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DANESHPOUR, Arian <http://orcid.org/0009-0000-2751-2741>, VANCAMPFORT, Davy, SCHUCH, Felipe, MACHACZEK, Katarzyna <http://orcid.org/0000-0001-5308-2407>, FIRTH, Joseph and STUBBS, Brendon

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Weekend warrior physical activity engagement and the risk of mental health conditions: A systematic review and narrative synthesis

Arian Daneshpour[1,2*], Davy Vancampfort[3], Felipe Schuch[4,5,6], Katarzyna Karolina Machaczek[7], Joseph Firth[8,2], Brendon Stubbs[,9,10]

1: Universal Scientific Education and Research Network (USERN), Tehran, Iran

2: Digital Innovation And Lifestyle Interventions Network (DIAL_IN), Universal Scientific Education and Research Network (USERN)

3: KU Leuven Department of Rehabilitation Sciences, Leuven, Belgium; University Psychiatric Center KU Leuven, Leuven-Kortenberg, Belgium

4: Department of Sports Methods and Techniques, Federal University of Santa Maria, Santa Maria, Brazil

5: Institute of Psychiatry, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil

6: Institute of Health Sciences, Universidad Autónoma de Chile, Providencia, Chile

7: Advanced Wellbeing Research Centre and Centre for Applied and Social Care Research, Sheffield Hallam University, Sheffield, United Kingdom

8: Division of Psychology and Mental Health, The University of Manchester, Manchester, United Kingdom

9: Centre for Sports Science, University of Vienna, Austria

10: Department of Psychological Medicine, Institute of Psychiatry, Psychology and Neuroscience, Kings College London, London, United Kingdom

*Corresponding author: Arian Daneshpour

Universal Scientific Education and Research Network (USERN), Tehran, Iran, USERN Headquarter Address: USERN Office, Children's Medical Center, Dr. Gharib St, Keshavarz Blvd, Tehran 1419733151, Iran. Tel: +9821-6657-6573

E-mail: daneshpourarian@gmail.com

Running title: Weekend warrior for mental health conditions

Highlights

- The weekend warrior (WW) may be associated with reduced anxiety and depression symptoms.

- Data on the link between WW pattern and other mental health conditions is limited.

- Age and sex may moderate the effects, but evidence is limited.

- A nonlinear, U-shaped link between MVPA and mental health were mostly reported.

- Future trials are needed to confirm the associations of the WW pattern.

Abstract

Background and aims: Regular moderate-to-vigorous physical activity (MVPA) offers mental health benefits, with guidelines recommending 150 minutes weekly. However, many struggle to meet this standard. The weekend warrior (WW) approach, which involves reaching this activity level in one or two days, may lower the risk of mental health conditions, but evidence is limited. This study reviews if the WW pattern reduces risks of mental disorders compared to regular physical activity (RPA) and inactivity.

Methods: A systematic search was conducted on October 30, 2025, for studies on WW PA and mental health conditions. Study quality was assessed using the Newcastle-Ottawa Scale (NOS). Narrative synthesis was employed for data synthesis.

Results: Twelve studies (eight cross-sectional, four prospective cohort) were included, mostly focusing on depression (N = 8). A narrative synthesis found that 10 studies confirmed the comparable association of WW and RPA with lower rates of depression and anxiety. All cohort studies (NOS Mean: 9 ± 0) and most cross-sectional studies (5.12 ± 0.64) were high quality. Inconsistent results may be partially explained by varying definitions of WW and populations, suggesting moderating effects of factors such as age and sex. Several studies indicate a U-shaped relationship between MVPA and mental health, but the evidence remains insufficient.

Conclusions: WW seems to have a comparable association with a lower risk of depression when compared to RPA. However, there is limited information regarding its impact on other mental health conditions. To gain a deeper understanding of this association, future research, particularly longitudinal studies and trials, is essential.

Keywords: weekend warrior, physical activity patterns, mental health, depression, systematic review

1. Introduction

In recent years, extensive research has highlighted the significant benefits of physical activity (PA) for diverse population groups (Schuch & Vancampfort, 2021). Current guidelines recommend that adults engage in 150 minutes of moderate intensity activity or 75 minutes of vigorous intensity activity per week, or a combination of both, to mitigate various health risks (Bull, et al., 2020). These guidelines also underscore PA's role in alleviating psychiatric symptoms as a complementary therapeutic approach for individuals with mental health conditions (Marx, et al., 2023; Solmi, et al., 2025; B. Stubbs, et al., 2018; You, et al., 2025). Compelling evidence supports the protective role of higher PA against incident mental disorders such as anxiety and depression (Schuch, et al., 2019; Schuch, et al., 2018). Moreover, other studies have demonstrated a reciprocal relationship between PA and mental well-being as a positive mental health status, extending beyond merely the absence of mental disorder (Ibáñez Román, et al., 2023; Martland, et al., 2024; You, et al., 2024).

