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Significant weight loss and health benefits associated with running: a cross-sectional study of 4720 Australian recreational runners.

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A profile of health and training habits of Australian recreational runners – the case for promoting recreational running for health benefits.

Abstract

Issue addressed: The aim of the study was to characterise lifestyle and training habits of a large cohort of Australian recreational runners. Understanding the health benefits of recreational running and differentiating between the habits of males and females may allow for the development of gender specific messaging for promoting recreational running as a form of physical activity.

Methods: An online questionnaire was used to collect data from 4720 Australian recreational runners. Data on physical, lifestyle and training characteristics of male and female subgroups were compared using Chi-square tests. Multiple logistic regression method was used to assess the effect of running experience on the reported clinically significant weight loss.

Results: The study cohort was 54.1% female and 45.9% male. The majority (72.9%) of runners had normal BMI and the cohort had significantly lower overweight/obesity rate than the Australian population. The logistic regression model indicated that commencing running may lead to a clinically significant weight loss irrespectively of sex, participation in other sports and injury history. Smoking was uncommon among surveyed runners. The most typical weekly running distance in the cohort was 20–40 km, usually distributed by 2–5 running sessions. Significantly more males than females reported running over 40 km per week and running more sessions.

Conclusion: Recreational running was associated with beneficial health outcomes. Commencement of running is associated with weight loss and regular running supports healthy weight maintenance. Male and female runners had different running preferences which should be taken into account for physical activity promotion.

Key words: Running, Running habits, Weight loss, Health, Body mass index

1 **1. Introduction**

2 According to the World Health Organisation (WHO) the leading global risk factors for mortality are
3 hypertension (responsible for 13% of deaths globally), tobacco use (9%), hyperglycaemia (6%),
4 physical inactivity (6%), and overweight and obesity (5%).(1) Approximately 31% of the burden of
5 disease in Australia could be prevented by reducing exposure to modifiable risk factors such as
6 tobacco use, harmful alcohol use, high body mass, physical inactivity and hypertension.(2) Clinically
7 significant weight loss of ≥ 5kg or 5% of baseline body weight was shown to be associated with health
8 benefits and reduced risks of cardiovascular disease, type 2 diabetes mellitus and hypertension.(3-5)
9 Health benefits of physical activity include decreased risks of chronic conditions including type 2
10 diabetes mellitus, cardiovascular disease and depression. Physical inactivity causes 6–10% of the
11 burden of disease worldwide and 9% of premature mortality.(6-8) Promotion of physical activity by
12 general practitioners could help to address this issue, however, only one-fifth of Australians reported
13 receiving such recommendations, suggesting that strategies to encourage exercise prescription by a
14 variety of health professionals require consideration.(9)

15 The WHO Physical Activity Guidelines recommend 150 minutes of moderate-intensity aerobic physical
16 activity or 75 minutes of vigorous-intensity physical activity throughout the week, based on strong
17 evidence of health benefits and reductions upon mortality rates.(10) However, according to the report
18 from the National Health Survey conducted in 2014–2015, only 57.7% of Australian men and 53.3% of
19 Australian women met the WHO Physical Activity Guidelines.(11) Recreational running, which may
20 also be referred to as jogging, is one of the most common physical activities worldwide, with regular
21 running consistently shown to reduce all-cause and cardiovascular mortality risks.(12-16) In Australia,
22 the rate of participation in running increased from 4.3% in 2005–06, to 7.4% in 2013–14.(17) Recent
23 data have indicated that current participation levels in athletics, including running, in the Australian
24 population may be as high as 15.8%.(18) Running provides a low-cost option for increasing physical
25 activity, without the restrictions of specific equipment or costs of sports club membership. Furthering
26 the understanding of the running habits and wider health characteristics of male and female

27 recreational runners may assist in the development of sex specific messaging to promote the health
28 benefits of recreational running as a form of physical activity.
29 The aim of this study was firstly, to describe the health and lifestyle characteristics of Australian
30 recreational runners and compare body mass index (BMI) to the Australian general population, and
31 secondly to examine the similarities and differences in training habits of male and female runners. It
32 was hypothesised that recreational runners would display characteristics of a healthy lifestyle
33 including participation in physical activity, maintaining a healthy BMI and having low rates of chronic
34 disease and smoking.

