findings highlighted the multifaceted nature of physical activity and its associations with mental health among U.S. college students. Running/jogging, weight lifting, and a heterogeneous “other” category were each associated with significantly fewer poor mental health days than walking in unadjusted pairwise comparisons, with small effect sizes. Walking’s position as the highest-distress comparator reflected its distributional breadth: it was practiced across the full mental health spectrum, from health-conscious students to those walking out of necessity. These patterns were consistent with the intensity-specificity hypothesis proposed by Li et al. (2025), who found that higher-effort physical activity was more strongly associated with better mental health outcomes than light-intensity movement.

The regression analyses underscored that psychosocial context, rather than exercise behavior, accounted for the preponderance of variance in poor mental health days. Adding PA modality variables to the demographic and PA type model produced no meaningful improvement in fit, indicating that how much students exercised added negligible explanatory power once activity type and demographics were controlled. By contrast, the addition of psychosocial factors produced the largest improvement in model fit across all nested comparisons. Perceived stress was the single dominant predictor, with a gradient spanning nearly 11 poor mental health days from always stressed to never stressed – a magnitude larger than any physical activity effect. Loneliness, history of depression, and life satisfaction were the next most influential factors, consistent with prior literature (Ramón-Arbús et al., 2020; Thomas et al., 2020).

Running/jogging was the only physical activity type that remained independently significant after full psychosocial and socioeconomic adjustment in both the continuous and binary outcome models. Not replicated for weight lifting, calisthenics, or other types after full covariate adjustment, this specificity suggested that aerobic, intentional exercise may present psychological benefits beyond what is explained by the shared psychosocial characteristics of those who exercise. This is consistent with Peluso and Guerra de Andrade (2005) and Goldstein et al. (2020), though the present analysis added the important nuance that once psychosocial determinants were controlled, most exercise-type differences diminished extensively.

The socioeconomic findings warranted careful interpretation. The food stamps findings, in which students not receiving food stamps reported more poor mental health days, was counterintuitive and was not robust to survey weighting, suggesting it should not be treated as a confirmed association. One plausible explanation is income-threshold confounding: students whose household income marginally exceeds the eligibility cutoff may experience financial strain comparable to those who qualify, yet receive no assistance, potentially increased distress without it being captured by receipt of benefits. Additionally, self-report bias may play a role, as students who apply for and receive food stamps may differ systematically in ways not captured by the available covariates.

Similarly, the emotional support findings merit cautious interpretation. Although students who reported rarely or never receiving emotional support did not emerge as significantly more distressed than expected after full adjustment, this may reflect multicollinearity with loneliness and stress rather than a true null effect, constructs that likely mediate or overlap with perceived social support. Response bias is also plausible, as students with poor mental health may underreport their support needs or perceive available support as inadequate regardless of its objective availability.

Notably, Hispanic ethnicity and job loss reached statistical significance in the survey-weighted model but not in the unweighted analysis, suggesting that the unweighted analytic sample underrepresented these groups relative to the broader college population. These findings highlight the importance of attending to both socioeconomic hardship and ethnic composition when designing campus mental health interventions. Gender identity was also significantly associated with mental health outcomes, with female and nonbinary students reporting greater distress than male peers, consistent with prior research (Beiter et al., 2015; Pedrelli et al., 2015).

From a practice standpoint, these findings suggested that university counseling centers and student wellness programs should prioritize stress management interventions (e.g., mindfulness-based stress reduction, cognitive-behavioral workshops) and social connectedness programming (e.g., peer-support networks, group fitness classes) as first-line mental health supports, with structured physical activity, particularly aerobic exercise such as running, promoted as a complementary component rather than a standalone solution.

