Appendix 6

Fire Instructor Long-term Health Study Proposal

University of Brighton

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Background

Training for new recruits to the fire service requires exposure to severe heat on successive days throughout a two week training programme. This protocol induces a significant degree of heat and physical stress on the trainees and the instructors (Barr et al., 2010, Williams-Bell et al., 2010). There is physiological evidence to suggest severe acute exposure of up to 600°C may reduce short term immune function (Barr et al., 2010, Reich, 1953, Scannell and Balmes, 1995, Sheppard et al., 1986, Shuster, 2000, Smith et al., 2005), while long term fire fighting personnel may be at greater risk of respiratory (Sheppard et al., 1986) and cardiovascular diseases (Rosenstock and Olsen, 2007, Fahs et al., 2011, Fernhall et al., 2011, Reich, 1953). Previous work (Smith et al., 2005) has identified short term changes in immune function using basic inflammatory markers pre, post and after 90 minutes recovery from live fire-fighting drills. Smith et al (2005) found significant leucocytosis and plasma adrenocorticotrophic hormone and cortisol immediately following exposure. Huang et al (2010) also found increases in pro-inflammatory cytokines and decreases in lymphocytes after one severe heat exposure in fire fighters. Fernhall et al (2012) found developing heart illness and diminished work capacity in fire fighters, while Fahs et al (2011) found similar decrements in heart function. Webb et al (2011) showed correlation between markers of immune and vascular function after controlled heat exposures in fire fighters Authors concluded that elevations in cortisol and interleukin-6 and associated vascular markers support the suggestion that fire fighters are at greater risk of a cardiovascular event as a result of repeated physiological stress.

However, Fire service instructors undertake severe repeated exposure protocols every working day throughout their career. Anecdotally, fire instructors report regular upper respiratory tract infections, fatigue and lethargy, yet many feel as though reporting these formally would affect how they are viewed in the service by colleagues. Therefore this is difficult to objectively quantify due to lack of reporting. Concerns over fire instructor health and the increased exposure of instructors compared to standard fire service personnel is the reason for the National Fire Service requesting the research team to investigate instructor’s heat exposure load and immune function. Our group has recently demonstrated an inflammatory

response to the fire instructor workload, while the washout period reported declines in immune function and inflammation suggesting an improvement in health with a relatively short break from hot wears (7weeks). Figure 1 illustrates the percentage changes in white blood cell constituents over the study wash out period in six fire instructors and six controls.

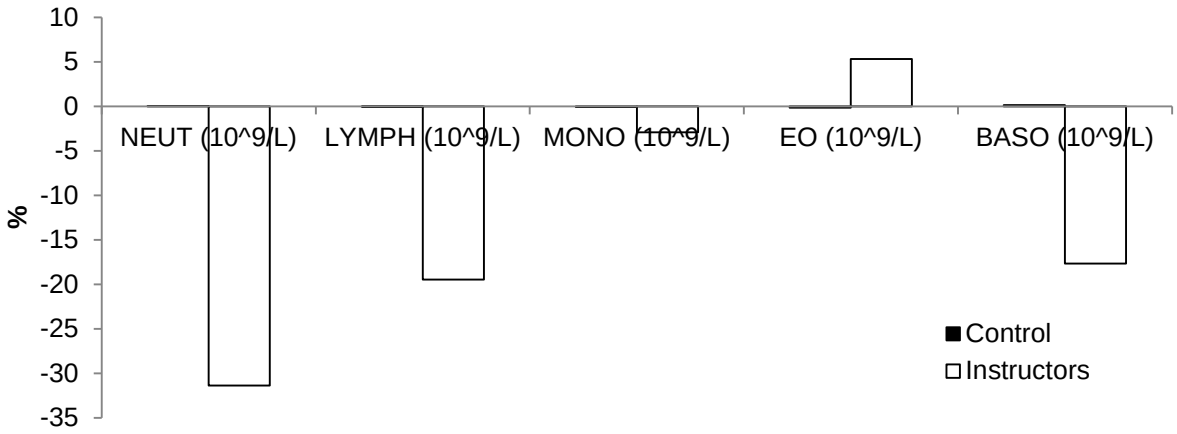

Figure 1: White blood cell content percentage change over the 7week washout period in controls and fire instructors.