Despite guideline recommendations, current evidence indicates that a significant portion of the global population fails to meet recommended levels of PA (Dai, et al., 2024). This issue is particularly pronounced among those with mental health conditions, who often exhibit low PA levels and poor adherence to exercise programs (Vancampfort, et al., 2017). This challenge is compounded by several barriers, including motivational difficulties, low mood, and high levels of perceived stress, which further hinder their ability to engage in PA (Joseph Firth, et al., 2016).

Due to the challenges of maintaining regular PA, the weekend warrior (WW) approach has gained popularity as a convenient leisure-time PA pattern (S. K. Kunutsor, Jae, & Laukkanen, 2023). The WW involves engaging in concentrated moderate to vigorous physical activity (MVPA) for 1 to 2 days a week, regardless of whether these days fall on the weekend (O'Donovan, Sarmiento, & Hamer, 2018). The health benefits of this pattern were first noted in 2004, when research showed that weekend warriors had a 15% lower risk of all-cause mortality compared to inactive (IA) individuals (I. M. Lee, Sesso, Oguma, & Paffenbarger, 2004). Recent studies continue to emphasize the WW pattern's positive effects in reducing cardiovascular issues, neurodegenerative diseases, and other health concerns (S. K. Kunutsor, et al., 2023; Ning, et al., 2024). Contrary to earlier suggestions emphasizing the balance between frequency, duration, and intensity as crucial for the beneficial benefits of PA, research on the WW pattern suggests

that the overall intensity of PA may be more critical than frequency (Mark Hamer, O'Donovan, Lee, & Stamatakis, 2017).

While the physical health associations of the WW pattern are well documented, research on its relationship with mental health outcomes remains limited and yields mixed results. Previous meta-analyses (Fu, Wang, Pan, Huang, & Li, 2025; Kim, Shin, Oh, Jeon, & Lee, 2025) have examined the association between WW and mental health but lacked specificity, comprehensiveness, and methodological rigor due to the inclusion of a small number of heterogeneous observational studies. Therefore, this study aims to conduct a comprehensive systematic review and narrative synthesis of the current literature on the relationship between the WW pattern and mental disorders. The narrative synthesis seeks to thoroughly scope the literature and determine whether individuals following the WW pattern exhibit associations with mental health conditions comparable to those observed among individuals engaging in regular physical activity (RPA) throughout the week. Moreover, it remains uncertain whether variations in the definition of WW or differences in the threshold of MVPA used to include in the definitions can influence the observed associations. Therefore, this study seeks to synthesize current data to evaluate how these definitional and threshold differences may affect the interpretation of WW-related outcomes. It also aims to explore potential moderating factors, such as age and sex, that may influence the relationship between WW pattern and mental health conditions. Exploring these factors can help determine whether the associations are consistent across groups and also support the development of more targeted strategies for different populations.

2. Methods

2.1 Protocol and registration

The present study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline (**Supplementary Material 1**) (Page, et al., 2021) and the Meta-analyses Of Observational Studies in Epidemiology (MOOSE) checklist (**Supplementary Material 2**). The protocol was submitted to the PROSPERO database under the registration number CRD42025612809.

2.2. Search strategy

On 30 October 2025, a comprehensive systematic search was conducted on PubMed, Embase, Scopus, Web of Science, PsycINFO, EBSCOhost (MEDLINE, SPORTDiscus, CINAHL) using keywords or terms related to the exposure ("weekend warrior") and outcome ("mental health"). Detailed search strategies are displayed in **Supplementary Material 3**. Furthermore, the reference list and citations of all articles included in the study were screened to identify potential eligible articles.

To identify grey literature, the unpublished preprints were explored in medRxiv, bioRxiv, and Preprints with The Lancet. The resources of ProQuest, EBSCO Open Dissertations, and open-access theses and dissertations (OATD) were inspected for unpublished theses and dissertations. Additionally, a comprehensive search was conducted on ClinicalTrials.gov for missing clinical trials. A manual search using Google Search and Google Scholar search engines was implemented to identify additional grey literature.

In order to identify possible eligible studies, the first author (A.D.) independently reviewed the titles and/or abstracts of the studies, subsequently retrieved the full text of the studies, and, if the full text was unavailable, contacted the corresponding author. The second author (J.F.) independently assessed the studies to determine their eligibility. Disagreements between the two reviewers were initially resolved through discussion, and subsequently by the third author (B.S.).

