Amateur endurance cycling practice and adult's physical and psychosocial health: a cross-sectional study of the influence of training volume.

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MAIN TEXT

Title

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Abstract

This study aimed to analyse the association between amateur cycling training volume and physical and psychosocial health. A cross-sectional study was developed**, via self-reported survey**, among 1669 cyclists and 1039 controls, where analysis of variance and hierarchical multiple linear regression test were developed. Independent of gender, high volumes of amateur endurance cycling practice benefited cyclists' body mass index and male cyclists' physical conditioning, while psychosocial health did not differ among the training volume groups. Hierarchical multiple linear regression analysis highlighted the contribution of training volume to lower cyclists' body mass index and better male cyclists' physical conditioning. All cyclists groups presented better physical and psychosocial health than controls. High volumes of amateur endurance cycling training were associated with better physical health without jeopardizing psychosocial health. The practice of amateur endurance cycling, both in low and high volumes, was associated with better physical and psychosocial health compared with inactivity.

Keywords: Exercise, endurance training, health, physical activity, physical performance.

Introduction

Regular exercise has been proposed as an effective preventive strategy for premature mortality, by leading to cardiorespiratory and metabolic adaptations (Hespanhol, Pillay, van Mechelen, & Verhagen, 2015) related with reduction of cardiometabolic risk factors (Churilla et al., 2018). Cycling, as one of the most common exercise/sport activities among adults, has been associated with a significant reduction in all-cause mortality (Oja et al., 2017).

Endurance cycling has positive effects on health status, such as better cardiometabolic health (Oja et al., 2011), and better physical and psychological quality of life (Crane, Rissel, Standen, & Greaves, 2014), even when the practice is started in adulthood (Munguia-Izquierdo et al., 2017). However, it has been questioned whether high volumes of regular endurance exercise lead to the highest cardiometabolic health benefits or whether they may be related to potential adverse cardiovascular outcomes (O'Keefe et al., 2012; Valenzuela, Foster, Lucía, & de la Villa, 2018). In addition, literature findings about how high volumes phases of training are concomitant with mental alterations are being debated (Drew et al., 2018; du Preez et al., 2017).

To date, **there is a lack of literature about** the association between amateur cycling training volume and adults' health outcomes. Focalizing on amateur practitioners when exploring the association between cycling training volume and cardiometabolic and psychosocial health is essential due to the unique characteristic of elite athletes compared with general population (Wolanin, Gross, & Hong, 2015). Therefore, the aim of this study was to analyse the cross-sectional association between amateur cycling training volume and adults' physical and psychosocial health. **We hypothesized that amateur cycling training volume is positively associated with better adults'**

physical and psychosocial health and that amateur cyclists would report better health outcomes than inactive control subjects.

Materials and methods

Procedures and participants

This study was developed as a part of a research project focused on exploring amateur cycling practice and its association with health (Mayolas-Pi, Munguia-Izquierdo, et al., 2017; Mayolas-Pi, Simón-Grima, et al., 2017; Munguia-Izquierdo et al., 2017). An invitation to participate in this cross-sectional study, **including information about study aims and protocol,** was sent to the 62856 male and 2483 female amateur cyclist officially registered in Spain via e-mail to the representatives of the 3426 clubs that were integrated into the the Royal Spanish Cycling Federation. **Participants who voluntarily agreed to participate were instructed about completing the online form, gave their informed consent and were asked to respond to a self-report online survey including standardized and validated questionnaires as we previously explained (Munguia-Izquierdo et al., 2017).** Data were collected in the last week of May 2016, and the same procedure was repeated in 2017 and 2018 to recruit new participants. Data were analysed on June 2019. The study protocol complied with the Spanish law of data protection and the Declaration of Helsinki and obtained ethical approval from The Committee on Biomedical Ethics of the Aragon Government. The STROBE guideline items were fulfilled during the course of the study.

Cyclists were included in this study as they fulfilled the following inclusion criteria: to be aged 18 to 65 years, had histories of intensive cycling practice, develop a minimum of 3 h/week of training and with the objective to participate in road cycling or mountain bike events. Each cyclist was instructed to invite people who had similar sociodemographic characteristics **(age and gender)** to participate in the study. Participants who were aged 18 to 65 years and were classified as insufficiently active according to the International Physical Activity Questionnaire (Craig et al., 2003) were included as the control group.

Measures

Sociodemographic characteristics.

