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ORIGINAL ARTICLE

Association between physical fitness and psychological distress among Brazilian armed force personnel

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Abstract

Previous research suggests that physical fitness moderates the adverse effects of stressful life events. However, the relation between fitness and psychological distress needs to be explored, especially in armed force personnel. The aim of this study was to investigate the association between physical fitness and psychological distress among Brazilian armed force personnel. In this cross-sectional study, we measured physical fitness and psychological distress of 1252 subjects, using, respectively, field tests and the General Health Questionnaire (GHQ-12). After adjusting for confounders, statistically significant direct associations ($p < 0.05$) between physical fitness and psychological distress were found. Low levels of muscle endurance (OR 1.65; 95% CI 1.2–2.3) and combined cardiorespiratory fitness and muscle endurance (OR 1.91; 95% CI 1.2–3.0) were associated with greater psychological distress in the overall sample. In the operational group, low levels of muscle endurance (OR 1.81; 95% CI 1.2–2.8), cardiorespiratory fitness (OR 2.09; 95% CI 1.2–3.6) and combined cardiorespiratory fitness and muscle endurance (OR 2.70; 95% CI 1.4–5.1) were also associated with greater psychological distress. On the other hand, no significant ($p > 0.05$) association was found for the non-operational group. Low levels of physical fitness were associated with greater psychological distress among armed force personnel, especially among those with operational status. These findings suggest that physical fitness is not only relevant for military functions but also for mental health.

Keywords Military personnel · Mental health · Cardiorespiratory fitness · Common mental disorders

Introduction

The mental health of military personnel has been studied in different circumstances, such as war situations [1, 2]. The emotional reactions of people affected by war situations can have harmful psychological consequences, and majority of the studies focuses on post-traumatic stress disorder among active personnel and veterans [3–5] or on mental health intervention [6]. On the other hand, few observational studies have investigated mental health among the military in peacetime [7–9].

Higher levels of physical fitness are associated with lower cardiovascular risk [10], all-cause mortality [11] and other harmful conditions [12, 13]. Investigations also indicate that physical fitness is associated with mental health in different populations [14–16]. Willis et al. [17], using a retrospective cohort design, showed that midlife physical fitness is associated with a lower risk of later-life depression. Job strain is also related to mental health [18]. Harvey et al. [18], using a British cohort study found that high job stress increases the

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risk of common mental disorders in midlife after 5 years of follow-up. Among the existing theoretical models to assess psychosocial stress in the workplace, the demand–control model proposed by Robert Karasek in 1979 has been the most widely used [19, 20]. The bases of the model are: (a) adverse health reactions from simultaneous exposure to heavy psychological demands and limited control over the work process (the negative scenario); (b) there is a "positive effect" from stress in the face of elevated psychological demand and control (the positive scenario).

Although few studies [21, 22] have been made in military populations, the association between physical fitness and mental health is particularly relevant because of the nature of the army environment, which is perhaps more physically and mentally demanding than any other occupation.

Psychological distress, defined as emotional suffering, is characterized by symptoms including depression and anxiety, and sometimes by somatic symptoms [23]. Physical fitness has been consistently associated with psychological distress [16, 24]. However, few studies [21, 25] have investigated the association between physical fitness and psychological distress among military personnel. A recent study [21] found an inverse association between physical fitness levels and depressive symptoms among American soldiers at a specific moment in time (training). Therefore, the present study may offer novel information regarding physical activity domains and mental health outcome in the work routine. Physical fitness involves a set of attributes that are skill-related and can be measured by different physical tests. In the military environment, it is quite common to walk long distances carrying all necessary equipment, highlighting the demand of cardiorespiratory and muscular systems. In this sense, it is plausible to suppose that these are the most important physical fitness domains.