Interleukin-6, a marker of inflammation, increased over the 4 weeks of fire instruction, increasing with each hot wear. Yet values declined with the washout period, as shown in Figure 2. Further information on the pilot study findings can be provided.

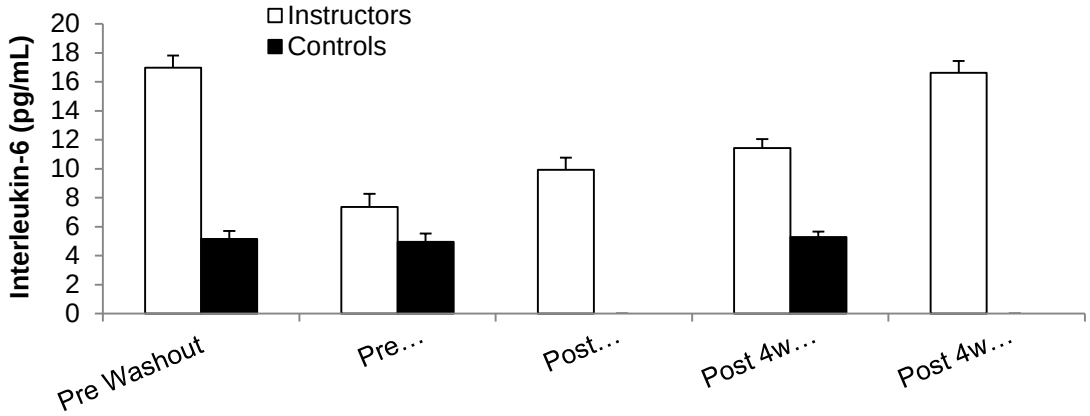

Figure 2: Interleukin-6 over the study duration in controls and fire instructors.

This work demonstrates that time away from heat exposure may be able to reduce this response and help improve fire instructors health, well-being and allow them to continue working longer and offer a better educational service for other fire staff.

However, to fully determine the time course of this response and understand the guidelines that need to be put into place there needs to be greater evaluation of current practices to allow fire instructors the best opportunity to maintain health and well-being.

Purpose

The purpose of this project is to evaluate rotas and strategies to reduce the long-term physiological consequences of repeated severe heat exposure in fire service instructors. These suggestions are based on the findings of previous pilot work by the University of Brighton, scientific literature available and lengthy discussions with fire instructors across a range of regional fire services with various levels and durations of service. These methods are open to further changes to meet the needs to the fire service, to create time effective strategies to aid this issue.

The background above demonstrates that there is a need to evaluate fire instructor health and well-being in a larger sample group, over a long-term study evaluating the use to heat instruction rotas.

Research Questions

1. Quantify time course of physiological and psychological changes over various rotas used across fire instructor groups
2. Identify best practices from across the UK fire instructors
3. Determine the optimal time away from heat
4. Determine the dose response of wears per week and inflammatory or immune function.
5. Evaluate the consequence of heat instruction service duration on heat tolerance and health.
6. Identify effective implementation methods to improve recovery and reduce physiological strain and inflammation during and after hot wears.

Outcomes

Clearly the project is of significant cost due to the time requirements and number of blood samples required. However, it is of our opinion that the findings of this work will help reduce long-term costs considerably. It is expected that by knowing the ‘best’ rota system to undertake, inflammation and immune function will be improved over the long term for fire instructors. This should have a notable improvement on number of sickness days and ultimately in the longer term the age of retirement due ill health. When considering the nature of the task, which requires a high degree of training, it is cost effective to ensure the staff maintain a healthy state.

- Identify appropriate time intervals of heat exposure training.

- Create guidelines on suggested heat exposure training rotas.

- Develop guidelines from good practices across the regions and from heat exposure literature to aid preparation and recovery from heat exposure bouts.

Planning & Method

Initial Survey

An initial online survey will be carried out to evaluate the current fire instructor practices of the UK. This survey will then be assessed to identify current best practices and guide specifics of the long-term research study.

Long term Fire Instructor Health Study

Participants

Fifty Fire Instructors and ten controls will be recruited from regional fire services across the South East of England. Participants will be informed of the requirements of the study and then be asked to give written consent before partaking in the study. The study protocols will need to be accepted by the University of Brighton Ethics Committee before any testing can take place.

