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Associations Between Physical Activity and Depressive Symptoms by Weight Status Among Adults With Type 2 Diabetes: Results From Diabetes MILES-Australia.

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2 **Associations between physical activity and depressive symptoms by weight**
3 **status among adults with type 2 diabetes: Results from Diabetes MILES –**
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15 **Abstract**

16 Background: To examine associations between physical activity (PA) and depressive
17 symptoms among adults with type 2 diabetes mellitus (Type 2 DM), and whether associations
18 varied according to weight status.

19 Methods: Diabetes MILES – Australia is a national survey of adults with diabetes, focused on
20 behavioral and psychosocial issues. Data from 705 respondents with Type 2 DM were
21 analyzed, including: demographic and clinical characteristics, PA (IPAQ-SF), depressive
22 symptoms (PHQ-9), and BMI (self-reported height and weight). Data analysis was performed
23 using ANCOVA.

24 Results: Respondents were aged 59 ± 8 years; 50% women. PA was negatively associated with
25 depressive symptoms for the overall sample ($\eta_p^2 = 0.04, p < 0.001$) and all weight categories
26 separately: healthy ($\eta_p^2 = 0.11, p = 0.041$), overweight ($\eta_p^2 = 0.04, p = 0.025$) and obese
27 ($\eta_p^2 = 0.03, p = 0.007$). For people who were healthy (BMI 18.5-24.9) or overweight (BMI 25-
28 29.9), high amounts of PA were significantly associated with fewer depressive symptoms; for
29 adults who were obese (BMI ≥ 30) however, both moderate and high amounts were
30 associated with fewer depressive symptoms.

31 Conclusions: PA is associated with fewer depressive symptoms among adults with Type
32 2DM, however the amount of PA associated with fewer depressive symptoms varies
33 according to weight status. Lower amounts of PA might be required for people who are obese
34 to achieve meaningful reductions in depressive symptoms compared to those who are healthy
35 weight or overweight. Further research is needed to establish the direction of the relationship
36 between PA and depressive symptoms.

37

38

39

Introduction

40

41 The associations between physical activity (PA) and depressive symptoms have been
42 examined extensively in the general population and show that PA is associated with fewer
43 depressive symptoms^{1,2}. There is also emerging evidence in the general population that the
44 associations between PA and depressive symptoms vary according to whether the person is of
45 healthy weight, overweight or obese³. These associations, however, have not been explored
46 thoroughly among people with Type 2 D^{4,5}.

47

48 Diabetes is a global epidemic⁶, projected to affect up to 3 million Australians over the age of
49 25 years by 2025⁷. Around 85% of diabetes is accounted for by Type 2 diabetes mellitus
50 (Type 2 DM)⁷. People with Type 2 DM are two to three times more likely to experience
51 depressive symptoms compared to the general population^{8,9}. In addition to being associated
52 with lower physical and mental functioning^{5,10} and lower quality of life¹¹, depressive
53 symptoms are also associated with increased/higher risk for suboptimal glycaemic control,
54 diabetes-related complications¹², increased/higher health service use¹⁰, and higher mortality
55 rates¹³. Examining factors, including PA that might be associated with higher or lower levels
56 of depressive symptoms among people with Type 2 DM is vital to inform healthcare practices
57 and the development of tailored interventions.

58

59 PA is a central component of the self-management regimen for people with Type 2 DM, and
60 thus associations with depressive symptoms are likely to be more complex than for other
61 population groups¹⁴. A small body of research has shown an inverse association between
62 depressive symptoms and participation in PA among people with Type 2 DM^{4,15,16}. These
63 associations require further investigation, specifically, including the role of weight status. An

64 examination of the associations between PA, depressive symptoms and weight status among
65 adults with Type 2 DM is needed because people with Type 2 DM have a high incidence of
66 overweight and obesity ¹⁷, and a recent study from the Diabetes MILES-Australia dataset
67 (also used in the current study) showed that higher body mass index (BMI) is associated with
68 greater symptoms of depression among people with Type 2 DM ¹².

