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Fire Service Instructors' Working Practices: A UK Survey

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ABSTRACT

Analysis of Fire Service Instructors (FSI) working practices and health is needed to minimise health risks related to heat illness, cardiovascular events and immunological stress. Online surveys were distributed to UK FSI and Firefighters (FF). One hundred and thirty FSI (age: 43±7yrs) and 232 FF (age: 41±8yrs) responded. FSI experienced 2-10 live fires per week, with 45% of FSI reporting management does not set a limit on the number of exposures. Few FSI followed hydration guidelines, or cooling methods. New symptoms of ill health were reported by 41% of FSI and 21% of FF. FSI with ≥11 Breathing Apparatus exposures per month were 4.5 times (**95% CI 1.33-15.09**) more likely to experience new symptoms. A large proportion of FSI are experiencing new symptoms of illness after starting their career, and guidelines on exposure and hydration are not universally in place to reduce the risk of future health problems.

KEY WORDS

Fire service; Occupational health; Heat exposures

ABBREVIATIONS

BA	Breathing apparatus
CFBT	Compartment fire behaviour training
CRP	C-reactive protein
EHI	Exertional heat illness
FF	Firefighters
FSI	Fire Service Instructors
IL-6	Interleukin-6
URTI	Upper respiratory tract infection

1. INTRODUCTION

Fire Service Instructors (FSI) are responsible for training newly recruited and operational firefighters. Instructors who teach on Breathing Apparatus (BA) and Compartment Fire Behaviour Training (CFBT) courses experience live fire scenarios (wears) on a regular basis. A wear is defined as a period in which an individual is breathing via a BA. Acute wear exposure can cause high levels of physiological and perceptual strain, due to the extreme environment, heavy protective clothing worn, and physical activity completed.[1,2] FSI and firefighters (FF) may also experience dehydration,[1,3] smoke and carcinogen inhalation, which can cause breathing difficulties,[4] and regular high impact tasks and handling of heavy objects, which may lead to muscular pain.[5,6]

Frequent fire exposure may also put FSI at risk of cardiac-related events, which are the highest cause of death amongst FF, accounting for 56% of US FF deaths in 2014.[7] The odds of a FF suffering a cardiovascular event are 12.1 to 136 times higher during fire suppression than when conducting nonemergency duties.[8] Numerous inflammatory markers, such as interleukin-6 (IL-6), platelet number, and C-reactive protein (CRP), have been documented to increase following fire exposure.[9] Repeated wears may therefore have a chronic effect on these markers,[1] potentially increasing an instructor's risk of a cardiac event. During an acute wear FSI are also at risk of suffering from an exertional heat illness (EHI).[10] The extreme temperature, which can reach 174.0 ± 83.9ºC, combined with heavy encapsulating clothing, and moderate physical exertion causes an uncompensable heat stress environment, reducing an instructors ability to dissipate heat.[11] In severe cases EHI can lead to organ failure and mortality.[12]

With appropriate preparation and recovery from each wear the risk of cardiac events and EHI could be reduced. There is strong evidence advocating the use of methods, such as: post

exposure arm cooling,[11,13] adequate hydration status,[3,11] and ice slurry pre cooling,[14] to reduce the risk. The latest "Health Management of Training Centre Instructor's" report suggests that individuals drink 1.5 times the amount of fluid lost during heat exposure, with case study examples of ~750-800mL prior to exposure, ~400-1000mL taken on during the activity and 1000mL post exposure given.[15] The report also suggests a minimum of 2hr between exposures, with cooling methods such as ice slurry, forearm cooling, dress down procedures, and wearing ice vests all recommended.[15] There is no clear guidance on wear limits, only that it is important to instigate a method to safeguard instructors' health.[15] However, it is unknown if instructors in the UK have been directly provided with and are following this advice.