35 **2. Methods**

36 **2.1. Study design**

37 The Australian Institute of Sport (AIS) Running Injury Study was a cross-sectional retrospective study
38 of self-described recreational runners. Participants were self-selected for inclusion into the study with
39 inclusion criteria being age over 18 years and recreational running practice of more than 15 km per
40 week. This self-reported, retrospective questionnaire, delivered using Internet software
41 (SurveyGizmo), was previously demonstrated to provide stable and reliable data.(19) This survey
42 contained questions covering demographic characteristics, running habits, injury history (e.g.
43 injured/uninjured in prior two years and details about particular injuries), dietary habits (e.g.
44 nutritional requirements and dietary supplements), and female health (for female participants e.g.
45 menstrual cycle), The full questionnaire tool was published by Domaschenz et al.(19) Data relating to
46 dietary habits and female health were not related to the current hypothesis and are not reported
47 here. The study was approved by the Bond University Human Research Ethics Committee (approval
48 RO1688B).

49 **2.2. Data Collection**

50 Study participants in the AIS Running Injury Study were recruited through social media, at running
51 events, and via promotion through a range of online websites and traditional media sources. The
52 enrolment period spanned September 2014 until October 2016. All respondents provided informed

53 consent to participate and provided personal data after accepting the conditions of the study on the
54 first page of the online questionnaire.

55 Participants' BMI was calculated from the responses to weight (kg) and height (cm) and categorised
56 as underweight (16-18.5 kg/m^2), normal (18.5 to <25 kg/m^2), overweight (25 to <30 kg/m^2), category
57 I of obesity (30 to <35 kg/m^2), category II of obesity (35 to <40 kg/m^2) and category III of obesity (≥40
58 kg/m^2).

59 **2.3. Statistical Analyses**

60 Statistical analysis was conducted in IBM SPSS Statistics version 24 (SPSS, Inc.). All numerical variables
61 were checked for normality using Kolmogorov-Smirnov and Q-Q plots, which indicated that the data
62 were not normally distributed. Median, minimum and maximum values and interquartile range (IQR)
63 were calculated for physical characteristics (age, height, weight, BMI) and independently presented
64 for the entire cohort and male and female subgroups. Mann-Whitney U test was performed to
65 compare the distributions of these continuous variables between male and female subgroups and
66 showed a significant difference (p<0.001) across all four variables. There were no missing data for
67 these variables. Logarithmic transformation was attempted to correct skewness, however, the
68 majority of the variables remained skewed after the transformation. Therefore, BMI and age were
69 categorised and subsequent analyses were performed using only categorical variables.

70 Categorical variables describing running habits and health conditions were summarised using counts
71 and percentages. Male and female subgroups were compared for all categorical variables using Chi-
72 square test. Not available (NA) data were presented for each categorical variable and comprised less
73 than 0.5%. BMI data of recreational runners were compared to published health data from the
74 Australian general population (18-74 years of age) which had been collected in the same way.

75 Multiple logistic regression was performed to assess the effect of running experience on the reported
76 clinically significant weight loss (≥5kg), after adjusting for sex, age, BMI, participation in other sports,
77 smoking history and injury history. Whilst weekly running distance and race pace were both
78 independently strongly associated (p<0.001) with reported weight loss in univariable analyses, they

were not used as predictors in the model due to strong association with running experience and sex respectively. To avoid multicollinearity, only predictors of interest that were not strongly associated with each other were selected in the model. Results of the multivariable analysis are presented as adjusted odds ratios with 95% confidence intervals and *p*-values. A Hosmer and Lemeshow test indicated that the model fit was acceptable (χ^2_8=11.69, *p*=0.17). Statistical significance was set at *p*<0.05.

