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Participation in Sports/Recreational Activities and the Occurrence of Psychological Distress in Mid-Aged Adults: Findings From the HABITAT Cohort Study

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Keywords: cohort studies | exercise | mental health | physical activity | sports

ABSTRACT

Objectives: The aim of this study was to investigate prospective associations between participation in sports/recreational activities and the occurrence of moderate-to-severe psychological distress over 2 years in a sample of mid-aged Australians.

Methods: This prospective study used data from 6699 adults aged 40+ years, living in Brisbane in 2007, and surveyed in 2009, 2011 and 2013. Participants provided self-reported data on frequency of participation in each of 11 sports/recreational activities in past 12 months and completed the Kessler Psychological Distress 6-item Scale (K6). Generalized estimating equation (GEE) models with a 2-year lag were used to assess the associations of participation in sports/recreational activities in 2009 and 2011 with new cases of moderate-to-severe psychological distress (K6 score ≥ 5) in 2011 and 2013.

Results: From 2009 to 2013, 22.4% of participants without moderate-to-severe psychological distress at baseline ($N = 4943$) developed this outcome in at least one survey. Overall, there were no clear patterns of association between frequency of participation in sports and recreational activities and occurrence of moderate-to-severe psychological distress. In unadjusted models, weekly participation in some activities (e.g., tennis, golf, and exercise classes) was associated with reduced odds of moderate-to-severe psychological distress over the next 2 years, but these associations were attenuated in most adjusted models with sociodemographic, lifestyle, and health covariates. Participation in home-based exercise and running/jogging were associated with higher odds of psychological distress.

Conclusion: Our findings do not provide strong evidence of beneficial associations of frequency of sport/recreational activities with psychological distress but show surprising negative associations of home-based exercise and running/jogging with occurrence of moderate-to-severe psychological distress over 2 years.

Abbreviations: K6, Kessler Psychological Distress 6-item Scale; GEE, generalized estimating equation; MET, metabolic equivalent task.

1 | Introduction

Psychological distress, characterized by anxio-depressive symptoms, affects around 15%–20% of adults in countries such as the United States, United Kingdom, and Australia [1]. High levels of psychological distress are associated with a range of chronic diseases and mortality [2, 3] and have been estimated to lead to $AU2.81 billion loss in productivity in Australia [4]. Given the considerable human and economic costs, it is crucial to advance our understanding of the preventive factors of psychological distress in order to develop effective public health policies and interventions.

Engaging in physical activities may reduce the occurrence of a range poor mental health, including distress, and symptoms of depression and anxiety [5, 6]. This can be attributed to physical activity having a role in modulation of physiological stress responses, elevating mood, and enhancement of social interactions and relationships [7]. A meta-analysis of data from 49 prospective cohort studies has demonstrated that high levels of physical activity have significant protective effects on depression, with risk reductions of approximately 10% in youths and 22% in adults [7]. However, such research has predominantly focused on adolescents and older adults, as well as specific mental disorders like depression and anxiety, whereas limited attention has been given to mid-aged individuals and generic psychological distress, which may not be diagnosed as depression or anxiety [8, 9]. Midlife appears to be a particularly vulnerable phase for psychological distress [10]. According to the Australia's Health 2018 [11], mid-aged adults are more likely to develop severe psychological distress than adults in other life stages, with the highest rates observed among women aged 45–64 in 2014–15. Therefore, the associations between physical activity and psychological distress at this life stage merit further exploration.

There is limited research on the prospective associations of types of sports/recreational activities, with psychological distress. Some studies have identified certain sports activities, like running and jogging [12], can positively impact mental health, but these findings are primarily based on small nonprobability samples and short-term interventions, with limited generalizability and length of observation. Most studies have focused on management of clinical populations such as those with somatic diseases or postsurgery patients, making the results less generalizable to nonclinical groups. Furthermore, few studies have excluded distressed participants from their baseline samples, resulting in findings being more about tertiary management and treatment of psychological distress rather than prevention, hence incurring a potential reverse-causation bias.

