Occupational health care in high-demand jobs: the usefulness of job-specific workers’ health surveillance for fire fighters
Plat, M.C.J.

Citation for published version (APA):
Plat, M. C. J. (2011). Occupational health care in high-demand jobs: the usefulness of job-specific workers’ health surveillance for fire fighters

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: http://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

UvA-DARE is a service provided by the library of the University of Amsterdam (http://dare.uva.nl)
Chapter 2

A systematic review of job-specific workers’ health surveillance activities for fire-fighting, ambulance, police and military personnel

MJ Plat, MHW Frings-Dresen and JK Sluiter
Abstract

Purpose Some occupations have tasks and activities that require monitoring safety and health aspects of the job, examples of such occupations are emergency services personnel and military personnel. The two objectives of this systematic review were to describe 1) the existing job-specific workers’ health surveillance (WHS) activities and 2) the effectiveness of job-specific WHS interventions with respect to work functioning, for selected jobs.

Methods The search strategy systematically searched the PubMed, PsycINFO and OSH-update databases. The search strategy consisted of several synonyms of the job titles of interest, combined with synonyms for workers’ health surveillance. The methodological quality was checked.

Results At least one study was found for each of the following occupations fire fighters, ambulance personnel, police personnel and military personnel. For the first objective, 24 studies described several job-specific WHS activities aimed at aspects of psychological, ‘physical’ (energetic, biomechanical and balance), sense-related, environmental exposure or cardiovascular requirements. The seven studies found for the second objective measured different outcomes related to work functioning. The methodological quality of the interventions varied, but with the exception of one study, all scored over 55% of the maximum score. Six studies showed effectiveness on at least some of the defined outcomes. The studies described several job-specific interventions: a trauma resilience training, healthy lifestyle promotion, physical readiness training, respiratory muscle training, endurance and resistance training, a physical exercise programme and comparing vaccines.

Conclusions Several examples of job-specific WHS activities were found for the four occupations. Compared to studies focusing on physical tasks, few studies were found that focus on psychological tasks. Effectiveness studies for job-specific WHS interventions were scarce, although their results were promising. We recommend studying job-specific WHS in effectiveness studies.
Introduction
There are certain occupations whose nature and requirements are such that they cannot be performed fully and properly by workers without inevitable exposure to danger and/or significant risk to the worker's health, both immediate and long term. Safe work for employees, prevention of work-related diseases, participation of employees with and without limitations and improvement of functioning at work are four aims of occupational health care as described by Hulshof and Frings-Dresen. One of the strategies used to achieve these aims is implementing workers' health surveillance (WHS). Koh and Aw described that WHS can be used the early detection of adverse health effects resulting from occupational exposures with appropriate preventive measures to be instituted promptly. To ensure that the employee meets the requirements of the job to execute the tasks safely and in a healthful manner, a periodic WHS can be necessary to monitor the employee on these requirements.

The goal of WHS is to monitor employees periodically, to be able to detect as early as possible adverse health effects caused by the exposure of the job and starting appropriate preventive measures. In 1998 the International Labour Office recommended that, for worldwide use of the WHS, it should be linked to the surveillance of occupational hazards present in the workplace, but WHS has different contents and goals in different countries. Within the Netherlands, legislation has established that the content of the monitoring on the WHS should be a reflection of the job and should be used as a preventive strategy. Furthermore, the detection of abnormalities should lead to appropriate action. Therefore, interventions related to the job as a consequence of the results of WHS can be performed as part of the procedure of WHS by the occupational physician in the Netherlands. From this point of view the term WHS is used in this article.

People who are involved in certain occupations, such as emergency services personnel or military personnel, are exposed to hazards that lie in the very nature of their job and they will always, to some extent, be exposed to it. If they do not fulfil the inevitable risky aspects of the job, it may have health implications for themselves and for the public as well. Physical and psychological abilities of the workers are necessary for safe performance in such jobs, like being able to provide an energetic peak load, having good vision, having adequate hearing, being able to handle emotional peak load, being able to maintain wakefulness combined with the ability to judge and not having too many risk factors for
Cardiovascular diseases. These abilities are necessary to perform the job tasks safely, and therefore, these may be checked in a periodical WHS.5

To develop content to the WHS, job tasks are first determined in a job analysis and consequently from those analyses, tests that reflect the reality should be developed, as recently confirmed in the framework as described by Payne and Harvey.6 Bos et al. described fire-fighting tasks after a job analysis in which e.g., lifting/carrying, pulling/dragging and walking stairs showed to be physical tasks in the job of a fire fighter.7 For police personnel, carrying loads, running and fighting were some of the frequently executed physical activities recorded and described.8,9

The exposures and activities in the job should be the basic principle of a WHS or for health monitoring activities in the job, pursuing prevention of work-related diseases. The job-specific way of testing was already suggested in the early nineties for fire fighters by Louhevaara et al. and afterwards for several jobs by Sluiter.5,10

In a WHS, job-related aspects should be tested. For physical activities, analogous activities should be used and the same might be applied for psychological aspects and for the abilities of senses. The use of job-specific WHS activities should lead to more valid and as a consequence more relevant results for the monitoring of the safety and healthy performance of the job. To study whether this line of reasoning of job-specific testing had been implemented and researched, a systematic review was conducted. Therefore, the two objectives of this review were to describe 1) existing job-specific WHS activities and 2) the effectiveness of job-specific WHS interventions with respect to work functioning. Both objectives were specified for the jobs of emergency services personnel and military personnel.

Methods

Search strategy
For the two objectives, one search strategy was used to systematically search in the PubMed, PsycINFO and OSH-update databases. The search strategy consisted of several synonyms of A) the job titles of interest, combined with the Boolean operator ‘AND’ with B) workers’ health surveillance. Job titles of interest included fire fighters, first responders (i.e. term used for fire fighters, police or ambulance personnel), police workers, rescue workers, ambulance personnel, soldiers, navy personnel and air force personnel. The synonyms used for workers’ health surveillance were e.g. periodical examination, health promotion workplace and occupational screening. Subject headings were adapted for the different databases.
The specific search strategy is available from the authors.

Inclusion criteria for titles and abstracts were those i) written in English or Dutch, ii) published between January 1993 and April 2010, iii) with study samples consisting of our working population(s) of interest. Specifically for the first objective, we required a description of a job-specific WHS or elements of a WHS and the (future) use of the activity in a WHS, medical evaluation or evaluation of the ability to perform job tasks. The inclusion for job-specific physical energetic tests was even stricter, as we required a simulation of a real task. That is prescribed for physical tests,11 while it cannot be followed for other job requirements. For the second objective, the following inclusion criteria were applied in addition to the first three criteria described: a job-specific intervention which could be used in a WHS; relevant/related outcome measure for work functioning, like job performance or work-related injuries; and study design with a control group or comparison over time. Selection was done by one author (MP). In cases of uncertainty, the specific title and abstract were discussed by the three authors (MP, MF and JS). Ten per cent of the inclusions and exclusions was checked at random by a second author (JS). Full articles were read and selected by one author (MP), in cases of uncertainty, the specific article was discussed by the authors (MP, MF and JS).