A questionnaire whose reproducibility was satisfactorily assessed previously (Munguia-Izquierdo et al., 2017) was used to evaluate gender, age, and the main sociodemographic variables that may condition the balance of training with family, social, and work obligations.

Training status

A questionnaire whose reproducibility was satisfactorily assessed previously (Munguia-Izquierdo et al., 2017) was used to assess the annual (km/year) training volume. The cyclists were classified according to quartiles of annual training volume (see the footnotes of Tables 1 and 2). This classification was performed independent of gender and for cycling modalities to guarantee maintaining the proportion of participants in each quartile group.

Health outcomes

Body Mass Index (BMI) was calculated by dividing weight by **squared** height (kg/m^2). ***Physical conditioning*** was assessed using the International Fitness Scale, where higher scores indicate better physical fitness (Ortega et al., 2011). ***Health-related quality of life (HRQoL)*** was assessed using version 2.0 of the 12-item Short-Form Health Survey, which is composed of 8 domains constituting physical and mental components scores, where higher scores indicate better functioning (Ware, Kosinski, & Keller, 1996). ***Sleep quality*** was assessed using the Pittsburgh Sleep Quality Index, which results in a global score where lower scores indicate better sleep quality (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). ***Depression and anxiety*** levels were determined using the Hospital Anxiety and Depression Scale, where lower scores indicate lower symptom levels (Zigmond & Snaith, 1983). ***The risk of exercise addiction (REA)*** was assessed using the Exercise Addiction Inventory, where lower scores indicate lower risk of exercise addiction (Terry, Szabo, & Griffiths, 2004).

Behavioural cardiometabolic risk factors.

Physical activity levels was assessed using the short version of the International Physical Activity Questionnaire (Craig et al., 2003). ***Adherence to Mediterranean diet*** was evaluated by the 14-point Mediterranean Diet Adherence Screener, where higher scores indicate higher adherence (Schroder et al., 2011). ***Dependence on tobacco*** was evaluated by the Fagerstrom Test for Nicotine Dependence revised, where lower scores indicate lower dependence on tobacco (Korte, Capron, Zvolensky, & Schmidt, 2013). ***Alcohol consumption*** was assessed by transforming the weekly volumes of beer, wine, and spirits drinks consumed into standard alcohol units, with lower units indicating lower consumption (Stockwell & Chikritzhs, 2000).

Analysis

Analysis was performed using the IBM Statistical Package for the Social Sciences software (IBM SPSS Statistics for Windows, version 20.0; IBM Corp, Armonk, NY). Analysis of variance test (ANOVA) was used to compare the variables of interest among quartile groups of cyclists and controls. Post-hoc analysis were analysed by

Bonferroni and Games-Howell correction to prevent type I errors caused by the multiple comparisons and unequal variances or sample size comparisons, respectively. To compare categorical variables, we used the chi-square test. In addition, 2-way ANOVA was also performed to establish whether there was an interaction of gender in the health parameters.

A series of hierarchical multiple linear regression analyses were performed to test the importance of cycling training volume to explain physical and psychosocial health outcomes. The analysis included three steps. In step 1, sociodemographic variables, which were selected based on their theoretical influence on conditioning the balance of training (Munguia-Izquierdo et al., 2017), were entered as covariates. Cycling training volume was analysed in step 2. In step 3, physical, psychosocial and behavioural cardiometabolic risk outcomes were entered to control the associations between training volume and health outcomes. The full model, with all variables entered simultaneously into the model, determined the contribution of study variables to explain health outcomes. We ensure that multi-collinearity was not a concern, and the normality, linearity, and homoscedasticity of residuals. The values were considered to be significant at $p < 0.050$.

Results

A total of 1669 cyclists and 1039 controls were included in the study and their sociodemographic characteristics were presented in Tables 1 and 2 for men and women, respectively. Women represented 10.1% (n=169) of cyclist and 41.3% (n=673) of control groups. Significant differences between cyclists' gender were found on several variables of interest. Annual training volume, mental HRQoL, age or BMI were significantly higher in men, while physical conditioning and ADM scores were significantly higher in women (data not shown).

Tables 1 and 2 show the results of analysis of variance for men and women, respectively. Independent of gender, BMI was lower while training volume was higher, with a difference of 1.2 and 0.8 kg/m^2 between the high and low training volume groups for men and women, respectively. Physical conditioning was better while training volume was higher only in men, with a significant difference of 0.4 points between the low and high training volume groups. No significant differences were found for psychosocial health outcomes among training volume groups, with differences lower than 1 point. A better cardiometabolic risk factors scores were found while training volume was higher for physical activity and alcohol consumption independent of gender, and for tobacco and AMD only in men.