The Brazilian Army is responsible for the protection of borders. Additionally, the Army has become more involved in international military peace operations and health care programs in hard-to-reach areas. Brazilian soldiers are classified into two categories: operational and non-operational. The operational category comprises soldiers actively engaged in different operations. Soldiers in the non-operational group, by contrast, have administrative functions. Considering the different demands of work, we hypothesized that low levels of physical fitness may be more relevant among operational personnel.

Therefore, the objective of the present study was to evaluate the association between objectively measured physical fitness and psychological distress among Brazilian soldiers, and to investigate differences by operational status.

Method

Participants

This cross-sectional study of male Brazilian soldiers ranking sergeant or higher was conducted during the year 2008 (from March to December). Twenty-two strata (11×2) were formed to contemplate the eleven military regions in the Brazilian Army's administrative structure and the soldiers' operating status (operational or non-operational). To select a representative sample of each of the 22 strata, the sampling plan was carried out for each stratum, their sum forming the whole study sample. Each sample size was calculated regarding a relative precision of 0.1, a significance level of 0.05 and assuming a true proportion of 0.8. The study sample comprised 1396 individuals, 137 of whom refused to participate. The final sample was thus 1259 participants (40 ± 8.5 years). Written informed consent was obtained from all participants, and the research protocols were approved by the Rural Federal University of Rio de Janeiro Ethics Committee.

Data collection

Data were gathered using the self-administered questionnaire filled out individually in the workplace or physical tests that were conducted in the physical education center where the participant is situated were attached. The tests were made with a maximum of five soldiers per time. An average of 8 min was needed to fill in the questionnaire during free time provided especially for the procedure by the participant's immediate boss under an institutional agreement.

Outcome

Psychological distress was measured by the 12-item General Health Questionnaire (GHQ-12). The Brazilian version of GHQ-12 has been validated against a structured psychiatric interview and identified a sensitivity of 85% and a specificity of 79% [26]. A previous study, using a confirmatory factor analysis, supports the psychometric properties of the instrument (Cronbach's alpha = 0.89) [27]. Each item of the GHQ-12 has four possible response options. For instance, the first one is: have you recently been able to concentrate on what you are doing? Scores for individual items were coded as absent (first or second option) or present (third or fourth option), and then added. Total scores of four or more were classified as having psychological distress.

Exposure

Cardiorespiratory fitness

The Cooper 12-min Run Test was performed to measure cardiorespiratory fitness. It consisted in running for 12 min on a 400 m athletics track [28]. The test presents a high level of reliability in adults (coefficient = 0.96) [29]. Individuals were familiar with the test, which is part of their routine. The total number of laps was counted and the finishing point was marked. Total distance (in meters) covered in 12 min was calculated by multiplying the number of complete laps by 400, and adding the distance covered (in meters) in the final incomplete lap. Instead of using the standard formula for the estimation of maximal oxygen consumption, those who covered more than 2800 m were allocated to the High-level group. This cut-off point is the same as that used by the army to evaluate the soldiers [28].

Muscle endurance

Muscle endurance was assessed with push-ups test [30]. The participants were familiar with the test procedure and started in an arm-extended (up) position with forearms and wrists pronated, feet at biacromial (shoulder) width, and fingers flexed. In the down position, forearm and wrists were kept pronated, whereas the elbow was flexed 90° and the shoulder abducted 45°. Individuals were asked to perform as many repetitions as possible in 1 min. For analytic purposes, those who performed more than 22 repetitions were allocated to the High-level group. This cut-off point is the same as that applied by the army.

Covariates

The covariates were (a) age, (b) educational level, (c) marital status, (d) operational status, and (e) rank. Education was measured using three categories according to years of education: (a) "elementary"—until 9 years, (b) "high school"—10–12 years, and (c) "college"—at least 13 years. Marital status was measured using two categories: (a) "married/cohabiting" and (b) "unmarried". Operational status was reported dichotomously by respondents: (a) "operational" or (b) "non-operational". Rank was categorized as: (a) "Superior officers and Captains" (captain, major, lieutenant colonel and colonel), (b) "Lieutenants", (c) "Sergeant Majors and (d) Sergeants". All these variables were evaluated as possible confounders in the associations between physical fitness and psychological distress because they are associated with physical fitness [31] and/or influence psychological distress [32].

