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Year: 2014

Version:

Please cite the original version:

Kettunen, O., Kyröläinen, H., Santtila, M., & Vasankari, T. (2014). Physical fitness and volume of leisure time physical activity relate with low stress and high mental resourses in young men. The Journal of Sports Medicine and Physical Fitness, 54(4), 545-551. http://www.minervamedica.it/index2.t?show=R40Y2014N04A0545

Physical fitness and volume of leisure time physical activity relate with low stress and high mental resources in young men

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Word count: 2963

Abstract word count: 238

Tables: 2

Figures: 2

Abstract

Objectives There is limited evidence available regarding the relationship between physical fitness, especially muscular fitness, and the mental well-being among young healthy men. Therefore, the aim of the present study was to investigate the impact of measured cardiovascular and muscle fitness and self reported leisure time physical activity (LTPA) on outcomes of stress and mental resources in Finnish young men.

Methods In a cross-sectional study, 831 men (mean age 25-y) underwent cardiovascular and muscle fitness test and completed LTPA and Occupational Stress Questionnaires (OSQ). For analysis, the subjects were divided to LTPA, CVF and MFI tertiles.

Results The group with low LTPA had 6% and 13% more stress (ANCOVA using age, body mass index, smoking and alcohol use as covariates, $p<0.05$ in both) and 6% and 12% ($p<0.05$ in both) less mental resources than the moderate and high LTPA groups, respectively. The group having low cardiovascular fitness had 8% and 9% ($p<0.001$ in both) more stress and 7% and 7% ($p<0.05$ in both) less mental resources than moderate and high cardiovascular fitness groups. The low muscle fitness index (MFI) group had 7% ($p<0.01$) less mental resources than those with moderate MFI and 8% ($p<0.001$) more stress and 8% ($p<0.001$) less mental resources than those with high MFI.

Conclusion Both good aerobic and muscular fitness together with high LTPA are associated with low stress and high mental resources.

Key words: physical fitness, leisure time physical activity, stress, mental resources

Introduction

Physical activity is an important tool used in public health to treat and prevent both physical and some mental diseases such as depressive and anxiety disorders (1, 2). Recent findings of both cross-sectional and longitudinal studies as well as clinical trials suggest that exercise and physical activity interventions have beneficial effects on several physical and mental health outcomes, including health related quality of life and better mood (3, 4).

There are several mechanisms that may explain how exercise alleviates the pathological effects of stress (2). It can be assumed that exercise results in reduced arousal (i.e. mood enhancement due to cognitive distraction or biochemical changes) or more positive behaviours during periods of stress. Exercise may bring about higher levels of fitness, and as an indirect consequence, a more efficient physiological stress regulation (i.e. reduced secretion of hormones, lowered blood pressure) or enhanced recovery processes (2).

A physically inactive lifestyle may result in decreases in body functions even in relatively early age (5). Physically active persons seem to be less reactive to psychological stressors (6) by reporting lower stress levels (7) and better mood states (1) than inactive ones. An association between emotional well-being and regular physical activity has been identified in comparisons with people who exercise regularly and inactive ones (8). Several studies have also reported decreased depressive symptoms in association with increased physical exercise (9, 10, 5).

According to Valtonen et al. (11) leisure time physical activity (LTPA) and cardio respiratory fitness contribute to mental health. Recent studies have also focused on positive psychological well-being and suggest that a high level of cardio respiratory fitness (CRF) is associated with better psychological well-being (12, 13). However, there is a limited evidence of the association between muscle fitness and well-being. There is some evidence of the effect of resistant training on well-being but not that of objectively measured muscle fitness. According to O'Connor et al. (14) the evidence supports the conclusion that strength training consistently reduces anxiety symptoms among healthy

adults. Although there is convergent evidence that exercise effects on the elements of mental health and well-being, the specific mechanisms and the conditions under which they operate have not yet been determined (15,16). According to previous studies there is a lot of evidence of the positive effects of physical exercise to well-being but whether the connection is caused by a high volume of physical exercise itself or good physical fitness is somewhat unclear.

