

Domain-specific physical activity and mental health: an updated systematic review and multilevel meta-analysis in a combined sample of 3.3 million people

Megan Teychenne ¹, Geovan M Sousa ^{1,2}, Thea Baker,¹ Caitlin Liddelow ^{3,4}, Mark Babic,⁵ Aiden J Chaunty,⁶ Madeleine France-Ratcliffe,⁷ Justin Guagliano,^{8,9} Hannah E Christie,¹⁰ Ella M Tremaine,¹¹ Bridget Booker,¹¹ Davide Gargioli,¹² Daniel J Bannell,⁷ Ran Bao,⁵ Cristy Brooks,^{8,9} David R Lubans ^{5,13}, Christian Swann ^{12,14}, Stewart A Vella ^{3,15}, Chris Lonsdale ¹¹, Alexandre Bergamo dos Santos,¹⁶ Rhiannon L White ⁹

► Additional supplemental material is published online only. To view, please visit the journal online (<https://doi.org/10.1136/bjsports-2025-109806>).

For numbered affiliations see end of article.

Correspondence to

Associate Professor Megan Teychenne;
mteych@deakin.edu.au

TB, CL, MB, AJC, MF-R, JG, HEC, EMT, BB, DG, DJB and CB contributed equally.

Accepted 7 August 2025
Published Online First
3 September 2025

ABSTRACT

Objective To update, synthesise and provide meta-analytical evidence of the associations between domain-specific physical activity (PA) and mental health and mental ill-health outcomes.

Design Systematic review and multilevel meta-analysis.

Data sources In March 2024, we systematically searched five databases.

Eligibility criteria Methods employed replicated those of a previous review in 2017. All studies examining associations between domain-specific PA and specified mental health outcomes were included.

Results 372 studies met inclusion criteria and 361 were included in the meta-analysis. Across the 372 studies (combined sample size of 3 323 711), 338 examined leisure-time PA, 54 work-related PA, 72 transport-related PA, 44 household PA, 5 school sport and 8 physical education. Multilevel meta-analyses showed that leisure-time PA ($r=0.205$, 95% CI 0.157 to 0.253), transport-related PA ($r=0.138$, 95% CI 0.042 to 0.231) and household PA ($r=0.096$, 95% CI 0.025 to 0.165) were positively associated with *mental health*. Leisure-time PA ($r=-0.149$, 95% CI -0.189 to -0.11) and school sport ($r=-0.096$, 95% CI -0.115 to -0.077) were inversely associated with *mental ill health*. However, work-related PA ($r=0.134$ 95% CI 0.069 to 0.199) was positively associated with *mental ill health*.

Conclusion The direction of the association between PA and mental health/mental ill health is dependent on the domain in which PA occurs. Promoting PA for leisure purposes is likely to yield the greatest benefits for both promoting mental health and preventing mental ill health. As such, leisure-time PA should be prioritised in messaging, guidelines and interventions/programmes designed to support mental health through PA.

PROSPERO registration number CRD42024510303.

BACKGROUND

Mental ill health has emerged as one of the leading causes of disease burden globally,¹ with the prevalence of diagnosed depression and anxiety alone increasing from 366 million (in 1990) to 580 million (in 2019).¹ Although first-line treatment currently involves psychotherapy and/or pharmacology, the use of physical activity as an effective strategy for

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Physical activity is associated with improved mental health and a lower incidence of mental ill health; however, the physical activity domain (ie, the life context in which physical activity is performed, including leisure time, transport, work related, household) is likely to moderate this relationship.
- ⇒ Based on previous meta-analytical evidence of $n=98$ studies, leisure-time physical activity is most consistently associated with positive *mental health* and inversely associated with *mental ill health*.
- ⇒ Limited evidence suggests that transport-related physical activity is positively associated with *mental health*; school sport is inversely associated with mental ill health; and work-related physical activity is positively associated with *mental ill health*.
- ⇒ Household physical activity is not associated with mental health or mental ill health.

WHAT THIS STUDY ADDS

- ⇒ New data (1160 effect sizes across 372 studies) confirm that the direction of the association between physical activity and mental health is clearly dependent on the domain in which physical activity is performed.
- ⇒ Despite now having access to four times more data, leisure-time physical activity remains the only physical activity domain that is associated with both better mental health and a lower likelihood of mental ill health. We confidently prioritise the promotion of leisure-time physical activity above all other domains when the objective is improving mental health.
- ⇒ Transport-related physical activity and household physical activity are also positively associated with *mental health*.
- ⇒ School sport is inversely associated with *mental ill health*, while conversely, work-related physical activity is positively associated with *mental ill health*.



© Author(s) (or their employer(s)) 2026. No commercial re-use. See rights and permissions. Published by BMJ Group.

To cite: Teychenne M, Sousa GM, Baker T, et al. *Br J Sports Med* 2026;**60**:267–285.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ Participation in leisure-time physical activity, where possible prioritising activities one enjoys or personally chooses to undertake, should be prioritised in physical activity messaging, guidelines, and intervention/program development which aim to support mental health through physical activity.
- ⇒ Given that cultural, environmental and climatic contexts are likely to influence associations between domain-specific physical activity and mental health, there is clear need for further longitudinal studies particularly in low- and middle-income countries.

both prevention² and management³ of mental ill health, as well as for the promotion of mental health (ie, being a positive state of well-being), has received substantial recognition.⁴ Despite gaining widespread acceptance as a mental health promotion strategy, results of intervention studies examining the effect of physical activity on mental health outcomes are usually highly heterogeneous, indicating that not all physical activities are of equal value, in terms of the potential mental health benefits.⁵ Similarly, observational epidemiological studies (which make a major contribution to the establishment of links between exposures and disease at a population level)⁶ have also demonstrated that the association between physical activity and mental health is largely heterogeneous and likely dependent on certain contextual factors of physical activity,⁷ warranting further exploration of the association between physical activity and mental health.

One contextual aspect of physical activity that could influence the strength and direction of the association between physical activity and mental health is the domain in which physical activity occurs.^{4,8,9} Physical activity, when defined as any voluntary movement that expends energy,¹⁰ refers to a broad range of movement behaviours that take place at varying times within peoples' lives. Physical activity domain refers to the life domain (ie, life context/purpose) in which physical activity is performed, including leisure time, transport, occupational, or school, and domestic/household.⁷ While it is widely assumed that all episodes of physical activity are beneficial to mental health, it is plausible that physical activity during people's free time may provide different psychological benefits than physical activity which may be required due to work, transport or household duties, since leisure-time physical activity may provide more opportunities to foster self-efficacy, social connection, a sense of autonomy and enjoyment.¹¹ Recent prospective research has also demonstrated that mechanisms (eg, self-efficacy, enjoyment, behavioural intentions) explaining the association between physical activity and mental health differ according to the domain in which physical activity is performed,¹² further underscoring the importance of understanding domain-specific associations between physical activity and mental health.

Furthermore, the physical activity paradox posits that while leisure-time physical activity is strongly associated with improved health outcomes (eg, reduced risk of cardiovascular disease and premature mortality), occupational physical activity does not confer the same benefits and may in fact be detrimental.¹³ Explanations for this include occupational heavy lifting or static postures elevating 24-hour blood pressure and occupational physical activity being performed for long periods without sufficient recovery time—leading to fatigue, exhaustion and subsequently increased risk of cardiovascular disease.¹³ As such, this

paradox provides further rationale as to why the domain of physical activity is an important consideration for mental health outcomes.

In 2017, members of our research group published a systematic review and meta-analysis comparing the relationship between physical activity and mental health outcomes, across different domains. The results indeed reported that the direction and strength of associations between physical activity and mental health/mental ill health were domain dependent.⁹ Specifically, leisure-time physical activity and transport-related physical activity were positively associated with mental health; leisure-time physical activity and school sport were inversely associated with mental ill health, while work-related physical activity was positively associated with mental ill health.⁹ This review remains the most comprehensive review and meta-analysis to examine the associations between different domains of physical activity and mental health/mental ill health.

Despite robust evidence showing that physical activity domain influences the association between physical activity and mental health being published in 2017, there were limitations to the previous review and advancements in the field that warrant reconsideration. While the previous review included 98 studies, most studies (n=93) examined leisure-time physical activity, meaning evidence was limited for all other domains. Further, the studies included in the 2017 review were predominantly cross-sectional, which precluded determining the direction of relationships or causality.⁹ Since the publication of this review,⁹ there has been a sizeable increase in the number of studies that have investigated the domain-specific relationship between physical activity and mental health/mental ill health.

Given the sizeable increase in studies examining associations between multiple domains of physical activity and mental health since 2017, and the increasing number of prospective and experimental studies, the primary aim of this paper was to update our previous review, providing up-to-date meta-analytical evidence of the associations between domain-specific physical activity and mental health/mental ill-health outcomes.

METHODS

The protocol of our systematic review and meta-analysis was registered with PROSPERO (ID: CRD42024510303), and reporting follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. The methods of this 'review update' replicated those of our 'original' (2017) systematic review⁹ to enable a comprehensive, combined evidence synthesis and meta-analysis of all studies to date, including those captured in the original review (from inception to 2015).

Equity, diversity and inclusion statement

The author group is gender balanced and consists of early, mid-career and senior researchers from four different countries (Australia, UK, USA, Brazil). Our study population included participants of all genders and age groups across multiple countries.

Patient and public involvement

Patients or the public were not involved in this study.

Eligibility criteria

Replicating the inclusion/exclusion criteria employed by White *et al*,⁹ studies were eligible if they met the criteria outlined in box 1.

Box 1 Inclusion and exclusion criteria**Inclusion criteria**

- ⇒ Quantitative assessment of physical activity within at least one specified domain (eg, leisure time, work, physical education, active commuting, or household or domestic duties), unless an experimental study was carried out within a specific domain (then, no domain-specific measure of physical activity was required).
- ⇒ Quantitative assessment of at least one mental health outcome variable (ie, mental health, mental well-being, psychological well-being, subjective well-being, life satisfaction, positive affect, negative affect, depression, anxiety, stress or psychological distress).
- ⇒ Quantitative assessment of the relationship between physical activity in a specified domain and mental health.
- ⇒ Cross-sectional, longitudinal or experimental design.
- ⇒ Full-text, peer-reviewed journal articles.

Exclusion criteria

- ⇒ Participants from special populations (eg, physically frail/cognitive impairment).
- ⇒ Measured only total physical activity, or did not specify the physical activity domain.
- ⇒ Measured sedentary behaviour but not physical activity.
- ⇒ Measured mental health in relation to a particular setting or circumstance (eg, job strain, academic anxiety).
- ⇒ Solely reported qualitative data.
- ⇒ Published in language other than English.

Box 2 Risk of bias criteria

- ⇒ Random selection of schools/participants (sampling procedures appropriate and adequately described, including randomisation for experimental studies).
- ⇒ Participant eligibility criteria clearly stated and adequately described, and appropriate to the aims of the research.
- ⇒ Power calculation reported, and the study was adequately powered to detect hypothesised relationships.
- ⇒ Valid measure of physical activity used. Objective measures of physical activity, self-reported measures with cited validity and reliability or experimental studies in which participants are allocated to a physical activity intervention relative to a control condition are all considered a valid assessment of physical activity.
- ⇒ Valid measure used for the mental health/mental ill-health outcome variable, or psychometric characteristics of the outcome variable reported and within accepted ranges (eg, Cronbach's alpha and test-retest reliability >0.60).
- ⇒ Confounding factors/covariates adjusted for in analyses (eg, sex, age).

results (eg, correlation, ORs, prevalence ratios, β values, F-statistic, M and SD).

Study quality assessment

We used the risk of bias criteria developed for the original review⁹ to assess the quality of the included studies because it was designed to be suitable for both observational and experimental studies, by assigning either a 1 (present and explicitly explained) or a 0 (absent or inadequately described) to six criterion (see [box 2](#) for full risk of bias criteria). To ensure robustness of the criteria, and its use among the research team, two researchers independently assessed 28 studies (10%) against the six criteria. We then calculated the percentage agreement (0.89) and Cohen's kappa coefficient (0.77).¹⁴ Given an acceptable kappa coefficient, the remaining studies were divided, with each assigned to a single researcher for risk of bias assessment. Scores were then summed for each study and categorised as follows: (a) high (maximum of one criterion not met/score of 5 or 6); (b) acceptable (most criteria met/score of 4); (c) low quality (some criteria met/score of 3 or less).

Once data extraction and quality assessments were complete, datasheets from both the 'original' review⁹ and the 'updated' search were combined to create one datasheet with all studies published between inception and 2024, enabling a comprehensive, combined meta-analysis.

Statistical analysis

To enable comparison of findings, we followed the same statistical analysis strategy employed in the original review.⁹ Correlation effect sizes were either extracted or calculated from each individual study.^{15 16} If a correlation coefficient was reported in the study, this was simply extracted to use in the meta-analysis. If no correlation was included in the study, the result was extracted in the form in which it was reported in the study. Published formulas were then used to calculate a correlation from the published results. For example, $r = \sqrt{t^2/t^2 + df}$ can be used to calculate a correlation from a t-test.^{15 16} Similarly, Cohen's d can be calculated by using $x_t - x_c / SD_{pooled}$ where x_t represents the mean of the treatment condition and x_c represents the mean of the control condition,¹⁷ and r can then be calculated from Cohen's

Search strategy and selection

In March 2024, we systematically searched five databases (PubMed, Scopus, PsycINFO, SPORTDiscus, Web of Science) for articles published between February 2015 (ie, the date the last search was conducted in the original review⁹) and March 2024. Given the original White *et al* review only searched the first four of the five databases named above, Web of Science was also searched from inception to 2015. Keywords/search terms pertaining to three key concepts (physical activity terms; mental health terms; domain-specific terms) were used, replicating those employed by White *et al*,⁹ and exclusion terms were also specified to reduce the number of irrelevant articles. The full search strategy can be found in online supplemental table 1.

Papers identified in this search were exported to EndNote (V.9.3.3) and uploaded to Covidence software (www.covidence.org). Aligned with the methods used by White *et al*,⁹ titles and abstracts of each paper were screened by two independent reviewers. Records recommended for exclusion by both reviewers were removed. Following this, two reviewers independently screened all remaining full-text papers. Records recommended for exclusion by both reviewers were then removed. Discrepancies were assessed by a third independent reviewer (MT/RLW—lead and senior author), where a consensus was then reached.

Data extraction

Data were independently extracted from each included article into a predefined data extraction table, and a second reviewer checked the extracted data for accuracy. All discrepancies were discussed and resolved. Data items extracted included: author, year of publication, study design, sample characteristics (size, age, sex, country), measures of physical activity and mental health/mental ill health, method of data analysis and statistical

d.^{15 16} Internal consistency scores (eg, Cronbach's alpha) were also extracted for the physical activity (self-reported measures only) and mental health variables used to correct each correlation for attenuation.^{18 19} When internal consistency was missing, the score reported in a similar literature was used. A conservative score of 0.70 was used²⁰ if an internal consistency score was not obtainable, or the study used a single-item measure. Where physical activity was device measured, or an experimental design was used, a score of 1.0 was used. Lastly, since r becomes more skewed as the value moves away from zero, all r values were transformed to Fisher's adjusted Z scale (z), which is almost normally distributed.^{15 16} The variance (v) and SE of each effect size were then calculated.¹⁵

Two random-effects meta-analyses (ie, one for mental health and one for mental ill health) were conducted. To account for dependent effect sizes (ie, multiple effect sizes within a single study), three-level meta-analyses were conducted using structural equation modelling, where multiple effect sizes (level 2) were clustered within studies (level 3).^{21 22} This was completed using the metaSEM package (version 1.5.0) in R (V4.4.0). The weighted average effect sizes (r) and 95% CIs have been reported in line with Cohen's guideline for interpreting the strength of correlations: $r=0.1$ was interpreted as weak, $r=0.3$ as moderate and $r=0.5$ as strong.²³

The I^2 statistic indicates the percentage of the total variation in effect sizes that is due to genuine differences between the individual study results as opposed to chance.²⁴ However, as I^2 increases rapidly towards 100%, as the number of participants within the primary studies increases, I^2 is interpreted as possible heterogeneity that may be relevant.²⁵ According to Cochrane's overlapping criteria, an I^2 statistic between 0% and 40% may not be important, 30–60% may represent moderate heterogeneity, 50–90% may represent substantial heterogeneity and 75% considerable heterogeneity.²⁶

Next, mixed-effects meta-analyses were conducted as they extend the random-effects meta-analyses by including fixed and random components within the one model in order to test study characteristics as potential predictors.²² Study characteristics tested as potential moderators included physical activity domain, the specific mental health outcomes, age, sex, study design, type of physical activity measure and risk of bias. Age was categorised as children (1–9 years), adolescents (10–19 years), adults (20–64 years) and older adults (≥ 65 years).^{27 28} The regression coefficient (β) was reported for each mixed-effects meta-analysis to indicate whether the moderator was a positive or negative predictor of the effect size. The R^2 , which demonstrates the proportion of heterogeneity explained by the moderator variable, is also reported.²¹ Moreover, an omnibus analysis of variance was performed to test whether the mixed-effects model was significantly different from the random-effects model (tables 1 and 2). When the mixed-effects meta-analysis was significantly different, the effect size and 95% CI within each subgroup were included.

