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Hiking and incident mental disorders: A nationwide cohort study using global positioning system-derived behavioral data

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Abstract

Background

Mental disorders represent a growing global health burden, and pharmacological treatment alone is insufficient for population-level prevention. Nature-based physical activities, including hiking, may provide additional mental health benefits beyond those of exercise alone; however, longitudinal evidence using objective behavioral data and clinically defined outcomes remains limited. We examined the association between objectively measured hiking activity and the incidence of clinically diagnosed mental disorders.

Methods

We conducted a cohort study linking global positioning system (GPS)-derived hiking data from the Tranggle application with National Health Insurance Service records in South Korea. Eligible participants were adults with at least one recorded hiking activity in 2016; after exclusions, 32,737 individuals were included. Hiking activity was assessed over 1 year from each participant's first recorded activity using four indicators: total distance, total duration, frequency, and regularity. Participants were classified as non-hikers or into tertiles of hiking activity. Incident mental disorders (ICD-10: F30–F55) were ascertained from administrative claims during 2018–2021. Cox proportional hazards models were used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs).

Results

Over 120,257 person-years of follow-up, 4,940 incident cases of mental disorders were identified. Compared with non-hikers, participants in the highest hiking activity group had a consistently lower hazard of mental disorders across all four indicators (HR range: 0.89–0.90), with point estimates indicating a consistent trend across activity levels.

Conclusions

Higher levels of hiking activity were associated with a lower incidence of mental disorders. These findings support integrating nature-based physical activities into public health strategies for mental disorders.

1. Background

Mental disorders are an increasing global public health burden. In 2021, they accounted for more than 155 million disability-adjusted life years (DALYs) worldwide; by 2023, approximately 15% of the global population was affected (GBD [1] Causes of Death Collaborators, 2024; GBD [2] Disease and Injury and

Risk Factor Collaborators, 2025). The economic impact is equally substantial, with mental health conditions costing the global economy an estimated US$2.5 trillion in 2010, and projected to rise to US$6 trillion by 2030 [3]. This burden increases with age and is expected to grow as the global population continues to age [4].

A major contributor to this burden is the widespread comorbidity of mental disorders and the limitations of relying solely on pharmacological treatment. Prior mental disorders substantially increase the risk of developing subsequent psychiatric conditions, with effects that may persist for decades after initial onset [5]. The co-occurrence of mental and physical conditions further worsens health trajectories through reciprocal biological and behavioral pathways [6]. Older adults are particularly vulnerable, as multimorbidity and polypharmacy are associated with increased hospitalization, higher healthcare costs, and reduced treatment effectiveness [7]. These compounding factors highlight the need for scalable, sustainable, and non-pharmacological prevention strategies.

Natural environments have emerged as promising settings for non-pharmacological approaches [8]. Green social prescribing, which connects individuals to nature-based activities through health and care referrals, has been integrated into NHS England's personalized care agenda [9]. Most recently, the WHO Regional Office for Europe emphasized nature-based solutions as an important public health strategy [10]. Epidemiological studies have consistently shown that green space exposure is associated with reduced all-cause and cardiovascular mortality, lower diabetes incidence, and improved mental health outcomes [11, 12]. Meta-analyses have further demonstrated that green space exposure is associated with reduced risks of depression and anxiety [13] and improvements in restorative outcomes such as fatigue and vitality [14]. Among these forms of natural exposure, active engagement with natural spaces appears to confer greater mental health benefits than residential proximity alone [15].

Nature-based physical activity may therefore represent a particularly effective form of exposure, combining the benefits of exercise with immersive contact with natural environments. Studies have suggested that physical activity in natural environments yields greater psychological benefits than equivalent activity in urban settings [16–18]. Activities such as green exercise and nature walking have shown benefits for depressive mood and anxiety [19]. Hiking, in particular, represents a compelling form of combined exposure because it integrates sustained physical activity with prolonged immersion in natural settings and has been associated with a range of mental health benefits [20].

Despite growing evidence, critical gaps remain. First, most studies have focused on exposure to residential green space rather than active engagement with natural environments. With respect to physical activity, heterogeneous activities performed across diverse environmental contexts are often grouped as equivalent exposures [19, 21]. Second, longitudinal evidence on long-term mental health outcomes remains limited, with much of the evidence relying on short-term intervention studies [14, 22]. Third, clinically diagnosed mental disorder outcomes are rarely examined, with assessments predominantly relying on self-reported symptom-based scales [23].

A further methodological limitation concerns the measurement of physical activity itself. Most existing studies have relied on self-reported measures, which are susceptible to recall bias and tend to systematically misestimate activity volumes and patterns [24, 25]. Objective measurement approaches, such as accelerometry, offer greater accuracy; however, they are typically deployed in short-term study settings, limiting their ability to capture habitual behavior over ecologically valid timescales [26]. GPS-derived data from smartphone applications address both limitations by providing continuous, objective records of real-world activity over extended periods [27].