To our knowledge, no research has examined associations between participation in different types of sports with the occurrence of psychological distress through large-scale prospective analyses. This approach is important if we are to improve understanding of potential value of sports and primary prevention approaches for mental health. Therefore, using data from repeated surveys from a large cohort of Australian mid-aged adults, the aim of this study was to investigate the association between participation in sports/recreational activities and the occurrence of moderate-to-severe psychological distress among mid-aged adults over 2 years.

2 | Methods

2.1 | Data Source and Study Sample

We used data from the HABITAT study, a longitudinal study of physical activities among mid-age adults who were living in Brisbane, Australia in 2007. Seventeen thousand individuals were randomly selected in 2007, and 11 035 participants returned the baseline questionnaire (response rate 68.4%). This cohort was then re-surveyed in 2009, 2011, and 2013, excluding those who left the study due to withdrawal, emigration, or death. Survey completion and return was taken as informed consent and the study protocols received ethical clearance from the Queensland University of Technology Human Research Ethics Committee. Further details about sampling, recruitment, and data collection have been published elsewhere [13]. Given that the outcome variable of distress was first assessed in 2007 (Survey 2), only participants who completed this survey and at least one of the subsequent surveys (2011, Survey 3 or 2013, Survey 4; $N = 6699$) were included in the analyses for this study.

2.2 | Exposures and Outcomes of Interest

2.2.1 | Participation in Sports/Recreational Activities

Participation in sports/recreational activities was assessed at Survey 1 (2007), Survey 2 (2009), and Survey 3 (2011). Participants were asked to report the frequency of their participation in each of 11 activities over the past 12 months. These activities included home-based exercise, swimming, cycling, running/jogging, weights, exercise class, yoga/Pilates/tai chi/qigong, golf, tennis, lawn bowls, and team sports. The response options included (a) never, (b) once every 6 months, (c) once a month, (d) once every 2 weeks, (e) once a week, and (f) more than once a week. The responses were categorized into one of three groups: never (a), some participation (b–d), or at least once a week (e, f) [14].

2.2.2 | Psychological Distress

Psychological distress was assessed at Survey 2 (2009), Survey 3 (2011), and Survey 4 (2013) using the Kessler Psychological Distress Scale (K6) [15]. Participants were asked about the frequency of a series of psychological symptoms (nervous, hopeless, restless, or fidgety, "so sad that nothing could cheer you up," "that everything was an effort," and worthless) within the last 4 weeks. The responses ranged from "none of the time" (coded 0) to "all of the time" (coded 4). The six items were summed to yield a score that ranged between 0 and 24. Participants with a score ≥5 were classified as having moderate-to-severe psychological distress. The validity of this threshold has been empirically demonstrated [16].

2.3 | Covariates

Covariates considered for these analyses were collected at each survey. To determine the potential confounders for the association between sports/recreational activities and psychological

distress, a directed cyclic graph (DAG) was drawn (Figure S1) based on evidence from the literature [17, 18]. Covariates included sex, age, education level, working status, annual income, disability status, living arrangements, neighborhood rating as a place to live, smoking status, and obesity status.

These covariates were categorized as follows: sex ("male" or "female"); age ("<45," "45–59," or "≥60" in years); education level ("bachelor degree or higher," "certificate/diploma," or "year 12 or less"); working status ("working" or "not working"); annual gross household income ("$93600 or more," "$52 000–93 599/year," "20 800–51 999/year," or "<20 799/year" in Australian dollars); living arrangements ("living alone" or "living with others"); neighborhood rating ("excellent," "very good/good" or "fair/poor"); obesity status ("not obese" or "obese"); smoking status ("never," "ex-smoker," "occasionally," or "daily"); and disability status ("no disability" or "disability"). Obesity was defined as BMI ≥30 kg/m^2 (calculated from self-reported height and weight). To account for any differences between K6 scores at baseline, we added individual distress score at baseline (Survey 2) as a covariate in our analyses.