Rosenthal's fail-safe N was calculated to indicate the number of unpublished studies with a null effect needed to cause the meta-analysis effect to become non-significant ($p \geq 0.05$).²⁹ A larger fail-safe N suggests that unpublished studies not included in the review would be unlikely to overturn the effect reported.²⁹ To assess the risk of bias across studies, Egger's regression asymmetry tests were conducted on the two overall meta-analyses (ie, mental health and mental ill health). However, Egger's test was not conducted for the meta-analyses on each physical activity domain, since 10 or more studies are required to distinguish chance from real asymmetry.^{26 30}

RESULTS

The current literature search yielded 21555 articles. After title/abstract screening, 1780 full-text papers were assessed for eligibility. A total of 284 studies met the inclusion criteria (for list of excluded studies see online supplemental file 4). We then combined the 284 studies and the original 98 and checked across the combined 382 studies for any duplicates. We removed 10 studies that were included in the current search, which were included in the initial review.⁹ This led to a total of 372 studies^{12 31–420} being included in this updated systematic review (98 from the original review and 274 additional studies). In the original review, two included studies used the same data, meaning only one study was included in the meta-analysis, and a correlation could not be calculated from 10 studies in the current search. This led to 361 studies being included in the meta-analysis (see figure 1).

Study characteristics

Online supplemental table 2 presents the study characteristics of the $n=372$ studies included in the updated review. Publication dates ranged from 1988 to 2024. Studies were predominantly cross-sectional ($n=2661$; 72%), while $n=85$ (23%) were longitudinal, and $n=21$ (6%) were experimental. Sample sizes ranged from $n=14$ to $n=500199$ (total sample= $3\,323\,711$). Studies included children ($n=13$; 4%), adolescents ($n=63$; 18%), adults ($n=231$; 64%) and older adults ($n=48$; 13%), with $n=6$ (2%) not reporting age. A total of 338 studies examined leisure-time physical activity, with 54 measuring work-related physical activity, 72 transport-related physical activity, 44 household physical activity, 5 school sport and 8 physical education. With many studies measuring multiple physical activity domains and multiple mental health-related outcomes, 1160 effect sizes were either extracted or calculated and used in the meta-analysis. Across these 1160 effects, 811 represented leisure time, 93 work related, 150 transport related, 71 household, 10 school sport and 25 physical education. A total of 408 effect sizes represented mental health, while 752 effect sizes represented mental ill health, with depression/depressive symptoms accounting for 391 of those effects. A total of 581 effect sizes cross-sectionally assessed leisure-time physical activity, 185 effect sizes longitudinally assessed leisure-time physical activity and 41 effect sizes assessed leisure-time physical activity via an experimental study design. Work-related physical activity (cross-sectional= 85 , longitudinal= 6), transport physical activity (cross-sectional= 121 , longitudinal= 27), household physical activity (cross-sectional= 61 , longitudinal= 10) and school sport (cross-sectional= 7 , longitudinal= 3) were all only assessed via observational studies. A total of 22 effect sizes assessed physical education cross-sectionally, and three effect sizes (ie, one study) assessed physical education via an experimental design. Further, 288 (77%) studies ($n=199$ cross-sectional; $n=74$ longitudinal; $n=15$ experimental) were conducted among high-income countries (HIC); 78 (21%) among middle-income countries ($n=60$ cross-sectional; $n=11$ longitudinal; $n=7$ experimental); three (1%) among combined middle- and high-income countries (all cross-sectional); and three (1%) among low-income countries (all cross-sectional).⁴⁰⁰

Risk of bias

The mean risk of bias was 3.28 ± 1.26 , with most studies scoring 4 in risk of bias ($n=110$; 30%). Scoring for all criteria across all studies is presented in online supplemental table 3. Egger's regression test was non-significant for mental ill health

Table 1 Domain-specific physical activity and mental ill health meta-analyses and moderator analyses

Variable	k	ES (n)	Participants (n)	r (95% CI)	I ² , %	Fail-safe <i>N</i>	Predictor coefficient β	ANOVA P value	R ² , %
Leisure-time PA	230	539	2 654 746	−0.149 (−0.189 to −0.11)	57.01	13 835			
Outcome								0.02	31
Psychological distress	40	89		−0.113 (−0.198 to −0.027)	37.21		0.06		
Perceived stress	34	54		−0.052 (−0.102 to −0.002)	39.41		0.10		
Life dissatisfaction	1	1		−0.046 (−0.591 to 0.500)	n/a		n/a		
Negative affect	21	34		−0.069 (−0.185 to 0.048)	29.49		0.09		
Depression	147	270		−0.182 (−0.235 to −0.129)	47.172		0.00		
Anxiety	45	91		−0.136 (−0.192 to −0.078)	65.45		0.04		
Age								0.998	2
Sex								0.002	9
Both	184	402		−0.134 (−0.174 to 0.094)	78.60				
Female	50	65		−0.174 (−0.276 to −0.069)	83.59				
Male	34	43		−0.168 (−0.292 to −0.039)	0				
Study design								0.004	11
Cross-sectional	162	381		−0.133 (−0.172 to −0.094)	41.13		0.08		
Longitudinal	57	131		−0.114 (−0.204 to −0.023)	60.98		0.10		
Experimental	16	27		−0.403 (−0.563 to −0.214)	75.94		−0.21		
Risk of bias								1.0	0
Work-related PA	36	61	470 768	0.134 (0.069 to 0.199)	24.55	253			
Outcome								0.52	13
Psychological distress	8	14		0.125 (0.017 to 0.230)	71.96		0.04		
Depression	25	37		0.103 (0.053 to 0.153)	53.72		0.03		
Anxiety	3	5		0.122 (−0.073 to 0.308)	0.00		0.07		
Age								0.85	8
Sex								1.0	0
Study design								0.47	14
Risk of bias								0.20	8
Transport-related PA	46	95	714 884	−0.012 (−0.061 to 0.037)	84.41				
Outcome								0.98	12
Age								0.18	13
Sex								1.0	0
Study design								0.84	1
Risk of bias								0.66	0
Household PA	27	43	965 027	0.041 (−0.084 to 0.165)	18.06				
Outcome								0.21	0
Age								0.91	3
Sex								0.83	8
Study design								0.99	0
Risk of bias								0.48	0
School sport	3	5	9259	−0.096 (−0.115 to −0.077)	0	16			
Outcome								0.33	0
Age								0.999	0
Sex								0.999	0
Study design								0.93	0
Risk of bias								0.47	0
Physical education	4	5	14 413	−0.069 (−0.168 to 0.031)	96.43				
Outcome								0.01	100
Negative affect	1	2		−0.085 (−0.103 to −0.068)	0				
Depression	2	2		0.045 (0.023 to 0.067)	0				
Anxiety	1	1		−0.274 (−0.443 to −0.106)	50				
Age								0.12	58
Sex								0.12	58
Study design								0.12	58
Risk of bias	4	5			n/a		0.059	0.05	76

Boldface indicates statistical significance.

ANOVA, analysis of variance; ES, effect size; I², I²-statistic, indicating the proportion of variation due to heterogeneity; k, number of studies; PA, physical activity; r, correlation effect size; R², proportion of heterogeneity that can be explained by the moderator variable; β , standardised regression coefficient.

Table 2 Domain-specific physical activity and mental health meta-analyses and moderator analyses

Variable	k	ES (n)	Participants (n)	r (95% CI)	I ² (%)	Fail-safe N	Predictor coefficient β	ANOVA P value	R ² , %
Leisure-time PA	135	268	1 175 311	0.205 (0.157 to 0.253)	41.50	5057			
Outcome								0.39	1
Age								0.95	2
Sex								1.0	0
Study design								0.56	2
Risk of bias								0.90	0
Work-related PA	20	30	54 063	0.113 (−0.006 to 0.232)	82.29	6			
Outcome								0.68	9
Age								0.98	1
Sex								0.96	0
Study design								0.009	48
Cross-sectional	17	27		0.046 (−0.012 to 0.104)	0		−0.11		
Longitudinal	3	3		0.472 (−0.038 to 0.787)	49.84		0.36		
Risk of bias								0.41	4
Transport-related PA	31	53	273 366	0.138 (0.042 to 0.231)	89.56	100			
Outcome								0.58	10
Age								0.99	2
Sex								0.96	0
Study design								0.96	0
Risk of bias								0.24	5
Household PA	18	28	541 429	0.096 (0.025 to 0.165)	84.21	28			
Outcome								0.44	22
Age								0.62	13
Sex								0.48	3
Study design								0.78	3
Risk of bias	18	28			n/a		−0.048	0.02	32
School sport	2	5	5611	−0.037 (−0.269 to 0.199)	0				
Outcome								0.65	0
Age								1.0	0
Sex								0.25	0
Study design								0.65	0
Risk of bias								1.0	0
Physical education	5	20	132 710	0.029 (−0.002 to 0.060)	0				
Outcome								0.56	0
Age								0.34	0
Sex								0.78	0
Study design								0.87	0
Risk of bias								0.82	0

Boldface indicates statistical significance.

ANOVA, analysis of variance; ES, effect size; I², I²-statistic, indicating the proportion of variation due to heterogeneity; k, number of studies; PA, physical activity; R², proportion of heterogeneity that can be explained by the moderator variable.; r, correlation effect size; β , standardised regression coefficient.

($z = -1.36$, $p = 0.173$), suggesting no publication bias, but significant for mental health ($z = 36.3$, $p < 0.001$).

Mental ill health

Overall, there was a significant weak negative association between physical activity and mental ill health ($r = -0.11$, 95% CI -0.15 to -0.07 , $p < 0.001$). Physical activity domain moderated the association between physical activity and mental ill health ($\beta = 0.056$, $p < 0.001$), with negative prediction of the effect size by leisure-time physical activity ($\beta = -0.177$, $p < 0.001$), and positive predictions by work-related physical activity ($\beta = 0.195$, $p < 0.001$), transport-related physical activity ($\beta = 0.066$, $p = 0.038$) and household physical activity ($\beta = -0.118$, $p = 0.004$).

Leisure-time physical activity was inversely and weakly associated with mental ill health ($r = 0.149$, 95% CI -0.189 to -0.11 ,

$p < 0.001$), with moderate heterogeneity (figure 2, table 1). Across the different outcome variables, the association was significantly different, with the outcome accounting for 31% of the explained variance, where leisure-time physical activity had weak inverse associations with psychological distress, perceived stress, depression and anxiety, but not with negative affect (table 1). An inverse association was also found for school sport ($r = -0.096$, 95% CI -0.115 to -0.077) (figure 2, table 1), but no effect of outcome was found (table 1). In contrast, for work-related physical activity, a weak positive association was found ($r = 0.134$, 95% CI 0.069 to 0.199 , $p < 0.001$) (figure 2, table 1), with an effect of outcome, where work-related physical activity positively predicted psychological distress and depression, but not anxiety (table 1). No association was found for transport physical activity, household physical activity and physical education. Although no association was found for physical education,

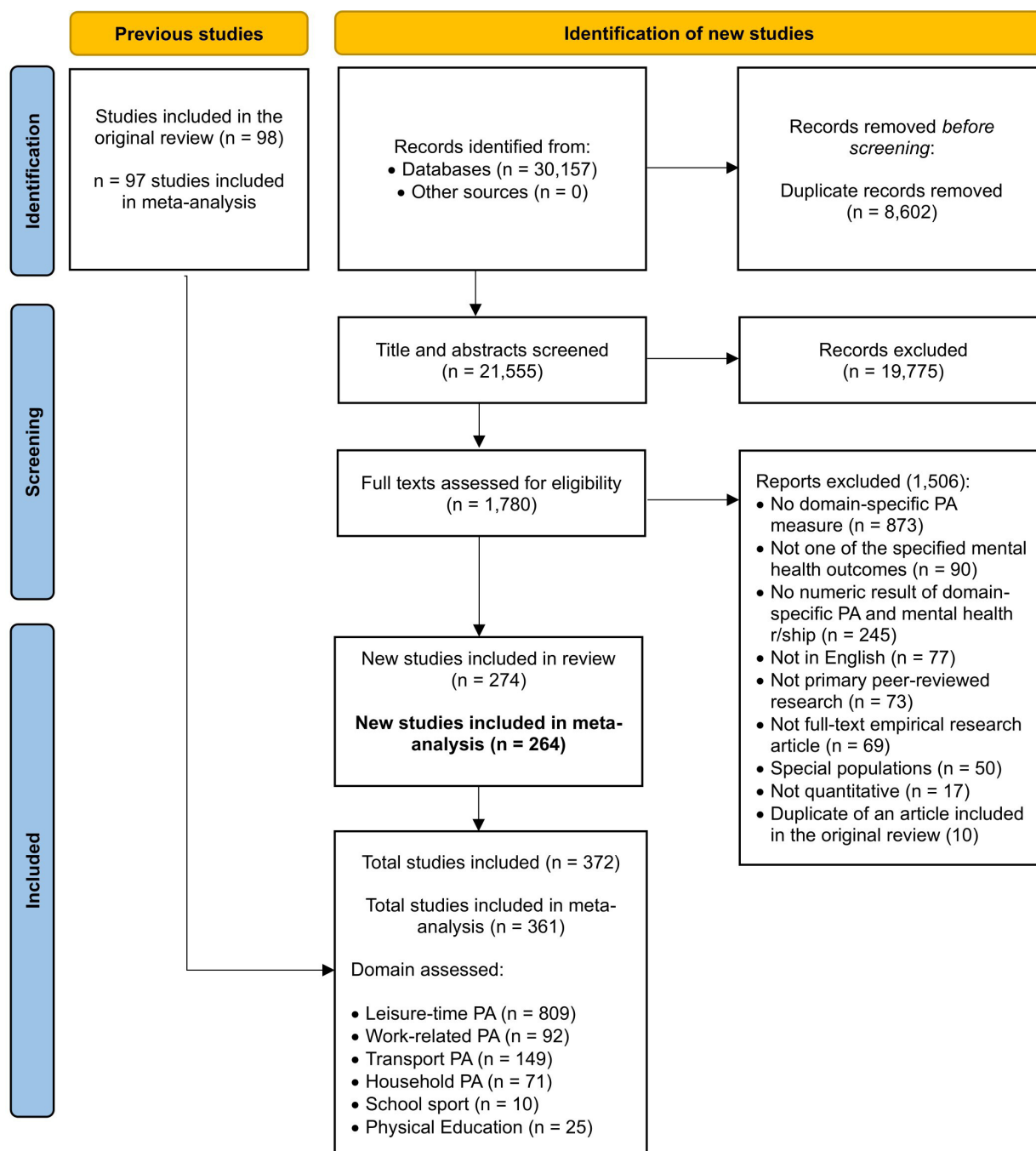


Figure 1 PRISMA diagram of articles throughout the updated systematic review. PA, physical activity; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

across the different outcome variables, the association was significantly different, with the outcome accounting for 100% of the explained variance. Physical education was inversely associated with negative affect and anxiety, but positively associated with depression.

Study design was a significant moderator of leisure-time physical activity; while significant effects were found for cross-sectional ($p < 0.001$), longitudinal ($p = 0.014$) and experimental ($p < 0.001$) studies, the latter had a higher effect size. Sex was also a significant moderator of leisure-time physical activity and mental ill health, accounting for 9% of explained variance, with larger effects among females than males (table 1). In addition, the association between physical education and mental ill health

was moderated by risk of bias ($\beta = 0.059$, $p = 0.013$), whereby a lower risk of bias was associated with stronger (more negative) effect sizes (table 1).

Mental health

For mental health, a weak association was found overall for all physical activity ($r = 0.198$, 95% CI 0.155 to 0.241, $p < 0.001$). Physical activity domain moderated the association between physical activity and mental health ($\beta = -0.028$, $p = 0.016$), with only leisure-time physical activity being a positive predictor of the effect size ($\beta = 0.082$, $p = 0.010$). Overall, leisure-time physical activity ($r = 0.205$, 95% CI

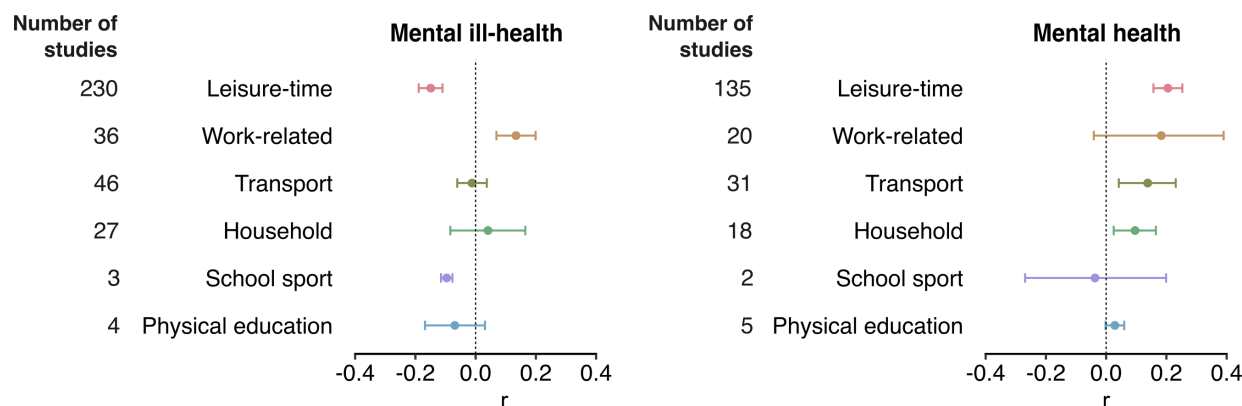


Figure 2 Correlation and 95% CI within specific physical activity domains for mental health and mental ill health.

0.157 to 0.253, $p < 0.001$), transport-related physical activity ($r = 0.138$, 95% CI 0.042 to 0.231, $p = 0.005$) and household physical activity ($r = 0.096$, 95% CI 0.025 to 0.165, $p = 0.008$) (figure 2, table 2) all had a weak positive association with mental health, while no association was found for work-related physical activity, school sport or physical education (table 2).

