Link to the final version: https://doi.org/10.1080/15438627.2020.1871349

MAIN TEXT

Title

Training volume and amateur cyclists' health: a six-month follow-up from coinciding with a high-demand cycling event.

Abstract

This study aimed to analyse the longitudinal association of amateur cycling training volume with health by comparing the proximity of participation in a high-demand cycling event. Variations in cycling training volume, behavioural cardiometabolic risk factors, and physical and psychosocial health were examined. Cyclists decreased their training volume by approximately 40% and their total physical activity volumes by approximately 20%, while controls maintained (~5%). A time*group interaction was found for men's physical conditioning, body mass index and anxiety and, independent of gender, for behavioural cardiometabolic risk factors. Variation in cycling training volume was positively correlated with variation in physical conditioning and total physical activity and negatively correlated with variation in body mass index. The high level of cycling training volume developed at the time coinciding with a high demand cycling event predisposes to better physical health and behavioural cardiometabolic risk factors, without negatively affect psychosocial health, compared with six month later.

KEYWORDS

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

Introduction

Currently, the rise of amateur endurance exercise poses a challenge for sports sciences **(Sports and Culture Ministry, 2019)**. Amateur cycling is one of the most common exercise/sport activities among adults (World Health Organization, 2010) and has been associated with a significant reduction in all-cause mortality and better cardiometabolic health, quality of life, and physical and psychosocial health (Munguia-Izquierdo et al., 2017; Oja et al., 2017).

A dose-response relationship between physical activity and exercise and adults' physical and psychosocial health has been established in the literature (Baumeister et al., 2017; Kim & Baggish, 2016). But also, previous findings have shown that mental disorders, such as anxiety or depression, are prevalent in individual sports athletes (Wolanin et al., 2015). The different characteristics between amateur individual sports practitioners and athletes require a specific focus on this population. To our knowledge, only a previous study of our research group analysed this association on amateur cyclists, which suggested cross-sectional associations between higher volumes of amateur endurance cycling and better physical health, without jeopardizing psychosocial health (Oviedo-Caro et al., 2020).

The influence of seasonal variation of training volumes on physical and psychosocial health have been studied on athletes populations with inconsistent findings. While some studies suggested that high volumes phases of training are concomitant with mental alterations (Rouveix et al., 2006), other studies suggested that the prevalence of mental disorders did not substantially vary from preseason to competition periods (Drew et al., 2018; du Preez et al., 2017). However, there is a lack of literature about how the associations of amateur endurance cycling training volume and adults' health may differ with the proximity of a high-demand cycling event.

The aim of this study was to analyse the longitudinal association of amateur cycling training volume with adults' health outcomes by comparing the proximity of participation in a high-demand cycling event. **Based on the results of a recent cross-sectional study** (Oviedo-Caro et al., 2020), **we hypothesized that the reduction of training volume six months after the high demand cycling event could be associated with a reduction on physical conditioning and behavioural cardiometabolic risk factors, and an increase of body mass index, without affecting psychosocial health.**

Material and methods

Procedures and participants

A longitudinal study was developed as part of a research project focused on exploring amateur endurance cycling practise and its associations with health through a web-based survey (Mayolas-Pi et al., 2017; Munguia-Izquierdo et al., 2017; Oviedo-Caro et al., 2020). An invitation to participate in this 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 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). The protocol complied with the Spanish laws for data protection and the Declaration of Helsinki and obtained ethical approval from The Committee on Biomedical Ethics of the Aragon Government. The STROBE guidelines were fulfilled during the course of the study.

Data were collected in the last week of May (baseline, coinciding with the participation of cyclists in their main cycling event) and November (6 months after the cycling event) 2016, and the same procedure was repeated during the same months in 2017 and 2018 to recruit new participants.

This study included amateur cyclists who were aged 18 to 65 **years**, had no chronic disease, develop a minimum of 7 hours of weekly training at baseline, with at least 1 year of cycling training experience, and their training was pursued with the objective to participate in road cycling events (>100 km) or mountain bike events (>45 km). Cyclists were instructed to invite people who had similar sociodemographic characteristics to participate in the study. Respondents were included as the control group as they aged 18 to 65, had no chronic disease, and had no experience in cycling training. Data were analysed in May 2019.

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 by obligations related with family, social status, and work.

Training status

The monthly training volume was assessed by a questionnaire whose reproducibility was satisfactorily assessed previously (Munguia-Izquierdo et al., 2017). Because most cyclists combine road and mountain bike cycling in their training and the kilometers developed on both modalities are not similar, training volume was calculated by summing the kilometres developed on each modality after correcting the kilometers developed on mountain bike cycling by a coefficient (1.42), obtained by comparing the mean velocity of the twenty best road and mountain bike cyclists in the main cycling events.

Health outcomes

Body Mass Index (BMI) was calculated by dividing weight by squared height squared (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 examines physical and mental component scores, with higher scores indicating better functioning (Ware et al., 1996). ***Sleep quality*** was assessed using the Pittsburgh Sleep Quality Index, which examined seven sleep components that yield a global score, with lower scores indicating better quality (Buysse et al., 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, which examined six components of addiction that yield a total score, with lower scores indicating a lower risk of exercise addiction (Terry et al., 2004).

Behavioural cardiometabolic risk factors.

Physical activity was measured with the short version of the International Physical Activity Questionnaire (Craig et al., 2003). ***Adherence to the Mediterranean diet (AMD)*** 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 et al., 2013). ***Alcohol consumption*** was calculated by transforming the volumes of beer, wine, and spirits drinks consumed in the last week 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) with the level of statistical significance set at α = 0.050. All data were checked for normality using Kolmogorov–Smirnov tests. Training volume and most of health outcomes showed non-normal distributions and appropriate analysis were developed.

Repeated measures analysis of variance (ANOVA) test was applied to analyse the data. Health outcomes scores at baseline and 6 months after the cycling event were considered the within-subject factor (time), and the cyclist and control groups were considered the between-subject factor. Partial eta squared (η^2) was calculated as the effect size (Field, 2009). In addition, post hoc paired t-tests were developed to compare longitudinal differences in the cyclist and control groups separately, and Cohen's d statistics (*d)* were used to determine effect sizes (Cohen, 1988). To avoid potential problems with violations of the assumptions underlying the ANOVA, we conducted a robust complementary analysis using the "bwtrim" function from the WRS2 package in R (Mair & Wilcox, 2019), which uses location estimators (20% trimmed mean) whose standard errors are significantly less affected by non-normal distributions than the sample mean. The results of the robust analysis corroborated the main findings from the repeated measures ANOVA (Supplementary table 2 and Supplementary table 3).

Associations between the variations of cycling training volume and health outcomes were explored using Spearman correlation coefficients.

