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Relationship Between Personality Profile and Physical Condition in the CELSPAC-FIREexpo Study of Newly-Recruited Firefighters in Training

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ABSTRACT

Introduction: The present study aimed to investigate the association between the five-factor personality model (FFM), physical fitness, and physical activity (PA), and the effect of firefighting skills training on physical condition in firefighter recruits. **Methods:** Data on 58 newly-recruited firefighters from the CELSPAC–FIREexpo human biomonitoring study were used. The sampling protocol was structured in the entry phase testing on the 5th week of training, and final testing on the 10th week of training. During the testing, participants filled out the International Physical Activity Questionnaire (IPAQ) and the Revised NEO Personality Inventory, and underwent analysis of body composition using Dual energy X-Ray Absorptiometry (DXA), a physical work capacity test (PWC 170), a muscular strength test (one repetition maximum bench press (1RM BP) and squat (1RM S)) and the measurement of body weight and height to calculate body mass index (BMI). Associations between study parameters were determined using the Spearman correlation. **Results:** Extraversion (E) was positively associated with time spent in vigorous physical activity (VPA) and Openness to Experience (O) was negatively associated with time spent sitting. Openness to Experience was also positively associated with BMI and lean mass differences between entry and output measurements. Furthermore, 1 RM S significantly increased during the training program. **Conclusion:** The observed association between personality from FFM and PA levels in the present study was lower than in the general population reported by other studies. The positive association between E and VPA suggests that using FFM and the relationship between personality and physical fitness as one of the criteria for the selection of suitable recruits may be beneficial.

Keywords: Firefighters; physical performance; personality traits; PWC 170; muscular strength tests

INTRODUCTION

Firefighters are exposed to a high workload and high physiological and psychological stressors for an unforeseeable amount of time during fire and rescue operations. These are, for example, night shift schedules, sleep deprivation, sudden alarm calls, strenuous physical work, exposure to smoke and other harmful substances during fire suppression, heartbreaking and tragic incidents, and victim search or rescue operations (Greenlee et al., 2014; Hemmatjo et al., 2017, 2018; Kazemi et al., 2018; Wolkow et al., 2016). Firefighting also requires a high metabolic work output and high muscular strength (Bilzon et al., 2001; Gledhill et al., 1992; Holmér et al., 2007; Lemon et al., 1977) and results in considerable cardiovascular and thermal strain (Fernhall et al., 2012; Smith et al., 2001; Smith et al., 2011).

In firefighting, a high level of fitness is recognized as crucial to safely fulfilling the required demands of the job (NFPA, 2018). Fitness may play a key role in the prevalence of musculoskeletal injuries. Poplin et al. (Poplin et al., 2016) demonstrated that less fit individuals were 2.9 times more likely to succumb to a sprain or strain compared to the most fit career fire service employees. In fact, the recent review by Orr et al. (Orr et al., 2019), shows that the prevalence of musculoskeletal injuries in firefighters may range from 9% to a relatively high figure of 74.4%. Also, high cardiorespiratory fitness was identified as a preventive factor with respect to developing cardiovascular complications in firefighters (Straus et al., 2021), yet Donovan et al. demonstrated that a significant proportion of firefighters have an estimated level of cardiorespiratory fitness below that suitable for working safely (Donovan et al., 2009), and sudden cardiac death has long been the most common cause of death among firefighters on duty (NFPA, 2019; Kales et al., 2003). Moreover, there is a well-documented high prevalence of overweight and obesity in firefighters (Smith et al., 2011). About 80% of U.S. firefighters are either overweight or obese (Clark et al., 2002; Munir et al., 2012), and a high prevalence of overweight and obesity (65%) was also shown among UK firefighters (Munir et al., 2012).

Firefighters are encouraged to enhance and maintain their physical fitness via regular exercise. Adaptations to exercise are believed to improve their job performance capabilities, reduce the risk of cardiovascular events, and prevent musculoskeletal injuries (Smith et al., 2011). There is, however, a lack of fitness programs aimed at firefighters worldwide. In the U.S. 30% of U.S. fire departments have launched preventive fitness initiatives and implemented programs to improve firefighters‘ health and physical fitness. In the majority of countries all over the world, including the Czech Republic, such programs are, however, missing (Gnacinski et al., 2015.). Additionally, the annual physical tests of Czech firefighters have only minimum requirements for physical condition, and the physical fitness of Czech firefighters is determined primarily by individual conditioning and physical activity in their leisure time. Moreover, evidence shows that physical activity level and even sporting performance may also be associated with personality traits (Allen et al., 2014). According to the five-factor model of personality (FFM), personality consists of Neuroticism (N), Extraversion (E), Openness to Experience (O), Agreeableness (A), and Conscientiousness (C) (Costa et al., 2008). Systematic reviews and meta-analyses consistently show that there is a negative association between physical activity and N, and a positive association between E and O (Rhodes et al., 2006; Sutin et al., 2016; Wilson et al., 2015).

