fire

Comment

Comment on Collins, C.N.; et al. Body Composition Changes of United States Smokejumpers during the 2017 Fire Season. *Fire* 2018, 1, 48

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In the recent manuscript by Collins et al. [1], the authors conclude that the manuscript sample (n = 9) of wildland firefighters (WLFFs) experienced changes in body composition across the 2017 season. However, the authors outline a misconception of what body composition analyses may provide agencies and fire crews in relation to detecting underlying cardiovascular risk. Moreover, the authors suggest that seasonal measurements of body composition can help to detect nutritional insufficiencies, impaired job performance, and cardiovascular risk but provide little supporting evidence.

> *Additionally, with cardiac events being the leading cause of WLFF deaths [28], BC* [body composition] *could also be a useful tool to predict underlying health issues before a WLFF is placed in less than ideal situations.*

This statement is misleading in that it does not consider the number of deaths due to aviation and vehicle accidents and does not accurately represent the data of Butler et al. [2]. Moreover, the measurement of body composition in non-obese individuals does not specifically predict risk for underlying health conditions that may predispose WLFFs to work-related cardiac events. General measures of aerobic fitness, blood pressure, body mass index, and blood lipids provide far more specific indices of overall cardiovascular health/risk.

The rationale for the stated hypothesis suggests an unfavorable change in body composition due to what appears to be a perception of occupational hazards that lead to negative energy balance. However, the hypothesis only forecasts change without a specified direction of change for measures of fat or fat-free mass.

1. Measurement Techniques

The reported measurement error of the skinfold methodology (±3.5% body fat) far exceeds the reported seasonal change in body fatness in the manuscript data set. This makes it questionable to conclude that the observed difference of 1.31% is due to the above-noted stressors versus the inherent error associated with the methodology. For example, (for a 30-year-old male) an estimated percent body fat of 7.7% results from a sum of skinfolds (sum of the chest, abdomen, thigh) approximating 21 mm. The post-season value of 8.9% results from a sum of skinfolds approximating 24 mm.

The authors state that "[a]ll repeated measurements were required to be within 2 mm of each other or re-measured." It is unclear why a ±2 mm difference was considered acceptable for repeat site measures. The Lange skinfold caliper is accurate to ±0.5 mm and should be used accordingly. Using these criteria alone and assuming a +2 mm discrepancy in each of the three measurement sites (resulting in a sum of skinfolds of 27 mm) increases the calculated body fat from 7.7% to 10.0%. Similarly, assuming a −2 mm discrepancy in each of the three measurement sites (resulting in a sum of skinfolds of 15 mm) decreases the calculated body fat from 7.7% to 5.4%.

Reporting body composition to two decimal places suggests far more precision than the skinfold technique can provide. It is also unclear when the post-season measures were obtained relative to final wildfire assignments and accumulated days off (both of which can significantly alter total body water (TBW) and body weight).

While differences in TBW will not likely alter skinfold thickness measures, increases or decreases in TBW will certainly alter body mass (a key metric in calculating fat and fat-free mass). Although the measure of body weight is not necessary for the reported calculation of percent body fat using the two-component model skinfold equation, not reporting outcome measures of fat and fat-free mass represents an incomplete analysis of the data. It is unclear why individual data are presented if the change in fat mass was not evaluated using a similar *t*-test.

> "*When fat mass (anything that is not muscle, bone, or ligaments) was compared between pre-season to post season, seven out of the nine smokejumpers gained body fat (Figure 1).*"

Since this appears to be the only seasonal pilot data reported on smokejumpers, it is imperative to report all that the methodology accommodates. Table 1 below represents the average pre and post-season values for fat and fat free mass calculated from body weight and percent body fat values presented in Table 1 from [1].

Table 1. Calculated values of fat and fat-free mass from the reported mean data.

	Pre	**Post**
Body weight (kg)	81.3	81.5
Fat mass (kg) *	6.2	7.3
Fat-free mass (kg) *	75.1	74.2

* Values calculated from the mean data depicted in Table 1 [1].