2.3. Eligibility criteria

Only original English-language studies that assess the association between the WW PA pattern and mental health conditions in human subjects were included in this systematic review. All study designs were eligible to be included in the current study, and there were no limitations regarding the study design. Animal studies, studies focusing on factors other than mental health outcomes, and studies that considered mental health problems as a confounder were all excluded from this research. Additionally, studies of low quality were also excluded from the current study.

2.4. Data extraction

Initially, the first author (A.D.) extracted pertinent data from eligible studies, and the second author (J.F.) independently assessed the extracted data. The third author (B.S) resolved the discrepancies. Following the PRISMA and MOOSE checklist and the study conducted by Kunutsor et al. (Setor K Kunutsor, Jae, & Laukkanen, 2022), the subsequent information was extracted: bibliographic data which includes the first author's name, year of publication, location (country), year of enrollment/data collection, study design, and name of the cohort/survey. Demographic information comprising the number of participants, age, percentage of males and the impact of demographics on the outcomes. The type of PA exposure, the method of assessing PA, the quantification of PA exposure, subgroups with varying PA patterns, the main finding pertinent to WW, the definition of WW, and the number of participants with WW PA pattern were extracted. The outcome of mental health conditions, including type (e.g., depression, anxiety, psychological distress), was examined, and the method of their assessment, and the covariates that were adjusted for, were extracted for each study. The measure of effect sizes and 95% CI were also obtained for data synthesis.

2.5. Quality assessment

Two authors (A.D. and J.F.) independently evaluated the studies' quality and risk of bias (ROB). In case of a disagreement regarding the scoring, the authors engaged in further discussion until they reached a consensus. If necessary, the third author (B.S.) was consulted. The quality of the studies and risk of bias (ROB) were first evaluated using the Newcastle-Ottawa Scale (NOS) for longitudinal studies and its modified version for cross-sectional studies. The NOS assesses the quality of studies and the risk of bias by utilizing three categories: participant selection, comparability, and outcomes. The items in each category are detailed in **Supplementary Material 4**. A study may receive a maximum of one point for each item in the selection and outcome categories, and a maximum of two points may be given for comparability. The NOS has a maximum possible score of 9. Cross-sectional studies can achieve a maximum of 7 stars, while longitudinal studies may reach up to 9 stars. In this regard, longitudinal studies were classified as low, moderate, and high quality based on scores of 0–3, 4–6, and 7–9. For cross-sectional studies, the scores of 0–2, 2–4, and 4–7 were categorized as low, moderate, and high quality, respectively (Sánchez-Sánchez, et al., 2024; Wells, et al., 2000). The studies of low quality were excluded from the current study.

2.6. Data synthesis

To systematically organize and synthesize the findings, a narrative synthesis was conducted in accordance with the guidelines of Popay, et al. (2006). The narrative synthesis comprised identifying, listing, tabulating, and quantifying results related to the review questions, in conjunction with a description of patterns across included studies. In this regard, the studies were evaluated to extract effect sizes with 95% confidence intervals (CI) for the comparison of the incidence and prevalence of mental health conditions in individuals with WW and RPA patterns, using the IA group as the reference. Additionally, key study characteristics, including participants, outcomes, subgroup analyses, and other relevant factors, were systematically tabulated to aid in narrative description and interpretation.

3. Results

3.1. Study Selection

The initial search in online databases resulted in a total of 105 studies, with the following distribution: 14 in PubMed, 19 in Embase, 35 in Scopus, 16 in Web of Science, 5 in PsycINFO, and 16 in EBSCOhost (MEDLINE, SPORTDiscus, CINAHL). Additionally, 50 studies were identified after searching grey literature. After removing duplicates and animal studies, 10 studies remained. After removing irrelevant studies from grey literature, 2 studies were retained, as these studies considered mental health conditions as a covariate. After reviewing the titles and abstracts, 2 studies were excluded based on our exclusion criteria. The full papers were sought, from the 10 remaining studies and 2 studies (one measured cognitive metrics in depressed individuals, and the other was determined to be of low quality) did not meet the eligibility criteria for inclusion in the current study. Investigating the reference lists of the included studies did not yield any additional studies for inclusion. Following an update on April 17 2025, 3 studies, and on October 30, 1 additional study, were identified. Ultimately, a total of 12 studies were included. The full detailed selection process is demonstrated in **Figure 1**.