In the case of C and A, there is a discrepancy in the findings reported in literature. While Sutin et al., 2016 and Wilson et al., 2015 found a positive association between physical activity and C, Rhodes et al., 2006 did not not. A significant positive correlation between physical activity and A was reported by Sutin et al., 2016. It is, however, unclear, whether the same findings would be applicable to professional firefighters, and the respective research is limited. Gnacinski investigated 9 cadets and 25 recruits, and found a positive correlation between physical performance tests (one repetition maximum strength, push-up endurance, functional movement) and C, O and E (Gnacinski et al., 2015). Kass et al., 2018 observed an association of C with aerobic fitness in male firefighter recruits, but not with muscular endurance or perceived fitness. However, there are limitations to the abovementioned studies and the results are inconclusive with respect to whether FFM may be associated with physical activity and fitness in firefighters.

There is a constant need for research on factors that have a positive influence on firefighters' physical activity and fitness. This knowledge should then be taken into consideration during firefighter recruitment and training as well as during a firefighter's career, and also during the setting and implementation of programs to improve the health and physical fitness of firefighters. In light of the above, this study aimed to investigate the relation between physical activity, physical performance, and FFM in firefighter recruits, and, secondarily, to evaluate the effect of intensive firefighting skill training programs on the physical condition of recruits. Such knowledge would help to optimize the procedure for selecting recruits, and further activities aimed at improving firefighter fitness. This research is part of CELSPAC–FIREexpo project. The CELSPAC–FIREexpo research project is a part of a wider concept that brings to practice the science-based measures and recommendations that would lead to the physical and mental health prevention, good fitness, and wellness of the Czech firefighters.

METHODS

Study population

Data from the CELSPAC–FIREexpo case-control human biomonitoring study (Řiháčková et al., 2023) on 58 newly-recruited firefighters before recruit training, collected from 2019 to 2020, were used. A smoking habit, chronic or acute infectious disease, mental illness, acute musculoskeletal injury, and age less than 18 or more than 35 years were all exclusion criteria. Participants were approached and recruited personally and by means of leaflets distributed in the Training Center of the Fire Rescue Service of the Czech Republic. All participants expressed and signed their informed consent before their participation in the study, and the study was approved by the ethics committee. The detailed characteristics of the study population were described by Řiháčková et al. (Řiháčková et al., 2023), and are presented in Table 1.

Table 1. The cohort characteristics (N = 58)

Age (years)	Median	25
	10th–90th perc.	21–30
	Min.–Max.	19–34
BMI (kg/m²)	Median	26.3
	10th–90th perc.	22.8–29.7
	Min.–Max.)	20.7–33.4
Infectious or chronic disease (%)	Yes	0.0
	No	100.0
Health (subjective assessment, %)	Always healthy and well	50.9
	Mostly healthy and well	49.2
	Often do not feel well	0.0
Length of firefighting career (years)	Median	0.5
	10th–90th perc.	0.25–1
	Min.–Max	0–5
Smoking (%)	Yes	0.0
	No	100.0
Former smoking (%)	Yes	11.9
	No	88.1
If a former smoker, years since quitting (years)	Median	4.0
	10th–90th perc.	0.5–10
	Min.–Max	0.5–10

Study design

Newly-recruited firefighters must complete a 15-week intensive training program before becoming professional firefighters. Therefore, the sampling protocol was structured into the entry and output phases, which corresponded with the 5th and 10th training weeks, respectively (Figure 1). Therefore, 5 training weeks elapsed between entry and output examinations. During this time, participants underwent a standard training program, which consisted of specific firefighting skills but did not include condition training.

In the entry phase, the examination included completion of the IPAQ and FFM inventory, the analysis of body composition using Dual energy X-ray Absorptiometry (DEXA), a physical working capacity test (PWC 170), one repetition maximum bench press (1RM BP) and squat (1RM S), and measurement of the participant‘s height and weight to calculate their BMI.

In the output phase, participants underwent the analysis of body composition using DXA, PWC 170, 1RM BP, and 1RM S, and the measurement of height and weight to calculate their BMI.

Participants were told to avoid any strenuous exercise on the day before the performance tests. All measurements were performed after training comprised of classroom-based lectures to minimize the effects of fatigue. Examinations were performed under the same conditions in both phases. They took place in university laboratories and at the Training Center of the Fire Rescue Service of the Czech Republic.

