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Body Composition and Fitness Characteristics from Structural Firefighters in a Health and Wellness Program: Differences According to Injury Status and Location

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INTRODUCTION

- Common occupational tasks for firefighters entail extinguishing fires, load carriage (e.g., personal protective equipment, self-contained breathing apparatus, equipment, hose bundles), hose pulls/hoists, ladder raises, forcible entries, stair climbs, crawl/search and rescues, salvages, and overhauls (1).
- The strenuous physical labor of structural firefighting can put firefighters at an elevated risk for injury (2,3,6).
- Commonly injured areas of structural firefighters include the leg and foot, arm and hand, trunk (especially the lower back), shoulder, and neck (2,3). This suggests injuries are not isolated to one location of the body (6).
- Numerous health and fitness characteristics (e.g., body composition, flexibility, muscular strength and endurance, aerobic capacity) can influence the performance of fireground operations, and could help prevent injury in firefighters (4,5,6).
- The purpose of this study was to analyze the differences in health and fitness between healthy structural firefighters, and structural firefighters who reported a current upper-body, lower-body, or back injury.

METHODS

- De-identified archival data from structural firefighters in a health and wellness program was investigated. This included 258 males (age = 42.45 ± 9.51 years; height = 1.80 ± 0.07 m; body mass = 90.61 ± 12.97 kg) and 12 females (age = 38.42 ± 11.72 years; height = 1.74 ± 0.08 m; body mass = 78.54 ± 11.48 kg).
- Body composition data included: height; body mass; body mass index (BMI); body fat percentage; fat and lean body mass; waist circumference; and waist:hip ratio.
- Fitness data included: measures of flexibility (trunk flexion, left rotation, right rotation, trunk extension, shoulder flexion, left lateral flexion, right lateral flexion); combined grip strength for both hands; predicted one-repetition maximum (1RM) leg press; 90-second crunches; 2-minute push-ups; and estimated maximal aerobic capacity (VO_{2max}) measured via the Bruce protocol.
- Firefighters self-reported whether they had a current injury, and the location of the current injury (upper-body [UBI], lower-body [LBI], or back [BI]).
- A one-way ANOVA ($p < 0.05$), with Bonferroni post hoc, compared the between-group differences as defined by injury status and location on body composition and fitness.

RESULTS

- Of the 270 structural firefighters, 208 self-reported they were healthy and 62 self-reported a current injury (UBI: 19; LBI: 26; BI: 17).
- Tables 1, 2, and 3 illustrate descriptive body composition, flexibility, and fitness data of structural firefighters who took part in a year-long health and wellness program.
- When compared to healthy firefighters, UBI firefighters performed worse in the predicted 1RM leg press and push-ups ($p \leq 0.041$) (Table3).
- Compared to healthy firefighters, LBI firefighters had worse BMI and waist circumference ($p \leq 0.004$) (Table 1), and had a lesser 1RM leg press, crunches, and VO_{2max} ($p \leq 0.012$) (Table 3).
- In comparison to healthy firefighters, BI firefighters performed worse in trunk extension (flexibility) (Table 2), 1RM leg press, crunches, and push-ups ($p \leq 0.002$) (Table 3).

Table 1. Descriptive body composition data (mean ± SD) for structural firefighters who participated in a year-long health and wellness program.

	Healthy	UBI	LBI	BI
Age (years)	41.29 ± 9.76	43.58 ± 9.51	46.81 ± 8.25	45.88 ± 7.39
Height (m)	1.80 ± 0.07	1.82 ± 0.07	1.78 ± 0.09	1.79 ± 0.08
Body Mass (kg)	88.85 ± 12.54	94.07 ± 14.99	95.51 ± 15.54	92.36 ± 11.84
BMI (kg/m^2)	27.48 ± 3.21	28.34 ± 4.14	30.03 ± 4.59*	28.74 ± 3.41
Body Fat %	18.12 ± 5.89	20.39 ± 5.61	20.45 ± 8.52	21.74 ± 5.16
Fat Mass (kg)	16.55 ± 7.25	19.81 ± 8.12	20.05 ± 10.27	20.44 ± 6.45
Lean Body Mass (kg)	72.51 ± 8.22	74.49 ± 8.62	75.69 ± 12.88	72.14 ± 7.57
Waist Circumference (cm)	90.49 ± 8.65	94.61 ± 11.41	97.42 ± 12.71*	94.74 ± 10.37
Waist:Hip Ratio	0.89 ± 0.07	0.91 ± 0.08	0.93 ± 0.09	0.92 ± 0.07