3. Results

Data from 5250 respondents who described themselves as recreational runners were collected over the 25-month period of recruitment. After duplicate (*n*=272), nonsense (*n*=4) and incomplete (*n*=35) responses were removed, 4939 responses remained. As a weekly running distance of greater than 15 km was stated as an inclusion criterion for participation in the survey, data from 219 runners who reported less than this distance were removed, resulting in 4720 responses included in the analysis. All respondents were 18 years of age or over. The study cohort was 54.1% female and 45.9% male (Table 1). A summary of training characteristics is displayed in Table 2. Frequencies of the reported lifetime chronic conditions are shown in Table 3. Summary statistics for BMI groups and logistic regression analysis of clinically significant weight loss are displayed in Tables 4 and 5.

3.1. Running habits

The training characteristics of respondents are described in Table 2. The most common weekly running distance was 20–40 km (45.8%) among the entire cohort, with very similar rates in male and female runners. However, males were more likely than females to run distances more than 40 km per week (χ^2_1=77.6, *p*<0.001), whereas females were more likely than males to run less than 20 km per week (χ^2_1=65.5, *p*<0.001). The most common category of respondents were those with over ten years of running experience (37.8%), with significantly more males than females within this experienced group (χ^2_1=71.3, *p*<0.001). The majority of respondents stated that they typically ran between two and five sessions per week. It was however observed that males were significantly more likely to run six or more times per week than females (χ^2_1=33.3, *p*<0.001). The typical race pace of a male runner was

105 reported as 4–5 min/km, whereas female runners reported 5–6 min/km. The majority of respondents
106 participated in other sports in addition to running. Significantly more female than male runners
107 reported participation in sports other than running (χ^2_1=63.8, *p*<0.001). Almost a half of recreational
108 runners reported injuries that occurred while running in the past two years, with significantly higher
109 rates in males than in females (χ^2_1=7.7, *p*=0.003).

110 **3.2. Smoking habits**

111 Smoking was uncommon among surveyed runners, with 0.6% reporting that they were current
112 smokers and a further 25.8% of runners reporting that they had smoked at any time in their life.
113 Reported smoking experience was not significantly associated with sex (24.7% versus 26.7%; χ^2_1=2.1,
114 *p*=0.1).

115 **3.3. Chronic conditions**

116 The survey included questions about 18 lifetime diagnoses of chronic conditions (Table 3). The most
117 common reported diagnosis was depression (15.3%) with significantly higher reported depression
118 rates among females than males (18.9% versus 11.1%; χ^2_1=55.7, *p*<0.001). The second most common
119 diagnosis was respiratory conditions (11.7%), which was significantly higher in females than males
120 (13% versus 10.2%; χ^2_1=9.0, *p*=0.002). Although anaemia was the third most common diagnosis (10%),
121 this was mainly reported by females (17.1% versus 1.6%, χ^2_1=315.8, *p*<0.001). A lifetime diagnosis of
122 hypertension was reported by 290 runners (6.1%). Hypertension was the third most common
123 diagnosis for males, accounting for 7.8%, with a significantly lower reported rate in females – 4.8%
124 (χ^2_1=18.1, *p*<0.001).

125 **3.4. Body mass index and weight loss**

126 Respondents were grouped by their BMI in accordance with the World Health Organisation guidelines
127 (Table 4).(20) The majority of runners were in the normal weight category with a BMI between 18.5
128 kg/m^2 and 25 kg/m^2 (72.9%). Of the remainder, 2.6% of runners were underweight (16 to 18.5 kg/m^2),
129 21.8% were overweight (25 to <30 kg/m^2) and 2.7% were obese (≥30 kg/m^2). There were no
130 participants in the cohort that were classified as severely underweight (<16 kg/m^2). When levels of