3.2. Studies and participants' characteristics

3.2.1. Cross-sectional studies

Eight cross-sectional studies published between 2017 and 2025 were included. M. Hamer, Biddle, and Stamatakis (2017) analyzed data from the Health Survey for England and the Scottish Health Survey, while Seol, So, Murai, and Matsuo (2024) conducted a web-based survey in Japan. de Victo, et al. (2025) utilized health screening data from the Preventive Medicine Center of the Hospital Israelita Albert Einstein in Brazil. Other studies used data from the U.S. National Health and Nutrition Examination Survey (NHANES). Sample sizes ranged from 1,803 (Li, et al., 2024) to 108,011 participants (M. Hamer, et al., 2017). Participants were adults aged 18–89 years, with mean ages ranging

from 44.48 ± 9.52 (de Victo, et al., 2025) to 49.13 ± 18.26 years (Xu, Zhao, & Hu, 2025). The proportion of male participants ranged from 43% (Li, et al., 2024) to 71.2% (de Victo, et al., 2025).

Four studies assessed depression using the PHQ-9 questionnaire, with a score ≥ 10 indicating depression (R. Chen, et al., 2023; Li, et al., 2024; Liang, et al., 2023; Xu, et al., 2025). M. Hamer, et al. (2017) applied the 12-Item General Health Questionnaire (GHQ-12; score > 3), Seol, et al. (2024) used the Center for Epidemiologic Studies Depression Scale (CES-D; score > 16), and de Victo, et al. (2025) employed the Beck Depression Inventory-II (BDI-II; score ≥ 14). Z. Chen, Xin, Jia, Tu, and Li (2025) evaluated anxiety via a computer-assisted personal interview. All studies measured PA through questionnaires, with MVPA defined as the exposure. Participants were categorized into four groups: inactive (IA), insufficiently active (ISA), WW, and RPA. The WW group proportion ranged from 1.91% (R. Chen, et al., 2023) to 29.84% (Xu, et al., 2025). Most studies defined WW as performing ≥ 150 min/week of moderate PA or ≥ 75 min/week of vigorous PA within 1–2 days. Just Li, et al. (2024) defined WW as engaging in recreational PA 1–2 times weekly totaling ≥ 600 MET-min/week. The main findings of the included studies are shown in **Figure 2**, with detailed characteristics summarized in **Table 1**.

3.2.2. Prospective cohort studies

The prospective cohort studies were published between 2024 and 2025, all utilizing pooled data from the UK Biobank. The number of participants in these studies ranged from 74,715 (Andersen, et al., 2025) to 84,570 (Liu, et al., 2025). The mean age, age range, and sex distribution were similar across studies, showing only minor differences (**Table 1**). The median follow-up duration varied slightly, with Min, Cao, Duan, Wang, and Xu (2024), Yang (2024), Andersen, et al. (2025), and Liu, et al. (2025) reporting median follow-up periods of 8.4, 8.8, 7.9, and 9.4 years, respectively. All studies employed wrist-worn accelerometers using similar methods to quantify PA and adopted consistent definitions for the WW pattern and subgroup classifications. The proportion of WW participants differed by approximately five percent between the highest and lowest values across studies. Regarding the outcomes, Andersen, et al. (2025) focused on depression alone; others on both depression and anxiety. Notably, variations were present in

the ICD-10 codes used for depression assessment. Andersen, et al. (2025) included only F32 codes for diagnosed depression as their outcome, while the others incorporated both F32 and F33 codes for the incidence of depression. Min, et al. (2024) also included the ICD-10 code F31 to assess bipolar disorder. Although all studies accounted for baseline covariates, they differed in the inclusion of additional covariates such as cardiovascular disease and type 2 diabetes history.

3.3. Study quality

All studies included in the current study demonstrated high quality and met the necessary criteria for inclusion, with mean scores of 5.12 ± 0.64 for cross-sectional studies and 9 ± 0 for prospective cohort studies. Only one study (Ling, 2023) was classified as low quality and did not meet the inclusion criteria. Additionally, all cross-sectional studies failed to adequately address the characteristics of non-respondents, which is crucial for mitigating selection bias, and ascertainment of the exposure as relied on self-reported questionnaires.

