CSP CADERNOS DE SAÚDE PÚBLICA
REPORTS IN PUBLIC HEALTH

ARTIGO
ARTICLE

Work-related factors in the etiology of symptoms of post-traumatic stress among first responders: the *Brazilian Firefighters Longitudinal Health Study* (FLoHS)

Fatores relacionados ao trabalho na etiologia de sintomas de estresse pós-traumático entre socorristas: o *Estudo Longitudinal de Saúde em Bombeiros Brasileiros* (FLoHS)

Factores laborales relacionados con la etiología de síntomas de estrés postraumático entre trabajadores de primeros auxilios: el *Estudio Longitudinal de Salud en Bomberos Brasileños* (FLoHS)

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doi: 10.1590/0102-311X00135920

Abstract

Two important aspects must be accounted for when discussing the mental health of first responders and, in particular, their report of post-traumatic stress symptoms (PTSS). The first concerns the provision of quantitative data from longitudinal study designs, the second concerns the sophistication of the work-related model used to frame such studies. This is a report on the development of a model for Brazilian firefighters who also work as first responders, from the establishment of a longitudinal panel design study, the Brazilian Firefighter Longitudinal Health Study *(FLoHS). The first objective was to compare trainee and active firefighters based on their follow-up data with a nationwide sample of similarly aged Brazilians. The second was to test the effect that operational and organizational experiences had on firefighters' PTSS level during follow up. At baseline, trainee firefighters came from higher socioeconomic backgrounds, were healthier and less exposed to trauma compared to a similarly aged national sample. At follow up, they reported higher prevalence of smoking, sleep problems, anhedonia and were more likely to be overweight. PTSS was predicted by operational and organizational stressors, even when controlled for health status at baseline. The results present not only the differences in the predictive status of operational and organizational events in relation to PTSS, but also how the effects of such events might interact. The data suggest the need for evidence-based interventions, support provided and changes at work environments to improve report rates for mental health in general and for PTSS in particular.*

Post-Traumatic Stress Disorders; Firefighters; Longitudinal Studies; Occupational Exposure

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Introduction

Experiencing trauma because of exposure to severely stressful situations at work is different than the on-going exposure to stressful and demanding situations that are part of normal working experiences. First responders working in emergency services are particularly affected [1]. Victim-based models as described by the *Diagnostic and Statistical Manual of Mental Disorders* (DSM) and the *International Statistical Classification of Diseases and Related Health Problems* (ICD) are insufficient to properly understand the etiology and effects of post-traumatic stress symptoms (PTSS) in these groups. Instead, we argue that an explicit work-based exposure model is required to account for temporal issues and the relationships between individual, operational and organizational factors [2]. This is a report on the development of a model for Brazilian firefighters who also work as first responders, through the establishment of a longitudinal panel design study, the *Brazilian Firefighter Longitudinal Health Study* (FLoHS).

At the individual level, first responders in Brazil are self-selected and then subject to a range of psychological and physical exams; these work as a strategy to manage the level of work-related trauma in this group [3]. First responders present a relatively unique set of individual characteristics at the start of their careers, often including specific and relevant personality traits [4]. The reported risk of developing mental health symptoms when working in the emergency sector partially depends on previous psychological health and functioning status [5]; on the other hand, remaining healthy depends on predispositions to deal with trauma [6]. This scenario is underestimated in most PTSS models, where the focus is largely on individual factors and experiences.

At the operational level, first responders are exposed daily to a wide range of traumatic events given the nature of their work, from natural disasters to traffic accidents and burn victims [7]. Studies on the effect of operational stressors on mental health are common [2,8]; however, little information on the effects of cumulative exposure to operational stressors over time is available. The focus on a single exposure and PTSS expression – as proposed by most victim-based models – is inappropriate as an approach for the emergency sector.

At the organizational level, first responders are exposed to many challenging situations regarding work organization and management. Control in the emergency sector is often hierarchical, rigid and imposes limits to the autonomy of low-ranking workers [9]. Fixed protocols with strict procedures exist to guide them during uncertain and challenging scenarios [10], which can also impede autonomy. First responders are subject to intense pressures when dealing with several victims at one event or with multiple events in a short period of time. At the same time, social interactions within the very emergency services can be a double-edged sword; while capable of providing valuable social support, these may become a negative factor when conflicts between superiors and colleagues emerge [11]. Finally, those in the emergency services, including firefighters, are subject to the burden of anti-social working hours (long and night shifts) and their effects on well-being [12].

Exposure to organizational stressors has been established as a health risk [13]; however, such exposure also affects how first responders perform and cope with their operational duties. Time limits imposed on answering emergency calls restrict workers' coping strategies when dealing with victims. Fixed protocols and a command-and-control culture negatively affect workers' emotional responses to trauma by blocking specific emotional reactions, such as anger and fear, and hinder peer disclosure [11]. This cumulative exposure to organizational and operational stressors can seriously erode firefighters' coping resources and impair their health.

The final element in the work-based exposure model is time, which must be defined in terms of synchronous and lagged effects [14]. Synchronous effects are short-term reactions observed when variations in the level of exposure to stressors and their magnitude are followed by concurrent variations in mental health symptoms. Lagged effects occur when those exposed to stressors develop mental health symptoms over a longer period of time (often demonstrating a peak in intensity followed by a decline). However, the magnitude of both synchronous and lagged ill-health effects can increase over time [15]. To better understand PTSS in the emergency sector, time lags must be considered in work-related models [16].

Thus, a longitudinal panel design study – FLoHS – was conducted with firefighters in Brazil to address the shortcomings discussed above and develop a work-based exposure model for PTSS and

better understand the relationship between individual, operational and organizational risk factors over time in the development of PTSS and other mental health symptoms in this group. FLoHS is based on three hypotheses: (1) Trainees and firefighters are not comparable to the general population on measures of health and on exposure to stress and trauma; (2) Exposure to operational and organizational stressors will be associated with poorer mental health, including PTSS; (3) Synchronic and lagged effects will result in increases in PTSS incidence in firefighters in their initial years working with the fire service.

This article focuses on the first two FLoHS hypotheses. More specifically, the first objective was to compare trainee and active firefighters with a national sample of similarly aged Brazilians; the second was to test the effect that operational and organizational experiences have on firefighters' PTSS level at follow up.