69

70 The purpose of this study was to provide further understanding of the associations between
71 PA, depressive symptoms and weight status in Type 2 DM. Specifically, the aims of this
72 study were to assess, in a large, population-based sample of adults with Type 2 DM: (1) the
73 associations between PA and depressive symptoms; and (2) whether associations between PA
74 and depressive symptoms varied according to weight status.

75

76 **Methods**

77 **Study Design**

78 Data was collected in 2011 as part of the Diabetes MILES (Management and Impact for
79 Long-term Empowerment and Success) – Australia study. Diabetes MILES – Australia is a
80 large, national survey of adults living with Type 1 or Type 2 DM, which aims to examine the
81 psychological, behavioral and social factors relevant to living diabetes. The study protocol
82 and sample characteristics are described in detail elsewhere ¹⁸.

83

84 Briefly, the Diabetes MILES – Australia survey was distributed by post to a random sample
85 of 15,000 registrants of the National Diabetes Services Scheme (NDSS), and made the survey
86 available online. Eligibility criteria were living with Type 1 or Type 2 DM, aged 18 to 70
87 years, living in Australia, and able to complete the survey in English without assistance. In

88 total, 3,338 eligible respondents completed the survey. Several survey versions were used in
89 order to tailor content to diabetes type and treatment, and to reduce respondent burden (not all
90 scales/items appeared in all versions). .

91

92 Ethics approval was granted by the Deakin University Human Research Ethics Committee
93 (2011-046).

94 **Measures**

95 *Demographic and Clinical Variables*

96 Demographic variables included gender, age, relationship status, highest level of education,
97 country of birth, and annual household income. Clinical data extracted for this study were
98 diabetes duration, insulin treatment (yes/no), co-morbidities and height and weight (for
99 calculation of BMI). For the co-morbidities item, respondents were asked if they have a range
100 of health conditions, for example, coeliac disease, fatty liver disease, heart disease / heart
101 attack, high blood pressure (hypertension). The number of comorbidities that respondents
102 reported was summed to represent the total number of comorbidities. All data were collected
103 by self-report.

104

105 *Depressive symptoms*

106 Depressive symptoms were assessed using the Patient Health Questionnaire-9 (PHQ-9),
107 which is the depression module of the self-administered version of the PRIME-MD
108 diagnostic instrument for common mental disorders. Respondents rated their experience of
109 each of the nine DSM-IV criteria (i.e. depressed mood or irritable; decreased interest or
110 pleasure in most activities; significant weight change or change in appetite; change in sleep;
111 change in activity; fatigue or loss of energy; guilt/worthlessness; diminished ability to think

112 or concentrate; suicidality) as “0” (not at all) to “3” (nearly every day)¹⁹. Item scores were
113 summed to form a total score (range: 0-27), with higher scores indicating higher levels of
114 depressive symptoms. Total scores of ≥ 10 indicate moderate-to-severe depressive symptoms
115 ¹⁹. The PHQ-9 has been validated in a range of population groups¹⁹⁻²¹. For example, in a
116 study of 6,000 patients, increased PHQ-9 depression severity was associated with a
117 substantial decrease in functional status on all 6 Short-Form General Health 20 subscales, and
118 increases in symptom-related difficulty, sick days, and health care utilization. In a study of
119 580 patients, where scores on the PHQ-9 were compared with independent structured mental
120 health professional interviews, a PHQ-9 score ≥ 10 had a sensitivity of 88% and a specificity
121 of 88% for major depression¹⁹. Among people with diabetes, , the PHQ-9 was an efficient
122 and well-received screening instrument for major depressive disorders in a sample of patients
123 in a specialized outpatient clinic²². For the current study, total score for depressive symptoms
124 was the outcome variable.

125 *Participation in physical activity*

126 PA was assessed using the International Physical Activity Questionnaire Short Form (IPAQ-
127 SF)²³. The IPAQ-SF encompasses PA across all domains (including leisure, work and
128 household chores) at three intensity levels: 1) vigorous, 2) moderate, and 3) walking. Studies
129 of the measurement properties of the IPAQ across 12-countries demonstrated that the IPAQ
130 instruments have acceptable measurement properties, at least as good as other established
131 self-reports. IPAQ-SF had fair to moderate agreement with accelerometer-measured physical
132 activity (pooled $r = .30$) and repeatability was at an acceptable level, with 75% of the
133 correlation coefficients observed above 0.65 and ranging from 0.88 to 0.32²³. The IPAQ-SF
134 has also been used in other studies of adults with Type 2 DM²⁴. Data were cleaned according
135 to the data processing rules provided by the IPAQ developers²⁵.