Risk of bias also moderated the association between household physical activity and *mental health* ($\beta = -0.048$, $p = 0.013$), where a lower risk of bias predicted stronger (more positive) effect sizes. Study design moderated the association between work-related physical activity and *mental health*, although no significant effects were found for the subcategories (cross-sectional, $p = 0.121$; longitudinal, $p = 0.068$) (table 2).

Studies not included in the meta-analysis

The 10 studies that could not be meta-analysed reported 40 individual effects. 19 of these effect sizes reflected leisure-time physical activity, with all 19 effects indicating a significant positive association with mental health or inverse association with mental ill health, therefore mirroring the meta-analytical results. Six effects were reported across two studies for transport-related physical activity, with four results reflecting a positive association with mental health and two indicating no significant association with mental ill health. Two studies reported no significant association for work-related physical activity, and two studies reported no significant association for household physical activity. One study reported eight different effects for school sport, four indicating a positive association with life satisfaction and four indicating an inverse association with depressive symptoms.

DISCUSSION

Our updated review and meta-analysis both confirms and extends the findings of the original 2017 review,⁹ as the association between physical activity and mental health/mental ill-health outcomes is clearly dependent on the domain in which physical activity occurs. Acknowledging that studies were predominantly cross-sectional and focused on associations, key findings were: (1) leisure-time physical activity was associated with both better mental health and a lower likelihood of mental ill health; (2) transport-related physical activity and household physical activity were positively associated with mental health; (3) school sport was inversely associated with mental ill health; and (4) work-related physical activity was positively associated with mental ill health.

Specifically, we found that leisure-time physical activity was the only domain weakly associated with both higher levels of mental health and lower levels of mental ill health, suggesting that physical activity during people's free time is likely to play the most substantial role in mental health promotion and mental ill-health prevention. This finding is important, but may be unsurprising, given a recent review of ($n = 247$) observational and experimental studies showed that the mechanisms via which physical activity is associated with mental health are predominantly psychological or social,¹¹ and these mechanisms may indeed be more easily activated during leisure-time physical activity. For example, one of the strongest mediators of physical activity and mental health is affect.¹¹ Although affect can be influenced by any physical activity experience, it is likely that physical activity during one's own free time is more likely to be chosen, or be in line with one's values, and therefore more likely to generate positive affective states than other forms of physical activity such as walking, either for transport or as part of one's occupation or household duties. Not only are leisure-time activities more likely to be autonomously driven behaviours, but a sense of 'autonomy' (ie, personally choosing to do a physical activity) is fundamental to human functioning and well-being,^{401 402} and evidence suggests that both autonomy and enjoyment are key aspects of physical activity that support mental health.^{4 7 12}

While autonomy and enjoyment are more obviously tied to leisure-time physical activity than other physical activity domains, strong evidence also suggests that self-esteem, self-efficacy and physical self-worth mediate the association between physical activity and mental health. Physical activity during leisure time is more likely to be task or goal oriented. While people can attach goals to, or derive joy and a sense of pride from, walking a certain distance or completing a certain amount of gardening, many leisure-time activities, whether sport or exercise based in nature, provide opportunities to develop skills and improve competence. Qualitative research has detailed how crucial this sense of achievement is to postexercise mood, and findings have explained how mastery, accomplishment and pride experienced in a leisure-time physical activity context translate into broader perceptions of confidence and self-esteem in everyday life,⁴⁰³ and moderate evidence suggests mastery is an important mechanism.¹¹ Social support, a sense of belonging and time spent socialising are also important mechanisms¹¹ which may explain why leisure-time physical activity is so valuable. These factors are more likely to be activated when undertaking physical activity for leisure purposes, as opposed to active travel which can often be completed in isolation (particularly

for adults), and household physical activity which is influenced by those in the same household. While other domains can be completed with other people, and leisure-time physical activity can be completed alone, group-based sport and exercise settings have the ability to unite people with similar interests and can create a fun social atmosphere, which may help develop a sense of belonging, leading to increased social support.⁴⁰³

Consistent with White *et al*'s findings,⁹ transport-related physical activity was weakly positively associated with mental health, although there was no association with mental ill health. Transport-related physical activity is unequivocally undertaken in outdoor environments, which may also offer opportunities for connecting with nature (ie, blue space, green space) and people (ie, social connection via walking to school or work), both of which have been strongly linked to positive mental health and well-being.^{404–406} Therefore, undertaking physical activity for transport purposes may be able to provide mental health benefits above and beyond those elicited via other physical activity domains that do not provide these opportunities. However, some physical environments in which transport-related physical activity occurs (eg, urban man-made environments that may be characterised by busy traffic, pollution and safety concerns) have been suggested to have negative impacts on mental health,⁴⁰⁷ which may explain why the association between transport-related physical activity and mental health and mental ill-health outcomes was not consistent in our meta-analysis. This premise aligns with that of a recent Australian consensus statement⁷ which posited that for optimising the mental health benefits of physical activity: “Where possible and appropriate, some physical activity be undertaken outside in pleasant natural environments (eg, green or blue spaces).”

Collectively, our findings complement/confirm recommendations provided in a recent ‘call to action’ and consensus statement,^{4,7} which suggest: “At least some physical activity be undertaken during leisure-time or via active travel, where possible prioritising activities one enjoys or personally chooses to undertake.”

Consistent with the original review,⁹ work-related physical activity was weakly positively associated with mental ill health. This may suggest that the physical activity performed for work purposes (eg, carrying building materials (builders), walking around a hospital (nurses)) could increase the likelihood of experiencing symptoms of psychological distress or depression. This could partly be explained by hypotheses described above, whereby factors important to elicit mental health benefits of physical activity (eg, enjoyment, autonomy) may not be present (or in fact adversely impacted) in physical activity undertaken for work-related purposes in which individuals have no volition over their behaviour.^{4,7} Further, aligned with biological mechanisms posited to explain the physical activity health paradox, occupational physical activity may result in increased heart rate/blood pressure, increased stress and insufficient recovery time from physical exertion, all of which could plausibly adversely impact mental health.¹³ Conversely, since a large proportion of studies were cross-sectional, it is plausible that those experiencing mental ill health are more likely to work in occupations that require higher levels of work-related physical activity (eg, blue-collar jobs that involve manual labour), which could also be an indicator of the well-established socioeconomic disparities in mental health.⁴⁰⁸ However, in contrast to this argument, our previous research among a large sample of women aimed to disentangle this relationship³⁷⁸ and found that

work-related physical activity (walking) was associated with lower psychological distress in those with trade, labour or transport-related occupations (ie, blue collar), but not those with ‘professional’ or ‘sales and service’ (ie, white-collar workers) occupations. Therefore, one’s occupation/occupational status may play an important role in explaining the association between work-related physical activity and mental ill health, yet more research is clearly needed in this space.

In contextualising the mixed findings regarding transport-related and work-related physical activities, it is noteworthy to consider the role of choice (ie, an autonomous, non-coercive decision whereby other options are feasible) versus necessity.⁴⁰⁹ For many, and particularly those living in low- and middle-income countries (LMICs), individuals may engage in transport-related or occupational physical activity as they have no alternative (ie, out of necessity),⁴⁰⁹ while others may choose to ride to work because they consider cycling to be an enjoyable activity. Despite both possibly occurring in outdoor environments and in the same domain, these two behaviours represent fundamentally different motivations, and previous research has shown that more autonomously motivated active travel can be beneficial to mental health, while active travel undertaken for controlled reasons can be detrimental.⁴¹⁰ Moreover, occupational physical activity can vary depending on the country in which it is performed (eg, LMICs vs HICs), such as involving more manual labour and occurring under different conditions. Given that only a small proportion of studies in our review were from LMICs (~22%), this is an important consideration for future research, with particular need for further longitudinal studies in LMICs and appropriately controlling for factors such as leisure-time physical activity and socioeconomic position. Physical activity and public health promotion efforts (including programmes and messaging) need to be relevant, responsive and respectful to local contexts—and as such should consider being grounded in ‘necessity-versus choice-based physical activity models’, which consider important contextual characteristics such as the job market, crime and violence, infrastructure and traffic safety.⁴⁰⁹

In contrast to the original review,⁹ this meta-analysis found that household physical activity was weakly positively associated with mental health. Although this finding is based on a smaller number of studies relative to other domains, this suggests that undertaking physical activity for domestic purposes (eg, cleaning the house, gardening, mowing the lawns) could provide benefits for mental health. Given that these activities could possibly bring about a sense of achievement and satisfaction,⁴¹¹ which in turn could support mental health, this is a plausible explanation. Acknowledging the potential for a bidirectional relationship, it is also highly likely that those who are experiencing poorer mental health are less likely to undertake household physical activity, due to symptoms such as low mood, low motivation and fatigue.⁴¹² Further, aligned with previous methods,⁴¹⁰ our definition of household physical activity was consistent with the one used in the International Physical Activity Questionnaire (long form), that is, *physical activity undertaken ‘in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family’*⁴¹³ (which excludes leisure activities). However, there are nuances between possible definitions of household physical activity, as one may distinguish household activities

as those that are required (eg, household chores) rather than others that are undertaken by choice and for enjoyment (eg, gardening). Moreover, changes in lifestyle and exercise behaviour may have led to more individuals exercising at home through enjoyable activities such as gardening or exercising with children via online mechanisms, and while these activities are not domestic, they do occur in the home, and they overlap with household physical activity related to caring for a house or caring for children. Therefore, as human behaviour changes, the physical activity behaviours being detected by measures of household physical activity could change. Further prospective research is warranted to better understand the direction of these relationships and the mechanisms explaining this association. It is also possible that deeper analysis of leisure-time and household physical activities using different definitions of household activity (eg, choice based vs necessity based)⁴⁰⁹ may help untangle this new result.

Acknowledging that only a small number of studies (n=5) examined this domain, we found that school sport was weakly inversely associated with mental ill health. School sport can be cocurricular (undertaken during the school day) or extracurricular (typically outside of school hours). It is often delivered by teachers (or external coaches with varying levels of expertise and qualifications) that may aim to support students' psychosocial factors such as social connection, mastery and self-efficacy, and could provide mental health benefits.⁷ Furthermore, children and adolescents typically 'choose' to participate in school sports they enjoy, suggesting that in this domain they may be 'autonomously motivated'.^{4,7} In contrast, participation in physical education was not associated with either mental health or mental ill health in the eight studies included in our review. Given that physical education is generally a mandatory part of the school curriculum (ie, all students are required to participate and are often not given a choice in the physical activities they perform),⁴¹⁴ the lack of autonomy associated with this domain could help explain the result. Although physical education was not associated with mental ill health with studies combined, it is important to note that physical education was inversely associated with anxiety but positively associated with depressive symptoms. However, rather than larger amounts of physical education indicating lower levels of anxiety, it is possible that students with higher symptoms of anxiety, embarrassment or self-consciousness do less physical education because they actively disengage and avoid participation.^{415–417} Physical education is one of the only subjects at school where effort and ability are on public display. Therefore, it has been argued that for some students, physical education can be quite an anxiety-inducing subject.^{418,419} Because of these complexities, and the small number of studies informing these results relative to other domains, further research is needed to understand the impact of physical activity throughout the school day on mental health.

Strengths and limitations

Our meta-analysis provides the most systematic and comprehensive synthesis of the evidence to date, investigating the domain-specific associations between physical activity and mental health/mental ill health. Specifically, included studies (n=360) resulted in a high volume (n=1160) of effect sizes being analysed (significant power), using sophisticated

multilevel meta-analysis techniques. By replicating the methods of the original review,⁹ this enabled a coherent and robust update of the evidence base. For example, since the 2017 paper,⁹ there has been a threefold increase in the number of studies published, with substantial increases in the number of prospective/longitudinal (n=85) and experimental (n=21) study designs, as well as studies exploring domains outside of simply leisure time (n=183). However, limitations include that study designs are predominantly observational, limiting ability to draw firm conclusions regarding the causality and direction of relationships. This limitation is particularly prominent in studies examining non-leisure-related domains. Given the evident challenges of designing interventions that target increasing physical activity in domains other than leisure time, such as work-related physical activity (ie, increasing the physical activity performed for the *purpose* of the job), this is unsurprising. Moreover, domain-specific physical activity measures varied significantly. For example, for transport-related physical activity, some measures combined walking and cycling, while others assessed these modes individually. Some included walking and cycling as part of public transportation use, while others focused exclusively on active travel modes. It is likely that this large heterogeneity in measures may impact findings. Therefore, it may be important for future research to consider combining both self-reported measures of physical activity (which capture domain) and device-based measures. Future studies should also consider using other novel methods (eg, ecological momentary assessment) to test the acute effects of domain-specific physical activity on a range of more transient emotional and affective states such as vitality and anxiousness. Further, less than 3% of included studies demonstrated a high methodological quality (score of 6) in risk of bias assessments, suggesting focus should be on conducting methodologically rigorous high-quality studies (over quantity). This includes using prospective and/or randomised controlled trial designs, use of reliable and valid measures of domain-specific physical activity and mental health outcomes, controlling for important confounding factors (eg, socioeconomic position) and recruitment of large representative samples. Finally, it is important to acknowledge that cultural, environmental and climatic contexts are likely to influence associations between domain-specific physical activity and mental health outcomes (eg, active transport in Europe vs USA; household physical activity in LMICs vs HICs, etc), and therefore generalisability may be limited across settings and contexts, particularly given that only ~22% of studies were conducted in LMICs. Indeed, our findings highlight a clear need for further longitudinal studies, particularly in LMICs.

CONCLUSIONS

Our findings confirm that the direction of the association between physical activity and mental health/mental ill health is dependent on the domain in which physical activity occurs, rather than being a 'one-size-fits-all'. While global physical activity recommendations currently encourage adults to be physically active in any life domain,⁴²⁰ our findings suggest that promoting physical activity for leisure purposes is likely to yield the greatest benefits for both promoting mental health and preventing mental ill health. As such, participation in leisure-time physical activity (where possible prioritising activities one enjoys or personally

chooses to undertake) should be prioritised in physical activity messaging, guidelines and intervention/programme development which aim to support mental health through physical activity.

Author affiliations

- ¹Institute for Physical Activity and Nutrition (IPAN), School of Exercise and Nutrition Sciences, Deakin University, Geelong, Victoria, Australia
- ²Laboratory of Hormone Measures, Department of Physiology and Behaviour, Federal University of Rio Grande do Norte, Natal, Rio Grande do Norte, Brazil
- ³School of Psychology, Faculty of Arts, Social Sciences and Humanities, University of Wollongong, Wollongong, New South Wales, Australia
- ⁴Department of Sport Science, Exercise and Health, School of Human Sciences, The University of Western Australia, Perth, Western Australia, Australia
- ⁵Centre for Active Living and Learning, College of Human and Social Futures, The University of Newcastle Australia, Callaghan, New South Wales, Australia
- ⁶Department of Exercise and Sport Science, The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA
- ⁷Research Institute for Sport and Exercise Sciences, Liverpool John Moores University, Liverpool, UK
- ⁸Translational Health Research Institute, Western Sydney University, Penrith, New South Wales, Australia
- ⁹School of Health Sciences, Western Sydney University, Penrith, New South Wales, Australia
- ¹⁰Division of Endocrinology, Metabolism, and Diabetes, Mayo Clinic, Rochester, Minnesota, USA
- ¹¹Institute for Positive Psychology and Education, Australian Catholic University, North Sydney, New South Wales, Australia
- ¹²Physical Activity, Sport and Exercise Research Theme, Faculty of Health, Southern Cross University, Coffs Harbour, New South Wales, Australia
- ¹³Hunter Medical Research Institute, New Lambton Heights, New South Wales, Australia
- ¹⁴Manna Institute, Southern Cross University, Coffs Harbour, New South Wales, Australia
- ¹⁵Movember Foundation, Richmond, Victoria, Australia
- ¹⁶School of Exercise and Nutrition Sciences, Deakin University, Melbourne, Victoria, Australia

Contributors MT, RLW and CLo contributed to the conception of the study. MT, RLW, DRL, CS, SAV and CLo contributed to the design of the study and development of the search strategy. RLW conducted the systematic search. MT, RLW, GMdS, TB, CLi, MB, AJC, MF-R, JG, HEC, EMT, BB, DG, DJB, RB, CB and ABdS contributed to screening, quality assessment and data extraction. GMdS conducted the data analysis. MT, RLW, DRL, CS and SAV contributed to interpretation. MT, RLW and GMdS led the writing and revision of the manuscript and DRL, CS and SAV contributed to the drafting and revision. All authors reviewed and approved the final submitted version of the manuscript. MT is the guarantor.

Funding MT is supported by a National Health and Medical Research Council Emerging Leadership Fellowship (APP1195335). GMdS is supported by CAPES (Proc 88887.892816/2023-00). AJC is supported by the National Heart, Lung and Blood Institute of the National Institutes of Health (award number R01HL162805). The Manna Institute is supported by the Australian Government Department of Education through the Regional Research Collaboration Scheme.