Method

Participants and procedure

In Brazil, fire services are organized at State level and have a military structure linked to the Civil Defence and Public Security Departments. Firefighters perform a wide range of activities including rescue and first emergency care, and firefighting. Entry to Brazilian Fire Department is based on public calls [17]. The selection procedure includes a written general knowledge examination, medical screening tests to assess the presence of infectious and chronic diseases, physical fitness examination and psychological assessments of cognitive ability and personality traits [18]. Psychiatric interviews are not applied but applicants are asked if they have ever received a diagnosis of a mental illness. Successful applicants undertake nine months of training at the Academy of the Fire Department.

FLoHS data were unrelated to the entrance examination or career development. Eligibility criteria for this study were: (1) being admitted to the Fire Department through a public selection procedure in either 2014 or 2017; (2) starting their career as a private, the first position in the firefighter hierarchy; and (3) having received initial training at the Academy of the Fire Department. Exclusion criteria were: (1) being absent at baseline data collection; and (2) leaving the Fire Service before finishing their nine-month training period.

At the time of writing, two cohorts had been admitted to the study: Cohort 2014 (N = 593) and Cohort 2017 (N = 501). The third cohort is scheduled to be assessed in November 2020 (Cohort 2020; N = 500). Follow-up data (T1) is only available for Cohort 2014 (N = 312).

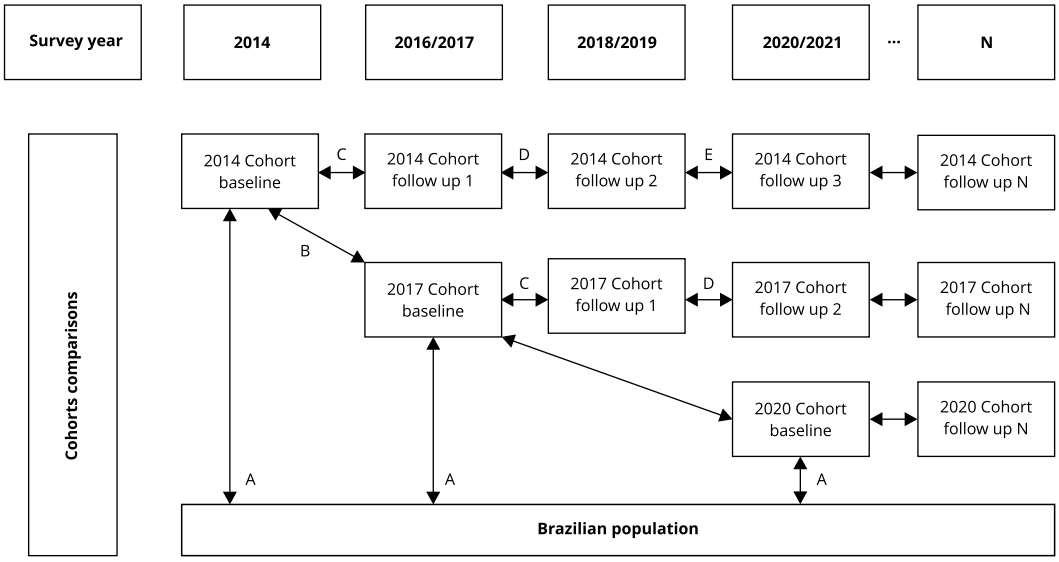
FLoHS data were collected from a self-reported questionnaire. The first assessment data (baseline data; T0) were collected face-to-face and included filling out the initial assessment questionnaire in the classroom at the first week of training period. For follow-up assessments (T1,…, Tn), the various cohorts of participants were invited to answer the online follow-up questionnaire every 24 months following consideration of the time lag for the onset of PTSS [19]. Invitations were made through institutional e-mail, telephone contact and visits to Fire Service units. Participants will be followed for 10 years from study entry (baseline + 5 follow up moments). Figure 1 presents a flow chart for the steps already conducted and the planned steps.

The data for the comparison group of Brazilian adults was extracted from the *Brazilian National Health Survey* (PNS) data [20]. PNS is a Brazilian population-based survey, conducted every five years, on health status, lifestyle, and health services. The last data collection available was from August 2013 to February 2014. Conglomerate sampling was conducted in three stages: (1) stratification of the census tracts (primary sampling units), (2) random selection of households (second stage units), and (3) selection of a resident aged 18 years or older (third-stage units). In total, 60,202 individuals participated although only the data for participants aged between 18 and 29 years old (n = 15,485) was used in the present study. The selection of this age-based subgroup was justified by the profile of trainee firefighters.

FLoHS was approved by the Research Ethics Committee of the Minas Gerais Federal University (CAAE: 15169813.1.0000.5149). The research team provided a detailed verbal explanation of the study procedure to participants before seeking they agreed to participate by signing an Informed

Figure 1

Flowchart for the study stages (baselines and follow ups) from the 2014 Cohort. *Brazilian Firefighter Longitudinal Health Study* (FloHS).



A: comparisons between cohort baseline and Brazilian young adult population; B: comparisons between cohorts at baseline; C: comparisons between baseline and follow up 1; D: comparisons between follow up 1 and follow up 2; E: comparisons between follow up 2 and follow up 3.

Consent Form. Participants were given an individual report on their mental health status and lifestyle and collective guidance on protecting and promoting health at the end of each assessment (baseline and follow up).

Measures

- **Sociodemographic characteristics**

Single items were used to assess sex, age, race, marital status, schooling, mothers' schooling, and income.

- **Psychological characteristics**

Personality: The Brazilian version of the *NEO-Five Factor Inventory* (NEO-FFI) was used to assess individual differences in personality factors. The self-report questionnaire comprised a 60-item rated on a five-point scale ranging from 0 (strongly disagree) to 4 (strongly agree). The personality domains assessed are neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. Factor scores could be interpreted via comparison to the scores of the Brazilian normative sample. The internal consistency (Cronbach's α) of the NEO-FFI factors ranged from 0.70 (agreeableness) to 0.82 (conscientiousness) in a Brazilian sample [21].
Core beliefs: *Cognitive Triad Inventory* (CTI) is a 36-item questionnaire used to assess the three components of Beck's cognitive triad: view of self, world, and future. Individuals are asked to rate how the item applies to them on a 7-point Likert scale from 1 (totally agree) to 7 (totally disagree). The scale showed good internal consistency (Cronbach's α ranged from 0.61 to 0.75) in a Brazilian sample. High total score indicates positive views and low scores negative views [22].

Coping: The *Coping with Occupational Traumatic Events Questionnaire* is a new self-rating scale designed to assess first-responders' coping strategies to deal with traumatic situations experienced at the workplace. Respondents answered 46 items using a scale ranging from 0 (not at all) to 3 (severely). Example items include "I get professional help to feel better (doctor, psychologist, others)", "I have already felt like I had lost control in this kind of situation", and "I focus on what must be done". A psychometric study has been developed to assess its configurational, metric and scalar structures (yet to be published).

