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ORIGINAL ARTICLE

Is trait anxiety associated with improving fitness?

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KEYWORDS
VO2max-cardiorespiratory fitness;
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Abstract
Introduction and objective: Information to explain the inter-individual variation of VO2max-cardiorespiratory fitness after training interventions is of great importance as regards health status. The main purpose of this study was to estimate whether the trait anxiety can influence cardiorespiratory fitness in controlled aerobic exercise training.
Methods: Twelve students were divided into a progressive light-aerobic training group (g-PAT, $n = 6$) and a control group (g-CON, $n = 6$). VO2max was assessed at baseline and after a 6-week training period. Training consisted of three 30-min sessions a week with the intensity of 50–70% of HR reserve.
Results: ANCOVA show a significant group effect in VO2max [$F(1,8) = 5.362$; $P < 0.05$], with higher values in g-PAT [36.45 (6.32)] compared to the g-CON [28.97 (6.38)], and a significant effect on baseline VO2max [$F(1,8) = 26.518$, $P < 0.001$] and trait anxiety [$F(1,8) = 8.229$, $P = 0.021$].
Conclusion: The main findings of this study suggest that VO2max training response is not only determined by a VO2max genetic factor, but is also determined by trait anxiety. This is the first exploratory study to estimate the proportion of the trait anxiety associated with the physiological response to an aerobic exercise. We suggest that the trait anxiety is taken into account as an individual difference which could determine the efficacy of aerobic exercise programs in sedentary people.

PALABRAS CLAVE
VO2max-fitness cardiorrespiratorio;
Actividad física;
Ansiedad rasgo

¿Está relacionada la ansiedad rasgo con la mejora del fitness?

Resumen
Introdución y objetivo: La información que permita explicar la variación inter-individiual del VO2max-fitness cardiorrespiratorio después de las intervenciones de entrenamiento es de gran importancia en relación al estado de salud. El objetivo principal de este estudio fue estimar si el rasgo de ansiedad puede influir en el fitness cardiorrespiratorio a partir de un entrenamiento controlado de ejercicio aeróbico.

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Método: Doce estudiantes fueron divididos en un grupo de entrenamiento aeróbico progresivo (g-PAT, n = 6) y en un grupo control (g-CON, n = 6). El VO2máx se evaluó antes y después de un período de entrenamiento de 6 semanas. El entrenamiento consistió en tres sesiones a la semana de 30 minutos con una intensidad de 50-70% de la FC de reserva.

Resultados: El ANCOVA muestra un efecto significativo del grupo sobre el VO2 máx [F (1,8) = 5,362, p <0,05], con valores más altos en el g-PAT [36,45 (6,32)] en comparación con el g-CON [28,97 (6,38)], y un efecto significativo del VO2max basal [F (1, 8) = 26.518, p =, 001] y de la ansiedad rasgo [F (1,8) = 8,229, p = 0,021].

Conclusión: Las principales conclusiones de este estudio sugieren que la respuesta al entrenamiento del VO2máx no sólo está determinada por factores genéticos sino también por la ansiedad rasgo. Este es un primer estudio exploratorio en estimar la proporción de la ansiedad rasgo en relación con la respuesta fisiológica a un ejercicio aeróbico. Sugerimos considerar la ansiedad rasgo como una diferencia individual que puede determinar la eficacia de los programas de ejercicio aeróbico en personas sedentarias.

Introduction

Maximum oxygen uptake (VO2max) is a gold standard feasible and accessible cardiovascular health-related index. VO2max-cardiorespiratory fitness, expressed in relative values (ml/min/kg), represents the heart functional status. Low VO2max-cardiorespiratory fitness has been linked with cardiovascular morbidity and mortality and cardiovascular diseases[1–3] and with major cardiovascular risk factors like type II diabetes mellitus, obesity, anxiety and hypertension.[4–8]

There is scientific evidence that regular exercise and/or physical activity can prevent the lifestyle-related cardiovascular disease and, therefore, may provide an added protective effect to decrease the cardiovascular risk by sedentary lifestyle.[9] Besides, improvements of VO2 are associated with reduced risk of death[10] and with positive changes on fitness after physical training. Thus, obtaining VO2max can help to identify the cardiac functional level. In normal population an indicator of cardiovascular system adaptability has been proven useful to the tasks of daily life,[11] while in the sports field it is one of the key elements to identify the potential to achieve high athletic performance.[12,13]

Nevertheless, recent examinations of physical activity and exercise training studies have yielded inconsistent results. Heterogeneity responses have been shown in the improvements in cardiorespiratory fitness after aerobic training, assessed by the change in VO2max.[14] There are a quite diverse and wide range of longitudinal exercise training studies that have shown different exercise training programs effects on this health status measure.[15–17] Literature suggests that amount and intensity of exercise,[18] gender, race and age[16] are important factors in achieving increases in VO2max. However, baseline VO2max is the major important determinant (genetic factor) of the cardiorespiratory fitness training response.[12,19–21] Hence, information with respect to explaining the inter-individual variation of VO2max-cardiorespiratory fitness after training interventions is of great importance concerning health status.

