Background Report Factsheet: Occupational exposure to heat in the Netherlands

1. Introduction

Summers in the Netherlands are getting hotter, and people are paying more attention to problems caused by extreme heat. Workers may be especially at risk, as physically heavy work and protective clothing can make them feel even hotter. Moreover, workers may be less able to avoid hot environments.

Heat stress happens when the body absorbs more heat than it can get rid of. Heat stress at work can cause symptoms like fatigue and concentration problems. Acute health effects include heat exhaustion and heat stroke, or even death. Excessive heat can also negatively impact workers' productivity and safety [1]. Prolonged exposure can lead to more chronic conditions such as kidney, heart, or respiratory conditions, and mental health problems [2], [3], [4].

To better understand occupational heat stress exposure, we created a tool that estimates the number of hours workers experience heat stress in the Netherlands. Our goal for the factsheet ' Beroepsmatige blootstelling aan hitte in Nederland' was to provide a short overview on heat stress in the Dutch working population. This background report provides more details on the methodology and results on the estimated heat stress hours and size of the population by job.

2. Methodology

To evaluate heat-related stress among Dutch workers, we developed a heat stress job exposure matrix (Heat-JEM) – a model to estimate the hours of heat stress experienced per occupation considering weather conditions and job specific characteristics [5].

By combining the Heat-JEM with population data, we assessed heat exposure prevalence and magnitude across the entire Dutch working population.

2.1 Heat-JEM

The Heat-JEM was developed based on standards set by ISO, specifically ISO 7243, 8996, and 9920 [6], [7], [8]. It considers meteorological conditions, as well as job specific physical activity levels, work clothing and the presence of local heat or cooling sources. In the Heat-JEM, the wet bulb globe temperature (WBGT) index integrates these factors as described by the ISO standards, allowing for comprehensive, job-specific heat stress estimates.

The WBGT index provides a way to evaluate the total heat stress to which a person is exposed and for establishing the presence or absence of heat stress. It evaluates the effect of heat on a person during his or her total working day (up to 8 h). It considers not only air temperature like a regular thermometer, but also includes humidity, radiation (i.e., a measure of sunlight), and wind, which all affect how easily the human body can cool itself.

We calculated the outdoor and indoor WBGT using a database on meteorological data (ERA5 reanalysis meteorological data provided by the European Centre for Medium Range Weather Forecasts (ECMWF) [9]). Then, the outdoor and indoor WBGT values were adjusted for job-specific clothing and local heat or cooling sources, resulting in the effective WBGT.

In the Heat-JEM, we defined heat stress as the effective WBGT exceeding the reference WBGT. The reference WBGT is a tolerance threshold for heat, determined by job-specific metabolic rate (determined by body surface area and job-specific physical activity) and then adjusted by acclimatization status [5]. For the factsheet, we assumed the entire Dutch working population was unacclimatized to heat.

2.2 Exposure assessment

Using the Heat-JEM, we assessed job-specific annual heat stress hours from 2020 to 2023 and then averaged the heat stress hours per occupation to estimate the recent averages for annual heat stress exposure.

Based on the presence of local heat sources and the time spent outdoors, we categorize occupations into three types: man-made, weather conditions, and mixed heat sources.

2.3 Population data

To estimate the number of workers per occupation in the Netherlands, we used the National Employment Survey (NEA) data from year 2023. In short, the survey was completed by a random sample (n=61819) of Dutch workers reporting their occupation encoded to the 4-digit International Standard Classification of Occupations 2008 (ISCO-08). A weighting factor per respondent was calculated using several demographics factors, including occupation, to obtain a survey dataset representative of the Dutch working population [10], [11].