Disclaimer The contents of the published material are solely the responsibility of the individual authors and do not reflect the views of the funding bodies

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. All data relevant to the study are included in the article or uploaded as supplementary information. Data are viewable in online supplemental file 5. All other data are available upon reasonable request.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

ORCID iDs

Megan Teychenne <https://orcid.org/0000-0002-7293-8255>
Geovan M Sousa <https://orcid.org/0000-0002-8674-5067>
Caitlin Liddelow <https://orcid.org/0000-0003-1083-5979>
David R Lubans <https://orcid.org/0000-0002-0204-8257>
Christian Swann <https://orcid.org/0000-0003-1502-3179>
Stewart A Vella <https://orcid.org/0000-0003-0537-9366>
Chris Lonsdale <https://orcid.org/0000-0002-2523-5565>
Rhianon L White <https://orcid.org/0000-0002-5118-6226>

REFERENCES

- 1 Collaborators GMD. Global, regional, and national burden of 12 mental disorders in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet Psychiatry* 2022;9:137–50.
- 2 Schuch FB, Vancampfort D, Firth J, et al. Physical Activity and Incident Depression: A Meta-Analysis of Prospective Cohort Studies. *Am J Psychiatry* 2018;175:631–48.
- 3 Singh B, Olds T, Curtis R, et al. Effectiveness of physical activity interventions for improving depression, anxiety and distress: an overview of systematic reviews. *Br J Sports Med* 2023;57:1203–9.
- 4 Teychenne M, White RL, Richards J, et al. Do we need physical activity guidelines for mental health: What does the evidence tell us? *Ment Health Phys Act* 2020;18:100315.
- 5 Vella SA, Sutcliffe JT, Fernandez D, et al. Context matters: A review of reviews examining the effects of contextual factors in physical activity interventions on mental health and wellbeing. *Ment Health Phys Act* 2023;25:100520.
- 6 Wakeford R. Association and causation in epidemiology - half a century since the publication of Bradford Hill's interpretational guidance. *J R Soc Med* 2015;108:4–6.
- 7 Vella SA, Aidman E, Teychenne M, et al. Optimising the effects of physical activity on mental health and wellbeing: A joint consensus statement from Sports Medicine Australia and the Australian Psychological Society. *J Sci Med Sport* 2023;26:132–9.
- 8 Teychenne M, Ball K, Salmon J. Physical activity and likelihood of depression in adults: a review. *Prev Med* 2008;46:397–411.
- 9 White RL, Babic MJ, Parker PD, et al. Domain-Specific Physical Activity and Mental Health: A Meta-analysis. *Am J Prev Med* 2017;52:653–66.
- 10 Shephard RJ. Limits to the measurement of habitual physical activity by questionnaires. *Br J Sports Med* 2003;37:197–206; .
- 11 White RL, Vella S, Biddle S, et al. Physical activity and mental health: a systematic review and best-evidence synthesis of mediation and moderation studies. *Int J Behav Nutr Phys Act* 2025;21:134.
- 12 Baker T, White R, Abbott G, et al. Investigating psychosocial and behavioural mediators of the relationship between physical activity and depressive symptoms in women from socioeconomically disadvantaged neighbourhoods. *Ment Health Phys Act* 2023;25:100560.
- 13 Holtermann A, Krause N, van der Beek AJ, et al. The physical activity paradox: six reasons why occupational physical activity (OPA) does not confer the cardiovascular health benefits that leisure time physical activity does. *Br J Sports Med* 2018;52:149–50.
- 14 McHugh ML. Interrater reliability: the kappa statistic. *Biochem Med (Zagreb)* 2012;22:276–82.
- 15 Borenstein M, Hedges LV, Higgins JP, et al. *Introduction to meta-analysis*. United Kingdom: West Sussex, 2009.
- 16 Rosenthal R. *Meta-analytic procedures for social science research*. Newbury Park, United States: SAGE Publications, 1991.
- 17 Thalheimer W, Cook S. How to calculate effect sizes from published research: a simplified methodology. Work-Learning Research, 2002–1–9.
- 18 Hunter JE, Schmidt FL. *Methods of Meta-Analysis: Correcting Error and Bias in Research Findings*. 2nd edn. London, UK: Sage, 2004.
- 19 Charles EP. The correction for attenuation due to measurement error: clarifying concepts and creating confidence sets. *Psychol Methods* 2005;10:206–26.
- 20 Cohen J, Cohen P, West SG, et al. *Applied multiple regression/correlation analysis for the behavioral sciences*. New Jersey: Routledge, 2013.
- 21 Cheung M. *Meta-analysis: a structural equation modeling approach*. West Sussex, UK: John Wiley & Sons, Ltd, 2015.
- 22 Cheung MWL. metaSEM: an R package for meta-analysis using structural equation modeling. *Front Psychol* 2014;5:1521.
- 23 Cohen J. *Statistical power analysis for the behavioral sciences*. New York, US: Academic Press, 1977.
- 24 Higgins JPT. Measuring inconsistency in meta-analyses. *BMJ* 2003;327:557–60.
- 25 Rücker G, Schwarzer G, Carpenter JR, et al. Undue reliance on I 2 in assessing heterogeneity may mislead. *BMC Med Res Methodol* 2008;8:79.
- 26 Higgins J. *Cochrane handbook for systematic reviews of interventions*. 5. Chichester, UK: Wiley Online Library, 2008.
- 27 Doherty D, Kaufman M, Lindsay D, et al. Age limits and adolescents [policy statement]. Ottawa (ON): Canadian Paediatric Society, 1994.
- 28 World health organization. Definition of an older or elderly person. Geneva, Switzerland World Health Organisation; 2010.

- 29 Rosenthal R. The file drawer problem and tolerance for null results. *Psychol Bull* 1979;86:638–41.
- 30 Sterne JA, Gavaghan D, Egger M. Publication and related bias in meta-analysis: power of statistical tests and prevalence in the literature. *J Clin Epidemiol* 2000;53:1119–29.
- 31 Abdel Hadi S, Mojzisch A, Krumm S, et al. Day-level relationships between work, physical activity, and well-being: Testing the physical activity-mediated demand-control (pamDC) model. *Work Stress* 2021.
- 32 Aghababa A, Zamani Sani SH, Rohani H, et al. No Evidence of Systematic Change of Physical Activity Patterns Before and During the Covid-19 Pandemic and Related Mood States Among Iranian Adults Attending Team Sports Activities. *Front Psychol* 2021;12:641895.
- 33 Aguilar BAS, Tebar WR, Silva SCB, et al. Leisure-time exercise is associated with lower depressive symptoms in community dwelling adults. *Eur J Sport Sci* 2022;22:916–25.
- 34 Aibar-Almazán A, Hita-Contreras F, Cruz-Díaz D, et al. Effects of Pilates training on sleep quality, anxiety, depression and fatigue in postmenopausal women: A randomized controlled trial. *Maturitas* 2019;124:62–7.
- 35 Albujulaya N, Stevinson C. Exercise Promotion in Saudi Arabia: Understanding Personal, Environmental, and Social Determinants of Physical Activity Participation and Well-Being. *Int J Environ Res Public Health* 2023;20:3554.
- 36 Aldana SG, Sutton LD, Jacobson BH, et al. Relationships between leisure time physical activity and perceived stress. *Percept Mot Skills* 1996;82:315–21.
- 37 Aliabadi S, Zobairy M, Zobairy L. The Relationship Between Depression and Leisure Time Activity in Female High School Students. *Procedia Soc Behav Sci* 2013;84:256–8.
- 38 Aliberti S, Raiola G. Effects of Line Dancing on Mental Health in Seniors after COVID-19 Pandemic. *Education Sciences* 2021;11:677.
- 39 Alonso-Fernández D, Fernández-Rodríguez R, Taboada-Iglesias Y, et al. Impact of High-Intensity Interval Training on Body Composition and Depressive Symptoms in Adults under Home Confinement. *Int J Environ Res Public Health* 2022;19:6145:10.
- 40 Ambrutytė J, Miežienė B, Emeljanovas A, et al. Relationships Between Young Men's Health-Related Behaviour, Psychological Distress, Physical Education and Sports Experience. *BJSHS* 2021;1:13–21.
- 41 Andrade-Gómez E, Martínez-Gómez D, Rodríguez-Artalejo F, et al. Sedentary behaviors, physical activity, and changes in depression and psychological distress symptoms in older adults. *Depress Anxiety* 2018;35:884–97.
- 42 Appelqvist-Schmidlechner K, Vaara J, Häkkinen A, et al. Relationships Between Youth Sports Participation and Mental Health in Young Adulthood Among Finnish Males. *Am J Health Promot* 2018;32:1502–9.
- 43 Appelqvist-Schmidlechner K, Vaara JP, Vasankari T, et al. Relationship between different domains of physical activity and positive mental health among young adult men. *BMC Public Health* 2020;20:1116.
- 44 Arat G, Wong PWC. The relationship between physical activity and mental health among adolescents in six middle-income countries: A cross-sectional study. *Child Youth Serv* 2017;38:180–95.
- 45 Armstrong K, Edwards H. The effectiveness of a pram-walking exercise programme in reducing depressive symptomatology for postnatal women. *Int J Nurs Pract* 2004;10:177–94.
- 46 Asztalos M, Wijndaele K, De Bourdeaudhuij I, et al. Specific associations between types of physical activity and components of mental health. *J Sci Med Sport* 2009;12:468–74.
- 47 Avila-Palencia I, de Nazelle A, Cole-Hunter T, et al. The relationship between bicycle commuting and perceived stress: a cross-sectional study. *BMJ Open* 2017;7:e013542.
- 48 Awais MA, Chaudhery MM, Khan MS, et al. Factors contributing to distress among school and college-going adolescents during COVID-19 Lockdown: A cross-sectional study conducted in Sibi Balochistan, Pakistan. *J Educ Health Promot* 2021;10:317.
- 49 Awotidibe TO, Oyeyemi AL, Ijadunola MY, et al. Occupational Physical Activity and Health-Related Quality of Life among Nigerian Vocational-Skilled Workers. *JOHE* 2020;9:239–47.
- 50 Badura P, Geckova AM, Sigmundova D, et al. When children play, they feel better: organized activity participation and health in adolescents. *BMC Public Health* 2015;15:1090.
- 51 Badura P, Hamrik Z, Dierckens M, et al. After the bell: adolescents' organised leisure-time activities and well-being in the context of social and socioeconomic inequalities. *J Epidemiol Community Health* 2021;75:628–36.
- 52 Bafageeh F, Loux T. The relationship between types of physical activity and mental health among U.S. adults. *Ment Health Prev* 2022;28:200244.
- 53 Balboa-Castillo T, León-Muñoz LM, Graciani A, et al. Longitudinal association of physical activity and sedentary behavior during leisure time with health-related quality of life in community-dwelling older adults. *Health Qual Life Outcomes* 2011;9:47:47–56.
- 54 Baldursdóttir B, Valdimarsdóttir HB, Krettek A, et al. Age-related differences in physical activity and depressive symptoms among 10–19-year-old adolescents: A population based study. *Psychol Sport Exerc* 2017;28:91–9.
- 55 Barranco-Ruiz Y, Mandic S, Paz-Viteri S, et al. A short dance-exercise intervention as a strategy for improving quality of life in inactive workers. *Health Educ J* 2017;76:936–45.
- 56 Barranco-Ruiz Y, Paz-Viteri S, Villa-González E. Dance Fitness Classes Improve the Health-Related Quality of Life in Sedentary Women. *IJERPH* 2020;17:3771.
- 57 Barrington WE, Ceballos RM, Bishop SK, et al. Perceived stress, behavior, and body mass index among adults participating in a worksite obesity prevention program, Seattle, 2005–2007. *Prev Chronic Dis* 2012;9:E152.
- 58 Barros MB de A, Lima MG, Azevedo RCS de, et al. Depression and health behaviors in Brazilian adults – PNS 2013. *Rev Saúde Pública* 2017;51:51.
- 59 Bélair M-A, Kohen DE, Kingsbury M, et al. Relationship between leisure time physical activity, sedentary behaviour and symptoms of depression and anxiety: evidence from a population-based sample of Canadian adolescents. *BMJ Open* 2018;8:e021119.
- 60 Bernaards CM, Jans MP, van den Heuvel SG, et al. Can strenuous leisure time physical activity prevent psychological complaints in a working population? *Occup Environ Med* 2006;63:10–6.
- 61 Bertelli-Costa T, Neri AL. Life satisfaction and participation among community-dwelling older adults: Data from the FIBRA study. *J Health Psychol* 2021;26:1860–71.
- 62 Bertheussen GF, Romundstad PR, Landmark T, et al. Associations between Physical Activity and Physical and Mental Health- A HUNT 3 Study. *Med Sci Sports Exerc* 2011;43:1220–8.
- 63 Bian J, Xiang Z. Do the various leisure forms have equal effects on mental health? A longitudinal analysis of self-selected leisure activities. *Front Public Health* 2023;11:1134854.
- 64 Binsinger C, Laure P, Ambard MF. Regular extra curricular sports practice does not prevent moderate or severe variations in self-esteem or trait anxiety in early adolescents. *J Sports Sci Med* 2006;5:123–9.
- 65 Birkeland MS, Torsheim T, Wold B. A longitudinal study of the relationship between leisure-time physical activity and depressed mood among adolescents. *Psychol Sport Exerc* 2009;10:25–34.
- 66 Bjerkan M, Rangul V, Skjesol K, et al. Physical Activity and Depression/Anxiety Symptoms in Adolescents – the Young-HUNT Study. *Physical Activity and Health* 2022;6:73–85.
- 67 Blonska K. The impact of physical activity on students' happiness in the context of positive and negative motivation. *PES* 2022;26:89–97.
- 68 Bogaert I, De Martelaer K, Deforche B, et al. Associations between different types of physical activity and teachers' perceived mental, physical, and work-related health. *BMC Public Health* 2014;14:1–9.
- 69 Bopp M, Wilson OWA, Duffey M, et al. An examination of active travel trends before and after college graduation. *J Transp Health* 2019;14:100602.
- 70 Borges LJ, Benedetti TRB, Xavier AJ, et al. Associated factors of depressive symptoms in the elderly: EpiFloripa study. *Rev Saude Publica* 2013;47:701–10.
- 71 Borraccino A, Lazzeri G, Kakaa O, et al. The Contribution of Organised Leisure-Time Activities in Shaping Positive Community Health Practices among 13- and 15-Year-Old Adolescents: Results from the Health Behaviours in School-Aged Children Study in Italy. *IJERPH* 2020;17:6637.
- 72 Branco JC, Jansen K, Oses JP, et al. Practice of leisure-time physical activities and episodes of mood alteration amongst men and women. *J Affect Disord* 2014;169:165–9.
- 73 Jackson SB, Stevenson KT, Larson LR, et al. Outdoor Activity Participation Improves Adolescents' Mental Health and Well-Being during the COVID-19 Pandemic. *Int J Environ Res Public Health* 2021;18:1–19.
- 74 Brière FN, Yale-Soulière G, Gonzalez-Sicilia D, et al. Prospective associations between sport participation and psychological adjustment in adolescents. *J Epidemiol Community Health* 2018;72:575–81.
- 75 Briki W. Why do exercisers with a higher trait self-control experience higher subjective well-being? The mediating effects of amount of leisure-time physical activity, perceived goal progress, and self-efficacy. *Pers Individ Dif* 2018;125:62–7.
- 76 Brooks FM, Smeeton NC, Chester K, et al. Associations between physical activity in adolescence and health behaviours, well-being, family and social relations. *Int J Health Promot Educ* 2014;52:271–82.
- 77 Brunes A, Augestad LB, Gudmundsdóttir SL. Personality, physical activity, and symptoms of anxiety and depression: the HUNT study. *Soc Psychiatry Psychiatr Epidemiol* 2013;48:745–56.
- 78 Brunes A, Gudmundsdóttir SL, Augestad LB. Gender-specific associations between leisure-time physical activity and symptoms of anxiety: the HUNT study. *Soc Psychiatry Psychiatr Epidemiol* 2015;50:419–27.
- 79 Bültmann U, Kant IJ, Kasl SV, et al. Lifestyle factors as risk factors for fatigue and psychological distress in the working population: prospective results from the Maastricht Cohort Study. *J Occup Environ Med* 2002;44:116–24.
- 80 Bustamante EE, Wilbur J, Marquez DX, et al. Physical activity characteristics and depressive symptoms in older Latino adults. *Ment Health Phys Act* 2013;6:69–77.
- 81 Buttery AK, Mensink GBM, Busch MA. Healthy behaviours and mental health: findings from the German Health Update (GEDA). *Eur J Public Health* 2015;25:219–25.