Given the previously demonstrated inverse association between physical activity and the occurrence of mental disorders [5], the total volume of physical activity in MET-min/week was also considered as a confounding variable in our analyses. This strategy was used to account for any potential effects of volume of physical activity levels on the associations between sports activities and moderate-to-severe psychological distress. Total physical activity volume was assessed using the Active Australia Survey, a monitoring tool for physical activity in Australia with acceptable levels of reliability and validity [19]. It measured the total duration of walking (for recreation, and to get to and from places), as well as moderate and vigorous physical activities over the previous week. As walking and moderate activity requires less energy expenditure than vigorous activity, the total volume of physical activity was calculated using a weighted measure: total physical activity (MET-min/week) = (walking minutes * 3.33 METS) + (moderate minutes * 3.33 METS) + (vigorous minutes * 6.66 METS). This variable was categorized into "<33.3," "33.3–499.9," "500–1999.9," or "≥2000" in MET-min/week, where the current WHO recommendation for physical activity [20] is equivalent to ≥500 MET-min/week.

2.4 | Statistical Analysis

Because of differences in the availability of variables across surveys (sports activities in Surveys 1–3 and psychological distress in Surveys 2–4), our analyses used data from Surveys 2, 3, and 4 to investigate the association between frequency of participation in sports activities and the occurrence of moderate–severe psychological distress over a 2-year period (Figure S2).

Initially, descriptive analyses were conducted to summarize and compare the characteristics of all the participants who responded to Survey 2 ($N = 7866$) with those included in the analytical sample ($N = 6699$). The prevalence of moderate-to-severe psychological distress at Survey 2, as well as the proportion of participants who reported participation in sports/recreational activities, was described according to sociodemographic and health variables. The proportions of participants without moderate-to-severe psychological distress in Survey 2 (2009, $N = 4943$) who developed moderate-to-severe psychological distress at Survey 3 (2011) or Survey 4 (2013) were calculated for each category of participation in sports/recreational activities variables, so cumulative incidence of moderate-to-severe psychological distress from 2009 to 2013 could be estimated. Logistic generalized estimating equation (GEE) models with a 2-year lag were used to assess the longitudinal associations between sports/recreational activities with the occurrence of the outcome. This strategy accounted for the repeated measures within individuals, with assumptions that observations are missing completely at random. Sports/recreational activities in the past 12 months at Surveys 2 (2009) and 3 (2011) were matched with moderate-to-severe psychological distress at Surveys 3 (2011) and 4 (2013), respectively (Figure S2). Participants classified with moderate-to-severe psychological distress at Survey 2 ($N = 1605$) were excluded from the analyses, so that occurrence of new cases could be assessed. Analyses were conducted using three models, with "never" used as the reference category: Model 1 was a crude analysis; Model 2 adjusted for sex, age, education level, working status, annual income, disability status, living arrangements, neighborhood rating, smoking status, obesity status, and baseline distress score; and Model 3 additionally included total volume of physical activity in MET-min/week.

2.4.1 | Sensitivity Analysis

Analyses were repeated using a subsample of participants who completed all Surveys 2 to 4 (80.7% of the analytical sample). Sensitivity analyses also included one additional model (Supplementary Model 4) to adjust for other concurrent sports/recreational activities and three models (Supplementary Models 5–7) to check over-adjustment. Multiple imputation was performed for the analytical sample ($N = 6699$) for frequency of participation in sports/recreational activities, distress status, and covariates to test if missing data might have impacted the observed association. In addition, the average distress scores at baseline were compared between the groups of sports/recreational activities to assess potential selection bias. E-values, which estimate the strength of the association (on the odds ratio scale) of an unmeasured confounder with both exposure and outcome needed to negate the observed associations [21], were computed to assess the potential effect of unmeasured confounding bias on the associations between sports/recreational activities and moderate-to-severe psychological distress. STATA/SE (version 18.0) was used for all analyses.

3 | Results

Sociodemographic characteristics of the sample at Survey 2 are presented in Table 1. Our cohort included a higher percentage of women and individuals who were aged 45–59, currently working, with relatively high income (≥$52 000/year), living

TABLE 1 | Sociodemographic characteristics of participants in the original [a] and analytical [b] sample at survey 2 (2009). Brisbane, Australia.