136

137 Amount of PA was categorised as 'high', 'moderate' and 'low', consistent with the IPAQ-SF
138 guidelines. These categories incorporate total metabolic equivalent (MET)/minutes per week
139 as well as the number of days/sessions of PA. Total MET minutes were calculated by
140 multiplying the minutes per week of walking, moderate-intensity PA and vigorous-intensity
141 PA by 3.3, 4.0 and 8.0, respectively. The criteria for the three levels take into account that the
142 questions in the IPAQ assess PA in all domains of daily life, resulting in higher median
143 MET-minutes estimates than those estimated from leisure-time participation alone. The
144 'high' category represents a minimum of one hour moderate-intensity activity over and above
145 the basal level of activity daily, or at least 30 minutes of vigorous-intensity activity over and
146 above basal levels daily (basal activity was considered to be equivalent to approximately
147 5000 steps per day).. This level is equivalent to population targets for health-enhancing PA
148 when multi-domain instruments, such as IPAQ, are used ²⁵. The 'moderate' category is
149 defined as doing some activity, more than the low active category, and is equivalent to half an
150 hour of at least moderate-intensity PA on most days. The 'low' category is defined as not
151 meeting any of the criteria for either of the previous categories ²⁵.

152

153 *Body Mass Index (BMI)*

154 BMI was calculated using respondents' self-reported weight, in kilograms, divided by the
155 square of their self-reported height, in metres. BMI was then categorised based on World
156 Health Organisation recommendations, with a BMI of 18.5-24.9 being considered healthy
157 weight; 25-29.9 considered overweight; and ≥ 30 considered obese.

158

159 Data Analysis

160 The present study used data from a randomly selected sub-sample of participants with Type 2
161 DM who received the MILES-Australia survey version that contained scales/items about PA
162 ($n= 862$). Analyses were performed on cases with valid and complete data and calculated
163 scores for depressive symptoms if respondents had one or fewer missing data points on the
164 PHQ-9 (with missing data imputed), otherwise the case was declared as missing. Cases with
165 missing or invalid data for key variables (i.e. PA, BMI and depressive symptoms) were
166 removed from the dataset prior to analysis; resulting in 705 valid cases). Demographic and
167 clinical characteristics of cases included in the analysis were compared with those that were
168 not included (due to missing or invalid data). There were no significant differences in any
169 demographic or clinical characteristics examined except level of education ($p =0.045$), with
170 those who had a university degree more likely to have valid answers for all items. For all
171 other variables included in the analyses, missing data were minimal (0-1.0%), except annual
172 household income and level of education, which had 5.2% and 5.7% of missing data,
173 respectively.

174
175 Univariate analyses (Pearson correlation coefficients and t-tests) were performed to examine
176 associations between demographics, clinical characteristics and depressive symptoms. The
177 following variables were dichotomised: relationship status (partner versus no partner), level
178 of education (less than university degree versus university degree and above), country of birth
179 (Australian born versus born overseas), annual household income ($\leq \$60,000$ versus
180 $\geq \$60,001$). We included variables significant at 0.05 level in subsequent analyses.

181
182 For the main analysis, a series of ANCOVA analyses were conducted. First, an analysis of
183 the associations between PA and depressive symptoms, unadjusted for covariates was

184 conducted. Following this, the overall association between amount of PA (low, moderate and
185 high) and depressive symptoms, after controlling for covariates (i.e., co-morbidities, BMI,
186 age [negative], income [negative], education level [negative], being single, and using insulin),
187 were examined. A subsequent analyses according to weight status was conducted to
188 determine whether being of healthy weight, overweight and obese had a modifying effect
189 (BMI was not controlled for in these analyses and people who were underweight ($n = 3$) were
190 not included in this analysis ²⁶). We used post hoc Bonferroni pairwise comparisons to
191 examine significant differences between PA categories for analyses where a main effect of
192 PA was significant. Mean differences reported are the adjusted mean differences after
193 controlling for covariates in the models. Differences were considered statistically significant
194 at $p < 0.05$.