**Data extraction and synthesis**

Studies were described for the first objective: first author, year of publication, job aspect, country, occupation of study population, extensive description of job-specific WHS and if available criteria for measurements and actions after exceeding the criteria. For the second objective, additional data were added: participants’ characteristics: number, age and percentage male; study design; description of workers’ health surveillance activity; outcome measure; results in terms of effectiveness; and methodological quality. Extracted information from the studies was discussed in the team.

**Methodological quality**

A checklist for methodological quality from Downs and Black was used to assess the quality of the intervention studies.12 This checklist can be used for randomised and non-randomised studies. Several aspects were evaluated: the quality of reporting items, external validity, internal validity with respect to bias, internal validity with respect to confounding and power. We removed one item that was
irrelevant for our studies and this resulted in an overall score using a 26 item-list, with a maximum score of 31 points.

Results
The search strategy provided a total of 1660 references after excluding the double references. One study was found by one of the authors (JS) which was not discovered with the search strategy. After inclusion of titles and abstracts, 67 references were checked for the full text. Thirty-one references could be included for the review. Table 1 shows which specific occupations were studied and how often the specified occupations were described in a job-specific way in the included articles (see Table 1). The highest number of studies were found for military personnel, followed by fire fighters, police personnel and ambulance personnel. For general police personnel, four studies were found and additional two studies were found for special groups of police personnel.

Table 1 Number of included articles per occupation

<table>
<thead>
<tr>
<th></th>
<th>Objective 1</th>
<th>Objective 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire fighters</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Police personnel</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Rescue and recovery</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>First responders police</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Ambulance personnel</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Military personnel</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24</strong></td>
<td><strong>7</strong></td>
</tr>
</tbody>
</table>

Job aspects
The included studies described (elements of) a job-specific WHS relating to different aspects of the jobs. Studies were categorised into (sub)groups of these job aspects:

- psychological
- physical
  - energetic, biomechanical
  - body balance
- senses
- environmental exposure
- cardiovascular
Description of job-specific WHS (Table 2)
The 24 studies with a description of the (elements of) job-specific health surveillance included three studies containing a description for the psychological job-related aspects, whereas 21 described several physical job aspects. Twelve studies were executed in North America, nine studies in Europe, two in Asia and one in Oceania. The oldest study found was published in 1994, and the most recent studies were published in 2010. Ten out of 24 articles were published in the last five years.

Psychological aspects
Three studies described job-specific WHS activities in relation to psychological aspects. Winwood et al. described a risk indicator for police personnel for five different areas: sleep, fatigue experience, failure to recover, Post Traumatic Stress Disorder (PTSD) and alcohol consumption. The second study applied a mental health screening part for rescue and recovery workers after the attacks of the World Trade Center in the USA, without reporting the exact instrument. Wright et al. described two screening programmes for soldiers, the Bosnia screening programme and the Kosovo screening programme, which was an extended version of the first programme. The Bosnia screening programme included PTSD, depression and alcohol questionnaires. The Kosovo programme added additional items such as a checklist of the trauma history with life events and lost workdays because of illness. Winwood and Wright described both PTSD and alcohol consumption scales as instruments in the surveillance of police personnel and soldiers.

Physical aspects
Nine studies investigated the energetic and biomechanical physical aspects of the jobs in their WHS. All nine studies described physical task-simulation tests. Fire fighters (n=5), police personnel (n=2) and military personnel (n=2) were the subject of study. The described fire-fighting tests all used the same approach of testing the skills and energetic ability of the fire fighters in one test with climbing stairs or dragging of hoses. Three studies included a task of dragging a dummy. Gerkin described additional parts of a medical examination. In one of the two studies found for police personnel, a circuit with physical job components was described and in the other, a job-specific energetic test was
found, in which police personnel had to walk on a treadmill because walking was seen as a routine occupational activity. One out of the two military studies described a representative service task track with several parts such as a lift and carry task (representing loading a truck) and a dig (representing sand bagging) while wearing the uniform and equipment. The second military study described the development of a backpack run test to be used in a physical fitness test with more occupationally relevant and health-related dimensions of fitness. One study described merely measuring the physical aspect of balance in a job-specific way for fire fighters; however, measuring balance was also part of the test described in the study of Plat et al.

**Senses**

Four studies described tests for the different abilities related to the senses; three studies included tests for vision and one study examined hearing. All four studies described tests for the military personnel, although one was specific for soldiers and one for aviators. Three studies described the vision readiness for military personnel, as a minimum standard for being ready to start an operation. Determining visual acuity was stressed in the three studies. In one study, an assessment of hearing loss by means of a pure-tone audiometry was described.

**Environmental exposure**

Four studies were found in relation to the environmental exposure in fire fighters, military and police personnel. These studies contained health measurements after exposure to substances during work. Two studies described health surveillances after fires with exposure to chemical substances. Blood samples and respiratory measures were taken to assess the health consequences of the exposure. McDiarmid et al. studied health-related measures after exposure to depleted uranium in Gulf war I veterans. Exposure evaluation of urban air pollutants was done in Italy in police personnel, with blood samples, spirometry and urine samples. Levin et al. also described medical and exposure assessment for rescue and recovery workers.
Cardiovascular aspects

The monitoring of job-related cardiovascular risk prevention was described in three studies. All three studies evaluated obesity by determining body mass index (BMI). Two of those studies focused mainly on obesity, one focused on military personnel \(^3\) and the other one focused on fire fighters.\(^4\) The third study focused on obesity, cholesterol, triglycerides, blood pressure and glucose.\(^5\)
Table 2 Description of job-specific WHS activity for emergency services and military personnel