Statistical analysis

We calculated descriptive statistics in the form of means and standard deviations for continuous variables and frequencies for nominal variables, by operational status. Logistic regression models were fitted for the dichotomous outcome. Odds ratios (OR) and confidence intervals (95% CI) were estimated before and after adjusting for confounders. The modeling process was performed in two steps: step 1 involved the overall sample and step 2 fitted the models separately for operational status. The adjusted models included the following independent variables: physical fitness variables, age, education, marital status, operational status, and rank. The analysis was performed using R, version 3.2.2 software.

Results

Participants' average age was 40 years (standard deviation 8.5); 84% were in the highest category of education; 47.6% were classified as operational; 75.1% were classified as 'low cardiorespiratory fitness'; and 56.5%, as "low muscle endurance". The average physical fitness test performance was 2800 ± 331 (1400–3600) meters and 24 ± 9 (1–44) push-up repetitions, respectively, for cardiovascular test and muscle endurance. Overall prevalence of psychological distress was 16%. Detailed characteristics can be seen in Table 1.

Analysis based on the overall sample showed that both muscle endurance and combined cardiorespiratory fitness and muscle endurance were significantly ($p < 0.05$) associated with psychological distress. In this connection, the fully adjusted model showed that participants classified as 'low muscle endurance' (OR 1.65; 95% CI 1.2–2.3) and with low performance in both tests (OR 1.91; 95% CI 1.2–3.0) were associated with greater psychological distress (Table 2).

Analysis restricted to the operational group showed that individuals with low physical fitness had higher odds of psychological distress in the fully adjusted models. For instance, low muscle endurance (OR 1.81; 95% CI 1.2–2.8) was associated with greater psychological distress. In addition, statistically significant ($p < 0.05$) and positive association was also detected among those who were classified as 'low fit' in both physical fitness domains (OR 2.70; 95% CI 1.2–5.1). By contrast, no significant ($p < 0.05$) association was detected in non-operational group (Table 3).

Discussion

This study sought to investigate the association between physical fitness and psychological distress in military personnel, and investigated differences by operational status. Our results largely confirmed that scores of physical tests

Table 1 Characteristics of the sample according to operational status

Variables	Number of observations and percentage—*n* (%)		
	Total	Operational	Non-operational
Psychological distress			
No	879 (66.7)	398 (66.7)	481 (72.7)
Yes	380 (30.2)	199 (33.3)	181 (27.3)
Cardiovascular fitness			
Upper	315 (25.0)	170 (28.5)	145 (21.9)
Lower	944 (75.0)	427 (71.5)	517 (78.1)
Muscle resistance			
Upper	625 (49.6)	329 (55.1)	296 (44.7)
Lower	634 (50.4)	268 (44.9)	366 (55.3)
Cardiovascular fitness/muscle resistance			
Upper	267 (21.2)	146 (24.5)	121 (18.3)
Intermediate	406 (32.2)	207 (34.7)	199 (30.1)
Lower	586 (46.5)	244 (40.9)	342 (51.7)
Rank			
Sergeant majors and sergeants	730 (58.9)	418 (70.6)	312 (48.1)
Lieutenants	195 (15.7)	81 (13.7)	114 (17.6)
Field officers and captains	315 (25.4)	93 (15.7)	222 (34.3)
Marital status			
Married or cohabited	927 (90.2)	429 (4.5)	498 (91.5)
Non-married	101 (9.8)	55 (69.1)	46 (8.4)
Education level			
Elementary	13 (1.3)	9 (44.1)	4 (0.7)
High school	56 (5.5)	39 (44.3)	17 (3.1)
College	953(93.2)	432 (44.8)	521 (96.1)

n (%) number of observations and percentages in columns

were associated with psychological distress. These findings may reflect how stressful it is to be a soldier with poor physical fitness, even in peacetime. It is important to consider how relevant is, in a military environment, to be in good physical condition, which is seen as an inherent part of the profession. In this regard, unfit individuals may experience feelings of not belonging and/or uselessness, which may lead to psychological distress. Therefore, it is relevant to consider the peculiarities of military environment: rigid hierarchy, heightened competition and the possibility of changes occurring against the individual's wishes [8]. These peculiarities could influence psychological distress [8].