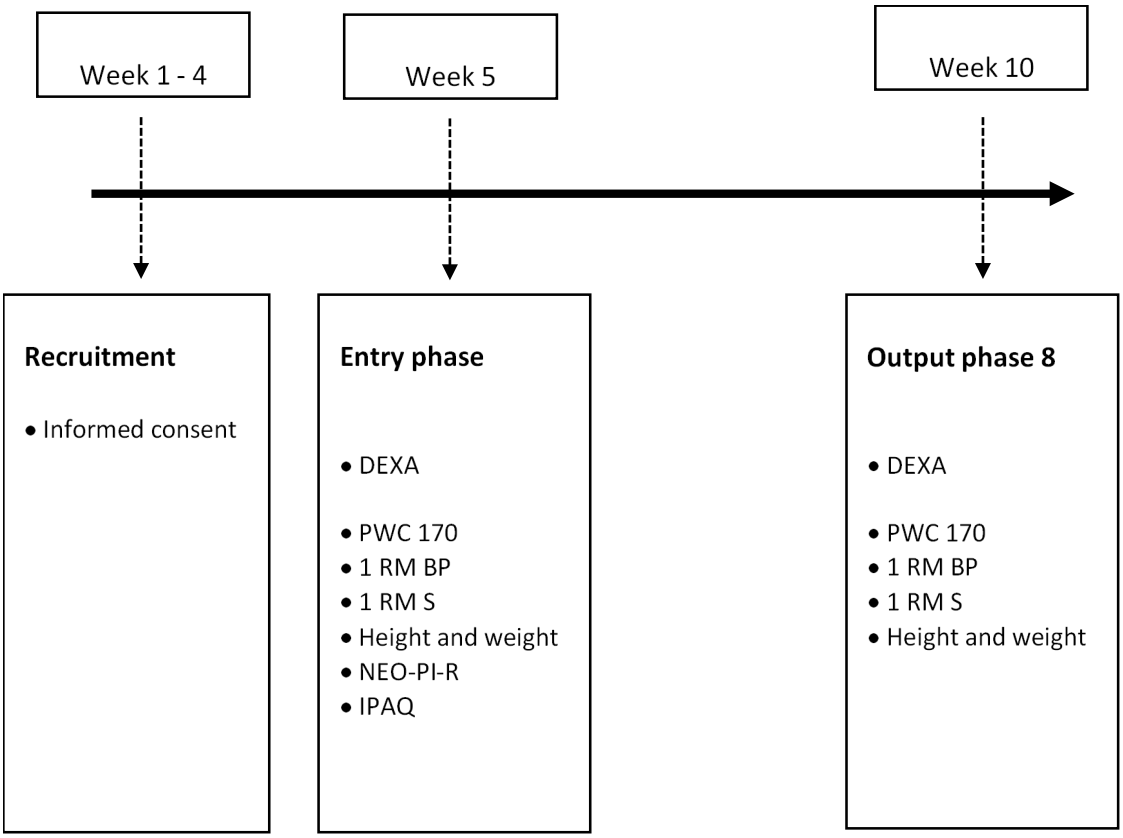

Figure 1: Study timeline. In total, data from 58 participants (newly-recruited firefighters who had not undergone occupational training at the start of the experiment) were used. Participants were recruited at the beginning (1st – 4th week) of the training period and signed their informed consent. In the 5th week of training (entry phase), participants underwent the first series of tests, then participated in training, and were tested again in the 10th week of training (output phase).

Tests of physical performance

All participants had previous experience with resistance training and practising individual exercises. However, before testing began, their exercise technique was checked to ensure it was correct.

The muscular strength tests 1RM BP and 1RM S were performed in accordance with the National Strength and Conditioning Association protocol (Niewiadomski et al., 2008). The reliability and validity of this protocol was confirmed in previous research (Michaelides et al., 2011).

Cardiorespiratory fitness was assessed via the PWC 170 test with a Lode Excalibur Sport bicycle ergometer (Groningen - Netherlands) in accordance with Eurofit guidelines (Adam et al., 1993). The heart rate (HR) during each exercise stage was recorded via a Polar H10 chest strap, and evaluated by MetaSoft® Studio. Because previous studies have shown power output during the PWC 170 test to be positively influenced by body weight, scores were expressed relatively as watts per kg of weight (Nikolaidis, 2015).