	Original sample ($N=7866$)		Analytical sample ($N=6699$)	
Variable	***N***	**%**	***N***	**%**
Sex				
Male	3349	42.6	2838	42.4
Female	4517	57.4	3861	57.6
Age				
<45	925	11.8	772	11.6
45–59	4889	62.3	4165	62.2
≥60	2029	25.9	1755	26.2
Education level				
Year 12 or less	2937	38.3	2443	37.3
Certificate/diploma	2811	36.6	2419	36.9
Bachelor degree or higher	1924	25.1	1688	25.8
Working status				
Working	5369	75.5	4596	75.6
Not working	1747	24.6	1487	24.5
Gross household annual income (AUD)				
<$20799/year	645	9.6	524	9.0
$20800–51999/year	1595	23.6	1335	23.0
$52000–93599/year	2042	30.2	1764	30.4
$93600 or more	2470	36.6	2178	37.6
Disability status				
No disability	6312	83.0	5440	83.7
Disability	1296	17.0	1056	16.3
Living arrangements				
Living alone	1209	16.4	1012	16.1
Living with others	6175	83.6	5289	83.9
Neighbourhood rating				
Excellent	1832	24.0	1587	24.4
Very good/good	5602	73.2	4761	73.1
Fair/poor	210	2.8	165	2.5
Smoking status				
Never	3956	52.1	3446	53.0
Ex-smoker	2687	35.4	2288	35.3
Occasionally	180	2.4	150	2.3
Daily	763	10.1	607	9.4
Obesity status[c]				
Not obese	6010	77.3	5131	77.4
Obese	1763	22.7	1498	22.6

(Continues)

TABLE 1 | (Continued)

Variable	Original sample ($N=7866$)		Analytical sample ($N=6699$)	
	N	%	*N*	%
Physical activity (MET-min/week)				
<33.3	848	11.4	690	10.8
33.3–499.9	1982	26.6	1693	26.6
500–1999.9	3009	40.3	2571	40.4
≥2000	1614	21.7	1416	22.2

Abbreviations: AUD, Australian dollars; MET, metabolic equivalent task.
[a]Original sample included all participants who completed survey 2.
[b]Analytical sample included only participants who completed survey 2 and at least one survey in 3 or 4.
[c]Derived from self-report height and weight, with 30 kg/m^2 as the cut point.

with others, never/ex-smokers, and doing more than 500 MET/mins per week of physical activity (i.e., meeting physical activity guidelines). The prevalence of obesity and disability was around 23% and 17%, respectively. There were no significant differences between the characteristics of the original and analytical samples at Survey 2.

The prevalence of moderate-to-severe psychological distress at Survey 2 (baseline) was 24.5% (95% CI: 23.5–25.6). This value varied with sociodemographic and health variables (Table S1A). Generally, moderate-to-severe psychological distress tended to be more prevalent in women, and those who were younger, had lower education, were not working, had lower annual income, who were daily smoking, with obesity, and with lower physical activity. The participants with disability, living alone or with low neighborhood rating also had a higher prevalence of moderate-to-severe distress. No significant differences were found in the prevalence of moderate-to-severe psychological distress between the original and analytical samples at baseline (Table S1B).

The description of sports/recreational activities according to sex, age, and income subgroups is presented in Table S2. Overall, home-based exercise (46.4% participation) and swimming (41.6% participation) were the two most commonly reported types of activities. Women were more likely than men to engage in home-based exercises, exercise classes, and yoga/tai chi, whereas men were more likely to report cycling, running/jogging, weights, golf, lawn bowls, and team sports. Younger mid-aged adults were more likely than older mid-aged adults to participate in sports activities, but a higher proportion of older mid-aged participants engaged in golf and lawn bowls on a weekly basis. The proportion of weekly participation in sports/recreational activities was generally higher among high-income participants than their low-income counterparts.