Experimental Design

Participants will be monitored over 52 weeks. Participants will be split into their fire instruction groups. Groups will be selected based on a selection of rotas and number of hot wears per week undertaken. A control group of fire personnel not undertaking hot wears will also be followed.

Over the year, fire instructors will be allowed a period away from heat based training. The study will measure bloods, respiratory variables and psychological assessment before and after the individual's period away from heat based activities.

Measures

Measures of physiological, psychological, cardiovascular fitness, blood and heat tolerance will be taken at 0, 26 and 52 weeks. Additional cardiovascular fitness, blood and respiratory measures will also be taken at 13 weeks.

Many of the measures to be used have been detailed above and will therefore not be repeated here. The single new measure being undertaken will be the Heat Tolerance Test, involving fire instructors to come to the Welkin Laboratories in Eastbourne on three occasions (0, 26 and 52 weeks) over the study period.

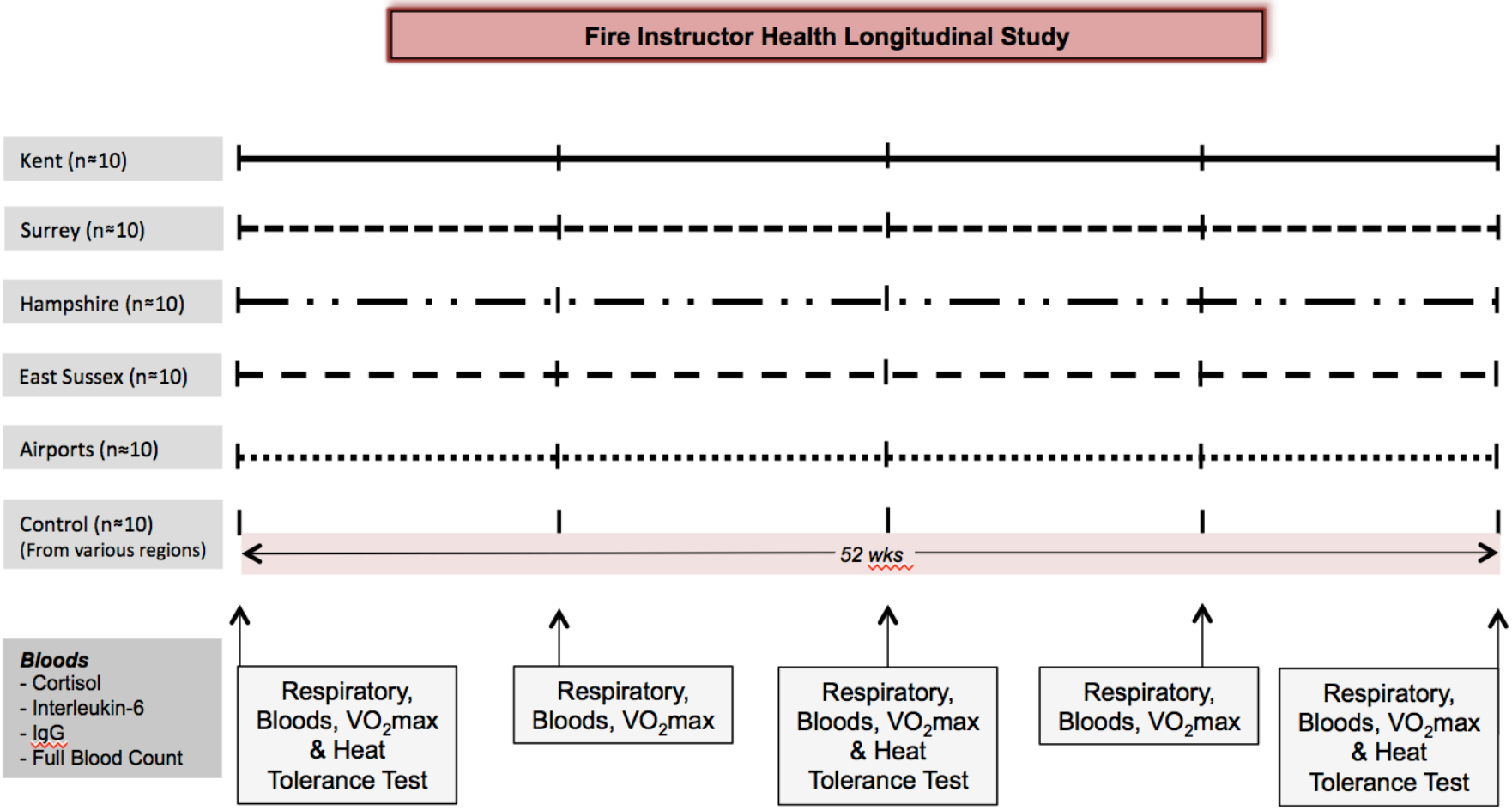

Figure 3: Schematic of the proposed longitudinal study

Heat Tolerance Test

Participants will be required to complete three 30min exercise tests in hot conditions (50°C, 10%) in the environmental chamber at the Welkin laboratories, Eastbourne. Measures of nude body mass (kg) will be taken pre and post exposure so sweat rate may be calculated as follows; Sweat rate = (Body mass pre – Body mass post) / Time (minutes). Heart rate ($b.min^{-1}$) R-R intervals will be monitored using a heart rate monitor (Polar S810, Norway) before, during and after the heat exposure, to identify differences in resting state and physiological strain (PSI) during exposure and individuals' capacity to recover. Core temperature (T_{core}) will be measured pre and post exposure using rectal thermistors (Henley, UK). Skin temperature will be recorded throughout on multiple sites (Squirrel, UK), to determine body heat content.

Participants will be required to record their body mass for three consecutive mornings in order to obtain a euhydrated baseline measurement, which will be used as a reference value. A fresh urine sample will also be provided on arrival to the training centre at each visit and analysed for urine specific gravity (U_{spg}) (Refractometer; Atago, USA), urine colour (U_{col}) (Colour Chart; Armstrong 2000) and urine osmolality (U_{osm}) (Freeze-point depression; Micro-osmometer 3300, Advanced Instruments Inc, USA).

Cardiovascular Fitness Assessment