195

196

Results

197

Sample characteristics

199 Respondents' age ranged from 23 to 70 years, with a mean of 59 ± 8 years, and 50% of
200 respondents were women ($n=351$). Most respondents were born in Australia ($n=516$, 73%),
201 and were either married or in a de facto relationship (i.e., living with another person as a
202 couple; $n=510$, 73%); 25% ($n=166$) reported a diploma/certificate as their highest level of
203 education, and a further 19% ($n=123$) had completed secondary school; almost half reported
204 an annual household income $\leq \$40,000$ ($\$20,001-\$40,000$: $n=163$, 24%; $\leq \$20,000$: $n=147$,
205 22%). Respondents had been living with Type 2 DM for 8.5 ± 6.7 years; 32% ($n=227$) were
206 using insulin to manage their condition and respondents reported a mean of 2.6 ± 2.2 co-
207 morbidities. See Table 1.

208

209 Table 1 here
210

211 **Depressive symptoms, weight status and physical activity**

212
213 Respondents' depressive symptom scores ranged from 0-27, with a mean of 6.6 ± 6.0 ; 28%
214 ($n=195$) of the sample had moderate-to-severe depressive symptoms. Respondents' BMI
215 ranged from 14.6 to 94.3, with a mean of 32.6 ± 7.8 ; 30% ($n=214$) of the sample were
216 overweight and 59% ($n=418$) were obese. In terms of volume of PA, 29% ($n=203$) reported
217 low levels of PA, 34% ($n=237$) reported moderate levels and 38% ($n=265$) reported high
218 levels. See Table 2.

219
220 Table 2 here

221 222 **Associations with depressive symptoms: univariate analyses**

223
224 Depressive symptoms were associated positively with the number of co-morbidities ($r =$
225 $0.382, p < 0.001$) and BMI ($r = 0.14, p < 0.001$) and negatively with age ($r = -0.13, p = 0.003$).
226 T-test showed that higher depressive symptoms were associated with having a lower income
227 ($t = 2.441, p = 0.015$), a lower education level ($t = 2.78, p = 0.006$), being single ($t = 3.045, p$
228 $= 0.002$), and using insulin ($t = -3.27, p = 0.001$). Each of these factors were included as
229 covariates in subsequent ANCOVA.

230 231 **Association between PA and depressive symptoms**

232 The unadjusted analyses are shown in Table 3. The following results refer to the analyses that
233 were adjusted for covariates. First, the overall association between PA and depressive
234 symptoms were examined (see Table 4). The ANCOVA model was significant and explained

235 22% of the variance in depressive symptoms. PA was significant and had a medium effect
236 size, controlling for other covariates in the model. There was a significant difference in
237 depressive symptoms between low and moderate amounts of PA (mean diff = 1.87, $p=0.002$,
238 95% CI = 0.585 to 3.153) and low and high amounts of PA (mean diff = 2.55, $p = <0.001$,
239 95% CI = 1.268 to 3.824), however the difference between moderate and high amounts of PA
240 was not significant ($p = 0.531$; 95% CI = -.525 to 1.878). These analyses show that moderate
241 and high amounts of PA, compared to low amounts, were associated with fewer depressive
242 symptoms.

243 Table 3 here

244

245 Table 4 here

246

247

248 For people of healthy weight, the ANCOVA model was significant and explained 29% of the
249 variance in depressive symptoms. PA was significant after controlling for covariates and had
250 a moderate effect size. There were significant differences in depressive symptoms between
251 low and high PA (mean diff = 3.99, $p=0.036$, 95% CI = 0.199 to 7.773) but no significant
252 difference between low and moderate amounts of PA ($p=0.270$, 95% CI = -1.261 to 7.102) or
253 moderate and high amounts of PA ($p=1.0$, 95% CI = -2.500 to 4.631). These results suggest
254 that high volumes of PA are associated with fewer depressive symptoms for people of healthy
255 weight.