The cross-sectional design of this study precluded causal conclusions. Future research should employ longitudinal designs that follow the same participants over time to clarify the directionality and mechanisms of the exercise–mental health relationship, and to evaluate the effectiveness of integrated wellness interventions in college populations. Furthermore, physical activity measurement should move beyond self-report toward objective, validated instruments, such as accelerometry or standardized activity logs, to ensure uniform and comparable reporting across participants. More broadly, all health-related predictors, including mental health outcomes, stress, loneliness, and social support, should be assessed using psychometrically validated, standardized measurements administered consistently across the sample, rather than relying on single-item or ad hoc survey questions. Such methodological

rigor would considerably strengthen the precision and interpretability of observed associations, reduce measurement error, and improve the reproducibility of findings across populations and settings.

Limitations

Several limitations of this study should be acknowledged. First, the cross-sectional design precluded causal inference: the observed associations between physical activity, psychosocial factors, and mental health may reflect reverse causation (e.g., students experiencing poor mental health may reduce exercise engagement) or unmeasured confounding. Second, all data were self-reported, introducing potential response bias, social desirability effects, and recall inaccuracies for both physical activity and mental health measures. Third, this study relied exclusively on the 2023 BRFSS data cycle, the first and currently the last to include the detailed physical activity type module (EXTRACT12) alongside session duration (PADUR1_) and total weekly minutes (MINAC12). These variables were discontinued beginning with the 2024 cycle, precluding replication or longitudinal trend analysis with subsequent BRFSS data. Fourth, three physical activity categories were excluded due to insufficient sample size (household activities, $n = 3$; aerobics, $n = 13$; elliptical/EFX machine exercise, $n = 14$), which limits the comprehensiveness of activity-type comparisons. Fifth, the relatively healthy sample ($\sim 76\%$ without a depression diagnosis; the majority meeting PA recommendations) may have attenuated effect sizes for both PA and psychosocial predictors, suggesting the associations reported here represent conservative estimates of the true relationships. Sixth, survey weights were applied in a sensitivity analysis; the primary unweighted and weighted estimates were directionally consistent for 46 of 47 predictors, though Hispanic ethnicity and job loss reached statistical significance only in the weighted model, indicating possible underrepresentation of these groups in the unweighted analytic sample. Seventh, several key constructs were unavailable in the BRFSS, including sedentary behavior, sleep quality, substance use, academic performance, and prior mental health treatment history, which would be all plausible confounders or mediators of the PA–mental health relationship. Eighth, the BRFSS mental health item (MENTHLTH) captures only the self-reported number of poor mental health days in the past 30 days and does not distinguish between depression, anxiety, stress, or other dimensions of psychological well-being, limiting the specificity of conclusions. Future research should consider replacing or supplementing this single-item measure with clinician-administered diagnostic assessments using standardized, validated instruments (e.g., PHQ-9, GAD-7, or SCID) to allow more precise identification of specific mental health conditions and their differential associations with physical activity. Finally, the moderate adjusted R^2 ($\approx 43\%$) in the full model indicated that significant variance in poor mental health days remained unexplained by the variables available in this dataset, reinforcing the complexity of mental health determinants in young adults.

Conclusion

Together, these findings challenge a common assumption in campus health promotion that increasing physical activity participation is itself a sufficient response to student mental health concerns. The data suggest otherwise. Across a nationally representative sample, the type of activity mattered less than the

psychosocial context surrounding it. Running/jogging carried a modest effect; no other activity type survived full adjustment. Stress, loneliness, depression history, and life satisfaction together drove the majority of variance in poor mental health days; a degree which no exercise intervention alone could plausibly match. Colleges seeking to reduce student mental distress should invest primarily in stress-reduction programming and student life infrastructure, positioning aerobic exercise as a meaningful complement rather than a centerpiece. The unique characteristics of the 2023 BRFSS make this the first nationally representative test of these questions in U.S. college students; replication with longitudinal designs and validated psychometric instruments will be essential to establish directionality and mechanism. Future longitudinal research should also test whether psychosocial and health-related factors such as stress, loneliness, and life satisfaction mediate or moderate the association between running and mental health outcomes. The cross-sectional design of the present study precludes formal mediation analysis, such as temporal ordering between exercise behavior and psychosocial state cannot be established from a single time point; but this mechanistic question is among the most important left open by these findings.