<table>
<thead>
<tr>
<th>First author &amp; year of publication</th>
<th>Job-aspect</th>
<th>Country and occupation study population</th>
<th>Extensive description of job-specific WHS activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winwood 2009</td>
<td>Psychological</td>
<td>Australia police personnel</td>
<td>Psychological Injury Risk Indicator (PIRI): The test is a self-reported measure of work-related psychological injury, covering five different areas: 1) disturbed sleep/poor sleep hygiene (PSQI scale); 2) chronic maladaptive fatigue experience (chronic fatigue subscale of Occupational Fatigue Exaudition recovery scale); 3) consistent failure to recover/renew physical and emotional energy between successive work sequences (recovery subscale of the Occupational Fatigue Exaudition Recovery scale); 4) Post Traumatic Stress Disorder (PTSD) symptoms (Purdue PTSD scale); 5) maladaptive alcohol consumption (RAPS4 scale). Per scale scores were converted to a score between 0 and 100, resulting in a maximum score for the instrument of 500.</td>
</tr>
<tr>
<td>Levin 2004</td>
<td>Psychological &amp; Environmental exposure</td>
<td>USA rescue and recovery workers</td>
<td>Standardised medical assessment for rescue workers after September 11th 2001 consisting of mental health screening questionnaires, medical- and exposure-assessment questionnaires, physical examination, pre- and post bronchodilator spirometry, complete blood count, blood chemistries, urinalysis and chest radiograph. Each measurement was separately judged.</td>
</tr>
<tr>
<td>Wright 2002</td>
<td>Psychological</td>
<td>USA military: soldiers/peacekeepers</td>
<td>Bosnia screening programme: Test contains demographic items, questions on deployment history, PTSD disorder scale (DSM-mental disorders criteria for clinical diagnosis of PTSD), self-rating depression scale, alcohol use scale. Kosovo screening programme: Added instruments to the original Bosnia screening programme: hostility scale of brief symptom inventory, quality of marriage index, peacekeeping incidents and experiences scale, life events checklist assessing trauma history, physical health questionnaire, lost work days because of illness. The scales were separately judged and in case of exceeding criteria on at least one of the scales a brief on-site psychological interview to determine the need for follow-up intervention was done.</td>
</tr>
</tbody>
</table>
Strating 2010
Physical: energetic and biomechanical
Netherlands police personnel
Physical Competency Test (PCT):
Components of the PCT: Running 226.5 m on a track that included climbing an obstacle (1 m 10 cm) and jumping over low obstacles; pushing a 200 kg cart three times over a distance of 6 m; pulling the cart two times over the same distance; lifting and carrying a ball of 5 kg 18 times for 3 m a time; dragging a 48 kg dummy casualty for 5 m. The whole circuit was electronically timed.

Plat 2010
Physical: energetic and biomechanical
Netherlands fire fighters
Fire-fighting stair-climb test:
The test contains climbing the stairs with full fire-fighting equipment and self-contained breathing apparatus connected (weighing 21 kg together), plus carrying fire-fighting-related materials of 20 kg in the hands (such as two rolled fire hoses), climbing a height of 20 meters in about 110 steps as fast as possible. Test time and % of maximum heart rate were measured.

Plat 2010
Physical: energetic and biomechanical
Netherlands fire fighters
Fire-fighting simulation test:
The test contains all physical aspects of daily consecutive fire-fighting activities: putting on fire fighter turn-out gear; attaching self-contained breathing apparatus, putting on gloves and carrying two hoses; throwing, coupling and dragging hoses; setting up the ladder, climbing the ladder three times to the 10th rung with different fire-fighting gear; connecting a self-contained breathing apparatus and forcible entry simulated by hitting a resistance; dragging a hose filled with water; rescuing a dummy (80 kg for 30 m); walking a balance beam repeatedly; hose-dragging simulation (80 kg; 2 x 15 m); stepping/climbing over a fence; smoke dive simulation while carrying a hose, in a walking and squatting position for 5 x 3 m forwards and backwards; ceiling demolition simulation. The test time was measured.

Richmond 2008
Physical: energetic and biomechanical
UK military: royal air force
Representative service tasks, representing core operational tasks:
Test contains: single lift (representing loading and unloading a truck and lifting heavy objects); repetitive lift and carry (representing loading a truck, sand bagging, basic fire-fighting, stretcher carrying and building a sandbag sanag); a fire and manoeuvre task (representing ground defence on foot against an enemy attack); a dig (representing sand bagging and building a sand bag sanag), while wearing full combat 95 uniform including boots and helmet. Total mass carried was 21 kg, including webbing, SA 80 weapon and personal clothing. Minimum standards were set by an expert panel: for the single lift 22 kg, repetitive lift and carry 15 bags, fire and manoeuvre task 3 min 10 s and for the digging task 6 min 30 s.
### Table 2 continued

<table>
<thead>
<tr>
<th>First author &amp; year of publication</th>
<th>Job-aspect</th>
<th>Country and occupation study population</th>
<th>Extensive description of job-specific WHS activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sothmann 2004 18</td>
<td>Physical: energetic and biomechanical</td>
<td>USA fire fighters</td>
<td>Fire Suppression Evolution: Fire-fighting tasks: pick up sledgehammer and walk to stairway; climbing three flights of stairs and carrying sledgehammer; walk to a dummy; place sledge hammer; drag a dummy (75 kg); walk back to stairway and pick up sledgehammer; descend three flights of stairs; walk to hose and couple; drag hose over shoulder; walk to high-rise pack; lift and carry high-rise pack up three flights of stairs and place in designated spot; descend three flights of stairs; and pull down in a simulated pike pole apparatus; walk to finish line. Video tapes were judged for the pace of executing to determine the minimum standard on testing time, with a threshold of 8 min and 5 s.</td>
</tr>
<tr>
<td>Vanderburgh 2000 23</td>
<td>Physical: energetic and biomechanical</td>
<td>USA military personnel</td>
<td>Backpack run test: Development of backpack run test, running two miles as fast as possible, adding 20 or 30 kg of backpack weight.</td>
</tr>
<tr>
<td>Capodaglio 1996 21</td>
<td>Physical: energetic and biomechanical</td>
<td>Italy police personnel</td>
<td>Treadmill test, walking: Submaximal incremental treadmill test with a constant speed of 4.8 km/h with five grades (7%, 7.5%, 10%, 12.5%, 15%), each grade was performed for 6 minutes. Oxygen consumption, ventilation, respiratory exchange ratio, heart rate, arterial pressure, blood lactates were measured and ECG was monitored.</td>
</tr>
<tr>
<td>Gerkin 1995 19</td>
<td>Physical: energetic and biomechanical and Sense, vision and hearing</td>
<td>USA fire fighters</td>
<td>Fitness for duty is described with a physical ability test: victim rescue, forcible entry and ventilation, hose advance, stair climb with load, hoisting, and a carrying evaluation. A medical examination with physical examination, pulmonary function testing, audiometry, vision testing, and laboratory tests of blood and urine, and resting ECG. Minimum standard was not given, but a fire fighter who fails the test, should be removed from firefighting duties and placed in a rehabilitation program to expedite a return to full duty.</td>
</tr>
<tr>
<td>Study</td>
<td>Test Type</td>
<td>Country</td>
<td>Details</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------</td>
<td>----------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Louhevaara 1994</td>
<td>Physical:</td>
<td>Finland fire firefighters</td>
<td>Test drill consisting of five tasks assessing physical work capacity, executed with full personal protective equipment: walking without and with two rolls of hose; stair climbing and ascending; hammering a truck tire; going over and under bars; hose rolling. The minimum standard for the test was a maximum test time of 14.5 min.</td>
</tr>
<tr>
<td>Punakallio 2003</td>
<td>Physical:</td>
<td>Finland fire fighters</td>
<td>Functional balance test: Balance test over 2.5 m long plank, 9 cm wide and 5 cm thick. Walking forward on a plank to its middle, turn around 180° and walk backwards to the end of the plank. The task was then immediately repeated from the opposite end. The performance time and the number of errors were recorded.</td>
</tr>
<tr>
<td>Hatch 2009</td>
<td>Sense, vision</td>
<td>USA military personnel</td>
<td>Confirmation of vision readiness standards, with shooting test. The test contains shooting under five different visual acuity conditions at distances of 50, 100, 150, 200, 250, 300 m on 5 target presentations, and shooting 12 times determining (two times at each distance) whether an object is enemy or friend. The current standards of 20/40 or better uncorrected or corrected vision are a valid choice and recommended for US Army, US Navy, US marine corps and also for law enforcement, as their basic marksmanship skills are similar.</td>
</tr>
<tr>
<td>Weaver 2001</td>
<td>Sense, vision</td>
<td>USA military: army</td>
<td>Vision readiness: Test conducted by optometrists: entrance test and lensometry (determining prescriptions of current spectacles). Two technicians assessed visual acuity in two screening lanes at a distance and nearby. The soldiers capable of uncorrected 20/20 visual acuity in each eye at each distance had no further evaluation. The soldiers achieving the same level of visual acuity with a current spectacle prescription had the prescription duplicated. The remaining soldiers, including contact lens wearers, were given brief but thorough eye examinations. Non-contact tonometry was performed on all soldiers age 35 years or older.</td>
</tr>
<tr>
<td>Erneston 1996</td>
<td>Sense, vision</td>
<td>USA military: air force</td>
<td>Vision readiness: Tests consists of entrance visual acuity with or without corrective lenses, measurement of phorias, ocular motility, intraocular pressures, refraction, visual field assessment, pupillary function, biomicroscopy, and ophthalmoscopy.</td>
</tr>
</tbody>
</table>
Table 2 continued