In addition, as a result of repeated wear exposures recent research suggests FSI may be at risk of overtraining.[1] Overtraining syndrome can be recognised by a prolonged maladaptation to several biological, neurochemical and hormonal regulation mechanisms, with confounding factors such as illness, inadequate nutrition, psychosocial stressors and sleep disorders, potentially being present.[16] It can develop due to a repeated exposure to stress leading to an altered responsiveness to subsequent stressful experiences, with reference usually given to high training loads.[16] Furthermore, overtraining and extremely heavy exercise have been previously linked to increased susceptibility and rates of upper respiratory tract infections (URTI) and illnesses, due to immunosuppression.[17]

Overtraining symptoms have previously been documented in Army recruits during training courses,[18] with prevalence amongst special military unit training suggested as being 24% of participants. [19] The prevalence of overtraining varies greatly amongst athletes, from 10-64%, with numbers altering based on the level of physical demand required for the sport and the duration of participation.[20–24] However, it is important to note that there is no single universally used diagnostic tool for overtraining, which may influence the prevalence rates

reported. [25] Amongst FSI, symptoms of overtraining have only been anecdotally reported. For FSI overtraining may not only be detrimental to their health but also to their occupational functionality, with loss of coordination, difficulty concentrating, and a reduced maximum work capacity. It is therefore important to identify the type and frequency of symptoms and illnesses experienced by FSI to form the basis for further investigation into the proposed overtraining response that repeated wear exposures may cause.

The purpose of the present study was therefore to document the working practices of FSI in comparison to FF, from across the UK, with specific reference to details of: wear types completed, preparation and recovery methods used, and illnesses and symptoms experienced. A secondary objective was to identify associations between new symptoms reported by FSI and the number of wears they completed, if they follow hydration guidelines, and their perception of recovery.

2. METHOD

Within the UK there are ~300 FSI and approximately 34,400 FF, across Fire and Rescue Services and private training providers. To establish the common demographics and working practices of instructors within the UK, in comparison to FF, both groups were invited to take part in an online survey. The survey was advertised across the UK via direct emails and social media. Those who responded to the survey and left their email address were contacted to ask them to further distribute the survey to their colleagues. The survey was also distributed upon visits to UK Training Centres and Fire Stations. All participants were informed that individual responses would be kept confidential, and therefore would not be provided to their superior colleagues. The study was approved by the University of Brighton ethics committee and conformed to the current Declaration of Helsinki guidelines (2013).

Prior to the survey a focus group was held with FSI from the "Health Management Research Project for Live Fire Instructors" to shape the direction of the questions and ensure the content was appropriate for the desired population. The focus group also identified the types of wears instructors complete, these were listed as: BA, CFBT, and BA cold/no smoke exposures. The focus of BA cold/no smoke and BA wears are for the students to be familiar with and learn how to use the equipment, whilst CFBT focuses on understanding how fire behaves and how to extinguish it. BA cold/no smoke wears involve learning how to use BA equipment in a temperate environment, however it should be noted PPE is worn and therefore elevated core temperatures may still occur. BA wears involve exposures to high environmental temperatures with instructors responsible for following teams of students to coach them when required. CFBT uses controlled live fires, where instructors coach students or remain outside the fire unit to control the environment with ventilation. Full details of the aim of exposures can be found in the SFJ Awards Qualification Handbook.[26] Preparation and recovery methods used at training centres were also suggested.

2.1. The Survey

A survey was generated using an online survey tool (surveymonkey.com, California, Palo Alto, USA). The survey consisted of 6 sections, covering demographics, wear types, preparation, recovery, illnesses, and an option to give any additional comments. After corrections based on pilot feedback the survey consisted of 36 questions, **please see the supplementary material for the survey questions**. Details of respondents' age, gender, and time as an instructor were gathered, alongside how often they completed each type of wear and which wear they found the most physically challenging. FSI do not regularly complete other wear types, however an open response box was available for them to give details of other working practices and exposures if relevant. Questions orientated around preparation and recovery included whether they had a routine, what methods they used, and how long

they prepared/recovered for. Instructors were also asked how often they were ill, what type of symptoms they experienced, and if they felt comfortable requesting sick days. Language used throughout the survey was non-biased, with neither positive nor negative phrasing of the introduction and questions.

