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State/trait anxiety and anxiolytic effects of acute physical exercises

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Summary

Study aim: To determine anxiolytic effects of acute physical exertions in relation to the initial anxiety state and trait in women.
Material and methods: A group of 163 women aged 16 – 56 years, attending fitness clubs in Warsaw, participated in the study. They selected a single exercise to perform – strength, aerobic or mixed, lasting 30 to over 60 min. They were requested to fill Spielberger's STAI questionnaires for determining the state anxiety (pre- and post-exercise) and trait anxiety (post-exercise). Questionnaire results were converted to logarithms, pre-post differences were computed and correlated with age, trait anxiety and pre-exercise state anxiety. Multiple correlation and the contributions of independent variables to the total variance of pre-post differences were also computed.
Results: Pre-post differences in state anxiety were significantly correlated with pre-exercise state anxiety ($r = 0.514$; $p<0.001$) but not with either age or trait anxiety. As shown by regression equation, pre-exercise state anxiety up to 28 may, on the average, be associated with post-exercise increases. The contribution of pre-exercise state anxiety to the total variance of pre-post differences amounted to 27% ($p<0.001$), those of other variables not exceeding 5%.
Conclusions: The fact that subjects with high pre-exercise state anxiety are prone to its highest decrease post-exercise ought to be considered when designing leisure activity programmes.

Key words: Acute exercise – Anxiolytic effect – Women – State anxiety – Trait anxiety

Introduction

Acute physical exertions were shown to reduce state anxiety as efficiently as relaxation [21] or autogenic training [6,9], that effect lasting several hours post-exertion [17,24]. Physical exertion affects predominantly somatic anxiety, i.e. perceived changes in muscle tonus, pains (including headaches), increased heart rate, nausea, etc. The effects on cognitive anxiety, i.e. imagining negative circumstances and experiences, worries for the future, concentration disorders or sleeplessness, are much less pronounced [17,27] as suggested by Rostad and Long [25], who reported that subjects engaged in physical exercises had lower somatic anxiety but higher cognitive anxiety compared with those engaged in meditation training. It ought to be remembered that motor activity may differently affect the two anxiety components – energy and tension; the latter may be reduced but the energy level may increase throughout the physical exercise, thus masking the anxiolytic effect especially immediately post-exercise [5,14,22,23]; anxiolytic effects were observed 10 – 15 min, as well as one hour post-exercise [9]. The time of conducting the test is of particular importance in strength exercises [2,8,19].

Factors determining the magnitude of anxiolytic effects of acute exertions have been increasingly sought and investigated. Among them are the type of exertion, its intensity and duration; the aerobic, rhythmic exercises of low or moderate intensity, engaging large muscle groups and lasting at least 20 min seem most promising [15,17,21], although the intensity issue remains controversial [5].

Cattell [4] and Spielberger [26] discerned state and trait anxiety; state anxiety was defined as the actually experienced emotional status – uneasiness, apprehension and tension, associated with stimulation of the autonomic nervous system; trait anxiety was defined as a predisposition to perceive diverse situations as threatening and to respond with anxiety. With respect to exertions, the magnitude of their anxiolytic effects depends on the level of state anxiety pre-exertion; in subjects with elevated pre-exertion state anxiety, its reduction (anxiolytic effect) is more pronounced than in those with low pre-exertion state anxiety. This prompted many

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investigators to induce an elevated pre-exertion state anxiety by applying diverse stimuli, e.g. caffeine [1,30] but studies on clinical populations are scarce. Breus and O'Connors [3] reported a significant decrease in state anxiety following 20 min of aerobic exercise of moderate intensity performed by female students whose state anxiety had been higher than in the general population. After all, a significant decrease would hardly be expected in subjects with low state anxiety.

As reported by Hale and Raglin [13], a 50-min aerobic stepper exercise had higher anxiolytic effect in subjects with initially high state anxiety (HA) than in those with low anxiety level (LA). In the latter ones, that effect was small but visible; thus, an acute aerobic exercise may bring psycho-emotional improvement even to those who do no experience marked anxiety, similar observation having been made also in case of maximal exercises [20]. The same authors [13] compared the effects of a strength exercise lasting also 50 min and of similar intensity; they found that LA subjects exhibited anxiolytic response only following aerobic exercise while the HA ones - following both, aerobic and strength exertions. That latter observation was not, however, confirmed by Bartholomew [1]. On the other hand, Focht [7] reported significant anxiolytic effects irrespectively of the intensity, either administered or volitional, of strength exertions at various times post-exercise (5 to 120 min) but only in HA subjects. LA subjects exhibited anxiolytic response one and two hours post-exercise but only following volitionally low intensity of exertion.