To assess the current level of physical activity in individuals, the short form of the IPAQ was completed by participants. They self-evaluated how much time in the past week they had spent engaged in vigorous physical activity (VPA), moderate physical activity (MPA), walking, and sitting. The answers were transferred to MET-minutes/week (Sjostrom et al., 2005). Validation of the short IPAQ questionnaire points to good test-retest reliability (r S =0.76). However, the criterion validity is lower (r S =0.30) (Craig et al., 2003).

Dual energy X-ray Absorptiometry

In accordance with other studies (Guimarães et al., 2018; Vangsoe et al., 2018), the participants were scanned at the same time and day of the week in both phases of research. The body composition software DXA Software version 13.6.0.5 presented values of fat mass and fat-free mass (lean and bone mineral) in grams for upper and lower limbs on both body sides, which together provided the references of the regional compositions (fat mass, fat-free mass, and total mass) of the upper and lower limbs, trunk, and whole-body. The equipment was calibrated following the manufacturer's recommendations and all analyses were performed by an experienced technician. Participants presented themselves for evaluation in underwear, without shoes or any metallic objects attached to the body, and were instructed to remain on their backs on a flat table until the end of the scan. Their toes pointed towards each other and their arms were placed parallel to the trunk in a supine position.

Body weight was measured using DXA, and body height was measured to the nearest 1.0 cm. BMI was calculated from the standardized formula used in previous research by dividing the weight in kg by the height in meters (Soteriades et al., 2011).

Revised NEO Personality Inventory

The standardized form of the Revised NEO Personality Inventory was used according to the Czech version manual (Hřebíčková, 2004). This inventory assesses an individual according to the FFM of personality, which consists of five main dimensions – N, E, O, A, C. The inventory contains 240 items, 48 items for each of five personality dimensions (Hřebíčková, 2004). Cronbach's alpha of individual scales ranges from 0.91 to 0.88 in Czech version (Hřebíčková, 2004).

Statistical analysis

All variables were continuous, numerical, and non-negative. Differences from normal statistical distributions were estimated using both visual assessment based on histograms and the Kolmogorov-Smirnov test of normality. Since for most of the variables the distribution was statistically significantly different form the normal distribution ($p < 0.001$), non-parametric methods were used for further analyses.

Mean values and differences between the entry and output phases of the study were calculated for all variables measured in both the entry and output phases in order to characterise both the long-term level of the variable and its change after the training. These were later used for time independent analyses of the physical activity variables. Differences between the values of these variables from the entry and output values were assessed using the Wilcoxon paired test of difference.

In order to assess possible associations between the level of physical activity or performance and the personality traits of the participants, correlation analysis for pairs of variables using the Spearman correlation coefficient was performed. The correlation analysis was conducted at a 95% level of significance. Statistical analyses were carried out using R version 4. 0. 5.

RESULTS

Descriptive statistics for variables measured in both the entry and output phases, as well as the results of the comparison between the two phases (Wilcoxon paired test) are shown in Table 2.

The results show that the median BMI between the entry and output phase changed significantly by 0.412 kg/m^2. In 19 individuals, the BMI increased (median increase of 0.229 kg/m2), while it decreased in 39 participants (median decrease of 0.319 kg/m2).

1RM S performance was significantly different between the entry and output phases (p = 0.003). Although the median difference was equal to zero, the 1RM S increased in 27 participants, with an average increase of 6.11 kg. The increase was more frequent and higher than the decrease, which occured in 10 individuals, with an average decrease of 4.70 kg in the participant's performance.

PWC 170 performance changed significantly between the entry and output phases (p = 0.007), with an increase of 0.052 W/kg body weight. Other variables that were measured in both the entry and output phases did not change significantly (total mass, fatmass, lean and BMC, 1 RM BP).

Spearman correlation coefficients (ρ) for mean values of, and differences in values between, the entry and output phases for variables relating to physical activity and performance and variables relating to physical activity from the IPAQ questionnaire (MET-minutes of sitting, walking, MPA, VPA and total PA) are listed in Table 3. Spearman correlation coefficients (ρ) for mean values of, and differences in values between, the entry and output phases for variables relating to physical activity and performance, variables from the IPAQ questionnaire, and personality traits from the FFM inventory are presented in Table 4. Statistically significant correlations (p <0.05) are marked by red (negative correlation) or green (positive correlation) color. Detailed summary statistics for all paramters measured in the entry and output phases are in Supplementary material (Tables SM1 and SM2).

Table 2. Descriptive statistics (median, 25th and 75th percentile) of variables measured in both the entry and output phases. Comparison of values between the two phases was carried out using the Wilcoxon paired test. The green color marks a statistically significant difference (p < 0.05).