A shorter version of the survey, containing 10 questions, was designed for firefighters. The questions were taken from the demographic, wear frequency, and illness sections of the instructor survey. The surveys were live for 12 months.

2.2. Statistical Analysis

Demographic quantitative data is displayed as Mean ± Standard Deviation (SD). A Mann-Whitney U test was conducted to analyse differences in interval data between FF and FSI when normal distribution assumptions were violated, as determined by a Shapiro-Wilk test. Prevalence of categorical data responses are reported in frequencies and percentages, with Pearson's chi square analysis performed to assess if the distribution of categorical variables differ from one another. A Fisher's exact test was used when >20% of expected frequencies within each category were less than 5. Subsequent odds ratios and 95% confidence intervals (CI) were calculated to analyse associations. Significance level was set at $p<0.05$. Qualitative responses to open questions were categorised into key themes.

3. RESULTS

The survey was completed by 130 FSI and 232 FF; response numbers for individual questions vary, as questions that did not apply could be skipped. Table 1 details the demographic of responders. All participants completed the survey within two days of initial engagement with the questions. Fisher's exact tests revealed that FSI responses did not differ

by time of year of survey completion for reported wear numbers (BA: $p = 0.81$, CFBT: $p=0.159$, BA cold/no smoke: $p = 0.464$) or new symptoms of ill health ($p = 0.296$).

3.1. Wear Types

The frequency of wear types completed by FSI in the previous month is presented in Figure 1. **Overall the median number of wears completed by FSI (± interquartile range) was 13 ± 8, with the minimum number experienced being 0 and the maximum being 40. When broken down into wear types, FSI completed 5 ± 6 BA wears, 3 ± 5 cold/no smoke wears, and 3 ± 4 CFBT wears.** The mode duration of a BA wear was 26-30 mins reported by 24 (23%) FSI, 36-40 mins for CFBT reported by 21 (20%) FSI, and 26-30 mins for BA cold/no smoke reported by 22 (23%) FSI.

The median number of live fire wears experienced by FF was 1 ± 3, with 214 (92%) FF having completed ≤5 wears in the previous month. Only 17 (13%) FSI completed ≤5 wears in a month.

When asked to order the wear types by how physically straining they found them, 60 (59%) reported that CFBT generated the greatest strain, and 78 (76%) FSI selected BA cold/no smoke as the least straining, see Table 2.

Of the respondents 39 (35%) FSI thought that they completed too many wears in a week, and 50 (45%) reported that they were unaware of any wear limit set by management. Of those who did have a limit (62, 55%), it ranged from 2-10 per week.

3.2. Preparation for Wear

Seventy-nine (73%) FSI were not allocated a period to prepare for a wear. Preparation methods used by FSI are displayed in Figure 2. The alternative methods reported by 20 (20%) FSI were grouped into themes and included: drinking water, checking tympanic temperatures,

and using rehydration sachets. Some FSI (15, 15%) used multiple methods of preparation, with the most common combinations being hydration checks with wearing a phase change vest (FSI: 6, 6%) and hydration checks with ice slurry consumption (FSI: 5, 5%). Having no hydration guidelines was reported by 44 (41%) FSI. Those with guidelines reported using visual charts to check urine colour and specific advice from within their service on water consumption.