Declarations

Disclosure Statement

The author has no conflicts of interest to report. This study used only publicly available, de-identified secondary data (2023 BRFSS) and did not involve direct contact with human participants. No IRB review was required.

Clinical trial number: not applicable.

Ethics, Consent to Participate, and Consent to Publish declarations: not applicable.

Data Statement

Data are available at https://www.cdc.gov/brfss/annual_data/annual_2023.html.

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Appendix

Appendix A. Multiple Linear Regression Model Evaluation Metrics

Model	Predictors	RMSE	R ²	Adj. R ²	MAE	AIC	BIC
0	Demographics only	7.870	0.059	0.055	6.053	12,986.8	13,042.1
1	PA type only	7.984	0.032	0.028	6.161	13,038.3	13,088.1
2	Demographics + PA type	7.796	0.077	0.070	5.951	12,965.5	13,059.5
3	Model 2 + PA modality	7.786	0.079	0.070	5.949	12,969.0	13,085.1
4	Model 3 + Psychosocial	6.058	0.443	0.430	4.365	12,078.3	12,316.0
5	Model 4 + SES (Full)	6.037	0.447	0.433	4.357	12,075.4	12,340.8

Note. LRT Model 3 vs. 2: $F(4) = 1.13$, $p = 0.341$. LRT Model 4 vs. 3: $F(22) = 53.94$, $p < 0.0001$. LRT Model 5 vs. 4: $F(5) = 2.52$, $p = 0.028$.

Appendix B. Full Model 5 Regression Coefficients – HC3 Robust Standard Errors (N = 1,862)

Variable	β	SE	t	95% CI	p	β^*
Sex (ref: Male)						
Female	1.154	0.331	3.488	[0.525, 1.784]	0.0005***	0.070
Nonbinary / Other	2.789	1.237	2.254	[0.924, 4.654]	0.024*	0.053
Age	-0.044	0.084	-0.529	[-0.203, 0.114]	0.597	-0.010
Race/Ethnicity (ref: White, Non-Hispanic)						
White, Non-Hispanic	—	—	—	—	—	—
Black, Non-Hispanic	-0.386	0.537	-0.718	[-1.411, 0.639]	0.473	-0.014
Asian, Non-Hispanic	-1.284	0.468	-2.743	[-2.256, -0.312]	0.006**	-0.049
American Indian / AK Native	-0.441	1.788	-0.247	[-3.245, 2.363]	0.805	-0.005
Hispanic	-0.340	0.463	-0.734	[-1.160, 0.480]	0.463	-0.015
Other race	0.058	0.590	0.098	[-1.134, 1.250]	0.922	0.002
Income (ref: < \$15,000)						
< \$15,000	—	—	—	—	—	—
\$15,000 – \$25,000	-0.871	0.627	-1.390	[-2.051, 0.309]	0.165	-0.035
\$25,000 – \$35,000	-0.799	0.653	-1.224	[-2.078, 0.481]	0.221	-0.033
\$35,000 – \$50,000	-0.471	0.639	-0.737	[-1.725, 0.782]	0.461	-0.020
\$50,000 – \$100,000	-0.507	0.552	-0.920	[-1.589, 0.575]	0.358	-0.028
\$100,000 – \$200,000	-0.437	0.605	-0.721	[-1.623, 0.750]	0.471	-0.020
≥ \$200,000	0.361	0.687	0.525	[-0.985, 1.707]	0.600	0.012
PA Type (ref: Walking)						
Walking	—	—	—	—	—	—
Running or jogging	-1.136	0.431	-2.635	[-1.990, -0.282]	0.008**	-0.054
Weight lifting	-0.342	0.554	-0.618	[-1.354, 0.670]	0.537	-0.017
Calisthenics	-1.634	1.014	-1.611	[-3.453, 0.185]	0.107	-0.033
Bicycling	-0.223	0.843	-0.265	[-1.862, 1.415]	0.791	-0.005
Yoga / Pilates / Tai Chi	0.252	1.502	0.168	[-2.190, 2.694]	0.867	0.004