*Significantly ($p < 0.05$) different from healthy structural firefighters.

Table 2. Descriptive flexibility (cm) data (mean ± SD) for structural firefighters who participated in a year-long health and wellness program.

	Healthy	UBI	LBI	BI
Trunk Flexion	40.57 ± 9.77	40.58 ± 8.52	39.54 ± 10.27	35.00 ± 11.25
Left Rotation	54.42 ± 9.77	53.05 ± 6.36	51.85 ± 10.20	51.00 ± 9.28
Right Rotation	55.72 ± 9.18	54.32 ± 6.71	52.38 ± 9.47	52.35 ± 9.53
Trunk Extension	43.00 ± 8.54	42.37 ± 9.09	43.81 ± 5.06	35.35 ± 6.76*
Shoulder Flexion	52.57 ± 13.11	51.21 ± 18.91	49.23 ± 10.97	50.24 ± 16.46
Left Lateral Flexion	25.94 ± 5.15	25.21 ± 4.80	24.96 ± 6.02	22.76 ± 5.15
Right Lateral Flexion	25.71 ± 4.96	25.37 ± 4.44	24.73 ± 5.47	23.65 ± 3.74

*Significantly ($p < 0.05$) different from healthy structural firefighters.

Table 3. Descriptive fitness data (mean ± SD) for structural firefighters who participated in a year-long health and wellness program.

	Healthy	UBI	LBI	BI
Combined Grip Strength (kg)	103.80 ± 15.85	104.95 ± 16.69	101.27 ± 15.66	103.88 ± 13.76
Predicted 1RM Leg Press (kg)	870.27 ± 243.35	700.68 ± 302.07*	654.31 ± 295.60*	537.06 ± 311.71*
Crunches (repetitions)	115.31 ± 40.84	96.89 ± 49.48	86.28 ± 50.33*	66.56 ± 61.33*
Push-Ups (repetitions)	40.39 ± 14.95	30.00 ± 19.74*	32.48 ± 18.75	25.71 ± 17.93*
Estimated VO_{2max} (ml/kg/min)	45.49 ± 8.83	39.87 ± 10.29	36.00 ± 10.66*	40.17 ± 5.78

*Significantly ($p < 0.05$) different from healthy structural firefighters.

CONCLUSIONS

- The results from this study suggest that body composition and fitness of structural firefighters may influence injury status and location (4,5,6).
- Although poorer performance in the fitness tests could be the result of the current injury, underdeveloped fitness characteristics could increase the risk of obtaining an injury. As a result, these data highlight certain fitness qualities that could be developed to prevent injuries in structural firefighters (4,5,6).
- Despite the self-reported injuries, these structural firefighters are still working, which could potentially lead to a decrease in job performance, exacerbate their current injury, and/or increase the risk of obtaining another injury (6).
- It could be beneficial for tactical practitioners to develop a method to track structural firefighters over time, to analyze if an injury occurred due to being unhealthier (i.e., inferior body composition) and/or weaker (i.e., poorer fitness), or because the injury transpired due to the arduous nature of the occupation (5,6).
- By participating in a regimented exercise and nutrition routine (e.g., a health and wellness program), tactical practitioners and fire departments can monitor and potentially improve the overall health and fitness of firefighters, while minimizing their risk for injury and increasing job performance (5,6).

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