3.3. Recovery from Wear

Seventy-six (70%) FSI also stated that they do not have a set allocated recovery time; FSI from organisations with a specified recovery time had a minimum of 2 hours between wears allocated. **However, 18 (55%) of those with a set recovery time reported having an actual average recovery period of less than 2 hours.** Average recovery periods ranged from 5min to 2hrs, with 31 (32%) FSI having ≤15min and 44 (45%) having >30min. Those that had >30min reported having additional tasks to do in that time, including debriefing students, paperwork and eating lunch. Recovery methods used are displayed in Figure 2. Themes of alternative methods included using rehydration sachets and dress down procedures. Some FSI (24, 24%) used multiple methods of recovery, with the most common combinations being drinking water with rehydration sachets (FSI: 8, 8%), and drinking water with forearm cooling (FSI: 9, 9%).

Only 3 (3%) FSI reported that they felt fully recovered after their recovery period, with the majority, 71 (65%), stating they were only just recovered, feeling worn out and warm. A further 9 (8%) FSI were exhausted and hot after a wear and did not feel recovered.

3.4. Illness

Over the previous year FF reported taking a greater number of sick days compared to FSI (3 ± 7 vs. 1 ± 3, respectively), $U = 18446$, $p < 0.001$. However, 49 (45%) FSI also reported that they did not feel comfortable reporting illness **at work** and taking sick leave. Participants were asked to recall periods of cold or flu over the last year, with 27 (25%) FSI having not suffered from a cold or flu, 60 (55%) had one or two occurrences, 20 (18%) had suffered 3-6 times, 1 (1%) had symptoms once a month, and 2 (2%) suffering 2-4 times a month. In comparison, 51 (22%) FF reported no cold or flu occurrences, 134 (59%) had symptoms once or twice in the year, 40 (18%) suffered 3-6 times, and 4 (2%) had a cold or flu once a month.

When FSI were asked if they frequently suffer from any other illnesses or symptoms that they did not experience prior to becoming an instructor, 45 (41%) said Yes. Some (48 (21%)) FF also reported suffering from a new illness or symptoms that they did not experience before becoming a FF.

There was an association between the number of BA wears completed (≤5, 6-10, or ≥11 a month) and presence of new symptoms, χ^2 (2) = 6.37, $p = 0.041$. The odds of suffering from a new illness or symptom was 1.6 (**95%** CI 0.66-3.66) times higher for FSI who conduct 6-10 BA wears a month, and 4.5 (**95%** CI 1.33-15.09) times more likely when completing ≥ 11 BA wears, compared to those who completed ≤5. There was no association between those suffering from new symptoms and those who had hydration guidelines, χ^2 (1) = 0.60, $p = 0.691$. How recovered FSI felt after their wear recovery (fully recovered, fine, worn out and warm, and exhausted) was associated with the presence of new symptoms, ($p = 0.004$, **Fisher's Exact Test**). Those who felt exhausted after a wear were 16.8 (**95%** CI 2.69-104.82) times more likely to suffer a new symptom than those who felt fine afterwards.

New symptoms reported by FSI were: fatigue (16), headaches (12), broken sleep (8), musculoskeletal pain (8), heavy sweating (6), problems thermoregulating (5), heart

palpitations (4), blood shot eyes (3), mood swings (3), and coughing and breathing problems (4). The common themes from FF were: back pain (11), post-traumatic stress disorder (PTSD) or depression (7), coughing or breathing problems (10), and headaches (5).

FSI and FF were also asked how they felt both physically and mentally at the end of a working week, results shown in Table 3.

3.5. Additional Comments

From the 39 (30%) FSI who left additional comments, the key themes were: frequently feeling fatigued (4), being worried about their health (4), concern over the number of wears (14), lack of fresh protective clothing (5), worry about breathing in contaminants (4) and support for hydration and cooling methods to reduce the acute effects of a wear (4).

4. DISCUSSION

The study aimed to document the working practices of FSI across the UK, to enable a better understanding of the frequency of heat exposures, the types of preparation and recovery methods used, and the prevalence and type of illnesses experienced. FF were used as a comparative group. The study also aimed to establish whether there was an effect of wear number, hydration advice, or perception of recovery on the presence of overtraining symptoms or illness. The number and duration of wears completed varied, however a larger proportion of FSI completed 6-10 BA wears a week than CFBT, with FSI completing a greater number of wears than FF. The findings from this survey also suggest that not all FSI are provided with, or follow, the advice on hydration and recovery methods suggested in the research literature. Furthermore, the prevalence of new symptoms and illnesses since starting the occupation is high (41%), with prevalence potentially linked to high wearing numbers and

poor recovery. Some FF also experience new symptoms (21%), although of a different nature to FSI.