Another issue with the measures of body fat relates to the site measures collected. The Jackson and Pollock equations to predict body density use differential site measurements for males and females. While the male specific equation is noted in the manuscript, the section from the manuscript (below) states that measures were taken from the triceps, abdomen, and thigh.

> *Measurements started with the triceps and were followed by the abdomen and thigh, respectively. All measurements were taken on the right side of the body, which was marked on the skin for consistency and adherence for site specific guidelines. All repeated measurements were required to be within 2 mm of each other or re-measured [32].*

However, the male specific equation is dependent on measures from the chest, abdomen, and thigh. Only the female specific Jackson and Pollock body density prediction equation uses the triceps skinfold measure (in addition to the suprailiac and thigh). Because the authors used the triceps measure in place of the intended chest skinfold measurement, the calculations of body density (and therefore percent body fat) are invalid.

Based on these limitations, the data do not support physiologically relevant changes in body composition expressed as percent body fat, fat, or fat-free mass (the mean $\pm$ SD of the latter two variables are not presented) and therefore do not support the stated conclusions or recommendations in the manuscript. It appears that neither fat nor fat-free masses demonstrated a statistically significant change and therefore were not included in the results (except for individual fat mass data, Figure 1 as noted above). These data suggest a general maintenance of fat and fat-free mass in response to the aggressive physiological demands of seasonal fire suppression that have been previously reported [3–6] but not eluded to in the manuscript. The authors miss the point that seasonal stability is an incredible finding. Despite the physical demands of the season, jumpers maintain healthy, normal body composition. This demonstrates tremendous resilience.

2. Conclusions and Recommendations

The stated conclusions and recommendations are not supported by the manuscript data. Nor can these data be linked to reported cardiovascular death risk (the reference is incorrect in the final paragraph (25) when the paper by Butler et al. is (28)). The additional suggestion that future work should consider sleep, training, nutrition, hydration, and recovery does not recognize or give credit to prior and extensive peer-reviewed research in each of these areas with WLFFs and is not supported by the manuscript results. The only valid conclusion that the manuscript data can provide is that body composition (fat mass and fat-free mass) appears to remain stable over a single fire season in nine smokejumpers.

For a partial representation of prior peer-reviewed work with WLFFs that the authors suggest requires further investigation, consider the following: sleep [7–10], training/load carriage [5,6,11], nutrition [3,12–14], hydration [15,16], recovery [14], and seasonal changes in metabolic and cardiovascular health [17].

Conflicts of Interest: The author declares a conflict of interest with the author of the Reply.

