Original article
Prospective associations of different contexts of physical activity with psychological distress and well-being among middle-aged adults: an analysis of the 1970 British Cohort Study

Running head: **Contexts of physical activity and mental health**

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Abstract

Background: Our aim was to investigate whether different types and social contexts of physical activity (PA) participation are prospectively associated with psychological distress and well-being among middle-aged adults.

Methods: Data from the 1970 British Cohort Study was used (N=5,144-2,733 women). At age 42y, participants reported their type of leisure-time PA, which was classified as individual PA or group PA (exposure). At age 46y, participants reported co-primary outcomes: psychological distress (Malaise Inventory) and well-being (Warwick-Edinburgh scale). Highest academic achievement, employment status, country of interview, baseline values of psychological distress and well-being, smoking, alcohol use, TV-viewing and total physical activity at 42y were used as covariates. Main analyses included linear regression stratifying by sex.

Results: Jogging, cross-country, road-running (both sexes) as well as team sports (men) were associated with higher well-being. Health, fitness, gym or conditioning activities and jogging, cross-country (women), road-running (women) and team sports (men) were associated with lower psychological distress. Participation in both individual and group PA were associated with lower psychological distress and higher well-being for both sexes in crude models. However, adjusted models revealed that only group PA was associated with lower psychological distress (*B*: -0.106; 95%CI:-0.188 to -0.025) and higher well-being (0.835; 0.050 to 1.619) among men but not women. In the sensitivity analysis, group PA was associated with higher well-being (0.855; 0.094 to 1.616) when compared with individual PA among men. Group PA was not associated with psychological distress among both sexes and well-being among women when compared with individual PA.

Conclusion: Group PA was prospectively associated with lower psychological distress and higher well-being among men but not females. Future PA interventions could focus on group activities for males. Further research to understand the relationship between individual/group PA and mental health is required in females.

Key words: exercise; mood; depressive symptoms; mental health

Introduction

Psychological distress and lower well-being are prospectively associated with a greater risk of several mental health conditions (Iasiello et al., 2019; Keyes et al., 2010). There is growing evidence that physical activity is associated with reduced psychological distress and higher well-being (Blomstrand et al., 2009; Perales et al., 2014; Sheikh et al., 2018). Considering that physical activity can be practiced in different domains (e.g. leisure-time, occupational, transport), the leisure-time domain has been consistently associated with lower mental health risks (Mason et al., 2016; White et al., 2017).

Leisure-time physical activity can influence mental health through different mechanisms, such as reducing inflammation (Fernandes et al., 2018; Goldman-Mellor et al., 2010), regulating cortisol release (Fuqua and Rogol, 2013), altering in neuroplasticity and increasing the hippocampal volume (Firth et al., 2018; Kubarych et al., 2012; Van 't Ent et al., 2017). However, some of the mechanisms linking leisure-time physical activity participation and mental health might be psychosocial in nature, such as through higher social inclusion and social support (Bian et al., 2018; Doré et al., 2018; Fu et al., 2017; Thoits, 2011).

Leisure-time physical activity can be practiced in different types (e.g. team sports, running, gym) and social contexts, such as individual or group settings. Findings indicate that participating in group activities are associated with more favorable mental health indicators, including lower depressive and anxiety symptoms and higher well-being (Brunet et al., 2013; Doré et al., 2018, 2016; Sabiston et al., 2016). However, doubts remain about how the different social contexts of leisure-time physical activity are associated with mental health in specific periods of life, where most previous studies were focused on the transition between adolescence and early adulthood (Brunet et al., 2013; Doré et al., 2018, 2016; Sabiston et al., 2016). Also, the modifying

80   effects of sex in relation to leisure-time physical activity context and mental health was

81   not previously explored. In this sense, sex can influence the association of contexts of

82   leisure-time physical activity and mental health considering that there is a possible sex-

83   differentiation in how social support is perceived (Caetano et al., 2013; Kim et al., 2019;

84   Tobiasz-Adamczyk et al., 2017). For example, women usually have higher social

85   networks, but the perception of social support can be most associated with well-being

86   than the size of the network itself, while the size of network can be more associated

87   with well-being among men (Ajrouch et al., 2005; Caetano et al., 2013). Therefore, the

88   increase in social connections through group physical activity practices can be most

89   beneficial for men.

90   Therefore, we aimed to investigate whether different types and social contexts of

91   leisure-time physical activity (i.e. individual or group-based PA) are associated with

92   psychological distress and well-being using a prospective cohort of middle-aged adults.