The fact that the initial level of state anxiety determines the magnitude of anxiolytic response may suggest that the predisposition to react with anxiety, i.e. the trait anxiety, may also play a role. The aim of the study was thus to assess the anxiolytic effect of acute physical exercises in relation to the pre-exercise state anxiety and to the trait anxiety in female subjects performing exercises of individually adjusted kind and intensity.

Material and Methods

Subjects: A group of 163 women aged 16 – 56 years volunteered to participate in the study; they were free to select the preferred form of exercises – individual or collective. They could also select the type of exercise – aerobic (individual exercise on a treadmill or stepper; collective – aerobic, step, fat burning), strength (individual exercises using various devices) or mixed, like body shaping (Total Body Conditioning – TBC; Abdominal, Buttocks, Thighs – ABT). The aerobic, strength and mixed exercises were performed by 46, 21 and 96 subjects, respectively. The exercises lasted from about 30 min (n = 20) to over one hour (n = 27), mostly 45 – 60 min (n = 116).

Methodology: All subjects were requested to fill Spielberger's STAI questionnaires (Polish adaptation, [28]); state anxiety questionnaire was filled just before starting the exercise; immediately after the exercise the subjects filled another state anxiety questionnaire and trait anxiety questionnaire. Thus, the post-exercise measurement of state anxiety took place 10 – 12 min after the exercise had been completed.

Data processing: The values of trait, and pre- and post-exercise state anxiety were converted to logarithms; the distributions did not significantly differ from the normal one by Shapiro-Wilk's test. Differences between individual log pre- and log post-exercise values were correlated with log pre-exercise and log trait anxiety values. For the purpose of comparing the results with those of meta-analyses, standard deviation for untransformed differences (pre/post) was computed. Pearson's correlation coefficients and percent contributions of variables to the total variance of the pre–post difference in state anxiety (by multiple regression) were computed, the level $p \leq 0.05$ being considered significant.

Results

The results are presented in Tables 1 and 2 and in Fig. 1. Since log data of trait and state anxiety were processed, Table 1 shows retransformed data, i.e. means and standard deviations converted from logarithms back to the raw values together with ranges expressed directly in raw units. Since the log pre/post-exercise values of state anxiety represent logs of pre-to-post ratios, they are presented in Table 1 as percentages. Mean pre-post ratio thus equals 1.144 (or 14.4%), the scatter being high and amounting to about 1.3, i.e. to the raw pre-exercise value multiplied/divided by 1.3.

Table 1. Mean values ($\times$ SD $^{\pm 1}$) of retransformed log values of trait and state anxiety and ranges of raw data recorded in women aged 16 – 56 years (n = 163)

	Mean · SD $^{\pm 1}$ (from log data)	Range (raw data)
Trait	$39.6 \cdot 1.236^{\pm 1}$	21 – 61
State (pre)	$35.8 \cdot 1.268^{\pm 1}$	20 – 69
State (pre – post) *	$14.4\% \cdot 1.298^{\pm 1}$	-27 – 43

Table 2. Coefficients of simple correlation between logarithms of studied variables and percent contributions to the total variance of the pre-post difference in state anxiety

	Trait	Pre	Pre–Post	%Contrib.
Age	0.114	0.050	-0.126	2º
Trait		0.574*	0.129	-3º
Pre			0.514*	27*

º $p<0.05$; * $p<0.001$

The pre/post-exercise difference in log state anxiety correlated significantly only with the pre-exercise value (r = 0.514) but not with either trait anxiety or age. In addition, multiple correlation (R^2) between pre-post differences (dependent variable) and age, trait anxiety, pre-exercise state anxiety, exercise duration and kind (independent variables) was found to be equal to 0.361 ($p<0.001$), i.e. these variables explained 36.1% of the total pre-post variance. This was partitioned into contributions of individual variables (Table 2). Only the pre-exercise state anxiety proved practically significant. The contributions of exercise duration and kind amounted to 0 and 5%, respectively.