4.1. Wear Types

The variety of wear frequency and duration reported was as expected based on previous findings.[1,10] It is clear that whilst the majority of FSI have a limit to the number of wears they can complete, as recommended by the Chief Fire Officers Association guidance,[15] there is not a universal practice. There is also large variation in the number of permitted wears set by each service, however there is currently no evidence based literature to support either the conservative or liberal prescription. Additionally, some FSI (4) report a very high limit (≥8 per week) of heat exposure frequency. This study also showed data that suggests FSI who complete ≥11 BA wears a week are 4.5 times more likely to experience new symptoms or illnesses.

Repeated heat exposures may cause chronic inflammation in FSI, with elevated resting C-reactive protein (CRP) (7378 ± 3770 $ng.mL^{-1}$) and IL-6 levels (11.4 ± 1.0$pg.mL^{-1}$) previously documented.[1] Inflammation plays a role in both the initiation and progression of atherosclerosis.[27] Elevated levels of inflammation, exacerbated by reduced recovery time between wears,[9] suggests that FSI may be at an increased risk of a cardiovascular event as the frequency of heat exposures rises.

4.2. Preparation and Recovery

This study also highlights the need for additional hydration education, as 44 (41%) FSI were unaware of any hydration guidelines. This is despite guidelines indicating that 1.5 times the amount of fluid lost during exposure should be consumed.[15] During a wear FSI have been reported to lose 1.28 $L.h^{-1}$ of sweat, equivalent to 1% of their body weight,[1] as the body

attempts to dissipate heat via sweating. However, some FSI carry out wears multiple times a day, and consequently may become progressively hypohydrated.[28] A reduction of body weight post exercise of ≥2% can cause decrements in both psychological and physiological performance, for example increasing decision making time and reducing fine motor skill accuracy.[28,29] However, no association was present between those who used hydration guidelines and FSI who reported new illnesses and symptoms.

Pre cooling may be a practical intervention available to FSI to reduce the physiological strain experienced during a wear, and is recommended by national FSI guidelines.[15] The reduction of core temperature prior to exercise in the heat via cooling methods is a well-established technique amongst athletes, as it can increase the body's heat storage capacity, enabling individuals to maintain their work intensity for longer, or reduce their end core temperature.[30] There are various pre cooling methods available, including cold water immersion,[31] ice jackets,[32] and ice slurry consumption,[33] which have been reported to reduce core temperature prior to exercise by 0.3-0.7ºC.[30] However, it is unclear which method of cooling is most beneficial for FSI, with specific advice on duration and dosage also currently not provided.[15] Consequently, further research is needed into the use of practical pre cooling methods for FSI, with the need for this research to be fed into FSI guidelines.

Additional information on the use of post cooling techniques should also be provided to FSI, as despite scientific literature and FSI guidelines supporting the use of various methods, little is being practically applied in the UK. Cheung et al.,[11] offers a comprehensive review of the use of recovery forearm immersion cooling for firefighters. However, a more recent review by Brearley & Walker reported that hand and forearm cooling results in an unacceptable cooling rate of <0.07°C.min^{-1}.[34] Ice slurries may offer a practical alternative, with cooling rates of 0.09°C.min^{-1} having been reported post live fire exposure.[35]

The responses to questions about recovery time in this survey highlight that few FSI have a period to rest and cool down, without other demands made of them. To discover what FSI view as a recovery period the questions in this survey were kept broad, asking only if they were allocated specific recovery time, the average recovery time experienced, and an option to provide details. The questions did not specify what should occur in the recovery time. Responses indicate that the recommended 2hr minimum between heat exposures is thought of by some FSI as their recovery period,[15] and can involve other tasks and often covers the lunch break period. **However, FSI are often not receiving a full 2hr period between wears.** Guidance for providing adequate time to rest immediately post a wear, when rehydration and cooling can occur, should be considered.