93

94   **Methods**

95   *Design and sample*

96   This study analyzed data from the 1970 British Birth Cohort (BCS70). The methods and

97   sample characteristics of the BCS70 has been described fully elsewhere (Elliott and

98   Shepherd, 2006). The BCS70 is a multidisciplinary longitudinal study designed as the

99   British Births Survey and included all individuals from England, Scotland, Wales and

100   Northern Ireland who were born in a specific week of 1970 (Elliott and Shepherd,

101   2006). The sample was followed-up in 1975 (5y), 1980 (10y), 1986 (16y), 1996 (26y),

102   2000 (30y), 2004 (34y), 2008 (38y), 2012 (42y) and 2016 (46y). The present study

103   analyzed data from the 2012 and 2016 waves. All procedures utilized for this study

104   complied with the ethical standards of the relevant national and institutional

105   committees on human experimentation and with the Helsinki Declaration of 1975 and

106   approved by the London- Central ethics committee (process: 11/LO/1560) for the 2012

107   wave and by the South East Coast – Brighton and Sussex (process 15/LO/1446).

108   Participants provided written consent during the interviews (Shepherd and Gilbert,

109   2019).

110   The initial study sample included 9,841 adults that participated in the 42 years

111   wave. The final sample with complete data for our analyses at 42 years and 46 years

112   was composed of 5,144 participants (2,733 women).

113

114   *Outcomes (psychological distress and well-being)*

115   The co-primary outcomes were psychological distress and well-being measured at 46

116   years. Psychological distress was evaluated using the Malaise Inventory, which asks

117   questions regarding depressive moods, lack of energy, anxiety and stress. The 9-

118   question version was applied (with scores ranging 0 to 9) (Rutter et al., 1970). The

119   Malaise Inventory of 24 Items presented good reliability (Cronbach alpha = 0.80) in the

120   UK population (Rodgers et al., 1999) and the 9-item version have a high correlation

121   with the 24-item questionnaire (Ploubidis et al., 2017). For well-being, the Warwick-

122   Edinburgh mental well-being scale was used. The Warwick-Edinburgh scale includes

123   questions regarding positive affect, satisfying interpersonal relationships and positive

124   functioning, with a score between 14 and 70 (Tennant et al., 2007). Previous validation

125   study also found good reliability for the Warwick-Edinburgh scale in the UK population

126   (Tennant et al., 2007).

127

128   *Exposure (leisure-time physical activity context)*

129   The social contexts of physical activity were reported through the question "How often

130   have you done each of the following sporting activities in the last 12 months?", with a

131   list of activities, which were classified into individual and group physical activity taking

132   into consideration the probability of be practiced in group or with at least one colleague

133   (Doré et al., 2018). Individual: 1) Health, fitness, gym or conditioning activities

134   (including aerobics, keep-fit classes, weight-training or weight-lifting); 2) Swimming or

135   diving; 3) Cycling, BMX or mountain biking; 4) Jogging, cross-country, road-running; 5)

136   Rambling / walking for pleasure; 6) Horse riding. Group practice: 1) Yoga / Pilates; 2)

137   Dancing; 3) Racquet sports (tennis, badminton, squash etc); 4) Team sports (Football,

138   Netball, Basketball, Rugby, Hockey, Cricket etc); 5) Martial arts, boxing, wrestling; 6)

139   Golf. We classified those reporting at least one group physical activity practice as

140   practicing group physical activity. The remaining participants, who practiced individual

141   physical activity, but without group physical activity practice were classified as

142   individual physical activity practice according with previous study (Doré et al., 2018).

143   Each type of leisure-time physical activity was also analyzed individually (practice vs.

144   non-practice).

145

146   *Potential confounders*

147   Country of origin, highest academic achievement, employment status, living status,

148   having a child, alcohol use, tobacco smoking, TV-viewing, total leisure-time physical

149   activity, values of psychological distress and well-being at baseline (42 years) were

150   inserted as covariates based on previous studies (Kandola et al., 2019). Highest

151   academic achievement was categorized into three groups: none (no formal education or

152   incomplete secondary education), at least high school and more than high school.

153   Employment status was assessed during adulthood (having a full-time job versus not

having a full-time job). Living status was classified as living with a spouse or partner or not. Having a child was classified as having a child in the household or not. Tobacco smoking was assessed through a question regarding the smoking frequency, those who answered positive for smoking at least occasionally were considered as smokers. Alcohol use was also assessed through a question asking about alcohol consumption frequency and participants that reported four or more days of alcohol consumption per week were considered as frequent consumers. TV-viewing was assessed as a proxy for sedentary behaviour, through questions about duration of TV-viewing during weekdays and weekends, which were collapsed into a single indicator using proportional means: "(TV-viewing during weekdays * 5 + TV-viewing during weekend * 2)/7". Leisure-time physical activity was assessed through questions about the frequency and duration as well as type of physical activity. For total leisure-time physical activity, participants were asked *"On how many days in a typical week do you do 30 minutes or more of exercise where you are working hard enough to raise your heart rate and break into a sweat?"*, with answers ranging from 0 to 7 days. We considered those reporting at least 5 days/week as active (World Health Organization, 2020).