- 82 de Camargo EM, López Gil JF, Costa CG, *et al.* Physical activity as a mediator of the association of body mass index change with anxiety/depression symptoms in Brazilian adults during COVID-19. *Nutr Hosp* 2023;41:426–32.
- 83 Cao B, Zhao YX, Ren ZY, *et al.* Are Physical Activities Associated With Perceived Stress? The Evidence From the China Health and Nutrition Survey. *Front Public Health* 2021;9:697484.
- 84 Casper JM, Bocarro JN, Lothary AF. An examination of pickleball participation, social connections, and psychological well-being among seniors during the COVID-19 pandemic. *World Leis J* 2021;63:330–46.
- 85 Cerin E, Leslie E, Sugiyama T, *et al.* Associations of multiple physical activity domains with mental well-being. *Ment Health Phys Act* 2009;2:55–64.
- 86 Chan BCL, Luciano M, Lee B. Interaction of Physical Activity and Personality in the Subjective Wellbeing of Older Adults in Hong Kong and the United Kingdom. *Behav Sci (Basel)* 2018;8:71.
- 87 Kim C, Kim J, Thapa B. Intensity of Leisure-Time Physical Activity and Dimensions of Mental Well-Being: A Reciprocal Approach Using Parallel Latent Growth Curve Modeling. *J Phys Act Health* 2021;18:165–74.
- 88 Chao SF. Changes in Leisure Activities and Dimensions of Depressive Symptoms in Later Life: A 12-Year Follow-Up. *Gerontologist* 2016;56:397–407.
- 89 Chen LJ, Stevinson C, Ku PW, *et al.* Relationships of leisure-time and non-leisure-time physical activity with depressive symptoms: a population-based study of Taiwanese older adults. *Int J Behav Nutr Phys Act* 2012;9:28.
- 90 Cheng L, Chang S, Wang B, *et al.* Cross-sectional study of depression tendency and sleep quality in 1352 people practicing Tai Chi. *Res Sports Med* 2023;31:650–62.
- 91 Cheng L, Qian L, Chang S, *et al.* Effect of Tai Chi on depression symptoms and sleep quality among older adult women after exercise cessation. *Res Sports Med* 2021;29:395–405.
- 92 Chi SH, Wang JY, Tsai AC. Combined association of leisure-time physical activity and fruit and vegetable consumption with depressive symptoms in older Taiwanese: Results of a national cohort study. *Geriatr Gerontol Int* 2016;16:244–51.
- 93 Chmelik F, Frömel K, Groffik D, *et al.* Does Vigorous Physical Activity Contribute to Adolescent Life Satisfaction? *Int J Environ Res Public Health* 2021;18:2236.
- 94 Choi J, Wilbur J, Miller A, *et al.* Correlates of leisure-time physical activity in Korean immigrant women. *West J Nurs Res* 2008;30:620–38.
- 95 Chow SKY, Choi EKY. Assessing the Mental Health, Physical Activity Levels, and Resilience of Today's Junior College Students in Self-Financing Institutions. *Int J Environ Res Public Health* 2019;16:3210:17.
- 96 Chu AHY, van Dam RM, Biddle SJH, *et al.* Self-reported domain-specific and accelerometer-based physical activity and sedentary behaviour in relation to psychological distress among an urban Asian population. *Int J Behav Nutr Phys Act* 2018;15:36.
- 97 Chun S, Heo J, Ryu J. Leisure Participation, Physical Health, and Mental Health in Older Adults. *Act Adapt Aging* 2023;47:195–213.
- 98 Clark B, Chatterjee K, Martin A, *et al.* How commuting affects subjective wellbeing. *Transportation (Amst)* 2020;47:2777–805.
- 99 Coakley KE, Lardier DT, Holladay KR, *et al.* Physical Activity Behavior and Mental Health Among University Students During COVID-19 Lockdown. *Front Sports Act Living* 2021;3:3.
- 100 Coledam DHC, de Arruda GA, Ribeiro EAG, *et al.* Association between domains of physical activity and health among teachers: a cross-sectional study. *Sport Sci Health* 2022;18:445–53.
- 101 Congsheng L, Kayani S, Khalid A. An empirical study of physical activity and sports affecting mental health of university students. *Front Psychol* 2022;13:917503.
- 102 Cosma A, Pavelka J, Badura P. Leisure Time Use and Adolescent Mental Well-Being: Insights from the COVID-19 Czech Spring Lockdown. *Int J Environ Res Public Health* 2021;18:23.
- 103 Craike MJ, Coleman D, MacMahon C. Direct and buffering effects of physical activity on stress-related depression in mothers of infants. *J Sport Exerc Psychol* 2010;32:23–38.
- 104 Cui Y, Russell M, Davern M, *et al.* Longitudinal evidence of the impact of dog ownership and dog walking on mental health. *J Public Health (Bangkok)* 2021;43:e145–52.
- 105 Curl A, Mason P. Neighbourhood perceptions and older adults' wellbeing: Does walking explain the relationship in deprived urban communities? *Transportation Research Part A: Policy and Practice* 2019;123:119–29.
- 106 Curl AL, Bibbo J, Johnson RA. Neighbourhood Engagement, Dogs, and Life Satisfaction in Older Adulthood. *J Appl Gerontol* 2021;40:1706–14.
- 107 da Costa BGG, Van Rooij AJ, Tuijnman A, *et al.* Associations Between Type and Timing of Physical Activity and Sedentary Behavior With Mental Health in Adolescents and Young Adults. *J Phys Act Health* 2023;20:655–63.
- 108 da Silva BGC, Menezes AMB, Gonçalves H, *et al.* Physical Activity During Adolescence and Mental Health in Early Adulthood: Findings From the 1993 Pelotas Birth Cohort Study. *J Phys Act Health* 2023;20:860–7.
- 109 Ochoa Del-Toro AG, Mitchell-Bennett LA, Machiorlatti M, *et al.* Community Exercise Program Participation and Mental Well-Being in the U.S. Texas–Mexico Border Region. *Healthcare (Basel)* 2023;11:2946.
- 110 Desha LN, Ziviani JM, Nicholson JM, *et al.* Physical activity and depressive symptoms in American adolescents. *J Sport Exerc Psychol* 2007;29:534–43.
- 111 Dinh KM, Kaspersen KA, Mikkelsen S, *et al.* Low-grade inflammation is negatively associated with physical Health-Related Quality of Life in healthy individuals: Results from The Danish Blood Donor Study (DBDS). *PLoS One* 2019;14:e0214468.
- 112 Doerksen SE, Elavsky S, Rebar AL, *et al.* Weekly Fluctuations in College Student Leisure Activities and Well-Being. *Leis Sci* 2014;36:14–34.
- 113 Doré I, O'Loughlin JL, Beauchamp G, *et al.* Volume and social context of physical activity in association with mental health, anxiety and depression among youth. *Prev Med* 2016;91:344–50.
- 114 Du C. Correlation between basketball exercise, psychological quality, and positive emotions of college students. *Revista Argentina de Clinica Psicologica* 2020;29:698–703.
- 115 Dugan SA, Bromberger JT, Segawa E, *et al.* Association between physical activity and depressive symptoms: midlife women in SWAN. *Med Sci Sports Exerc* 2015;47:335–42.
- 116 Dupuis SL, Smale BJA. An Examination of Relationship Between Psychological Well-Being and Depression and Leisure Activity Participation Among Older Adults. *Loisir et Société / Society and Leisure* 1995;18:67–92.
- 117 Eime R, Harvey J, Payne W. Dose-response of women's health-related quality of life (HRQoL) and life satisfaction to physical activity. *J Phys Act Health* 2014;11:330–8.
- 118 Ejiri M, Kawai H, Kera T, *et al.* Exercise as a coping strategy and its impact on the psychological well-being of Japanese community-dwelling older adults during the COVID-19 pandemic: A longitudinal study. *Psychol Sport Exerc* 2021;57:102054:57.
- 119 Mzadi AE, Zouini B, Kerekes N, *et al.* Mental Health Profiles in a Sample of Moroccan High School Students: Comparison Before and During the COVID-19 Pandemic. *Front Psychiatry* 2022;12:12.
- 120 Elsdén E, Bu FF, Fancourt D, *et al.* Frequency of leisure activity engagement and health functioning over a 4-year period: a population-based study amongst middle-aged adults. *BMC Public Health* 2022;22:1275.
- 121 Engels ES, Mutz M, Demetriou Y, *et al.* Levels of physical activity in four domains and affective wellbeing before and during the Covid-19 pandemic. *Arch Public Health* 2021;79:122.
- 122 Esenturk OK, Akandere M, Yarımkaya E, *et al.* The effect of physical activity program on trait anxiety level on adults. *Ovidius Univ Ann Ser Phys Educ Sport Sci Mov Health* 2016;16:609–18.
- 123 Faria J, Quaresma L, Cataldi S, *et al.* Pre- and Post-Activity Anxiety for Sustainable Rafting. *Sustainability* 2022;14:5075.
- 124 Fernandez-Montero A, Moreno-Galarraga L, Sánchez-Villegas A, *et al.* Dimensions of leisure-time physical activity and risk of depression in the "Seguimiento Universidad de Navarra" (SUN) prospective cohort. *BMC Psychiatry* 2020;20:98.
- 125 Feuerhahn N, Sonnentag S, Woll A. Exercise after work, psychological mediators, and affect: A day-level study. *Eur J Work Organ Psychol* 2014;23:62–79.
- 126 Fisher KJ, Li F. A community-based walking trial to improve neighborhood quality of life in older adults: a multilevel analysis. *Ann Behav Med* 2004;28:186–94.
- 127 Fløtnes IS, Nilsen TIL, Augestad LB. Norwegian adolescents, physical activity and mental health: The Young-HUNT study. *Nor J Epidemiol* 2011;20:153–61.
- 128 Frömel K, Groffik D, Mitáš J, *et al.* Active Travel of Czech and Polish Adolescents in Relation to Their Well-Being: Support for Physical Activity and Health. *Int J Environ Res Public Health* 2020;17:2001.
- 129 Frömel K, Groffik D, Valach P, *et al.* The Impact of Distance Education during the COVID-19 Pandemic on Physical Activity and Well-Being of Czech and Polish Adolescents. *J Sch Health* 2022;92:1137–47.
- 130 Frömel K, Jakubec L, Groffik D, *et al.* Physical activity of secondary school adolescents at risk of depressive symptoms. *J Sch Health* 2020;90:641–50.
- 131 Fukai K, Kuwahara K, Chen SM, *et al.* The association of leisure-time physical activity and walking during commuting to work with depressive symptoms among Japanese workers: A cross-sectional study. *J Occup Health* 2020;62:e12120.
- 132 Gao Y, Jia Z, Zhao L, *et al.* The Effect of Activity Participation in Middle-Aged and Older People on the Trajectory of Depression in Later Life: National Cohort Study. *JMIR Public Health Surveill* 2023;9:e44682.
- 133 García-Mayor J, Gouveia ER, Marques A, *et al.* Exploring the Role of Physical Activity in Mediating the Association between Educational Level and Health-Related Quality of Life in an Adult Lifespan Sample from Madeira Island. *Int J Environ Res Public Health* 2022;19:7608:13.
- 134 Gerber M, Isoard-Gautheur S, Schilling R, *et al.* When Low Leisure-Time Physical Activity Meets Unsatisfied Psychological Needs: Insights From a Stress-Buffer Perspective. *Front Psychol* 2018;9:2097:2097.
- 135 Giacobbi PR Jr, Tuccitto DE, Frye N. Exercise, affect, and university students' appraisals of academic events prior to the final examination period. *Psychol Sport Exerc* 2007;8:261–74.
- 136 Gilbert AS, Schmidt L, Beck A, *et al.* Associations of physical activity and sedentary behaviors with child mental well-being during the COVID-19 pandemic. *BMC Public Health* 2021;21:1770.
- 137 Goldfield GS, Henderson K, Buchholz A, *et al.* Physical activity and psychological adjustment in adolescents. *J Phys Act Health* 2011;8:157–63.
- 138 Gomez-Baya D, Mendoza R, Matos MG de, *et al.* Sport participation, body satisfaction and depressive symptoms in adolescence: a moderated-mediation analysis of gender differences. *Eur J Dev Psychol* 2019;16:183–97.

- 139 Gomez-Baya D, Sarmiento H, Nicoletti JA, *et al.* Cross-Sectional Associations between Playing Sports or Electronic Games in Leisure Time and Life Satisfaction in 12-Year-Old Children from the European Union. *Eur J Invest Health Psychol Educ* 2022;12:1050–66.
- 140 Grau-Ruiz R, Løvoll HS, Dyrda GM. Norwegian Outdoor Happiness: Residential Outdoor Spaces and Active Leisure Time Contributions to Subjective Well-being at the National Population Level at the Start of and During the COVID-19 Pandemic. *J Happiness Stud* 2024;25:25.
- 141 Griffiths LJ, Dowda M, Dezateux C, *et al.* Associations between sport and screen-entertainment with mental health problems in 5-year-old children. *Int J Behav Nutr Phys Act* 2010;7:30.
- 142 Gu YX, Ali SH, Guo AM. The association between leisure activity engagement and functional health, mental health, and subjective health among Chinese older adults. *J Public Health (Berl)* 2025;33:1199–208.
- 143 Guddal MH, Stensland SO, Småstuen MC, *et al.* Physical activity and sport participation among adolescents: associations with mental health in different age groups. Results from the Young-HUNT study: a cross-sectional survey. *BMJ Open* 2019;9.
- 144 Abdel Hadi S, Mojzisch A, Krumm S, *et al.* Day-level relationships between work, physical activity, and well-being: Testing the physical activity-mediated demand-control (pamDC) model. *Work Stress* 2022;36:355–76.
- 145 Hallgren M, Nguyen T-T-D, Herring MP, *et al.* Associations of physical activity with anxiety symptoms and disorders: Findings from the Swedish National March Cohort. *Gen Hosp Psychiatry* 2019;58:45–50.
- 146 Hamer M, Molloy GJ, Oliveira C, *et al.* Leisure time physical activity, risk of depressive symptoms, and inflammatory mediators: The English Longitudinal Study of Ageing. *Psychoneuroendocrinology* 2009;34:1050–5.
- 147 Hamer M, Stamatakis E, Steptoe A. Dose-response relationship between physical activity and mental health: The Scottish Health Survey. *Br J Sports Med* 2009;43:1111–4.
- 148 Han A, Kim J. A Study of Leisure Walking Intensity Levels on Mental Health and Health Perception of Older Adults. *Gerontol Geriatr Med* 2021;7.
- 149 Hansmann R, Fritz L, Pagani A, *et al.* Activities, Housing Situation and Other Factors Influencing Psychological Strain Experienced During the First COVID-19 Lockdown in Switzerland. *Front Psychol* 2021;12:735293.
- 150 Haukka E, Gluschkoff K, Kalliolahhti E, *et al.* Changes in active commuting and changes in health: Within- and between-individual analyses among 16 881 Finnish public sector employees. *Prev Med* 2023;177:107744.
- 151 He F, Li Y, Hu ZX, *et al.* Association of domain-specific physical activity with depressive symptoms: A population-based study. *Eur Psychiatry* 2023;66.
- 152 Heemskerk C, Strand S, Malmberg LE. Physical activity predicts task-related behaviour, affect and tiredness in the primary school classroom: A within-person experiment. *Br J Educ Psychol* 2023;93 Suppl 1:130–51.
- 153 Henning G, Stenling A, Bielak AAM, *et al.* Towards an active and happy retirement? Changes in leisure activity and depressive symptoms during the retirement transition. *Aging Ment Health* 2021;25:621–31.
- 154 Herman KM, Hopman WM, Sabiston CM. Physical activity, screen time and self-rated health and mental health in Canadian adolescents. *Prev Med* 2015;73:112–6.
- 155 Hewett ZL, Pampa KL, Smith CA, *et al.* Effect of a 16-week Bikram yoga program on perceived stress, self-efficacy and health-related quality of life in stressed and sedentary adults: A randomised controlled trial. *J Sci Med Sport* 2018;21:352–7.
- 156 Hu L, Zhu L, Lyu JY, *et al.* Benefits of Walking on Menopausal Symptoms and Mental Health Outcomes among Chinese Postmenopausal Women. *Int J Gerontol* 2017;11:166–70.
- 157 Hu YH, Chiu CJ, Wong JD, *et al.* The Role of Leisure Activities in the Relationship Between Marital Transition in Later Midlife and Psychological Well-Being Trajectories. *Int J Aging Hum Dev* 2018;86:327–46.
- 158 Hu Z, Lin X, Chiwanda Kaminga A, *et al.* Impact of the COVID-19 Epidemic on Lifestyle Behaviors and Their Association With Subjective Well-Being Among the General Population in Mainland China: Cross-Sectional Study. *J Med Internet Res* 2020;22:e21176.
- 159 Huang AA, Huang SY. Increased vigorous exercise and decreased sedentary activities are associated with decreased depressive symptoms in United States adults: Analysis of The National Health and Nutrition Examination Survey (NHANES) 2017–2020. *Health Sci Rep* 2023;6:e1473.
- 160 Humphreys DK, Goodman A, Ogilvie D. Associations between active commuting and physical and mental wellbeing. *Prev Med* 2013;57:135–9.
- 161 Hyde AL, Conroy DE, Pincus AL, *et al.* Unpacking the Feel-Good Effect of Free-Time Physical Activity: Between- and Within-Person Associations With Pleasant-Activated Feeling States. *J Sport Exerc Psychol* 2011;33:884–902.
- 162 Ibsen B, Elmose-Østerlund K, Hoyer-Kruse J. Associations of types of physical activity with self-rated physical and mental health in Denmark. *Prev Med Rep* 2024;37:102557.
- 163 Ihle A, Gouveia BR, Gouveia ER, *et al.* Physical Activity Dimensions Differentially Predict Physical and Mental Components of Health-Related Quality of Life: Evidence from a Sport for All Study. *Sustainability* 2021;13:13370.
- 164 Im E-O, Ham OK, Chee E, *et al.* Physical activity and depressive symptoms in four ethnic groups of midlife women. *West J Nurs Res* 2015;37:746–66.
- 165 Inal S, Subasi F, Ay SM, *et al.* The links between health-related behaviors and life satisfaction in elderly individuals who prefer institutional living. *BMC Health Serv Res* 2007;7:30.
- 166 Isaksson J, Selinus EN, Åslund C, *et al.* Physical activity in early adolescence predicts depressive symptoms 3 years later: A community-based study. *J Affect Disord* 2020;277:825–30.
- 167 Iwasaki Y, Zuzanek J, Mannell RC. The effects of physically active leisure on stress-health relationships. *Canadian Journal of Public Health* 2001;92:214–8.
- 168 Jääskeläinen T, Sääksjärvi K, Pietilä A, *et al.* Poor health status before the COVID-19 pandemic is associated with unfavourable changes in health-related lifestyle. *Scand J Public Health* 2023;51:792–6.
- 169 Javelle F, Laborde S, Hosang TJ, *et al.* The Importance of Nature Exposure and Physical Activity for Psychological Health and Stress Perception: Evidence From the First Lockdown Period During the Coronavirus Pandemic 2020 in France and Germany. *Front Psychol* 2021;12:12.
- 170 Jewett R, Sabiston CM, Brunet J, *et al.* School Sport Participation During Adolescence and Mental Health in Early Adulthood. *Journal of Adolescent Health* 2014;55:640–4.
- 171 Jindo T, Kai Y, Kitano N, *et al.* Relationship of workplace exercise with work engagement and psychological distress in employees: A cross-sectional study from the MYLS study. *Prev Med Rep* 2020;17:101030.
- 172 Joo MJ, Jang YS, Jang YS, *et al.* Association between work-related physical activity and depressive symptoms in Korean workers: data from the Korea national health and nutrition examination survey 2014, 2016, 2018, and 2020. *BMC Public Health* 2023;23.
- 173 Joseph RP, Royse KE, Benitez TJ, *et al.* Physical activity and quality of life among university students: exploring self-efficacy, self-esteem, and affect as potential mediators. *Qual Life Res* 2014;23:659–67.
- 174 Jurakić D, Pedišić Z, Greblo Z. Physical activity in different domains and health-related quality of life: a population-based study. *Qual Life Res* 2010;19:1303–9.
- 175 Jussila JJ, Pulkka A, Ervasti J, *et al.* Associations of leisure-time physical activity and active school transport with mental health outcomes: A population-based study. *Scand J Med Sci Sports* 2023;33:670–81.
- 176 Ishii K, Shibata A, Adachi M, *et al.* Association of Physical Activity and Sedentary Behavior With Psychological Well-Being Among Japanese Children. *Percept Mot Skills* 2016;123:445–59.
- 177 Kayani S, Kiyani T, Kayani S, *et al.* Physical Activity and Anxiety of Chinese University Students: Mediation of Self-System. *Int J Environ Res Public Health* 2021;18:4468.
- 178 Kennellwell E, Curtis RG, Maher C, *et al.* The relationships between school children's wellbeing, socio-economic disadvantage and after-school activities: a cross-sectional study. *BMC Pediatr* 2022;22:297.
- 179 Kettunen O, Vuorimaa T, Vasankari T. A 12-month exercise intervention decreased stress symptoms and increased mental resources among working adults - Results perceived after a 12-month follow-up. *Int J Occup Med Environ Health* 2015;28:157–68.
- 180 Khan A, Ahmed K, Hidajat T, *et al.* Examining the Association between Sports Participation and Mental Health of Adolescents. *IJERPH* 2022;19:17078.
- 181 Kilpatrick M, Sanderson K, Blizzard L, *et al.* Cross-sectional associations between sitting at work and psychological distress: Reducing sitting time may benefit mental health. *Ment Health Phys Act* 2013;6:103–9.
- 182 Kim D, Park J, Park B. How do leisure activities impact leisure domain and life domain satisfaction and subjective well-being? *Journal of Tourism Research* 2024;26.
- 183 Kim J, Chun S, Heo J, *et al.* Contribution of leisure-time physical activity on psychological benefits among elderly immigrants. *Appl Res Qual Life* 2014;11:461–70.
- 184 Kim J, Kim J, Han A. Leisure Time Physical Activity Mediates the Relationship Between Neighborhood Social Cohesion and Mental Health Among Older Adults. *J Appl Gerontol* 2020;39:292–300.
- 185 Kim J, Heo J, Dvorak R, *et al.* Benefits of leisure activities for health and life satisfaction among Western migrants. *Annals of Leisure Research* 2018;21:47–57.
- 186 Kim J, Park C, Fish M, *et al.* Are certain types of leisure activities associated with happiness and life satisfaction among college students? *World Leis J* 2024;66:12–25.
- 187 Kim JY, Lee SW, Chun SH, *et al.* The effects of leisure-time physical activity for optimism, life satisfaction, psychological well-being, and positive affect among older adults with loneliness. *Annals of Leisure Research* 2017;20:406–15.
- 188 Kjellenberg K, Ekblom O, Ahlen J, *et al.* Cross-sectional associations between physical activity pattern, sports participation, screen time and mental health in Swedish adolescents. *BMJ Open* 2022;12:e061929.
- 189 Kleppang AL, Hartz I, Thurston M, *et al.* The association between physical activity and symptoms of depression in different contexts – a cross-sectional study of Norwegian adolescents. *BMC Public Health* 2018;18:18.
- 190 Kleppang AL, Skille EÅ. Leisure-Time Activities in Different Contexts and Depressive Symptoms in Norwegian Adolescents: A Cross-Sectional Study. *IJERPH* 2022;19:10769.
- 191 Kleppang AL, Thurston M, Hartz I, *et al.* Psychological distress among Norwegian adolescents: Changes between 2001 and 2009 and associations with leisure time

