CLINICAL SCIENCE

Absence of the predisposing factors and signs and symptoms usually associated with overreaching and overtraining in physical fitness centers

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OBJECTIVE: The aim of this study was to evaluate the occurrence of the well-known predisposing factors and signs and symptoms usually associated with either overreaching or overtraining syndrome in physical fitness centers in São Paulo City, Brazil.

METHOD: A questionnaire consisting of 13 question groups pertaining to either predisposing factors (1-7) or signs and symptoms (8-13) was given to 413 subjects. The general training schedule of the volunteers was characterized by workout sessions of 2.18 $\pm$ 0.04 h for a total of 11.0 $\pm$ 0.3 h/week for 33 $\pm$ 2 months independent of the type of exercise performed (walking, running, spinning, bodybuilding and stretching). A mean score was calculated ranging from 1 (completely absent) to 5 (severe) for each question group. A low occurrence was considered to be a question group score lower than 4, which was observed in all 13 question groups.

RESULTS: The psychological evaluation by POMS Mood State Questionnaire indicated a normal non-inverted iceberg. The hematological parameters, creatine kinase activity, cortisol, total testosterone and free testosterone concentrations were within the normal ranges for the majority of the volunteers selected for this analysis (n = 60).

CONCLUSION: According to the questionnaire score analysis, no predisposing factors or signs and symptoms usually associated with either overreaching or overtraining were detected among the members of physical fitness centers in São Paulo City, Brazil. This observation was corroborated by the absence of any significant hematological or stress hormone level alterations in blood analyses of the majority of the selected volunteers (n = 60).

KEYWORDS: Overtraining; Overreaching. Mood states; Blood and Biochemical analysis; Questionnaire.

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INTRODUCTION

It is known that excessive training can lead to overreaching state (OVR) and overtraining (OVT) syndrome, two physiological conditions characterized by an impairment of physical performance.[1-7] While OVR is a desirable state that follows a high intensity exercise bout and is characterized by a fast recovery and a positive physiological adaptation phase in response to exercise, the same cannot be said about OVT. A sustained and dramatic impairment of physical performance occurs in OVT due to excessive exercise sessions (high intensity or high volume training) associated with inadequate recovery periods.[5,7] In OVT, this impaired physical state lasts longer than 6 weeks and is usually unaccompanied by any obvious clinical cause. Despite these differences, OVR and OVT states seem to present similar hormonal, neuronal, immunological, cardiovascular, and respiratory system disturbances.[2,3,9] A ''gold standard'' to characterize these two states is not yet available. In fact, there is a push to develop an easy-to-use tool for coaches, athletes and the physically active population to identify these two states. Currently, the most reliable features associated with overtraining syndrome are impairment of physical performance and a disturbed mood profile.[4,6-8,9-12]

Exercise is recommended as a strategy for improving physical performance and quality of life. There has been a substantial increase in the prevalence of physical fitness centers, primarily in big cities. This development has helped the general population adhere to the habit of exercising and thus overcome the undesirable and unhealthy sedentary condition. As a rule, subjects starting or in the course of an

exercise training program should undergo a periodic physical conditioning evaluation and a medical examination. However, this does not seem to be a general rule, and it is rarely practiced in physical fitness centers with poor facilities and/or a small number of members or supervisors. In those cases, subjects usually engage in classes without an adequate physical conditioning evaluation and/or medical examination, or worse, classes are not accompanied by a supervisor. We hypothesized that there would be a high probability of finding OVR or OVT states in members of those types of centers. We based this hypothesis on the likelihood of those members engaging in hard exercise training and physical fitness regimens to meet the social and aesthetic pressures for a ''perfect body,'' a goal that is attractive to the population in general and is put in extreme evidence by all forms of media.