Analysis

Absolute and relative frequencies were used for characteristics of the sample as well as attrition analyses, including chi-square and t-test to compare sex. Analysis of variance and the Bonferroni post-hoc test was used to compare psychological distress and well-being according to different physical activity contexts. Linear regression models were used to analyze the association of different social contexts of leisure-time physical activity practice with well-being and psychological distress. Psychological distress was

179 square root transformed, considering its non-normal distribution. The models adopted

180 participants without leisure-time physical activity practice as reference. Sensitivity

181 analyses using linear regression models were created to analyze the association of

182 different contexts of leisure-time physical activity practice with well-being and

183 psychological distress only including participants with leisure-time physical activity

184 practice (adopting individual physical activity practice as reference). For both analyzes,

185 we created three models for the whole sample and stratifying by sex: Model 1: Crude

186 model. Model 2: Adjusted for highest academic achievement, employment status, living

187 status, having a child, country of interview and baseline values of well-being (for well-

188 being model) and psychological distress (for psychological distress model). Model 3:

189 Model 2 + tobacco smoking, alcohol use, TV-viewing and total physical activity volume.

190 Also, analyses for the association of different types of leisure-time physical activity with

191 psychological distress and well-being for the whole sample and stratifying by sex were

192 conducted using linear regression models. The models were adjusted for highest

193 academic achievement, employment status, living status, having a child, country of

194 interview and baseline values of well-being (for well-being model) and psychological

195 distress (for psychological distress model), tobacco smoking, alcohol use, TV-viewing

196 and total physical activity. All analyzes were performed using the software Stata 15.1.

197
198
199 **Results**
200
201
202 Characteristics of the sample according to sex are presented in **Table 1**. Women had

203 lower group physical activity levels and higher psychological distress at baseline and

204 follow-up. The prevalence of women, participants from Wales and with higher

205 education were slightly higher among those included in comparison with those

206 excluded, while there were no differences regarding physical activity participation

207 between them (**Table 2**). Also, included participants presented lower psychological

208 distress and higher well-being.

209 Both participants that practice individual and group physical activity at 42 years,

210 presented lower psychological distress and higher well-being in comparison with the

211 physically inactive group (**Figure 1**). The associations of different social contexts of

212 physical activity at 42 years with well-being and psychological distress at 46 years are

213 presented at **Table 3**. In crude models, both individual and group physical activity were

214 associated with higher well-being and lower psychological distress among both sexes.

215 After the adjustment for covariates, only group physical activity was associated with

216 lower psychological distress (*B*: -0.106; 95%CI: -0.188 to -0.025) and a 0.835 higher

217 well-being score (*B*: 0.835; 95%CI: 0.050 to 1.619) among men, when compared with

218 physically inactive participants. However, there were no sex-interactions.

219 In further analyses we directly compared social contexts of physical activity

220 excluding inactive participants (**Table 4**). We found that group physical activity was

221 associated with higher well-being (*B*: 0.855; 95%CI: 0.094 to 1.616) when compared

222 with individual physical activity practice among men. No associations were found

223 among women. There were no sex-interactions.

224 The association of different types of physical activity with well-being and

225 psychological distress are presented in **Table 5** and **Table 6,** respectively. The practice

226 of jogging, cross-country, road-running was associated with higher well-being in both

227 sexes (Whole sample: *B*: 0.890; 95%CI: 0.320 to 1.459. Men: *B*: 0.790; 95%CI: 0.033 to

228 1.548. Women: *B*: 1.010; 95%CI: 0.154 to 1.866) and team sports was associated with

229 higher well-being in the whole sample (*B:* 0.874; 95%CI: 0.003 to 1.746) and among

230 men (*B:* 1.063; 95%CI: 0.144 to 1.981). Health, fitness, gym or conditioning activities

231 and jogging, cross-country, road-running were associated with lower psychological

232 distress in the whole sample (Health, fitness, gym or conditioning activities: *B*: -0.049;

233 95%CI: -0.090 to -0.007. Jogging, cross-country, road-running: *B*: -0.071; 95%CI: -0.130

234 to -0.013) as well as among women (Health, fitness, gym or conditioning activities: *B*: -

235 0.068; 95%CI: -0.125 to -0.011. Jogging, cross-country, road-running: *B*: -0.089; 95%CI:

236 -0.174 to -0.003), while team sports practice was associated with lower psychological

237 distress in the whole sample (*B*: -0.098; 95%CI: -0.187 to -0.009) and among men (*B*: -

238 0.108; 95%CI: -0.203 to -0.012)

239

240 **Discussion**

241 We aimed to investigate whether different types and social contexts of physical activity

242 are prospectively associated with psychological distress and well-being. Our main

243 findings were that physical activities that are predominantly practiced individually (i.e.