3.1 | Sports/Recreational Activities and Moderate-to-Severe Psychological Distress

From 2009 to 2013, 22.4% of the participants without moderate-to-severe psychological distress at Survey 2 developed this outcome. A detailed comparison of the proportion of people with moderate-to-severe distress by sports/recreational activities is shown in Table 2. The association between participation in each of the 11 activities and the occurrence of moderate-to-severe psychological distress is illustrated in Table 3. Overall, no clear pattern of associations was observed between participation in sports and recreational activities and the occurrence of moderate-to-severe psychological distress. In unadjusted models, lower odds of moderate-to-severe psychological distress were observed among participants who reported at least weekly exercise classes, golf and tennis, but these were attenuated in adjusted models.

Conversely, in adjusted models, our results showed positive associations between participation in home-based exercise and running/jogging with the outcome; weekly participation in home-based exercise and running/jogging were associated with 39% and 46% increased odds of moderate-to-severe psychological distress, respectively.

3.2 | Sensitivity Analysis

Sensitivity analyses were performed for participants who completed all Surveys 2 to 4 ($N=5404$) (Table S3). In general, the magnitude of the associations did not change, although some results had wider confidence intervals because of smaller sample sizes. The results of multiple imputation, which largely aligned with the results of the main analyses despite some decreases in the magnitude of the associations, are illustrated in Table S4. A possible reason for this is the relatively high percentage of missing data in annual household income, in which low income is a strong predictor of moderate-to-severe psychological distress. One additional model (Model 4) was conducted to account for the participation in other sports/recreational activities (Table S5). As illustrated, the associations with home-based exercise, running/jogging, and tennis remained.

Average psychological distress scores at baseline for each sport/recreational activity are shown in Table S6; there were no significant differences. Comparisons between model performance are illustrated in Table S7 and Figure S3, where adjusted models showed higher prediction accuracy than crude models. Over-adjustment was checked via three models, adjusting for sociodemographic, health risk factors, and environmental factors (Tables S8 and S9, and Figure S4). As shown, none of the three categories led to over-adjustment.

TABLE 2 | Cumulative occurrence of moderate-to-severe psychological distress among participants without distress in survey 2, by activity groups, 2009–2013 ($N = 4943$).

Sports and recreational activities	*N* (%)[a]	% Distress[b]	% Distress[c]
Home-based exercise			
Never	2538 (53.4)	15.2	21.6
Some	843 (17.7)	18.4	24.8
At least weekly	1372 (28.9)	16.4	22.8
Swimming			
Never	2725 (57.4)	16.2	22.6
Some	1505 (31.7)	16.0	22.4
At least weekly	517 (10.9)	15.7	22.1
Cycling			
Never	3149 (66.3)	16.0	22.3
Some	974 (20.5)	17.0	23.8
At least weekly	624 (13.2)	15.1	21.6
Running or jogging			
Never	3190 (67.2)	16.0	22.2
Some	755 (15.9)	18.8	25.7
At least weekly	799 (16.8)	14.3	21.2
Weights			
Never	3174 (67.2)	16.8	23.0
Some	505 (10.7)	16.6	24.8
At least weekly	1045 (22.1)	13.8	19.8
Exercise class			
Never	3747 (79.4)	16.7	23.3
Some	285 (6.0)	13.3	21.4
At least weekly	686 (14.5)	14.3	19.1
Yoga/Pilates/Tai chi/Qi gong			
Never	3887 (81.8)	16.6	22.8
Some	354 (7.4)	15.5	23.2
At least weekly	514 (10.8)	13.6	20.2
Golf			
Never	3944 (83.2)	16.4	22.7
Some	583 (12.3)	16.6	24.4
At least weekly	215 (4.5)	10.2	14.4
Tennis			
Never	4038 (85.4)	16.6	23.1
Some	504 (10.7)	14.7	21.0
At least weekly	185 (3.9)	11.4	15.7
Lawn bowls			

(Continues)

TABLE 2 | (Continued)

Sports and recreational activities	*N* (%)[a]	% Distress[b]	% Distress[c]
Never	4408 (93.1)	15.9	22.4
Some	255 (5.4)	18.8	24.3
At least weekly	70 (1.5)	17.1	21.4
Team sports			
Never	4430 (93.6)	16.1	22.4
Some	123 (2.6)	19.5	26.0
At least weekly	181 (3.8)	16.6	25.4

[a]At survey 2, 2009.
[b]At survey 3, 2011.
[c]At survey 4, 2013.