When comparing health outcomes between cyclist training volume groups and controls, we found better cyclists' scores for all health outcomes, independent of gender, except for sleep quality on women. A lower BMI was found in all cyclist training volume groups compared with controls, independent of gender, with a difference of $\approx$ 1.0 kg/m^2 between the low volume and control groups or $\approx$ 2.0 kg/m^2 between the high volume and control groups (all $p < 0.050$, except for the low-to-medium volume group of women). Better physical conditioning was found in all cyclist training volume groups than in controls, with a difference higher than 1 point between the high volume group and controls and at least 1 point between the low volume group and controls for both genders (all $p < 0.050$). Physical and mental HRQoL scores were higher in all cyclist training volume groups than in controls, with differences of $\approx$5 points for physical and $\approx$10 points in the mental component for both genders (all $p < 0.050$). Sleep quality scores were better, although non-significant, in all cyclist training volume groups of men than in controls, but they were slightly worse in the low-to-medium and the high cyclist training volume groups of women. Anxiety scores were significantly lower in all cyclist training volume groups than in controls for both genders, with a difference higher than 1 point. Depression scores were lower in all cyclist training volume groups than in controls independent of gender, except for low female cyclist training volume group, with significant differences of ≈ 0.8 points in men and ≈ 1.0 points in women. REA was significantly higher (> 6 points) in all cyclist training volume groups than in controls, independent of gender. Among behavioural cardiometabolic risk factors, physical activity and AMD were significantly higher in all cyclist training volume groups than in controls independent of gender. Tobacco dependence and alcohol consumption were lower in all cyclist training volume groups than in controls independent of gender, but only significant differences for alcohol consumption were found in the medium-to-high and the high cyclist training volume groups compared with controls.

The results of hierarchical multiple regression analyses for men and women are shown in Tables 3 and 4, respectively. The first block was statistically significant for BMI, physical conditioning, and physical and mental HRQoL in men (Table 3), and for BMI in women (Table 4). The addition of training status (block 2) significantly added to the aforementioned models for both genders and for REA in men and anxiety in women. When physical, psychosocial and behavioural cardiometabolic risk outcomes were introduced to control the associations between training volume and health outcomes (block 3), they significantly added to the aforementioned models and to anxiety and depression in men; they also added to the aforementioned models and to physical conditioning, physical and mental HRQoL, and depression in women. The full model revealed that training volume significantly contributed to better physical conditioning

(β=0.15) and a lower BMI (β=-0.18) in men (Adjusted R^2=0.26 and 0.20, respectively), whereas only a significant contribution to a better BMI (β=-0.14) was found on women (Adjusted R^2= 0.28). No significant contribution of training volume was found for psychosocial outcomes, independent of gender.

Discussion

The main finding of this study suggests that high volumes of amateur endurance cycling training benefit cyclists' health without jeopardizing psychosocial health. Compared with controls, cyclists had better physical and psychosocial health outcomes, both practising low and high volumes of cycling. Therefore, amateur endurance cycling practice may be proposed as a good way to preserve adults' health without the risk of high training volume jeopardizing psychosocial health.

Amateur endurance cycling training volume contributed to a better BMI and physical conditioning when the training volume was higher, which is consistent with previous **study** that showed that larger training volume programmes demonstrated more consistent improvements in body composition and aerobic capacity (Foulds, Bredin, Charlesworth, Ivey, & Warburton, 2014). The fact that there were no differences among female cyclists' physical conditioning could be explained not only by the small sample size of them in our study but also by the differences in cycling intensity according to gender, as suggested by a previous study (De Geus, De Smet, Nijs, & Meeusen, 2007). The suggested dose-response and the long-term benefits obtained from endurance exercise could be explained by the cardiorespiratory and biological adaptations derived from regular practice, such as the increase of cardiac stroke and blood volume or the improved lipoprotein profile, which benefits cardiorespiratory and cardiometabolic health outcomes (Hespanhol et al., 2015). Amateur endurance cycling could be an important activity to be implemented on interventions, such as the promising new approach to e-health interventions (Wienert, Kuhlmann, Storm, Reinwand, & Lippke, 2019), aimed to develop a healthy behavioural change.