256

257 For people who are overweight, the ANCOVA model was significant and explained 16% of
258 the variance in depressive symptoms. PA was significant after controlling for covariates and
259 had a moderate effect size. There were significant differences in depressive symptoms

260 between low and high PA (mean difference = 2.79, $p=0.024$, 95% CI = 0.282 to 5.297) but no
261 significant differences between low and moderate amounts PA ($p=0.469$, 95% CI = -1.029 to
262 3.979) or moderate to high amounts of PA ($p=0.338$, 95% CI = -0.677 to 3.305). Similar to
263 people of healthy weight, these results suggest that, for people who are overweight, high
264 amounts of PA, are associated with fewer depressive symptoms.

265
266 For people who are obese, the ANCOVA model was significant and explained 21% of the
267 variance in depressive symptoms. PA was significant after controlling for covariates and had
268 a medium effect size. There was a significant difference in depressive symptoms between low
269 and moderate amounts of PA (mean diff = 1.786, $p=0.034$, 95% CI = 0.101 to 3.471) and low
270 and high amounts of PA (mean diff = 2.055, $p=0.012$, 95% CI = 0.345 to 3.765) but not
271 between moderate and high amounts of PA ($p=1.0$, 95% CI = -1.422 to 1.960). These results
272 suggest that for people who are obese, moderate and high amounts of PA are associated with
273 fewer depressive symptoms.

274

275 Figure 1 shows the associations between amount of PA and depressive symptoms for each
276 weight classification (i.e., healthy weight, overweight and obese).

277

278 Figure 1 here

279

Discussion

280 This study examined associations between PA and depressive symptoms, controlling for a
281 range of potential covariates, among a large, population-based, sample of adults with Type 2
282 DM. The findings suggest that associations between PA and depressive symptoms are
283 complex; although PA was associated with fewer depressive symptoms, the amount of PA

284 that was associated with fewer depressive symptoms differed according to weight status.
285 These findings present a range of avenues for future research in this area and have
286 implications for the design of interventions that seek to reduce the burden of depressive
287 symptoms and increase PA for people with Type 2 DM.

288

289 The present findings support previous research indicating that PA is associated with fewer
290 depressive symptoms among adults with Type 2 DM^{15,16}. The findings suggest that the
291 amount of PA that is associated with lower depressive symptoms is equivalent to thirty
292 minutes of moderate-intensity PA across all domains (e.g., active transport, household chores
293 and leisure-time) on most days. Higher amounts of PA were not associated with additional
294 declines in depressive symptoms above this level of participation. For the overall sample,
295 after controlling for BMI, these findings suggested that PA, even at lower volumes than the
296 recommended level for a physical health benefit²⁵, appears to be associated with fewer
297 depressive symptoms. Other population-based research has shown that mental health benefits
298 are associated with lower levels of PA than required for physical health^{3,27}. Given that most
299 adults with Type 2 DM find it challenging to meet PA guidelines, a lower level of
300 participation is likely to be more achievable for the majority of the population,²⁸ which is
301 an encouraging finding.

302

303 Interestingly, the findings of the current study indicate that the amount of PA associated with
304 fewer depressive symptoms varied by weight status. For people in the healthy weight or
305 overweight classification, a high amount of PA (equivalent to at least an hour or more of
306 moderate-intensity activity, or thirty minutes of vigorous-intensity activity, on most days),
307 was associated with fewer depressive symptoms. In contrast, for people in the obese
308 classification, moderate amounts of PA were associated with fewer depressive symptoms and

309 there was no difference in depressive symptoms between moderate and high amounts of PA.
310 These findings may, in part, be explained by the higher baseline depressive symptoms of
311 people who are obese (mean depressive symptoms score for healthy, overweight and obese
312 respondents was 5.5, 5.4, and 7.4, respectively) and a preference for lower intensity PA.
313 Previously published findings from the Diabetes MILES – Australia study¹² showed that
314 people with Type 2 DM who were severely obese were more likely to report moderate-severe
315 depressive symptoms than matched controls (37% versus 27%). A systematic review of the
316 effects of PA on depressive symptoms for people with chronic illness showed that PA had
317 larger effects on depressive symptoms when baseline depressive symptoms were higher²⁹.
318 Also, people who are obese experience stigma due to their weight and this is related to PA
319 avoidance³⁰. Such stigma and feelings of self-consciousness are likely to be magnified when
320 performing vigorous physical activities such as running and aerobics^{31,32}, and thus it is
321 possible that more moderate levels of PA may be preferred by this group.