<table>
<thead>
<tr>
<th>First author &amp; year of publication</th>
<th>Job-aspect</th>
<th>Country and occupation study population</th>
<th>Extensive description of job-specific WHS activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Büyükçakir 2005</td>
<td>Sense, hearing</td>
<td>Turkey military: aviators</td>
<td>Pure-tone audiogram: To detect hearing loss a pure-tone audiogram was performed at frequencies of 250, 500, 750, 1000, 1500, 2000, 3000, 4000, 6000 and 8000 Hz at noise intensities from 1 to 120 dB.</td>
</tr>
<tr>
<td>Greven 2009</td>
<td>Environmental exposure</td>
<td>Netherlands first responders (police officers and fire fighters)</td>
<td>Reactive airways dysfunction syndrome (RADS) was determined 6 years after a fire, as residents were exposed to combustion products in the aftermath of a chemical waste depot. The European Community Respiratory health survey questionnaire was taken and the self-reported exposure to combustion products, date of exposure and distance to the source were questioned. The emergency services first responders visited a lung physician for an interview and physical examination. Blood samples were obtained for immunological testing for inhalation allergens. Lung function was measured: forced vital capacity, forced expiratory volume in one second, histamine challenge testing. Each measurement was separately judged.</td>
</tr>
<tr>
<td>McDiarmid 2007</td>
<td>Environmental exposure</td>
<td>USA military: army</td>
<td>Health surveillance for exposure to depleted uranium. Identifying uranium-related changes in health by measuring uranium concentration in urine. And a clinical assessment that included a detailed medical history, an extensive exposure history, a thorough physical examination and laboratory studies, which included hematological and blood clinical chemistry measures, neuroendocrine and genotoxicological parameters, and semen quality measures. Urine samples were obtained for measurement of clinical chemistry parameters related to renal function and for urine U determinations. Neurocognitive assessment was performed as well. Each measurement was separately judged.</td>
</tr>
<tr>
<td>Vimercati 2006</td>
<td>Environmental exposure</td>
<td>Italy police: traffic warden</td>
<td>Exposure evaluation to urban air pollutants. Blood samples were taken to measure serum-specific IgE; urine samples were taken to measure exposure to PAH with 1-OH-Py; lung function was tested with spirometry and each subject had a CO exhaled monitor. Each measurement was separately judged.</td>
</tr>
</tbody>
</table>
Kelly 2002 30  Environmental exposure  USA fire fighters  Health surveillance programme for New York fire fighters and emergency medical technicians after an electrical transformer fire with exposure to polychlorinated biphenyls and polychlorinated dibenzofurans. Health surveillance consists of ECG, body weight and fat, fire department New York stepmill exercise test, spirometry, urine and blood analysis. Post-exposure results were compared with pre-exposure values.

Naghii 2006 33  Cardio-vascular  Iran military: army  Body weight management Description of content of body weight management: 1) appropriate assessment of BMI and fat; 2) weight-reduction or management with focus on increased physical activity and reduction of caloric intake by altering eating habits.

Soteriades 2005 34  Cardio-vascular  USA fire fighters  Examinations included detailed medical and occupational/environmental history, a physical examination, and routine laboratory tests. Focus is measuring BMI 703 x(weight in pounds)/(height in inches)² to determine obesity. Additional cardiovascular risk factors smoking status, blood pressure, blood glucose, lipids and updated medical history were determined. It is recommended to couple periodic medical evaluations with exercise and dietary guidelines and to exclude fire fighters with BMI > 40 from active duty.

Byczek 2004 35  Cardio-vascular  USA fire fighters  Cardiovascular risk factors were determined: obesity with BMI (weight in pounds)/(height in inches)² x 703; cholesterol and triglycerides with 12 hour fasting blood test; blood pressure was taken in seated position; glucose measured with 12 hours fasting blood test. Each measurement was separately judged.
Effectiveness of intervention studies (Table 3)

For the second aim of the study, seven intervention studies were included. One study aimed at psychological aspects and six at physical aspects in their study. Three studies were performed in Europe and four studies in North America. With the exception of one study published in 1993, all studies were published since 2004. The study design of the included studies contained four RCTs, one controlled trial, one retrospective cohort analysis and one study with a pre-post design. The search strategy included studies with a broad scope for work functioning. The interventions aimed at improving work functioning or outcomes related to it. Most outcome measures in the intervention studies were directly related to the aims of interventions in the short term. As a result, outcome variables ranged from cortisol measures in the blood to beliefs about lifestyle and from physical performance measured in a task simulation to the incidence rate of disease.