Previous studies [1, 2] of military personnel have detected several psychiatric disorders, including major depression, anxiety disorders and post-traumatic stress disorder after different kinds of missions, showing the importance of being physically active. It is well-known that psychiatric disorders affect occupational effectiveness, which is strongly related to retention and productivity of military personnel [33]. Thus, factors related to mental health problems should be one of the concerns of military work.

A theory proposed by Hellerstedt and Jeffery [34] is that 'high demand' work may reduce workers' capacity to exercise regularly. In a Finnish study that corroborated this hypothesis, an inverse association between job stress and leisure time physical activity was observed in 46,573 subjects [33]. In a military context, physical exercise is part of the work routine (not leisure time). In this sense, it is possible to speculate that physical exercise does not have a positive impact on mental health. A recent meta-analysis [35] showed that only leisure time and transport-related physical activities were associated with mental health.

Distress can be considered a contributing factor to sedentary lifestyles, because of the psychological and physical symptoms. For example, individuals with depressive symptoms, which are associated with distress, display lifestyle changes, such as social isolation, fatigue, low motivation and physical inactivity [36, 37]. A review showed that patients with severe psychiatric disorders have lower levels of physical activity as compared to the general population [38]. Another study, focused on symptoms of depression and distress, found that at high levels of distress, both sexes tended to be more inactive [39].

Considering the whole sample, our findings demonstrated that psychological distress was more strongly associated with low levels of muscle endurance than with cardiorespiratory fitness. We postulate two explanations for this: (a) low performance in the muscle endurance test may be related to stress because it is associated with physically demanding military activity. In this situation, military personnel may feel useless, which, in turn, could be attributed to psychological distress; (b) alternatively, job stress may play a role in this finding. Taking into account the demand–control model [40], we hypothesize that participants with low muscle resistance may have low job control and high job demand (e.g., mission, training). In this direction, previous studies [8, 41] have observed an association between job stress and psychological distress.

The models stratified by operational status showed an association between physical fitness and psychological distress only in the operational group. Two explanations could be postulated: First, operational military personnel (those in mission-priority functions) face higher potential demand than non-operational personnel and low control. In fact, in some jobs, the employees have no control or low level of control in what they have to do. For instance, soldiers in operational group could be engaged in an unexpected mission. Consequently, they will be away from home for at least 2 weeks. Higher demands and lower control is the worst-case scenario according to the demand–control model [42]. Alternatively, unfitted operational soldiers may

Table 2 Association between physical fitness and psychological distress

Physical fitness	Psychological distress		
	n (%)	Unadjusted OR (95% CI)	Fully adjusted OR (95% CI)
Cardiovascular fitness			
Upper	315 (21.9)	1.00	1.00
Lower	944 (26.6)	1.37 (**1.0–1.8**)	1.29 (0.9–1.8)
Muscle resistance			
Upper	625 (21.9)	1.00	1.00
Lower	634 (28.8)	1.43 (**1.2–1.8**)	1.70 (**1.2–2.3**)
Cardiovascular fitness/muscle resistance			
Upper	267 (20.9)	1.00	1.00
Intermediate	406 (23.1)	1.34 (0.9–1.9)	1.31 (0.8–2.0)
Lower	586 (29.0)	1.65 (**1.2–2.3**)	1.82 (**1.2–2.7**)

Unadjusted and adjusted odds ratios (OR) and respective 95% confidence intervals (95%) for the logistic regression models fitted using physical fitness as the predictors of psychological distress (individuals without psychological distress was the reference group)

n(%) number of observations and percentages of psychological distress of each level of physical fitness. Fully adjusted model: adjusted by age, education, marital status, operational status and rank