The aims of this study were as follows: to develop a questionnaire to assess the main predisposing factors and signs and symptoms associated with OVR and OVT that can be used to calculate an OVR/OVT mean score; to assess the OVR/OVT mean score among members of physical fitness centers in São Paulo City, Brazil, using the questionnaire; to determine if the OVR/OVT index was significantly related to the biochemical or psychological markers of OVR/OVT. The questionnaire was based on the main predisposing factors and signs and symptoms described to be associated with those OVR and OVT.[2,3,9] In contrast to the initial hypothesis, the OVR /OVT mean score generated by the designed questionnaire form indicated the absence of those two states among members of physical fitness centers in São Paulo City. This finding was supported by the absence of any significant biochemical or psychological alterations among the study subjects.[1,4,7,13-17] To the authors' knowledge, this is the first study assessing the predisposing factors, signs, and symptoms usually associated with OVR or OVT in members of physical fitness centers.

MATERIALS AND METHODS

Subjects

A total of 413 subjects (216 men and 197 women) volunteered for this study. The subjects were recruited from 17 physical fitness centers in the Metropolitan Area of São Paulo City and enrolled in the study on the basis of the following criteria: 1) subjects performed at least one daily exercise session not shorter than 60 min, with a minimum frequency of 4 days/week (total of 4 hours/week) and 2) aged between 18 and 35 years. All kinds of physical exercise were acceptable (walking, running, spinning, bodybuilding, stretching). The anthropometric parameters were as follows for men and women, respectively: age, 25.7 $\pm$ 0.3 years and 25.2 $\pm$ 0.3 years; height, 1.77 $\pm$ 0.01 m and 1.64 $\pm$ 0.01 m; and body mass, 76.3 $\pm$ 0.7 kg and 58.0 $\pm$ 0.5 kg. This study was approved by the institutional review board, and written informed consent was obtained from each participant in accordance with the University Ethics Committee guidelines. Subjects were allowed to withdraw at any time during the study.

Questionnaire design

A questionnaire assessing the main predisposing factors and signs and symptoms that are most frequently associated with either overreaching or overtraining was designed based on scientific literature describing the overreaching and overtraining states.[1-4] The questionnaire comprised 41 questions that were classified in 13 question groups relating to either predisposing factors (question groups 1 to 7) or signs and symptoms (question groups 8 to 13). Work activity, non-training related problems, non-professional training attendance, training motivation, recovery patterns, and nutritional and hydration patterns were considered as predisposing factors. Self-perception of training, performance and recovery schedules, training monotony, motivation and tiredness, patterns of sleep and appetite, weight loss, previous injuries, frequency of upper respiratory tract infections, and sudoresis were considered as signs and symptoms (Table 1). The design and validation of the questionnaire was based on the guidelines outlined by Juniper et al.[18]

The questionnaire was administered to the volunteers by a team of 12 interviewers previously trained not to bias any of the volunteer answers. Each volunteer was asked to make a self-assessment for each question using a five-point scale. The scale ranged from 1 (absence) to 5 (severe). Mean score (MS) for each question were calculated according to the expression: $MS = \Sigma\ (f \times S)_n$, where f stands for the ratio between the frequency of the response for the number of alternatives and the total frequency (%) obtained for each alternative within a question, S stands for the score attributed to each alternative within a question, and n stands for the number of alternatives for each question. The final MS for a specific question group was calculated as the mean of each individual MS obtained for the selected questions fitted to a specific question group. Self-perception of training, performance, and recovery features (question group 8) were assessed by a score range adapted from the Borg Perceived Exertion Scale[19], with a score ranging from 1 (too light) to 7 (too heavy). The individual MS for the three features were computed using the same formula as described above, and the final group MS was calculated as the mean of the three individual mean scores. A minimum of 8 of the 13 question groups with mean scores higher than 4 associated with a disturbed mood profile was arbitrarily considered as indicative of OVR/OVT.

Psychological assessment

The volunteer mood profile was assessed by the Profile of Mood States (POMS) questionnaire, which is a self-reporting questionnaire consisting of 65 items that fit into 6

Table 1 - General features of the entire volunteer population.