In South Korea (hereafter, Korea), GPS-derived hiking data from a large-scale activity-tracking application linked to nationwide health insurance records offer a unique opportunity to address these gaps. This data infrastructure is particularly well suited to the Korean context, where forested land accounts for approximately 63% of the national territory [28]. Hiking is among the most widely practiced leisure-time physical activities [29], creating a representative and ecologically valid form of nature-based physical activity for population-level studies.

This study aimed to examine the association between hiking activity and the incidence of clinically diagnosed mental disorders using GPS-derived behavioral data linked to national health insurance claims records.

2. Methods

2.1. Study design

This study employed an observational cohort design that linked GPS-derived activity records from the Tranggle® application with individual-level administrative data from the National Health Insurance Service (NHIS). The data linkage was requested by the National Institute of Forest Science through the NHIS Data Combination Service [30], which performed pseudonymization and linkage with NHIS records. All personally identifiable information was de-identified before linkage, yielding an anonymized dataset made available only to pre-approved researchers. Informed consent was obtained from all participants via the Tranggle application. The study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the Public Institutional Review Board designated by the Ministry of Health and Welfare, Republic of Korea (IRB No. P01-202209-01-038).

2.2. Data source

2.2.1. GPS-derived activity records

Individual-level activity records were obtained using the Tranggle mobile application, a Korea-based free-to-use GPS-tracking platform on which users voluntarily record their outdoor physical activities. Each activity log, hereafter referred to as a session, includes activity type (hiking, walking, cycling), distance (km), duration (min), and average and maximum speed. These data provide objective and temporally precise measures of real-world physical activity behavior. Activity type is self-selected by users from

predefined categories at the start of each session within the application interface and is required to initiate a session.

2.2.2. NHIS health examination and claims records

The NHIS administrative database provides near-universal coverage of the Korean population under a mandatory single-payer system, making it a robust infrastructure for population-based research. The database integrates insurance eligibility records, healthcare utilization claims, diagnosis records, health examinations, and questionnaire data, enabling the longitudinal tracking of health status and healthcare use. Adults are generally eligible for biennial health examinations; therefore, baseline examination data were primarily obtained from the 2016 cycle, with 2017 records used where 2016 records were unavailable.

2.3. Study participants

The cohort was assembled from individuals with at least one recorded Tranggle session in 2016, including hiking, walking, or cycling, with baseline defined as the date of each participant's first recorded session during that year. The exclusion criteria were applied to ensure data quality and to establish a disease-free baseline. Individuals with implausible activity values, missing health examinations or insurance eligibility records, incomplete covariate data, or any mental disorder diagnosis during the 2016–2017 washout period were excluded. The details of participant selection are shown in Fig. 1.

2.4. Measures

The exposure window spanned 12 months following each participant's baseline date, thereby capturing a full year of individual-level activity behavior. The outcome window was subsequently defined from January 1, 2018, to December 31, 2021, ensuring temporal separation between exposure measurement and outcome ascertainment (Fig. 2).

2.4.1. Exposure

Four hiking activity indicators were derived during the exposure window: total distance (km), total duration (min), frequency (total number of sessions), and regularity (number of distinct active calendar months, range: 1–12). These were computed separately for hiking and for overall physical activity, which included hiking, walking, and cycling combined.

Based on hiking-specific indicators, participants were classified into four groups: G0 (no hiking activity), which served as the reference group, and G1–G3, representing the lowest to highest tertiles among participants with at least one hiking session. Tertile cutoffs were defined separately for each indicator.

For overall physical activity, participants were classified into quartiles (Q1–Q4), with Q1 as the reference group. As all Tranggle users had at least one recorded activity session, a no-activity reference group analogous to G0 could not be constructed for overall physical activity; therefore, direct comparisons between hiking-specific and overall activity estimates should be interpreted with caution.

2.4.2. Outcome

Mental disorder outcomes were selected based on two criteria: (1) established associations with nature-based physical activity in the existing literature [19, 22, 31], and (2) suitability for release within the data linkage framework, excluding categories associated with high stigmatization risk or severe congenital conditions.

Three ICD-10 diagnostic categories were included: mood disorders (F30–F39), neurotic and stress-related disorders (F40–F48), and behavioral syndromes associated with physiological disturbances (F50–F55). These categories include bipolar disorder, depressive episodes, anxiety disorders, reactions to severe stress, adjustment disorders, somatoform disorders, eating disorders, and sleep disorders.