Gardening / yard work	0.976	2.042	0.478	[-2.055, 4.007]	0.633	0.011
Other	-0.368	0.495	-0.742	[-1.282, 0.547]	0.458	-0.017
PA Modality						
Frequency (sessions/wk)	0.047	0.059	0.797	[-0.072, 0.166]	0.425	0.018
Session duration (min)	-0.001	0.004	-0.233	[-0.008, 0.006]	0.816	-0.007
Total minutes/week	0.001	0.001	0.931	[-0.000, 0.002]	0.352	0.039
Strength freq. (sessions/wk)	0.043	0.070	0.612	[-0.090, 0.176]	0.541	0.013
Depression Diagnosis						
Yes	—	—	—	—	—	—
No	-3.826	0.449	-8.523	[-4.556, -3.097]	< 0.0001***	-0.201
Life Satisfaction (ref: Very satisfied)						
Very satisfied	—	—	—	—	—	—
Satisfied	1.108	0.333	3.327	[0.418, 1.798]	0.0009***	0.066
Dissatisfied	4.318	0.956	4.517	[2.844, 5.792]	< 0.0001***	0.122
Very dissatisfied	7.221	3.340	2.162	[2.768, 11.674]	0.031*	0.058
Emotional Support (ref: Always)						
Always	—	—	—	—	—	—
Usually	0.427	0.342	1.249	[-0.243, 1.097]	0.212	0.026
Sometimes	0.262	0.532	0.494	[-0.780, 1.305]	0.622	0.012
Rarely	0.166	1.032	0.161	[-1.856, 2.188]	0.872	0.004
Never	-1.249	1.393	-0.897	[-3.979, 1.481]	0.370	-0.021
Loneliness (ref: Always)						
Always	—	—	—	—	—	—
Usually	-1.472	2.041	-0.721	[-5.472, 2.528]	0.471	-0.044
Sometimes	-3.872	1.955	-1.980	[-7.707, -0.036]	0.048*	-0.228
Rarely	-5.242	1.954	-2.683	[-9.074, -1.410]	0.007**	-0.315

Never	-5.582	1.959	-2.849	[-9.424, -1.739]	0.004**	-0.263
Stress (ref: Always)						
Always	—	—	—	—	—	—
Usually	-4.819	1.109	-4.347	[-6.993, -2.645]	< 0.0001***	-0.201
Sometimes	-8.886	1.039	-8.556	[-10.922, -6.849]	< 0.0001***	-0.505
Rarely	-10.877	1.045	-10.408	[-12.927, -8.826]	< 0.0001***	-0.588
Never	-11.449	1.064	-10.763	[-13.534, -9.364]	< 0.0001***	-0.608
Socioeconomic Indicators (ref: Yes for each)						
Job loss — No	-0.541	0.473	-1.143	[-1.352, 0.270]	0.253	-0.024
Food stamps — No	1.653	0.593	2.789	[0.508, 2.799]	0.005**	0.052
Unpaid bills — No	0.057	0.853	0.067	[-1.615, 1.730]	0.946	0.002
Utility issues — No	-0.984	1.077	-0.914	[-3.095, 1.127]	0.361	-0.021
Transport barrier — No	0.933	0.675	1.382	[-0.390, 2.257]	0.167	0.031

Note. *** $p < 0.001$. ** $p < 0.01$. * $p < 0.1$. Statistics with significant β^* values appear in bold.