		Entry phase	**Output phase**	**p-value (Wilcoxon paired test)**
PWC 170 (W/kg body weight)	Median 25th – 75th perc.	3.574 3.046–4.083	3.626 3.139–4.121	**0.007**
Total mass (g)	Median 25th – 75th	85000.0 78820.0–91695.0	84488.0 78187.5– 91998.0	0.237
BMI (kg/m^2)	Median 25th – 75th perc.	25.881 23.949–27.661	25.469 23.529–27.174	**0.000**
Fatmass (g)	Median 25th – 75th perc.	18359.0 15831.0–22963.0	18691.0 15666.5–22123.5	0.467
Lean+BMC (g)	Median 25th – 75th perc.	64909.0 61299.0–69880.0	64931.0 60712.5–70070.0	0.474
1 RM BP (kg)	Median 25th – 75th perc.	85.00 75.00–97.50	85.00 78.75–98.75	0.609
1 RM S (kg)	Median 25th – 75th perc.	105.00 90.00–118.75	105.00 93.75–123.75	**0.003**

There are several positively correlated descriptive/physical/performance variables of similar type (total and percentage content of fat, BMI etc.) and highly significant negative correlations

between fat mass/percentage content and the physical work capacity test. Further, BMI and lean mass were positively associated with 1RM squat and 1RM bench press performance.

Conscientiousness was correlated with higher age, in contrast to neuroticism, which was correlated with lower age. Both extraversion and openness were correlated with an increase in BMI; in the case of openness, this was also accompanied by a correlation with lean mass increase. Finally, extraversion was positively correlated with vigorous physical activity, while openness was negatively correlated with length of sitting.

Table 3. Spearman correlation of variables of physical activity from IPAQ (MET-minutes of sitting, walking, MPA, VPA and total PA), mean values (m) of, and differences in values (d) between, entry and output phases for performance variables (1RM BP (kg), 1RM S (kg) and PWC 170 (W/kg body weight)), and anthropometric variables (age (years), height (m), fat (%), fat (g), BMI (kg/m^2), Lean and BMC (g)). Statistically significant correlations ($p < 0.05$) are marked by red (negative correlation) or green (positive correlation) shading.

	Age (years)	Height (m)	Fat m (%)	Fat d (%)	BMI m (kg/ m2)	BMI d (kg/ m2)	Fat m (g)	Fat d (g)	Lean and BMC m (g)	Lean and BMC d (g)	Walking (met minutes per week)	Moderate physical activity (met minutes per week)	Vigorous physical activity (met minutes per week)	Total physical activity (met minutes per week)	Years since quitting smoking	Sitting on a week day (total minutes per week)	1 RM BP m (kg)	1 RM BP d (kg)	1 RM S m (kg)	1 RM S d (kg)	PWC 170 relative (W/ kg body weight)
Age (years)	1.00	-0.07	-0.04	-0.11	0.16	0.00	0.04	-0.07	0.14	0.10	-0.18	-0.24	-0.13	-0.21	0.44	**0.38**	0.09	0.16	0.00	-0.19	0.01
Height (cm)	-0.07	1.00	-0.02	-0.05	-0.15	-0.04	0.21	-0.09	**0.50**	-0.04	0.25	0.21	-0.01	0.13	**0.76**	0.03	-0.24	0.12	0.01	-0.05	-0.12
Fat m (%)	-0.04	-0.02	1.00	0.00	**0.60**	-0.15	**0.90**	-0.07	0.11	-0.24	0.18	-0.18	-0.13	-0.06	0.00	0.10	-0.13	-0.08	-0.11	0.17	**-0.52**
Fat d (%)	-0.11	-0.05	0.00	1.00	0.05	**0.47**	0.03	**0.97**	-0.01	**-0.36**	0.05	0.15	0.04	0.09	**-0.76**	-0.02	-0.19	0.09	0.05	0.04	0.01
BMI m (kg/m2)	0.16	-0.15	**0.60**	0.05	1.00	0.02	**0.77**	0.03	**0.62**	-0.15	0.05	-0.10	-0.02	-0.05	-0.13	0.00	**0.43**	0.03	**0.49**	-0.04	**-0.42**
BMI d (kg/m2)	0.00	-0.04	-0.15	**0.47**	0.02	1.00	-0.09	**0.65**	0.04	**0.56**	0.00	-0.02	0.04	0.00	0.20	-0.08	-0.10	**0.38**	-0.03	0.14	0.10
Fat m (g)	0.04	0.21	**0.90**	0.03	**0.77**	-0.09	1.00	-0.04	**0.50**	-0.24	0.18	-0.09	-0.09	-0.01	-0.13	0.05	0.03	0.04	0.14	0.10	**-0.55**
Fat d (g)	-0.07	-0.09	-0.07	**0.97**	0.03	**0.65**	-0.04	1.00	-0.02	-0.14	0.04	0.12	0.05	0.09	-0.62	-0.03	-0.18	0.17	0.03	0.04	0.05
Lean and BMC m (g)	0.14	**0.50**	0.11	-0.01	**0.62**	0.04	**0.50**	-0.02	1.00	-0.08	0.10	0.15	0.08	0.07	0.47	-0.07	**0.38**	0.12	**0.61**	-0.14	-0.25
Lean and BMC d (g)	0.10	-0.04	-0.24	**-0.36**	-0.15	**0.56**	-0.24	-0.14	-0.08	1.00	-0.10	-0.13	-0.01	-0.12	0.38	-0.06	0.06	**0.30**	-0.15	0.05	0.16
Walking (met minutes per week)	-0.18	0.25	0.18	0.05	0.05	0.00	0.18	0.04	0.10	-0.10	1.00	**0.33**	**0.34**	**0.72**	0.46	0.10	-0.06	-0.04	0.00	0.08	0.07
Moderate physical activity (met minutes per week)	-0.24	0.21	-0.18	0.15	-0.10	-0.02	-0.09	0.12	0.15	-0.13	**0.33**	1.00	**0.46**	**0.65**	0.66	**-0.31**	-0.11	0.00	0.00	0.15	0.07