Cardiovascular fitness will be assessed at five periods over the study (Figure 3) using an incremental VO_2max test. Participants will start at $8km.hr^{-1}$ and increase running speed by $1km.hr^{-1}$ every minute. Heart rate ($b.min^{-1}$), rating of perceived exertion (RPE) and ventilation measures will be recorded at the end of every minute stage. The test will continue until volitional exhaustion or a plateau in heart rate or ventilatory measures is recorded. Maximal oxygen uptake (VO_2max) can then be assessed (Weltman et al, 2001)

Blood Measures

Blood will be taken from the anti-cubital fossa using a 20ml syringe pre and post exposure, while the participant is half lying. Blood will be spun in a centrifuge at 2000rpm for 10 minutes at 4°C in four EDTA tubes, placed into ten microvettes and put into ice slurry during transit and then stored at -86°C for later analysis.

Interleukin-6 is an inflammatory marker, released to stimulate the immune response. Cortisol (Crt) is a steroidal hormone released in response to physiological stress, which suppresses immune function. Immunoglobulin G is produced during an immune response to stop infections. By measuring these blood based proteins, it will be possible to identify any alterations to immune function, whether in the short term or that have occurred with long term repeated exposures. These blood measures will be analysed at the biochemical laboratories at the University of Brighton using enzyme-linked immunosorbent assay plates (ELISA). To analyse each plate type, approximately one day is required. A full blood count will also be analysed to gain a more detailed health profile.

Respiratory Measures

Lung Function will be taken at five periods over the study (Figure 3) using a spirometer (Vitalograph, UK). Participants will be required to inhale maximally and then maximally exhale into a large tube. From this parameters can be used to assess lung capabilities and disease states. Carbon monoxide will be measured by slowing breathing into a breath monitor tube (Micro+, Bedfont, UK) to assess levels of carbon monoxide poisoning.

Psychological Measures

Multidimensional Fatigue Syndrome Inventory will recorded pre exposure. Psychological Feeling State will be assessed using a modified version of the Profile of Moods States (POMS, McNair et al., 1971) questionnaire pre and post exposures. This modified questionnaire will allow measurement of short and long-term levels of perceived tension, depression, anger, vigour, fatigue and confusion to be measured. Sport and Exercise Psychologist, Dr.

Smeeton, will administer this questionnaire within a private area. If participants identify as experiencing mental health issues, they will be approached confidentially by Dr Nick Smeeton and asked if they wish to seek advice from the Fire Service welfare support team. Thermal sensation and rating of perceived exertion scales will also be recorded pre and post exposures.