References

1. Collins, C.N.; Brooks, R.H.; Sturz, B.D.; Nelson, A.S.; Keefe, R.F. Body composition changes of United States smokejumpers during the 2017 Fire Season. *Fire* **2018**, *1*, 48. [CrossRef]
2. Butler, C.; Marsh, S.; Domitrovich, J.W.; Helmkamp, J. Wildland firefighter deaths in the United States: A comparison of existing surveillance systems. *J. Occup. Environ. Hyg.* **2017**, *14*, 258–270. [CrossRef] [PubMed]
3. Ruby, B.C.; Shriver, T.C.; Zderic, T.W.; Sharkey, B.J.; Burks, C.; Tysk, S. Total energy expenditure during arduous wildfire suppression. *Med. Sci. Sports Exerc.* **2002**, *34*, 1048–1054. [CrossRef] [PubMed]
4. Cuddy, J.S.; Sol, J.A.; Hailes, W.S.; Ruby, B.C. Work patterns dictate energy demands and thermal strain during wildland firefighting. *Wilderness Environ. Med.* **2015**, *26*, 221–226. [CrossRef] [PubMed]
5. Sol, J.A.; Ruby, B.C.; Gaskill, S.E.; Dumke, C.L.; Domitrovich, J.W. Metabolic Demand of Hiking in Wildland Firefighting. *Wilderness Environ. Med.* **2018**, *29*, 304–314. [CrossRef] [PubMed]
6. Ruby, B.C.; Leadbetter, G.W., III; Armstrong, D.W.; Gaskill, S.E. Wildland firefighter load carriage: Effects on transit time and physiological responses during simulated escape to safety zone. *Int. J. Wildl. Fire* **2003**, *12*, 111–116. [CrossRef]
7. Vincent, G.E.; Ferguson, S.; Larsen, B.; Ridgers, N.D.; Snow, R.; Aisbett, B. Adding sleep restriction to the equation: Impact on wildland firefighters' work performance and physiology in hot conditions. *Int. Arch. Occup. Environ. Health* **2018**, *91*, 601–611. [CrossRef] [PubMed]
8. Wolkow, A.; Aisbett, B.; Reynolds, J.; Ferguson, S.A.; Main, L.C. Relationships between inflammatory cytokine and cortisol responses in firefighters exposed to simulated wildfire suppression work and sleep restriction. *Physiol. Rep.* **2015**, *3*. [CrossRef] [PubMed]
9. Wolkow, A.; Aisbett, B.; Reynolds, J.; Ferguson, S.A.; Main, L.C. Acute Psychophysiological Relationships Between Mood, Inflammatory and Cortisol Changes in Response to Simulated Physical Firefighting Work and Sleep Restriction. *Appl. Psychophysiol. Biofeedback* **2016**, *41*, 165–180. [CrossRef] [PubMed]
10. Wolkow, A.; Ferguson, S.A.; Vincent, G.E.; Larsen, B.; Aisbett, B.; Main, L.C. The Impact of Sleep Restriction and Simulated Physical Firefighting Work on Acute Inflammatory Stress Responses. *PLoS ONE* **2015**, *10*, e0138128. [CrossRef] [PubMed]
11. Phillips, M.; Petersen, A.; Abbiss, C.R.; Netto, K.; Payne, W.; Nichols, D.; Aisbett, B. Pack hike test finishing time for Australian firefighters: Pass rates and correlates of performance. *Appl. Ergon.* **2011**, *42*, 411–418. [CrossRef] [PubMed]
12. Cuddy, J.S.; Gaskill, S.E.; Sharkey, B.J.; Harger, S.G.; Ruby, B.C. Supplemental feedings increase self-selected work output during wildfire suppression. *Med. Sci. Sports Exerc.* **2007**, *39*, 1004–1012. [CrossRef] [PubMed]
13. Montain, S.J.; Baker-Fulco, C.J.; Niro, P.J.; Reinert, A.R.; Cuddy, J.S.; Ruby, B.C. Efficacy of eat-on-move ration for sustaining physical activity, reaction time, and mood. *Med. Sci. Sports Exerc.* **2008**, *40*, 1970–1976. [CrossRef] [PubMed]

14. Cuddy, J.S.; Slivka, D.R.; Tucker, T.J.; Hailes, W.S.; Ruby, B.C. Glycogen levels in wildland firefighters during wildfire suppression. *Wilderness Environ. Med.* **2011**, *22*, 23–27. [CrossRef] [PubMed]
15. Ruby, B.C.; Schoeller, D.A.; Sharkey, B.J.; Burks, C.; Tysk, S. Water turnover and changes in body composition during arduous wildfire suppression. *Med. Sci. Sports Exerc.* **2003**, *35*, 1760–1765. [CrossRef] [PubMed]
16. Cuddy, J.S.; Ham, J.A.; Harger, S.G.; Slivka, D.R.; Ruby, B.C. Effects of an electrolyte additive on hydration and drinking behavior during wildfire suppression. *Wilderness Environ. Med.* **2008**, *19*, 172–180. [CrossRef] [PubMed]
17. Coker, R.H.; Murphy, C.J.; Johannsen, M.; Galvin, G.; Ruby, B.C. Wildland Firefighting: Adverse Influence on Indices of Metabolic and Cardiovascular Health. *J. Occup. Environ. Med.* **2019**. [CrossRef] [PubMed]