The e-values of observed associations are shown in Table S10. The confidence intervals of the observed associations have e-values close to null (1), suggesting that all determined associations had relatively weak strength.

4 | Discussion

The study aim was to explore associations between frequency of participation in sports/recreational activities and the self-reported occurrence of moderate-to-severe psychological distress among mid-aged adults over 2 years. To our knowledge, this is one of the first studies to employ a large, population-based sample to analyze the prospective associations between participation in sports/recreational activities and moderate-to-severe psychological distress. Overall, findings from this study did not show a clear pattern of associations between participation in sports/recreational activities and the occurrence of moderate-to-severe psychological distress. Lower odds of moderate-to-severe psychological distress were observed among participants who reported some activities (e.g., exercise class, golf, and tennis) at least once a week, but only in unadjusted models. Higher odds were observed among those who reported participation in home-based exercise and running/jogging.

In our cohort, higher prevalence rates of moderate-to-severe psychological distress were observed in women, and in participants who were not working, and those with lower education level, lower annual income, daily smoking, obesity, and lower physical activity. The prevalence rate of the outcome was also higher in participants with disability, those who were living alone, or with low rating of the neighborhood as a place to live. These are consistent with the findings of other studies [22].

The most common sports/recreational activities among the cohort were home-based exercise (46.4% participation) and swimming (41.6% participation), which is in line with previous evidence from the same sample that mid-aged adults prefer individual, flexible, and unsupervised forms of physical activity [23, 24]. We also observed differences in participation in sports/recreational activities by sex, age, and income. Specifically, women were more likely to engage in home-based exercise, exercise classes, and yoga/tai chi than men, whereas men reported higher participation in running/jogging and cycling. These results align with previous studies, which suggest that competitive, vigorous, and outdoor activities are more popular among men than women [25]. Older adults over 60 at baseline were less likely to engage in sports, except for golf and lawn bowls. This is consistent with a previous finding from this cohort [24] that older people prefer doing moderate-intensity activities with people of similar age. Participants with lower annual household income generally had lower engagement in sports/recreational activities than those with higher income, which is consistent with a recent statement that economic inequality may lead to inequality in physical activity [26].

The potential negative associations between activities such as exercise classes, golf, and tennis with incident moderate-to-severe psychological distress might be explained via social connection and cognitive stimulation [27]. Engaging in these activities could help to develop social resources and interpersonal functioning, and socialization itself may provide a sense of security and encourage further participation [28]. These activities also require focus and concentration, which can lead to reduction in rumination and negative thinking. In addition, golf and tennis are usually played outdoors, exposure to outdoor environments has been linked to improved mood and mental well-being [29], which might partially explain our findings. Evidence has also suggested that short, repeated intervals of higher intensity exercise can significantly reduce stress [30], which aligns with our results for exercises classes and tennis. These potential associations are in consistent with the findings of a recent umbrella review, which provided meta-analytical evidence that physical activity can prevent depressive disorders [31]. However, further research is needed to explore the mechanisms underlying this relationship for these specific types of activities.

Our results suggest that home-based exercises and running/jogging were associated with a higher occurrence of moderate-to-severe psychological distress. The explanation may be that these activities are often done alone, and lack of social interaction may contribute to the development of psychological distress [32], but these associations require further exploration. The results for running/jogging in this study contrast with the findings of other

TABLE 3 | Association between sports and recreational activities with the occurrence of moderate to severe psychological distress in 2009–2013, analytical sample.[a]