Statistical Analysis

Standard statistical analysis procedures will be followed to ensure objectivity and reliability. Data will be checked for normality and sphericity and will be adjusted using the Huynh-Feldt method. Pearson's product moment correlation coefficient will used to determine correlation between selected variables. All data will be analysed using a standard statistical package (SPSS version 16). The correlational analysis will be used to evaluate if long-term heat exposure is significantly related to suppression in immune and physiological function. Tests of significant difference will be used to measure changes in immune and physiological function before and after heat exposure in fire instructors, other instructors and those matched for time in the fire service, and whether or not tolerance to severe heat exposure is affected by long-term heat exposure.

People

As described the research group has previously completed a pilot research study, which worked well over a number of weeks. The reporting and presentations were completed on time and well received. Information on the project was also presented at the FireFt UK conference. The work has had a great deal of interest for fire instructors all over the country and places across the world demonstrating the interest and need for this and further research into the area.

This work is in collaboration with the regional fire services of the South East, who are keen to work with us and help improve the understanding of the area and ultimately develop national guidelines on fire instruction. Our groups have already worked very closely on the pilot project and two other projects on undergarment thermoregulation and pre/post hot wear cooling strategies. These smaller studies have already evidenced methods to reduce physiological strain and inflammation post hot wears for fire instructors. It is hoped that this excellent relationship can continue to be beneficial.

Resourcing

Consumables

Item	Quantity	Cost (£)
Blood Extraction Consumables		900
Lab Consumables		2000
Interleukin-6 Assay	8	2000
Cortisol Assay	8	2000
Immunoglobulin G Assay	8	1200
Blood Count	400	2400
Delivery of ELISA plates		150
		Total Cost inc VAT: £15,440

Travel - This is dependent upon fire services selected but each place would need to be visited on at least six occasions.

Trip (round)	Mileage (miles) RTN	Quantity	Cost
Eastbourne to Eastleigh	120	6	288
Eastbourne to Maresfield	40	6	96
Eastbourne to Marston	120	6	288
Eastbourne to London	100	6	240
Eastbourne to Surrey	90	6	216
			Total Cost: £1128

Staffing

Staff	Time (hours)
Dr Alan Richardson (Project Leader)	140
Dr Neil Maxwell	30
Dr Peter Watt	60
Dr Nick Smeeton	40
Miss Emily Watkins (Research Officer)	1600
	Total: £38,010

General

Catering	500
Printing/Photocopying	100
Equipment	600
University indirect costs (Facilities)	12420
	Total: £13,520

Grand Total: £68,098

Previous Funding

The group has previously gained funding (£9500) from the South East regional fire services to run a pilot study to ascertain if health is being affected by doing BA fire instruction over a four week period. This demonstrates a need from the perspective of the South Eastern regions. Further funding will allow greater evaluation into the implementation of appropriate rotas or guidelines to reduce the effect on health and well-being. Thus this work would build upon the previous funding already supplied by a number of fire services.

Evaluating

Evaluation of the project will be sort through feedback from regional fire instructor groups via discussion forums to identify the usefulness of the research findings and how these can be feasibly integrated into their workload models and practices. Feedback will also be taken at the presentation and discussion session. Prior to this, the full report will have been circulated for viewing by the Fire Trust and various fire groups. Further long-term evaluation using an online survey for fire instructors will take place after one year of implementing changes as a result of the research project. These later findings will also be fed back to the Fire Trust.

Reporting

Findings of the study will be presented in a written report for the UK Fire Service. Presentations by the researchers will be given to fire service instructors to ensure all staff are aware of and have access to the findings. Lead researcher Dr Alan Richardson and Miss Emily Watkins will also be contactable during and after the study to discuss the findings and the uses of the work to the UK's regional fire services.

Short reports will be issued to the Fire Trust at the following time points, larger reports will be presented at 24 months and 30 months.

- 12 months – Post survey completion, Started long-term study, ongoing
- 18 months – Study testing nearly completed
- 24 months – Results of the study fed back to Fire Trust
    - Findings sent out the regional fire services, all services invited to discuss findings at a national presentation and discussion session.
- 30 months – Guidelines written for the Fire Services

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