322
323 The cross-sectional nature of this study precludes assessment of the directionality of the
324 association between PA and depressive symptoms. It is likely that the association between
325 PA and depressive symptoms is bi-directional³³; as well as the possibility of higher levels of
326 PA reducing depressive symptoms, more depressive symptoms may lead to lower levels of
327 PA. People with Type 2 DM and depressive symptoms are often physically inactive⁵.
328 Symptoms of depression include a lack of motivation and energy and increased apathy³⁴ and
329 may thus act as a barrier to participation in PA among people with Type 2 DM. A recent
330 study of healthy older adults, however, found that those with depressive symptoms responded
331 well to an exercise intervention that incorporated 14 face-to-face counselling sessions over 4
332 years designed to increase aerobic exercise.; half of those with depressive symptoms in the
333 intervention group were able to maintain increased aerobic exercise during the four years of

334 follow-up³⁵. Thus, interventions that reduce depressive symptoms might lead to increased PA
335 in this group. Furthermore, the association between depression and increased risk of mortality
336 among people with Type 2 DM¹³ might be partly explained by low levels of participation in
337 PA among people who are depressed.

338

339 As well as BMI, a range of other socio-demographic and clinical factors were associated with
340 depressive symptoms in our sample. Socio-demographic factors including being single, being
341 younger, having a lower income, lower education level and clinical factors including the
342 number of comorbidities and being treated with insulin, were associated significantly with
343 depressive symptoms. These associations have been identified in other studies of people with
344 diabetes^{36,37,38}, suggesting that it is important that they are considered in future studies that
345 aim to examine the independent association between behavioural or psycho-social factors and
346 depressive symptoms among adults with Type 2 DM. These findings also suggest that some
347 population groups, such as those with lower socio-economic status, are more likely to
348 experience depressive symptoms, and should be a focus of interventions that aim to reduce
349 depressive symptoms.

350

351 Key strengths of this study are the large, population-based sample of adults with Type 2 DM
352 and novel in-depth examination of the associations between PA, weight and depressive
353 symptoms. The limitations of this study include the cross-sectional nature of the data, which
354 means that causality cannot be implied by the findings. Self-report data were used to measure
355 participation in PA as well as height and weight, which may result in social desirability bias.
356 For large population-based studies, however, direct observation is not feasible and it is
357 necessary to rely on self-report. Furthermore, the associations examined were less impacted
358 by any self-report bias than would be the case if examining the effect of an intervention, the

359 measure of PA used in this study has adequate reliability and validity²³, and self-report
360 height and weight has been shown to accurately identify weight categories³⁹. We categorized
361 PA according to the IPAQ-SF guidelines, however, a limitation of this approach is that these
362 categories do not allow independent examination of the frequency or intensity of PA and
363 future research should examine the impact of these on depressive symptoms among people
364 with Type 2 DM. Limitations of the broader MILES study are also applicable to the current
365 study and have been described in detail previously¹⁸.

366

367 In conclusion, this study advances current knowledge on associations between PA, weight
368 status and depressive symptoms among people with Type 2 DM. The findings suggest that
369 even moderate amounts of PA are associated with fewer depressive symptoms. Therefore,
370 improving participation in PA may lead to decline in depressive symptoms, or a reduction in
371 depressive symptoms may help to improve participation in PA. The role of weight status
372 needs further examination in future studies to test the robustness of these findings concerning
373 the levels of PA that are associated with fewer depressive symptoms among people in
374 different weight categories.