- **Mental health symptoms**

Anxiety symptoms: Symptoms of anxiety were measured using the Brazilian-version of the *Beck Anxiety Inventory* (BAI), a 21-item self-report questionnaire. Respondents rate items using a scale from 0 (not at all) to 3 (severely); the total score ranges from 0 to 63 and is calculated by the sum of the severity ratings for all 21 items. Scores greater than or equal to 21 were used to evaluate the presence of probable anxiety caseness. The scale demonstrated good internal consistency (Cronbach's $\alpha = 0.92$) and convergent validity evidence with *State-Trait Anxiety Inventory* ($r = 0.78$; $p < 0.001$) in a Brazilian sample [23].

Depression symptoms: The 20-item Brazilian-version of the *Center for Epidemiologic Studies-Depression* (CES-D) was used to assess the level of severity of depression symptoms [24]. Participants were required to rate the level or severity during the previous week on a 4-point Likert scale ranging from 0 (not at all) to 3 (severe). Scores greater than or equal to 16 were used to evaluate the probable presence of depression caseness. The Brazilian-version of CES-D showed satisfactory convergent validity evidence with *Beck Hopelessness Scale* and good internal consistency (Cronbach's α ranged from 0.80 to 0.90) in a Brazilian sample.

Common mental disorders symptoms (CMDS): CMDS was measured using the Brazilian-version of the *Self-Reporting Questionnaire* (SRQ-20). This version assesses 20 symptoms and participants must respond "yes" or "no", questions include crying more than usual, sleep badly or having frequent headaches. Score of seven or above indicate probable CMDS case. The SRQ-20 showed satisfactory discriminant validity (area under receiver operating characteristic curve = 0.91 [0.88-0.94]) using *Structured Clinical Interview for DSM-IV-TR* as the gold standard. Cronbach's α was 0.86 in a Brazilian sample [25].

PTSS: PTSS were measured using the Brazilian-version of *Post-traumatic Stress Disorder Checklist for DSM-5* (PCL-5), which is a 20-item scale that parallels the diagnostic criteria of the DSM-5 [26]. Respondents rate items using a scale ranging from 0 (not at all) to 4 (extremely). PCL-5 scores greater than or equal to 32 were used to evaluate the prevalence of probable post-traumatic stress disorder (PTSD) caseness. PCL-5 scores showed good internal consistency (Cronbach's $\alpha = 0.90$) and convergent validity with *Post-traumatic Stress Disorder Checklist Specific* (PCL-S) in a military sample ($r = 0.87$) [27].

Other mental health outcomes: Besides the validated questionnaires mentioned above, sleep problems, psychiatric medication use, and clinical diagnoses of mental health problems in the past (depression, anxiety, other mental disorders) were investigated through single items. The items were equivalent to those used in PNS [20] to allow a comparison between firefighters and the general population.

- **General health status**

Nocive behaviors: History of potential alcohol abuse was identified by the endorsement of two or more items from the *CAGE Questionnaire* (based on four items – "Cut-down", "Annoyed", "Guilty", and "Eye-opener"). CAGE scores showed good internal consistency (Cronbach's $\alpha = 0.8$) and convergent validity with *Alcohol Use Disorders Identification Test* (AUDIT) ($r = 0.5$) [28]. History of tobacco use was investigated by two questions: "Have you ever smoked at least 100 cigarettes in your life?" and "Do you currently smoke?". The combination of answers to both questions results in the three possible status including smoker, ex-smoker and non-smoker.

Sickness absence: Data for sick leave were obtained from the Fire Department's Sickness Absence Register. This included long sick-leave episodes (i.e., 7 days or more) during basic training and work-

ing periods. The number of these episodes was calculated along with the total number of sick-leave days for each participant. The number of sick-leave days were dichotomised during the training periods resulting in "short sick-leave period" (less than 7 days) versus "long sick-leave period" (7 days or more).

Physical health status: Chronic noncommunicable diseases were measured through individual items (heart attack, stroke, hypertension, diabetes, repetitive strain injury, low back pain, asthma, and bronchitis), and self-reported height and weight (to estimate body mass index, overweight and obesity status). The items were equivalent to those used in PNS [20] to enable comparisons between firefighters and the general population. Regarding physical activity, participants who did not engage in vigorous activity for at least 75 minutes per week or moderate intensity activity for at least 150 minutes per week were considered physically inactive [29].

- **Exposure to stressful and traumatic events**

Stressful life events: Participants were asked 9 yes or no questions related to stressful life events unrelated to death or risk of death experienced in the last 12 months. Examples include "Have you been admitted to the hospital due to illness or accident?" and "Have you faced financial difficulties more severe than usual?". The total score ranged from 0 to 9 and indicated the frequency of exposure to stressful life events in the last 12 months. There is no scoring protocol or interpretation for this measure [30].

Traumatic life events: Exposure to traumatic events during the entire life was measured using the Brazilian version of *Life Events Checklist for DSM-5* (LEC-5). Participants were asked 16 questions related to stressful life events associated with death or risk of death and rated their levels of exposure on 5 points nominal scales (1 = happened to me; 2 = witnessed it; 3 = learned about it; 4 = not sure; 5 = does not apply). Respondents could check multiple levels of exposure to the same trauma event. Example items are "Assault with a weapon (for example, being shot, stabbed, threatened with a knife, gun, bomb)" and "Sexual assault (rape, attempted rape, made to perform any type of sexual act through force or threat of harm)". LEC-5 is theoretically and semantically equivalent to the original version [26].

Organizational stressors: Job demands, job control and social support were measured using the Brazilian version of 17-item *Job Stress Scale* to measure. Items on all three dimensions were rated on a 4-point Likert scale. The first two ranged from 1 (frequently) to 4 (never/almost never), whereas responses to the social support dimension were between 1 (strongly agree) and 4 (strongly disagree). The scale demonstrated good internal consistency (Cronbach's $\alpha = 0.72$ – demand; Cronbach's $\alpha = 0.63$ – control; Cronbach's $\alpha = 0.86$ – social support) and adequate temporal reliability ($r = 0.88$; $p < 0.05$ – demand; $r = 0.87$; $p < 0.05$ – control; $r = 0.86$; $p < 0.05$ – social support) in a Brazilian sample [31].