On the other hand, trait anxiety is considered to be a characteristic of personality that endures over time and it is manifest across a variety of situations.[22] Studies on general population[23–26] and on athletes[27] have reported the anxiety impact on several physical, behavioral, physiological and psychological health-related outcomes. Interestingly, psychological stress and trait anxiety have been negatively associated with cardiorespiratory values[28] and fitness.[29] Even though prior research indicates the negative role of trait anxiety on the fitness status in university students,[30] to our knowledge, no study to date has investigated trait anxiety influence on VO2max responses to exercise training.

Therefore, the purpose of the present study is to analyze the influence of the trait anxiety on the cardiorespiratory fitness response to moderate exercise training. In this regard, we guess that trait anxiety score and baseline VO2max values would be related to VO2max response to exercise after a 6-weeks progressive aerobic training program in sedentary undergraduate students.

Method

Participants

Forty-five undergraduate university students were contacted and informed about the study. Participants were able to receive extra credit in their university classes by participating. They were invited to a first screened session and were eligible to participate if they met the following criteria: (1) healthy (positive physical aptitude), (2) sedentary (less than 2 h/week of structured exercise during the last 6 months), and (3) nonsmokers. 12 participants who met the inclusion criteria were randomly assigned to either the training group (g-PAT, $n = 6$) or the control group (g-CON, $n = 6$). Both groups were constituted by 5 females and 1 male. Characteristics of participants are presented in Table 1. All participants provided written informed consent to participate after explanations of the experimental procedures and possible risks and benefits.

Table 1 Characteristics of the two groups of participants.

	Baseline values	
	g-PLAT ($n = 6$)	g-CON ($n = 6$)
Age	24.66 (4.58)	25.50 (4.37)
Height (cm)	166.17 (5.03)	164.17 (4.99)
BMI (kg m^{-2})	22.06 (2.58)	22.32 (5.88)
Trait anxiety	20.16 (8.68)	26.16 (13.49)
VO2max (ml/min/kg)	31.81 (2.51)	29.10 (5.03)

Values are mean (SD). *n*: number of subjects; BMI: body mass index.

Design and procedures

Each participant attended several sessions into a sport sciences laboratory following the same order: (1) screening first visit; (2) pre-training, baseline psycho-physiological assessment; and (3) post-training psycho-physiological assessment (see Fig. 1 for graphical view). The participants were asked not to eat for 3 h before the tests, not to consume caffeine-containing products for 12 h, and to abstain from alcohol use and heavy physical exercise for 24 h before testing. During two weeks before initiation into the study, all participants were assessed at baseline for height, body mass and VO2max cardiorespiratory fitness. The same assessment was performed after the training period at the same time of the day for each participant.

Trait anxiety

Participants completed the Spanish version of the Trait scale from the State-Trait Anxiety Inventory (STAI).[31] Trait scale of the STAI (STAI-T) is a 20-item self-report instrument, which evaluate how the respondent feels ''generally'', rated on a four-point Likert-type scale from ''not at all'' to ''very much so''. STAI-T has an internal consistency between 0.86 and 0.95. Cronbach's alpha is >0.88.[22]

Cardiorespiratory fitness assessment

The UKK-2-km Walk-Test[32] was used to assess cardiorespiratory fitness. This walking test provides an accurate estimate of the maximum level of oxygen consumption (VO2max).

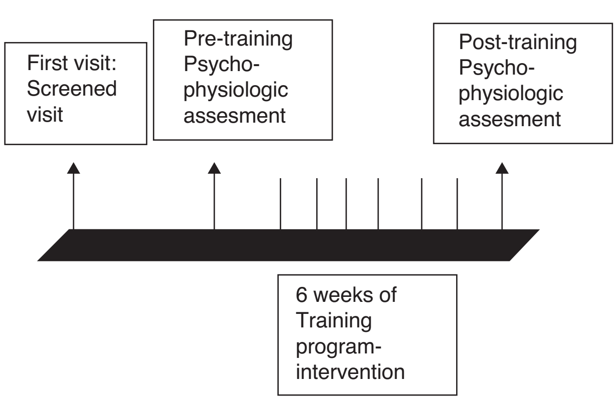

Figure 1 Schematic representation of the study protocol.