3.4. Narrative synthesis

3.4.1 Comparing WW and RPA

Most of the cross-sectional studies (R. Chen, et al., 2023; Liang, et al., 2023; Seol, et al., 2024; Xu, et al., 2025) reported similar associations of WW and RPA with depression/depressive symptoms except for two studies (de Victo, et al., 2025; Li, et al., 2024). Z. Chen, et al. (2025) and M. Hamer, et al. (2017) also indicated comparable associations of WW and RPA with a lower prevalence of anxiety and common mental disorder, respectively. All of the prospective cohorts also noted a similar association of WW and RPA with a lower risk of anxiety and depression. However, since all of these cohorts included overlapping populations within the UK Biobank, caution is warranted when directly comparing their findings (**Table 2**).

de Victo, et al. (2025) discussed that one of the main reasons their analyses produced different results was the adoption of a more stringent criterion, requiring full adherence to the recommended levels of PA on one or two days. However, in the literature, the WW pattern is typically defined as performing 50% or more of the recommended PA within one to two days. They also suggested that the non-significant findings might be due to insufficient statistical power to detect a true effect, indicating that the results for this group should be interpreted with caution.

Min, et al. (2024) and Yang (2024) examined different alternative WW definitions, such as accumulating at least 75% of total MVPA over one or two days, at least 50% over one to two consecutive days, or at least 50% over one to two weekend days, to determine whether the association between WW activity and mental health conditions would differ. However, their findings remained consistent across these definitions and suggested that higher concentrations of MVPA over fewer days may offer enhanced mental health benefits. Liang, et al. (2023) also explored the association of different PA frequencies (1, 2, 3-4, and ≥ 5 sessions/week) and different PA intensities (as defined by the proportion of VPA to MVPA) and depression symptoms in their subgroup analyses. Participants engaging in more frequent PA showed lower depression symptom prevalence. Compared with those exercising less often, WW participants active twice per week and individuals that have RPA over four times weekly had reduced risk. Higher-intensity PA was also protective in both groups, with those performing 51–75% or over 76% of their activity as vigorous showing lower odds of depressive symptoms.

Li, et al. (2024) focused on opioid users with depression as a subpopulation within NHANES and found no significant association between WW and depression compared to inactive participants. They suggested that this finding may be explained by the greater pain experienced by individuals taking prescription opioids compared to healthy individuals, which could limit their ability to engage in MVPA within the limited sessions, which is a characteristic of the WW pattern. However, they also included a relatively small number of WW participants in their study, which may have influenced their results. Interestingly, Min, et al. (2024) found that WW and RPA were differentially associated with bipolar disorder. Specifically, WW was linked to a lower risk of bipolar disorder (crude hazard ratio: 0.61, 95% CI: 0.19–1.95) compared with the reference group. However, this association did not reach statistical significance and remained non-significant after adjusting for confounders (adjusted hazard ratio: 0.74, 95% CI: 0.22–2.44). Although

the result was not statistically significant, likely due to the low prevalence and complexity of bipolar disorder, future studies with larger sample sizes are warranted to clarify this association.

3.4.2 Stratified analyses by moderators

In the study by M. Hamer, et al. (2017) associations between PA and mental health outcomes were consistent across groups with different sex, age, obesity, and smoking status. Both men and women, as well as younger and older adults, exhibited similar protective trends, though effects were slightly stronger among participants over 60 years. Of note, among individuals with chronic diseases, even sub-guideline levels of MVPA were linked to lower psychological distress, whereas healthy individuals needed to meet full PA recommendations (≥150 min/week) to obtain similar results. In the study of Xu, et al. (2025), for adults aged 18–64, the WW group showed a lower risk of depression than inactive individuals but a higher risk than regularly active ones. Among older adults (65–80 years), both WW and regular activity patterns conferred similar protective associations. Subgroup analyses by R. Chen, et al. (2023) indicated a consistent association between the WW PA pattern and depression risk across subgroups with different demographic factors. Nonetheless, age-specific effects appeared strongest in adults aged 45–64 years. Z. Chen, et al. (2025) also found broadly consistent mental health benefits of WW activity across sex, age, BMI, smoking, alcohol use, education, and hypertension categories, with no significant interactions. Yet socioeconomic status and metabolic health emerged as meaningful modifiers. Individuals with lower income or diabetes experienced a stronger anxiety risk reduction from WW activity than high-income participants or those without diabetes.

The study by Li, et al. (2024) was the only one that divided PA into occupational PA, transportation-related PA, and recreational PA. Only regular recreational PA had significant associations with lower depression risk, and the researchers found no significant difference in the risk of depression between WW and inactivity groups among adult prescription opioid users. Additionally, the protective link between recreational PA and depression was most evident in females, non-Hispanic Black individuals, those with low education or income, and people living alone. Moreover,

recreational RPA appeared more effective in long-term opioid users, although this subgroup result was not statistically significant.