An incident case was defined as the first recorded diagnosis within any target category during the outcome window (January 1, 2018, to December 31, 2021). Diagnoses were ascertained from any of the five diagnostic fields routinely recorded in NHIS claims (primary diagnosis and up to four secondary diagnoses). Participants without a diagnosis were censored on December 31, 2021.

2.4.3. Covariates

Covariates were derived from NHIS health screening records (2016 preferred; 2017 when unavailable) and included sex; age (10-year intervals); household income level (low: 1st − 3rd, moderate: 4th − 7th, high: 8th − 10th insurance premium deciles); residential region (metropolitan, major city, or other); alcohol use (drinker vs. non-drinker); smoking status (ever vs. never); body mass index (BMI; normal < 23, overweight 23–<25, class □ obese 25–<30, class □–□ obese ≥ 30 kg/m^2); and medical history, defined as any self-reported physician-diagnosed chronic condition (liver disease, hypertension, stroke, heart disease, diabetes mellitus, cancer, or other chronic conditions).

The Charlson Comorbidity Index was not included because several required diagnostic categories were unavailable in the study dataset.

2.5. Statistical analysis

Baseline characteristics are summarized as frequencies and percentages, stratified by sex. Associations between each physical activity exposure and incident mental disorders were estimated using Cox proportional hazards regression, with hazard ratios (HRs) and 95% confidence intervals (CIs). The follow-up time was calculated from January 1, 2018, to the date of the first mental disorder diagnosis or censoring on December 31, 2021.

Analyses were conducted separately for each indicator using Cox proportional hazards regression with G0 and Q1 as the respective reference groups. Three models were fitted: Model 1 (unadjusted), Model 2 (adjusted for age and sex), and Model 3 (adjusted for income level, residential region, smoking status, alcohol use, BMI, and medical history).

In sensitivity analyses, outcome ascertainment was restricted to the primary diagnosis and the first secondary diagnosis. In addition, age was recategorized into three broader groups (20–39, 40–59, and ≥ 60 years) to improve model stability, given the limited number of outcome events. All analyses were performed using the SAS software (version 9.4).

3. Results

3.1. Baseline characteristics

Table 1 presents the baseline characteristics of the 32,737 participants, stratified by sex. The cohort was predominantly male (n = 30,021; 91.7%), with participants in their 40s and 50s accounting for approximately 70% of the total population.

Table 1
Baseline characteristics of study participants by sex

Variable	Total (n = 32,737)	Male (n = 30,021)	Female (n = 2,716)	p-value
Age				
20–29 years	541 (2%)	453 (2%)	88 (3%)	< 0.01
30–39 years	4,590 (14%)	4,251 (14%)	339 (12%)	
40–49 years	12,645 (39%)	11,351 (38%)	1,294 (48%)	
50–59 years	9,916 (30%)	9,119 (30%)	797 (29%)	
60–69 years	4,573 (14%)	4,382 (15%)	191 (7%)	
70–79 years	472 (1%)	465 (2%)	7 (0.3%)	
BMI category (kg/m^2)				
Normal (< 23)	8,212 (25%)	6,633 (22%)	1,579 (58%)	< 0.01
Overweight (23–<25)	9,266 (28%)	8,696 (29%)	570 (21%)	
Obesity class □ (25–<30)	14,076 (43%)	13,576 (45%)	500 (18%)	
Obesity class □/□ (≥ 30)	1,183 (4%)	1,116 (4%)	67 (2%)	
Current alcohol consumption				
Yes	24,862 (76%)	23,505 (78%)	1,357 (50%)	< 0.01
No	7,875 (24%)	6,516 (22%)	1,359 (50%)	
Lifetime smoking history				
Ever	21,782 (67%)	21,595 (72%)	187 (7%)	< 0.01
Never	10,955 (33%)	8,426 (28%)	2,529 (93%)	
Household income level				
High	19,255 (59%)	18,365 (61%)	890 (33%)	< 0.01
Middle	9,988 (30%)	8,879 (30%)	1,109 (41%)	
Low	3,494 (11%)	2,777 (9%)	717 (26%)	
Area of residence				
Seoul metropolitan area	16,684 (51%)	15,190 (51%)	1,494 (55%)	< 0.01

[1] Defined as self-reported physician-diagnosed conditions, including liver disease, hypertension, stroke, heart disease, diabetes mellitus, cancer, or other chronic conditions.

Variable	Total (n = 32,737)	Male (n = 30,021)	Female (n = 2,716)	p-value
Age				
Metropolitan city	7,059 (22%)	6,477 (22%)	582 (21%)	
Other	8,994 (27%)	8,354 (28%)	640 (24%)	
History of chronic diseases[1]				
Yes	9,436 (29%)	8,994 (30%)	442 (16%)	< 0.01
No	23,301 (71%)	21,027 (70%)	2,274 (84%)	

[1] Defined as self-reported physician-diagnosed conditions, including liver disease, hypertension, stroke, heart disease, diabetes mellitus, cancer, or other chronic conditions.