The aim of the present study was to investigate the impact of objectively measured cardiovascular and muscle fitness and self reported leisure time physical activity (LTPA) on well-being of the Finnish young men. We hypothesized that also good muscular fitness is associated with reduced stress and stronger mental resources.

Methods

The study group was enrolled from April 2008 to November 2008 during eight refresher courses organized around the country. Of 1155 invited reservists, 922 participated in the courses and 831 volunteered for the present study. 66 participants were excluded from the analysis because they had missed some of physical fitness tests due to the medical reasons. Thus, 831 men, age between 20-45 years volunteered for the present study. Because of the compulsory military service, the study population, reservists that have underwent their military service, is a geographically representative sample of healthy Finnish young men. Participants signed a written consent form indicating that they were aware of risks and the benefits of study. The mean (SD) age of the study group was 25 (±5) years, height 180 (±6) cm, mean body mass 81 (±13) kg and body mass index (BMI) 24.8 (±3.8) 38% of the participants were smokers. (Table 1)

The reservists were informed about the study in the call up letter to the refresher course. All the measurements were performed during the eight refresher courses. Health examination and the presentation of measurements were done at the beginning of the refresher course. The participants completed the questionnaires including health, use of

alcohol and tobacco products, leisure-time physical activity and stress questions. The participants were divided into groups of ten men for the tests. The body height and weight were measured while participants were wearing light sport clothing. After light breakfast muscle fitness was measured by four consecutive tests: grip strength, push-ups, sit-ups, and repeated squats, followed by the test of maximal aerobic capacity (VO_2max). The ethical committees of the University of Jyvaskyla and the Central Finland Health Care District as well as the Headquarters of the Finnish Defence Forces approved the study and the publication of this article. The guidelines of the Helsinki declaration were followed. The detailed study protocol has been reported earlier (3).

LTPA

The weekly leisure time physical activity (LTPA, containing frequency and intensity) was determined from responses to a single question with six categories: (1) no physical activity at all, (2) some physical activity without feeling out of breath or sweating, (3) physical activity without feeling out of breath or sweating, (4) physical activity with feeling out of breath or sweating twice a week, (5) physical activity with feeling out of breath or sweating three times a week, and (6) physical activity with feeling out of breath or sweating at least four times a week.(3) In the analysis, the participants were recorded to three groups according their physical activity level: low (combination of LTPA categories 1 and 2), moderate (categories 3 and 4), or high (categories 5 and 6). In further analyses, the effects of LTPA on stress symptoms and mental resources are presented in the 6 LTPA groups according to the question of LTPA (Figure 1 and Figure 2).

Cardiovascular Fitness

Oxygen uptake (VO_2max) was measured indirectly using a bicycle ergometer test (Ergoline 800 S, Ergoselect 100 K or 200 K, Bitz Germany). The handlebars and seats were individually adjusted. After a 5-min warm up, the test began with a power output of 50 W, which was increased by 25 W after every other minute. The pedalling rate of 60

rpm was maintained throughout the test. The hearth rate (HR) was recorded continuously (Polar Vantage NV or S610, S710 or 810, Kempele, Finland). The test was terminated at volitional exhaustion, including a decrease in the pedalling rate to below 50 rpm. Predicted VO_2max was determined from the HR and power (Fitware, Mikkeli, Finland) as follows: VO_2max (ml/kg/min) = [(P-$_{max-}$ *12.48) +217] / body mass, where P_{max} is maximal power. The test-retest repeatability was 0.96 for men (3).