131 obesity were categorised, 127 runners were divided into 3 subgroups: category I of obesity (*n*=111),
132 category II (*n*=14) and category III (*n*=2), accounting for approximately 2.35%, 0.30% and 0.04%
133 respectively of the entire sample. Due to these low numbers in severe and very severe categories, it
134 was decided to keep a general 'obese' group for analysis. Significantly more women than men were
135 in the underweight and normal weight categories (χ_1^2=50.6, *p*<0.001; χ_1^2=66.8, *p*<0.001 respectively),
136 whereas significantly more men than women were overweight (χ_1^2=136.3, *p*<0.001). Nevertheless,
137 proportions of obese male and female runners were almost equal. The BMI distribution data of
138 surveyed runners were compared to BMI data in the Australian population collected in the 2014-15
139 National Health Survey published by the Australian Bureau of Statistics (ABS) (Figure 1).(11)
140 Recreational runners were asked whether they had gained or lost a clinically significant amount of
141 weight (≥5kg) in the past two years. Clinically significant weight loss over the last two years was
142 reported by 27% of all respondents. Multiple logistic regression analysis (Table 5) showed that
143 clinically significant weight loss was more likely to be reported by younger runners, and overweight
144 and obese runners. Runners with two or less years of running experience were three times more likely
145 to report clinically significant weight loss in the past two years than runners with over ten years of
146 running experience. However, sex, participation in other sports, and history of injuries in the past two
147 years did not have a statistically significant association with clinically significant weight loss.
148 Interestingly, smoking experience (smoking at any time in life) was associated with reported clinically
149 significant weight loss. The logistic regression results indicate that commencing a running program
150 may lead to a clinically significant weight loss irrespective of sex, participation in other sports and
151 injury in the previous two years.

152 **4. Discussion**

153 This study described one of the largest cohorts of recreational runners, analysing the medical and
154 lifestyle characteristics of the participants and sex differences in training habits. In this study, we
155 demonstrated that a large proportion of recreational runners avoided the majority of modifiable risk
156 factors that contribute to the burden of disease. In the Australian population, the five strongest

157 contributors to the burden of disease in 2011 were tobacco use (9%), high body mass (5.5%), alcohol
158 use (5%), physical inactivity (5%) and hypertension (5%).(21) Data from the Australian Nutrition and
159 Physical Activity Survey showed that both sufficient physical activity level and reduced sitting time
160 were important factors for prevention of cardiovascular disease and metabolic syndrome.(22) This
161 study demonstrated that Australian recreational runners typically have a BMI in the normal range, are
162 meeting physical activity guidelines through recreational running and participation in other sports,
163 and have low levels of smoking. This cohort runs on average 20–40 km in greater than two sessions
164 per week, and 76.1% of respondents play additional sport, indicating that recreational runners are
165 likely to be meeting the recommended WHO Physical Activity Guidelines. Considering that 80% of
166 surveyed recreational runners have been running for at least three years, we can speculate that they
167 have managed to sustain a habit of regular physical activity at the recommended level for at least
168 three years.

169 Australian recreational runners self-reported a lower BMI than the general population. Additionally, a
170 weight loss of greater than five kilograms in the past two years was reported by approximately 40%
171 of runners with less than two years of experience. Physical activity is a key component in the
172 multidisciplinary approach of effective weight loss programs, and is especially important when
173 preventing continued weight gain or maintaining lower weight.(23) Indeed, endurance running has
174 been shown to be beneficial to physically inactive adults leading to body mass and body fat reduction,
175 with a systematic review concluding that one year of running training was effective in reducing body
176 mass by 3.3 kg.(24) Several systematic reviews have shown that aerobic exercise, such as running,
177 significantly contributes to weight loss, with strong evidence that this type of activity is effective in
178 reducing visceral fat.(25, 26) Additionally there is a dose-response relationship between aerobic
179 exercise and visceral fat reduction in obese participants, indicating that an activity such as recreational
180 running could be effective in improving health via a reduction of visceral fat.(27) A systematic review
181 indicated that risks of all-cause mortality and cardiovascular mortality were lower in people with high
182 BMI and good aerobic fitness than in people with normal BMI and poor fitness. However, aerobically

183 fit people with high BMI were still at a greater risk of type 2 diabetes mellitus and cardiovascular
184 disease.(28) In an Australian population it has been shown that walking is the most common type of
185 physically activity recommended to patients by their doctor.(29, 30) Our results, taken together with
186 previous findings indicate that recreational running could be promoted by general practitioners as an
187 effective mechanism for building aerobic fitness and maintaining a healthy body weight.