All statistically significant associations are in bold

Table 3 Association between physical fitness and psychological distress according to operational status

Physical fitness	Psychological distress					
	Operational			Non-operational		
	n (%)	Unadjusted OR (95% CI)	Fully adjusted OR (95% CI)	n (%)	Unadjusted OR (95% CI)	Fully adjusted OR (95% CI)
Cardiovascular fitness						
Upper	170 (27.0)	1.00	1.00	145 (23.4)	1.00	1.00
Lower	427 (35.8)	1.51 (**1.0–2.5**)	1.39 (0.9–2.2)	517 (28.4)	1.29 (0.8–1.9)	1.23 (0.7–2.1)
Muscle resistance						
Upper	329 (27.6)	1.00	1.00	296 (25.0)	1.00	1.00
Lower	268 (40.3)	1.77 (**1.2–3.4**)	2.07 (**1.2–3.1**)	366 (29.2)	1.24 (0.8–1.7)	1.41 (0.9–2.1)
Cardiovascular fitness/muscle resistance						
Upper	146 (25.3)	1.00	1.00	121 (21.4)	1.00	1.00
Intermediate	207 (30.4)	1.29 (0.8–1.9)	1.34 (0.8–1.8)	149 (37.6)	1.43 (0.9–2.4)	1.27 (0.6–1.3)
Lower	244 (40.5)	2.01 (**1.3–3.1**)	2.20 (**1.2–3.8**)	342 (28.9)	1.49 (0.9–2.4)	1.54 (0.8–2.7)

Unadjusted and adjusted odds ratios (OR) and respective 95% confidence intervals (95%) for the logistic regression models fitted using physical fitness as the predictors of psychological distress (individuals without psychological distress was the reference group)

n (%) Number of observations and percentages of psychological distress of each level of physical fitness

Fully adjusted model: adjusted by age, education, marital status and rank

All statistically significant associations are in bold

feel uncomfortable in a military environment. Probably, strong feelings of uselessness could influence psychological distress.

A study conducted in a large American military cohort showed complementary findings to the present approach [9]. In this line, the authors found that older participants and those with longer lengths of service had more favorable mental health but less favorable physical health. They also observed that participants with low levels of educational attainment had less favorable mental and physical health. Although this is not the focus of the present approach, these findings emphasize the idea of investigate both physical and mental health among military population.

Our findings detected a relatively high percentage of military personnel with low physical fitness in the operational group, exactly those who were intended to be more involved

in physical training activities. Two explanations could be postulated. First, officers may be less required in physical training since they are usually in charge of them. Second, some operational functions in the army, such as communication occupations do not require higher levels of physical fitness, but rather specific skills.

Some limitations of the study should be mentioned. First, the study population did not include women, corporals or privates. Accordingly, our findings cannot be extrapolated, but they do indicate a clear association between psychological distress and specific indicators of physical fitness in operational military personnel. Second, only two physical tests were used, although several physical tests are applied in the military routine to access different components of physical fitness. Nevertheless, the tests chosen were the most commonly used, and evaluated two important components of physical fitness. In this sense, this approach increases the external validity of the study. However, the muscle resistance test used evaluates only superior muscle group. Third, as the study design was based on data at one point in time, it was not possible to evaluate possible changes in physical fitness related to psychological distress or, consequently, to detect a causal relationship.

Conclusion

Several studies [13, 36, 43] have investigated the association between physical activity and psychological distress, but little is known about this relationship in military personnel. This research used a representative sample of Brazilian soldiers and found evidence that physical fitness was associated with psychological distress with higher effect for soldiers in the operational group. These findings could have implications for soldier's health in peacetime. In this line, improved fitness is related to low psychological distress, which is useful to increase the levels of physical fitness. Future studies should investigate the directionality of the association. It is plausible to wonder if physical fitness influences psychological distress or vice versa. Furthermore, it would be useful to investigate the mechanisms underlying the relationship between physical fitness and psychological distress among armed force personnel.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent All participants provided written informed consent after being informed about the protocols and objectives of the present study. This was approved by the research ethics committee of the Rural Federal University of Rio de Janeiro.

