

## Abstracts

**Introduction** Respiratory protective devices are used to protect workers from inhalation of hazardous atmospheres. Beside the aspects related to adequacy of the device in protecting the worker, it is necessary to investigate also the aspects related to the suitability of the device such as ergonomic factors: one of the most common complain of the workers is related to the face thermal sensation perceived as hot.

In this study, the effect of a power assisted filtering device incorporating a full face mask on the thermophysiological response of a thermal manikin is investigated.

**Methods** The experimental protocol schedules tests on a standing sweating thermal manikin (Newton) in the climatic chamber, where hot conditions were simulated (air temperature at 34°C, relative humidity at 32%). Two conditions were tested: manikin with the respirator powered on (CR) and manikin without the respirator (CC). Two different levels of metabolic rate were set (1 MET and 3 METs).

**Results** Results show:

- at 1 MET the manikin is in thermal balance with the external environment with or without respirator.
- at 3 MET, although the thermoregulation system is very stressed (the rectal temperature increases continuously with or without respirator), the effect of the respirator produces a small decrease of the local and global temperatures and also of the amount of sweat generated by active thermoregulation that reaches its maximum value of 30 g/min in CC). The body reaches sensation between 'hot' (CC) and 'warm' (CR) while the face sensation increases rapidly reaching the value correspondent to 'very hot' both for CC and CR.

**Discussion** At M=1 MET and M=3 MET the effect of the hot environment is weakened by the action of the respirator which allows a continuous heat exchange removing and renovating the air layer around the face without providing an additional thermal load.

### 1568 SEASONAL CHANGES OF PHYSIOLOGICAL RESPONSES ASSOCIATED WITH HEAT ACCLIMATISATION

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**Introduction** It is known that heat stroke is likely to occur when workers are not acclimatised to heat. The purpose of this study is to clarify if the physiological responses of heat acclimatisation are different by the seasonal difference of the temperature in living environment.

**Methods** Four healthy males in twenties repeated a 20 minutes-exercise on an ergometer at 40% VO<sub>2</sub>max for three times in three different thermal environments in the artificial climate room controlled at 28°C, then elevated to 34°C and finally to 40°C where relative humidity was fixed at 50%. Each exercise was followed by 20 minutes-rest period kept seated in the adjunct room at 24°C. They were asked to exercise consecutively for five days. This series of intervention was repeated during summer and winter seasons. We continuously measured their auditory canal temperature (*t*<sub>ac</sub>) and heart rate (HR). We also examined their sweat Na<sup>+</sup> and K<sup>+</sup> concentration and estimated their sweat volume from the body weight loss.

**Result** The observed *t*<sub>ac</sub> and HR at the end of the exercise were generally higher in winter compared to summer. The sweat volume gradually increased for five days and the volume during the first exercise period at 28°C was larger in summer; however, the amount of increase was larger in winter. The sweat Na<sup>+</sup> concentration positively correlated with sweat volume and we observed smaller elevation of Na<sup>+</sup> concentration along with the increase of sweat volume in summer.

**Discussion** The lower *t*<sub>ac</sub> and HR, earlier sweating, and smaller elevation of Na<sup>+</sup> concentration during heat acclimatisation in summer seem to be caused by the different thermal condition of living environment

### 841 PEOPLE AT ELEVATED RISK OF DEVELOPING HEAT-RELATED ILLNESS AT WORKPLACE: A CASE-CONTROL STUDY

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**Introduction** Primary causes of heat-related illness (HRI) at work are:

- extreme heat and humidity,
- heavy work load,
- continuous exertion and infrequent rest,
- clothes with poor vapor-permeability, and
- personal health condition.

Empirical research has not been performed to investigate the effect of underlying health problems to HRI.

**Methods** A case-control study was performed by asking occupational health staffs to report all HRI cases occurred at their workplaces in 2015 and 2016. One co-worker control of the same gender at the closest in age was also reported for each case. Target population included:

- 26 large manufacturing factories,
- 15 major construction companies,
- all traffic guard companies in Japan, and
- a fire stations in Kitakyushu city.

Their results of the periodic health examination were collected to evaluate the underlying health problems of obesity (BMI >25), impaired glucose tolerance, IGT (HbA1c ≥6.5%, fast blood sugar ≥126 mg/dL, and/or casual blood sugar ≥200 mg/dL), high blood pressure, HBP (≥140/90 mmHg), and dyslipidemia (LDL-C ≥140 mg/dL, HDL-C <40 mg/dL, or TG ≥150 mg/dL). Data were statistically compared between the case and the control using JMP Pro 13.

**Results** Overall incidence rate of HRI at the examined workplaces was 0.065% (114 cases/1 76 094 person-year). A total of 102 pairs (n=204) could be compared. Cases showed higher BMI (p=0.046) and visceral circumference (p=0.045). Cases and controls included 12 and 2 persons with IGT, respectively (p=0.005). Multiple logistic regression analysis revealed increase of HbA1c elevated the risk of developing HRI (OR 16.76 [95% CI: 2.44 to 165.5], p=0.0014), whereas LDL-cholesterol showed protective effect (OR 0.97 [0.95–0.99], p<0.001).