188 Only one quarter of recreational runners surveyed reported smoking at any time during their life and
189 0.6% were current smokers. These rates were substantially lower than those reported by the
190 Australian Bureau of Statistics, which showed that 14.5% of adult Australians were daily smokers, 1.5%
191 smoked less often than daily and about one third (31.4%) were ex-smokers.(11) A systematic review
192 of co-occurrence of smoking and physical activity showed negative association in 20 studies on adults
193 in several European countries, Japan and Australia and 13 studies with nonsignificant, mixed or
194 positive association, indicating possible complex relationships between smoking and physical activity
195 due to race, income level and other factors.(31) Hence, the very small proportion of runners currently
196 smoking could reflect their overall healthy lifestyle as well as the positive effects of individual exercise
197 bouts in reducing cravings for smoking.

198 Depression was the most common life-time diagnosis reported by recreational runners (15.3%).
199 Affective disorders, which comprise all levels and severity of depressive disorders and bipolar disorder,
200 accounted for 15% of life-time prevalence in Australian population.(32) The depression prevalence in
201 the Australian recreational running population is largely the same as in the general population.

202 Hypertension is a significant risk factor for chronic diseases including stroke, coronary heart disease,
203 heart failure and chronic kidney disease and is identified as the leading global risk factor for
204 mortality.(1) Based on measured data from the Australian Institute of Health and Welfare, 32% of
205 Australians aged 18 and over have hypertension.(33) However, only 6.1% of Australian recreational
206 runners surveyed self-reported that they had been diagnosed with hypertension. The reduced levels
207 suggest that recreational running is associated with lower rates of hypertension as a risk factor for
208 burden of disease.

209 Running, as a form of physical activity, has consistently been shown to provide a range of health
210 benefits, including reducing the overall risk of cardiovascular disease and all-cause mortality.(12, 13,
211 15, 34) More importantly, the clustering of various healthy behaviours has been shown to be inversely
212 related to the risk of all-cause mortality, with four or more healthy behaviours reducing mortality risk
213 by 66%.(35) Here we demonstrated that a large proportion of Australian recreational runners
214 displayed healthy behaviours including meeting physical activity guidelines, avoidance of overweight
215 or obesity and reduced smoking.

216 We suggest that recreational running could be promoted as a low-cost option for adhering to physical
217 activity guidelines. Marketing of recreational running through mass participation events, for example
218 *parkrun*, has been considered as a public health intervention.(36, 37) However, there is a risk of
219 sustaining an injury during participation in recreational running, with 49% of participants in this study
220 reporting a running injury over the preceding two years. This potential injury risk must be taken into
221 account when advising participation in recreational running. Additionally, commencement of a
222 running program for individuals with musculoskeletal injuries of the lower body should be supervised
223 by a qualified medical practitioner. The current study demonstrated that there are differences in male
224 and female preferences to consider when aiming to encourage people to begin a running program.
225 We show here that female runners were more likely to report shorter weekly distances while running
226 a similar number of sessions as male runners. This study did not investigate the motivations for
227 participation in recreational running, however several studies have demonstrated that the
228 motivations of males and females, in relation to participation in physical activity, differ in a number of
229 ways.(38-40) An Australian study demonstrated that, while both males and females are motivated by
230 general health and maintenance of fitness, women often cite weight loss/appearance and mental
231 health as motivating factors for increasing their physical activity levels while men participate for social
232 reasons and enjoyment.(18) Both motivational factors and running habits should be taken into
233 account when marketing recreational running for health benefits or encouraging participation.