	Age (years)	**Height (m)**	**Fat m (%)**	**Fat d (%)**	**BMI m (kg/ m2)**	**BMI d (kg/ m2)**	**Fat m (g)**	**Fat d (g)**	**Lean and BMC m (g)**	**Lean and BMC d (g)**	**Walking (met minutes per week)**	**Moderate physical activity (met minutes per week)**	**Vigorous physical activity (met minutes per week)**	**Total physical activity (met minutes per week)**	**Years since quitting smoking**	**Sitting on a week day (total minutes per week)**	**1 RM BP m (kg)**	**1 RM BP d (kg)**	**1 RM S m (kg)**	**1 RM S d (kg)**	**PWC 170 relative (W/ kg body weight)**
Vigorous physical activity (met minutes per week)	-0.13	-0.01	-0.13	0.04	-0.02	0.04	-0.09	0.05	0.08	-0.01	**0.34**	**0.46**	1.00	**0.82**	0.05	**-0.29**	0.08	0.07	-0.01	-0.06	0.15
Total physical activity (met minutes per week)	-0.21	0.13	-0.06	0.09	-0.05	0.00	-0.01	0.09	0.07	-0.12	**0.72**	**0.65**	**0.82**	1.00	0.36	-0.07	-0.02	0.01	0.02	0.09	0.14
Years since quitting smoking	0.44	**0.76**	0.00	**-0.76**	-0.13	0.20	-0.13	-0.62	0.47	0.38	0.46	0.66	0.05	0.36	1.00	-0.10	-0.22	0.42	-0.23	0.73	-0.22
Sitting on a week day (total minutes per week)	**0.38**	0.03	0.10	-0.02	0.00	-0.08	0.05	-0.03	-0.07	-0.06	0.10	**-0.31**	**-0.29**	-0.07	-0.10	1.00	-0.03	-0.15	0.03	-0.21	0.03
1 RM BP m (kg)	0.09	-0.24	-0.13	-0.19	**0.43**	-0.10	0.03	-0.18	**0.38**	0.06	-0.06	-0.11	0.08	-0.02	-0.22	-0.03	1.00	-0.10	**0.67**	-0.23	0.02
1 RM BP d (kg)	0.16	0.12	-0.08	0.09	0.03	**0.38**	0.04	0.17	0.12	**0.30**	-0.04	0.00	0.07	0.01	0.42	-0.15	-0.10	1.00	-0.01	0.19	0.05
1 RM S m / kg	0.00	0.01	-0.11	0.05	**0.49**	-0.03	0.14	0.03	**0.61**	-0.15	0.00	0.00	-0.01	0.02	-0.23	0.03	**0.67**	-0.01	1.00	-0.20	-0.18
1 RM S d (kg)	-0.19	-0.05	0.17	0.04	-0.04	0.14	0.10	0.04	-0.14	0.05	0.08	0.15	-0.06	0.09	0.73	-0.21	-0.23	0.19	-0.20	1.00	0.04
PWC 170 relative (W/ kg body weight)	0.01	-0.12	**-0.52**	0.01	**-0.42**	0.10	**-0.55**	0.05	-0.25	0.16	0.07	0.07	0.15	0.14	-0.22	0.03	0.02	0.05	-0.18	0.04	1.00

Table 4: Spearman correlation coefficients of anthropometric variables (age (years), height (m), fat (%), fat (g), BMI (kg/m^2), Lean and BMC (g)), physical activity variables from IPAQ (MET-minutes of sitting, walking, MPA, VPA and total PA), performance variables (1RM BP (kg), 1RM S (kg), PWC 170 (W/kg body weight)), and personality trait variables (neuroticism , extraversion , openness to experience , agreeableness , conscientiousness). Statistically significant correlations ($p < 0.05$) are marked by red (negative correlation) or green (positive correlation) shading. M is mean and d is difference (used for variables that were measured in both the entry and output phases).