Sports and recreational activities	Model 1, OR (95% CI)	Model 2, OR (95% CI)	Model 3, OR (95% CI)
Home-based exercise			
Never	1.00	1.00	1.00
Some	1.29 (1.02–1.64)	1.26 (0.97–1.63)	1.31 (1.00–1.71)
At least weekly	1.19 (0.97–1.46)	1.34 (1.07–1.69)	1.39 (1.10–1.76)
Swimming			
Never	1.00	1.00	1.00
Some	0.92 (0.75–1.12)	0.94 (0.76–1.18)	0.96 (0.76–1.20)
At least weekly	0.81 (0.59–1.10)	0.82 (0.58–1.17)	0.84 (0.59–1.21)
Cycling			
Never	1.00	1.00	1.00
Some	1.15 (0.92–1.43)	1.11 (0.86–1.43)	1.17 (0.91–1.51)
At least weekly	0.85 (0.63–1.13)	0.91 (0.65–1.25)	0.99 (0.70–1.40)
Running or jogging			
Never	1.00	1.00	1.00
Some	1.35 (1.06–1.72)	1.19 (0.90–1.56)	1.19 (0.90–1.57)
At least weekly	1.12 (0.87–1.45)	1.31 (0.98–1.74)	1.46 (1.08–1.98)
Weights			
Never	1.00	1.00	1.00
Some	1.02 (0.78–1.35)	1.00 (0.73–1.36)	1.05 (0.76–1.43)
At least weekly	0.80 (0.63–1.01)	0.92 (0.71–1.18)	0.95 (0.72–1.24)
Exercise class			
Never	1.00	1.00	1.00
Some	0.94 (0.65–1.35)	1.01 (0.68–1.50)	1.07 (0.72–1.60)
At least weekly	0.77 (0.59–1.00)	0.87 (0.64–1.17)	0.91 (0.66–1.25)
Yoga/Pilates/Tai chi/Qi gong			
Never	1.00	1.00	1.00
Some	1.22 (0.88–1.69)	1.07 (0.73–1.56)	1.12 (0.77–1.64)
At least weekly	0.79 (0.58–1.06)	0.90 (0.64–1.26)	0.98 (0.69–1.39)
Golf			
Never	1.00	1.00	1.00
Some	0.88 (0.66–1.17)	0.90 (0.66–1.23)	0.96 (0.70–1.32)
At least weekly	0.49 (0.29–0.82)	0.64 (0.37–1.11)	0.70 (0.40–1.23)
Tennis			
Never	1.00	1.00	1.00
Some	0.94 (0.69–1.28)	0.92 (0.66–1.28)	0.96 (0.68–1.34)
At least weekly	0.37 (0.21–0.66)	0.60 (0.33–1.09)	0.55 (0.29–1.03)

(Continues)

TABLE 3 | (Continued)

Sports and recreational activities	Model 1, OR (95% CI)	Model 2, OR (95% CI)	Model 3, OR (95% CI)
Lawn bowls			
Never	1.00	1.00	1.00
Some	1.36 (0.93–1.99)	1.15 (0.76–1.75)	1.18 (0.78–1.80)
At least weekly	0.78 (0.36–1.68)	0.58 (0.23–1.46)	0.61 (0.24–1.56)
Team sports			
Never	1.00	1.00	1.00
Some	1.30 (0.75–2.25)	1.31 (0.73–2.33)	1.40 (0.78–2.50)
At least weekly	1.13 (0.69–1.84)	1.12 (0.66–1.90)	1.20 (0.71–2.04)

Note: Model 1: crude analysis. Model 2: adjusted for sex, age, obesity status, education level, working status, annual income, living arrangements, neighbourhood rating, smoking status, disability status, and baseline distress scores. Model 3: adjusted for Model 2 plus total physical activity in MET-min/week.
[a]Analytical sample size (*N*) varied from 4675 to 4694 in sport groups.

studies [12, 33]. On the basis of empirical evidence [34], our hypothesis for this is that runners/joggers in the current study may be high achievers and competitive, and these characteristics may increase their vulnerability to higher levels of psychological distress.

4.1 | Causality

We assessed our associations against Bradford Hill's criteria for causality. Prospective cohort studies provide strong evidence for temporality, and the relatively small estimates of e-values suggest our observed associations might be explained by a small number of unmeasured confounders [21], so the strength of the associations was relatively low. Possible mechanisms for the associations were mentioned in the previous section. The criterion of specificity was not met as psychological distress is not the only health condition associated with physical inactivity. The potential negative association between some activities and moderate-to-severe psychological distress did not conflict with the natural history and biology of mental health issues, so coherence was supported. However, our observed associations for home-based exercise and running/jogging did not align with the commonly recognized associations between physical activity and mental health. Overall, our findings partially supported a causal relationship between participation in sports/recreational activities with moderate-to-severe psychological distress. The beneficial association with some activities aligns with a previous systemic review of 116 primary prospective cohort studies, which found a probable causal relationship between higher levels of physical activity with a lower risk of mental illnesses [35]. However, the observed associations for home-based exercise and running/jogging were inconsistent with many recent findings [12].