While the self-report nature of data collection could introduce bias and error, the survey tool has been shown to be reliable and questions did not require respondents to recall long-term details of running habits or injuries. (19) The term of recall for injuries and running habits was limited to the two years preceding survey response, as it has been show that retrospective data beyond this point is not reliable. (41, 42) A further study limitation may have been sampling bias with higher proportion of female runners and middle-aged runners in the studied cohort in comparison with a demographic data of physically active Australian adults.(17) Lastly, absence of data from non-runners or those who may be interested in taking up recreational running precludes extrapolation of findings to non-runners.

5. Conclusion

Recreational running is associated with benefits across a range of measurable health outcomes. A high proportion of the Australian recreational runners who participated in this study had a body mass index within the healthy weight range, seemed to be meeting the WHO Physical Activity Guidelines each week for many years and were non-smokers. Additionally, our results indicate that taking up running is associated with weight loss and weight remains stable if individuals persist with running. Male and female runners reported different running preferences and these should be taken into account when promoting recreational running or encouraging participation.

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Authors' contributions

MK participated in the study design, data collection, performed data analysis and drafted the manuscript; NV participated in the study design, data collection, helped to draft the manuscript; ER helped with data analysis and revised the draft of the manuscript; SM participated in the data collection and revised the draft of the manuscript; JK participated in the study design and data collection and revised the draft of the manuscript. DCH participated in the study design, helped to draft the manuscript and then revised the draft of the manuscript.

All authors read and approved final version of the paper and agreed with the order of presentation of the authors.

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369 **Table 1: Characteristics of participants.**

Characteristics	All runners (*N*=4720)		Male runners (*n*=2165; 45.9%)		Female runners (*n*=2555; 54.1%)	
	Median (range)	IQR	Median (range)	IQR	Median (range)	IQR
Age (years)	40 (18 – 80)	33 – 47	42 (18 – 80)	34 – 49	39 (18 – 77)	32 – 46
Weight (kg)	68 (40 – 135)	60 – 77	76 (45 – 135)	70 – 83	61 (40 – 110)	56 – 68
Height (cm)	172 (120 – 210)	165 – 179	179 (152 – 210)	175 – 183	166 (120 – 190)	162 – 170
Body Mass Index (BMI) (kg/m^2)	23 (16 – 44.4)	21.3 – 25	23.8 (16 – 40.8)	22.3 – 25.6	22.2 (16.3 – 44.4)	20.6 – 24.2

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373 **Table 2: Training characteristics of Australian recreational running cohort.**

Training characteristics		All runners (*N*=4720)		Male runners (*N*=2165)		Female runners (*N*=2555)	
		n	%	*n*	%	*n*	%
Weekly running distance**	<20 km	1424	30.2	526	24.3	898	35.1
	20-40 km	2164	45.8	991	45.8	1173	45.9
	>40 km	1132	24.0	648	29.9	484	18.9
Running experience**	≤2 years	942	20.0	364	16.8	578	22.6
	3-5 years	1267	26.8	542	25.0	725	28.4
	6-9 years	722	15.1	297	13.7	425	16.6
	10+ years	1783	37.8	958	44.2	825	32.3
	NA	6	0.1	4	0.2	2	0.1
Run sessions per week**	1	15	0.3	10	0.5	5	0.2
	2 or 3	2041	43.2	869	40.1	1172	45.9
	4 or 5	2226	47.5	1027	47.4	1199	46.9
	6+	422	8.9	250	11.5	172	6.7
	NA	16	0.3	9	0.4	7	0.3
Race pace**	<4 min/km	403	8.5	329	15.2	74	2.9
	4-5 min/km	1591	33.7	1022	47.2	569	22.3
	5-6 min/km	1819	38.5	633	29.2	1186	46.4
	6-7 min/km	706	15.0	141	6.5	565	22.1
	>7 min km	189	4.0	34	1.6	155	6.1
	NA	12	0.3	6	0.3	6	0.2
Participation in other sports**	Yes	3590	76.1	1530	70.7	2060	80.6
	No	1113	23.6	629	29.1	484	18.9
	NA	17	0.4	6	0.2	11	0.5
Reported injuries occurred while running in past two years*	Yes	2315	49	1109	51.2	1206	47.2
	No	2405	51	1056	48.8	1349	52.8