Training characteristics	
Volunteers instructed by a fitness professional/instructor	86.3%
Duration of workout session	2.18 $\pm$ 0.04 h
Volume of training/week	11.0 $\pm$ 0.3 h/week
Training period	33 $\pm$ 2 months
Type of training	Walking, running, spinning, bodybuilding, stretching
Complaints of health disturbances associated with physical training	
Complaints of health disturbances associated with physical training	23.4%
Complaints lasting longer than 15 days	12%
Use of ergogenic supplements and medicines	
Ergogenic supplements	36%
Medicines (including antidepressants and appetite inhibitors)	5.3%

categories: tension, depression, anger, vigor, fatigue and confusion, and scored from 1-4 according to severity. The questionnaire yields a global measure of mood. The global score is computed by subtracting the only positive category (vigor) from the sum of the five negative categories (tension, depression, anger, fatigue and confusion). The standard instructional set of the POMS questionnaire was employed in this study. That is, the volunteer answered the question, ''how have you been feeling during the past week including today?'' rather than ''generally,'' ''today,'' or ''right now.'' A T-score for each category was obtained by looking for the corresponding value of the MS of the entire volunteer population in the T-score table.[20] The highly positive ''iceberg profile''[21] is obtained when the subject presents the five negative categories and the one positive category below and above the mean value of the study population, respectively, to validate the POMS questionnaire.[22,23] As such, the POMS scores for elite athletes are consistently under the 50th percentile for the five negative categories and over the 50th percentile for the vigor scale.[22] It has been shown that the POMS profile for overtrained athletes changes to what is called the ''inverted iceberg,'' with the five negative categories above the 50th percentile and the vigor scale below the 50th percentile.[1] The POMS questionnaire was utilized because of its reliability, validity, feasibility and common use in psychometric studies.[10,23]

Blood and biochemical analysis

Due to financial restraints and difficulties with volunteer adherence, only the groups at the two extremes of the MS frequency distribution curve for question group 8 (self-perception of physical training, performance and recovery) for the total volunteer population underwent a blood exam and biochemical analysis. Of the volunteers selected, 15/60 self-assessed themselves as light trainers with good performance and good recovery, and the remaining 45/60 self-assessed themselves as heavy trainers with bad performance and bad recovery.

No recommendation was given for exercise training during the day before blood sampling. Venous blood samples were collected at 8 am after an overnight fast; sample hematological parameters (erythrocytes, hemoglobin, hematocrit, platelet counts, leukocytes, and lymphocytes) were quantified, and creatine kinase (CK) activity and cortisol, total testosterone and free testosterone concentrations were measured (Table 3). In addition, the individual POMS profiles from the 60 volunteers were analyzed.

Data analysis

Data are expressed as mean $\pm$ SE (standard error) for the questionnaire questions, POMS scores, and blood and biochemical analyses.

RESULTS

General features

Training characteristics, complaints of health disturbances associated with physical training and use of ergogenic supplements and medicines are shown in Table 1.

Questionnaire analysis

The group MS for the 13 question groups from the entire volunteer population is shown in Table 2. The group mean scores were below 3 for 12 of the 13 question groups and were higher than 3 for question group 4, which was related to training motivation. These data strongly suggest a low occurrence of the predisposing factors and signs and symptoms commonly associated with overreaching or overtraining among the members of the studied fitness centers.

Table 2 - Analysis of the 13 question groups on the questionnaire (n = 413).

Question Group	Predisposing Factors	Number of Questions	MS
Group 1	Work activity	4	2.6
Group 2	Non-training related problems	2	2.3
Group 3	Non-professional training attendance	1	1.1
Group 4	Training motivation	3	3.7
Group 5	Recovery pattern	4	2.7
Group 6	Nutritional pattern	5	2.1
Group 7	Hydration pattern	3	2.0
	Signs and symptoms		
Group 8	Self-perception of training, performance and recovery	3	1.9
Group 9	Training monotony, motivation and tiredness	5	1.9
Group 10	Sleep patterns	5	1.7
Group 11	Previous injuries	1	2.4
Group 12	Appetite pattern changes and weight loss	2	1.7
Group 13	Superior respiratory tract infections and sudoresis	3	1.6
TOTAL		**41**	

POMS analysis

The POMS profile of the entire volunteer population is shown in Figure 1 and was compared with the POMS profile for elite athletes who show no signs of overtraining and that for elite athletes with signs of overtraining.[1] Clearly, no signs of mood disturbances were detected, as the POMS profile presented a T-score for vigor higher than 60 and a T-score lower than 50 for tension, depression, fatigue and confusion. Thus, the iceberg profile of the study

Table 3 - Blood chemical parameters.