**Conclusion** Significantly elevated risk of developing heat-related illness was observed among workers with IGT.

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Impaired endothelium-dependent vasodilatation among workers with IGT may decrease heat dissipation by conduction, convection, radiation, and sweat evaporation and may pose a risk to develop HRI.

**1536**

### OCCUPATIONAL HEAT ILLNESS IN OUTDOOR WORKERS BEFORE AND AFTER THE IMPLEMENTATION OF A HEAT STRESS AWARENESS PROGRAM

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**Introduction** Heat Stress is an occupational hazard expected to increase in severity and breadth with climate change. Workers exposed to heat and hot environments can have increased injuries, exacerbation of disease, reduced productivity, and heat illness resulting in death. Strategies to respond are mitigation policies and preparedness. The National Institute of Occupational Safety and Health's (NIOSH) Revised Criteria for a Recommended Standard, Occupational Exposure to Heat and Hot Environments outlines training for and medical surveillance and research of worker populations exposed.

**Methods** Heat illness and worker's compensation costs before and after the implementation of a Heat Stress Awareness Program (HSAP) were evaluated retrospectively in a cohort of outdoor municipal workers from 2010–2016. The HSAP brought training and medical surveillance to at risk workers as outlined in NIOSH's Criteria for a Recommended Standard Occupational Exposure to Heat and Hot Environments.

**Results** 526 outdoor workers met inclusion criteria. Prior to implementation of the HSAP the occupational heat illness rate was 3%, this decreased to 1% the first three years of the program and less than 1% the last two years. Workers with heat illness were more likely to be extremely obese ( $p<0.0003$ ) and more likely to have two or more heat illness risk factors. Total worker's compensation costs decreased approximately 50% per illness or less than prior to HSAP.

**Discussion** Training, determining fitness for duty and regular medical monitoring prior to work in a hot environment may decrease frequency of occupational heat illness and occupational medical care costs in exposed workers. This study supports NIOSH's Occupational Exposure to Heat and Hot Environments' promulgation into U.S. law which can provide protection to vulnerable U.S. workers and may provide valuable guidance to the unknown numbers that will be added to the climate-vulnerable population as the global temperature continues to rise.

**1509**

### TRANSITION OF GOVERNMENTAL GUIDELINES TO PREVENT HEAT STROKE AT WORK IN JAPAN

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**Introduction** In Japan, the prevention of fatal heat strokes at work has become more important along with the global warming.

**Methods** This research introduces the transition of methods to prevent heat stroke at workplaces in Japan within the latest 20 years.

**Results** The number of fatal heat stroke at work in Japan had been less than 20 until 1993; however, it exceeded 20 in 1994 and in 1995, consecutively because of the heat wave attack during summer. Therefore, in 1996, the guideline on prevention of heat stroke at work was formulated and publicised by the Labour Standard Bureau, Ministry of Health, Labour and Welfare. It advocated fundamental methods for the prevention of heat stroke such as working environment management, work management, health management and occupational health education at workplaces exposed to heat stress. Besides, the government started to announce the number of compensated cases of heat strokes every year. In 2005, another guideline was issued advocating the measurement of WBGT at the workplaces and the utilisation of the value for appropriate countermeasures. In 2009, the first guideline was totally revised by adding many new contents: the utilisation of WBGT, the promotion of heat acclimation, the method of desirable water and salt intake, the consideration for vulnerable persons with underlying diseases and the management of daily physical conditions. In addition, due to the impact of the Great East Japan Earthquake in 2011, nuclear power generation in Japan was temporarily suspended, and the need for the development of measures against heat stroke that did not use electric power as much as possible had increased, from the viewpoint of energy saving. Therefore, sports drinks and oral rehydration, salt candy, cool best to cool the body, clothing of quick-drying/cool feeling materials, etc. have started to be sold and widely spread.

**Discussion** Although the motivation for the prevention of heat strokes have spread rapidly during the last 20 years, according to the guidelines formulated by the government, the number of mortality often exceeds 20, including 47 in the historically worst year of 2010. While easy and inexpensive devices to prevent heat stroke such as nutritional supplements and special wears have become widespread, it is important to verify its effectiveness in an objective manner and to standardise the definition of devices able to cool down the body heat.

## Toxicology of Metals

**1275**

### METHYLTRANSFERASE GENE EXPRESSION AS POSSIBLE MEDIATOR OF THE EFFECTS OF ARSENIC EXPOSURE: AN EPIGENETIC STUDY IN FOUNDRY WORKERS

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**Introduction** Arsenic is an environmental carcinogen that undergoes methylation while metabolised. Subsequent intracellular methyl groups depletion can decrease global DNA methylation, facilitating carcinogenesis. On the other hand, hypermethylation in promoter regions of tumour suppressor genes related to arsenic exposure has been observed *in-vivo*. The effects of arsenic on enzymes regulating gene-specific methylation (DNA-methyltransferases) have not been fully