UKK 2-km Walk-Test represents a reliability, safety, feasibility and health-related validity VO2mx measure.[33] For the UKK test, participants were instructed to walk 2 km without stopping, as fast as possible. They were equipped with a Polar 810i Heart Rate Monitor (Polar Electro Oy, Kempele, Finland). The time required to complete the distance was manually recorded on a stopwatch. Heart rate frequency was recorded immediately after the end of the walking test. VO2max was estimated using the equation provided by Oja et al.[32] that takes into account participants' weight, age, sex, cardiac frequency post-exercise, and time taken to cover the 2-km distance.

Training

Participants of g-PAT completed a controlled 6-week progressive aerobic training (PAT) period with three 30-min sessions each week consisted of walking, jogging or running on treadmill (Powerjog, model JX100, Birmingham, England) at a low-intensity level according to recommendations of American College of Sports Medicine.[4] The training intensity was determined for each participant based on Karvonen[34] cardiac frequency formula. Aerobic exercise consisted, for the first 3 weeks, of 30 min at 50—60% of HR reserve and, for the second 3 weeks, of 30 min at 60—70% of HR reserve. The laboratory aerobic exercise program is presented in Table 2. Exercise sessions included warm-up and cool-down 10-min periods. In order to meet the study's exercise training compliance requirements, subjects in the training group were required to attend 90% of the 30 original exercise sessions prescribed. Heart rate was continuously monitored during training sessions using a Polar 810i heart rate watch monitor. Training out treadmill-laboratory was allowed one session for week to allow participants to make-up any missed appointments. All subjects were familiarized with the use of a HR monitor and treadmill running velocity during the training and during the daily. Each session was carefully supervised by a physical coach. Participants of g-CON were instructed to maintain their normal sedentary lifestyles during the 6-week intervention period.

Statistical analysis

All data are presented as mean ± SD. Statistical analyses were conducted using the Statistical Package for the Social Sciences software (v14, SPSS Inc., Chicago, WI, USA). Data

Table 2 Progressive light aerobic training program duration, frequency and intensity of loads.

Weeks of training	Exercise duration	Exercise intensity
1	10′ + 3′R + 10′	50—60% HR reserve
2	9′ + 1′R + 9′ + 1′R + 9′ + 1′R	
3	18′ + 2′R + 18′	
4	10′ + 3′R + 10′	60—70% HR reserve
5	9′ + 1′R + 9′ + 1′R + 9′ + 1′R	
6	18′ + 2′R + 18′	

x′R: recuperation in minutes.

normality was established using the Kolmogorov–Smirnov statistic. The level of significance was set at $P < 0.05$. One-way ANOVA was performed to compare the physical characteristics, trait anxiety, baseline VO2max values score between the two groups. Also, VO2max training response (%) was computed for the g-PAT. Since it has been shown that the major determinants of the VO2max training responses are their own baseline values (genetic influences)[14] and that trait anxiety is a risk factor related to cardiovascular diseases,[23,35] an analysis of covariance (ANCOVA) was performed to confirm the effectiveness of PAT and the contribution of covariates on the improvement participants' VO2max. The independent variable was the experimental training program (g-PAT and g-CON) and the dependent variable consisted of values on VO2max training response. Baseline VO2max and trait anxiety score were used as the covariates in this analysis. Due to the preliminary nature of the data and small sample, effect sizes are reported in place of, or in addition to, traditional levels of statistical significance. Effect sizes are reported as eta-squared values (η^2).[36]

Results

Baseline data

Before training, no differences were found for age, height, weight, BMI, VO2max and trait anxiety between the 2 groups. Group characteristics are presented in Table 1. Additionally, the g-PAT showed a VO2max training response ranging from 4.78 to 39.10%.

Aerobic training effect and determinants of VO2max cardiorespiratory fitness after exercise training

The main purpose of the test of the covariate was to evaluate the relationship between Baseline VO2max and trait anxiety, and the VO2max training response (dependent variable). ANCOVA showed a significant group effect in VO2max [$F(1,8) = 5.362$; $P = 0.05$; $\eta^2 = 0.10$], with higher values in g-PAT [36.45 (6.32)] compared to the g-CON [28.97 (6.38)], a main effect of baseline VO2max [$F(1,8) = 26.518$; $P = 0.001$; $\eta^2 = 0.54$] and trait anxiety [$F(1,8) = 8.229$; $P = 0.021$; $\eta^2 = 0.17$] (Table 3). Therefore, the relationship was significant between baseline VO2max and trait anxiety score with VO2max training response to 6-weeks PAT.