Muscle Fitness

Muscle fitness was measured by four tests: grip strength, push-ups, sit-ups, and repeated squats. The result of the push-ups, sit-ups, and repeated squats were expressed as the number of correctly performed repetitions within 60 s, while the grip strength was measured during a single maximal isometric contraction. Grip-strength was determined twice from both hands and final score was the average of the highest scores of both hands (sitting, elbow in 90 degree, Saehan Corporation, Masan, South Korea) (17,18). In the start position of sit-up test, participant was lying supine on the floor with knees flexed in 90 degrees and hands behind his neck. The ankles were fixed to the floor by assistant and a repetition was counted after the participant's elbows touched the flexed knees. To execute one repetition of push-ups, the participant had shoulder-wide stance and fingers pointing forward. From this start position, elbows were flexed in 90 degree and torso touching the floor; next the upper extremities were fully extended while upper body was straight and fully extended (19). Repeated squats movement started while standing straight and lowering the upper body while knees are flexing until the thighs were at horizontal level. After this, the participant flexed his lower extremities in order to stand straight again. In MFI calculations the absolute results for each muscle fitness test were scored to corresponding fitness categories from poor, satisfactory, good to excellent. The total Muscle Fitness Index (MFI) was calculated as the sum of four tests. Before the tests, supervisors demonstrated the correct technique of each test. Thereafter, the performance technique was controlled by supervisors (3). Both cardio respiratory and muscular fitness

tests have age-specific reference values used in the Finnish Defense Forces since 2000, and they are based on data of 3635 civilians (20).

Stress and mental resources

The stress level and mental resources were measured by a part of questions of Occupational Stress Questionnaire (OSQ) (21). The Stress Index was calculated as a sum of four questions with five categories: A) Stress means the situation when a person feels tense, restless, nervous, or anxious, or is unable to sleep at night because his mind is troubled all the time. Do you feel that kind of stress these days? (1) not at all 1, (2) only a little, (3) to some extent, (4) rather much, (5) very much. B) What is your health state compared to that of other people your age? (1) very good, (2) rather good, (3) average, (4) rather poor, (5) very poor. C) How satisfied are you with your present work? (1) very satisfied, (2) rather satisfied, (3) neither satisfied nor dissatisfied, (4) rather dissatisfied, (5) very dissatisfied (5). D) How satisfied are you with your present life? (1) very satisfied, (2) rather satisfied, (3) neither satisfied nor dissatisfied, (4) rather dissatisfied, (5) very dissatisfied. High sum scale means high level of stress and low sum scale means low level of stress (21). Mental resources in this study mean how active and energetic and capable and confident one feels oneself in daily chores (21). The Mental Resources Index was calculated using sum of three questions with five categories: A) Have you been active and energetic lately? (1) constantly, (2) rather often, (3) now and then, (4) rather seldom, (5) not at all. B) Do you feel yourself capable and confident? (1) constantly, (2) rather often, (3) now and then, (4) rather seldom, (5) never. C) Do you think you have done your daily chores well lately? (1) constantly, (2) rather often, (3) now and then, (4) rather seldom, (5) not at all (10). Low sum scale means high mental resources and high sum scale means low mental resources (21).

Statistical analyses

The results are presented as means with standard deviations. After the examination of assumptions, the effects of physical activity and physical fitness (both cardiovascular and musculoskeletal fitness) on stress symptoms and mental resources among groups were tested using analysis of variance (ANOVA) and by using age, BMI, tobacco and alcohol use as covariates (ANCOVA). For the analysis, the study group was divided in three groups (high, moderate and low) concerning volume of LTPA, cardiovascular fitness level and MFI. The mean (±SD) cardiovascular fitness and MFI of the study group was 41.6 (±6.4) ml/kg/min and 12.4 (±3.8) points. For the statistical analysis, subjects were divided to fitness tertiles according to both the cardiovascular fitness and the MFI. Cut points for cardiovascular fitness tertiles were 37.9 ml/kg/min and 44.9 ml/kg/min, and for MFI tertiles 10.5 and 14.8 points.