4.3. Illness

Prevalence of cold and flu symptoms amongst FF and FSI were similar, with 22% vs 25% not experiencing symptoms, 59% vs 55% having one or two occurrences, and 19% vs 21% suffering more than 3 times a year. This is similar to the prevalence of cold and flu amongst a normal European population group have previously been reported with 25% hardly ever catching a cold, 50% experiencing symptoms once or twice a year and 21% suffering 3-4 times a year.[36] This suggests that FF and FSI do not sufferer from a greater number of URTI.

A greater proportion of FSI reported experiencing new symptoms (41%) than FF (21%). Two symptoms crossed over both groups: headaches, and coughing and breathing problems. FF have previously been reported to have a high prevalence of dyspnea, coughs, and sinusitis, [4,37] alongside lower forced vital capacities (5.09 ± 0.68 L) and forced expiratory volume in one second (4.06 ± 0.56 L) compared to predicted values (5.26 ± 0.61 and 4.38 ± 0.54, respectively) $p<0.05$.[37] FF have also been reported to have an increased risk of developing adult-onset asthma compared to police officers (OR= 1.23).[38] Exposure to air pollutants, from

combustion products, is the probable cause of these symptoms, as they have been documented to exacerbate respiratory symptoms and increase bronchial reactivity.[4,39] Minimising exposure to "dirty" PPE and the use of effective decontamination processes, **alongside good occupational hygiene practices, such as wearing BA when near smoke on the training ground and during overhaul situations, may reduce individual's exposure to toxic air contaminants. [40] Future investigation into the practices used within the UK fire service, with reference to the effectiveness of different processes, could be warranted.**

FF also reported experiencing back pain. Previous studies have documented that up to 44% of FF may suffer from back pain, with this percentage rising with time in service.[41] The additional weight carried by FF due to PPE and BA, combined with reduced ankle flexibility caused by restrictive boots, may result is additional compressive forces on the spine.[5] Frequent heavy lifting and wearing PPE have also been reported to increase the odds (OR = 1.3) of suffering from lower back pain in the military.[6] FF wear PPE to response to all emergency calls in the UK, and therefore may stand in full PPE for numerous hours, for instance when attending a road traffic collision. Consequently, these prolonged periods of PPE wearing combined with manual tasks may explain why this symptom was prevalent amongst FF but not FSI.

The final symptoms reported only by FF were PTSD and depression. Operational FF are likely to see traumatic events, being the first responders to a larger variety of situations. Prevalence of PTSD amongst first responders ranges from 10-32%.[42,43] Assisting survivors and exposure to fatally injured persons increases the likelihood of PTSD (OR = 2.98 and OR = 3.40, respectively).[42] Walker et al., suggest that FF may be predisposed to PTSD, due to chronic low grade inflammation they may suffer as a consequence of altered sleep patterns, high physical workloads, injuries, and heat and smoke exposure.[44] Whilst this study suggests

that FF in the UK are not frequently exposed to fire situations, shift patterns and manual tasks could still be involved in predisposing FF to PTSD.

Amongst the new symptoms reported by FSI are those that have also been associated with overtraining. Insomnia (with and without night sweats), fatigue, mood swings, and muscle pain as reported by the FSIs in this survey are all signs of an overtraining syndrome.[17] Frequent high stress experiences may lead to chronic inflammation, evident by increased IL-6, and have been linked to immune function dysregulation.[45] Suppression of cell mediated immune function has been hypothesised to be a leading factor in the development of overtraining syndrome.[17] It can therefore be postulated that repeated exposure, of up to 10 times a week as documented in this study, could result in FSI developing a syndrome similar to that of the overtraining syndrome.