Male participants were more frequently classified as overweight or obese, whereas most female participants were within the normal BMI range. Current alcohol consumption (76%) and lifetime smoking history (67%) were substantially more common among males than among females. A high household income was the most prevalent income category (59%), and approximately half of the participants resided in the Seoul metropolitan area (51%). A history of chronic disease was reported by 29% of the overall cohort.

Statistically significant sex differences were observed across all baseline characteristics ($p < 0.01$)

3.2. Distribution of hiking activity indicators

Table 2 summarizes the distribution of hiking activity indicators accumulated during the 1-year exposure window. Considerable variability was observed across all indicators, reflecting a wide range of hiking behavior within the cohort.

Table 2
Distribution of hiking activity indicators over the 1-year exposure window

Indicator		Min–Max	Median	Mean
Total distance (km)		0–6,746	33.1	123.6
Total duration (min)		0–113,549	961	3370.7
Frequency	Total number of sessions	0–614	5	15.3
Regularity	Number of distinct active calendar months	0–12	3	4.5

The total hiking distance ranged from 0 to 6,746 km (median: 33.1 km), and the total duration ranged from 0 to 113,549 min (median: 961 min). The frequency ranged from 0 to 614 sessions (median: 5), and

regularity ranged from 0 to 12 active months (median: 3), indicating that most participants engaged in hiking sporadically rather than consistently throughout the year.

Group-specific baseline characteristics by hiking activity level are presented in Additional file 1 (Tables S1–S4).

3.3. Association between hiking activity and incident mental disorders

A total of 4,940 incident mental disorder cases were identified over 120,257 person-years of follow-up during 2018–2021, corresponding to an overall incidence proportion of approximately 15%. Among the three diagnostic categories, neurotic and stress-related disorders (F40–F48) were the most prevalent (55.8%), followed by mood disorders (F30–F39, 24.4%), and behavioral syndromes associated with physiological disturbances (F50–F55, 19.8%).

Figure 3 presents Model 3 estimates for the associations between hiking activity and incident mental disorders. The full results for Models 1–3, including overall physical activity, are presented in Additional file 1 (Table S5).

Statistically significant inverse associations were observed in the highest activity group (G3) across all four indicators, with HRs ranging from 0.89 to 0.90, indicating an approximately 10–11% reduction in the hazard of mental disorders relative to the no-hiking group (G0). Lower activity groups (G1 and G2) showed attenuated, largely non-significant point estimates, with associations that trended consistently across activity levels. In contrast, no statistically significant associations were observed for overall physical activity across quartiles (Additional file 1, Table S5).

In sensitivity analyses restricted to primary and secondary diagnoses (n = 2,261 events), G3 point estimates remained directionally consistent with the primary findings (HR: 0.88–0.92), although CIs were wider and statistical significance was not consistently achieved. Nevertheless, the overall pattern of estimates supported the robustness of the primary findings (Additional file 1, Table S6).

4. Discussion

4.1. Interpretation

To our knowledge, this is the first prospective study to examine the association between objectively measured hiking activity, captured using GPS-derived behavioral data, and incident clinically diagnosed mental disorders in a nationwide cohort. Our findings demonstrate a consistent inverse association between hiking engagement and the risk of mental disorders across all four indicators (total distance, total duration, frequency, and regularity). The highest activity group exhibited an approximately 10–11% lower hazard compared with non-hikers, with point estimates that trended consistently across activity levels.

The present findings are consistent with evidence that forest-based activities are associated with improved mental health outcomes. Systematic reviews have reported that forest-based interventions reduce stress, depression, and anxiety [22], and hiking specifically has been linked to improved mood and reduced depressive symptoms [20]. Notably, emerging longitudinal evidence suggests that cumulative and habitual engagement with natural environments may confer greater mental health benefits than episodic contact [32, 33]—consistent with the pattern observed across activity levels in this study. The distinctive characteristics of forest environments, including reduced noise, favorable microclimates, and exposure to biogenic compounds, may contribute to these effects by reducing physiological stress and promoting psychological restoration [34]. Supporting this, recent evidence from Korea indicates that forest cover is consistently associated with lower perceived stress at the national scale, whereas grass cover and overall greenness (Normalized Difference Vegetation Index) show more variable associations [35]. This pattern suggests that forested environments may be particularly beneficial for mental health beyond other vegetated settings.