244 health, fitness, gym or conditioning activities and jogging, cross-country, road-running)

245 were associated with lower psychological distress and higher well-being among women,

246 while team sports practices were the strongly associated with lower psychological

247 distress and higher well-being among men. The analyzes comparing individual and

248 group-based activities revealed that participants who practiced group physical activity

249 at baseline had higher well-being and lower psychological distress at follow up, while

250 the practice of individual physical activity was not associated with well-being and lower

251 psychological distress in the adjusted models. Further analysis suggest that group

252 physical activity was more strongly associated with higher well-being and lower

253 psychological distress in men, compared with individual physical activity practice.

254   Our findings are in line with previous studies using smaller samples during the

255 adolescence and young adults investigating the association with depressive symptoms

256   (Brunet et al., 2013; Doré et al., 2018, 2016; Sabiston et al., 2016) as well as cross-

257   sectional finding among adults investigating the association with quality of life (Eime et

258   al., 2010). However, our study advances in exploring the different types of activities and

259   analyzing together indicators of positive and negative mental health, highlighting that

260   group physical activity can benefit beyond to avoid negative mental health, also

261   promoting positive mental health.

262   Leisure-time practice of physical activity has been consistently associated

263   different mental health indicators, including positive mental health indicators as well-

264   being and quality of life (Blomstrand et al., 2009; Eime et al., 2010; Mason et al., 2016),

265   negative indicators as psychological distress (Perales et al., 2014; Sheikh et al., 2018;

266   White et al., 2017) and symptoms of mental disorders (Werneck et al., 2020; White et

267   al., 2017). The benefits of leisure-time physical activity might act via participation in

268   higher intensities of moderate-to-vigorous activity, which is associated with several

269   potential mechanisms, including biological and social (Kandola et al., 2019). Some

270   biological mechanisms of physical activity practice include the reduction of

271   inflammatory markers, cortisol hormone and neuroplasticity adaptations as increase

272   hippocampal volume and increase BDNF-α release, which are associated with better

273   mental health indicators, especially those related with negative mental health (Firth et

274   al., 2018; Goldman-Mellor et al., 2010; Kandola et al., 2019; Kubarych et al., 2012;

275   Paolucci et al., 2018; Van 't Ent et al., 2017).

276   Even without sex-differences we found that group-based physical activity

277   practice presented higher protection than individual physical activity among men, but

278   not women. It is possible that men have clearer benefits with the expansion of their

279   social networks than women (Ajrouch et al., 2005; Sonnenberg et al., 2013). This finding

280   also highlights the importance of gender equality to promote leisure-time physical

281   activity (Balish et al., 2016). In this sense, women with higher schooling and economic

282   level, which are indicators of gender equality present similar levels of leisure-time

283   physical activity than men (Azevedo et al., 2007; Brown et al., 2016; Mao et al., 2020),

284   but women tend to practice individual physical activities as we found in the present

285   study (Stamatakis and Chaudhury, 2008), which can reflect cultural gender inequalities

286   in group physical activities, also explaining part of the null results among women.

287   Therefore, the context of leisure-time physical activity practice can be more decisive for

288   men.

289   The association between group physical activity and well-being among men, can

290   be partly explained by some social mechanisms. Group practices can increase social

291   support and social integration (Andersen et al., 2019), which in turn are associated with

292   lower psychological distress and higher well-being (Siedlecki et al., 2014). Also, the

293   higher social support can help individuals to cope with negative emotions caused by

294   daily life (Thoits, 2011; Wang et al., 2014). However, further studies investigating the

295   mechanisms linking group physical activity and mental health are needed.

296   Our study included a large cohort study to investigate the association between

297   the social context of physical activity and mental health among middle-aged adults.