Biochemical parameters	Female	Male
CK (U/L)	142 $\pm$ 22	321 $\pm$ 42
	(range 60 – 525)	(range 93 – 1058)
	(up to 165)[a]	(up to 190)[a]
Cortisol (μg/dl)	17.7 $\pm$ 1.4	16 $\pm$ 0.9
	(range 6.6 – 32.8)	(range 1.2 – 28.0)
	(5-25)[a]	(5-25)[a]
Plasma free testosterone (pg/ml)	1.7 $\pm$ 0.2	22 $\pm$ 1.5
	(range $<$0.2 – 4.2)	(range 2.8 – 36.6)
	(0.8-3.2)[a]	(18-41)[a]
Total Testosterone (ng/dl)	65 $\pm$ 6.7	559 $\pm$ 35.3
	(range 20 – 177)	(range 29.1 – 825)
	(49-120)[a]	(280-1500)[a]
FTCR ($\times 10^{-3}$)	0.012 $\pm$ 0.008	0.181 $\pm$ 0.220
	(range 0.0009 – 0.0313)	(range 0.0056 – 0.3265)
	$<$ 0.35[b]	$<$ 0.35[b]

Values are mean $\pm$ SE (n = 60)
a - number in parenthesis for each parameter indicates the normal range
FTCR - plasma free testosterone:cortisol ratio
b - FTCR for overtraining athletes

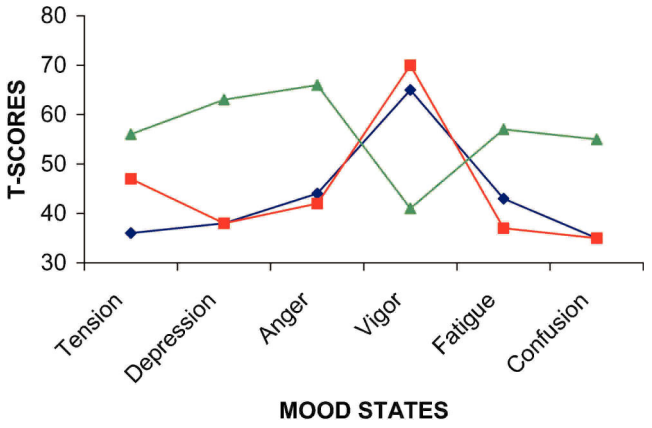

Figure 1 - Comparison of the POMS profile of the physical fitness center members (♦) with those of elite athletes with signs of overtraining[1] (▲) and elite athletes who show no signs of overtraining[22] (■).

population was very similar to the POMS profile described for the normal population and elite athletes.

Although we did not observe a high occurrence of the predisposing factors and signs and symptoms usually associated with overreaching or overtraining states, the possibility that some of the volunteers may present them cannot be excluded. A high occurrence of predisposing factors and signs and symptoms usually associated with overreaching or overtraining was not detected, even after further selection of the volunteers based on their responses to question group 8.

Blood and biochemical analyses

Table 3 illustrates the biochemical data of the study population (n = 60). All mean hematological parameters were within the normal range for the majority of volunteers in the study population (data not shown). In addition, the mean level of CK protein was significantly higher than normal in the male volunteers of this sample and was within the normal range for the females. The blood levels of hormones related to stress, such as cortisol, plasma free testosterone and total testosterone, were within the normal range, but the calculated plasma free testosterone–cortisol ratio was below the normal range for both males and females (Table 3).

DISCUSSION

This study attempted to assemble and develop a simple questionnaire to assess the predisposing factors and signs and symptoms associated with overreaching or overtraining states. The questionnaire is intended to serve as a practical, inexpensive, easy-to-use and non-time-consuming tool to be used by anyone involved in exercise training control. The questionnaire was developed and validated according to epidemiological rules[18] and administered to 413 members of 17 physical fitness centers in the metropolitan area of São Paulo City, Brazil. According to the proposed questionnaire score analysis, no predisposing factors or signs and symptoms of overreaching or overtraining were detected in the study population. This observation was supported by the absence of significant hematological parameter or stress hormone level (cortisol, plasma free testosterone, and total testosterone) alterations in the blood analyses performed in the subgroup of volunteers (n = 60) selected according to their responses to question group 8, which related to self-perception of training, performance, and recovery features. For recovery features, the creatine kinase (CK) level was significantly higher than normal in the male volunteers, and the free plasma testosterone-cortisol ratio was lower than the normal range for both sexes.