- physical activity and screen-based sedentary behaviour. *Scand J Public Health* 2019;47:166–73.
- 192 Kleszczewska D, Mazur J, Bucksch J, *et al.* Active Transport to School May Reduce Psychosomatic Symptoms in School-Aged Children: Data from Nine Countries. *IJERPH* 2020;17:8709.
 - 193 Kliziene I, Cizauskas G, Sipaviciene S, *et al.* Effects of a Physical Education Program on Physical Activity and Emotional Well-Being among Primary School Children. *Int J Environ Res Public Health* 2021;18:7536:14.
 - 194 Klusman K, Langer J, Nichols AL. The Relationship Between Physical Activity, Health, and Well-Being Type of Exercise and Self-Connection as Moderators. *European Journal of Health Psychology* 2021;28:59–70.
 - 195 Knott CS, Panter J, Foley L, *et al.* Changes in the mode of travel to work and the severity of depressive symptoms: a longitudinal analysis of UK Biobank. *Prev Med* 2018;112:61–9.
 - 196 Korniloff K, Vanhala M, Kautiainen H, *et al.* Lifetime leisure-time physical activity and the risk of depressive symptoms at the ages of 65–74 years: The FIN-D2D survey. *Prev Med* 2012;54:313–5.
 - 197 Kremer P, Elshaug C, Leslie E, *et al.* Physical activity, leisure-time screen use and depression among children and young adolescents. *J Sci Med Sport* 2014;17:183–7.
 - 198 Ku PW, Fox KR, Chen LJ. Physical activity and depressive symptoms in Taiwanese older adults: A seven-year follow-up study. *Prev Med* 2009;48:250–5.
 - 199 Ku PW, Fox KR, Chen LJ. Leisure-Time Physical Activity, Sedentary Behaviors and Subjective Well-Being in Older Adults: An Eight-Year Longitudinal Research. *Soc Indic Res* 2016;127:1349–61.
 - 200 Kull M, Ainsaar M, Kiive E, *et al.* Relationship between low depressiveness and domain specific physical activity in women. *Health Care Women Int* 2012;33:457–72.
 - 201 Kurspahic-Mujčić A, Mujčić A. The relationship between leisure time physical activity, socio - demographic characteristics and the levels of perceived stress. *Homo Sporticus* 2019;16–22.
 - 202 Kuwahara K, Honda T, Nakagawa T, *et al.* Associations of leisure-time, occupational, and commuting physical activity with risk of depressive symptoms among Japanese workers: a cohort study. *Int J Behav Nutr Phys Act* 2015;12:119:119.
 - 203 Kuwahara K, Honda T, Nakagawa T, *et al.* Intensity of Leisure-Time Exercise and Risk of Depressive Symptoms Among Japanese Workers: A Cohort Study. *J Epidemiol* 2018;28:94–8.
 - 204 Kwag KH, Martin P, Russell D, *et al.* The Impact of Perceived Stress, Social Support, and Home-Based Physical Activity on Mental Health among Older Adults. *Int J Aging Hum Dev* 2011;72:137–54.
 - 205 La Rocque CL, Mazurka R, Stuckless TJR, *et al.* Randomized controlled trial of bikram yoga and aerobic exercise for depression in women: Efficacy and stress-based mechanisms. *J Affect Disord* 2021;280:457–66.
 - 206 Laczko T, Ács P, Morvay-Sey K, *et al.* The Role of Sports in the Subjective Psychological Well-Being of Hungarian Adult Population in Three Waves of the COVID-19 Pandemic. *Int J Environ Res Public Health* 2022;20:660.
 - 207 Lades LK, Laffan K, Daly M, *et al.* Daily emotional well-being during the COVID-19 pandemic. *British J Health Psychol* 2020;25:902–11.
 - 208 Lahti J, Lahelma E, Rahkonen O. Changes in leisure-time physical activity and subsequent common mental disorders among ageing employees. *Eur J Public Health* 2017;27:765–7.
 - 209 Lahti J, Sabia S, Singh-Manoux A, *et al.* Leisure time physical activity and subsequent physical and mental health functioning among midlife Finnish, British and Japanese employees: a follow-up study in three occupational cohorts. *BMJ Open* 2016;6:e009788.
 - 210 Lallukka T, Shiri R, Pietiläinen O, *et al.* Timing of Entry into Paid Employment, Adverse Physical Work Exposures and Health: The Young Helsinki Health Study. *IJERPH* 2020;17:7854.
 - 211 Lee PL, Lan W, Lee CCL. Physical Activity Related to Depression and Predicted Mortality Risk: Results from the Americans' Changing Lives Study. *Educ Gerontol* 2012;38:678–90.
 - 212 Legey S, Aquino F, Lamego MK, *et al.* Relationship Among Physical Activity Level, Mood and Anxiety States and Quality of Life in Physical Education Students. *Clin Pract Epidemiol Ment Health* 2017;13:82–91.
 - 213 Lera-López F, Irisarri MAG, Fernández MJS. The correlates of physical activity among the population aged 50–70 years. *Retos-Nuevas Tendencias En Educacion Fisica Deporte Y Recreacion* 2017;181–7.
 - 214 Lera-López F, Ollo-López A, Sánchez-Santos JM. How Does Physical Activity Make You Feel Better? The Mediatorial Role of Perceived Health. *Applied Research Quality Life* 2017;12:511–31.
 - 215 Li H, Li Y, Wang Z, *et al.* Green physical activity for leisure connects perceived residential greenspace and mental well-being. *Front Public Health* 2023;11:1254185.
 - 216 Li J, Yuan B, Lan J, *et al.* How Late-Life Working Affects Depression Among Retirement-Aged Workers? An Examination of the Influence Paths of Job-Related (Non-Job-Related) Physical Activity and Social Contact. *J Occup Environ Med* 2022;64:e435–42.
 - 217 Li X, Wang P, Jiang Y, *et al.* Physical activity and health-related quality of life in older adults: depression as a mediator. *BMC Geriatr* 2024;24.
 - 218 Li YM, Hachenberger J, Lemola S. The Role of the Context of Physical Activity for Its Association with Affective Well-Being: An Experience Sampling Study in Young Adults. *Int J Environ Res Public Health* 2022;19:10468:17.
 - 219 Liang J-H, Huang S, Pu Y-Q, *et al.* Whether weekend warrior activity and other leisure-time physical activity pattern reduce the risk of depression symptom in the representative adults? A population-based analysis of NHANES 2007–2020. *J Affect Disord* 2023;340:329–39.
 - 220 Lin CY, Kim B, Liao Y, *et al.* Personal, behavioral, and perceived environmental factors associated with late-life depression in older men and women. *Psychol Res Behav Manag* 2019;12:641–50.
 - 221 Lin L, Halgin RP, Well AD, *et al.* The Relationship Between Depression and Occupational, Household, and Leisure-Time Physical Activity. *J Clin Sport Psychol* 2008;2:95–107.
 - 222 Lin ST, Hung YH, Yang MH. The Relationships among Sport Participation Level, Flow Experience, Perceived Health Status and Depression Level of College Students. *IJERPH* 2023;20:251.
 - 223 Lin Y, Zhao B, Ma X. The Influence of Guozhuang Dance on the Subjective Well-Being of Older Adults: The Chain Mediating Effect of Group Identity and Self-Efficacy. *IJERPH* 2022;19:14545.
 - 224 Liposki DB, da Silva Nagata IF, Silvano GA, *et al.* Influence of a Pilates exercise program on the quality of life of sedentary elderly people: A randomized clinical trial. *J Bodyw Mov Ther* 2019;23:390–3.
 - 225 Liu D, Sun F, Zhu Y, *et al.* Fitness Dance Counteracts Female Ph.D. Candidates' Stress by Affecting Emotion Regulation. *IJERPH* 2022;19:14627.
 - 226 Liu H-L, Lavender-Stott ES, Carotta CL, *et al.* Leisure experience and participation and its contribution to stress-related growth amid COVID-19 pandemic. *Leisure Studies* 2022;41:70–84.
 - 227 Liu NN, Zhong QK. The impact of sports participation on individuals' subjective well-being: the mediating role of class identity and health. *Humanit Soc Sci Commun* 2023;10.
 - 228 Liu S, Chen S, Zhu X, *et al.* Association between Active School Travel and Depressive Symptoms among 51,702 Adolescents in 26 Low- and Middle-Income Countries. *Int J Ment Health Promot* 2021;23:141–53.
 - 229 Lopes MVV, Matias TS, da Costa BGG, *et al.* The relationship between physical activity and depressive symptoms is domain-specific, age-dependent, and non-linear: An analysis of the Brazilian national health survey. *J Psychiatr Res* 2023;159:205–12.
 - 230 Lukmanji A, Williams JVA, Bulloch AGM, *et al.* The Association of Active Living Environments and Mental Health: A Canadian Epidemiological Analysis. *Int J Environ Res Public Health* 2020;17:1910.
 - 231 Lutz RS, Lochbaum MR, Lanning B, *et al.* Cross-lagged relationships among leisure-time exercise and perceived stress in blue-collar workers. *J Sport Exerc Psychol* 2007;29:687–705.
 - 232 Ma L, Hagquist C, Kleppang AL. Leisure time physical activity and depressive symptoms among adolescents in Sweden. *BMC Public Health* 2020;20.
 - 233 Ma L, Ye RN. Utilitarian Bicycling and Mental Wellbeing Role of the Built Environment. *J Am Plann Assoc* 2022;88:262–76.
 - 234 Ma L, Ye RN, Wang HY. Exploring the causal effects of bicycling for transportation on mental health. *Transp Res D Transp Environ* 2021;93:102773.
 - 235 Machado-Oliveira L, Oliveira da Silva A, Quintella Farah B, *et al.* Team sports as a protective factor against mental health problems and suicidal ideation in adolescents. *Salud Ment* 2023;46:177–84.
 - 236 Malebo A, van Eeden C, Wissing MP. Sport Participation, Psychological Well-Being, and Psychosocial Development in a Group of Young Black Adults. *S Afr J Psychol* 2007;37:188–206.
 - 237 Marlier M, Van Dyck D, Cardon G, *et al.* Interrelation of Sport Participation, Physical Activity, Social Capital and Mental Health in Disadvantaged Communities: A SEM-Analysis. *PLoS ONE* 2015;10:e0140196.
 - 238 Marques A, Peralta M, Gouveia ER, *et al.* Leisure-time physical activity is negatively associated with depression symptoms independently of the socioeconomic status. *Eur J Sport Sci* 2020;20:1268–76.
 - 239 Martin A, Goryakin Y, Suhrcke M. Does active commuting improve psychological wellbeing? Longitudinal evidence from eighteen waves of the British Household Panel Survey. *Prev Med* 2014;69:296–303.
 - 240 Martins LCX, Lopes CS. Rank, job stress, psychological distress and physical activity among military personnel. *BMC Public Health* 2013;13:716–26.
 - 241 Mason P, Curl A, Kearns A. Domains and levels of physical activity are linked to adult mental health and wellbeing in deprived neighbourhoods: A cross-sectional study. *Ment Health Phys Act* 2016;11:19–28.
 - 242 Matias TS, Lopes MVV, da Costa BGG, *et al.* Relationship between types of physical activity and depression among 88,522 adults. *J Affect Disord* 2022;297:415–20.
 - 243 Mayolas-Pi C, Sitko S, Oviedo-Caro MA, *et al.* Influence of organised sports practice during adolescence on health of adult women with special emphasis on participation in aesthetic sports. *Eur J Sport Sci* 2021;21:107–17.
 - 244 McGuine TA, M Biese K, Hetzel SJ, *et al.* High School Sports During the COVID-19 Pandemic: The Effect of Sport Participation on the Health of Adolescents. *J Athl Train* 2022;57:51–8.