Work-related traumatic events: The *Checklist of Occupational Traumatic Events for Emergency Professionals* (LET-PE) was used to investigate exposure to 15 potentially traumatic occupational-related events (e.g., death of a child, physical aggression, disaster). Participants were asked to rate the frequency of each event on a 5-point Likert-type scale (1 = never to 4 = once a week). The total score (ranging from 15 to 60) indicated the frequency of exposure to traumatic occupational events in the last 12 months. A previous psychometric study indicated a satisfactory temporal reliability using the Bland-Altman graph and the repeatability index (RI = 8.23) [32].

Data obtained in baseline and follow-up assessments were classified as exposure, outcomes, or both (Table 1).

Data analysis

Chi-square tests were used to compare frequency data (absolute and relative) among the four groups: 2014 Cohort baseline, 2014 Cohort follow up 1, 2017 Cohort baseline, and 2013-2014 sample of young Brazilian adults. The bivariate correlations were assessed for relationships between mental health outcomes, personality and work stressors. Linear regressions analyses were used to summarize the PTSS prediction at T1. These analyses controlled for the report of the variable at T0. This analysis is based on the assertion that the predictor variables reflect experiences across from T0 to T1. Significance was considered when $p < 0.05$.

Table 1

Variables obtained in baseline and follow up assessments and their type as exposure or outcome measures. *Brazilian Firefighter Longitudinal Health Study* (FloHS).

Variables	Baseline	Follow up	Type
1. Sociodemographic			
Sex, race, age, marital status, schooling, income	Yes	Yes	Exposure
Mother's schooling	Yes	No	Exposure
2. Psychological characteristics			
Personality	Yes	No	Exposure
Cognitive beliefs	Yes	Yes	Exposure
Coping with occupational related-traumatic events	No	Yes	Exposure and outcome
3. Mental health symptoms			
Symptoms of anxiety	Yes	No	Exposure
Symptoms of depression	Yes	Yes	Outcome
Symptoms of CMD	Yes	Yes	Outcome
Symptoms of PTS	Yes	Yes	Outcome
4. Other mental health outcomes			
Previous diagnostic of mental disorder (self-report)	Yes	Yes	Exposure and outcome
Psychiatric medication use	Yes	Yes	Exposure and outcome
Sleep problems	Yes	Yes	Outcome
5. Nocive behavior			
Alcohol abuse	Yes	Yes	Exposure and outcome
Tobacco use	Yes	Yes	Exposure and outcome
Physical activity	No	Yes	Exposure
6. Sickness absence			
Number of sick-leave episodes, number of days of sickness absence	Yes	Yes	Exposure and outcome
7. Physical health status			
Diagnosis of chronic non-communicable diseases	Yes	Yes	Exposure
Weight and height	Yes	Yes	Exposure
8. Stressful and traumatic events			
Exposure to stressful life events unrelated to death or risk of death	Yes	Yes	Exposure
Exposure to traumatic life events	Yes	No	Exposure
Organizational stressors	No	Yes	Exposure
Operational stressors	No	Yes	Exposure

CMD: common mental disorder; PTS: post-traumatic stress.

Results

Description of participants

In total, 979 individuals were admitted to Fire Service in 2014 (2014 Cohort baseline). Of these, 386 did not fit the study inclusion criteria because they did not train in the Firefighter Academy. Of the 593 individuals eligible, 12 were absent from data collection due to sick leave and eight did not complete the questionnaire. This meant a sample size of 573 (96.6% response rate). At the follow up of this group (2014 Cohort follow up 1), 16 participants had left the Fire Service. Of the 557 eligible for follow up, 312 firefighters participated (56% response rate; 54.07% of the baseline). Differences between respondents and non-respondents in 2014 Cohort follow up 1 were not significant for sex, age, race, trauma exposure and most mental health symptoms ($0.0001 < \text{chi-square tests} < 6.90$; $p > 0.05$). The only exception was that there was a higher percentage of probable PTSS cases among non-respondents at the baseline measure (chi-square tests = 3.85; $p = 0.05$).

The 2017 Cohort baseline consisted of 501 trainee firefighters; all met the eligibility criteria for the study. Of these, 493 trainee firefighters were assessed at baseline (98.4% response rate). The first follow up study of 2017 Cohort baseline will take place in January 2020. Tables 1, 2 and 3 summarize data on all subjects' demographic and health status.

Table 2

Sociodemographic information of the firefighters included in baselines in 2014 (n = 573) and 2017 Cohorts (n = 493), 2014 Cohort follow up (n = 312), and Brazilian adults (n = 15,485). *Brazilian Firefighter Longitudinal Health Study* (FIoHS).

Sociodemographic information	2014 Cohort baseline		2017 Cohort baseline		2014 Cohort follow up		Brazilian adults	
	%	95%CI	%	95%CI	%	95%CI	%	95%CI
Sex *,**,***								
Man	90.1	87.6; 92.5	89.0	86.3; 91.8	88.5	84.9; 92.0	47.8	46.3; 49.4
Woman	9.9	7.5; 12.4	11.0	8.2; 13.7	11.5	7.9; 15.1	52.2	50.6; 53.7
Race *,**,***,#								
White	40.5	36.5; 44.5	44.4	40.0; 48.8	44.6	39.0; 50.1	43.5	42.2; 45.0
Mixed	46.2	42.1; 50.3	45.4	41.0; 49.8	39.4	33.9; 44.9	46.6	45.2; 48.0
Black	10.5	8.0; 13.0	9.5	6.9; 12.1	10.3	6.9; 13.6	8.5	7.8; 9.3
Other	2.8	1.4; 4.1	0.6	0.1; 1.3	5.8	3.2; 8.4	1.4	1.1; 1.8
Age (years) *,**,***,#,##								
Mean (SD)	23.6	(3.53)	24.3	(3.05)	27.7	(3.52)	24.0	(0.05)
< 21	22.2	18.8; 25.6	14.2	11.1; 17.3	0.0		26.5	25.1; 27.9
21-23	28.6	24.9; 32.3	25.4	21.5; 29.2	11.9	8.3; 15.5	23.9	22.6; 25.2
24-26	25.7	22.1; 29.2	31.2	27.1; 35.3	28.8	23.8; 33.9	24.9	23.7; 26.2
> 26	23.6	20.1; 27.0	29.2	25.2; 33.2	59.3	53.8; 64.8	24.7	23.6; 25.9
Marital status *,**,***,##								
Living with a partner	15.3	12.3; 18.3	15.7	12.5; 19.0	39.4	33.9; 44.9	18.6	17.5; 19.7
Living alone	84.7	8.2; 8.8	84.3	81.0; 87.5	60.6	55.1; 66.0	81.4	80.3; 82.4
Schooling *,**,***,##								
Elementary or less	0.0		0.0		0.0		38.7	37.2; 40.2
High school	38.3	34.3; 42.3	17.1	13.7; 20.4	34.0	28.8; 39.4	37.8	36.4; 39.3
Some college	39.7	35.7; 43.8	47.6	43.1; 52.0	38.1	32.8; 43.7	14.8	13.8; 15.9
Higher education	22.0	18.6; 25.4	35.4	31.1; 39.6	27.6	22.7; 32.6	8.7	7.8; 9.6
Mother's schooling #								
Elementary school	39.2	34.9; 43.5	24.1	20.3; 27.9	-		-	
High school	36.4	32.2; 40.7	34.5	30.3; 38.7				
College	24.3	20.6; 28.1	41.4	37.1; 45.8				
Income (minimum wages per family member) *,**,#								
< 1	30.8	26.7; 34.9	21.6	17.9; 25.5	-		90.4	89.6; 91.1
1-1.9	37.2	32.9; 41.5	44.1	39.7; 48.6			6.5	5.9; 7.2
2-2.9	21.4	17.8; 25.0	15.0	11.8; 18.2			1.7	1.4; 2.0
> 3	10.6	7.9; 13.3	19.3	15.8; 22.8			1.4	1.2; 1.7