Results

Three hundred thirty cyclists and 560 controls were included in the study and their sociodemographic characteristics are presented in Supplementary table 1. Male and female cyclists developed a mean of 1151 ± 478 and 826 ± 306 km/month, respectively, at the time coinciding with the cycling event, which represented approximately 70% and 60% of their total physical activity, respectively (Tables 1 and 2). Independent of gender, the cyclists significantly decreased their training volume by approximately 40% and their physical activity volume by approximately 20%. Controls maintained their physical activity volume, with variations lower than a 5%, independent of gender.

Cyclists' health outcomes variations are analysed for male and female in Table 1 and Table 2, respectively. Male cyclists' physical health levels significantly decreased six month after the cycling event, with an increase of BMI (ES = 0.21, $p < 0.001$) and a decrease of overall physical conditioning (ES = 0.19, $p = 0.001$) and several of its domains. Only muscular strength domain of physical conditioning significantly **vary** for female cyclists (ES = 0.41, $p = 0.031$). Controls did not significantly varied physical health on this period, except for female BMI (ES = 0.17, $p = 0.004$). Cyclists' sleep quality improved six months after the cycling event (Male: ES = 0.26, $p < 0.001$; Female: ES = 0.38, $p = 0.045$). In addition, male cyclists' mental component summary of HRQoL and REA also improved over this period (ES = 0.23 and 0.23, p = 0.010 and < 0.001, respectively), while physical component summary of HRQoL and depression significantly got worse (ES = 0.15 and 0.36, p = 0.010 and 0.001, respectively). The same longitudinal variations were found for male controls, while female controls' anxiety and depression increased over this period (Tables 1 and 2, respectively). Cyclists' adherence to the Mediterranean diet and alcohol consumption got worse six months after the cycling event, independent of gender (all ES < 0.35, $p < 0.050$). Controls did not significantly vary any behavioural cardiometabolic risk factors.

Results of the repeated measures ANOVA assessing the differences between cyclists' and controls' health outcomes are also presented for men (Table 1) and women (Table 2). We observed time*group interactions on men's overall physical conditioning ($p = 0.042$, $\eta 2$ =

0.01), with time and groups effects, and BMI ($p = 0.001$, ŋ2 = 0.02), with groups effects. No time*group interaction was found on psychosocial health, independent of gender, except for men's anxiety ($p = 0.045$, ŋ2 = 0.01), with time and groups effects. Group effects were also found in all psychosocial health outcomes, except for men's sleep quality and women's depression. We observed time*group interactions on behavioural cardiometabolic risk factors, independent of gender, on AMD (Men: $p < 0.001$, ŋ2 = 0.02; Women: $p < 0.001$, ŋ2 = 0.06) and alcohol consumption (Men: $p < 0.001$, ŋ2 = 0.03; Women: $p = 0.005$, ŋ2 = 0.02), and only on men's physical activity ($p = 0.001$, ŋ2 = 0.02) and tobacco consumption ($p < 0.021$, ŋ2 = 0.01).

Table 3 shows the correlations between variations in cycling training and total physical activity volumes and health. The variation of male cycling training volume was positively associated with variation in cardiorespiratory fitness ($r = 0.19$), overall physical conditioning ($r = 0.13$), and physical activity volume ($r = 0.15$), and negatively associated with BMI variation ($r = -0.20$), all $p < 0.050$. Variation in male cyclists' total physical activity volume was positively correlated with variation in PCS ($r = 0.13$) and negatively associated with BMI and sleep quality variations (both $r = -0.14$, $p < 0.050$). A significant positive correlation was found among female cyclists between the variation in total physical activity volume and REA ($r = 0.55$, $p = 0.002$). Independent of gender, controls' variation in total physical activity volume was positively associated with cardiorespiratory fitness (Men: $r = 0.15$; Women: $r = 0.18$) and REA (Men: $r = 0.14$; Women: 0.18), all $p < 0.050$. In addition, female controls' variation in total physical activity volume was positively associated with speed/agility and flexibility domains of physical conditioning and mental component summary of HRQoL variations (r from 0.14 to 0.18, all $p < 0.050$).

Discussion

The main findings of this study highlight that the proximity of a high demand cycling event supposes a high level of cycling training volume, which is associated with better physical health and behavioural cardiometabolic risk factor levels compared with six months after the event, without negatively influences psychosocial health.

As expected, amateur endurance cyclists decreased their training volume by approximately 40% six months after the high-demand cycling event, consistent with the literature on elite cyclists (Sassi et al., 2008)**, although this decrease of training volume is more significant on amateur cyclists because of the different characteristics of the elite cyclists' season compared with amateur cyclists whose competitions usually are concentrated in a short space of time**. This decrease in endurance cycling training volume implied a decrease in cyclists' total physical activity, although with different magnitudes, implying that the percentage of total physical activity corresponding to cycling decreased from ≈65% to ≈50%. This finding, linked with the fact that controls did not substantially **vary** their physical activity volume, supports that the reduction of cyclists' physical activity volume could be mainly related with training programming and not with seasonal factors such as meteorology or the reduction of hours of sunlight suggested by previous studies (Cepeda et al., 2018). In addition, our findings suggest that cyclists' compensate their decline in training volume with other activities minimizing the decline of physical activity six months after the high-demand cycling event. The use of IPAQ, which ask about volume and intensities, avoid us to know the specific activities developed. Future studies analysing the specific activities that cyclists combined with cycling training may expand our findings.

Cyclists' BMI and physical conditioning worsened six month after the high-demand cycling event. The decrease of cycling training volume and behavioural cardiometabolic risk factors (physical activity, AMD and alcohol consumption) levels could explain these findings. In line with this, the literature has shown that elite cyclists' aerobic fitness were lower at non-competition compared with competition period (Sassi et al., 2008), which could be explained by cardiorespiratory and biological adaptations derived from regular endurance exercise (**Earnest et al., 2019**; Hespanhol et al., 2015; Zilinski et al., 2015). In addition, a variation on adults' BMI has been suggested from warmer to cold months, which could be explained by changes in physical activity and diet patterns (Marti-Soler et al., 2014). When comparing with controls, cyclists' BMI and physical conditioning levels were better both at the time coinciding with the cycling event and six month later. Consistently, literature findings support that the practice of amateur endurance cycling benefits adults' physical health (Foulds et al., 2014).