Figures

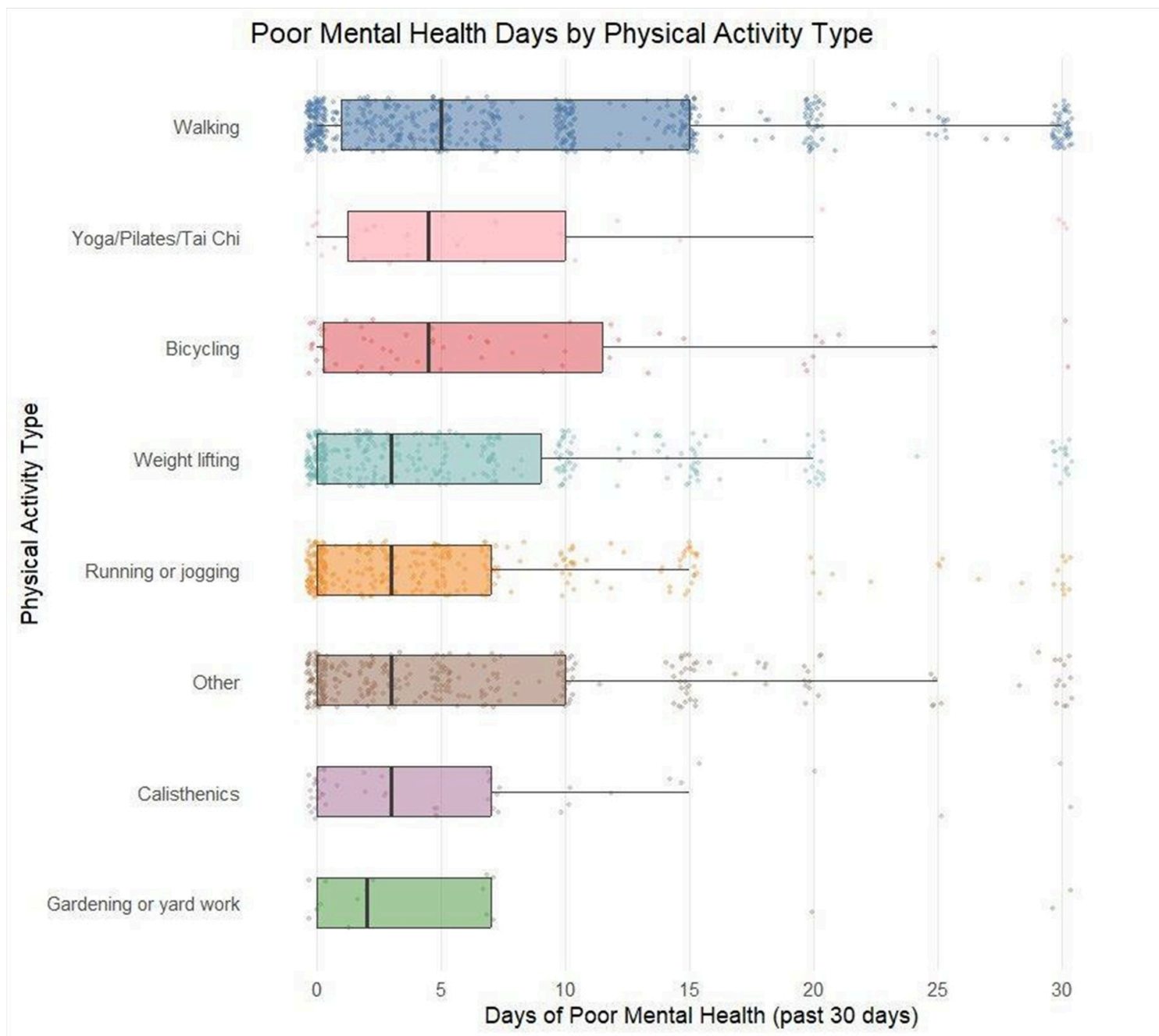


Figure 1

Poor Mental Health Days by Physical Activity Type (2023 BRFSS, n = 1,862). Groups ordered by median. Points show individual observations; box shows median and IQR.