Methodological quality

The methodological quality of the studies for goal 2 varied between 13 and 23.5 out of a maximum of 31 points. The exact description for each study is given in Table 3.

Psychological aspects

One study evaluated psychological aspects. This trauma resilience training for police personnel was found effective by Arnetz et al. The 18 police officers in the study were divided into an intervention group and a control group. The intervention group got (nine police officers) 20 hours of relaxation and imagery training with mental skill rehearsal while the control group had no additional preparatory training. Evaluated in a critical incident simulation, the intervention group showed significantly less negative mood, better heart rate reactivity, a larger increase in antithrombin, cortisol drop was larger in control group (contrary to expectations) and better police performance compared to controls. So, on most outcome variables, the intervention was effective.

Physical aspects

The interventions aimed at improving the physical aspects of performing the job showed diverse results: the interventions for healthy lifestyle promotion in fire
fighters,\textsuperscript{38} physical readiness training in the army\textsuperscript{41} and resistance and endurance training in military personnel were effective.\textsuperscript{40} The exercise intervention programme for ambulance personnel was partly effective \textsuperscript{36} and respiratory muscle training for military personnel turned out to be not effective.\textsuperscript{39}

Elliot et al. described the promotion of a healthy lifestyle in fire fighters, comparing two different strategies to a control group: a team-centred curriculum and an individual motivational interviewing strategy.\textsuperscript{38} Both interventions resulted in increased fruit and vegetable consumption, and a significant effect was seen for BMI, with less weight gain during one year measures. An index of general well-being was significantly better in the two intervention groups compared to the control group. Both interventions were effective for most outcomes.

A physical readiness training for the US army was evaluated in the study of Knapik and colleagues,\textsuperscript{41} this study described four evaluations of the same programme. In the first three evaluation studies, the purpose of a 34 session 9-week training programme was to improve physical fitness, prevent injuries, progressively train soldiers and develop soldiers’ self-confidence and discipline. The training consisted of on-ground tasks (e.g. running, guerrilla drills), off-ground tasks (e.g. climbing drills, obstacle courses) and combatives. The programme was found to be effective with respect to injury risk and for passing the army physical fitness test comparing the control and experimental group, in those three evaluation studies. A fourth evaluation study compared the physical readiness training with another physical training programme; the programme took eight weeks with five training sessions per week. Both groups showed improved results on all simulated occupational military tasks.

In the study from Sperlich et al. a respiratory muscle training did not increase physical performance in the special force units and military personnel.\textsuperscript{39} The training consisted of 30 breath cycles twice a day (about 90\% of inspiratory mouth pressure to near maximum fatigue) using a lung training device. The training was not effective on all outcome parameters.

An endurance and resistance training for military personnel was evaluated on various military tasks in the study of Kraemer et al.\textsuperscript{41} The training consisted of 48 training sessions, in four different exercise groups. The four groups received a combined programme of training in endurance and resistance, or a programme of separate training for endurance or resistance. All training programmes turned out to be effective comparing pre- and post-measurements within the groups.
The occupational benefits of an exercise intervention programme for ambulance personnel were studied by Gamble et al. The authors had the idea to increase the physiological capacity with their exercise intervention programme, resulting in changes in work capacity and other physical fitness measures. The programme consisted of 20 training sessions, in which half of the sessions consisted of physical flexibility exercises and continuous indoor soccer, while the other half of the sessions included warming-up, physical flexibility exercises and a circuit of alternating aerobic and strength exercises. Significant and positive changes in the experimental group were found in flexibility, sit-up performance, standing broad jump, VO₂max, end lactate concentration and anaerobic threshold. In addition, a significant drop in the metabolic cost of the simulated emergency incident after the training was found. The experimental group favoured on most outcome variables. None of the post-intervention measurements between the experimental and control group showed an effect.

Environmental exposure

The comparison of two vaccines against influenza-like illnesses resulted in two effective vaccines, both for different subpopulations within military personnel. The study described the comparison of a live attenuated influenza vaccine (LAIV) versus a trivalent, inactivated influenza vaccine (TIV) among military service members. A distinction was made between recruits (members of the military who are just joining the army and undergoing basic training) and non-recruits (members of the military who completed the basic training). In a retrospective cohort study, the incidence of influenza-like illness was compared after immunization with either of the two vaccines. Results suggest favouring immunisation with LAIV for the recruit population, whereas for the non-recruit population, immunization against influenza with TIV was favoured.
**Table 3** Characteristics of included intervention studies describing the effectiveness of job-specific WHS

<table>
<thead>
<tr>
<th>First author &amp; year of publication</th>
<th>Job-aspect</th>
<th>Study population for experimental (EG) and control group (CG)</th>
<th>Description of WHS intervention</th>
<th>Outcome (variable)</th>
<th>Effectiveness of study on work functioning/ work-related injuries/and other related outcomes</th>
<th>Methodological quality [max. score 31]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arnetz 2009</td>
<td>Psychological</td>
<td>Sweden/USA Police officers N = 18 (EG N=9; CG N=9) Age: not reported (all having 1 year of police experience) Male: 100% Study design: RCT</td>
<td>Police trauma resilience training: initial psycho-educational session followed by ten weekly, 2 hour, small group sessions consisting of relaxation and imagery training with mental skill rehearsal.</td>
<td>During critical incident simulation: 1) Antithrombin and cortisol in blood 2) Heart rate 3) Behavioural benchmarks by expert from score 0 (poor) – 100 (excellent performance) 4) Profile of mood states 5) Perceived stress with VAS</td>
<td>1) Antithrombin ↑ EG &gt; CG** (0.12 EG vs. 0.01 CG) Cortisol: after simulation level ↓ CG &gt; EG (-1.48 EG vs. -1.46.44 CG) 2) Heart rate ↑ EG &lt; CG**, from presimulation to most critical moment in simulation (38.5 EG vs. 64.3 CG beats per minute). 3) Behavioural benchmarks by expert were better in EG** (298.9 EG vs. 253.4 CG). 4a) Less negative mood in EG** (16.6 EG vs. 24.9 CG). 4b) No significant difference in positive mood between EG and CG (17.9 EG vs. 17.7 CG) 5) Perceived stress ↑ EG &lt; CG from precritical to postcritical incident simulation (3.2 EG vs.16.0 CG).</td>
<td>23.5</td>
</tr>
</tbody>
</table>