The proximity of a high-demand cycling event did not jeopardize cyclists' psychosocial health. Although the mental component summary of HRQoL, sleep quality and REA improved and the physical component summary of HRQoL and depression worsened from the time coinciding with the cycling event to six months later, the same variation on this outcomes were observed on controls, suggesting the influence of the seasonality on these variables as previous study showed (Jia & Lubetkin, 2009). In addition, the high training volume reached at the time coinciding with the cycling event did not involve a worse perception of anxiety and depression; on the contrary, the scores became worse when reducing cycling training and physical activity volumes. This result is consistent with previous studies on elite athletes (Drew et al., 2018; du Preez et al., 2017), but inconsistent with studies suggesting that high volume phases of training are concomitant with alterations in mood state (Rouveix et al., 2006). This discrepancy could be explained by other factors such as career dissatisfaction or conflicts with a trainer (Gouttebarge et al., 2017), which do not seem to be present in amateur cyclists. When comparing with controls, amateur endurance cyclists' presented better psychosocial health level, which suggest that the practise of amateur endurance cycling benefits adult's psychosocial health, as literature supports (Mantovani et al., 2016; Oviedo-Caro et al., 2020). Cyclists' REA levels were higher both at the time coinciding with the cycling event and six months later. Although higher than controls, it did not overcome the threshold for high risk of REA (Terry et al., 2004). The fact that REA scores slightly decreased over time, suggests that the high cycling training volume reached at the time coinciding with the main cycling event does not involve a high risk of REA.

The practice of amateur endurance cycling leads to better behavioural cardiometabolic risk factors, mainly at the time coinciding with their main cycling event. This finding is consistent with the literature regarding the association of physical activity with ADM and tobacco and alcohol consumption (Marventano et al., 2018). In contrast, our results suggest that ADM and alcohol and tobacco consumption are transient, highlighting that focusing on a cycling event involves a predisposition to improve behavioural cardiometabolic risk factors among adults.

Our study expands the current knowledge on the association between amateur endurance cycling and adult health, analysing longitudinally this association for first time. However, the design of this study is not without limitations. First, we used an observational study that only allows us to explain how the association among study outcomes evolves, avoiding us from inferring any reasons for changes in outcomes variables. Future studies developing interventions promoting and controlling amateur endurance cycling training volume may expand the current knowledge on this topic. Self-report measures have inherent limitations that should be taken into account when interpreting the results. However, we have used validated questionnaires for epidemiological studies that have been sensitive enough to differentiate the health status of adults population (Buysse et al., 1989; Ortega et al., 2011; Ware et al., 1996; Zigmond & Snaith, 1983). Our relatively small sample of female cyclists also limits the statistical power and validity of the data. An improved control of gender and ethnicity should be the focus of future research.

Conclusion

The high level of amateur endurance cycling training volume developed at the time coinciding with a high demand cycling event predisposes to better adults' physical health and behavioural cardiometabolic risk factors levels, without negatively affect psychosocial health, compared with six month later. Training volume decreased along this 6-months follow-up, which was associated with a decrease of physical health and behavioural cardiometabolic risk factors levels.

REFERENCES

Baumeister, S. E., Leitzmann, M. F., Bahls, M., Dörr, M., Schmid, D., Schomerus, G., Appel, K., Markus, M. R. P., Völzke, H., Gläser, S., & Grabe, H. J. (2017). Associations of leisure-time and occupational physical activity and cardiorespiratory fitness with incident and recurrent major depressive disorder, depressive symptoms, and incident anxiety in a general population. *Journal of Clinical Psychiatry*, *78*(1), e41–e47. https://doi.org/10.4088/JCP.15m10474

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193–213. https://doi.org/10.1016/0165-1781(89)90047-4

Cepeda, M., Koolhaas, C. M., van Rooij, F. J. A., Tiemeier, H., Guxens, M., Franco, O. H., & Schoufour, J. D. (2018). Seasonality of physical activity, sedentary behavior, and sleep in a middle-aged and elderly population: The Rotterdam study. *Maturitas*, *110*, 41–50. https://doi.org/10.1016/j.maturitas.2018.01.016

Cohen, J. (1988). Statistical Power Analysis for the Behavioural Science (2nd Edition). In

Statistical Power Anaylsis for the Behavioural Science (2nd Edition).

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J. F., & Oja, P. (2003). International physical activity questionnaire: 12-Country reliability and validity. *Medicine and Science in Sports and Exercise*, *35*(8), 1381–1395. https://doi.org/10.1249/01.MSS.0000078924.61453.FB

Drew, M., Vlahovich, N., Hughes, D., Appaneal, R., Burke, L. M., Lundy, B., Rogers, M., Toomey, M., Watts, D., Lovell, G., Praet, S., Halson, S. L., Colbey, C., Manzanero, S., Welvaert, M., West, N. P., Pyne, D. B., & Waddington, G. (2018). Prevalence of illness, poor mental health and sleep quality and low energy availability prior to the 2016 summer Olympic games. *British Journal of Sports Medicine*, *52*(1), 47–53. https://doi.org/10.1136/bjsports-2017-098208

du Preez, E. J., Graham, K. S., Gan, T. Y., Moses, B., Ball, C., & Kuah, D. E. (2017). Depression, Anxiety, and Alcohol Use in Elite Rugby League Players Over a Competitive Season. *Clinical Journal of Sport Medicine*, *27*(6), 530–535. https://doi.org/10.1097/JSM.0000000000000411

Earnest, C. P., Rothschild, J., Harnish, C. R., & Naderi, A. (2019). Metabolic adaptations to endurance training and nutrition strategies influencing performance. *Research in Sports Medicine*, *27*(2), 134–146. https://doi.org/10.1080/15438627.2018.1544134

Field, A. (2009). Discovering Statistics Using SPSS. In *Discovering Statistics Using SPSS*. https://doi.org/10.1234/12345678

Foulds, H. J. A., Bredin, S. S. D., Charlesworth, S. A., Ivey, A. C., & Warburton, D. E. R. (2014). Exercise volume and intensity: A dose-response relationship with health benefits. *European Journal of Applied Physiology*, *114*(8), 1563–1571.

https://doi.org/10.1007/s00421-014-2887-9

Gouttebarge, V., Aoki, H., Verhagen, E. A. L. M., & Kerkhoffs, G. M. M. J. (2017). A 12-Month Prospective Cohort Study of Symptoms of Common Mental Disorders among European Professional Footballers. *Clinical Journal of Sport Medicine*, *27*(5), 487–492. https://doi.org/10.1097/JSM.0000000000000388

Hespanhol, L. C., Pillay, J. D., van Mechelen, W., & Verhagen, E. (2015). Meta-Analyses of the Effects of Habitual Running on Indices of Health in Physically Inactive Adults. *Sports Medicine*, *45*(10), 1455–1468. https://doi.org/10.1007/s40279-015-0359-y

Jia, H., & Lubetkin, E. I. (2009). Time trends and seasonal patterns of health-related quality of life among U.S. adults. *Public Health Reports*, *124*(5), 692–701. https://doi.org/10.1177/003335490912400511