References

1. Xue C, Ge Y, Tang B, Liu Y, Kang P, Wang M, Zhang L (2015) A meta-analysis of risk factors for combat-related PTSD among military personnel and veterans. PLoS One 10(3):e0120270. https://doi.org/10.1371/journal.pone.0120270
2. Zamorski MA, Rusu C, Garber BG (2014) Prevalence and correlates of mental health problems in Canadian Forces personnel who deployed in support of the mission in Afghanistan: findings from postdeployment screenings, 2009–2012. Can J Psychiatry 59:319–326. https://doi.org/10.1177/070674371405900605
3. Hines LA, Sundin J, Rona RJ, Wessely S, Fear NT (2014) Posttraumatic stress disorder post Iraq and Afghanistan: prevalence among military subgroups. Can J Psychiatry 59:468–479. https://doi.org/10.1177/070674371405900903
4. Roy SS, Foraker RE, Girton RA, Mansfield AJ (2015) Posttraumatic stress disorder and incident heart failure among a community-based sample of US veterans. Am J Public Health 105:757–763. https://doi.org/10.2105/AJPH.2014.302342
5. Steenkamp MM, Nash WP, Litz BT (2013) Post-traumatic stress disorder: review of the comprehensive soldier fitness program. Am J Prev Med 44:507–512. https://doi.org/10.1016/j.amepre.2013.01.013
6. Rowan AB, Varga CM, Clayton SP, Martin Zona DM (2014) Career impacts and referral patterns: army mental health treatment in the combat theater. Mil Med 179:973–978. https://doi.org/10.7205/MILMED-D-13-00518
7. Freeman MD, Woodruff SI (2011) Incidence and predictors of mental health hospitalizations in a cohort of young U.S. Navy women. Mil Med 176(5):524–530
8. Martins LC, Lopes CS (2012) Military hierarchy, job stress and mental health in peacetime. Occup Med 62:182–187. https://doi.org/10.1093/occmed/kqs006
9. Smith TC, Zamorski M, Smith B, Riddle JR, Leardmann CA, Wells TS, Engel CC, Hoge CW, Adkins J, Blaze D, Millennium Cohort Study T (2007) The physical and mental health of a large military cohort: baseline functional health status of the Millennium Cohort. BMC Public Health 7:340. https://doi.org/10.1186/1471-2458-7-340
10. Sassen B, Cornelissen VA, Kiers H, Wittink H, Kok G, Vanhees L (2009) Physical fitness matters more than physical activity in controlling cardiovascular disease risk factors. Eur J Cardiovasc Prev Rehabil 16(6):677–683. https://doi.org/10.1097/HJR.0b013e3283312e94
11. Jensen MT, Suadicani P, Hein HO, Gyntelberg F (2013) Elevated resting heart rate, physical fitness and all-cause mortality: a 16-year follow-up in the Copenhagen Male Study. Heart 99(12):882–887. https://doi.org/10.1136/heartjnl-2012-303375
12. van der Kolk NM, van Nimwegen M, Speelman AD, Munneke M, Backx FJ, Donders R, Post B, Overeem S, Bloem BR (2014) A personalized coaching program increases outdoor activities and physical fitness in sedentary Parkinson patients; a post-hoc analysis of the ParkFit trial. Parkinsonism Relat Disord 20:1442–1444. https://doi.org/10.1016/j.parkreldis.2014.10.004
13. Vancampfort D, Probst M, Scheewe T, De Herdt A, Sweers K, Knapen J, van Winkel R, De Hert M (2013) Relationships between physical fitness, physical activity, smoking and metabolic and