**Note:** 1 = increase, ↓ = decrease

* = significant difference between pre-post measurement
** = significant difference between EG vs. CG
*** = significant difference for pre-post and EG vs. CG
### Table 3 continued

<table>
<thead>
<tr>
<th>First author &amp; year of publication</th>
<th>Job-aspect</th>
<th>Study population for experimental (EG) and control group (CG)</th>
<th>Description of WHS intervention</th>
<th>Outcome (variable)</th>
<th>Effectiveness of study on work functioning</th>
<th>Methodological quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elliot 2007</td>
<td>Physical USA Fire fighters</td>
<td>N = 481 (EG1 N = 186; EG2 N = 166; CG N = 129) Age: EG1 39 (SD 9); EG2 42 (SD 9); CG 41 (SD 9) Male: EG1 96%; EG2 97%; CG 98% Study design: RCT, with randomization on fire station level</td>
<td>Promoting healthy lifestyle alternative models: comparison of team-centred (EG1), individuals with motivational interviewing (EG2), and control condition (CG). A) EG1: 11 x 45 minute team sessions consisting of 3-6 activities. Content: nutrition, physical activity, and energy balance. B) EG2 group: 4 individual sessions with counsellor, additional 5 hrs. Discussing study goals, determining priorities influencing behaviour, reviewing baseline results, and identifying potential health behaviour changes. In both intervention groups: Firefighters’ Health &amp; fitness Guide, a booklet containing information about lifestyle, physical activity and nutrition. C) CG received test results of their health with brief explanation of values.</td>
<td>1) Surveys were completed (most with Likert-scale (1-7)): a) daily servings of fruits and vegetables b) % of total calories from fat c) healthy dietary behaviour d) dietary understanding e) positive dietary social support f) positive physical activity social support g) healthy physical activity behaviour h) physical activity beliefs and understanding i) overall well-being (5 points) 2) O2 uptake (Bruce protocol treadmill). 3) Sit-ups/one minute 4) BMI</td>
<td>1) a) Fruit and vegetables Baseline 1-year</td>
<td>22</td>
</tr>
</tbody>
</table>

1b, g, h; 2) No significant effects in the three groups between baseline and 1-year follow-up were found for: % calories from fat, healthy physical activity behaviour, physical activity beliefs and understanding, and peak O2 uptake.
Knapik 2009

Physical: energetic and biomechanical

USA
Military personnel
4 evaluation studies
1) N= 2580 (EG N= 1284 | CG N= 1296)
   Age: not reported
   Male: not reported
2) N= 1967 (EG N= 829 | CG N= 1138)
   Age: not reported
   Male: not reported
3) N= 3542 (EG N=1283 | CG N= 2259)
   Age: not reported
   Male: not reported
4) N= 32 (EG N=17 | TG N= 15)
   Age: not reported
   Male: not reported

Study design:
Controlled trial

For the first three studies:
Experimental group (EG): Physical Readiness training (calisthenics, dumbbell drills, guerrilla drills, interval and long-distance training) for 9 weeks, 3-5 times a week compared to traditional training (CG).

First three studies:
Risk of injury evaluated by examining medical records of participants; and passing rates in army physical fitness test.

Fourth study:
Evaluating 3.2-km run with a 32-kg backpack load; 400-m run with 18-kg backpack load; obstacle course; 5 x 30-m runs to and from prone position; 80-kg casualty drag for 50 m; standing vertical jump; standing horizontal jump; 3.2-km unloaded run; treadmill VO\text{\textsubscript{2}}\text{max}, body composition assessment (with DEXA).

Effect on injuries and pass rate in 3 studies:
1) CG has 1.5 times higher injury risk (95% CI 1.0-2.1); Pass rate on Army physical fitness test: 83% EG vs. 75% CG**
2) CG has 1.6 times higher injury risk (95% CI 1.2-2.0); Pass rate 88% EG vs. 84% CG**
3) Men in CG have 1.5 times higher injury risk than men in EC (95% CI 1.2-1.8), women in CG have 1.8 times higher injury risk than women in EC (95% CI 1.1-2.8); Pass rate 80% EG vs. 82% CG
4) EG and TG improved significantly on the simulated military tasks. Improvements same for EG vs. TG, except obstacle course: EG > TG**. VO\text{\textsubscript{2}}\text{max} and DEXA body composition changes not different between EG and TG.
### Table 3 continued

<table>
<thead>
<tr>
<th>First author &amp; year of publication</th>
<th>Job-aspect</th>
<th>Study population for experimental (EG) and control group (CG)</th>
<th>Description of WHS intervention</th>
<th>Outcome (variable)</th>
<th>Effectiveness of study on work functioning</th>
<th>Methodological quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sperlich 2009</td>
<td>Physical: energetic and biomechanical</td>
<td>Germany Special forces police squad (police/military) N= 17 (EG N=9</td>
<td>CG N= 8) Age: 24.9 (SD 3) Male: 71% Study design: RCT</td>
<td>Respiratory muscle training 6 weeks. EG training: 2 x 30 breath cycles to near maximum fatigue using a lung training device. Training resistance was adjusted weekly to maintain ~90% of inspiratory mouth pressure. CG: same training protocol without breathing resistance.</td>
<td>Physical performance: Maximal: VO$_2$ max (ml/min/kg), max. running speed (m/s), heart rate (bt/min). Submaximal (evaluated with treadmill ramp test protocol): heart rate, running speed at 4 mmol/l lactate threshold (V_t in m/s), rate of perception of respiratory effort (SRE), vital capacity (VC in l), forced vital capacity (FVC in l), forced expiratory flow in 1 second (FEV$_1$ in l).</td>
<td>Maximal VO$_2$max (ml/min/kg): EG Pre 53.5 Post 55.4 CG Pre 55.7 Post 55.8 Heart rate (bt/min): EG Pre 4.9 Post 4.9 CG Pre 4.8 Post 4.8</td>
</tr>
</tbody>
</table>

| | | | | | Physical performance: Maximal: VO$_2$ max (ml/min/kg), max. running speed (m/s), heart rate (bt/min). Submaximal (evaluated with treadmill ramp test protocol): heart rate, running speed at 4 mmol/l lactate threshold (V_t in m/s), rate of perception of respiratory effort (SRE), vital capacity (VC in l), forced vital capacity (FVC in l), forced expiratory flow in 1 second (FEV$_1$ in l). | Maximal VO$_2$max (ml/min/kg): EG Pre 53.5 Post 55.4 CG Pre 55.7 Post 55.8 Heart rate (bt/min): EG Pre 4.9 Post 4.9 CG Pre 4.8 Post 4.8 | 19 |
Physical and biomechanical

Endurance and resistance training in four groups for 12 weeks, 4 days per week:
- EG1: Resistance training (RT) and endurance training (ET)
- EG2: Upper body resistance training (UB) and ET
- EG3: only RT
- EG4: only ET

Resistance training consisted of a) strength exercises for upper and lower body and trunk with sets of 5, max. repetition 3-10, with a rest of 2-3 minutes. b) hypertrophy exercises for trunk, upper and lower body, with 3 sets, max. repetition of 10-25, with 1 minute rest.