Kim, J. H., & Baggish, A. L. (2016). Physical Activity, Endurance Exercise, and Excess—Can One Overdose? *Current Treatment Options in Cardiovascular Medicine*, *18*(11), 68. https://doi.org/10.1007/s11936-016-0490-6

Korte, K. J., Capron, D. W., Zvolensky, M., & Schmidt, N. B. (2013). The Fagerström Test for Nicotine Dependence: Do revisions in the item scoring enhance the psychometric properties? *Addictive Behaviors*, *38*(3), 1757–1763. https://doi.org/10.1016/j.addbeh.2012.10.013

Mair, P., & Wilcox, R. (2019). Robust statistical methods in R using the WRS2 package. *Behavior Research Methods*, *Epub ahead*. https://doi.org/10.3758/s13428-019-01246-w

Mantovani, A. M., Duncan, S., Fernandes, R. A., Lima, M. C. S., & Codogno, J. S. (2016). Different Amounts of Physical Activity Measured by Pedometer and the Associations With Health Outcomes in Adults. *Journal of Physical Activity and Health*, *13*(11), 1183–1191. https://doi.org/10.1123/jpah.2015-0730

Marti-Soler, H., Gubelmann, C., Aeschbacher, S., Alves, L., Bobak, M., Bongard, V., Clays, E., De Gaetano, G., Di Castelnuovo, A., Elosua, R., Ferrieres, J., Guessous, I., Igland, J., Jrøgensen, T., Nikitin, Y., O'Doherty, M. G., Palmieri, L., Ramos, R., Simons, J., … Marques-Vidal, P. (2014). Seasonality of cardiovascular risk factors: An analysis including over 230 000 participants in 15 countries. *Heart*, *100*(19), 1517–1523. https://doi.org/10.1136/heartjnl-2014-305623

Marventano, S., Godos, J., Platania, A., Galvano, F., Mistretta, A., & Grosso, G. (2018). Mediterranean diet adherence in the Mediterranean healthy eating, aging and lifestyle (MEAL) study cohort. *International Journal of Food Sciences and Nutrition*, *69*(1), 100–107. https://doi.org/10.1080/09637486.2017.1332170

Mayolas-Pi, C., Simón-Grima, J., Peñarrubia-Lozano, C., Munguía-Izquierdo, D., Moliner-Urdiales, D., & Legaz-Arrese, A. (2017). Exercise addiction risk and health in male and female amateur endurance cyclists. *Journal of Behavioral Addictions*, *6*(1), 74–83. https://doi.org/10.1556/2006.6.2017.018

Munguia-Izquierdo, D., Mayolas-Pi, C., Peñarrubia-Lozano, C., Paris-Garcia, F., Bueno-Antequera, J., Oviedo-Caro, M. A., & Legaz-Arrese, A. (2017). Effects of Adolescent Sport Practice on Health Outcomes of Adult Amateur Endurance Cyclists: Adulthood Is Not Too Late to Start. *Journal of Physical Activity and Health*, *14*(11), 876–882. https://doi.org/10.1123/jpah.2017-0010

Oja, P., Kelly, P., Pedisic, Z., Titze, S., Bauman, A., Foster, C., Hamer, M., Hillsdon, M., & Stamatakis, E. (2017). Associations of specific types of sports and exercise with all-cause and cardiovascular-disease mortality: a cohort study of 80 306 British adults. *British Journal of Sports Medicine*, *51*(10), 812–817. https://doi.org/10.1136/bjsports-2016-096822

Ortega, F. B., Ruiz, J. R., España-Romero, V., Vicente-Rodriguez, G., Martínez-Gómez, D., Manios, Y., Béghin, L., Molnar, D., Widhalm, K., Moreno, L. A., Sjöström, M., & Castillo, M. J. (2011). The International Fitness Scale (IFIS): Usefulness of self-reported fitness in youth. *International Journal of Epidemiology*, *40*(3), 701–711. https://doi.org/10.1093/ije/dyr039

Oviedo-Caro, M., Mayolas-Pi, C., López-Laval, I., Reverter-Masia, J., Munguía-Izquierdo, D., Bueno-Antequera, J., Guillén-Correas, R., Lapetra-Costa, S., & Legaz-Arrese, A. (2020). Amateur endurance cycling practice and adult’s physical and psychosocial health: a cross-sectional study of the influence of training volume. *Research in Sports Medicine*. https://doi.org/doi: 10.1080/15438627.2020.1731689

Rouveix, M., Duclos, M., Gouarne, C., Beauvieux, M. C., & Filaire, E. (2006). The 24 h urinary cortisol/cortisone ratio and epinephrine/norepinephrine ratio for monitoring training in young female tennis players. *International Journal of Sports Medicine*, *27*(11), 856–863. https://doi.org/10.1055/s-2006-923778

Sassi, A., Impellizzeri, F. M., Morelli, A., Menaspà, P., & Rampinini, E. (2008). Seasonal changes in aerobic fitness indices in elite cyclists. *Applied Physiology, Nutrition, and Metabolism*, *33*(4), 735–742. https://doi.org/10.1139/h08-046

Schroder, H., Fito, M., Estruch, R., Martinez-Gonzalez, M. A., Corella, D., Salas-Salvado, J., Lamuela-Raventos, R., Ros, E., Salaverria, I., Fiol, M., Lapetra, J., Vinyoles, E., Gomez-Gracia, E., Lahoz, C., Serra-Majem, L., Pinto, X., Ruiz-Gutierrez, V., & Covas, M.-I. (2011). A Short Screener Is Valid for Assessing Mediterranean Diet Adherence among Older Spanish Men and Women. *Journal of Nutrition*, *141*(6), 1140–1145. https://doi.org/10.3945/jn.110.135566

Sports and Culture Ministry, S. G. (2019). *Anuario de Actividades Deportivas*. Cultura, Ciencia y Deporte. http://www.culturaydeporte.gob.es/dam/jcr:dc406096-a312-4b9d-bd73-2830d0affb2d/anuario-de-estadisticas-deportivas-2019.pdf

Stockwell, T., & Chikritzhs, T. (2000). *International Guide for Monitoring Alcohol Consumption and Harm*. Geneva (CHE): World Health Organisation.