95% family-wise confidence level

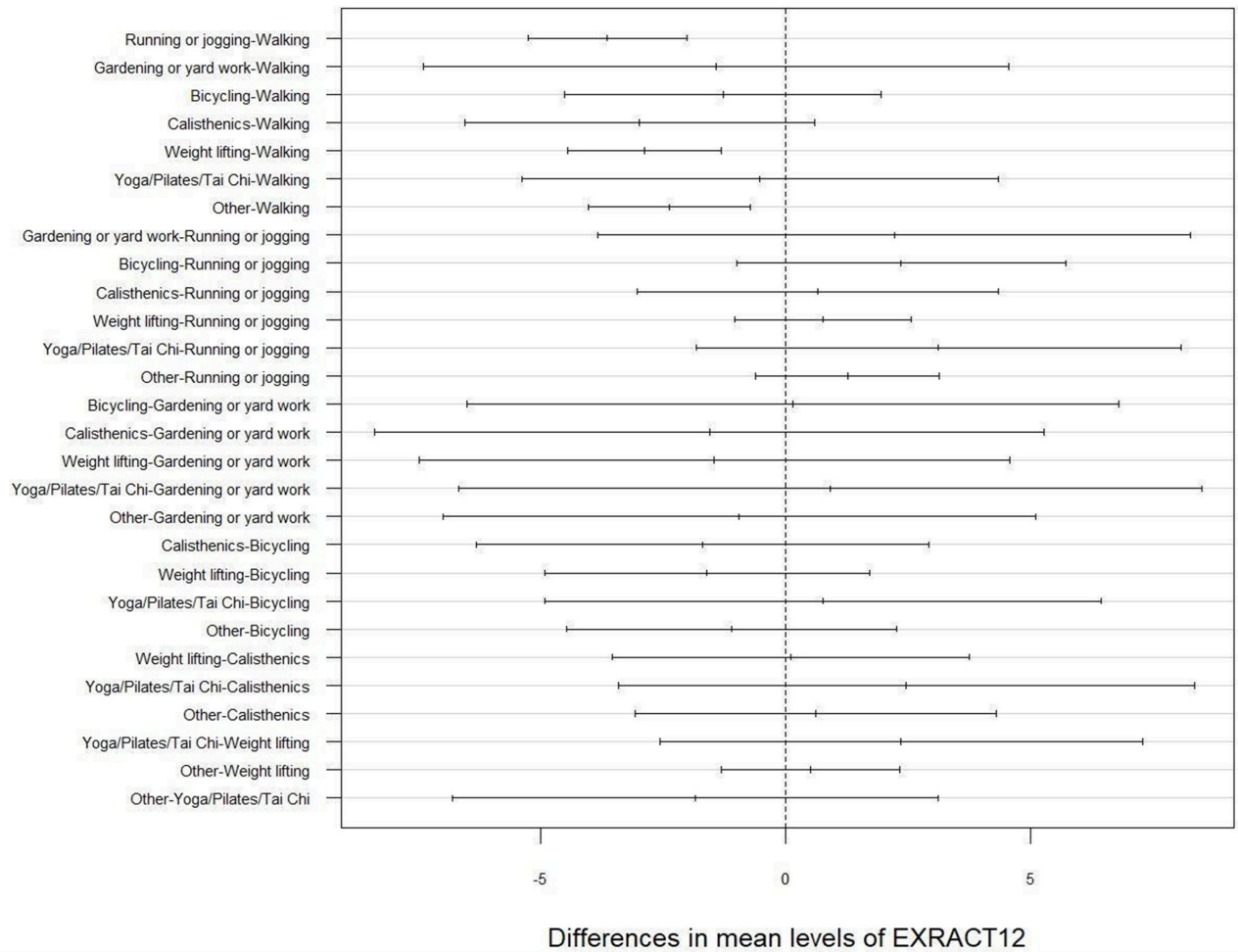


Figure 2

TukeyHSD 95% Confidence Intervals: PA Type vs. Poor Mental Health Days. Intervals not crossing zero indicate statistically significant pairwise differences.