Endurance training consisted of running long distance (max. running distance in 40 minutes) and sprint interval (400-800 m) with exercise-to-rest ratios 1:4 to 1:0.5.

Evaluating tests:
- Army physical fitness test with push-ups (max. in 2 minutes); sit-ups (max. in 2 minutes); 2-mile run unloaded (in seconds).
- Additionally, 2-mile loaded run, carrying 44.7 kg measuring end heart rate (in bt/min), rating of perceived exertion and time (in seconds); body composition assessing body mass (in kg); fat free mass (in kg); % body fat and to assess leg power counter-movement jump height (in cm).

<table>
<thead>
<tr>
<th>Test</th>
<th>EG1</th>
<th>EG2</th>
<th>EG3</th>
<th>EG4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push-ups:</td>
<td>62.8</td>
<td>50.6</td>
<td>51.2</td>
<td>44.5</td>
</tr>
<tr>
<td>Sit-ups:</td>
<td>68.9</td>
<td>58.4</td>
<td>52.9</td>
<td>47.6</td>
</tr>
<tr>
<td>2-mile run (s):</td>
<td>804</td>
<td>906</td>
<td>888</td>
<td>924</td>
</tr>
</tbody>
</table>

Body mass (kg):
- EG1: 74.2
- EG2: 75.6
- EG3: 76.6
- EG4: 75.3

Fat free mass (kg):
- EG1: 63.6
- EG2: 62.0
- EG3: 61.8
- EG4: 61.1

% body fat:
- EG1: 13.1
- EG2: 17.4
- EG3: 18.3
- EG4: 18.5

2-mile run loaded: did not differ significantly for heart rate, rating of perceived exertion and time for pre versus post measures in each group, except for the time in EG1* and EG2*.

Jump height ↑ in EG1* and EG3* pre versus post measurements (exact data were not reported in original article).
<table>
<thead>
<tr>
<th>First author &amp; year of publication</th>
<th>Job-aspect</th>
<th>Study population for experimental (EG) and control group (CG)</th>
<th>Description of WHS intervention</th>
<th>Outcome (variable)</th>
<th>Effectiveness of study on work functioning</th>
<th>Methodological quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gamble 1993</td>
<td>Physical: energetic and biomechanical</td>
<td>UK Ambulance personnel N = 14 (EG N= 8</td>
<td>CG N= 6)</td>
<td>Exercise intervention programme for experimental group (EG): 10-weeks, twice per week intensive training; First session in the week: 10 minutes flexibility exercises, followed by 45 minutes continuous soccer; Second session in the week: 5 min, general warm-up, followed by 10 min flexibility session, a circuit of alternating aerobic and strength exercises, using simple equipment (such as medicine balls). CG: programme not reported.</td>
<td>Two evaluation tests which were performed pre and post of the intervention period: 1) General measurements related to the intervention goals 2) Physical working capacity changes measured by a staged incident simulation: ascending four flights of stairs, dragging a manikin, and transporting it downstairs using a standard carry chair. Relative effort during the incident was assessed by measures of: ventilation, heart rate and blood sample (for blood lactate). 3) Maximal treadmill test: ventilation measures and blood samples.</td>
<td>1) General measurements</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Standing broad jump (cm)</td>
<td>EG 175</td>
<td>CG 178</td>
<td>179</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Flexibility (cm)</td>
<td>EG 12.9</td>
<td>CG 14.6</td>
<td>16.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sit-ups (n/30 sec)</td>
<td>EG 16</td>
<td>CG 18</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>VO2max (ml/kg/min)</td>
<td>EG 43.5</td>
<td>CG 47.8</td>
<td>4*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mean O2 consumption</td>
<td>EG 36.5</td>
<td>CG 33.3</td>
<td>3*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Heart rate</td>
<td>EG 148</td>
<td>CG 138</td>
<td>5*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>End lactate concentration</td>
<td>EG 5.9</td>
<td>CG 5.4</td>
<td>4*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Peak O2 consumption during incident (% VO2max)</td>
<td>EG 81</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2) Staged emergency incident</td>
<td>3) Max. treadmill test: Max. O2 consumption</td>
<td>EG 43.5</td>
<td>47.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Anaerobic threshold (% of max. O2 consumption)</td>
<td>EG 62</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No significant changes in pre-post comparisons for EG and CG for: weight, % body fat, blood pressure (only EG measured), hand grip strength (only EG measured), quadriceps or hamstring strength (only EG measured).</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Comparison of two influenza vaccines (trivalent, inactivated influenza vaccine (TIV) vs. live attenuated influenza vaccine (LAIV), in two periods.

Incidence rate of Influenza-like illness recorded in defence medical surveillance system

Non-recruits: incidence rate (95% CI) of LAIV: 1.17 (1.14-1.20); and varies between the three analysis cohorts from 1.25 to 1.33 compared to TIV

Recruits: incidence rate (95% CI) of LAIV vaccine varies between the cohorts from 0.49 (0.41-0.59) – 0.82 (0.62 – 1.09) compared to TIV

Eick

2009

Environmental exposure

USA
Military service members (soldiers, airmen and sailors and recruits and non-recruits)
Non-recruits N = 145844 (TIV N = 937282 | LAIV N = 521562)
Recruits N = 118292 (TIV N = 80410 | LAIV N = 37882)
Age: not reported
Male: Non-recruits 85.6%; Recruits 81.5%
Study design: Retrospective cohort analysis

49
Discussion

For the first objective, 24 studies described several job-specific WHS activities on psychological, ‘physical’ (energetic, biomechanical and balance), sense-related, environmental exposure or cardiovascular job requirements. Seven studies described the effectiveness of WHS interventions: a trauma resilience training, healthy lifestyle promotion, physical readiness training, respiratory muscle training, endurance and resistance training, a physical exercise programme and comparing vaccines. Six out of the seven intervention studies were shown to be effective on (some of) the chosen outcomes; one of the effective studies gave a decisive answer about which vaccine was to be used most effectively. Besides, one negative study was found. The methodological quality of the intervention studies varied, but all scored a minimum of 42% of the maximum score.