From a methodological perspective, this study addresses several limitations of prior research. Most previous studies relied on self-reported measures of physical activity, which are susceptible to recall bias and misestimation. In addition, the importance of capturing actual behavioral engagement with natural environments has been increasingly recognized; however, studies directly measuring such engagement remain scarce [36, 37]. GPS-derived measures of real-world hiking behavior collected over a 1-year period address both limitations by providing an objective and ecologically valid assessment of habitual activity. Furthermore, the use of ICD-10 diagnoses from nationwide health insurance records enabled the identification of clinically defined incident mental disorders, extending the evidence base beyond symptom-based self-reported outcomes. By integrating these two data sources within a longitudinal framework, this study addresses a key methodological gap in the literature on nature-based physical activity and mental health.

The null finding for overall physical activity requires careful interpretation and should not be interpreted as physical activity being unrelated to mental health, given the well-established evidence to the contrary [38, 39]. A key consideration is the structural composition of the overall physical activity comparator; as all Tranggle users had at least one recorded session, the lowest quartile may not represent a truly inactive population, potentially attenuating any observable gradient. Alternatively, the heterogeneity of activity types and environmental contexts subsumed within the composite measure may further obscure the associations specific to nature-based exposure. Nonetheless, even within this relatively active and outdoor-oriented sample, significant associations were observed specifically for hiking, suggesting that the environmental context may play a meaningful role in shaping the mental health effects of physical activity, although this interpretation warrants caution.

4.2. Public health and policy implications

The study’s findings have important implications for population-level mental health prevention. They suggest that habitual hiking may contribute to the prevention of new-onset mental disorders, supporting its role as a primary prevention strategy. To realize this potential, public health efforts should prioritize

promoting regular engagement with nature-based physical activity through awareness campaigns, structured programs, and improved access to walking and hiking infrastructure.

Effective translation into practice will require improved understanding among public health and clinical stakeholders of the relationship between nature exposure and mental health. Strengthening awareness across sectors, including primary care, public health, and urban planning, is a prerequisite for evidence-based policy development [40]. As this evidence base matures, more structured approaches may become feasible, including the incorporation of nature-based physical activity into preventive care pathways through green social prescribing frameworks implemented in settings such as the NHS in England [9].

Furthermore, equity considerations must be central to any policy response. Access to natural environments is not evenly distributed, and disparities in greenspace access may exacerbate existing health inequalities, particularly as evidenced during the COVID-19 pandemic [41, 42]. Therefore, policymakers should ensure that efforts to promote nature-based health strategies explicitly address these structural barriers to ensure that the potential benefits of such approaches are equitably distributed across the population [4].

4.3. Strengths and limitations

The strengths of this study include: 1) Both exposures and outcomes were ascertained from objective data sources, minimizing recall and social desirability biases. 2) The study employed a clearly defined temporal structure, with a washout period to confirm disease-free status at baseline and to establish the temporal precedence of exposure over outcome, thereby reducing the potential for reverse causation. 3) The multidimensional characterization of hiking exposure, encompassing total distance, total duration, frequency, and regularity, allowed for a comprehensive assessment of habitual activity patterns across multiple behavioral dimensions.

This study has some limitations. First, the study population was subject to selection bias, as participants were limited to users of a specific activity-tracking application and were predominantly male and middle-aged, thereby limiting generalizability. Second, although we adjusted for a range of sociodemographic, lifestyle, and clinical covariates, residual confounding by unmeasured factors, including baseline mental health and social engagement, cannot be excluded. Third, the observational design precludes definitive causal inference despite the temporally separated exposure–outcome framework. Finally, this study did not allow for the disentanglement of the relative contributions of physical activity and environmental exposure, and the environmental context of non-hiking activities could not be determined, limiting the interpretation of the null findings for overall physical activity.

In addition, the COVID-19 pandemic coincided with the latter part of the outcome follow-up period and may have influenced mental health status, healthcare-seeking behavior, and diagnostic ascertainment. However, because hiking exposure was ascertained before the pandemic and the associations were

estimated within a temporally separated exposure window, it is unlikely that the pandemic fully accounts for the observed inverse associations.

4.4. Future research

Future research should further elucidate the mechanisms linking nature-based physical activity and mental health, including the relative contributions of physical activity, stress reduction, and environmental exposure, as well as potential effect modifiers across population subgroups [8]. The potential influence of unmeasured confounders, including occupational flexibility, social engagement, and environmental accessibility, warrants formal quantification, for example, using sensitivity analyses such as E-values.

Incorporating high-resolution environmental data (e.g., forest density, biodiversity, air quality) would further help to clarify which specific attributes of natural environments drive the observed effects. Finally, future studies should examine whether these benefits are equally distributed across socioeconomic and geographic groups, as this is essential for translating these findings into inclusive public health policies.