Since the Heat-JEM was developed in ISCO 1988 (ISCO-88(COM) for European purposes), we needed to convert the population data from ISCO-08 to ISCO-88(COM). Firstly, we converted the population data from 4-digit ISCO-08 to 4-digit ISCO-88 using official conversion table published by the United Nation (UN) International Labour Organization (ILO) [12]. When a single 4-digit ISCO-08 code matches with multiple 4-digit ISCO-88 codes, we selected the most likely ISCO-88 per ISCO-08 based on the available and comparable population statistics. The population statistics were obtained from SYNERGY control subject population data from a Europe-wide lung cancer case-control study [13]. Then, we linked the population data from ISCO-88 to ISCO-88(COM) according to the guidelines in the user manual for the occupational statistics community [14], [15].

3. Results

In total, more than 4% of the Dutch working population (around 358,000 workers) experienced heat stress for more than 80 hours annually (on average between 2020-2023).

The most common heat affected occupations were mainly from the industry, hospitality, and safety sector (Figure 1). Cooks, police and bakers were the largest heat-affected occupations in the Netherlands with over 100,000 workers in total.

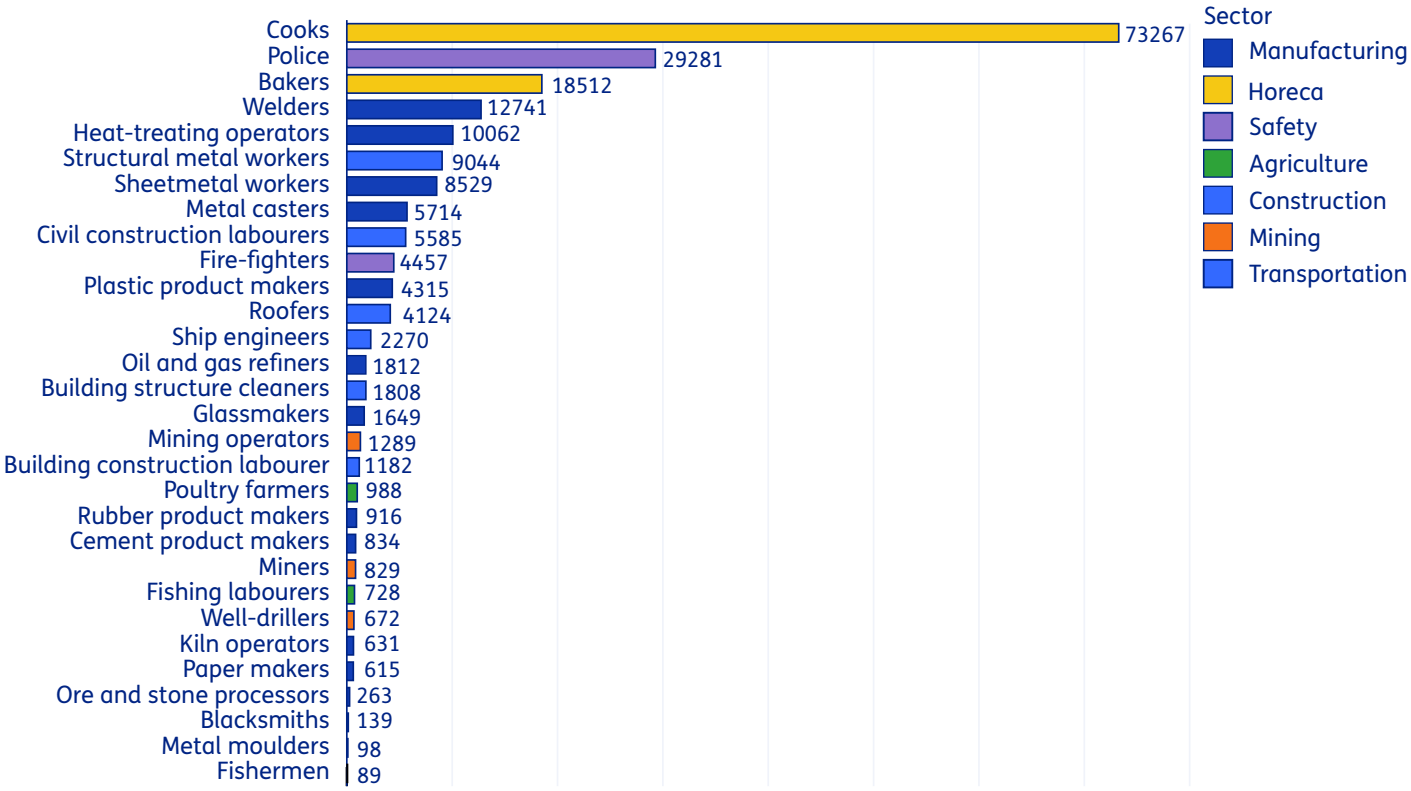

Figure 1: Number of workers in jobs experiencing at least 80 hours of heat stress per year in the top 30 most common occupations.

Workers in industry and hospitality, especially cooks and metal operators, experience the highest number of hours of heat stress, since they work near heat sources year-round (maximum 1242-1260 hours per year, Table 1). Workers in other industries, including agriculture, construction, mining, and safety, also experience heat stress. But since heat exposure mainly comes from outdoor weather conditions, it happens less often (maximum 162-533 hours per year).

From the top 30 occupations with the highest numbers of hours of annual heat stress exposure, most workers were exposed to man-made heat sources (57%), while 16% of the workers were exposed to weather-related heat and 27% were exposed to a combination of both sources.

Table 1: Description of top 30 occupations with the highest number of annual heat stress hours

Sector	Occupation	Number of workers	Heat stress hours	Heat source
Manufacturing	Metal moulders	98	1260	Man-made
Manufacturing	Kiln operators	631	1256	Man-made
Manufacturing	Metal casters	5714	1249	Man-made
Horeca	Cooks	73267	1242	Man-made
Manufacturing	Chemical/heat-treating operators	10062	739	Man-made