In line with a previous study (Doré, O'Loughlin, Beauchamp, Martineau, & Fournier, 2016), our results suggested that psychosocial health did not differ among cyclists' training volume groups, even for REA. In contrast, previous findings suggested that individual sports practice, especially on elite athletes, may be related to a high prevalence of mental disorders such as depression or anxiety (Gouttebarge, Aoki, Verhagen, & Kerkhoffs, 2017). These differences could be explained by other factors related to the competition rather than to the exercise, such as career dissatisfaction or conflicts with a trainer (Gouttebarge et al., 2017), factors that do not seem to be presented in amateur cyclists. We **found no** differences in REA among training volumes, and none of the cyclist groups overcame the threshold of high risk of REA (Terry et al., 2004). As previous findings suggested, exercise volume was not solely linked with a higher REA, and its development may be responsible for other factors, mainly related to intrinsic factors (Mayolas-Pi, Munguia-Izquierdo, et al., 2017).

Consistent with previous studies suggesting that physical activity, even in low volumes, improves physical conditioning and cardiometabolic health (Foulds et al., 2014; Hespanhol et al., 2015; Munguia-Izquierdo et al., 2017; Oja et al., 2011), our findings suggested that amateur endurance cycling led to better cyclists' cardiometabolic health and physical conditioning than inactive people. Literature findings also highlight the benefits of physical activity to psychosocial health compared with inactivity (Baumeister et al., 2017; Pucci, Rech, Fermino, & Reis, 2012). In line, our findings showed that amateur endurance cycling were associated with better cyclists' HRQoL scores than controls, overcoming the minimally relevant threshold; and lower cyclists' anxiety and depression symptomatology than controls, that, although below the moderate symptomatology threshold in both groups, were farther to reaching this threshold in cyclists (Stern, 2014). Consistently with literature findings (Mantovani, Duncan, Fernandes, Lima, & Codogno, 2016), we found that male cyclists' sleep quality were better than controls. However, sleep quality was slightly worse in several cyclist groups of women than in controls, which could be explained by not only the small female sample size but also by other factors that may mediate this association such as the level of physical conditioning or the acute effect of exercise related to the time between practice and sleep (Hurdiel et al., 2018; Kredlow, Capozzoli, Hearon, Calkins, & Otto, 2015). Behavioural cardiometabolic risk factors were also better in amateur endurance cyclists than controls, consistently with the mediation of exercise on them suggested by literature (Mayolas-Pi, Munguia-Izquierdo, et al., 2017). In this sense, amateur cycling practice may be useful to improve behavioural cardiometabolic risk factors, which lead to protection against the main causes of morbidity and mortality (Noble, Paul, Turon, & Oldmeadow, 2015).

This study analysed by first time the association between amateur cycling training volume and adults' health, providing several practical implications such as the usefulness of amateur cycling practise to preserve adults' health and the benefits that both low and high training volumes have to cyclists' physical health without jeopardizing their psychosocial health. Several strengths could be highlighted on this study. The high sample size allows this study to be representative to the cyclist population of its setting, Spain. The inclusion of amateur cyclist with at least 3 h/week of endurance cycling practice allows the analysis of the influence of different volumes of practice. Although this inclusion criterion may seem a low level, it could be considered as the minimum of a regular sport practice. However, the design is not without limitations. The cross-sectional design precludes the identification of any casual relations. Future longitudinal studies could help to identify dose-response relationships between endurance cycling training volumes and health outcomes, **as have been proposed in other sports (Roeh et al., 2019**). The self-report measure of the data has inherent limitations, such as recall bias of social desirability that should be taken into account in interpreting the results. However, we have used validated questionnaires for epidemiological studies that have been sensitive enough to differentiate the health status among the adult population (Buysse et al., 1989; Ortega et al., 2011; Ware et al., 1996; Zigmond & Snaith, 1983). **Future researcher using objective measures will improve our design**. The sample in this study was very biased towards males, although this represents the real differences in the proportion of men and women participating in endurance cycling events in Spain. To limit the bias in the interpretation of data, we separated male and female samples in the analysis.

Conclusion

In conclusion, high volumes of amateur endurance cycling training are associated with better physical health without jeopardizing psychosocial health. The practice of amateur endurance cycling, both in low and high volumes, is associated with better physical conditioning, cardiometabolic and psychosocial health compared with inactivity. Behavioural cardiometabolic risk factors are also improved by amateur endurance cycling practice. Amateur endurance cycling is a recommended practice because of its benefits, leading to the preservation of adult health without the risk of jeopardizing psychosocial health.

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Table 1. Comparison among groups of training volume and controls men.