Discussion

Since VO2max is determinate by genetic factors,[19,21] we performed an ANCOVA analysis to explain the VO2max training response. In this sense, our results show and confirm that the major predictor of the VO2max improvement after exercise training corresponds to the baseline VO2max values.

However, as we argued, VO2max is one prognostic factor for cardiac health disease and cardiac mortality and anxiety is other important independent risk factor of these cardiac related events.[41–44] In this sense, the main finding of our analysis is that we have added information in order to explain VO2max training response. We found that trait anxiety is related to the cardiorespiratory fitness. Specifically, results show that the effect sizes (η^2-value) indicate that the influence of the PAT is moderate, of both baseline VO2max and trait anxiety is large, according to Cohen.[35] These data highlight the positive and negative roles of both baseline VO2max (genetic factor) and trait anxiety, respectively, on the VO2max training response in the study participants. Thus, the statistically significant contribution of both psychological and physiological factors in the prediction both VO2max response support the challenge for research addressing joint baseline cardiorespiratory fitness and trait anxiety influences to training response in sedentary subjects. There is one study that has examined trait anxiety in relation to physical exercise during tread mill test, but has done it to predict experience distress.[45] Anxiety has been also negatively associated with exercise performance.[26] Although fitness status and trait anxiety have been related previously,[30] our findings are relevant, since it reveals the importance of the trait anxiety as a possible indicator to explain fitness improvements after an exercise training program in sedentary population.

In this study, the analyses performed on the VO2max confirmed that the participants in the g-PAT showed significant improvement in the VO2max estimated after 6 weeks of aerobic training, while the VO2max of g-CON participants remained unchanged. In agreement with long-term (9–12 months) and short-term (7–8 weeks)[15,17,37] exercise training protocols, our study found that a 6-week of aerobic training is a valid training protocol to increase the cardiorespiratory fitness as evidenced by VO2max values. These data are important since maximal oxygen uptake has become as one of the most important cardiac health status measure. Regarding the potential mechanisms involved in exercise training, VO2max is typically investigated by measuring exercise performance, population-based fitness and cardiovascular disease.[3,38–40]

Additionally, Hautala et al.[14] reported heterogeneity of VO2max response, ranging from 10% to 45%, to diverse exercise training protocols. Consistent to similar previous longitudinal studies,[16] our results also showed similar variation of VO2max gain ranging from 4.78 to 39.10% in the training group. In our study, analysis results showed that the group effect in presence of the trait anxiety and baseline VO2max covariates explain the 77.5% of the VO2max post-training. The evaluation protocol used in this study could be an effective way of assessing health status related to fitness and it would be valuable to develop individualized exercise programs in sedentary population. In addition, periodic-protocol testing provides a convenient way to monitor cardiorespiratory fitness improvements throughout an exercise program.

The main limitation of the present study is the small sample size, so caution has to be taken concerning the generalization of our results. Nevertheless, the values concerning VO2max are in line with those reported in previous studies[33,46] and training sessions made in laboratory conditions may be considered as highly standardized.

In conclusion, our results extend previous knowledge in this area by suggesting that exercise response is not only determined by VO2max genetic factor but it is also explained

Table 3 Mean ± standard deviation (SD) of VO2max values of the two groups of participants before (baseline) and after training.

Variable	Experimental group ($n = 6$)		Control group ($n = 6$)		Main effect (η^2)		
	Before-training	After-training	Before-training	After-training	Group effect	Baseline VO2max values	Trait anxiety
VO2max (ml/min/kg)	31.81 (2.51)	36.45 (6.32)	29.10 (5.03)	28.97 (6.38)	(0.10)*	(0.54)*	(0.17)*

Group effect from pre to post training on VO2max (measured by the UKK walk-test) as a function of their baseline values and trait anxiety scores as covariates. Partial estimated effect size (η^2).
* $P < 0.05$ ANCOVA.

by trait anxiety in sedentary youth people. In this sense, this is the first exploratory study to estimate the contribution of the trait anxiety which is related with the physiological response to an aerobic exercise. Thus, in applied settings, we suggest to take into account the trait anxiety assessment as an individual difference which could determine the efficacy of aerobic exercise programs in sedentary people. For example, it could be interesting to choose the exercise type (individual/group, indoor/outdoor, etc.) according to trait anxiety level of people.

Conflict of interests

Authors declare that they do not have any conflict of interests.

Acknowledgments

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