95%CI: 95% confidence interval; SD: standard deviation.

Note: significant differences (chi-square; $p < 0.05$) between: (*) 2014 Cohort baseline and Brazilian adults; (**) 2017 Cohort baseline and Brazilian adults; (***) 2014 Cohort follow up and Brazilian adults; (#) 2014 Cohort baseline and 2017 Cohort baseline; (##) 2014 Cohort baseline and 2014 Cohort follow up.

Table 3

Health information of the firefighters included in baselines in 2014 (n = 573) and 2017 Cohorts (n = 493), 2014 Cohort follow up (n = 312), and Brazilian adults (n = 15,485). *Brazilian Firefighter Longitudinal Health Study* (FloHS).

Health information	2014 Cohort baseline		2017 Cohort baseline		2014 Cohort follow up		Brazilian adults	
	%	95%CI	%	95%CI	%	95%CI	%	95%CI
Chronic non-communicable diseases *,**								
No	85.7	82.8; 88.6	80.9	77.5; 84.4	-		80.7	79.5; 81.9
Yes	14.3	11.4; 17.2	19.1	15.6; 22.5			19.3	18.1; 20.5
BMI (kg/m^2) **,***,#,##								
Normal (< 25)	76.5	73.0; 80.0	71.9	67.9; 75.9	55.5	49.8; 61.1	62.5	60.7; 64.3
Overweigh (> 25)	23.5	20.0; 27.0	28.1	24.1; 32.1	44.5	38.9; 50.2	37.5	35.7; 39.3
Smoking *,**,***,#,##								
Non-smoker	87.5	84.3; 89.8	92.4	90.0; 94.7	89.4	86.0; 92.9	88.8	87.8; 89.7
Ex-smoker	10.4	7.8; 12.8	6.0	3.9; 8.1	6.4	3.7; 9.1	2.4	2.0; 2.9
Smoker	2.1	0.9; 3.3	1.7	0.5; 2.8	4.2	1.9; 6.4	8.8	7.9; 9.8
Previous diagnose of mental health (in life) **,#								
No	98.1	96.7; 99.1	96.9	95.4; 98.5	-		95.7	95.0; 96.3
Yes	1.9	0.7; 3.0	3.1	1.5; 4.6			4.3	3.7; 5.0
CMD disorder symptoms ***								
No	96.5	95.0; 98.0	96.6	94.9; 98.1	87.1	83.4; 90.9	-	
Yes	3.5	2.0; 5.0	3.4	1.8; 5.1	12.9	9.1; 16.6		
Anxiety symptoms								
No	98.0	93.7; 97.2	98.5	97.5; 99.6	-		-	
Yes	2.0	0.7; 3.0	1.5	0.4; 2.5				
Depression symptoms **,#								
No	98.7	97.7; 99.7	98.9	97.9; 99.8	-		94.2	93.5; 94.8
Yes	1.3	0.3; 2.3	1.1	0.1; 2.0			5.8	5.2; 6.5
PTSS *,***								
No	98.3	97.1; 99.3	99.8	97.5; 99.6	94.6	92.0; 97.1	-	
Yes	1.6	0.5; 2.6	0.2	0.0; 0.6	5.4	2.9; 8.0		
Sleep problems ***,##								
No	77.5	74.0; 80.8	77.9	74.2; 81.6	70.8	65.7; 76.5	77.5	76.3; 78.7
Yes	22.5	19.1; 25.9	22.1	18.4; 25.8	29.2	24.1; 34.2	22.5	21.3; 23.8
Anhedonia **,***,#,##								
No	95.6	93.5; 97.8	96.8	95.0; 98.7	83.3	78.9; 87.2	78.6	77.5; 79.8
Yes	4.4	2.7; 60.4	3.2	1.7; 4.8	16.7	12.5; 20.8	21.4	20.3; 22.5
Number of long sick-leaves episodes during training *								
No	91.8	89.5; 94.1	95.1	93.2; 97.0	-		-	
Yes (> 7 days)	8.2	5.9; 10.5	4.9	2.9; 6.8				
Personality	**Mean**	**SD**	**Mean**	**SD**				
Neuroticism	23.0	6.2	22.8	6.2				
Extraversion	40.5	6.4	41.2	4.9				
Open experience *	41.5	6.2	42.5	5.4				
Agreeableness	51.2	6.1	51.3	4.8				
Conscientiousness *	44.1	6.0	45.0	5.7				

95%CI: 95% confidence interval; BMI: body mass index; CMD: common mental disorder; PTSS: post-traumatic stress symptoms; SD: standard deviation.
Note: significant differences (chi-square; $p < 0.05$) between: (*) 2014 Cohort baseline and 2017 Cohort baseline; (**) 2014 Cohort baseline and Brazilian adults; (***) 2014 Cohort baseline and 2014 Cohort follow up; (#) 2017 Cohort baseline and Brazilian adults; (##) 2014 Cohort follow up and Brazilian adults.

First research objective

- **Differences and similarities between the 2014 and 2017 baselines**

Chi-square tests indicated significant differences between firefighters from the 2014 and 2017 Cohorts at baseline (Table 2).

Sociodemographic characteristics: The 2017 Cohort baseline (compared to the 2014 baseline) was older, more likely to be white, and to have higher family income ($16.30 < \text{chi-square} < 29.06$; $p < 0.05$). They are also more schooled and more had mothers who had higher education degrees ($40.06 < \text{chi-square} < 62.37$; $p < 0.05$).