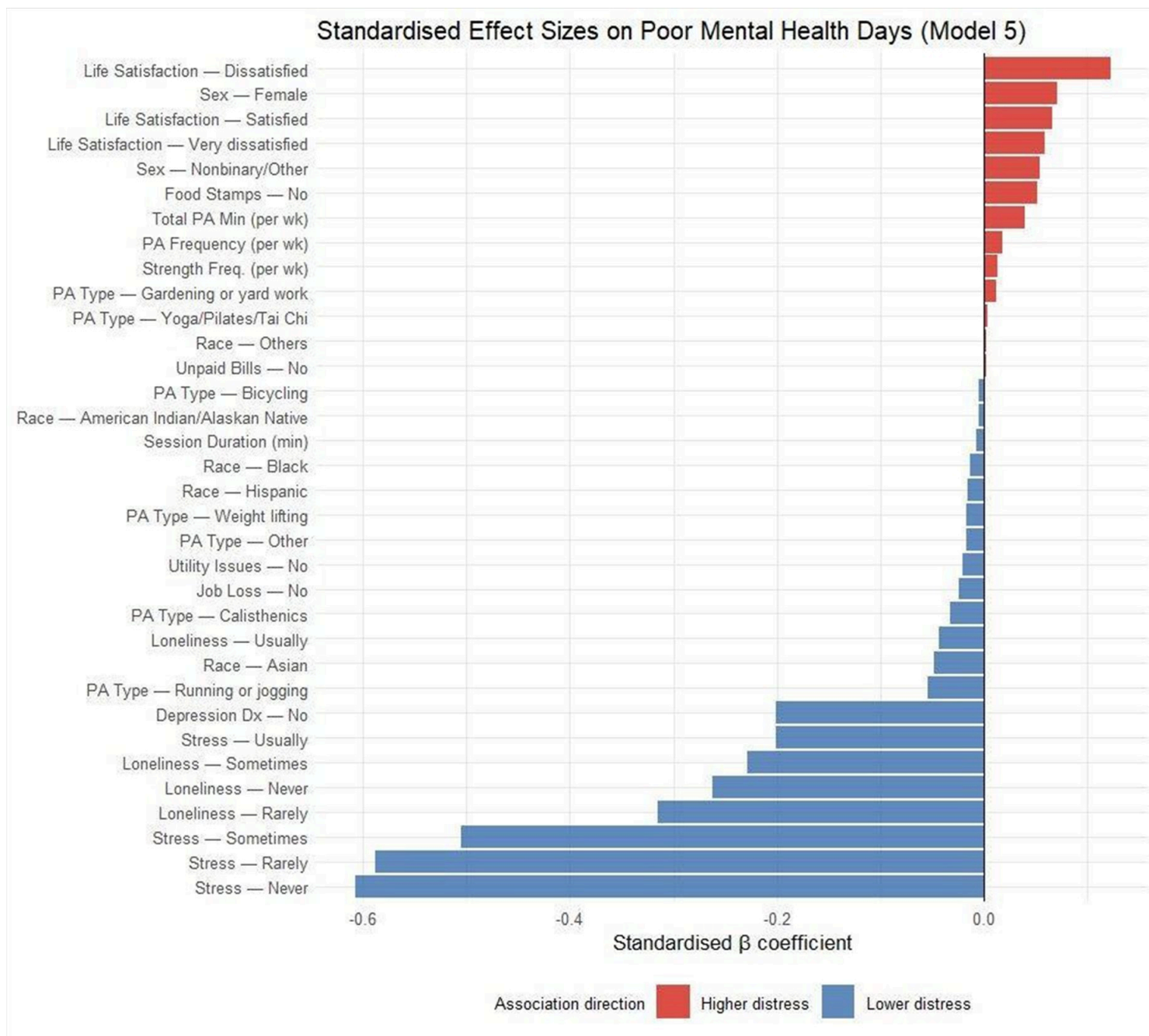


Figure 3

Standardized Effect Sizes (β^*) on Poor Mental Health Days — Model 5 ($n = 1,862$). Red bars = positive association (more distress); blue bars = negative association (less distress).