- 245 McKercher C, Patton GC, Schmidt MD, *et al.* Physical activity and depression symptom profiles in young men and women with major depression. *Psychosom Med* 2013;75:366–74.
- 246 McKercher C, Schmidt MD, Sanderson K, *et al.* Physical activity and depressed mood in primary and secondary school-children. *Ment Health Phys Act* 2012;5:50–6.
- 247 McKercher CM, Schmidt MD, Sanderson KA, *et al.* Physical activity and depression in young adults. *Am J Prev Med* 2009;36:161–4.
- 248 Meira CM, Meneguelli KS, Leopoldo MPG, *et al.* Anxiety and Leisure-Domain Physical Activity Frequency, Duration, and Intensity During Covid-19 Pandemic. *Front Psychol* 2020;11:603770.
- 249 Melby PS, Elsborg P, Bentsen P, *et al.* Cross-sectional associations between adolescents' physical literacy, sport and exercise participation, and wellbeing. *Front Public Health* 2022;10:1054482.
- 250 Meng YT, Luo Y, Qin S, *et al.* The effects of leisure time physical activity on depression among older women depend on intensity and frequency. *J Affect Disord* 2021;295:822–30.
- 251 Michael SL, Lowry R, Merlo C, *et al.* Physical activity, sedentary, and dietary behaviors associated with indicators of mental health and suicide risk. *Prev Med Rep* 2020;19:101153.
- 252 Mizrahi D, Swain CTV, Bruinsma F, *et al.* The Relationship Between Psychological Distress and Physical Activity Is Non-linear and Differs by Domain: a Cross-Sectional Study. *Int J Behav Med* 2023;30:673–81.
- 253 Mockus P, Mockienė A, Karanauskienė D, *et al.* Relationships between the Psychoemotional State of Middle-Aged People and their Physical Activity Levels. *BIJSHS* 2020;1:10–9.
- 254 Molarius A, Berglund K, Eriksson C, *et al.* Mental health symptoms in relation to socio-economic conditions and lifestyle factors--a population-based study in Sweden. *BMC Public Health* 2009;9:302–10.
- 255 Molina-García J, Castillo I, Queralt A, *et al.* Precursors of Body Dissatisfaction and its Implication for Psychological Well-Being in Young Adults. *Univ Psychol* 2019;18:1–11.
- 256 Moore KA, Babyak MA, Wood CE, *et al.* The Association between Physical Activity and Depression in Older Depressed Adults. *J Aging Phys Act* 1999;7:55–61.
- 257 Morgan JK, Hourani L, Tueller S. Health-Related Coping Behaviors and Mental Health in Military Personnel. *Mil Med* 2017;182:e1620–7.
- 258 Motl RW, Birnbaum AS, Kubik MY, *et al.* Naturally occurring changes in physical activity are inversely related to depressive symptoms during early adolescence. *Psychosom Med* 2004;66:336–42.
- 259 Mouchacca J, Abbott GR, Ball K. Associations between psychological stress, eating, physical activity, sedentary behaviours and body weight among women: a longitudinal study. *BMC Public Health* 2013;13:828.
- 260 Mouton CP, Calmbach WL, Dhandu R, *et al.* Barriers and benefits to leisure-time physical activity among older Mexican Americans. *Arch Fam Med* 2000;9:892–7.
- 261 Moya CAM, Soares FC, Lima RA, *et al.* Depressive symptoms in older adults: the role of physical activity and social support. *Trends Psychiatry Psychother* 2021;43:185–92.
- 262 Muñoz C, Rodríguez P, Suárez MJ. An insight into physical activity across domains: implications for depression and perceived health. *Eur Sport Manag Q* 2023;23:508–25.
- 263 Mutrie N, Hannah MK. The importance of both setting and intensity of physical activity in relation to non-clinical anxiety and depression. *Int J Health Promot Educ* 2007;45:24–32.
- 264 Mutz M. Forced adaptations of sporting behaviours during the Covid-19 pandemic and their effects on subjective well-being. *European Societies* 2021;23:184–98.
- 265 Mutz M, Reimers AK, Demetriou Y. Leisure Time Sports Activities and Life Satisfaction: Deeper Insights Based on a Representative Survey from Germany. *ARQOL* 2021;16:2155–71.
- 266 Nagata S, McCormick B, Piatt J. The effect of leisure coping on depressive symptoms among individuals with depression: examination of potential confounding effects of physical activity and extraversion. *Psychol Health Med* 2019;24:654–66.
- 267 Nakamura PM, Teixeira IP, Smirmaul BPC, *et al.* Health related quality of life is differently associated with leisure-time physical activity intensities according to gender: a cross-sectional approach. *Health Qual Life Outcomes* 2014;12:98.
- 268 Niven AG, Strain T. Domains matter: Cross-sectional associations between mental well-being and domain specific physical activity and sedentary behaviour in n=31,818 adults in Scotland. *Ment Health Phys Act* 2023;25:25:100556.
- 269 Nordbø ECA, Raanaas RK, Nordh H, *et al.* Disentangling how the built environment relates to children's well-being: Participation in leisure activities as a mediating pathway among 8-year-olds based on the Norwegian Mother and Child Cohort Study. *Health Place* 2020;64.
- 270 Nowak PF, Božek A, Blukacz M. Physical Activity, Sedentary Behavior, and Quality of Life among University Students. *Biomed Res Int* 2019;2019:1–10.
- 271 O'Loughlin EK, Low NCP, Sabiston CM, *et al.* Symptoms of specific anxiety disorders may relate differentially to different physical activity modalities in young adults. *Ment Health Phys Act* 2013;6:155–61.
- 272 Oberle E, Ji XR, Guhn M, *et al.* Benefits of Extracurricular Participation in Early Adolescence: Associations with Peer Belonging and Mental Health. *J Youth Adolesc* 2019;48:2255–70.
- 273 Ohta M, Mizoue T, Mishima N, *et al.* Effect of the Physical Activities in Leisure Time and Commuting to Work on Mental Health. *J Occup Health* 2007;49:46–52.
- 274 Omorou AY, Vuillemin A, Menai M, *et al.* 10-year cumulative and bidirectional associations of domain-specific physical activity and sedentary behaviour with health-related quality of life in French adults: Results from the SU.VI.MAX studies. *Prev Med* 2016;88:66–72.
- 275 Pacewicz CE, Rowley TW, Savage JL. Physical Activity and the Link Among Stress, Burnout, and Well-Being in Athletic Trainers. *J Athl Train* 2023;58:374–80.
- 276 Pagán R. How Do Leisure Activities Impact on Life Satisfaction? Evidence for German People with Disabilities. *Applied Research Quality Life* 2015;10:557–72.
- 277 Päivärinne V, Kautiainen H, Heinonen A, *et al.* Relations between subdomains of physical activity, sedentary lifestyle, and quality of life in young adult men. *Scand J Med Sci Sports* 2018;28:1389–96.
- 278 Pan Y, Zhou D, Shek DTL. After-School Extracurricular Activities Participation and Depressive Symptoms in Chinese Early Adolescents: Moderating Effect of Gender and Family Economic Status. *IJERPH* 2022;19:4231.
- 279 Park S. Associations between the passive, active, and social leisure participation in the life satisfaction of older adults: a longitudinal analysis of the Korea Retirement and Income Study. *Educ Gerontol* 2023;49:947–60.
- 280 Park SH, Petrunoff NA, Wang NX, *et al.* Daily park use, physical activity, and psychological stress: A study using smartphone-based ecological momentary assessment amongst a multi-ethnic Asian cohort. *Ment Health Phys Act* 2022;22:22:100440.
- 281 Pasanen TP, Tamminen N, Martelin T, *et al.* Positive Mental Health of Finnish People Living Alone: The Role of Circumstantial Factors and Leisure-Time Activities. *Int J Environ Res Public Health* 2021;18:6735:13.
- 282 Pasanen TP, White MP, Wheeler BW, *et al.* Neighbourhood blue space, health and wellbeing: The mediating role of different types of physical activity. *Environ Int* 2019;131:105016.
- 283 Pasco JA, Williams LJ, Jacka FN, *et al.* Habitual physical activity and the risk for depressive and anxiety disorders among older men and women. *Int Psychogeriatr* 2011;23:292–8.
- 284 Pastor Y, Balaguer I, Pons D, *et al.* Testing direct and indirect effects of sports participation on perceived health in Spanish adolescents between 15 and 18 years of age. *J Adolesc* 2003;26:717–30.
- 285 Patterson MS, Gagnon LR, Vukelich A, *et al.* Social networks, group exercise, and anxiety among college students. *J Am Coll Health* 2021;69:361–9.
- 286 Pears M, Kola-Palmer S, De Azevedo LB. The impact of sitting time and physical activity on mental health during COVID-19 lockdown. *Sport Sci Health* 2022;18:179–91.
- 287 Pedišić Ž, Greblo Z, Phongsavan P, *et al.* Are total, intensity- and domain-specific physical activity levels associated with life satisfaction among university students? *PLoS ONE* 2015;10:e0118137.
- 288 Peeters G, van Gellecum YR, van Uffelen JGZ, *et al.* Contribution of house and garden work to the association between physical activity and well-being in young, mid-aged and older women. *Br J Sports Med* 2014;48:996–1001.
- 289 Perez LG, Arredondo EM, McKenzie TL, *et al.* Neighborhood Social Cohesion and Depressive Symptoms Among Latinos: Does Use of Community Resources for Physical Activity Matter? *J Phys Act Health* 2015;12:1361–8.
- 290 Perez-Sousa MA, Olivares PR, Gonzalez-Guerrero JL, *et al.* Effects of an exercise program linked to primary care on depression in elderly: fitness as mediator of the improvement. *Qual Life Res* 2020;29:1239–46.
- 291 Petronyte G, Zaborskis A. The influence of individual and regional factors on association between leisure time physical activity and psychological complaints among adolescents in Europe. *Cent Eur J Public Health* 2009;17:215–9.
- 292 Phansikar M, Gothe N, Hernandez R, *et al.* Feasibility and impact of a remote moderate-intensity yoga intervention on stress and executive functioning in working adults: a randomized controlled trial. *J Behav Med* 2023;46:720–31.
- 293 Pickett K, Yardley L, Kendrick T. Physical activity and depression: A multiple mediation analysis. *Ment Health Phys Act* 2012;5:125–34.
- 294 Pittsinger R, Kress J, Crussemeyer J. The Effect of a Single Bout of Surfing on Exercise Induced Affect. *Int J Exerc Sci* 2017;10:989–99.
- 295 Plateau CR, Anthony J, Clemes SA, *et al.* Prospective study of beginner running groups: psychological predictors and outcomes of participation. *Behav Med* 2024;50:55–62.
- 296 Pollak MJ, Milte CM, van der Pligt P, *et al.* Total physical activity but not diet quality associated with postnatal depressive symptoms amongst women living in socioeconomically disadvantaged neighborhoods. *Nutr Res* 2019;68:54–61.
- 297 Popov S, Volarov M, Rakočević N. The relationship between physical activity and mental health: Is more always better? *PP* 2023;16:349–74.
- 298 Hoegh Poulsen P, Biering K, Andersen JH. The association between leisure time physical activity in adolescence and poor mental health in early adulthood: a prospective cohort study. *BMC Public Health* 2015;16.
- 299 Purakom A, Nakornkhet K, Tanomsuk M, *et al.* Associations between physical activity, functional fitness, and mental health among older adults in Nakornpathom, Thailand. *AJESS* 2014;11:25–35.
- 300 Puterman E, Hives B, Mazara N, *et al.* COVID-19 Pandemic and Exercise (COPE) trial: a multigroup pragmatic randomised controlled trial examining effects of

- app-based at-home exercise programs on depressive symptoms. *Br J Sports Med* 2022;56:546–52.
- 301 Qie R, Huang H, Sun P, *et al.* Physical activity domains and patterns with risk of depressive symptoms: A cross-sectional study in China. *J Affect Disord* 2023;337:120–7.
 - 302 Quarta S, Levante A, García-Conesa M-T, *et al.* Assessment of Subjective Well-Being in a Cohort of University Students and Staff Members: Association with Physical Activity and Outdoor Leisure Time during the COVID-19 Pandemic. *Int J Environ Res Public Health* 2022;19:4787.
 - 303 Quezada AD, Macias-Waldman N, Salmerón J, *et al.* Physical activity and calorie intake mediate the relationship from depression to body fat mass among female Mexican health workers. *Int J Behav Nutr Phys Act* 2017;14:160:160.
 - 304 Raatikainen I, Mäntyselkä P, Heinonen A, *et al.* Does baseline leisure-time physical activity level predict future depressive symptoms or physical activity among depressive patients? Findings from a Finnish five-year cohort study. *Nord J Psychiatry* 2021;75:356–61.
 - 305 Radino A, Tarantino V. Impact of physical activity on response to stress in people aged 65 and over during COVID-19 pandemic lockdown. *Psychogeriatrics* 2022;22:227–35.
 - 306 Rao UT, Noronha JA, Adiga K. Effect of aerobic exercises on depressive symptoms, anxiety, self-esteem, and quality of life among adults with depression. *Clin Epidemiol Glob Health* 2020;8:1147–51.
 - 307 Redig L, Feter N, Dumith SC, *et al.* Physical Inactivity From Childhood to Adolescence and Incident Depression. *Am J Prev Med* 2022;62:211–8.
 - 308 Ribeiro SML, Malmstrom TK, Morley JE, *et al.* Fruit and vegetable intake, physical activity, and depressive symptoms in the African American Health (AAH) study. *J Affect Disord* 2017;220:31–7.
 - 309 Riddervold S, Haug E, Kristensen SM. Sports participation, body appreciation and life satisfaction in Norwegian adolescents: A moderated mediation analysis. *Scand J Public Health* 2023.
 - 310 Rocha SV, de Araújo TM, de Almeida MMG, *et al.* Practice of physical activity during leisure time and common mental disorders among residents of a municipality of Northeast Brazil. *Rev Bras Epidemiol* 2012;15:871–83.
 - 311 Rodríguez-Romo G, Acebes-Sánchez J, García-Merino S, *et al.* Physical Activity and Mental Health in Undergraduate Students. *Int J Environ Res Public Health* 2023;20.
 - 312 Rutherford ER, Vandelanotte C, Chapman J, *et al.* Associations between depression, domain-specific physical activity, and BMI among US adults: NHANES 2011–2014 cross-sectional data. *BMC Public Health* 2022;22:1618.
 - 313 Ryu J, Heo J. Relationships between leisure activity types and well-being in older adults. *Leisure Studies* 2018;37:331–42.
 - 314 Ryu J, Jeong A, Min J-H, *et al.* The relationship between domain-specific physical activity and depressive symptoms in Korean adults: Analysis of the Korea National Health and Nutrition Examination Survey. *J Affect Disord* 2022;302:428–34.
 - 315 Sabiston CM, O'Loughlin E, Brunet J, *et al.* Linking depression symptom trajectories in adolescence to physical activity and team sports participation in young adults. *Prev Med* 2013;56:95–8.
 - 316 Saito Y, Nakamura S, Watanabe K, *et al.* Age group differences in psychological distress and leisure-time exercise/socioeconomic status during the COVID-19 pandemic: a cross-sectional analysis during 2020 to 2021 of a cohort study in Japan. *Front Public Health* 2023;11:11.
 - 317 Sanchez-Villegas A, Ara I, Dierssen T, *et al.* Physical activity during leisure time and quality of life in a Spanish cohort: SUN (Seguimiento Universidad de Navarra) Project. *Br J Sports Med* 2012;46:443–8.
 - 318 Sanchez-Villegas A, Ara I, Guillén-Grima F, *et al.* Physical activity, sedentary index, and mental disorders in the SUN cohort study. *Med Sci Sports Exerc* 2008;40:827–34.
 - 319 Sasidharan V, Payne L, Orsega-Smith E, *et al.* Older adults' physical activity participation and perceptions of wellbeing: Examining the role of social support for leisure. *Managing Leisure* 2006;11:164–85.
 - 320 Scarabottolo CC, Cyrino ES, Nakamura PM, *et al.* Relationship of different domains of physical activity practice with health-related quality of life among community-dwelling older people: a cross-sectional study. *BMJ Open* 2019;9:e027751.
 - 321 Scarabottolo CC, Tebar WR, Gobbo LA, *et al.* Analysis of different domains of physical activity with health-related quality of life in adults: 2-year cohort. *Health Qual Life Outcomes* 2022;20.
 - 322 Scheepers CE, Wendel-Vos GCW, van Wesemael PJV, *et al.* Perceived health status associated with transport choice for short distance trips. *Prev Med Rep* 2015;2:839–44.
 - 323 Schnohr P, Kristensen TS, Prescott E, *et al.* Stress and life dissatisfaction are inversely associated with jogging and other types of physical activity in leisure time--The Copenhagen City Heart Study. *Scand J Med Sci Sports* 2005;15:107–12.
 - 324 Schuch FB, Werneck AO, Vancampfort D, *et al.* Cross-sectional associations of leisure and transport related physical activity with depression and anxiety. *J Psychiatr Res* 2021;140:228–34.
 - 325 Sciamanna CN, Smyth JM, Doerksen SE, *et al.* Physical Activity Mode and Mental Distress in Adulthood. *Am J Prev Med* 2017;52:85–93.
 - 326 Seiffer B, Rösel I, Welkerling J, *et al.* The association of changes in leisure-time physical activity on depressive symptoms during Covid-19 in German adults: A longitudinal study. *Psychol Sport Exerc* 2024;70:102562.
 - 327 Şentürk E, Sağaltıcı E, Geniş B, *et al.* Predictors of depression, anxiety and stress among remote workers during the COVID-19 pandemic. *WOR* 2021;70:41–51.
 - 328 Serrano-Sanchez JA, Lera-Navarro A, Espino-Torón L. Physical activity and differences of functional fitness and quality of life in older males. *Revista Internacional de Medicina y Ciencias de La Actividad Física y Del Deporte* 2013;13:87–105.
 - 329 Sfendla A, Hadrya F. Factors Associated with Psychological Distress and Physical Activity During the COVID-19 Pandemic. *Health Secur* 2020;18:444–53.
 - 330 Sheikh MA, Vancampfort D, Stubbs B. Leisure time physical activity and future psychological distress: A thirteen year longitudinal population-based study. *J Psychiatr Res* 2018;101:50–6.
 - 331 Shen B, Cui GY, Bo J. How does change in leisure-time physical activity influence the growth trajectory of depressive symptoms in college students? *J Am Coll Health* 2025;73:1205–12.
 - 332 Shennar-Golan V, Walter O. Physical Activity Intensity Among Adolescents and Association With Parent-Adolescent Relationship and Well-Being. *Am J Mens Health* 2018;12:1530–40.
 - 333 Siefken K, Junge A, Laemmle L. How does sport affect mental health? An investigation into the relationship of leisure-time physical activity with depression and anxiety. *Hum Mov* 2019;20:62–74.
 - 334 Sieverdes JC, Ray BM, Sui X, *et al.* Association between leisure time physical activity and depressive symptoms in men. *Med Sci Sports Exerc* 2012;44:260–5.
 - 335 Silva DAS, Duncan MJ, Kuzik N, *et al.* Associations between anxiety disorders and depression symptoms are related to 24-hour movement behaviors among Brazilian adolescents. *J Affect Disord* 2023;339:280–92.
 - 336 Silva SCB, Tebar WR, Ferrari G, *et al.* Sports practice, walking and biking are positively related to quality of life in adults: A cross-sectional study. *J Transp Health* 2023;33:101701.
 - 337 Singh M, Sharma P, Raj D, *et al.* Leisure Time Physical Activity and Risk of Developing Depression among the Youth of Kangra District, Himachal Pradesh, India. *Indian J Psychol Med* 2018;40:426–32.
 - 338 Sliwa SA, Must A, Peréa FC, *et al.* Occupational Physical Activity and Weight-Related Outcomes in Immigrant Mothers. *Am J Prev Med* 2016;51:637–46.
 - 339 Soini E, Rosenström T, Määttänen I, *et al.* Physical activity and specific symptoms of depression: A pooled analysis of six cohort studies. *J Affect Disord* 2024;348:44–53.
 - 340 Stea TH, Solaas SA, Kleppang AL. Association between physical activity, sedentary time, participation in organized activities, social support, sleep problems and mental distress among adults in Southern Norway: a cross-sectional study among 28,047 adults from the general population. *BMC Public Health* 2022;22:384.
 - 341 Stephens T. Physical activity and mental health in the United States and Canada: Evidence from four population surveys. *Prev Med* 1988;17:35–47.
 - 342 Sun Y, Liu Y, Tao FB. Associations Between Active Commuting to School, Body Fat, and Mental Well-being: Population-Based, Cross-Sectional Study in China. *J Adolesc Health* 2015;57:679–85.
 - 343 Surkan PJ, Ryan LM, Bidwell HW, *et al.* Psychosocial Correlates of Leisure-Time Physical Activity in Urban Working-Class Adults. *J Phys Act Health* 2005;2:397–411.
 - 344 Suzuki Y, Maeda N, Hirado D, *et al.* Physical Activity Changes and Its Risk Factors among Community-Dwelling Japanese Older Adults during the COVID-19 Epidemic: Associations with Subjective Well-Being and Health-Related Quality of Life. *IJERPH* 2020;17:6591.
 - 345 Swed S, Alilbrahim H, Bohsas H, *et al.* Mental distress links with physical activities, sedentary lifestyle, social support, and sleep problems: A Syrian population cross-sectional study. *Front Psychiatry* 2023;13:13.
 - 346 Szabo A, Boros S, Mezei S, *et al.* Subjective psychological experiences in leisure and competitive swimming. *Annals of Leisure Research* 2019;22:629–41.
 - 347 Takeda F, Noguchi H, Monma T, *et al.* How Possibly Do Leisure and Social Activities Impact Mental Health of Middle-Aged Adults in Japan?: An Evidence from a National Longitudinal Survey. *PLoS ONE* 2015;10:e013977710.
 - 348 Talapko J, Perić I, Vulić P, *et al.* Mental Health and Physical Activity in Health-Related University Students during the COVID-19 Pandemic. *Healthcare (Basel)* 2021;9:801.
 - 349 Tamminen N, Reinikainen J, Appelqvist-Schmidlechner K, *et al.* Associations of physical activity with positive mental health: A population-based study. *Ment Health Phys Act* 2020;18:100319.
 - 350 Tanikaga M, Uemura JI, Hori F, *et al.* Changes in Community-Dwelling Elderly's Activity and Participation Affecting Depression during COVID-19 Pandemic: A Cross-Sectional Study. *Int J Environ Res Public Health* 2023;20:4228.
 - 351 Taşkın A, Eroğlu Kolayış İ. Relationship with physical activity habits, quality of life and sleep quality in different exercise types. *INTJORASS* 2022;6:5–15.
 - 352 Tessier S, Vuillemin A, Bertrais S, *et al.* Association between leisure-time physical activity and health-related quality of life changes over time. *Prev Med* 2007;44:202–8.
 - 353 Teychenne M, Abbott G, Lamb KE, *et al.* Is the link between movement and mental health a two-way street? Prospective associations between physical activity, sedentary behaviour and depressive symptoms among women living in socioeconomically disadvantaged neighbourhoods. *Prev Med* 2017;102:72–8.