mental health parameters in people with schizophrenia. Psychiatry Res 207:25–32. https://doi.org/10.1016/j.psychres.2012.09.026
14. Kettunen O, Kyrolainen H, Santtila M, Vasankari T (2014) Physical fitness and volume of leisure time physical activity relate with low stress and high mental resources in young men. J Sports Med Phys Fit 54:545–551
15. Richards J, Foster C, Townsend N, Bauman A (2014) Physical fitness and mental health impact of a sport-for-development intervention in a post-conflict setting: randomised controlled trial nested within an observational study of adolescents in Gulu, Uganda. BMC Public Health 14:619. https://doi.org/10.1186/1471-2458-14-619
16. Sener U, Ucok K, Ulasli AM, Genc A, Karabacak H, Coban NF, Simsek H, Cevik H (2016) Evaluation of health-related physical fitness parameters and association analysis with depression, anxiety, and quality of life in patients with fibromyalgia. Int J Rheum Dis 19:763–772. https://doi.org/10.1111/1756-185X.12237
17. Willis BL, Leonard D, Barlow CE, Martin SB, DeFina LF, Trivedi MH (2018) Association of midlife cardiorespiratory fitness with incident depression and cardiovascular death after depression in later life. JAMA Psychiatry. https://doi.org/10.1001/jamapsychiatry.2018.1467 **(Epub ahead of print)**
18. Harvey SB, Sellahewa DA, Wang MJ, Milligan-Saville J, Bryan BT, Henderson M, Hatch SL, Mykletun A (2018) The role of job strain in understanding midlife common mental disorder: a national birth cohort study. Lancet Psychiatry 5:498–506. https://doi.org/10.1016/S2215-0366(18)30137-8
19. Useche S, Montoro L, Cendales B, Gómez V (2018) Job strain in public transport drivers: data to assess the relationship between demand-control model indicators, traffic accidents and sanctions. Data Brief 19:293–298. https://doi.org/10.1016/j.dib.2018.05.036
20. Cendales-Ayala B, Useche SA, Gómez-Ortiz V, Bocarejo JP (2018) Bus operators' responses to job strain: An experimental test of the job demand-control model. J Occup Health Psychol 22(4):518–527. https://doi.org/10.1037/ocp0000040
21. Crowley SK, Wilkinson LL, Wigfall LT, Reynolds AM, Muraca ST, Glover SH, Wooten NR, Sui X, Beets MW, Durstine JL, Newman-Norlund RD, Youngstedt SD (2015) Physical fitness and depressive symptoms during army basic combat training. Med Sci Sports Exerc 47:151–158. https://doi.org/10.1249/MSS.0000000000000396
22. Gubata ME, Urban N, Cowan DN, Niebuhr DW (2013) A prospective study of physical fitness, obesity, and the subsequent risk of mental disorders among healthy young adults in army training. J Psychosom Res 75:43–48. https://doi.org/10.1016/j.jpsychores.2013.04.003
23. Ridner SH (2004) Psychological distress: concept analysis. J Adv Nurs 45:536–545
24. Mollaoglu H, Ucok K, Kaplan A, Genc A, Mayda H, Guzel HI, Sener U, Uygur E, Ozbulut O (2012) Association analyses of depression, anxiety, and physical fitness parameters in Turkish obese adults. J Back Musculoskelet Rehabil 25:253–260. https://doi.org/10.3233/BMR-2012-0333
25. Taylor MK, Markham AE, Reis JP, Padilla GA, Potterat EG, Drummond SP, Mujica-Parodi LR (2008) Physical fitness influences stress reactions to extreme military training. Mil Med 173:738–742
26. Mari JJ, Williams P (1985) A comparison of the validity of two psychiatric screening questionnaires (GHQ-12 and SRQ-20) in Brazil, using Relative Operating Characteristic (ROC) analysis. Psychol Med 15:651–659