The need for a practical, inexpensive, easy-to-use and non-time-consuming tool, such as a questionnaire, to detect predisposing factors and signs and symptoms associated with overreaching and/or overtraining in under-developed or developing countries, like Brazil, is fundamental to help people involved in the control of exercise training, rehabilitation and health care programs. The idea of testing the questionnaire using members of physical fitness centers is justifiable because the majority of the physically active Brazilian population can afford to work out in the fitness centers that are widespread in big cities, such as São Paulo. By contrast, the possibility of undergoing a thorough physical evaluation and a medical examination before starting a physical exercise program, although quite desirable, is inaccessible to the majority of the population.

Overtraining syndrome has been described in elite athletes as a consequence of high intensity and/or large volume training associated with insufficient recovery, leading to impairment of both physical performance and training capacity.[1-4] Many factors have been described to enhance the risk of either overreaching or overtraining states, including a high frequency of competition, monotonous training, inadequate nutrition and sleep patterns, environmental conditions, and psychological stressors.[1-4,9]

It is well known that the main predisposing factor of overreaching and overtraining is the imbalance between training sessions and recovery.[1-4] Our initial hypothesis was that there was a high probability of identifying the predisposing factors and signs and symptoms usually observed in overreaching or overtraining states among members of physical fitness centers. A growing number of individuals stimulated to exercise for either health or appearance do so with little or no clinical or physical evaluation before they start their exercise classes. These conditions are exacerbated in the Brazilian population due to the absence of an exercise class follow up by a professional. As the transition from adequate-to-excessive training could be gradual and nearly imperceptible, it is quite difficult to distinguish the signs and symptoms linked to a severe homeostatic disturbance from those related to a daily exercise session. In fact, although several attempts have been made to detect overreaching or overtraining states in their earliest stages in athletes, no reliable, specific, or sensitive parameters have been identified.[13,16,17,24,25]

In contrast to our initial assumption, we did not detect the predisposing factors, signs or symptoms of overreaching or overtraining among highly active individuals (Table 2). Regarding predisposing factors (question groups 1 to 7), the group MS for all question groups was under 4, although question group 4 (training motivation: 3.7) was near the borderline according to our criteria. Similar results were obtained for the group MS values of the study population in terms of signs and symptoms, i.e., in all question groups, the mean was under 4 (question groups 8 to 13 in Table 2), indicating a low occurrence of the signs and symptoms. Nonetheless, some important points should be stressed.

First, complaints about training monotony, motivation and tiredness were absent (mean MS for question group 9 = 1.9), regardless of the high frequency of similar workouts usually performed in physical fitness centers. The low occurrence of training monotony is probably related to the social aspect of exercise classes at physical fitness centers in contrast to the loneliness and toughness of training sessions endured by elite athletes in individual sports. Secondly, the low occurrence of sleeping pattern disturbances in this population (mean MS 1.7) is indicative of the fair adjustment between workouts and recovery periods given that an altered sleeping pattern is quite frequently observed among overtrained athletes. It is also interesting to note that the study participants had adequate nutrition given that they had meals within 2 hours after their exercise session in accordance with the recommendation to optimize glycogen muscle repletion after exertion.[1,26]

The initial hypothesis of detecting the predisposing factors and signs and symptoms of overreaching or overtraining among members of physical fitness centers was based on the supposition that this specific population could be involved in an excessive training volume without monitoring by a fitness professional. However, the absence of the predisposing factors and signs and symptoms of overreaching and overtraining as indicated by the questionnaire answers is probably due to the low intensity or volume of the participants' training schedules. It seems that the intensity and/or volume of training performed by highly active members of the physical fitness centers in São Paulo City were not sufficiently heavy to cause a severe imbalance in body homeostasis. In fact, although we did not directly evaluate physical performance, the self-perception of intensity/volume of the exercise training performed by each volunteer (11 hours of workout per week) is certainly far from the high levels of exercise training endured by elite athletes. Finally, the absence of competition stress in the study population favored the low occurrence of the above-mentioned predisposing factors, signs and symptoms. By contrast, frequent competition combined with the stress associated with needing to win is often present in elite athletes.