	Low volume (376)	Low-to-medium volume (380)	Medium-to-high volume (372)	High volume (372)	Controls (366)
Sociodemographic characteristics					
Age, y	37.8 ± 9.8	39.6 ± 8.4	40.1 ± 8.7*	39.9 ± 8.6*	37.2 ± 12.8+^#
Marital status (single)	21.0 %	17.6 %	16.7 %	13.7 %*	36.9 %*+^#
Educational level (university studies)	48.9 %	47.6 %	43.8 %	40.6 %*	43.2 %
Employment situation (employees)	88.8 %	90.5 %	88.7 %	90.1 %	70.8 %*+^#
Number of children	0.8 ± 1.0	1.0 ± 1.0*	1.0 ± 1.0*	1.0 ± 1.0	0.8 ± 1.1
Size of municipality of residence (1-5)	3.2 ± 1.2	3.2 ± 1.1	3.1 ± 1.1	3.0 ± 1.0	3.3 ± 1.2#
Health outcomes					
BMI, kg/m^2	24.7 ± 2.7	24.6 ± 2.6	24.3 ± 2.4	23.5 ± 2.2*+^	25.8 ± 3.8*+^#
Physical conditioning (1-5)	3.9 ± 0.7	4.0 ± 0.7	4.1 ± 0.7*	4.3 ± 0.7*+^	2.9 ± 0.8*+^#
Physical HRQoL (0-100)	55.9 ± 5.8	55.7 ± 5.3	56.5 ± 5.2	56.3 ± 5.9	50.6 ± 10.*+^#
Mental HRQoL (0-100)	51.7 ± 11.7	51.9 ± 12.0	52.5 ± 12.6	52.7 ± 11.9	41.7 ± 17.2*+^#
Sleep (0-21)	4.9 ± 2.7	4.9 ± 2.7	4.7 ± 2.7	5.1 ± 3.0	5.4 ± 3.1^
Anxiety (0-21)	8.3 ± 2.3	8.5 ± 2.2	8.2 ± 2.3	8.1 ± 2.3	9.7 ± 3.0*+^#
Depression (0-21)	9.4 ± 2.0	9.5 ± 2.0	9.5 ± 2.1	9.4 ± 2.2	10.3 ± 2.9*+^#
REA (0-30)	18.7 ± 4.3	18.8 ± 4.4	19.4 ± 4.4	19.3 ± 4.2	12.0 ± 5.3*+^#
Behavioural cardiometabolic risk factors					
Physical activity, MET·min/wk	4563.7 ± 2705.1	5045.1 ± 2931.7	5659.7 ± 2684.1*+	6286.1 ± 2922.5*+^	522.9 ± 674.5*+^#
AMD (0-14)	8.1 ± 2.0	8.3 ± 2.1	8.5 ± 1.9	9.0 ± 2.0*+^	7.1 ± 2.2*+^#
Alcohol, SAU/wk	6.1 ± 7.3	6.6 ± 12.3	5.5 ± 8.5	5.0 ± 9.2	7.6 ± 10.0^#
Tobacco (0-16)	0.3 ± 1.2	0.3 ± 1.3	0.1 ± 0.6*+	0.1 ± 0.7	1.3 ± 2.8*+^#

Values are the mean ± standard deviation or percentage. Study sample was divided by quartile groups of annual training volume: low volume (2583.6 ± 1255.3 km/y) low-to-medium (5454.6 ± 1497.1 km/y), medium-to-high (8822.8 ± 1686.1 km/y), and high (14888.8 ± 3655.3). The level of signification was set at $p < 0.050$. *significantly different from low volume group; + significantly different from low-to-medium volume group; ^ significantly different from medium-to-high volume group; # significantly different from high volume group. Abbreviations: HRQoL: health-related quality of life; REA: risk of exercise addiction; BMI: body mass index; AMD: adherence to Mediterranean diet.

Table 2. Comparison among groups of training volume and controls women.