5. Conclusions

This study provides prospective evidence that habitual hiking is associated with a reduced incidence of clinically diagnosed mental disorders, with consistent patterns observed across total distance, total duration, frequency, and regularity. The specificity of this association with hiking suggests that the observed mental health benefits reflect not only physical activity but also sustained engagement with the natural environment.

By integrating GPS-derived behavioral data with clinically ascertained outcomes within a longitudinal framework, this study addresses the methodological gaps that have constrained prior research in this area. In the context of growing mental health burdens and aging populations, these results support integrating nature-based physical activity into public health and preventive care strategies, particularly in forest-rich settings such as Korea. Future research should clarify the underlying mechanisms, examine the environment-specific effects across diverse natural settings, and evaluate the equitable distribution of these benefits across sociodemographic groups.

Abbreviations

DALYs
disability-adjusted life years
GPS
global positioning system
NHIS
National Health Insurance Service

ICD-10
International Classification of Diseases,10th Revision
HR
hazard ratio
CI
confidence interval
BMI
body mass index
GBD
Global Burden of Disease
NHS
National Health Service
WHO
World Health Organization
SAS
Statistical Analysis System
G0–G3
hiking activity groups (G0: no hiking activity
G1–G3: lowest to highest tertiles of hiking activity)
Q1–Q4
quartiles of overall physical activity.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the Public Institutional Review Board designated by the Ministry of Health and Welfare, Republic of Korea (IRB No. P01-202209-01-038). Informed consent was obtained from all participants via the Tranggle application.

Consent for publication

Not applicable

Availability of data and materials

The data underlying this study were used under license from the National Health Insurance Service (NHIS) of Korea and are not publicly available due to privacy and confidentiality restrictions. Data are, however, available from the corresponding author upon reasonable request and with permission of the NHIS.

Competing interests

The authors declare that they have no competing interests.

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Author Contributions

Conceptualization: YK, SjP, GK, YL, S-iC / Data curation: SJ, GR / Formal analysis: YK, YC / Funding acquisition: SjP, S-iC / Methodology: YK, S-iC / Project administration: SjP / Supervision: SjP, S-iC / Visualization: YK / Writing-original draft: YK / Writing-review and editing: YK, SjP, HK, SsP, S-iC

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Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the authors used ChatGPT in order to improve the readability and language of the manuscript. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Clinical trial number