Horeca	Bakers	18512	725	Man-made
Manufacturing	Blacksmiths	139	669	Mixed
Manufacturing	Rubber product makers	916	615	Man-made
Manufacturing	Plastic product makers	4315	614	Man-made
Manufacturing	Paper makers	615	611	Man-made
Safety	Fire-fighters	4457	533	Mixed
Manufacturing	Welders	12741	517	Mixed
Agriculture	Fishermen	89	496	Weather condition
Construction	Civil construction labourers	5585	365	Mixed
Manufacturing	Ore and stone processors	263	325	Mixed
Mining	Miners	829	295	Mixed
Agriculture	Fishing labourers	728	291	Weather condition
Transportation	Ship engineers	2270	271	Mixed
Mining	Well-drillers	672	240	Mixed
Construction	Building construction labourers	1182	237	Weather condition
Construction	Structural metal workers	9044	236	Mixed
Manufacturing	Cement product makers	834	224	Mixed
Manufacturing	Sheetmetal workers	8529	216	Mixed
Mining	Mining operators	1289	215	Mixed
Manufacturing	Glassmakers	1649	201	Man-made
Safety	Police officers	29281	198	Weather condition
Manufacturing	Oil and gas refiners	1812	198	Mixed
Agriculture	Poultry farmers	988	179	Mixed
Construction	Roofers	4124	163	Mixed
Construction	Building structure cleaners	1808	162	Weather condition

4. Discussion

Our result shows the general pattern of heat stress exposure in the Dutch working population, based on general working conditions for occupations. We did not consider specific work situations within each occupation, which may differ significantly between different persons and workplaces. We also assumed workers are not acclimatized to the heat, which might not be true for those who work near heat sources all year. While these limitations of our results exist, the Heat-JEM is a valuable framework that can be adapted to fit specific working conditions and provide sector- or company-specific heat assessment. It is also possible to take into account acclimatization. This assessment of heat stress among Dutch workers provides insights for strategies to help workers adapt to heat so that they remain safe and productive in hot working environments [16].

The health risk of occupational heat exposure is preventable. Various effective heat stress preventive interventions have been developed, including better air ventilations or providing shade in hot workplaces, adjusting working hours or breaks during hot periods, adequate hydration, and light clothing when applicable [17], [18].

5. Acknowledgement

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6. Referenties

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