The presence of some of the new symptoms reported by FSI could also impact on their safety whilst conducting wears. Sleep deprivation is a risk factor for EHI,[46] with partial sleep disruption increasing heat strain during exercise in a hot environment when performed in the afternoon.[47] Sleep deprivation can also increase the risk of inflammatory disease, with markers of inflammation, such as IL-6, exhibiting a greater increase during exercise when individuals are sleep deprived.[48] With IL-6 already elevated in FSI both at rest and post wear,[1] sleep deprivation may be further exacerbating the rise.

FSI also reported experiencing heart palpitations, which although usually benign, can be caused by arrhythmias, which include supraventricular tachycardia, ventricular extrasystoles, or atrial fibrillation.[49,50] Suffering from an arrhythmia can increase the risk of sudden cardiac death (relative risk 3.2, 95% CI 2.0-5.3).[49] Atrial fibrillation is also a predictor of cardiovascular events (rate ratio 1.8, 95% CI 1.3-2.5), with 66% of men with atrial fibrillation experiencing an event over a 20 year period, compared to 45% of asymptomatic men.[51] The

possibly life threatening consequences of sleep deprivation and heart palpitations reported by FSI suggest that further investigation into the health of FSI is warranted, with determining methods and guidelines to reduce the incidence of these new symptoms of paramount importance.

4.4. Limitations

Whilst the study reports working practices of FSI compared to FF, it can only offer a snapshot of the UK, as not all UK Fire and Rescue Services responded to the survey. However, 33 training centres and 46 of 52 UK Services were represented in the survey. **The total number of BA wears completed by FSI may be underestimated, as specific information regarding the completion of wears outside of instructing duties was not gathered.** In addition, reports of illnesses were subjective, as verification by a medical professional was not obtained. Due to the subjective nature of these findings cause and effect cannot be confirmed between variables. Furthermore, participants were asked to give retrospective accounts of working practices and illnesses, which may have resulted in recall bias. The distribution of the survey via word of mouth may have caused some response bias toward those suffering ill health, as they may have been more inclined to make their voice heard. However to try and mitigate against this, wording of the title and intro referred only to working practices, not health, and included non-biased language.

5. CONCLUSION

This survey is the first to document FSI working practices from different training centres in the UK. FF experienced few live fire situations in comparison to FSI. FSI who complete a greater number of BA wears may be at an increased risk of suffering from a new symptom or illness. Some services employ a wearing limit, which would appear to be justified good practice based on the findings of this study. Further research into how many wears can be

conducted before negative health consequences develop is needed. Research into the benefit of pre cooling methods for FSI is also required, with the need for this information, and that of effective post cooling methods, to be better fed into FSI guidelines. Some FF (21%) are reporting new health issues, although of a different nature to FSI, with key concerns being back pain and PTSD. Overall, 41% of FSI are experiencing new health problems after becoming instructors, with some of the symptoms reported increasing the risk of EHI and cardiovascular events. Consequently, this survey highlights the need for quantitative laboratory and field investigations into the health of FSI.

6. ACKNOWLEDGEMENTS

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8. LIST OF TABLES

Table 1. Demographic details of both Fire Service Instructor and Firefighter survey responders.

	Fire Service Instructor	Firefighter
Age Mean ±SD (yrs)	43	41
Age Standard Deviation (yrs)	7	8
Time as FSI Mean (yrs)	5	N/A
Time as FSI Standard Deviation (yrs)	5	N/A
Number of Male Participants	124	215
Percentage of Male Participants (%)	95%	93%
Number of Female Participants	6	17
Percentage of Female Participants (%)	5%	7%

Table 2. Ranking of wears in order of perceived physiological challenge, 1 being the easiest to complete and 3 being the hardest. N/A for those that did not complete that wear type.