	Low volume (43)	Low-to-medium volume (40)	Medium-to-high volume (44)	High volume (42)	Controls (673)
Sociodemographic characteristics					
Age, y	35.7 ± 8.1	36.1 ± 8.0	37.4 ± 7.2	37.2 ± 8.9	34.9 ± 12.9
Marital status (single)	18.6 %	25.0 %	13.6 %	16.7 %	30.6 %$^{\wedge}$
Educational level (university studies)	58.1 %	57.5 %	59.1 %	61.9 %	59.7 %
Employment situation (employees)	86.0 %	82.5 %	75.0 %	81.0 %	57.1 %$^{*+\wedge\#}$
Number of children	0.6 ± 0.9	0.7 ± 1.0	0.5 ± 0.8	0.4 ± 0.7	0.8 ± 1.1$^{\#}$
Size of municipality of residence (1-5)	3.2 ± 1.2	3.1 ± 1.4	3.1 ± 1.2	3.1 ± 1.2	3.1 ± 1.2
Health outcomes					
BMI, kg/m^2	22.5 ± 3.9	22.7 ± 2.5	21.8 ± 2.5	21.7 ± 2.3	23.6 ± 4.4$^{*\wedge\#}$
Physical conditioning (1-5)	4.2 ± 0.8	4.2 ± 0.7	4.1 ± 0.7	4.3 ± 0.6	2.9 ± 0.8$^{*+\wedge\#}$
Physical HRQoL (0-100)	55.4 ± 6.0	56.6 ± 4.0	56.3 ± 6.5	56.2 ± 5.9	50.9 ± 11.4$^{*+\wedge\#}$
Mental HRQoL (0-100)	48.5 ± 13.2	51.7 ± 10.8	48.9 ± 12.7	48.5 ± 12.7	38.9 ± 18.0$^{*+\wedge\#}$
Sleep (0-21)	4.7 ± 2.6	5.2 ± 3.1	4.7 ± 2.3	5.3 ± 3.6	5.1 ± 3.0
Anxiety (0-21)	8.7 ± 2.8	8.1 ± 1.7	8.6 ± 2.3	7.7 ± 1.7	10.3 ± 3.0$^{*+\wedge\#}$
Depression (0-21)	9.9 ± 2.8	9.4 ± 1.6	9.4 ± 2.0	9.2 ± 1.8	10.5 ± 3.0$^{+\wedge\#}$
REA (0-30)	17.4 ± 4.7	18.7 ± 4.8	18.8 ± 4.4	18.8 ± 4.4	11.3 ± 4.7$^{*+\wedge\#}$
Behavioural cardiometabolic risk factors					
Physical activity, MET·min/wk	5210.2 ± 3482.1	4875.5 ± 2667.9	5385.8 ± 1972.4	6292.5 ± 3726.9$^{*+\wedge}$	396.5 ± 391.8$^{*+\wedge\#}$
AMD (0-14)	9.3 ± 1.7	8.7 ± 2.0	8.7 ± 2.1	9.2 ± 1.6	7.6 ± 2.1$^{*+\wedge\#}$
Alcohol, SAU/wk	3.0 ± 5.0	3.4 ± 6.0	2.0 ± 4.2	1.6 ± 2.9	4.2 ± 8.0$^{\wedge\#}$
Tobacco (0-16)	0.0 ± 0.3	0.0 ± 0.0	0.0 ± 0.2	0.2 ± 1.2	0.8 ± 2.0$^{*+\wedge\#}$

Values are the mean ± standard deviation or percentage. Study sample was divided by quartile groups of annual training volume: low volume (1762.7 ± 979.2 km/y) low-to-medium (3354.8 ± 640.8 km/y), medium-to-high (5728.3 ± 1280.1 km/y), and high (11490.2 ± 3036.8 km/y). The level of signification was set at $p < 0.050$. *significantly different from low volume group; + significantly different from low-to-medium volume group; ^ significantly different from medium-to-high volume group; # significantly different from high volume group. Abbreviations: HRQoL: health-related quality of life; REA: risk of exercise addiction; BMI: body mass index; AMD: adherence to Mediterranean diet.

Table 3. Hierarchical linear regression models for variables explaining men's health outcomes.