Notably, Liu, et al. (2025) demonstrated that individuals with lower polygenic risk scores (PRS) who engaged in RPA or WW patterns exhibited the lowest depression and anxiety risks, whereas inactive individuals with high PRS showed the highest vulnerability. Notably, on the contrary, Liang, et al. (2023) reported significant interactions between the WW PA pattern and factors such as age, sex, race or ethnicity, education, income, smoking, alcohol use, and sleep duration. Their stratified results showed notable associations between WW activity and reduced depression risk, particularly among females, middle-aged adults (40–59 years), individuals with some college education, those above the poverty line, married participants, smokers, and adults with normal sleep duration (7–9 hours). Taken together, these findings highlight that while the WW PA pattern is generally associated with lower risk of mental health conditions, results regarding moderating factors such as age and sex remain inconsistent across studies. This variability underscores the need for further research to clarify how these factors influence the relationship between PA patterns and mental health conditions. The summary of subgroup analyses in all studies is demonstrated in **Table 3**.

3.4.3 MVPA threshold

The current literature defines the WW pattern as concentrating at least 150 minutes of MVPA or 75 minutes of vigorous PA within one or two sessions per week (M. Hamer, et al., 2017). Across the included studies, MVPA exhibits a nonlinear, U-shaped, threshold-dependent relationship with depression and anxiety risk, where both insufficient and excessive levels are associated with higher risk. In particular, Z. Chen, et al. (2025) observed a U-shaped association between MVPA and anxiety, where inactivity and excessive activity (>2,400 min/week) both corresponded to higher risk. Andersen, et al. (2025) further supported a curvilinear pattern, where higher doses of MVPA were curvilinearly associated with reduced depression risk, with the steepest minute-per-minute added benefits occurring between 5 and 280 minutes per week. The lowest value of the upper 95% CI was observed at 875

min per week, which we therefore defined as the optimal dose. Beyond this point, hazard ratios continued to decrease until 3000 min per week, but the 95% CI widened, reducing certainty.

Moreover, Yang (2024) found nonlinear threshold effects based on MVPA distribution patterns, with depression and anxiety risks lowest at specific activity levels (65–70% of weekly MVPA on two days) above guideline thresholds (≥150–400 min/week). Below the 25th percentile (≥115.2 min), the relationship between the maximum MVPA percentage on any two days and risk was linear. In contrast, at the guideline (≥150 min), median (≥230.4 min), and 75th percentile (≥403.2 min) thresholds, the relationship was nonlinear and significant. Li, et al. (2024) also noted a clear inflection point around 600 metabolic equivalent task (MET) min/week, above which additional activity produced no added protective association, reinforcing the notion of a plateau in the dose-response relationship between PA and lower prevalence of depression. Liang, et al. (2023) reported an inverse dose-response relationship between total weekly MVPA and the prevalence of depressive symptoms. They categorized total MVPA into four quartiles: Q1 (<210 minutes), Q2 (210–600 minutes), Q3 (600–1580 minutes), and Q4 (>1580 minutes). The association between the WW pattern and lower prevalence of depressive symptoms was significant only in the Q2 and Q3 groups compared to Q1. Their restricted cubic spline analysis revealed that as total MVPA increased, the odds ratio for depressive symptoms steadily declined, indicating a dose–response effect. However, between approximately 250 and 500 minutes per week, the slope of decline became less steep, indicating diminishing marginal benefits of additional MVPA beyond this range. By around 1000 minutes per week, the odds ratio plateaued, suggesting no further reduction in depression risk with higher activity levels.

Altogether, current evidence indicates a nonlinear, threshold-dependent association between weekly MVPA and reduced risk of depression and anxiety, with optimal benefits observed at moderate activity levels, while both low and excessive amounts are linked to higher risk. Nonetheless, existing studies remain limited in defining precise dose–response patterns and individual variability, underscoring the need for future research to develop more refined, distribution-based, and dose-specific PA guidelines.

Discussion

The narrative synthesis of cross-sectional and prospective cohort studies showed that WW and RPA patterns can have comparable associations with lower risks of depression in most studies (Andersen, et al., 2025; R. Chen, et al., 2023; Liang, et al., 2023; Liu, et al., 2025; Min, et al., 2024; Seol, et al., 2024; Xu, et al., 2025; Yang, 2024), with limited information for anxiety (Z. Chen, et al., 2025; Yang, 2024) and other mental health outcomes (M. Hamer, et al., 2017). Stratified analyses revealed inconsistent findings due to varying WW definitions and population subgroups, suggesting that factors such as age (M. Hamer, et al., 2017; Liang, et al., 2023; Xu, et al., 2025), sex (Liang, et al., 2023), socioeconomic status (Z. Chen, et al., 2025; Liang, et al., 2023), chronic disease (M. Hamer, et al., 2017), diabetes (Z. Chen, et al., 2025), and genetic risk (Liu, et al., 2025) may moderate these associations, though evidence remains limited. Most studies reported a nonlinear, U-shaped relationship between MVPA and mental health, where moderate activity levels are associated with the lowest risk of depression (Andersen, et al., 2025; Li, et al., 2024; Liang, et al., 2023; Yang, 2024) and anxiety (Z. Chen, et al., 2025; Yang, 2024), while both insufficient and excessive activity are associated with higher risk. However, the limited results prevent reaching definitive conclusions.