Terry, A., Szabo, A., & Griffiths, M. (2004). The exercise addiction inventory: A new brief screening tool. *Addiction Research and Theory*, *12*(5), 489–499. https://doi.org/10.1080/16066350310001637363

Ware, J. E., Kosinski, M., & Keller, S. D. (1996). A 12-Item Short-Form Health Survey: Construction of Scales and Preliminary Tests of Reliability and Validity. *Medical Care*, *34*(3), 220–233. https://doi.org/10.1097/00005650-199603000-00003

Wolanin, A., Gross, M., & Hong, E. (2015). Depression in athletes: Prevalence and risk factors. *Current Sports Medicine Reports*, *14*(1), 56–60. https://doi.org/10.1249/JSR.0000000000000123

World Health Organization. (2010). *Global Recommendations on Pysical Activity For Health*. https://doi.org/ISBN 978 92 4 159 997 9

Zigmond, A. S., & Snaith, R. P. (1983). The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavica*, *67*(6), 361–370. https://doi.org/10.1111/j.1600-0447.1983.tb09716.x

Zilinski, J. L., Contursi, M. E., Isaacs, S. K., Deluca, J. R., Lewis, G. D., Weiner, R. B., Hutter, A. M., D'Hemecourt, P. A., Troyanos, C., Dyer, K. S., & Baggish, A. L. (2015). Myocardial adaptations to recreational marathon training among middle-aged men. *Circulation: Cardiovascular Imaging*, *8*(2), e002487. https://doi.org/10.1161/CIRCIMAGING.114.002487

Table 1. Comparisons between male cyclists and controls characteristics.

	Cyclists (n=300)					Controls (n=266)					Repeated measures ANOVA								
	Baseline	Variation	Paired t-test			Baseline	Variation	Paired t-test			Time			Group			Time * group		
	Mean ± SD	Mean ± SD	t	p	*d*	Mean ± SD	Mean ± SD	t	p	*d*	F	p	η^2	F	p	η^2	F	p	η^2
Training status																			
Experience in cycling. y	5.9 ± 5.3																		
Monthly training volume. km	1151 ± 478	-460 ± 459	17.3	<0.001	1.00														
Weekly training volume. h/wk	11.6 ± 3.4	-4.3 ± 4.2	17.9	<0.001	1.03														
Weekly training frequency. d/wk	4.1 ± 1.2	-1.1 ± 1.5	12.9	<0.001	0.74														
Health outcomes																			
BMI. kg/m² [a]	24.0 ± 2.5	0.2 ± 1.0	3.7	<0.001	0.21	25.9 ± 3.9	-0.1 ± 1.3	1.5	0.137	0.09	0.9	0.357	0.00	38.4	<0.001	0.06	11.6	0.001	0.02
Overall physical conditioning (1-5)	4.2 ± 0.7	-0.1 ± 0.6	3.3	0.001	0.19	3.6 ± 0.9	0.0 ± 0.7	0.2	0.852	0.01	5.4	0.021	0.01	95.2	<0.001	0.14	4.1	0.042	0.01
Cardiorespiratory fitness (1-5)	4.3 ± 0.7	-0.1 ± 0.7	2.4	0.018	0.14	3.5 ± 1.1	0.0 ± 0.7	0.5	0.616	0.03	1.3	0.248	0.00	114.8	<0.001	0.17	3.7	0.054	0.01
Muscular strength (1-5)	3.9 ± 0.7	-0.1 ± 0.6	1.9	0.059	0.11	3.5 ± 0.8	0.0 ± 0.6	0.8	0.415	0.05	3.5	0.060	0.01	35.5	<0.001	0.06	0.4	0.503	0.00
Speed–agility (1-5)	3.8 ± 0.7	-0.1 ± 0.7	2.9	0.005	0.16	3.4 ± 0.9	0.0 ± 0.7	0.6	0.542	0.04	5.6	0.018	0.01	35.9	<0.001	0.06	2.1	0.147	0.00
Flexibility (1-5)	3.2 ± 0.9	0.0 ± 0.6	0.6	0.529	0.04	2.8 ± 0.9	0.0 ± 0.7	1.2	0.234	0.07	1.7	0.190	0.00	26.6	<0.001	0.05	0.2	0.643	0.00
Physical component summary	56.8 ± 4.7	-0.9 ± 5.9	2.6	0.010	0.15	55.6 ± 6.7	-1.3 ± 7.4	2.9	0.004	0.18	15.2	<0.001	0.03	11.5	0.001	0.02	0.5	0.459	0.00
Mental component summary	52.4 ± 11.2	2.8 ± 11.9	4.0	<0.001	0.23	47.7 ± 13.1	2.4 ± 14.1	2.8	0.006	0.17	22.3	<0.001	0.04	25.5	<0.001	0.04	0.1	0.728	0.00
Sleep quality (0-21)	4.6 ± 2.3	-0.5 ± 2.0	4.5	<0.001	0.26	4.8 ± 2.4	-0.3 ± 2.0	2.3	0.025	0.14	22.3	<0.001	0.04	2.5	0.112	0.00	2.0	0.158	0.00
Anxiety (0-21)	7.8 ± 1.9	0.1 ± 1.8	0.9	0.346	0.05	8.4 ± 2.2	0.4 ± 2.1	3.3	0.001	0.20	10.3	0.001	0.02	20.1	<0.001	0.03	4.0	0.045	0.01
Depression (0-21)	9.4 ± 1.9	0.9 ± 2.4	6.2	<0.001	0.36	9.8 ± 1.9	1.0 ± 2.8	6.0	<0.001	0.37	74.2	<0.001	0.12	12.6	<0.001	0.02	0.4	0.519	0.00
REA (0-30) [b]	19.3 ± 4.2	-1.0 ± 4.3	3.9	<0.001	0.23	16.4 ± 5.0	-0.4 ± 4.1	1.4	0.150	0.09	14.1	<0.001	0.02	52.8	<0.001	0.09	2.8	0.093	0.01
Behavioral Cardiometabolic Risk Factors																			
Physical activity. h/wk [c]	16.9 ± 8.1	-3.0 ± 9.0	5.5	<0.001	0.34	11.3 ± 8.8	-0.4 ± 8.4	0.8	0.416	0.05	20.0	<0.001	0.04	43.7	<0.001	0.08	11.1	0.001	0.02
AMD (0-14)	8.8 ± 2.0	-1.1 ± 3.1	6.1	<0.001	0.35	8.0 ± 1.9	-0.3 ± 2.8	1.8	0.068	0.11	31.9	<0.001	0.05	11.2	0.001	0.02	9.9	0.002	0.02
Alcohol. SAU/wk [d]	6.4 ± 9.6	2.7 ± 7.5	6.2	<0.001	0.36	6.9 ± 10.7	-0.6 ± 10.8	1.0	0.329	0.06	6.8	0.009	0.01	2.0	0.161	0.00	18.3	<0.001	0.03
Tobacco (0-16) [e]	0.1 ± 0.5	0.1 ± 0.7	1.6	0.116	0.09	0.5 ± 1.6	-0.1 ± 0.7	1.7	0.091	0.10	0.0	0.886	0.00	14.6	<0.001	0.03	5.3	0.021	0.01

Abbreviations: body mass index (BMI), risk of exercise addiction (REA), adherence to Mediterranean diet (AMD). [a]Incomplete BMI data (n=1). [b]Incomplete EAI data (n=1). [c]Incomplete IPAQ data (n=62). [d]Incomplete alcohol data (n=1). [e]Incomplete Fagerstrom Test data (n=1). Effect size interpretation: η^2 = 0.01 to 0.05: small, 0.06 to 0.14: medium, >0.14: large (Field, 2009); Cohen's *d* = 0.01 to 0.19: insignificant, 0.20 to 0.49: small, 0.50 to 0.79: medium, >0.80: large (Cohen, 1988).