Figure 4. Odds Ratios for Frequent Mental Distress (≥ 14 poor days)

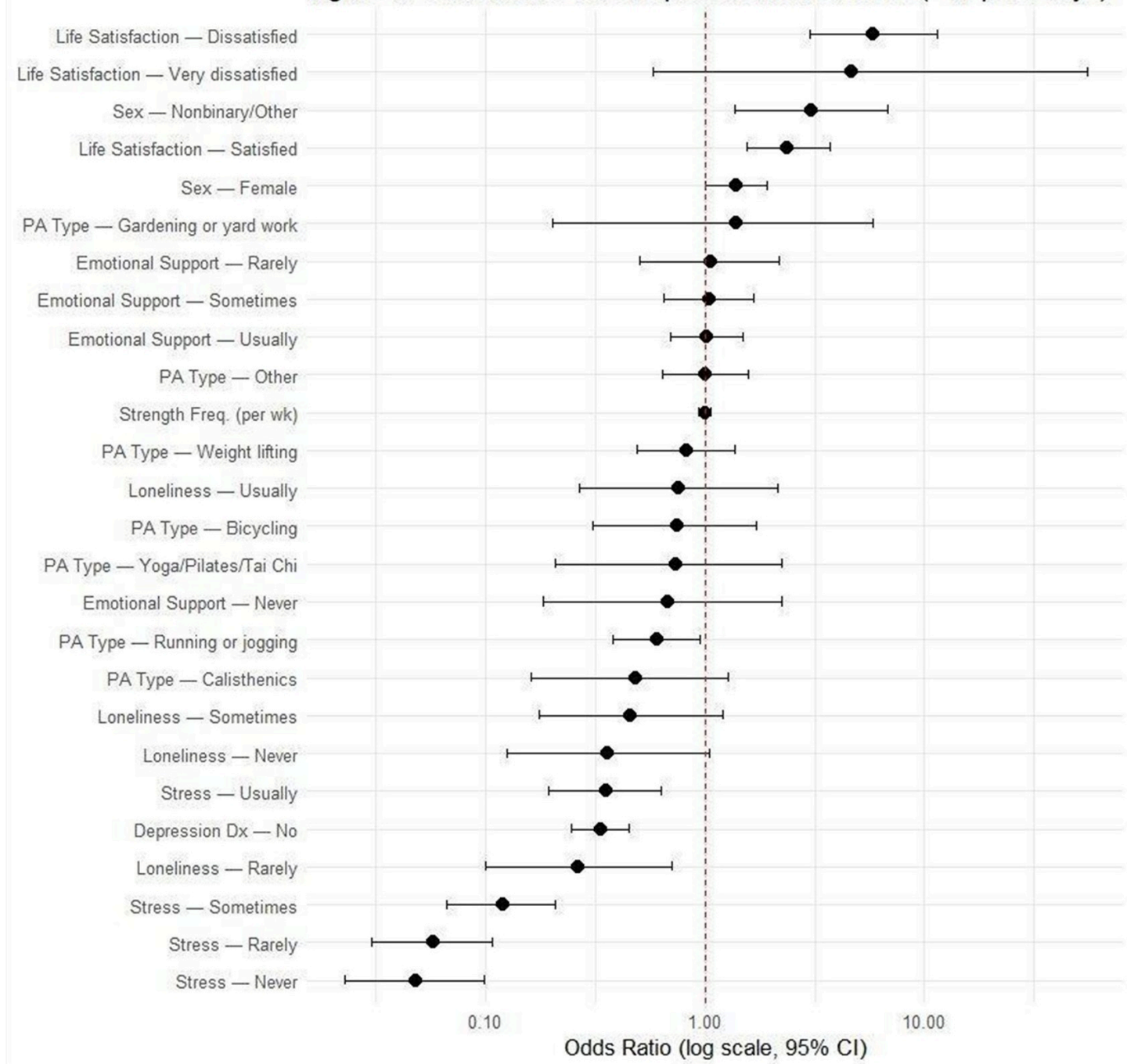


Figure 4

Odds Ratios for Frequent Mental Distress (≥ 14 poor mental health days) — Binary Logistic Regression ($n = 1,862$). Log scale. Dashed line at $OR = 1.00$.