It is interesting to note that the presence of previous health disturbances associated with training was detected in 23.4% of the volunteers, which is quite high. Although personal misevaluation in the computation of this factor is possible, the relative elevated occurrence of health disturbances strongly suggests recommendation of a regular medical/physical follow up.

Although a ''gold standard'' to diagnose the overreaching or overtraining state does not exist, impairment of physical performance and a disturbed mood profile seem to be reliable markers for these two states.[6,7,12] Physical performance evaluation, such as aerobic, anaerobic, flexibility and body composition tests, is not regularly required in Brazilian physical fitness centers. Considering the difficulty of involving volunteers in this evaluation, we reinforced the main questionnaire by including a POMS analysis of the volunteer population.[20] A high MS on the questionnaire was anticipated to be accompanied by a disturbed mood profile. The POMS profile of the members of physical fitness centers was similar to the POMS profile presented by elite athletes (Figure 1), thus showing the absence of any disturbed mood profile among the volunteers. However, an intriguing relationship was observed when volunteers were investigated according to their individual mood profiles. Some of the volunteers with a flat POMS profile, although not considered abnormal, had the highest group MS for question group 8, which related to the perception of training conditions. This finding suggests that they perceived their training to be strenuous with poor performance and recovery patterns. This relationship suggests that some of the volunteers might have some level of homeostatic imbalance, although it was not sufficiently intense to elicit the signs and symptoms of excessive exercise.

Regarding blood analysis, the complete hemogram was normal for the selected sample of volunteers (not shown), whereas the biochemical analyses were not consistently within the normal range (Table 3). Although the plasma CK concentration was within the normal range in the female volunteers, the free testosterone-cortisol ratio was lower than the normal value of 0.35×10^{-3}, suggesting a predominance of catabolism over anabolism, a condition that is commonly observed in overtrained athletes.[27] For the male volunteers, both the plasma CK concentration, which was higher than the normal range, and the free-testosterone-cortisol ratio, which was lower than the normal value, might be indicative of a homeostatic disturbance (Table 3). However, the reliability of either CK level or hormone ratio as definitive overtraining markers has not been fully accepted. According to Viru and Viru[28], the free-testosterone-cortisol ratio must be very low to be regarded as important. The elevated plasma CK concentration is more likely to be related to muscular damage associated with the last workout than to a sign of homeostatic alterations. The present study has some limitations. First, the questionnaire should have been given to a population with an elevated likelihood of overreaching and overtraining, such as elite athletes. Second, the study design should be longitudinal rather than cross-sectional. In the present study, the cross-sectional design drastically minimized the possibility of identifying the predisposing factors and signs and symptoms usually associated with overreaching and overtraining states. Unfortunately, it is quite difficult to recruit volunteers for a longitudinal study at physical fitness centers, mainly because of the high member turnover rate. Although this population has been training for 33 ± 2 months, it is not possible to ensure that they remain in the same fitness center or that they perform the same kind of exercise for the entire study period. Therefore, it could be difficult to follow the study population. Third, it is possible that people who present with the predisposing factors and signs and symptoms of overreaching and overtraining would be less likely to volunteer because of their disturbed mood. The absence of a ''gold-standard'' diagnosis of overreaching and overtraining led us to group different features (biochemical, psychological, and physical) associated with overreaching and overtraining. For this reason, we did not call the questionnaire an overreaching and overtraining questionnaire. It was proposed as a tool to detect the predisposing factors and signs and symptoms usually associated with overreaching and overtraining without the need for more sophisticated laboratory tests. Thus, its consistency in detecting people engaged in excessive exercise training needs to be confirmed.

In summary, we have provided evidence for the absence of predisposing factors and signs and symptoms usually associated with overreaching or overtraining states among members of physical fitness centers in São Paulo City,

Brazil. It remains possible that some fitness center members participated in excessive exercise. Excessive exercisers should be made aware of the signs of physical and mental adverse effects of excessive exercise by their fitness professionals/instructors.

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