Mental health symptoms and general health status: The 2017 Cohort baseline (compared to the 2014 baseline) reported more medical diagnoses of chronic diseases, fewer possible PTSS cases and fewer alcohol abusers and smokers ($4.35 < \text{chi-square} < 9.28$; $p < 0.05$). They also had fewer long sick-leave episodes during training (chi-square = 4.74; $p < 0.05$). No significant differences were found between the two cohorts for the presence of depression, anxiety and CMDS ($0.00 < \text{chi-square} < 0.90$; $p > 0.05$). Most trainees from both cohorts were classified as having a normal body mass index (chi-square = 2.92; $p = 0.87$) (Table 3).

Personality: Trainees from both cohorts showed similar personality profile at baseline. Significant differences could be observed in Openness to experience and Conscientiousness traits.

Exposure to stressful and traumatic events: There were no significant differences between the two cohorts in relation to the previous experience of stressful events (chi-square < 0.62; $p > 0.05$) or direct exposure to traumatic events (chi-square = 2.66; $p = 0.10$). However, the 2014 Cohort baseline reported more previous experiences of indirect exposure to traumatic events (chi-square = 4.75; $p = 0.03$). Regarding work-related exposure, the 2017 Cohort baseline was less likely to have worked as emergency first responders in the past (chi-square = 16.76; $p < 0.001$) and reported less exposure to traumatic events in past work experiences (chi-square = 34.53; $p < 0.001$) (Table 4).

- **Differences and similarities between the 2014 cohort at baseline and at follow up**

Sociodemographic characteristics: Firefighters in the 2014 Cohort baseline were more likely to be married at follow up than at baseline (chi-square = 64.38; $p < 0.001$).

Mental health symptoms and general health status: Firefighters in the 2014 Cohort follow up 1 were more likely to be overweight, smoke, and report CMDS and PTSS and sleep problems ($4.85 < \text{chi-square} < 40.82$; $p < 0.05$).

Exposure to stressful and traumatic events: The 2014 Cohort follow up 1 reported more admissions to a hospital due to accidents or illness (chi-square = 8.36; $p < 0.05$).

- **Differences and similarities between 2014 and 2017 Cohorts and Brazilian adults**

Sociodemographic characteristics: About 90% of the firefighters in this study were men. This is a higher percentage than that found in the general population ($325.24 < \text{chi-square} < 394.64$; $p < 0.05$). Compared to the 2013-2014 sample of young Brazilian adults, both cohorts of firefighters at baseline presented higher schooling and reported higher family income ($1{,}860.74 < \text{chi-square} < 2{,}301.39$; $p < 0.001$). Differences regarding race and marital status were observed only between the 2014 Cohort and the 2013-2014 sample of young Brazilian adults. More trainee firefighters were living without a partner and self-reported their racial/ethnic group as black or other (chi-square = 72.167; $p < 0.001$; $1{,}860.74 < \text{chi-square} = 3.98$; $p = 0.05$). Trainees in the 2014 Cohort baseline were younger at baseline than the 2013-2014 sample of young Brazilian adults (chi-square = 9.48; $p < 0.05$) whereas trainees in the 2017 Cohort baseline were older (chi-square = 39.66; $p < 0.05$). Differences between the 2014 Cohort follow up 1 and the 2013-2014 sample of young Brazilian adults largely showed the same pattern as at baseline.

Mental health symptoms and general health status: Compared to the 2013-2014 sample of young Brazilian adults, both the 2014 and 2017 Cohort baselines were less likely to be overweight ($22.86 < \text{chi-square} < 53.83$; $p < 0.001$), to be smokers ($39.368 < \text{chi-square} < 125.42$; $p < 0.001$) and to report

Table 4

Exposure to traumatic and stressful events in firefighters included in baselines in 2014 (n = 573) and 2017 Cohorts (n = 493), 2014 Cohort follow up (n = 312), and Brazilian adults (n = 15,485). *Brazilian Firefighter Longitudinal Health Study* (FIoHS).

Exposure to traumatic and stressful events	2014 Cohort baseline		2017 Cohort baseline		2014 Cohort follow up		Brazilian adults	
	%	95%CI	%	95%CI	%	95%CI	%	95%CI
Previous work as emergency professional *								
No	89.9	87.4; 92.4	96.3	94.7; 98.0	-		-	
Yes	10.1	7.6; 12.6	3.7	2.0; 5.3				
Direct exposure to traumatic events								
No	49.6	45.2; 54.0	54.8	50.4; 59.2	-		-	
Yes	50.4	46.0; 54.8	45.2	40.8; 49.6				
Indirect exposure to traumatic events *								
No	14.5	11.4; 17.6	19.7	16.2; 23.2	-		-	
Yes	85.5	82.2; 88.6	80.3	76.8; 83.8				
Exposure at work to traumatic events *								
No	82.3	79.0; 85.7	94.3	92.3; 96.4	-		-	
Yes	17.7	14.3; 21.0	5.7	3.6; 7.7				
Exposure to stressful life events								
No	55.0	50.9; 59.1	53.9	49.4; 58.3	-		-	
Yes	45.0	40.9; 49.1	46.1	41.7; 50.6				
Exposure to physical assault *,**,***,#,##								
No	98.6	97.6; 99.6	98.8	96.5; 99.7	99.7	99.0; 99.9	95.9	95.2; 96.5
Yes	1.4	0.4; 2.4	1.2	0.2; 2.2	0.3	0.0; 0.9	4.1	3.5; 4.8
Hospitalization due to accident or illness **,***,#								
No	97.9	96.7; 99.1	97.2	95.7; 98.6	94.2	91.6; 96.8	94.1	93.4; 94.7
Yes	2.1	0.9; 3.3	2.8	1.4; 4.3	5.8	3.2; 8.4	5.9	5.3; 6.6

95%CI: 95% confidence interval.

Note: significant differences (chi-square; $p < 0.05$) between: (*) 2014 Cohort baseline and 2017 Cohort baseline; (**) 2014 Cohort baseline and 2014 Cohort follow up; (***) 2014 Cohort baseline and Brazilian adults; (#) 2017 Cohort baseline and Brazilian adults; (##) 2014 Cohort follow up and Brazilian adults.

symptoms compatible with depression (24.06 < chi-square < 27.46; $p < 0.001$). At baseline, only the 2014 Cohort baseline reported fewer cases of previous diagnoses of mental health problems (chi-square = 7.72; $p < 0.05$). The 2014 Cohort follow up 1 was more overweight (chi-square = 3.92; $p < 0.05$) and reported more sleep problems (chi-square = 4.51; $p < 0.05$) than the 2013-2014 sample of young Brazilian adults.