The included studies collectively suggest that increasing the duration, frequency, and intensity of PA is associated with lower levels of depression (Andersen, et al., 2025; Li, et al., 2024; Liang, et al., 2023; Yang, 2024) and, to some extent, anxiety (Z. Chen, et al., 2025; Yang, 2024), as long as it does not exceed tolerable limits. However, the WW pattern appears to offer greater practicality and accessibility compared with RPA. Consistent with these findings, other research has also reported associations between higher PA frequency and improved mental health outcomes. However, many of these studies did not compare lower and higher PA frequency groups while keeping total activity volume constant (Du, Jiang, & Yuan, 2025; Wiklund, Ekblom, Wang, & Ekblom, 2025). Regarding differences in PA frequency between one and two days per week, Hallgren et al. (Hallgren, et al., 2020) reported that regular exercise (1–2 times per week or more) correlates with a reduced likelihood of experiencing frequent symptoms of depression and anxiety. In turn, Kanamori, et al. (2018) reported that the risk of depression can be reduced by exercising two or more times per week and/or exercising with others. Nevertheless, the researchers did not address the effectiveness of one-day PA and instead recommend that this question be explored in future research.

Reviewing the aforementioned studies makes several inconsistencies in the definition of WW evident. It appears that many of the controversies surrounding WW stem from definitional variability (Brawner & Keteyian, 2025). WW is predominantly defined as the PA pattern in which individuals achieve 50% or more of the recommended PA levels, specifically MVPA of 150 minutes or more or VPA of 75 minutes or more, during one or two days of the week. However, there may be differences between performing WW in 1 or 2 days. Some literature suggests that performing PA once per week is inefficient for alleviating the symptoms of mental disorders (Wanjau, et al., 2023), while other research underscores its effectiveness (Shannon, Shevlin, Brick, & Breslin, 2023). Only one study (Liang, et al., 2023) assessed this potential difference, finding that participants who performed WW 2 times per week were at a lower risk for the prevalence of depressive symptoms compared to those who performed it 1 time per week.

The percentage of MVPA should also be considered. Brawner and Keteyian (Brawner & Keteyian, 2025) noted that setting a minimum MVPA threshold of 50% for WW may be controversial and difficult to implement. This is because achieving 50% MVPA on WW days means that the remaining 50% must be completed on non-WW days, thereby diluting the concentration of PA and potentially undermining the intended benefits of focused activity patterns. Min et al. (Min, et al., 2024), Yang et al. (Yang, 2024) found that 50% or 75% MVPA for 1-2 days or any days per week had similar benefits. The 75% group in the consecutive pattern was slightly more protective. Moreover, the sedentary time, as a risk factor exacerbating mental health conditions (A. A. Kandola, et al., 2021), also needs to be addressed. Liu et al. (Liu, et al., 2025) examined whether sedentary time and light PA moderated the association between MVPA in WW and depression/anxiety. Their research indicates that RPA and active WW groups have greater benefits for depression and anxiety in individuals with high sedentary time (≥13h/day) and low light PA (≤60 min/day). However, implementing PA in this population poses significant challenges, as their existing limitations contribute to low light PA and prolonged sedentary behavior. Moreover, the lower exercise capacities in these individuals must also be taken into account, as they require more regular sessions to adapt to PA.

Further studies should explore the combination of light PA with MVPA, particularly during the initial stages of performing WW. Light PA may be a more accessible and feasible starting point, especially for vulnerable populations (Felez-Nobrega, et al., 2021). Engaging in MVPA without adequate preparation or conditioning can increase the risk

of injuries. Individuals following the WW pattern may be particularly susceptible to musculoskeletal and cardiovascular injuries, such as strains or joint issues, and cardiovascular events, especially if they are not accustomed to regular physical activity or have underlying health conditions. (Hartnett, Milner, & DeFroda, 2022; Roberts, et al., 2014). WW studies did not measure the incidence of injuries, highlighting the need for more rigorous evaluations to understand potential adverse effects associated with the WW pattern.