For the first aim of this review, several examples of job-specific parts of WHS were found. However, for the second aim of the review, effectiveness studies of the job-specific interventions were scarce. Possible reasons could be that other facets of WHS were tested first, like test quality, feasibility or acceptability. The authors of the present study stress the importance of these other facets. Many descriptive studies were published recently, so it is likely that effectiveness studies of job-specific WHS interventions will be more common in searches in the upcoming years. Nevertheless, this review resulted in finding some high-quality designed examples of effective job-specific intervention studies.

The found 31 studies in this review focus on different aspects of WHS, but are all job-specific for the studied occupation. Job-specific means that the measured aspect is a risk for the health or safety of the employee or the public, due to the tasks in the job. Some of the different aspects covered in this study were the traditional WHS, as measuring late responses to exposure in real work. However, some less traditional aspects of WHS were covered also and the job specificity of some of these studies might need some explanation. The studies about the cardiovascular aspect were included because fire fighters and soldiers experience pronounced cardiovascular stress while performing heavy physical job tasks, these exposures produce extraordinary cardiovascular stresses and may increase the risk of cardiovascular events, in which the safety of the employee, colleagues and the public is not guaranteed. The same concerned the job specificity of the study describing an intervention for healthy lifestyle, as outcomes are indirectly related to cardiovascular aspects. Besides, contact with people is inherent to
a task of the soldier, and therefore they have an increased chance of getting or spreading influenza and therefore this aspect is considered as job-specific.42

The aim of the review was to find job-specific WHS activities. Many studies in this review were excluded because the absence of 1) a clear relation to the job requirements, and 2) a description of job-specific WHS activity or medical evaluation or to test the ability to perform job tasks. Nevertheless, the 31 studies included in the review show that the line of reasoning from exposures and activities in the job to choices of WHS activities should be a basic principle of the WHS. This principle is globally practiced and researched, as was mirrored in the different continents the studies came from. Internationally, the different countries had different objectives for the WHS activities. In the USA, WHS is mostly considered as a medically oriented programme,19 however, recently in the Netherlands, in the legislation about WHS testing requirements for the job was entered.1 Some of the included studies focused on medical functioning, while assessing work functioning in a job-specific way should lead to more valid results. As a result of these differences worldwide, some differences were found between the included studies. For example, in the fire fighter studies, it became clear that for testing physical aspects in a job-specific manner, the same approach is used in many countries: having a track with simulated fire-fighting tasks as a test for functioning. For psychological aspects, some primary preventive as well as secondary preventive job-specific health surveillance activities were described. For the environmental exposure studies, the reasons for starting a WHS activity were job-specific; however, in some of those studies, not always a clear description was made by the authors of the relation between the job requirements and the measurement.14,30 In the intervention studies, it was clear how the interventions related to the job. Although the relation between the goals of the intervention with the job existed, the chosen exercises were not always job-specific. For example, in the study of Gamble et al.,36 one of the exercises in the intervention for ambulance personnel was playing soccer. The result of the job-specific evaluation test of that study was significant anyhow: the training programme resulted in a decreased metabolic cost during the simulation of an emergency incident. If the ideas of Åstrand et al. were followed, a specific training for the activity under study could lead to an even better result.11

A few studies concerning psychological WHS activities or interventions were found, compared to the number of studies found for physical aspects. Within the first
goal three studies for psychological versus ten studies for physical related activities were found and for the second goal were one and five studies found for psychological and physical interventions respectively. It seems that in those jobs the interest for the physical part of the job exist since the beginning of the nineties, while the studies for the psychological part started only since the beginning of this century. Both aspects are presented in those jobs and should therefore, in our opinion, be part of a periodical monitoring system. The best WHS activities should be determined by studying all relevant aspects of the jobs, in particular those aspects which were infrequently studied till now.

Due to the fact that our search strategy included job titles and synonyms of WHS, we found a very broad spectrum of studies; as a result, the intervention studies included several outcome measurements related to work functioning. The outcome measurements were proxies of work functioning, instead of measuring work functioning directly. If the proxies improved, it was assumed that work functioning would improve as well. Proxies were sometimes closely related to work functioning, as in the study of Arnetz et al., where the behaviour of the police personnel was judged by an expert, during a simulated incident. However, proxies were sometimes less related to work functioning, like the number of sit-ups per minute for military personnel and fire fighters. The job-specific interventions of the included studies aimed at improving aspects related to work functioning and were mostly effective for the goals of their intervention. However, it is not guaranteed that there is improve of work functioning with those interventions. We think that there was an improvement in the studies by measuring job-specific outcomes related to work functioning, but future studies should still measure outcome variables that are as closely related as possible to work functioning and are appropriate for the intervention.

This review did not result in evidence pro- or contra-specific interventions because of the different outcome measures. However, each study got a score on methodological quality, with the list of Downs and Black. From the scores, it can be concluded that the methodological quality of the studies was variable, due to the different designs that were included for this review (RCT as well as pre-post-design). The methodological quality assessment in this study gave the readers the opportunity to consider the study quality.

For this review, three databases were searched, Medline, PsycINFO and OSH-update. The search resulted in peer-reviewed articles as well as in grey literature.
We assumed that in the grey literature some WHS activities could be described, which were not in peer reviewed journals. Finally, the review included one study of Levin et al. that was published in a weekly report, which was considered as grey literature.\textsuperscript{14}

The present review showed that job-specific WHS activities were described in a reasonable number of studies. However, the effectiveness of job-specific WHS activities was studied infrequently. In the future, we advise researchers and practitioners to describe (effective) job-specific interventions in the international published literature as this information can help the specific occupational group. We recommend that for all relevant aspects of the job, in particular for those aspects which were infrequently found in this review, such as the psychological aspect. In addition, making policymakers and the sectors familiar with interventions that were found to be effective in their occupation will help them in their decision-making on which interventions to implement.

**Conclusion**

It can be concluded that for each of the occupational groups of fire fighters, ambulance, police and military personnel, at least one study was found to describe job-specific WHS activities. The studies describing existing job-specific WHS activities showed job-specific WHS activities for psychological, physical, sense-related, environmental exposure and cardiovascular aspects. Compared to studies focusing on physical tasks, few studies were found that focus on psychological tasks. Effectiveness studies after the job-specific interventions with respect to related outcomes to work functioning were found in fewer articles. Most studies have shown the intervention to be effective at least in some of their chosen outcomes. In the future, we recommend studying the effectiveness of job-specific WHS activities.
Occupational health care in high-demand jobs

References
4. NVAB. Guideline Workers' Health Surveillance [In Dutch: Leidraad Preventief medisch onderzoek]. Utrecht, the Netherlands, NVAB, 2005.
17. Plat MJ, Frings-Dresen MHW, Sluiter JK. Clinimetric quality of the fire fighting simulation test as part of the Dutch fire fighters workers' health surveillance. BMC Health Services Res 2010;10(32).
Occupational health care in high-demand jobs