298   However, our findings should be inferred in light of potential limitations. First, all

299   measures were self-reported and therefore, can contain recall bias, although our

300   exposures were based on contexts of physical activity and our outcomes were

301   psychological distress and well-being, which we currently still do not have an objective

302   measure. Second, there was a considerable rate of missing data and the included sample

303   was slightly different from the non-included sample, with a slightly higher education as

304   well as lower baseline values of psychological distress and higher well-being. In general,

305   the dropout along the years reduces the generalizability of the study, although the

306   retention rates of cohort studies with long-term follow-ups are low (Teague et al.,

307   2018). Third, we did not specifically evaluate if the physical activities were undertaken

308   with others and therefore certain activities may have been misclassified (e.g. running or

309   cycling group). Fourth, the low prevalence of group-based physical activity participation

310   and the larger prevalence of individual physical activity can lead to unstable estimates

311   especially for women.

312   **Conclusions**

313   Both individual and group physical activities were prospectively associated with higher

314   well-being and lower psychological distress. However, when adjusted for covariates

315   including total time spent in physical activity, only group physical activity was

316   associated higher well-being when compared with individual physical activity practice,

317   among men. Future interventions should focus on group physical activities.

318

328

329   **COMPLIANCE WITH ETHICAL STANDARDS**

330

337 **Conflicts of interest:** None.

338 **Ethics approval:** The authors assert that all procedures contributing to this work

339 comply with the ethical standards of the relevant national and institutional committees

340 on human experimentation and with the Helsinki Declaration of 1975, as revised in

341 2008. All procedures involving human subjects/patients were approved by the London-

342 Central MREC (11/LO/1560) for the 2012 wave and South East Coast – Brighton and

343 Sussex (15/LO/1446) for the 2016 wave.

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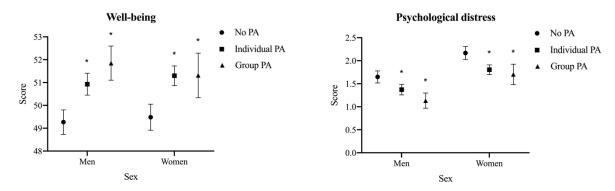
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Figure 1. Well-being and psychological distress according to type of physical activity practice. Values are presented using mean and 95% confidence interval. Analysis of variance with Bonferroni post-hoc were used to compare groups. *p<0.05 vs. no PA group. PA, physical activity.

517 **Table 1.** Characteristics of the sample according to sex.

	Men (n=2,411)	Women (n=2,733)	p
42 years			
Country of residence, %			0.318
England	2,098 (87.0)	2,410 (88.2)	
Scotland	115 (4.8)	129 (4.7)	
Wales	198 (8.2)	194 (7.1)	
Highest academic achievement, %			<0.001
None	652 (27.0)	589 (21.6)	
Up to high school	933 (38.7)	1,099 (40.2)	
More than high school	826 (34.3)	1,045 (38.2)	
Employment (yes), %	1,808 (75.0)	1,989 (72.8)	0.072
Living with a partner (yes), %	1,918 (79.6)	2,130 (78.0)	0.165
Child living in the household (yes), %	1,625 (67.4)	2,136 (78.2)	<0.001
Tobacco smoking, %	557 (23.1)	575 (21.0)	0.075
Alcohol use, %	1,341 (55.6)	1,162 (42.5)	<0.001
Physical activity (150min/week)	649 (27.3)	511 (19.0)	<0.001
Physical activity type, %			<0.001
No	952 (39.5)	995 (36.4)	
Individual only	1,060 (44.1)	1,466 (53.6)	
Group practice	399 (16.6)	272 (10.0)	
Psychological distress, score	1.5 ± 1.8	2.0 ± 2.0	<0.001
Wellbeing, score	49.6 ± 7.8	49.6 ± 8.4	0.408
46 years			
Psychological distress, score	1.4 ± 1.9	1.9 ± 2.1	<0.001
Well-being, score	50.4 ± 8.1	50.6 ± 8.7	0.184

518 **Note.** Values are presented in absolute and relative frequencies or means and standard
519 deviations. Chi-square (categorical variables) and t-test (continuous variables) were
520 used to compare sex.
521
522

523 **Table 2**. Characteristics of included vs. non-included sample during the baseline.