	BMI	Physical conditioning	Physical HRQoL	Mental HRQoL	Sleep	Anxiety	Depression	REA
Block 1								
Age	0.14***	-0.01	-0.04	-0.01	0.06	0.02	-0.02	-0.06
Marital status (single)	0.10***	-0.09*	-0.02	-0.02	0.01	0.02	0.00	0.01
Educational level (university studies)	-0.06*	0.08***	0.09***	-0.04	0.00	-0.02	-0.02	0.05*
Employment situation (employees)	-0.02	-0.07*	-0.03	-0.06*	0.03	0.02	0.03	0.02
Number of children	0.05	-0.04	-0.03	0.11***	-0.06	-0.05	-0.04	0.03
Size of municipality of residence (1-5)	0.00	0.07*	0.01	0.02	0.01	0.01	-0.06*	0.04
F p value	0.000	0.000	0.001	0.002	0.418	0.730	0.067	0.104
R2	0.062	0.030	0.015	0.014	0.004	0.002	0.008	0.007
Standardized R2	0.058	0.026	0.011	0.010	0.000	-0.002	0.004	0.003
Block 2								
Age	0.17***	-0.04	-0.05	-0.02	0.06	0.03	-0.02	-0.07
Marital status (single)	0.09***	-0.08*	-0.02	-0.01	0.01	0.02	0.00	0.01
Educational level (university studies)	-0.08***	0.09***	0.09***	-0.04	0.00	-0.02	-0.02	0.06*
Employment situation (employees)	-0.01	-0.07***	-0.03	-0.06*	0.03	0.02	0.03	0.02
Number of children	0.05	-0.04	-0.03	0.11***	-0.06	-0.06	-0.04	0.03
Size of municipality of residence (1-5)	0.00	0.08***	0.01	0.02	0.01	0.01	-0.06*	0.05
Annual training volume. km	-0.25***	0.26***	0.04	0.04	0.02	-0.05	-0.03	0.06*
F p value	0.000	0.000	0.001	0.002	0.445	0.482	0.061	0.025
R2	0.124	0.097	0.017	0.016	0.005	0.005	0.009	0.011
Standardized R2	0.120	0.093	0.012	0.011	0.000	0.000	0.004	0.006
Block 3								
Age	0.17***	0.02	-0.05	-0.04	0.08*	0.02	-0.03	-0.08*
Marital status (single)	0.07*	-0.05	0.00	0.00	0.01	0.01	-0.02	0.01
Educational level (university studies)	-0.05	0.07***	0.03	-0.04	-0.01	-0.02	-0.03	0.06*
Employment situation (employees)	-0.04	-0.06*	-0.03	-0.04	0.03	-0.02	0.01	0.02
Number of children	0.04	-0.05	0.03	0.09***	-0.06	-0.01	0.02	0.05
Size of municipality of residence (1-5)	0.01	0.07***	0.01	0.00	0.00	0.03	-0.06*	0.04
Annual training volume. km	-0.18***	0.15***	-0.04	-0.04	0.02	-0.01	-0.02	0.04
BMI. kg/m^2		-0.23***	-0.06*	-0.02	-0.04	-0.02	0.02	0.05
Physical conditioning (1-5)	-0.25***		0.26***	0.18***	0.04	-0.08***	0.04	0.08**
Physical HRQoL (0-100)	-0.07*	0.25***		-0.37***	0.03	-0.12***	-0.07*	0.03
Mental HRQoL (0-100)	-0.03	0.24***	-0.50***		0.02	-0.41***	-0.38***	-0.04
Sleep (0-21)	-0.03	0.03	0.02	0.01		0.06**	-0.01	0.00
Anxiety (0-21)	-0.02	-0.08***	-0.13***	-0.32***	0.09**		0.18***	0.18***
Depression (0-21)	0.02	0.04	-0.07*	-0.27***	-0.01	0.17***		0.03
REA (0-30)	0.04	0.06*	0.02	-0.03	0.00	0.14***	0.03	
Physical activity. MET·min/wk	0.04	0.10***	-0.03	0.01	-0.04	0.01	0.02	0.09***
AMD (0-14)	-0.08***	0.02	0.07***	0.07***	-0.05	0.01	-0.03	-0.01
Alcohol. SAU/wk	0.05*	-0.01	0.01	0.02	-0.01	0.04	-0.01	0.03
Tobacco (0-16)	-0.02	-0.02	-0.07***	-0.05*	0.02	0.03	-0.04	-0.04
F p value	0.000	0.000	0.000	0.000	0.112	0.000	0.000	0.000
R2	0.206	0.273	0.249	0.457	0.018	0.302	0.236	0.074
Standardized R2	0.196	0.264	0.240	0.450	0.005	0.293	0.226	0.062

* $p < 0.050$; ** $p < 0.010$; *** $p < 0.005$. Abbreviations: HRQoL: health-related quality of life; BMI: body mass index; REA: risk of exercise addiction; AMD: adherence to Mediterranean diet.

Table 4. Hierarchical linear regression models for variables explaining women's health outcomes.