Results

The mean stress index of the study group was 8.8 (±2.4). 3% of the study group had high stress level, 8% had moderate stress, 31% of the study group had some stress, 42% had a low stress level and 16% had no stress at all. The mean level of mental resources of the study group was 6.7 (±1.8) points. 12% of the study group had high level of mental resources, 59% of the study group had moderately high level of mental resources, 23% of the study group had some mental resources, 5 % of the study group had low level of mental resources and 1% of the study group had no mental resources at all.

LTPA, stress and mental resources.

The sum points of stress index differed between the LTPA groups (ANOVA, $p<0.0001$), and the difference was significant when age, BMI, alcohol and tobacco use (ANCOVA, $p<0.0001$) were taken as covariates (Table 2). The group with low LTPA had 6% and 13% more stress ($p=0.011$ and $p<0.0001$) than the moderate and high LTPA groups,

respectively. The sum points of mental resources index differed between LTPA groups (ANOVA, $p<0.0001$), and the difference was significant when age, BMI, alcohol and tobacco use (ANCOVA, $p<0.0001$) were considered as covariates. (Table 2) The low LTPA group had 6% and 12% ($p=0.018$ and $p<0.0001$) less mental resources than the moderate and high LTPA groups, respectively. Is cardiovascular fitness were also taken as a covariate in addition to age, BMI, alcohol and tobacco use, the results in ANCOVA was still significant in the sum points of stress index ($p=0.002$) and mental resources ($p=0.001$)

Cardiovascular fitness, stress and mental resources

The sum points of stress index differed between the cardiovascular fitness groups (ANOVA, $p<0.0001$), and the difference persisted when age, BMI, alcohol and tobacco use (ANCOVA, $p<0.0001$) were taken as covariates (Table 2). The group having low cardiovascular fitness had 8% and 9% ($p<0.0001$ and $p=0.005$) more stress than the moderate and high cardiovascular fitness groups, respectively.

The sum points of mental resources index differed significantly between cardiovascular fitness groups (ANOVA, $p<0.0001$). The difference remained significant when age, BMI, alcohol and tobacco use (ANCOVA, $p<0.0001$) were considered as covariates (Table 2). The group having low cardiovascular fitness had 7% ($p=0.009$) less mental resources than the moderate cardiovascular fitness group and 7% ($p=0.011$) less mental resources than high cardiovascular fitness groups. If LTPA were also taken as a covariate in addition to age, BMI, alcohol and tobacco use, the results in ANCOVA was still significant in the sum points of stress index ($p=0.005$) and mental resources ($p=0.012$).

Muscle Fitness Index (MFI), stress and mental resources

The sum points of stress index differed between the MFI groups (ANOVA, $p=0.002$), and the difference was significant when age, BMI, alcohol and tobacco use (ANCOVA,

p=0.037) were taken as covariates (Table 2). The group having low muscle fitness had 8% (p=0.001) more stress than those with high muscle fitness.

The sum points of mental resources index differed between MFI groups (ANOVA, p=0.003), and the difference persisted when age, BMI, alcohol and tobacco use (ANCOVA, p=0.016) were considered as covariates (Table 2). The group having low MFI had 7% (p=0.016) less mental resources than the subgroup having the moderate MFI and 8% (p=0.005) less mental resources than the high MFI group. If cardiovascular fitness were also taken as a covariate in addition to age, BMI, alcohol and tobacco use, the results in ANCOVA was not significant either in the sum points of stress index (p=0.25, NS) or mental resources (p=0.073, NS).

Discussion

The present study demonstrated in a relatively large sample of Finnish young men that both regular leisure time physical activity and high fitness level (both aerobic and muscular) are associated with more favourable scores in mental well-being dimensions. These associations remained statistically significant when adjusting the results with age, BMI, alcohol consumption and smoking. Differences between LTPA, CVF and MFI subgroups were relatively small but still they were statistically significant. Interestingly, also MFI was associated with mental well-being. However, if cardiovascular fitness were also taken as a covariate in MFI subgroups in addition to age, BMI, alcohol and tobacco use, no differences were seen any more either in the sum points of stress index or mental resources. This could be caused by the fact that cardiovascular fitness is also closely related to muscular fitness. Hence, the use of cardiovascular fitness as a covariate is somewhat problematic.