Variable	Included (n = 5,144)	Non-included (n = 4,697)	p
Sex (Women)	53.1 (51.8 to 54.5)	50.8 (49.3 to 52.2)	0.019
Country of residence			
England	87.6 (86.7 to 88.5)	85.0 (83.9 to 86.0)	0.001
Scotland	7.6 (6.9 to 8.4)	6.0 (5.4 to 6.8)	
Wales	4.7 (4.2 to 5.4)	9.0 (8.2 to 9.8)	
Education			<0.001
None	24.1 (23.0 to 25.3)	33.3 (31.6 to 35.1)	
Up to high school	39.5 (38.2 to 40.8)	34.4 (32.7 to 36.3)	
More than high school	36.4 (35.1 to 37.7)	32.2 (30.5 to 34.0)	
Physical activity (150min/wk)*	22.9 (21.8 to 24.1)	24.4 (23.2 to 25.7)	0.080
Psychological distress**	1.8 (1.7 to 1.8)	2.0 (1.9 to 2.1)	<0.001
Well-being***	49.6 (49.4 to 49.8)	48.5 (48.2 to 48.8)	<0.001

524 **Note.** Values are presented using relative frequencies and 95% confidence intervals.
525 *Non-included sample included 4,607 participants. **Non-included sample included
526 3,434 participants Chi-square was used to compare sex. ***Non-included sample
527 included 2,926 participants.

528 **Table 3**. Regression models of the association of different contexts of leisure-time physical activity at 42 years with well-being and
529 psychological distress at 46 years, considering no leisure-time physical activity as reference (n = 5,144).

	Well-being			Psychological distress		
	Whole sample *B* (95% CI)	Men *B* (95% CI)	Women *B* (95% CI)	Whole sample *B* (95% CI)	Men *B* (95% CI)	Women *B* (95% CI)
Model 1						
No PA	REF	REF	REF	REF	REF	REF
Individual PA	1.767 (1.271 to 2.265)	1.660 (0.953 to 2.368)	1.820 (1.120 to 2.520)	-0.126 (-0.178 to -0.074)	-0.140 (-0.216 to -0.065)	-0.144 (-0.215 to -0.074)
Group PA	2.258 (1.520 to 2.996)	2.583 (1.638 to 3.528)	1.837 (0.671 to 3.003)	-0.239 (-0.317 to -0.162)	-0.240 (-0.341 to -0.139)	-0.176 (-0.294 to -0.059)
Model 2						
No PA	REF	REF	REF	REF	REF	REF
Individual PA	0.462 (0.058 to 0.867)	0.234 (-0.348 to 0.815)	0.652 (0.088 to 1.216)	-0.049 (-0.090 to -0.008)	-0.044 (-0.104 to 0.017)	-0.052 (-0.109 to 0.004)
Group PA	0.888 (0.290 to 1.486)	0.988 (0.215 to 1.762)	0.766 (-0.170 to 1.703)	-0.103 (-0.164 to -0.042)	-0.120 (-0.200 to -0.040)	-0.079 (-0.172 to 0.015)
Model 3						
No PA	REF	REF	REF	REF	REF	REF
Individual PA	0.293 (-0.125 to 0.711)	0.006 (-0.596 to 0.608)	0.530 (-0.052 to 1.111)	-0.032 (-0.074 to 0.011)	-0.028 (-0.091 to 0.034)	-0.033 (-0.091 to 0.025)
Group PA	0.683 (0.074 to 1.293)	0.835 (0.050 to 1.619)	0.470 (-0.492 to 1.433)	-0.088 (-0.150 to -0.026)	-0.106 (-0.188 to -0.025)	-0.058 (-0.154 to 0.039)

530 Note. Values of psychological distress were square root transformed. Model 1: Crude model. Model 2: Adjusted for highest academic
531 achievement, employment status, living status, having a child, country of interview and baseline values of well-being (for well-being
532 model) and psychological distress (for psychological distress model). Model 3: Model 2 + tobacco smoking, alcohol use, TV-viewing and
533 total physical activity. PA, physical activity. CI, confidence interval. Sex interactions (adopting No PA and Men as reference): Well-being:
534 Model 1: Individual PA + women = 0.160 (-0.841 to 1.160); Group PA + women = -0.746 (-2.242 to 0.750). Model 2: Individual PA +
535 women = 0.468 (-0.372 to 1.307); Group PA + women = 0.180 (-1.089 to 1.450). Model 3: Individual PA + women = 0.504 (-0.306 to
536 1.314); Group PA + women = -0.364 (-1.583 to 0.855). Psychological distress: Model 1: Individual PA + women = -0.004 (-0.108 to
537 0.099); Group PA + women = 0.064 (-0.091 to 0.219). Model 2: Individual PA + women = -0.010 (-0.092 to 0.072); Group PA + women =
538 0.043 (-0.080 to 0.165). Model 3: Individual PA + women = -0.013 (-0.095 to 0.070); Group PA + women = -0.043 (-0.081 to 0.168).
539
540
541

542 **Table 4**. Regression models of the association of different contexts of leisure-time physical activity at 42 years with well-being and
543 psychological distress at 46 years, considering no individual physical activity as reference (n = 3,197).