	BMI	Physical conditioning	Physical HRQoL	Mental HRQoL	Sleep	Anxiety	Depression	REA
Block 1								
Age	0,31***	0,03	0,06	0,09	0,20	-0,12	-0,12	-0,11
Marital status (single)	-0,31***	0,05	0,05	0,08	-0,17	0,07	0,07	-0,14
Educational level (university studies)	-0,08	0,23**	0,09	-0,13	-0,08	0,24**	-0,02	0,08
Employment situation (employees)	0,08	-0,05	0,05	-0,06	-0,02	0,10	0,03	0,06
Number of children	0,16	0,01	-0,04	-0,03	-0,17	0,06	-0,08	0,07
Size of municipality of residence (1-5)	-0,18*	-0,01	0,04	0,04	-0,13	0,02	-0,02	0,11
F p value	0,002	0,125	0,852	0,291	0,096	0,114	0,715	0,172
R2	0,123	0,060	0,016	0,045	0,065	0,062	0,023	0,055
Standardized R2	0,090	0,025	-0,021	0,009	0,029	0,026	-0,014	0,019
Block 2								
Age	0,33***	0,01	0,06	0,10	0,19	-0,10	-0,10	-0,12
Marital status (single)	-0,30***	0,04	0,04	0,08	-0,17	0,08	0,08	-0,14
Educational level (university studies)	-0,08	0,23**	0,09	-0,13	-0,08	0,24**	-0,02	0,09
Employment situation (employees)	0,08	-0,05	0,05	-0,06	-0,02	0,10	0,04	0,06
Number of children	0,13	0,03	-0,04	-0,04	-0,17	0,03	-0,10	0,09
Size of municipality of residence (1-5)	-0,19*	0,00	0,04	0,04	-0,13	0,01	-0,03	0,11
Annual training volume, km	-0,16*	0,12	0,04	-0,06	0,02	-0,17*	-0,13	0,12
F p value	0,001	0,092	0,901	0,350	0,147	0,033	0,484	0,127
R2	0,148	0,074	0,017	0,047	0,065	0,091	0,040	0,068
Standardized R2	0,110	0,032	-0,026	0,005	0,024	0,050	-0,003	0,027
Block 3								
Age	0,31***	0,06	0,03	0,07	0,19	0,05	-0,03	-0,13
Marital status (single)	-0,26***	-0,06	0,12	0,11	-0,19	0,04	0,03	-0,12
Educational level (university studies)	0,09	0,22**	0,01	-0,10	-0,10	0,23***	-0,12	0,03
Employment situation (employees)	0,12	-0,03	0,06	0,01	0,01	0,12	-0,05	0,04
Number of children	0,18*	0,14	-0,11	-0,09	-0,17	0,04	-0,10	0,09
Size of municipality of residence (1-5)	-0,20**	-0,11	0,11	0,08	-0,15	0,01	-0,05	0,10
Annual training volume, km	-0,14*	0,00	-0,03	-0,12	0,03	-0,13	-0,09	0,10
BMI. kg/m^2		-0,36***	0,32***	0,28***	0,03	-0,06	-0,08	0,17
Physical conditioning (1-5)	-0,37***		0,10	-0,02	-0,05	-0,21*	-0,01	0,11
Physical HRQoL (0-100)	0,08	0,27***		-0,36***	0,14	-0,18*	-0,01	0,02
Mental HRQoL (0-100)	-0,02	0,26***	-0,41***		0,06	-0,27***	-0,14	-0,08
Sleep (0-21)	-0,04	0,02	0,12	0,05		0,05	-0,10	0,01
Anxiety (0-21)	-0,21*	-0,06	-0,22*	-0,29***	0,07		0,36***	0,14
Depression (0-21)	-0,01	-0,07	-0,01	-0,13	-0,11	0,31***		-0,13
REA (0-30)	0,09	0,13	0,01	-0,06	0,01	0,10	-0,11	
Physical activity, MET·min/wk	0,02	0,20***	-0,13	-0,11	-0,02	-0,16*	0,12	-0,01
AMD (0-14)	-0,15*	-0,09	0,15	0,11	-0,01	0,05	-0,07	-0,15
Alcohol, SAU/wk	0,22***	0,06	-0,04	-0,02	0,15	0,11	-0,18*	-0,15
Tobacco (0-16)	-0,05	-0,08	0,02	0,07	-0,13	0,01	-0,05	0,09
F p value	0,000	0,000	0,001	0,000	0,176	0,000	0,000	0,107
R2	0,358	0,368	0,245	0,337	0,140	0,371	0,275	0,153
Standardized R2	0,280	0,290	0,153	0,256	0,035	0,294	0,186	0,049

* $p < 0.050$; ** $p < 0.010$; *** $p < 0.005$. Abbreviations: HRQoL: health-related quality of life; BMI: body mass index; REA: risk of exercise addiction; AMD: adherence to Mediterranean diet.