Exposure to stressful and traumatic events: Firefighters in both cohorts were less exposed to physical assaults than the 2013-2014 sample of young Brazilian adults (chi-square = 11.330; $p < 0.001$). They reported fewer episodes of hospitalization at baseline (5.28 < chi-square < 10.77; $p < 0.05$) but this difference was not obvious at follow up (2014 Cohort follow up 1) (chi-square = 0.244; $p > 0.05$).

Second research objective

- **Operational and organizational stressors as predictors of firefighter mental health**

The simple correlations, accepted at the $p < 0.01$ level described a web of associations across variables and time (Table 5).

PTSS was predicted by the report of operational trauma and of a lack of social support (Table 6).

Table 5

Bivariate correlations with personality, post-traumatic stress symptoms (PTSS) (Time 0 and Time 1), life events and work stressors (Time 1). (2014 Cohort baseline and follow up 1; n = 312). *Brazilian Firefighter Longitudinal Health Study* (FloHS).

Variables	M	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Neuroticism T0	23.0	6.2	(0.73)	-0.39 *	0.02	-0.37 *	-0.44 *	-0.06	0.06	-0.12 **	-0.16 *	0.08	0.49 *	0.19 *
2. Extroversion T0	40.5	5.8		(0.68)	0.29 *	0.46 *	0.45 *	-0.11 **	-0.02	0.12 **	0.11	-0.01	-0.24 *	-0.16 *
3. Openness T0	41.5	5.9			(0.51)	0.16 *	0.09 *	-0.08	0.04	0.02	-0.03	0.06	0.08	-0.08
4. Agreeableness T0	51.2	5.5				(0.72)	0.51 *	-0.01	-0.06	0.13 **	0.11	-0.11	-0.34 *	-0.21 *
5. Conscientiousness T0	44.5	5.9					(0.84)	0.15 **	0.02	0.24 *	0.18 *	-0.09	-0.29 *	-0.23 *
6. Operational trauma T1	21.3	4.8						(0.84)	0.19 *	0.3 ***	0.2 ***	-0.05	0.04	-0.05
7. Job demands T1	13.3	2.6							(0.71)	-0.01	-0.32 *	0.18 *	0.27 *	0.17 *
8. Job control T1	16.9	2.6								(0.63)	0.4 *	-0.10	-0.14 **	-0.12 **
9. Social support T1	19.5	3.7									(0.91)	-0.31 *	-0.31 *	-0.22 *
10. Life events T1	1.0	1.2										(0.42)	0.25 *	0.27 *
11. PTSS T0	22.7	6.4											(0.86)	0.43 *
12. PTSS T1	8.2	10.9												(0.94)

M: mean; SD: standard deviation; T0: Time 0 – baseline data; T1: Time 1 – follow up data.

Note: significant differences (bivariate correlations): * p < 0.01, ** p < 0.05, and *** p < 0.001. Coefficient alpha reliabilities are reported in (parenthesis) along the diagonal.

Table 6

Regressions analysis with post-traumatic stress symptoms (PTSS) Time 1 (2014 Cohort baseline and follow up 1; n = 312). *Brazilian Firefighter Longitudinal Health Study* (FloHS).

Step	Predictors	PTSS T1
1	Gender	-0.10
	Age	0-.03
	ΔR^2	0.02
2	Neuroticism T0	0.10
	Extroversion T0	0.03
	Openness T0	-0.03
	Agreeableness T0	-0.11
	Conscientiousness T0	-0.15
	ΔR^2	0.07 *
	PTSS T0	0.42 **
	ΔR^2	0.14 *
3	Operational trauma T1	0.14 ***
	Job demands T1	0.09
	Job control T1	-0.02
	Social support T1	-0.22 *
	Life events T1	0.07
	ΔR^2	0.09 **

T0: Time 0 – baseline data; T1: Time 1 – follow up data; ΔR^2: is the *change* in the proportion of the variance for a dependent variable that is explained by the independent variables between two regression models.

Note: significant differences: * p < 0.01, ** p < 0.001, and *** p < 0.05.

Discussion

The first hypothesis postulated is that firefighters are not comparable to the Brazilian general population in relation to measures of health and exposure to stress and trauma. The results for the first research objective showed that trainee firefighters came from higher socioeconomic backgrounds and were healthier and less exposed to trauma when compared to a similarly aged national sample of the Brazilian population. The difference was significant for both cohorts but is more pronounced for 2017 Cohort. This could be, in part, due to the Brazilian economic situation. At the time of data collection, Brazil was recovering from a period of severe recession, resulting in substantial changes to its economic and political conditions. The situation grew worse since 2013 and the slow economic growth significantly constrained the demand for workers in the labor market. This led to low employment rates in more secure jobs with concomitant high rates of unemployment and precarious work, particularly among young adults [33]. The unemployment rate in 2014 was 6.8%, increasing to 12.7% by 2017 [34]. The pool of applicants grew due to the scarcity of secure and well-paid jobs; by 2017 a more educated and wealthier group of young adults were considering the Fire Service as an attractive employer.

In general, firefighters were characterized as healthier (both psychologically and physically) due to pre-employment screening, selection and training. Several of their difference on individual factors are related to mental health resilience, for example, being married and having higher schooling could be considered protective against the severity of work-related trauma. Moreover, lower exposure to previous traumatic life-events, both personal and work-related, could contribute to minimize PTSS.

In general, it was observed that at follow up firefighters presented marked deterioration in their health and health-related behaviors. They were more likely to be overweight and report a higher prevalence of smoking, sleep problems and anhedonia. This may be due to the influence of firefighters' shift work, which results in physiological and behavioral changes in workers. Working in shifts contributes to changes in lifestyle such as irregular sleeping times, skipping main meals and increased snacking behaviors [35].

The findings of the regression analyses (second research objective) supported the second hypothesis where PTSS at follow up was predicted by operational and organizational stressors, even when controlling for health status at baseline. This is consistent with several earlier studies involving police officers [36] and firefighters [37], and a review covering uniformed services [2].

From the conceptual framework developed around this longitudinal study, these initial results suggest that exposure to operational trauma and organizational stress have somewhat different effects, but the presence of good social support might be an ameliorating factor. However, the simple correlations also suggest that, in this particular occupational group, greater social support is associated with the report of greater job control and more reasonable job demands.

Moving forward, questions arise as to whether exposure to organizational stressors (i.e., low social support, low job control and high job demands) moderate the influence of operational trauma on health outcomes. This effect is suggested in a study on PTSS in police officers, which found that organizational work stress mediated the relationship between critical incident exposure and PTSS and between current negative life events and PTSS [38].