	Well-being			Psychological distress		
	Whole sample B (95% CI)	Men B (95% CI)	Women B (95% CI)	Whole sample B (95% CI)	Men B (95% CI)	Women B (95% CI)
Model 1						
Individual PA	REF	REF	REF	REF	REF	REF
Group PA	0.491 (-0.204 to 1.185)	0.922 (0.017 to 1.827)	0.016 (-1.070 to 1.103)	-0.113 (-0.187 to -0.039)	-0.100 (-0.198 to -0.002)	-0.032 (-0.144 to 0.080)
Model 2						
Individual PA	REF	REF	REF	REF	REF	REF
Group PA	0.443 (-0.133 to 1.018)	0.764 (0.014 to 1.514)	0.089 (-0.801 to 0.978)	-0.053 (-0.112 to 0.007)	-0.077 (-0.156 to 0.002)	-0.019 (-0.109 to 0.071)
Model 3						
Individual PA	REF	REF	REF	REF	REF	REF
Group PA	0.406 (-0.176 to 0.989)	0.855 (0.094 to 1.616)	-0.096 (-0.999 to 0.807)	-0.054 (-0.114 to 0.005)	-0.080 (-0.160 to 0.001)	-0.016 (-0.107 to 0.075)

544 Note. Values of psychological distress were square root transformed. Model 1: Crude model. Model 2: Adjusted for highest academic
545 achievement, employment status, living status, having a child, country of interview and baseline values of well-being (for well-being
546 model) and psychological distress (for psychological distress model). Model 3: Model 2 + tobacco smoking, alcohol use, TV-viewing and
547 total physical activity. PA, physical activity. CI, confidence interval. *sex interactions had "no PA group" and "men" as reference. Sex
548 interactions (adopting individual PA and Men as reference): Well-being: Model 1: Group PA + women = -0.906 (-2.318 to 0.507). Model
549 2: Group PA + women = -0.683 (-1.843 to 0.477). Model 3: Group PA + women = -0.933 (-2.110 to 0.243). Psychological distress: Model
550 1: Group PA + women = 0.068 (-0.081 to 0.217). Model 2: Group PA + women = 0.059 (-0.061 to 0.178). Model 3: Group PA + women =
551 0.028 (-0.100 to 0.155).

552

553 **Table 5.** Regression models of the association of different types of leisure-time physical activity at 42 years with well-being at 46 years
554 (n = 5,144).

	Whole sample B (95%CI)	Men B (95%CI)	Women B (95%CI)	Sex interaction* B (95%CI)
Health, fitness, gym or conditioning activities				
No	REF	REF	REF	REF
Yes	0.470 (0.061 to 0.880)	0.345 (-0.240 to 0.931)	0.571 (-0.002 to 1.145)	0.239 (-0.563 to 1.040)
Swimming or diving				
No	REF	REF	REF	REF
Yes	0.058 (-0.578 to 0.695)	0.224 (-0.725 to 1.173)	-0.052 (-0.914 to 0.809)	-0.204 (-1.482 to 1.075)
Cycling, BMX or mountain biking				
No	REF	REF	REF	REF
Yes	0.184 (-0.414 to 0.783)	0.177 (-0.542 to 0.896)	0.083 (-0.977 to 1.144)	-0.061 (-1.307 to 1.185)
Jogging, cross-country, road-running				
No	REF	REF	REF	REF
Yes	0.890 (0.320 to 1.459)	0.790 (0.033 to 1.548)	1.010 (0.154 to 1.866)	0.308 (-0.804 to 1.419)
Rambling / walking for pleasure				
No	REF	REF	REF	REF
Yes	0.054 (-0.374 to 0.483)	0.527 (-0.126 to 1.180)	-0.261 (-0.835 to 0.314)	-0.851 (-1.711 to 0.008)
Horse riding				
No	REF	REF	REF	REF
Yes	-0.764 (-2.376 to 0.849)	-2.759 (-8.537 to 3.018)	-0.549 (-2.279 to 1.180)	2.027 (-4.138 to 8.192)
Yoga / Pilates				
No	REF	REF	REF	REF
Yes	0.006(-0.870 to 0.881)	-0.392 (-2.595 to 1.810)	0.037 (-0.939 to 1.013)	0.261 (-2.188 to 2.710)
Dancing				
No	REF	REF	REF	REF
Yes	0.302 (-0.727 to 1.332)	1.158 (-1.254 to 3.570)	0.176 (-0.985 to 1.338)	-1.111 (-3.834 to 1.611)
Racquet sports				
No	REF	REF	REF	REF
Yes	0.463 (-0.585 to 1.511)	1.093 (-0.233 to 2.419)	-0.319 (-1.999 to 1.360)	-1.281 (-3.402 to 0.841)
Team sports				
No	REF	REF	REF	REF
Yes	0.874 (0.003 to 1.746)	1.063 (0.144 to 1.981)	-0.039 (-2.358 to 2.281)	-0.928 (-3.374 to 1.518)
Martial arts, boxing, wrestling				
No	REF	REF	REF	REF
Yes	0.328 (-1.134 to 1.790)	0.352 (-1.362 to 2.067)	0.164 (-2.523 to 2.851)	-0.275 (-3.428 to 2.878)
Golf				
No	REF	REF	REF	REF
Yes	0.585 (-0.599 to 1.768)	0.387 (-0.823 to 1.597)	2.783 (-1.158 to 6.725)	2.146 (-1.886 to 6.178)