Table 2. Comparisons between lemacc ydycists anh yontrocs y. arayteristiys(

	Cdycists =n3 0) 2					Controcs =n3 6Ru2					Nepeateh measOres AVBP A								
	- asecine	P ariation	Taireh tGtest			- asecine	P ariation	Taireh tGtest			* ime			g roOp			* ime M±roOp		
	S ean DFD	S ean DFD	t	p	*d*	S ean DFD	S ean D FD	t	p	*d*	E	p	x^{6}	E	p	x^{6}	E	p	x^{6}
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5 9perienye in ydycin±(d	0(v D 0(0																		
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Health outcomes																			
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S entac yomponent sOmmard	v8(7 D R(u	0(R D 8u()	8(v	) (8u8	) (64	u6() D 8v(4	) (R D 87(4	) (R	) (0<)	) () v	6(6	) (807	) () 8	8v(6	W)()) 8	) () v	) (R	) (0u4	) ())
Fceep qOacitd =) G682	u(8 D 6(0	G(4 D 6(8	6(8	) () uv	) (04	v(6 D 6(4	) () D 6(v	) ()	) (R7u	) ())	6(4	) () Rv	) () 8	R(v	) ()) 6	) () 0	6(<	) (8))	) () 8
An9ietd =) G682	<(6 D 8(7	) (7 D 6(8	8(<	) (8) 4	) (0)	R(u D 6(7	) (7 D 6(v	0(<	W)()) 8	) (66	7(8	) () 8u	) () 6	8R(R	W)()) 8	) () 7	) ()	) (47R	) ())
Depression =) G682	R(7 D 8(4	8() D 6(7	6()	) () vu	) (0<	R(7 D 8(R	) (< D 6(4	u(6	W)()) 8	) (6u	R(v	) ()) 6	) () 0	) (6	) (7R)	) ())	) (0	) (78u	) ())
N5 A =) G0) 2	8R(7 D u(0	G(4 D v(8	) (4	) (u6)	) (8v	8u(v D v(7	G(8 D u(<	) (v	) (7v6	) () 0	8()	) (06v	) ())	6<()	W)()) 8	) () 4	) (v	) (u<v	) ())
Behavioral Cardiometabolic Risk Factors																			
T. dsiyac aytikitd(. fw1[a]	8<() D 7(0	G6(7 D 4(u	8(<	) (8))	) (08	4(< D 4(R	) (u D R()	) (7	) (v04	) () u	8(<	) (8R0	) () 8	60(8	W)()) 8	) () 4	6(R	) () 4R	) () 8
AS D =) G8u2	R(v D 6(0	G6(v D 0(R	0(7	) ()) 8	) (7v	4() D 6()	G(6 D 6(u	8(<	) () R)	) (8)	08()	W)()) 8	) () R	8(<	) (8R<	) () 8	68(8	W)()) 8	) () 7
Acyo. oc(FAUfw1	6(v D u(6	6(< D <()	6(8	) () uv	) (04	0(R D 7(4	G(7 D v(4	8(<	) () R)	) (8)	0(u	) () 7<	) () 8	) ()	) (4u<	) ())	4(8	) ()) v	) () 6
* obayyo =) G872	) () D) ()	G(6 D) (<	) ()	W)()) 8	) ())	) (v D 8(7	) (8 D) (R	8(7	) (86)	) () R	) (6	) (76)	) ())	6(<	) (8) 0	) () 8	) (6	) (76)	) ())

Abbrekiations: bohd mass inhe9 =- S I2, ris1 ol e9eryise ahhiytion =N5 A2, ah. erenye to S ehiterranean hiet =AS D2([a]Inyompcete ITAQ hata =n3 u42(5 1leyt size interpretation: x^{6} 3) () 8 to) () v: smacc,) () 7 to) (8u: mehiOm, >) (8u: car±e =Eiech, 6)) R2; Co. en's *d* 3) () 8 to) (8R: insi±niliyant,) (6) to) (uR: smacc,) (v) to) (<R: mehiOm, >) (4) : car±e =Co. en, 8R442(

Table 3. Correlations between variation in cycling training and physical activity volume and variation in adults' health outcomes.

	Cyclists								Controls			
	Men (n=300)				Women (n=30)				Men (n=266)		Women (n=294)	
	Training volume		PA volume [a]		Training volume		PA volume [a]		PA volume [a]		PA volume [a]	
	r	p	r	p	r	p	r	p	r	p	r	p
Health outcomes												
BMI. kg/m^2 [b]	-0.20	0.001	-0.14	0.027	-0.24	0.199	-0.21	0.266	-0.08	0.237	0.03	0.670
Physical Conditioning												
Overall (1-5)	0.13	0.027	0.08	0.206	0.13	0.501	0.16	0.411	0.05	0.454	0.12	0.067
Cardiorespiratory fitness (1-5)	0.19	0.001	0.08	0.175	0.28	0.129	-0.23	0.235	0.15	0.017	0.18	0.004
Muscular strength (1-5)	0.11	0.066	-0.01	0.855	0.07	0.716	0.06	0.759	0.06	0.361	0.06	0.340
Speed–agility (1-5)	0.06	0.272	0.09	0.143	-0.24	0.209	-0.14	0.463	-0.01	0.880	0.18	0.004
Flexibility (1-5)	0.03	0.599	-0.02	0.787	0.11	0.574	0.08	0.688	0.11	0.097	0.14	0.023
Physical component summary	0.10	0.072	0.13	0.039	-0.06	0.748	-0.03	0.857	0.01	0.936	0.07	0.300
Mental component summary	0.03	0.575	0.04	0.495	-0.05	0.805	-0.06	0.766	0.04	0.565	0.16	0.011
Sleep quality (0-21)	-0.07	0.223	-0.14	0.027	-0.09	0.642	0.02	0.904	0.12	0.066	0.03	0.690
Anxiety (0-21)	-0.01	0.832	-0.07	0.252	-0.13	0.479	-0.23	0.224	-0.07	0.306	-0.01	0.888
Depression (0-21)	0.06	0.305	-0.06	0.315	0.13	0.510	-0.09	0.638	-0.06	0.399	-0.08	0.203
REA (0-30) [c]	0.07	0.214	0.11	0.071	0.08	0.692	0.55	0.002	0.14	0.029	0.18	0.005
Behavioral Cardiometabolic Risk Factors												
Physical activity. h/wk [a]	0.17	0.006	1.00		0.09	0.636	1.00		1.00		1.00	
AMD (0-14)	-0.09	0.139	-0.02	0.792	-0.20	0.282	0.01	0.957	0.06	0.333	0.07	0.270
Alcohol. SAU/wk [d]	-0.05	0.347	-0.06	0.368	-0.32	0.085	-0.35	0.060	0.00	0.997	0.01	0.924
Tobacco (0-16) [e]	0.00	0.952	-0.08	0.200	0.00*		0.00*		-0.10	0.119	0.04	0.505