Not applicable

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Figures

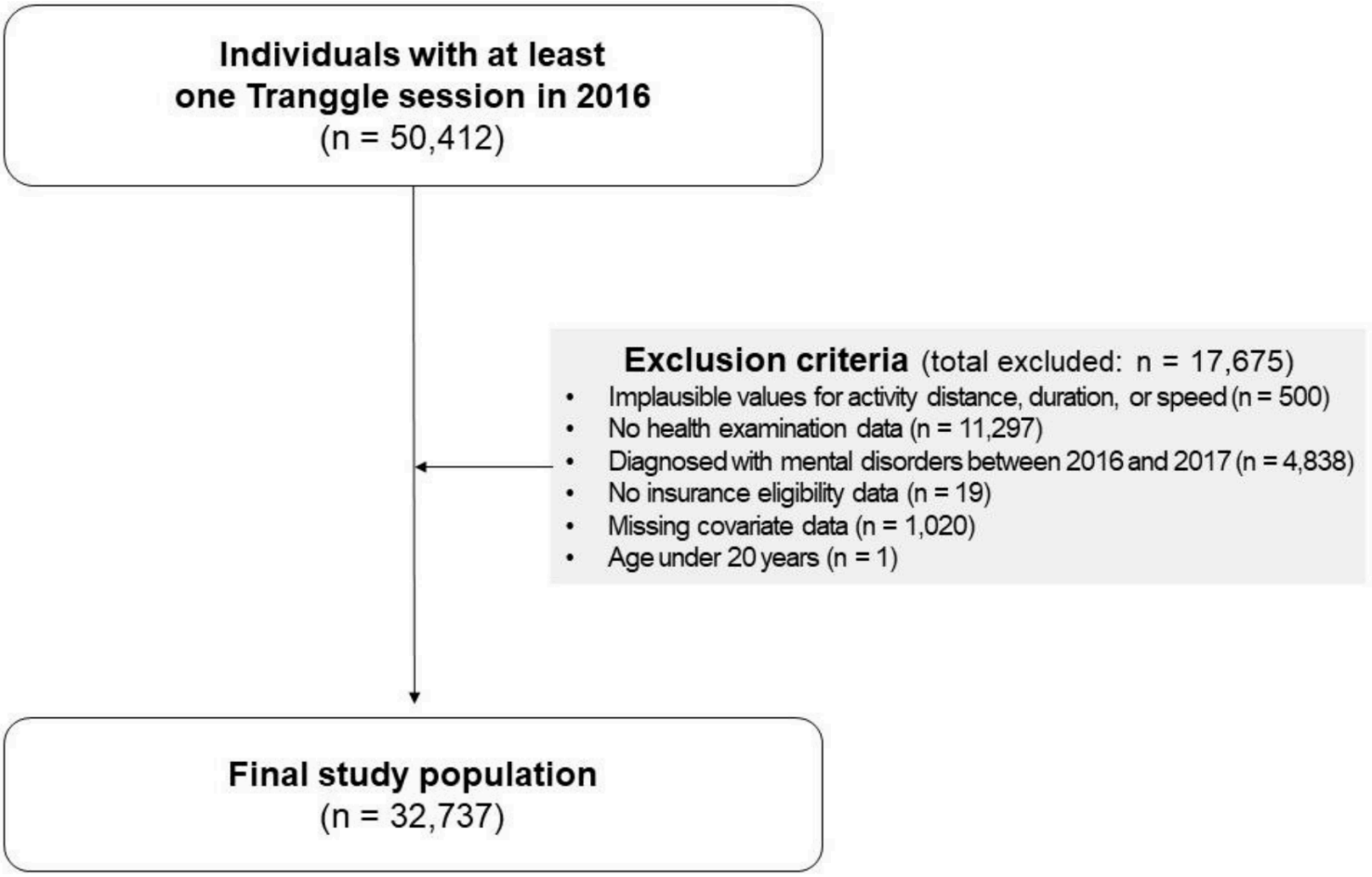


Figure 1

Study participant selection flowchart

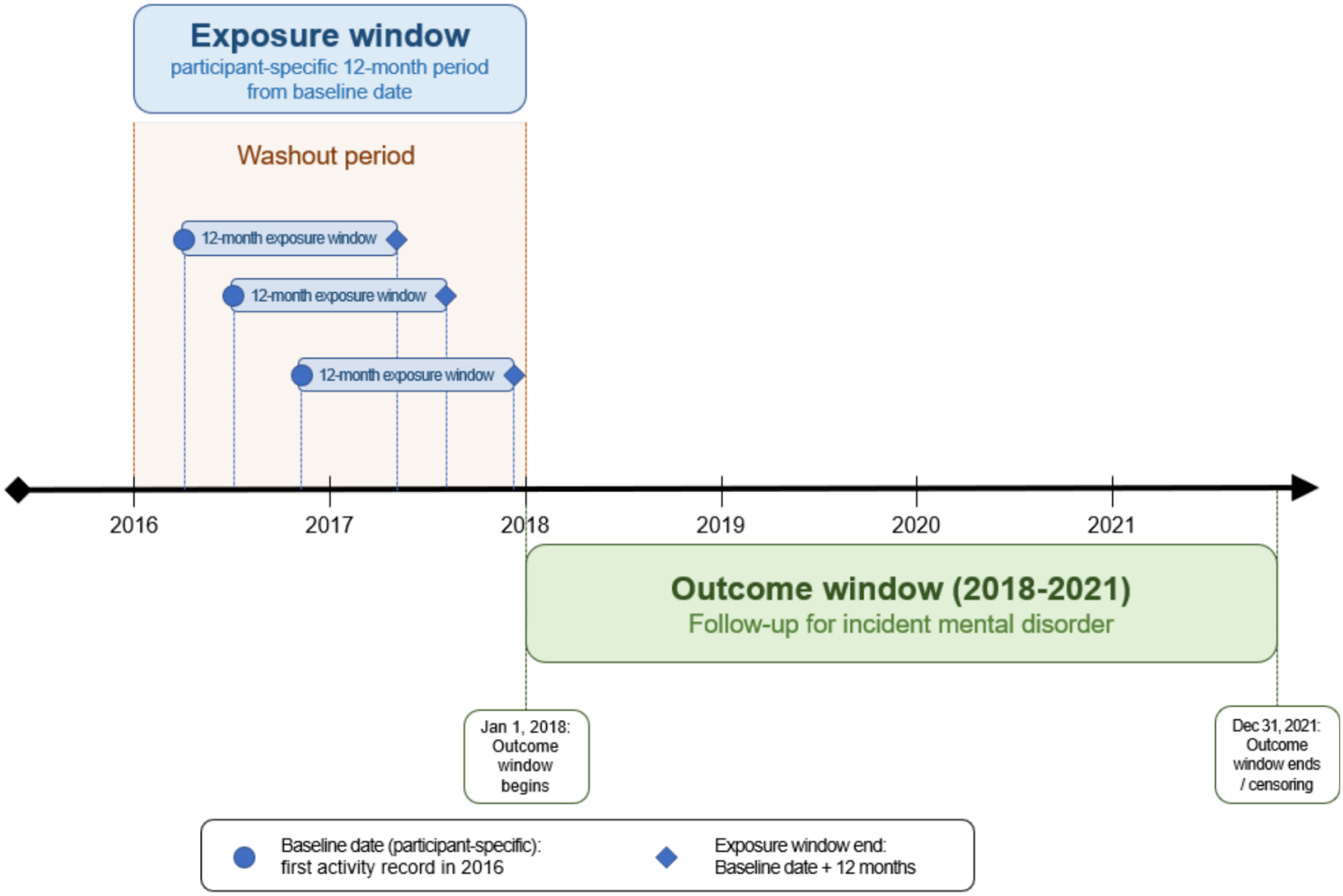


Figure 2