4.2 | Strengths and Limitations

The present study has several strengths. The study included repeated assessments, which enabled the consideration of within-person changes in participation and distress over time. Our analyses accounted for the differences in time spent in other physical activities (e.g., walking/cycling for transport), via adjusting for total physical activity over the previous week, which gave largely unchanged results. Given that participants in any of the sports/recreational activities associated with distress may have also engaged in other sports activities, we established a model to adjust for concurrent sports/recreational activities, which generated similar results and further supported the observed associations.

This study also has some limitations. The response rate at baseline (68.4%) may have introduced selection bias. Compared with 2006 census data [36], respondents of the HABITAT study were more likely to be women, in work, with higher education levels, and from less disadvantaged areas. Therefore, the generalizability of our results might be limited to these groups. The frequency of participation in sports/recreational activities and symptoms of psychological distress were assessed using self-report questionnaires, which are vulnerable to recall and social desirability bias. Activity participation was assessed over the past 12 months, which may be considered somewhat basic. Furthermore, as the duration, intensity, and context (e.g., done socially/alone/competitively) of these activities were not measured in this study, their potential effects of amount of different types of activity on our findings were not accounted for. Our determined associations had relatively small e-values, suggesting that these associations might be explained away by unmeasured confounders like medication use and alcohol consumption. In addition, the low sensitivity (0.36) of the K6 scale for psychological distress [15] could have resulted in participants with moderate-to-severe psychological distress not being excluded from the baseline and being included in the analytical sample. As empirical studies suggest a bidirectional relationship between physical activity and mental health [37], the potential bidirectionality may contribute to reverse-causality. Therefore, further research will be needed to confirm our findings.

5 | Perspective

Preventive measures for moderate-to-severe psychological distress are not widely implemented, and the cost of prevention is a major barrier [38]. Our study demonstrates that frequency of participation in some activities may have a protective effect on the occurrence of moderate-to-severe psychological distress, and if this was

true, it would offer preventive approach that is accessible to the public and impose a relatively low economic burden on individuals and government. Our study endorses prior claims of mental health benefits of participation in golf and tennis [39, 40]. Our findings imply the need for future research to investigate the potential associations between the intensity, duration, and context of sports/recreational activities and psychological well-being. Such investigations could provide further insights to explain our results.

6 | Conclusion

Through a prospective design, we investigated the association between participation in sports/recreational activities in midlife and the occurrence of moderate-to-severe psychological distress in a large population-based cohort of Australian adults. Our findings suggest a potential association between weekly participation in some activities with reduced occurrence of moderate-to-severe psychological distress. However, running/jogging and home-based exercise were associated with a higher occurrence of this outcome, which requires further exploration. Given the increasing prevalence of poor mental health among the mid-aged population [10], our findings can contribute to increased awareness of the potential impact of sports, active recreation, and exercise in the field of psychological distress, and serve as a foundation for relevant studies in the future.

Author Contributions

R.Y. participated in the design of the study, conducted data analysis, and wrote the drafts of the manuscript. W.J.B. and N.W.B. contributed to the conceptualization and establishment of the HABITAT study, data collection and provided feedback on the drafts of the manuscript. G.I.M. was the supervisor of this study, contributed to study design, and provided feedback on the drafts of the manuscript.

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Ethical Approval

All study protocol received ethical clearance from the Queensland University of Technology Human Research Ethics Committee (ref. nos. 3967 H &1300000161).

Consent to Participate

All individual participants were consulted, clarified, and accepted participation in the study by signing an Informed Consent Form. All methods were carried out in accordance with relevant guidelines and regulations.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

There are no linked research data sets for this submission. The data used are confidential.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.