The comorbidities between mental disorders are another important factor to consider in future studies, as there is notable collinearity between these conditions (McGrath, et al., 2020). Previous studies have reported higher PA benefits for the prevention of comorbid mental disorders (Ma, et al., 2023). In the study by Chen et al. (Z. Chen, et al., 2025), the benefits of WW in alleviating anxiety symptoms diminished after considering depression as a covariate. More holistic approaches alongside longitudinal research are required (Machaczek, et al., 2022). Ultimately, the neurobiological effects of exercise on reducing mental health conditions, such as its impact on reducing brain inflammation, oxidative stress, and other mechanisms, have been elucidated to some extent (A. Kandola, Ashdown-Franks, Hendrikse, Sabiston, & Stubbs, 2019; Schuch, et al., 2016; Brendon Stubbs, et al., 2017). Some animal studies (La Tour, et al., 2024; Öztürk, et al., 2023) explored the impact of WW patterns in reducing brain inflammation and enhancing the expression of the hippocampal BDNF gene. However, no thorough human study has addressed whether the long-lasting changes in neurobiological markers can be manifested with the exertion frequency in the WW pattern.

Limitations

This study has some limitations. First, the small number of included studies, most of which relied on self-reported PA and have a cross-sectional design that may contribute to several biases, such as healthy user and recall bias. Most studies were conducted on UK and US participants, limiting the generalizability of the findings to a broader population. The studies that included measurements of PA levels with accelerometers also have some limitations. These studies failed to evaluate the varying effects of different PA domains. Accelerometer-based studies are generally unable to distinguish between PA domains. As a result, many participants in the RPA pattern may have met

PA recommendations primarily through work- or transport-related activity, whereas the WW group might include more individuals achieving those recommendations through leisure-time PA (e.g., playing sports once or twice a week). Since there is evidence suggesting that the PA domain can impact mental health outcomes, the potentially greater number of participants meeting PA recommendations with work or transport-related PA in the RPA group may diminish the protective effect of PA in depression.

Future directions

Comparing the mental health benefits of the WW and RPA patterns in longitudinal clinical trials with a large population, considering sex and age differences, using more robust accelerometer data in repeated measures and biological markers is essential to yield more accurate results in future studies. Future research should consider the effects of sedentary behavior on non-active days, comorbid conditions, PA concentration levels, and types to develop more practical, tailored strategies for diverse populations. The social effects of PA should be considered a covariate in future studies, as PA can provide psychologically and socially rewarding experiences even at low levels (Soini, Rosenström, Määttänen, & Jokela, 2024). Thus, it should be addressed whether performing WW alone is beneficial for individuals who do not have sufficient time or resources or have certain problems with social presence and interaction. Of note, it is crucial to see the associations between WW and mental disorders beyond the solely mental realm, as mental disorders can result in lower quality of life, premature mortality, cardiovascular problems and other serious physical conditions (J. Firth, et al., 2019). Previous studies demonstrated that increasing PA can mitigate these adverse situations (D. H. Lee, et al., 2022). Future research on the WW PA pattern should address the intersection between these consequences in a more comprehensive way.

Conclusions

In conclusion, this study suggests that the weekend warrior (WW) physical activity (PA) pattern and regular physical activity (RPA) may have comparable associations with mental health conditions such as depression and anxiety. This PA pattern could be an accessible strategy for individuals who are unable to meet recommended PA levels on a regular basis. However, significant gaps remain regarding the definition of WW pertaining to its optimal frequency, intensity, and concentration. Additionally, the impact of other contributing factors such as sedentary behavior on non-active days, comorbid situations, and the varying effects of different types of PA needs to be considered more distinctly. The major limitations of current WW studies are inconsistencies in the methodologies, reliance on self-reported data, and a lack of robust longitudinal studies. Therefore, more comprehensive studies are required to address these limitations, refine the definition of the WW pattern, and develop more tailored recommendations so that a broader range of individuals can benefit from this promising approach.

Declaration of Competing Interest

Funding

Conflict of interest

BS is on the editorial Board of the Journal of Physical Activity and Health, Ageing Research Reviews, Mental Health and Physical Activity, The Journal of Evidence Based Medicine, and The Brazilian Journal of Psychiatry. Brendon has received honorarium from a co-edited book on exercise and mental illness (Elsevier), an education course and unrelated advisory work from ASICS and FitXR LTD. The other authors declared no conflict of interest.

Figure and table legends

Figure 1: PRISMA flow diagram

Table 1: Characteristics of the included studies.

Table 2: Effect sizes for the associations between weekend warrior and regular physical activity with mental health outcomes.

Table 3: Overview of moderators examined in stratified analyses across the included studies.

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