Type of Wear	**Perception of Physiological Challenge**			
	1	2	3	N/A
BA live fire	9	66	24	1
BA cold/no smoke	78	10	17	3
CFBT	16	32	60	2

577 **Table 3.** Fire Service Instructor and Firefighter perception of how they feel, both physically
578 and mentally, at the end of an average wearing week.

	Nature of Illness	Frequency of Feelings Post Wearing Week					
		Ill	Exhausted	Tired	OK	Good	Great
Fire Service Instructor	Physical	2	28	65	9	6	0
	Physical (%)	1.8%	25.5%	59.1%	8.2%	5.5%	0.0%
	Mental	1	22	58	17	8	1
	Mental (%)	0.9%	20.6%	54.2%	15.9%	7.5%	0.9%
Firefighter	Physical	0	28	102	47	35	18
	Physical (%)	0.0%	12.2%	20.4%	20.4%	15.2%	7.8%
	Mental	3	28	96	45	37	19
	Mental (%)	1.3%	12.3%	42.1%	19.7%	16.2%	8.3%

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580 **9. LIST OF FIGURES**
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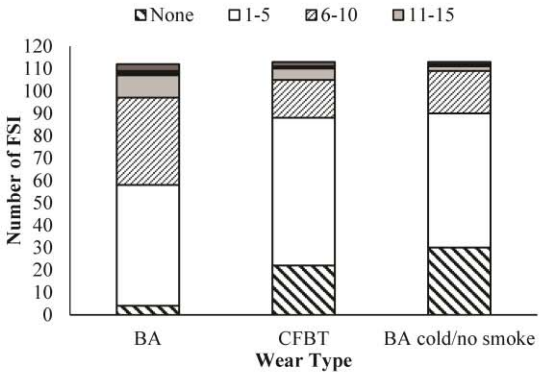

Figure 1

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585 **Figure 1.** The number of FSI who completed each frequency of wear types during a one

586 month period.

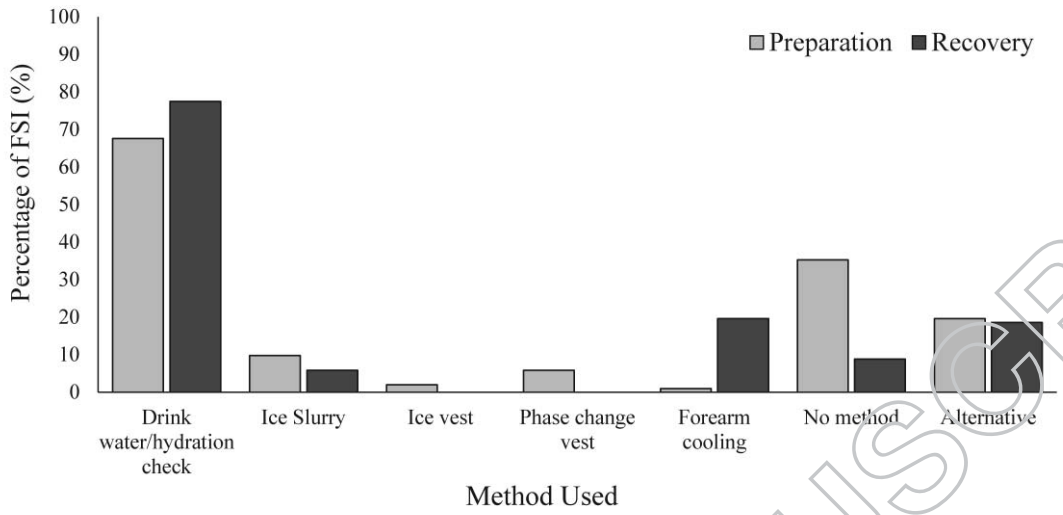

Figure 2. The percentage of FSI using different methods during the preparation and recovery periods prior to and following a wear. The preparation graph represents 102 responders with 144 method responses; the recovery graph represents 102 responders with 133 method responses.