27. Gouveia VV, Barbosa GA, Oliveira AED, Carneiro MB (2010) Factorial validity and reliability of the General Health Questionnaire (GHQ-12) in the Brazilian physician population. Cad Saude Publica 26:1439–1445
28. Cooper KH (1968) A means of assessing maximal oxygen intake. Correlation between field and treadmill testing. JAMA 203:201–204
29. Crotti M, Bosio A, Invernizzi PL (2018) Validity and reliability of submaximal fitness tests based on perceptual variables. J Sports Med Phys Fit 58:555–562. https://doi.org/10.23736/S0022-4707.17.07199-7
30. Fielitz L, Coelho J, Horne T, Brechue W (2016) Inter-rater reliability and intra-rater reliability of assessing the 2-minute push-up test. Mil Med 181(2):167–172. https://doi.org/10.7205/MILMED-D-14-00533
31. Ortega FB, Brown WJ, Lee DC, Baruth M, Sui X, Blair SN (2011) In fitness and health? A prospective study of changes in marital status and fitness in men and women. Am J Epidemiol 173:337–344. https://doi.org/10.1093/aje/kwq362
32. Byles JE, Gallienne L, Blyth FM, Banks E (2012) Relationship of age and gender to the prevalence and correlates of psychological distress in later life. Int Psychogeriatr 24:1009–1018. https://doi.org/10.1017/S1041610211002602
33. Hourani LL, Williams TV, Kress AM (2006) Stress, mental health, and job performance among active duty military personnel: findings from the 2002 Department of Defense Health-Related Behaviors Survey. Mil Med 171:849–856
34. Hellerstedt WL, Jeffery RW (1997) The association of job strain and health behaviours in men and women. Int J Epidemiol 26:575–583
35. White RL, Babic MJ, Parker PD, Lubans DR, Astell-Burt T, Lonsdale C (2017) Domain-specific physical activity and mental health: a meta-analysis. Am J Prev Med 52:653–666. https://doi.org/10.1016/j.amepre.2016.12.008
36. Harvey SB, Hotopf M, Overland S, Mykletun A (2010) Physical activity and common mental disorders. Br J Psychiatry 197:357–364. https://doi.org/10.1192/bjp.bp.109.075176
37. Hu GC, Chien KL, Hsieh SF, Chen CY, Tsai WH, Su TC (2014) Occupational versus leisure-time physical activity in reducing cardiovascular risks and mortality among ethnic Chinese adults in Taiwan. Asia Pac J Public Health 26:604–613. https://doi.org/10.1177/1010539512471966
38. Scott D, Happell B (2011) The high prevalence of poor physical health and unhealthy lifestyle behaviours in individuals with severe mental illness. Issues Ment Health Nurs 32:589–597. https://doi.org/10.3109/01612840.2011.569846
39. Muhsen K, Garty-Sandalon N, Gross R, Green MS (2010) Psychological distress is independently associated with physical inactivity in Israeli adults. Prev Med 50(3):118–122. https://doi.org/10.1016/j.ypmed.2009.12.002
40. Hausser JA, Schulz-Hardt S, Mojzisch A (2014) The active learning hypothesis of the job-demand-control model: an experimental examination. Ergonomics 57:23–33. https://doi.org/10.1080/00140139.2013.854929
41. Conway PM, Campanini P, Punzi S, Fichera GP, Camerino D, Francioli L, Neri L, Costa G (2013) Work stress, common mental disorders and Work Ability Index among call center workers of an Italian company. Epidemiol Prev 37:17–28
42. Soderfeldt B, Soderfeldt M, Muntaner C, O'Campo P, Warg LE, Ohlson CG (1996) Psychosocial work environment in human service organizations: a conceptual analysis and development of the demand-control model. Soc Sci Med 42:1217–1226
43. Kim K, Shin YJ, Nam JH, Choi BY, Kim MK (2008) A dose-response relationship between types of physical activity and distress. J Korean Med Sci 23:218–225. https://doi.org/10.3346/jkms.2008.23.2.218