*Female cyclists' mean SD value is zero. Abbreviations: body mass index (BMI), risk of exercise addiction (REA), adherence to Mediterranean diet (AMD). [a] Incomplete IPAQ data (Men = 62; Women = 48), [b]Incomplete BMI data (Men =1), [c]Incomplete EAI data (Men = 1), [d]Incomplete alcohol data (n=1). [e]Incomplete Fagerstrom Test data (n=1).

Supplementary Table 1. Comparisons between cyclists and controls sociodemographic characteristics.

	Men				Women			
	Cyclists (n=300)	Controls (n=266)	Statistics		Cyclists (n=30)	Controls (n=294)	Statistics	
	Mean ± SD or n(%)	Mean ± SD or n(%)	Value*	p	Mean ± SD or n(%)	Mean ± SD or n(%)	Value*	p
Age	40.2 ± 8.1	39.1 ± 10.9	-1.3	0.197	37.5 ± 7.0	35.1 ± 11.6	-1.1	0.101
Education (university studies)	159 (53.0%)	157 (59.0%)	2.1	0.150	22 (73.3%)	212 (72.1%)	21.1	0.000
Occupational status (employed)	277 (92.3%)	201 (75.6%)	30.2	0.000	27 (90.0%)	195 (66.3%	7.1	0.008
Marital status (without couple)	35 (11.7%)	61 (22.9%)	12.7	0.000	27 (90.0%)	208 (70.7%)	5.1	0.024
Number of children (≥1)	178 (59.3%)	136 (51.1%)	3.8	0.050	10 (33.3%)	115 (39.1%)	0.4	0.535
Size of municipality (≥ 100.000)	108 (36%)	147 (55.3%)	21.1	0.000	15 (50.0%)	155 (52.7%)	0.1	0.776

* Statistics are t value for continuous variables or χ^2 value for categorical variables.

Supplementary table 2. Robust comparisons between male cyclists and controls characteristics.

	Cyclists								Controls						Repeated measures ANOVA**					
	Trimmed mean		Correlation				T-test*		Trimmed mean		Correlation		T-test*		Time		Group		Time*group	
			Training volume		PA volume[a]						PA volume[a]									
	Baseline	Variation	r	p	r	p	p	ξ	Baseline	Variation	r	p	p	ξ	Q	p	Q	p	Q	p
Training status																				
Experience in cycling. y	5.9																			
Monthly training volume. km	1090.5	-440.6					<0.001	0.64												
Weekly training volume. h/wk	11.2	-4.3					<0.001	0.80												
Weekly training frequency. d/wk	4.1	-1.1					<0.001	0.43												
Health outcomes																				
BMI. kg/m^2 [b]	23.7	0.2	-0.19	0.001	-0.14	0.020	<0.001	0.07	25.5	-0.1	-0.07	0.256	0.081	0.02	1.3	0.250	36.0	<0.001	15.7	<0.001
Physical conditioning																				
Overall physical conditioning (1-5)	4.2	-0.1	0.13	0.030	0.08	0.190	0.001	0.14	3.6	0.0	0.05	0.427	0.889	0.01	5.6	0.019	94.9	<0.001	4.7	0.031
Cardiorespiratory fitness (1-5)	4.3	-0.1	0.19	0.001	0.08	0.196	0.017	0.10	3.5	0.0	0.15	0.019	0.764	0.01	3.8	0.051	154.2	<0.001	2.4	0.124
Muscular strength (1-5)	3.9	-0.1	0.11	0.064	-0.01	0.819	0.048	0.08	3.5	0.0	0.05	0.468	0.887	0.01	1.5	0.225	34.1	<0.001	2.0	0.154
Speed–agility (1-5)	3.8	-0.1	0.07	0.247	0.08	0.176	0.004	0.12	3.4	0.0	0.00	0.970	0.486	0.03	6.7	<0.010	25.5	<0.001	2.6	0.110
Flexibility (1-5)	3.2	0.1	0.02	0.696	-0.03	0.669	0.132	0.06	2.8	0.1	0.11	0.077	0.187	0.05	3.8	0.053	43.0	<0.001	0.1	0.784
Physical component summary	56.9	-0.9	0.10	0.074	0.14	0.024	0.012	0.12	56.0	-1.3	0.01	0.851	0.124	0.09	6.8	0.010	10.4	0.001	0.0	0.948
Mental component summary	53.6	2.8	0.04	0.522	0.03	0.682	<0.001	0.27	50.0	2.4	0.04	0.539	0.003	0.14	37.0	<0.001	23.9	<0.001	1.4	0.239
Sleep quality (0-21)	4.4	-0.5	-0.07	0.220	-0.13	0.028	<0.001	0.19	4.5	-0.3	0.11	0.090	<0.001	0.15	37.1	<0.001	1.4	0.244	1.8	0.180
Anxiety (0-21)	7.7	0.1	-0.00	0.978	-0.07	0.260	0.841	0.01	8.2	0.4	-0.07	0.294	0.028	0.12	3.6	<0.058	18.0	<0.001	2.8	0.097
Depression (0-21)	9.3	0.9	0.05	0.403	-0.06	0.367	<0.001	0.33	9.7	1.0	-0.05	0.429	0	0.48	105.2	<0.001	10.6	0.001	0.6	0.423
REA (0-30)	19.4	-1.0	0.07	0.200	0.13	0.036	<0.001	0.18	16.7	-0.4	0.12	0.060	0.097	0.07	13.5	<0.001	39.1	<0.001	1.6	0.212
Behavioral Cardiometabolic Risk Factors																				
Physical activity. h/wk[a]	15.4	-3.0	0.15	0.013	1.00		<0.001	0.31	9.5	-0.5	1.00		0.606	0.02	23.0	<0.001	56.3	<0.001	16.6	<0.001
AMD (0-14)	8.8	-1.1	-0.07	0.244	-0.00	0.940	<0.001	0.35	7.9	-0.3	0.06	0.364	0.158	0.09	25.5	<0.001	13.5	<0.001	9.4	0.002
Alcohol. SAU/wk	4.1	2.7	-0.05	0.346	-0.06	0.366	<0.001	0.19	3.9	-0.6	-0.02	0.723	0.835	0.01	13.4	<0.001	3.7	0.057	11.3	0.001
Tobacco (0-16) †	0.0	0.1							0.0	-0.1										