375

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381

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493 **Table 1: Demographic and clinical characteristics of sample**

	<i>N</i>	<i>Mean / n</i>	<i>SD / %</i>
<i>Gender</i>	700		
Women		351	50.1
<i>Age</i>	703	58.9	8.3
<i>Relationship status</i>	700		
Single		71	10.1
In steady relationship		7	1.0
Married/defacto		510	72.9
Separated		25	3.6
Divorced		64	9.1
Widowed		23	3.3
<i>Education (highest level)</i>	665		
No formal qualifications		67	10.1
School/intermediate certificate		96	14.4
High school/leaving certificate		123	18.5
Trade/apprenticeship		68	10.2
Certificate/diploma		166	25.0
University degree		95	14.3
Higher university degree		50	7.5
<i>Household Income (annual)</i>	668		
Up to \$20,000		147	22.0
\$20,001-40,000		163	24.4
\$40,001-60,000		142	21.3
\$60,001-100,000		128	19.2

Physical activity and depressive symptoms

\$100,101-150,000		55	8.2
\$150,001 or more		33	4.9
<i>Country of birth</i>	705		
Australia		516	73.2
Other		189	26.8
<i>Diabetes duration - years since diagnosis</i>	698	8.5	6.7
<i>Diabetes management</i>	700		
Diet / lifestyle only		124	17.7
Oral medication		338	48.3
Insulin		227	32.2
Non-insulin injectables		11	1.6
<i>Co-morbidities</i>	705	2.6	2.2

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498 **Table 2 Main Study Variables Descriptive Statistics**

	<i>N</i>	<i>Mean / n</i>	<i>SD / %</i>
<i>Depressive symptoms</i>			
PHQ-9 total	705	6.6	6.0
Moderate-to-severe depressive symptoms (PHQ-9 total ≥ 10)		195	28
<i>Body mass index</i>			
<i>Weight Status</i>			
Underweight		3	0.4
Healthy weight		70	9.9
Overweight		214	30.4
Obese		418	59.3
<i>Physical Activity</i>			
Low	705	203	28.8
Medium		237	33.6
High		265	37.6

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501 **Table 3 Depressive Symptoms by Volume of Physical Activity (Unadjusted ANCOVA)**

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	SS	df	MS	F	P	η_p^2
<i>Whole Sample</i>						
Volume of Physical						
Activity	1577.60	2	788.80	23.66	<0.001	0.06
Error	23403.63	702	33.34			
Total	55546.00	705				
R ² = .06 (Adjusted R ² = .06)						
<i>Healthy Weight</i>						
Volume of Physical						
Activity	229.77	2	114.89	3.76	0.028	0.10
Error	2047.72	67	30.56			
Total	4384.00	70				
R ² = .101 (Adjusted R Squared = .074)						
<i>Overweight</i>						
Volume of Physical						
Activity	309.10	2	154.55	5.49	0.005	0.05
Error	5941.71	211	28.16			
Total	12463.00	214				
R ² = .05 (Adjusted R ² = .04)						
<i>Obese</i>						
Volume of Physical						
Activity	863.96	2	431.98	12.06	<0.001	.06
Error	14867.30	415	35.83			

Total 38426.00 418

$R^2 = .06$ (Adjusted $R^2 = .05$)

MS = Mean Square; SS = Sum of squares

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506 **Table 4 Depressive Symptoms by Volume of Physical Activity (ANCOVA adjusted for**
 507 **covariates)**

	SS	df	MS	F	P	η_p^2
<i>Whole Sample</i>						
Volume of Physical						
Activity	650.78	2	325.39	11.81	<0.001	0.04
Error	16910.76	614	27.54			
Total	48577.00	624				
$R^2 = .23$ (Adjusted $R^2 = .22$)						
<i>Healthy Weight</i>						
Volume of Physical						
Activity	157.56	2	77.78	3.40	0.041	0.11
Error	1250.96	54	23.17			
Total	3943.00	63				
$R^2 = .38$ (Adjusted $R^2 = .29$)						
<i>Overweight</i>						
Volume of Physical						
Activity	188.77	2	94.37	3.78	0.025	0.04
Error	4525.66	181	25.00			
Total	11217.00	190				
$R^2 = .19$ (Adjusted $R^2 = .16$)						
<i>Obese</i>						
Volume of Physical						
Activity	295.52	2	147.76	4.98	0.007	0.03
Error	10659.54	359	29.69			

Total 33144.00 368

$R^2 = .23$ (Adjusted $R^2 = .21$)

MS = Mean Square; SS = Sum of squares

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