555 Note. Adjusted for highest academic achievement, employment status, living status, having a child, country of interview and baseline
556 values of well-being psychological distress, tobacco smoking, alcohol use, TV-viewing and total physical activity. CI, confidence interval.
557 *sex interactions had "without the practice" and "men" as reference.

558

559 **Table 6**. Regression models of the association of different types of leisure-time physical activity at 42 years with psychological distress
560 at 46 years (n = 5,144).

	Whole sample B (95%CI)	Men B (95%CI)	Women B (95%CI)	Sex interaction* B (95%CI)
Health, fitness, gym or conditioning activities				
No	REF	REF	REF	REF
Yes	-0.049 (-0.090 to -0.007)	-0.030 (-0.091 to 0.031)	-0.068 (-0.125 to -0.011)	-0.041 (-0.123 to 0.041)
Swimming or diving				
No	REF	REF	REF	REF
Yes	-0.039 (-0.104 to 0.025)	0.001 (-0.098 to 0.100)	-0.069 (-0.155 to 0.017)	-0.072 (-0.202 to 0.058)
Cycling, BMX or mountain biking				
No	REF	REF	REF	REF
Yes	-0.055 (-0.116 to 0.006)	-0.062 (-0.137 to 0.013)	-0.039 (-0.145 to 0.067)	0.011 (-0.116 to 0.138)
Jogging, cross-country, road-running				
No	REF	REF	REF	REF
Yes	-0.071 (-0.130 to -0.013)	-0.057 (-0.137 to 0.022)	-0.089 (-0.174 to -0.003)	-0.042 (-0.155 to 0.071)
Rambling / walking for pleasure				
No	REF	REF	REF	REF
Yes	0.017 (-0.027 to 0.060)	-0.018 (-0.087 to 0.050)	0.041 (-0.017 to 0.098)	0.052 (-0.036 to 0.140)
Horse riding				
No	REF	REF	REF	REF
Yes	-0.040 (-0.204 to 0.125)	0.376 (-0.227 to 0.980)	-0.066 (-0.239 to 0.107)	-0.449 (-1.077 to 0.180)
Yoga / Pilates				
No	REF	REF	REF	REF
Yes	-0.054 (-0.143 to 0.035)	0.040 (-0.190 to 0.270)	-0.065 (-0.163 to 0.032)	-0.103 (-0.352 to 0.147)
Dancing				
No	REF	REF	REF	REF
Yes	-0.085 (-0.190 to 0.020)	-0.108 (-0.359 to 0.144)	-0.083 (-0.199 to 0.033)	0.029 (-0.249 to 0.306)
Racquet sports				
No	REF	REF	REF	REF
Yes	-0.021 (-0.128 to 0.086)	-0.081 (-0.219 to 0.058)	0.060 (-0.108 to 0.227)	0.127 (-0.089 to 0.344)
Team sports				
No	REF	REF	REF	REF
Yes	-0.098 (-0.187 to -0.009)	-0.108 (-0.203 to -0.012)	-0.014 (-0.246 to 0.218)	0.092 (-0.157 to 0.341)
Martial arts, boxing, wrestling				
No	REF	REF	REF	REF
Yes	-0.107 (-0.256 to 0.042)	-0.106 (-0.285 to 0.073)	-0.101 (-0.369 to 0.168)	0.001 (-0.321 to 0.322)
Golf				
No	REF	REF	REF	REF
Yes	-0.115 (-0.236 to 0.005)	-0.081 (-0.207 to 0.046)	-0.427 (-0.821 to -0.032)	-0.335 (-0.746 to 0.076)

561 Note. Values of psychological distress were square root transformed. Adjusted for highest academic achievement, employment status,
562 living status, having a child, country of interview and baseline values of psychological distress, tobacco smoking, alcohol use, TV-viewing
563 and total physical activity. CI, confidence interval. *sex interactions had "without the practice" and "men" as reference.
564