- 354 Teychenne M, Ball K, Salmon J. Associations between physical activity and depressive symptoms in women. *Int J Behav Nutr Phys Act* 2008;5:27.
- 355 Teychenne M, Ball K, Salmon J. Physical activity, sedentary behavior and depression among disadvantaged women. *Health Educ Res* 2010;25:632–44.
- 356 Teychenne M, Torres S, McNaughton SA, et al. Mediators of the relationship between sedentary behavior and depressive symptoms amongst disadvantaged women. *Ment Health Phys Act* 2014;7:30–6.
- 357 Thøgersen-Ntoumani C, Fox KR, Ntoumanis N. Relationships between exercise and three components of mental well-being in corporate employees. *Psychol Sport Exerc* 2005;6:609–27.
- 358 Triaca LM, Frio GS, Aniceto França MT. A gender analysis of the impact of physical education on the mental health of brazilian schoolchildren. *SSM Popul Health* 2019;8:100419:100419.
- 359 Tsuji T, Miyaguni Y, Kanamori S, et al. Community-level Sports Group Participation and Older Individuals' Depressive Symptoms. *Med Sci Sports Exerc* 2018;50:1199–205.
- 360 Ubolnua N, Luangpon N, Pitchayadejanant K, et al. Psychosocial and Physical Predictors of Stress in University Students during the COVID-19 Pandemic: An Observational Study. *Healthcare (Basel)* 2022;10:786.
- 361 Urchaga JD, Guevara RM, Cabaco AS, et al. Life Satisfaction, Physical Activity and Quality of Life Associated with the Health of School-Age Adolescents. *Sustainability* 2020;12:9486.
- 362 Vallance J, Eurich D, Gardiner P, et al. Associations of Daily Pedometer Steps and Self-Reported Physical Activity With Health-Related Quality of Life: Results From the Alberta Older Adult Health Survey. *J Aging Health* 2016;28:661–74.
- 363 Valois RF, Zullig KJ, Huebner ES, et al. Physical Activity Behaviors and Perceived Life Satisfaction Among Public High School Adolescents. *Journal of School Health* 2004;74:59–65.
- 364 van den Berg MM, van Poppel M, van Kamp I, et al. Do Physical Activity, Social Cohesion, and Loneliness Mediate the Association Between Time Spent Visiting Green Space and Mental Health? *Environ Behav* 2019;51:144–66.
- 365 Van Dyck D, Teychenne M, McNaughton SA, et al. Relationship of the Perceived Social and Physical Environment with Mental Health-Related Quality of Life in Middle-Aged and Older Adults: Mediating Effects of Physical Activity. *PLoS ONE* 2015;10:e0120475.
- 366 Vella SA, Swann C, Allen MS, et al. Bidirectional Associations between Sport Involvement and Mental Health in Adolescence. *Med Sci Sports Exerc* 2017;49:687–94.
- 367 Vittengl JR. Does context moderate physical activity's relations with depression?: A cross-sectional study. *Ment Health Phys Act* 2021;20:20:100374.
- 368 Vuillemin A, Boini S, Bertrais S, et al. Leisure time physical activity and health-related quality of life. *Prev Med* 2005;41:562–9.
- 369 Wang F, DesMeules M, Luo W, et al. Leisure-time physical activity and marital status in relation to depression between men and women: A prospective study. *Health Psychol* 2011;30:204–11.
- 370 Wang Y, Li Z, Fu C. Urban-rural differences in the association between social activities and depressive symptoms among older adults in China: a cross-sectional study. *BMC Geriatr* 2021;21:569.
- 371 Wei JK, Xie LY, Song SH, et al. Isotemporal substitution modeling on sedentary behaviors and physical activity with depressive symptoms among older adults in the U.S.: The national health and nutrition examination survey, 2007–2016. *J Affect Disord* 2019;257:257–62.
- 372 Wendel-Vos GCW, Schuit AJ, Tjehuis MAR, et al. Leisure time physical activity and health-related quality of life: cross-sectional and longitudinal associations. *Qual Life Res* 2004;13:667–77.
- 373 Werneck AO, Kandola A, Barboza LL, et al. Does stressful workplace characteristics moderate or confound the association between occupational physical activity and elevated depressive symptoms? A large study including 36,442 adults. *J Affect Disord* 2022;303:196–202.
- 374 Werneck AO, Schuch FB, Felez-Nobrega M, et al. Does occupation moderate the association between domain-based physical activity and depressive symptoms? *Ment Health Phys Act* 2023;24:24:100507.
- 375 Werneck AO, Schuch FB, Fernandes RA, et al. Different social contexts of leisure-time physical activity: Does the association with depressive symptoms differ? *Ment Health Phys Act* 2021;20:20:100390.
- 376 Werneck AO, Schuch FB, Vancampfort D, et al. Physical activity domains and incident clinical depression: A 4-year follow-up analysis from the ELSA-Brasil cohort. *J Affect Disord* 2023;329:385–93.
- 377 Werneck AO, Stubbs B, Szwarcwald CL, et al. Independent relationships between different domains of physical activity and depressive symptoms among 60,202 Brazilian adults. *Gen Hosp Psychiatry* 2020;64:26–32.
- 378 White RL, Bennie J, Abbott G, et al. Work-related physical activity and psychological distress among women in different occupations: a cross-sectional study. *BMC Public Health* 2020;20:1007.
- 379 White RL, Parker PD, Lubans DR, et al. Domain-specific physical activity and affective wellbeing among adolescents: an observational study of the moderating roles of autonomous and controlled motivation. *Int J Behav Nutr Phys Act* 2018;15:87:87.
- 380 Wijndaele K, Matton L, Duvigneaud N, et al. Association between leisure time physical activity and stress, social support and coping: A cluster-analytical approach. *Psychol Sport Exerc* 2007;8:425–40.
- 381 Won D, Bang H, Davis L, et al. The role of adolescents' participation in physical education and leisure-time sport activity on their social connectedness, depression, and aggressive behaviour. *Asia Pac J Educ* 2025;45:942–61.
- 382 Wu J, Song J, He Y, et al. Effect of Tai Chi on Young Adults with Subthreshold Depression via a Stress-Reward Complex: A Randomized Controlled Trial. *Sports Med Open* 2023;9:90.
- 383 Xiao CH, Yang Y, Chi GQ. Does the mental health of migrant workers suffer from long commute time? Evidence from China. *J Transp Health* 2020;19:100932.
- 384 Yan YH, Wang X, Zhang RF, et al. The relationship between leisure activities and the mental health of college students during the COVID-19 pandemic. *World Leis J* 2023;65:119–42.
- 385 Yang X, Telama R, Hirsensalo M, et al. Moderating effects of leisure-time physical activity on the association between job strain and depressive symptoms: the Cardiovascular Risk in Young Finns Study. *J Occup Environ Med* 2012;54:303–9.
- 386 Yao B, Takata SC, Mack WJ, et al. Modeling extracurricular activity participation with physical and mental health in college students over time. *J Am Coll Health* 2023;71:1232–40.
- 387 Yen HY, Liao Y, Huang WH. Household physical activity and subjective well-being: An international comparison among East Asian older adult populations. *Arch Gerontol Geriatr* 2024;117:105220.
- 388 Yman J, Helgadóttir B, Kjellberg K, et al. Associations between organised sports participation, general health, stress, screen-time and sleep duration in adolescents. *Acta Paediatr* 2023;112:452–9.
- 389 You Y, Wei M, Chen Y, et al. The association between recreational physical activity and depression in the short sleep population: a cross-sectional study. *Front Neurosci* 2023;17:1016619.
- 390 You YW, Chen YQ, Yin JH, et al. Relationship between leisure-time physical activity and depressive symptoms under different levels of dietary inflammatory index. *Front Nutr* 2022;9:9.
- 391 Young DR, Hong BD, Lo T, et al. The longitudinal associations of physical activity, time spent outdoors in nature and symptoms of depression and anxiety during COVID-19 quarantine and social distancing in the United States. *Prev Med* 2022;154:106863.
- 392 Yu J, Chiu Y-L, Guu S-M, et al. The association between leisure activity and mental health in the older adults in China: amazing Guangchangwu. *Front Public Health* 2024;11:11.
- 393 Zhang J, Gu X, Zhang X, et al. Longitudinal Effects of Motivation and Physical Activity on Depressive Symptoms among College Students. *IJERPH* 2021;18:5121.
- 394 Zhang SH, Ye M, Liu XM. Impact of Urban Historical Parks on Physical Activity and Public Health in Beijing. *J Urban Plann Dev* 2022;148.
- 395 Zhao GR, Lu Z, Sun YY, et al. Dissecting the causal association between social or physical inactivity and depression: a bidirectional two-sample Mendelian Randomization study. *Transl Psychiatry* 2023;13.
- 396 Zijlema WL, Avila-Palencia I, Triguero-Mas M, et al. Active commuting through natural environments is associated with better mental health: Results from the PHENOTYPE project. *Environ Int* 2018;121:721–7.
- 397 Zullig KJ, White RJ. Physical Activity, Life Satisfaction, and Self-Rated Health of Middle School Students. *Applied Research Quality Life* 2011;6:277–89.
- 398 Zulyniak S, Williams JVA, Bulloch AGM, et al. The association of recreational and non-recreational physical activity with mental health: A Canadian cross-sectional analysis. *J Affect Disord Rep* 2020;1:100021.
- 399 Zurawik MA, Carson J, Snape R. "Magic Mirror on the Wall": is Nordic walking or rambling better for your mental well-being? *World Leis J* 2020;62:132–45.
- 400 World bank country and lending groups. Available: https://datacatalogapi.worldbank.org/ddhext/ResourceDownload?resource_unique_id=DR0090755 [Accessed 25 Mar 2025].
- 401 Ryan RM, Deci EL. On happiness and human potentials: a review of research on hedonic and eudaimonic well-being. *Annu Rev Psychol* 2001;52:141–66.
- 402 Ryan RM, Deci EL. *Self-determination theory: basic psychological needs in motivation, development, and wellness*. New York: Guilford Publications, 2017.
- 403 White RL, Ryan D, Young C, et al. How does the context of physical activity influence perceived mood and wellbeing after exercise? *Ment Health Phys Act* 2023;24:100504.
- 404 Gascon M, Zijlema W, Vert C, et al. Outdoor blue spaces, human health and well-being: A systematic review of quantitative studies. *Int J Hyg Environ Health* 2017;220:1207–21.
- 405 Song S, Tu R, Lu Y, et al. Restorative Effects from Green Exposure: A Systematic Review and Meta-Analysis of Randomized Control Trials. *Int J Environ Res Public Health* 2022;19:14506.
- 406 Holt-Lunstad J. Social connection as a critical factor for mental and physical health: evidence, trends, challenges, and future implications. *World Psychiatry* 2024;23:312–32.
- 407 Roe J, McCay L. *Restorative cities: urban design for mental health and wellbeing*. Bloomsbury Publishing, 2021.

- 408 Muntaner C, Eaton WW, Miech R, *et al.* Socioeconomic position and major mental disorders. *Epidemiol Rev* 2004;26:53–62.
- 409 Salvo D, Jáuregui A, Adlakha D, *et al.* When Moving Is the Only Option: The Role of Necessity Versus Choice for Understanding and Promoting Physical Activity in Low- and Middle-Income Countries. *Annu Rev Public Health* 2023;44:151–69.
- 410 White RL, Parker PD, Lubans DR, *et al.* Domain-specific physical activity and affective wellbeing among adolescents: an observational study of the moderating roles of autonomous and controlled motivation. *Int J Behav Nutr Phys Act* 2018;15:87.
- 411 Zhang B, Coene G. Meaningfulness experienced in performing domestic labor in Chinese families: a qualitative study from caregivers' perspectives. *J Chin Sociol* 2024;11:8.
- 412 World Health Organization. *Other common mental disorders: global health estimates*. Geneva: World Health Organization, 2017.
- 413 Craig CL, Marshall AL, Sjöström M, *et al.* International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc* 2003;35:1381–95.
- 414 Physical and sport education — delivery requirements. 2020 Available: <https://www2.education.vic.gov.au/pal/physical-and-sport-education-delivery-requirements/policy>
- 415 Fiset JL. 'Are you listening?': adolescent girls voice how they negotiate self-identified barriers to their success and survival in physical education. *Physical Education & Sport Pedagogy* 2013;18:184–203.
- 416 Ladwig MA, Vazou S, Ekkekakis P. "My Best Memory Is When I Was Done with It": PE Memories Are Associated with Adult Sedentary Behavior. *Transl J ACSM* 2018;3:119–29.
- 417 White RL, Babic M, Bennie A, *et al.* Student experiences of fitness testing in physical education: The role of self-concept. *Health Educ J* 2025;00178969251330862.
- 418 Lubans DR, Lonsdale C, Cohen K, *et al.* Framework for the design and delivery of organized physical activity sessions for children and adolescents: rationale and description of the 'SAAFE' teaching principles. *Int J Behav Nutr Phys Act* 2017;14:24.
- 419 Hogue CM, Fry MD, Fry AC. The differential impact of motivational climate on adolescents' psychological and physiological stress responses. *Psychol Sport Exerc* 2017;30:118–27.
- 420 World Health Organization. *WHO guidelines on physical activity and sedentary behaviour*. Geneva: World Health Organization, 2020.