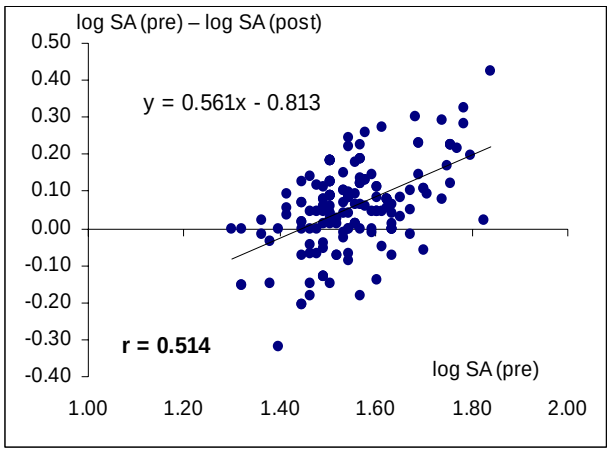

Fig. 1. Relationship between the pre–post differences in log state anxiety and pre-exercise log state anxiety values in women aged 16 – 56 years (n = 163)

As follows from the regression equation (Fig. 1), when the pre-exercise state anxiety exceeds 28 (log value = 1.449), increases in the post-exercise values may be expected (on average). However, decreases were observed up to pre-exercise state anxiety equal to 51 due to a high scatter.

In order to make the data comparable with the results of meta-analyses, standard deviation for the raw pre-post differences in the state anxiety was found equal to 9.7. When the subjects were classified according to the pre-exercise state anxiety into 3 categories – low (Sten 1 – 4), medium (Sten 5 and 6) or high (above Sten 6), mean raw pre-post differences divided by that SD amounted to -0.23, 0.52 and 1.05, respectively.

Discussion

The presented results confirmed the reports of many authors on the anxiolytic effect of acute exercises although this study was not an experimental one. Instead, it was conducted under natural conditions which made a control of possible interfering variables difficult. This pertained especially to the kind, duration and intensity of exertions which were selected by subjects according to their current preferences. On the other hand, such conditions meet the criterion of "ecological accuracy" of a study; namely, when the participants are assigned to groups by random, the assigned mode of exercise may be at variance with individual preferences thus reducing psycho-emotional benefits [7]. That supposition may be supported by the fact that the anxiolytic effects noted in subjects classified by their pre-exercise state anxiety were markedly greater than reported in meta-analyses of experimental reports although STAI questionnaire is supposed to measure predominantly the cognitive anxiety. McDonald and Hodgdon [18] found that effect of a single aerobic exercise to amount to 0.28 (mean pre-post difference divided by standard deviation of pre-exercise state anxiety), and Petruzzello *et al*. [21] reported 0.24.

The presented results confirmed the significance of the pre-exercise state anxiety as a determinant of anxiolytic effect reported by many authors [7,13,20]; namely, no significant pre/post-exercise difference was noted in women whose pre-exercise state anxiety was low which was obvious due to too little room for changes. In addition, STAI measures only the level of anxiety, irrespectively of its origin (energy/tension), a small increase in the energy stimulation might result in slightly elevated state anxiety. Otherwise, anxiolytic effects in women were found to be related to the pre-exercise state anxiety following aerobic [11] or yoga [10] exercises.

The presented results indicated that trait anxiety plays no significant role as a determinant of anxiolytic effect of exercise. In earlier studies, the physical exercise-induced psycho-emotional benefits were found to be related to trait anxiety or, more generally, to neuroticism. Changes in state anxiety and neuroticism or anxiety-related tension and trait anxiety were significantly

correlated with one another; decreases in state anxiety and tension were greater in subjects, undertaking diverse physical activities, with high neuroticism or predisposition to respond with anxiety [12]. On the other hand, women who were engaged in aerobic exertions exhibited no significant relationships between the pre-post change in state anxiety and trait anxiety [11] and the same was true for women engaged in yoga exercises [10]. These somewhat controversial findings may be explained by the fact that the pre-exercise state anxiety and trait anxiety are fairly well correlated ($r = 0.574$; $p<0.001$), thus the supposed effects of trait anxiety could, in fact, be attributed to state anxiety.

Why physical exertions induce anxiolytic effects? One of the most frequent explanations is the decrease in psycho-emotional tension associated with exercise-induced increase in body temperature, like in case of sauna or hot bath [17]. Yet, additional stimuli which increase body temperature during exertion do not amplify anxiolytic effects; thus, some researchers are of the opinion that the prime factor is not the temperature of the body but that of brain [16,21,29,30]. Some role may be also played by distractive mechanisms; namely, physical exertions may avert attention from daily worries and may enable averting anxiety-inducing thoughts; anxiolytic effects were observed in subjects intensely walking, engaged in relaxation or reclining in an armchair [29]. On the other hand, thinking of everyday troubles while exercising physically eliminates the expected anxiolytic effect [3].

Summing up, highest anxiolytic effect induced by acute exertions may be expected in subjects exhibiting high state anxiety pre-exercise, the magnitude of that effect being independent of the trait anxiety, i.e. the predisposition to respond with anxiety.

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