The initial results from FLoHS suggest that organizations have a role and responsibility in managing the mental health of firefighters. These include modifications to the current selection procedures, the provision of social support through work and developments in the design and management of the work of firefighters. In some of these areas, interventions may involve improvements in colleague and management training. Progress can be evaluated either through the inclusion of additional measures in FLoHS or by an independent study using appropriate designs.

Strengths and limitations of the study

This is the first longitudinal study of firefighters – at least in Brazil – and we are now beginning to recruit the third cohort (2020 Cohort). The first two cohorts are substantial in size and, so far, presented a low attrition rate. Furthermore, this study holds access to self-reported measures from participants and the records stored at organizational level (personnel and health).

One of the main limitations of the study is that 2013-2014 national sample of young Brazilian adults is "frozen in time" (PNS data were collected over 2013-2014). Therefore, the Brazilian sample is more suitable for comparison to firefighters of 2014 Cohort and not as much for those of later cohorts. Another limitation on the use of the 2013-2014 national sample of Brazilians is that PNS and FLoHS have different sampling strategies. PNS used a survey weight for the data, the researchers designed a stratified sample and gave weights for variables in the analysis (sex, age, region of the country) to ensure that the distribution of the sample resembled the distribution of the national population. Weighting was not used for the FLoHS sample.

The FLoHS study is important due to its design by providing longitudinal data on the work-related experiences of Brazilian firefighters in relation to their mental health including their PTSS reports. It not only suggests differences in the predictive status of operational and organizational events but also how they might interact in their effects and with individual characteristics over time. In doing so, the data is suggestive of evidence-based interventions based on selection, support at work, and work design that may improve the report rates for mental health in general and for PTSS in particular. Its findings and their impact on the selection and management of firefighters should be made clearer as data from later cohorts and from further follow ups are included in the analyses.

Contributors

A. G. Vasconcelos and E. P. Lima contributed to the literature review, methodological design, data collection (baseline and follow up) and analysis, and discussion of the study. K. Teoh and S. MacLennan contributed to the literature review, methodological design, data analysis, and discussion of the study. E. Nascimento and T. Cox contributed to the literature review, methodological design, data analysis, discussion of the study, and review of the manuscript.

Additional informations

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Acknowledgments

We would like to thank the Minas Gerais State Resaerch Foundation (FAPEMIG) for the financial support. We also thank the Minas Gerais Military Fire Department (CBMMG) for the logistical and operational support. Finally, we thank all CBMMG firefighters for participating in this research project.

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Resumo

Há duas questões subjacentes importantes na saúde mental dos socorristas, e particularmente em seu relato de sintomas de transtorno de estresse pós-traumático (TEPT). A primeira diz respeito à produção de dados quantitativos a partir do delineamento de estudos longitudinais, e a segunda está relacionada à sofisticação do modelo relacionado ao trabalho para contextualizar tais estudos. O artigo aborda o desenvolvimento de um modelo para bombeiros brasileiros, que também são socorristas, através do estabelecimento de um estudo com delineamento de painel longitudinal, chamado Estudo Longitudinal de Saúde em Bombeiros Brasileiros *(FLoHS). O primeiro objetivo foi a comparação de bombeiros estagiários versus efetivados com base em dados de seguimento com uma amostra nacional de brasileiros com idades semelhantes. O segundo objetivo foi testar o efeito das experiências operacionais e organizacionais sobre os níveis de sintomas de TEPT nos bombeiros durante o seguimento. Na linha de base, os bombeiros estagiários vinham de origens socioeconômicas mais favoráveis e eram mais saudáveis e menos expostos a trauma, em comparação com uma amostra nacional da população com idade semelhante. No seguimento, os estagiários relatavam maior prevalência de tabagismo, problemas de sono, anedonia e maior sobrepeso. Os sintomas de TEPT eram previstos por estressores operacionais e organizacionais, mesmo depois de controlar para o estado de saúde na linha de base. Os resultados apontaram não apenas para diferenças no estado preditivo dos eventos operacionais e organizacionais em relação aos sintomas de TEPT, como também, para a maneira pela qual esses eventos podem interagir em termos de efeitos. Assim, os dados sugerem intervenções baseadas em evidências, apoio através do trabalho e organização do trabalho que possam melhorar as taxas de notificação para saúde mental em geral e sintomas de TEPT em particular.*

Transtornos de Estresse Pós-Traumáticos; Bombeiros; Estudos Longitudinais; Exposição Ocupacional

Resumen

Existen dos importantes temas subyacentes a la salud mental de los trabajadores de primeros auxilios y, uno en particular, es la manifestación de síntomas de estrés postraumático (PTSS). El primero está relacionado con la provisión de datos cuantitativos, procedentes de estudios de diseños longitudinales, y, el segundo, con la sofisticación según el modelo de trabajo usado para enmarcar tales estudios. Este trabajo informó del desarrollo de un modelo para los bomberos brasileños, que también son trabajadores de primeros auxilios, mediante el establecimiento de un estudio de diseño longitudinal: el Estudio Longitudinal de Salud en Bomberos Brasileños *(FloHS). El primer objetivo fue comparar bomberos entrenados y activos, basándonos en sus datos de seguimiento, con una muestra nacional de brasileños en edades similares. El segundo objetivo fue probar el efecto que las experiencias operacionales y organizativas tuvieron en el nivel de PTSS entre los bomberos durante el seguimiento. En la base de referencia, los bomberos entrenados contaban con antecedentes socioeconómicos más altos, estaban más sanos y menos expuestos al trauma, cuando se comparan con una muestra nacional de población en edad similar. Durante el seguimiento, informaron de una prevalencia más alta de fumadores, problemas de sueño, anhedonia y tenían más probabilidad de tener sobrepeso. Los PTSS se predijeron mediante estresores operacionales y organizativos, incluso controlando el estatus de salud en la base de referencia. Los resultados apuntaron no solo las diferencias en el estatus predictivo de eventos operacionales y organizativos, en relación con PTSS, sino también la forma en la que tal vez tales eventos interactúan en sus efectos. De este modo, los datos animan intervenciones basadas en la evidencia, además de apoyo mediante el trabajo y diseño de intervenciones, que tal vez mejore las tasas de informes para la salud mental en general y para los PTSS en particular.*

Trastornos por Estrés Postraumático; Bomberos; Estudios Longitudinales; Exposición Profesional

Submitted on 02/Jun/2020
Final version resubmitted on 16/Nov/2020
Approved on 23/Nov/2020