To our knowledge this is the first population based study to investigate association between objectively measured muscle fitness and stress symptoms / mental resources. The mental health consequences of strength training are also less frequently studied and less well understood than the psychological effects of aerobic training (14). O'Connor et

al. (14) reviewed randomized controlled trials examining the effects of strength training to mental health benefits in adults and found reduction in anxiety symptoms (5 trials), depressive symptoms (2 trials), fatigue symptoms (10 trials) and improvements in self-esteem (6 trials) (14). Our result underlines the statement of O´Connor et al. (14) that it is likely that the effects of strength training and in our study muscle fitness on mental health outcomes are underestimated. It is important also to consider that some people prefer strength training to aerobic training and that preference can influence mental health outcomes (14).

Some studies have investigated the association between stress symptoms and cardiovascular fitness (6, 22, 23). Jackson and Dishman (24) found that good cardio respiratory fitness helps recovery from stress in a meta-analysis of 73 studies and it was associated with psychological resources in a community sample (25). In our study, good cardiovascular fitness was associated with low stress and high mental resources. The results are in accordance with the stress-buffering hypothesis of exercise against stress (25, 2) or the idea that good physical condition or improved fitness are likely to facilitate the individual`s capacity for dealing with stress (6).

Previous studies have investigated mostly associations of LTPA on mental well-being and they have found a positive association in employees (26) and the general population (26, 27, 28). Stress symptoms decreased linearly and mental resources increased linearly while LTPA increased in our study. (Figure 1 and 2)

Physically active men exercising at least three times a week or more experienced significantly lower stress levels. They also had higher mental resources than men exercising less, however only 30% of the reservists exercised three times or more per week. The stress decreased and mental resources increased gradually when LTPA increased from the no exercisers to those who have at least 3 times per week moderate to vigorous leisure time physical activity. The large Finnish cardiovascular risk factor study among 25-64 years adults found significantly less depression, anger, cynical distrust, and

stress among individuals that exercised at least two to three times a week than those exercising less frequently or not at all (28).

There are no definitive exercise recommendations for mental health promotion. However, all activities above the sedentary level seem to be beneficial for mental health, and the current recommendations of a minimum of moderate-intensity aerobic physical activity (PA) 30 min, 5 days per week, or vigorous-intensity aerobic PA for a minimum of 20 min, 3 days per week, seems to be a relevant recommendation for both physical and mental health (29).

The study sample is reasonably large and it represents quite well Finnish young men. CVF and MFI were objectively measured, but the cross-sectional design of the study reduces its power to establish causal relationships. There is also considerable heterogeneity in defining and measuring stress (2). High varieties of subjective outcomes to measure mental well-being make it difficult to compare results to other studies. However, despite the methodological diversity to measure subjectively stress symptoms and mental resources, the results are in accordance with earlier studies.

Conclusion

The results underline the importance of both physical activity and good physical fitness while promoting mental well-being. Physical activity as well as maintaining a moderate to high level of physical fitness could be recommended as an important low cost preventive and non-pharmacological method in prevention of stress symptoms and in maintaining mental resources among young adult men. To our knowledge this is the first population based study to investigate association between stress symptoms / mental resources and objectively measured muscular fitness.

Acknowledgements

The present study was supported by The Scientific Committee for National Defense. We thank biostatician Elina Kokkonen for her consulting and the expertise towards the statistical analysis. There has been no financial assistance with the project.

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Figure legends:

Figure 1. Stress sum scale in six leisure time physical activity (LTPA) categories. Mean (±SD). High stress sum scale means high stress. MVPA=moderate to vigorous physical activity.

Figure 2. Mental resources sum scale in six leisure time physical activity (LTPA) categories. Mean (±SD). High mental resources sum scale means low mental resources. MVPA=moderate to vigorous physical activity.

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