Study timeline illustrating the exposure and outcome windows

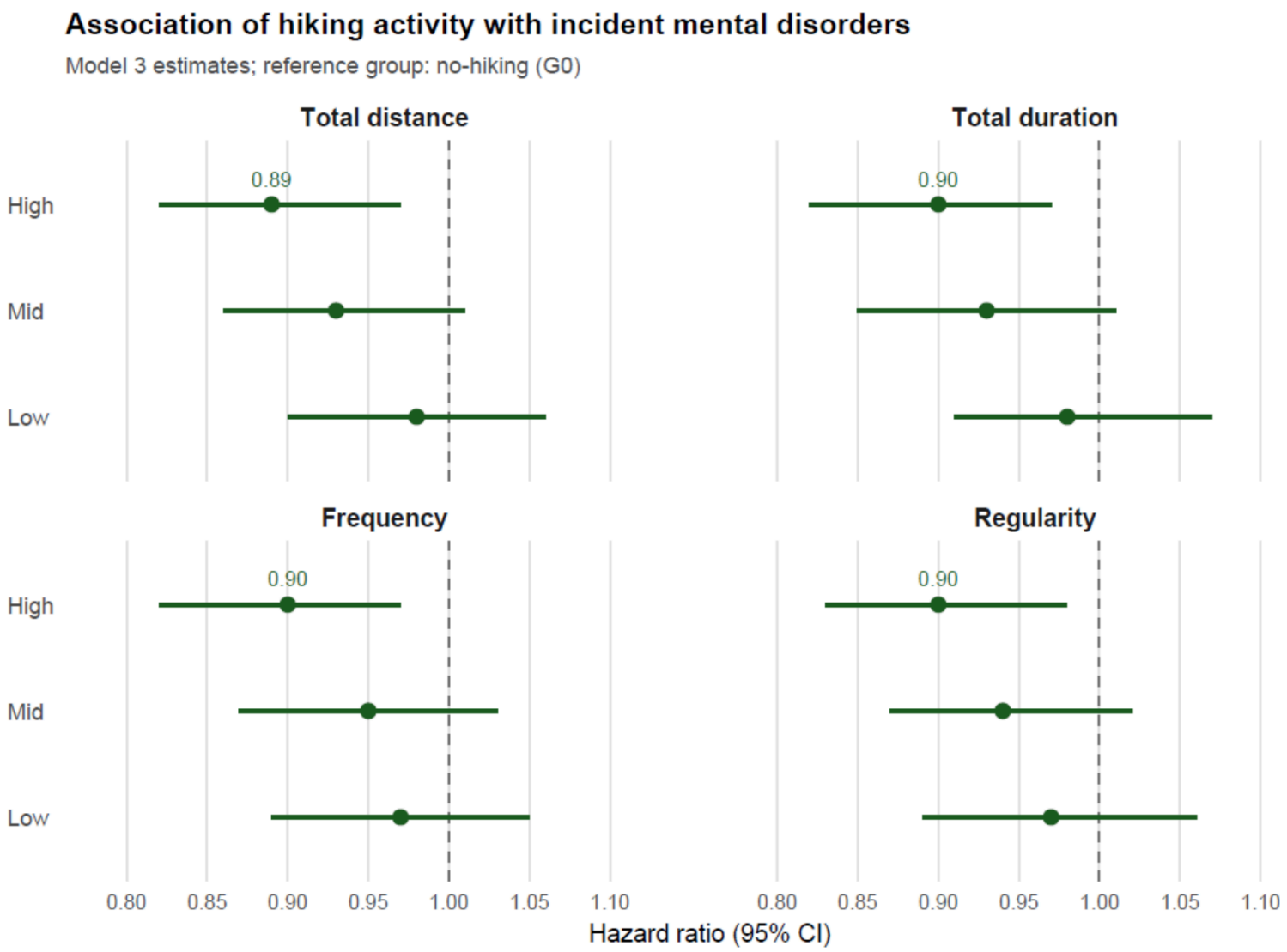


Figure 3

Association between hiking and incident mental disorders

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