	Agreeableness	**Conscientiousness**	**Extraversion**	**Neuroticism**	**Openness**
Age (years)	0.16	0.30	0.05	-0.31	0.06
Height (cm)	0.08	0.00	-0.11	-0.08	-0.23
Fat m (%)	0.12	0.07	-0.06	-0.07	-0.20
Fat d (%)	-0.01	0.02	0.08	0.05	-0.06
BMI m (kg/m2)	0.09	0.15	0.14	-0.23	-0.09
BMI d (kg/m2)	0.05	0.06	0.29	-0.05	0.32
Fat m (g)	0.17	0.10	0.01	-0.16	-0.22
Fat d (g)	-0.01	0.04	0.15	0.04	0.06
Lean and BMC m (g)	0.09	0.14	0.11	-0.21	-0.14
Lean and BMC d (g)	0.00	-0.01	0.24	-0.05	0.38
Walking (met minutes/ week)	-0.12	0.03	-0.06	-0.03	-0.06
Moderate physical activity (met minutes/ week)	-0.01	-0.18	0.11	0.15	0.12
Vigorous physical activity (met minutes/week)	-0.09	0.22	0.30	-0.21	0.09
Total physical activity (met minutes /week)	-0.12	0.02	0.18	-0.15	-0.07
Sitting on a week day (total minutes / week)	0.07	0.04	-0.13	-0.12	-0.31
1 RM BM m (kg)	-0.21	0.09	0.16	-0.16	0.08
1 RM BP d (kg)	0.09	0.08	0.07	-0.13	0.08
1 RM S m (kg)	-0.17	0.05	0.15	-0.16	-0.10
1 RM S d (kg)	-0.02	-0.24	-0.08	0.03	0.01
PWC 170 relative (W/kg body weight)	-0.14	-0.01	-0.03	0.09	0.21

DISCUSSION

The psychological assessment of recruits, including the determination of personality traits, has long been one of the selection procedures for the position of firefighter in Czech Republic. Research reported in literature has shown that there might be an association between the FFM of personality and mental health (Kyron et al., 2021), stress levels, anxiety levels (Lee et al., 2018), and degree of emotional empathy (which was associated with levels of PTSD (Wagner et al., 2019) hostility (Wagner et al., 2016), burnout (Vaulerin et al., 2016), job satisfaction (Wagner et al., 2012), or firefighting performance (Fannin et al., 2003). Personality traits might also be associated with physical activity or performance level (Allen et al., 2014). The present study was designed to investigate the association between the FFM of personality and physical fitness and physical activity, which could improve the selection of suitable candidates or help the targeting of fitness programs for professional firefighters.

Firefighters in many countries struggle with overweight or with maintaining a suitable fitness level. Apart from mandatory or recommended conditioning programs, an individual's level of total physical activity including outside working hours may be a significant factor in achieving a suitable physical condition. The results of the current study suggest that in comparison with the general population the PA level of participants seems to be less associated with the FFM of personality. Only the time spent engaged in VPA was positively correlated with E in the current sample. These results are in line with research which consistently shows a positive association between E and PA Further, meta-analysis demonstrated that this association may be stronger for moderate-to-vigorous than for mild-to-moderate activity (Wilson et al., 2015). Similarly to PA, sedentary behaviour in the current sample is also less associated with the FFM of personality than in the general population. In contrast to the meta-analysis (Sutin et al., 2016), we did not observe any association between sedentary behaviour and N or C, that both were constant. In the current sample, only O was negatively associated with time spend sitting.

The fact that we found a smaller dependence of PA and sedentary behavior on the FFM of personality could be due to the selection of suitable recruits prior to firefighting training, which meant that the current sample scored lower in N and higher in C, which approximately corresponds to the 31th and 71th percentile of the Czech male population, respectively (Hřebíčková, 2004). Taken together, values of the FFM of personality might be less associated with PA or sedentary behaviour in firefighters than in the general population, this situation possibly resulting from the selection process for recruits. Nevertheless, the positive association between E and VPA was found even in the current pre-selected sample of recruits with high E. Therefore, from the point of view of PA, individuals with higher E may be considered as more suitable candidates for a firefighting career.