Abbreviations: body mass index (BMI), risk of exercise addiction (REA), adherence to Mediterranean diet (AMD). †Trimmed mean value is zero. *Robust paired t-test (“yuend” function), ξ is a robust explanatory measure of effect size (Mair & Wilcox, 2019): ξ = 0.01 to 0.09: insignificant, 0.10 to 0.29: small, 0.30 to 0.49: medium, >0.50: large. ** The bwtrim function returns the test statistic Q, which is approximately F-distributed, but returns neither degrees of freedom nor effect sizes (Mair & Wilcox, 2019). [a]Incomplete BMI data (n=1). [b]Incomplete EAI data (n=1). [c]Incomplete IPAQ data (n=62). [d]Incomplete alcohol data (n=1). [e]Incomplete Fagerstrom Test data (n=1).

Supplementary table 3. Robust comparisons between lemaye cdcyists anh controys c. aracteristicsC

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			graininv Poyume		- A Poyume[a]						- A Poyume[a]									
	Baseyine	* ariation	r	p	r	p	p	Q	Baseyine	* ariation	r	p	p	Q	E	p	E	p	E	p
Training status																				
x5perience in cdcyinvCd	9CM																			
k ont. yd traininv PoyumeC1m	049G6	G9MM					<WCWW	W2W												
3 ee1yd traininv PoyumeC. 8w1	/ WCW	G9G4					<WCWW	W0W												
3 ee1yd traininv lref uencdCh8w1	4G9	GWq					WCW2M	W96												
Health outcomes																				
Bk IC1v8m[7 b]	7/ C0	WCW	GWC72	WCq4	GWCM	W49/	W690	WCW	77G4	WC7	WCW9	W249	WCWWM	WCW4	/ C2	WC7Wq	9C7	WCWq4	/ C9	WC729
- . dsicayconhitioninv																				
VPerayyp. dsicayconhitioninv (/ GM)	4CM	GWC7	WCq	W92M	WC9	WCMW	W72q	WC7W	9G4	WCW	WC7	WCW2q	W6W9	WCW	/ C7	WC7q0	24G4	<WCWW	/ C9	WC7M4
Narhiorespiratord litness (/ GM)	4CM	GWC7	W9/	WCW64	GWC77	WC740	W47M	WCM	7Gq	WC	WC7W	WCWW7	WCW7W	WCW0	WCW	W00/	/ 49Gq	<WCWW	7CW	WCM2
k uscuyar strenvt. (/ GM)	4C7	GW9	WCWM	W0W	WCWM	Wq6q	WCW6/	WC0	9C	WCW	WCW2	W992	WCM26	WCW7	7C7	WC49	M4C9	<WCWW	9CM	WCW27
Speeh–aviyitd (/ GM)	4CW	GWC	GWC7/	WC72W	GWC2	W4/ M	W460	WC/	9C	WC	WC6	WCWW9	WCW00	WCW2	WCW	W60W	9M6	<WCWW	/ C2	WC7Wq
Fye5ibiyitd (/ GM)	9C0	GWC7	WC/	WCM29	WCW2	WqM	W9W4	WC9	9C7	WCW	WC2	WCW4	WqM6	WCW	W6	W94M	9CM	WCW29	/ C7	WC7q7
- . dsicaycomponent summard	MqC7	WC	GWC7	WCM9q	GWCW7	W607	W06q	WCW7	M2CW	GC7	WCW	WC94	WCWW4	WC4	/ C0	WC0M	6CM	WCWW7	7G4	WC7/
k entaycomponent summard	M9C2	4C7	GWCW2	WqM7	GWCW6	W2MM	WCW67	W97	44G4	/ CM	WC0	WCWW4	WC2M	WCW2	4C0	WCW76	9W6	<WCWW	/ C	WC76q
Syeep fuayitd (WG7/)	9G6	GW0	GWC7	WCM9W	WCW9	W022	WCWM	W76	4Gq	WCW	WCW4	WCM96	Wq20	WCW	4C9	WCW96	0CM	WCWW4	9C2	WCWM6
An5ietd (WG7/)	2G6	W0	GWC9	WCMW	GWC72	WC0/	WCW44	W99	0G6	WCM	GWCW9	W246	WCWW7	WC9	/ Wq	WCWW	M4G6	<WCWW	WCM	W404
Depression (WG7/)	6G4	/ C2	WC7	WCM4	GWC9	WCMW	WCWW	WCMq	6CM	Wq	GWC/	WCW00	WCWW	WC7W	7MC	<WCWW	9G6	WCWM9	4CW	WCWM
RxA (W9W)	/ 6G6	GWq	WCWM	W0Wq	WCMq	WCWW	W996	WC4	/ 4CM	GWC7	WC0	WCWW2	WCMW7	WCW9	/ C4	WC747	29Gq	<WCWW	W4	WCM90
Behavioral Cardiometabolic Risk Factors																				
- . dsicayactiPitdC. 8w1[a]	/ 2CM	G9C2	WC7	WCM46	/ CWW		WCW99	W9M	2G4	Wq	/ CWW		WCWq6	WCW0	9C7	WCWqM	4qG6	<WCWW	qC7	WCWW0
Ak D (WG4)	6G6	G9G4	GWCM	W444	WCW4	W094	<WCWW	W22	0CW	GW9	WCW0	WC7/ 4	WCW26	WCW	77G6	<WCWW	/ C2	WC7/ 9	/ MCM	<WCWW
Ayco. oyCSAU8w1	/ C7	/ C	GWC7M	WC0M	GW9M	WCW29	WCq0	WC77	7CW	GW4	GWCW	W074	WCW	WCWq	W0	W907	WCW	W6q2	9C9	WCWq/
gobacco (WG2)†	WCW								WCW											

AbbrePiations: bohd mass inhe5 (Bk I), ris1 ol e5ercise ahhiction (RxA), ah. erence to k ehiterranean hiet (Ak D)C†grimmeh mean Payue is zeroCTRobust paireh tGest ("duenh" lunction), Qis a robust e5pyanatord measure ol ellect size (k air & 3 iyco5, 7W6): Q= WCW to WCW6: insivnilicant, WCWto WC76: smayy, W9Wto W46: mehium, >WCMW yarveCTT g. e bwtrim lunction returns t. e test statistic E, w. ic. is appro5imateyd FG histributeh, but returns neit. er hevrees ol lreehom nor ellect sizes (k air & 3 iyco5, 7W6)C[a]Incompyete I- AE hata (n=40)C