374 NA – Not Available; * – statistically significant difference between males and females (p<0.05), **– statistically significant difference between males and females (p<0.001)

375 **Table 3: Lifetime diagnoses of chronic conditions reported by recreational runners.**

Chronic conditions	All runners (*N*=4720)		Male runners (*N*=2165)		Female runners (*N*=2555)	
	n	%	*n*	%	*n*	%
Depression**	724	15.3	240	11.1	484	18.9
Respiratory conditions**	554	11.7	221	10.2	333	13.0
Anaemia**	472	10.0	34	1.6	438	17.1
Hypertension**	290	6.1	168	7.8	122	4.8
Skin disease*	277	5.9	111	5.1	166	6.5
Cancer	238	5.0	108	5.0	130	5.1
Insomnia**	193	4.1	54	2.5	139	5.4
Osteoarthritis	184	3.9	74	3.4	110	4.3
Gastrointestinal disease**	186	3.9	56	2.6	130	5.1
Cardiac conditions	179	3.8	94	4.3	85	3.3
Thyroid disease**	180	3.8	30	1.4	150	5.9
Neurological conditions	88	1.9	37	1.7	51	2.0
Diabetes	68	1.4	30	1.4	38	1.5
Rheumatoid arthritis	54	1.1	19	0.9	35	1.4
Osteoporosis*	53	1.1	14	0.6	39	1.5
Chronic renal failure	11	0.2	7	0.3	4	0.2
Cerebral palsy	8	0.2	5	0.2	3	0.1
Cystic fibrosis	7	0.1	5	0.2	2	0.1

376 * – statistically significant difference between males and females ($p<0.05$),
377 **– statistically significant difference between males and females ($p<0.001$).
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380 **Table 4: Frequencies of body mass index categories.**

Body Mass Index	All runners (*N*=4720)		Male runners (*N*=2165)		Female runners (*N*=2555)	
	N	%	*n*	%	*n*	%
Underweight (<18.5 kg/m^2)*	121	2.6	17	0.8	104	4.1
Normal (18.5 to <25 kg/m^2)*	3443	72.9	1455	67.2	1988	77.8
Overweight (25 to <30 kg/m^2)*	1029	21.8	637	29.4	392	15.3
Obese (≥30 kg/m^2)	127	2.7	56	2.6	71	2.8

381 *– statistically significant difference between males and females ($p<0.001$).

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383 **Table 5: Multiple logistic regression analysis results with adjusted odds ratio (OR) estimates for**
384 **the effects of runner characteristics on clinically significant weight loss (≥5kg).**

Variable	OR[1]	95% CI	*P* value
Sex			
Female[2]	1.00		
Male	1.04	0.90, 1.19	0.62
Age group			
> 55 years[2]	1.00		
35-55 years	1.91	1.43, 2.54	<0.001
< 35 years	2.20	1.62, 2.96	<0.001
BMI group			
Normal[2]	1.00		
Underweight	0.69	0.42, 1.13	0.14
Overweight	1.96	1.68, 2.29	<0.001
Obese	2.51	1.76, 3.58	<0.001
Running experience			
≥ 10 years[2]	1.00		
6-9 years	1.22	0.98, 1.52	0.07
3-5 years	1.63	1.36, 1.94	<0.001
≤ 2 years	3.15	2.63, 3.78	<0.001
Participation in other sports			
No[2]	1.00		
Yes	0.99	0.85, 1.16	0.92
Injury occurrence			
No[2]	1.00		
Yes	1.02	0.89, 1.69	0.77
Smoking history			
No[2]	1.00		
Yes	1.34	1.15, 1.56	<0.001

385 CI – Confidence Interval
386 [1] Adjusted for the other variables in the table; [2] Reference category
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392 Figure 1. Comparison of BMI group percentages between Australian surveyed male (Figure 1a) and
393 female (Figure 1b) runners and Australian population surveyed by Australian Bureau of Statistics of
394 different age groups.

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