Research reported in the literature suggests that there may be associations between FFM domains and the physical performance of firefighters-in-training. One study reports positive associations between C and 1RM BP, 1RM S, and an endurance push ups test (Gnacinski et al., 2015). In addition, their results report a positive association between O and 1RM BP and endurance push ups. Further, Kass et al. (Kass et al., 2018) report an association between C and aerobic fitness in firefighter recruits. It should be added that this research was published as a

symposium poster. We failed to detect any significant association between the FFM of personality and physical performance or change in physical performance during the 5-week training period in the current study. However, it should be taken into account that the current sample scored high in C, which may play a significant role. Also, the obligatory training program aimed mostly at firefighting skills not physical conditioning. Gnacinski et al., 2015 point out the similarity of their results to results reported in the sport domain. However, the current study does not support such a connection. More research is needed to understand the role of personality (according to FFM) in physical fitness and the habits of new firefighter recruits. Longitudinal studies which could potentially help to reveal the relationship between FFM and the development of physical fitness and PA habits during active service would be very beneficial.

It is remarkable that the percentage of body fat was not associated with 1RM BP, 1RM S, or PA level according to IPAQ. Therefore, it could be suggested that body fat in the current sample is not associated with leisure time PA or strength performance. On the other hand, the results indicate a strong negative association between body fat and PWC 170, which in turn indicates that the percentage of body fat may be a factor in relative submaximal firefighting performance. Contrary to research on obesity in different populations (Jokela et al., 2013; Magee et al., 2011; Sutin et al., 2011), body fat was not associated with any FFM domain. This possibly supports the relevance of selecting firefighter candidates with high C and low N, as low C and high N are, in research, consistently associated with a higher overweight and obesity risk (Jokela et al., 2013; Magee et al., 2011; Sutin et al., 2011). This research confirms the important role of muscle mass in physical performace, as lean mass was associated with better 1RM BP and 1RM S performance. An association between O, and the difference in lean mass between the entry and output phases was observed.

Strengths and Limitations

Although this research does not support some of the relationships identified in previous studies, it serves as a solid foundation for further, longitudinal studies that could potentially help reveal the relationship between FFM and the development of physical fitness and PA habits during firefighters' active duty. A higher number of participants in the planned future study could enhance the conclusiveness of the associations among the studied parameters, aiding in decision making regarding the selection of suitable candidates, or targetting of fitness programs for professional firefighters.

This study is based on validated questionaires and well-established methods. Direct collaboration with the firegighting department ensured a thorough understanding of firefighters' training and working conditions, allowing us to properly target the research questions and methods. This study is part of the larger, complex CELSPAC–FIREexpo research project, which has multiple endpoints and the potential to translate research findings into practice.

CONCLUSIONS

In summary, the study demonstrates that although 1RM S and PWC 170 performance improved during the training period, the median difference was small (0 kg and 0.052 W/kg body weight respectively). There were no significant changes in 1RM BP. The results of the current study also reveal smaller associations between the FFM of personality and PA levels, physical performance,

and body composition in firefighter recruits compared with these associations in other populations. Importantly, E was positively associated with time spent engaged in vigorous physical activity, even in the current sample with high E scores. Therefore, from the point of view of PA, recruits with high E may be more suitable than counterparts with lower values. Further, O correlated negatively with time spent sitting and positively with BMI and lean mass difference between entry and output measurement. Interestingly, the results demonstrate that even the intensive training of firefighting skills may not be sufficient to increase the physical performance of recruits. Therefore, special conditioning programs may be helpful in allowing firefighters who are undertaking firefighting skills training to reach and maintain a sufficient level of physical fitness, and, indeed, also necessary for occupational safety.

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LIST OF ABBREVIATIONS

A – Agreeableness
BMC – bone mineral content
BMI – body mass index
C – Conscientiousness
DXA – Dual energy X-ray Absorptiometry
E – Extraversion
FFM – five-factor personality model
IPAQ – International physical activity questionnaire
Lean – lean body tissue
MET – metabolic equivalent of task
MPA – moderate physical activity
NEO - personality Inventory
N – neuroticism
O – openness to Experience
PA – physical activity
PWC 170 – physical working capacity test
1RM BP – one repetition maximum bench press
1RM S – one repetition maximum squat
VPA – vigorous physical activity

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved ethics committee. All participants received an information brochure and participated in personal interviews to be fully informed about the study and their participation, and informed consent was obtained from each participant before participation in the study. All data were pseudonymized to protect the identity of the participants.

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