

HSE Workplace Health Expert Committee  
(WHEC)

**Risks of bakery work: the adverse  
effects of working in high  
temperatures and of  
occupational asthma**



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## **Risks of bakery work: the adverse effects of working in high temperatures and of occupational asthma**

This report, its contents, including any opinions and/or conclusions expressed, are those of the committee members alone and do not necessarily reflect HSE policy.



## Foreword

The development of policy in HSE needs to be informed by the best available contemporary scientific evidence. In 2015, HSE formed the Workplace Health Expert Committee (WHEC) to provide independent expert advice to them on:

- New and emerging workplace health issues
- New and emerging evidence relating to existing workplace health issues
- The quality and relevance of the evidence base on workplace health issues

Questions about workplace health issues come to WHEC from many sources, which include HSE, trade unions, employers, interested individuals and members of WHEC. WHEC's responses to these questions are published online as reports to HSE, as position papers following investigation, or as a briefer response where the current evidence is insufficient to warrant further investigation. In cases where the evidence-base is limited WHEC will maintain a watching brief and undertake further investigation if new and sufficient evidence emerges.

In its formal considerations, WHEC aims to provide answers to the questions asked based on the available evidence. This will generally include review of the relevant scientific literature, identifying the sources of evidence relied on in coming to its conclusions, and the quality and limitations of these sources of evidence.

The purpose of WHEC reports is to analyse the relevant evidence to provide HSE with an informed opinion on which to base policy. Where there are gaps in the evidence, which mean that this is not possible, WHEC will identify these and, if appropriate, recommend how the gaps might be filled.

## Executive Summary

The issues of high working temperatures in bakeries and bakers' asthma were brought to the attention of WHEC by the Bakers, Food and Allied Workers Union.

The committee could find no environmental data on the temperatures experienced at work by UK bakery workers and there seems to be no reported evidence of any relevant adverse health effects in this group. Robust data on current thermal (and other environmental) parameters and exposures is needed if further understanding of the potential risks of heat exposure on health, wellbeing and accidents are to be determined.

What information is available suggests that exposures to flour in UK bakeries are frequently higher than the level at which occupational asthma could develop; and that the incidence of bakers' asthma is high and unremitting. Progress on prevention of occupational asthma in the industry has been disappointing. WHEC recommends that in close collaboration with the key stakeholders in the sector an evidence-based sector-wide intervention study is developed, implemented and evaluated.

## Introduction

WHEC has been asked by the Bakers, Food and Allied Workers Union to investigate the current evidence on the risks to bakers of the adverse effects of working at high temperatures, and in addition of occupational asthma. WHEC invited a small group to undertake an initial review of these issues.



## A. WORK AT HIGH TEMPERATURES

This section deals with the relationship between ambient working temperature and accidents and provides some background regarding the nature of heat stress.

### Background to the request

In Canada:

*Kim Douglas Warner, 44, died from heat stroke in Barrie, Ontario during a 12-hour day shift at a Weston Bakeries plant in temperatures estimated at 49° Celsius. Lack of water and rest breaks also contributed to the fatality. Warner's core body temperature rose to a 42.5° C at time of death. Sadly, the Canadian Auto Workers (CAW) had been poised to negotiate their first collective agreement with the employer. Hot working conditions were a major issue during the organizing drive. Two and a half years later Weston Bakeries was fined \$215,000 under the Occupational Health and Safety Act.*

### The Nature of heat stress (1)

1. **Heat stroke:** in heat stroke, the temperature-regulating system fails, and sweating becomes inadequate to keep the body temperature within normal range; the body's core temperature rises. Signs and symptoms include hot and usually dry skin that is red or spotted, a temperature above 41°C, mental confusion, delirium, convulsions or unconsciousness.
2. **Heat exhaustion** is caused by the loss of large amounts of fluid by sweating (and sometimes excessive loss of salt) from continuous work in high temperatures. A worker sweats, but experiences some or all of these symptoms: extreme weakness, dizziness, headache, nausea, vomiting, muscle cramps, breathlessness and numbness of the hands or feet.
3. **Heat** cramps are sharp muscle spasms that occur in those who sweat copiously in heat, drink plenty of water, but do not adequately replace fluid.
4. **Fainting, heat rash and transient heat fatigue** are also consequences of prolonged exposure to hot conditions.
5. **'Transient'** heat fatigue' is a short and temporary state of physical and mental/emotional discomfort which can cause a decline in performance, alertness and safe working habits.

## Ergonomics/Human factors perspective

The ergonomics/human factors' perspective takes a broad, systems approach to help the understanding of the problem. It is helpful to consider three important elements that describe a complex set of interactions; temperature is only one factor within this system. Thus any analysis of heat stress must also take into account: -

### 1. The job/task being done

- the demands on the worker (activities, workload, work pacing, shift-work and fatigue).
- the equipment used (its design in terms of size, shape, controls, displays, and how appropriate it is for the task).
- the information used (how it is presented, accessed, and changed).
- the physical environment (temperature, humidity, lighting, noise, vibration).

### 2. The individual's physical and psychological characteristics

- body size and shape.
- fitness and strength.
- posture.
- the senses, especially vision, hearing and touch.
- mental abilities.
- personality.
- knowledge.
- training.
- experience.

### 3. The organisation and social environment

- teamwork and team structure.
- supervision and leadership.
- supportive management.
- communications, resources etc.

## Associated effects

Heat stress can also trigger safety problems, including incidents resulting from fogging of safety glasses, sweaty palms and dizziness. Mental alertness and physical competency may decline as the temperature goes up, with increased discomfort promoting anger, irritability and other negative emotions that can spark incidents.

## Heat and work/task performance

Hygge (2) reviews the topic and finds it difficult to establish a direct relationship between body temperature and performance.

**Vigilance** may be compromised when thermal load causes the body temperature to move away from normal/steady-state. However, much of the evidence has been acquired during laboratory experimental work and the extent to which such results are valid in a complex work environment has rarely been explored. The impact of temperature on performance factors may vary according to personal characteristics. The exact nature of the relationship between heat and **reaction time**, regardless of whether it is a simple, complex or serial reaction time, seems to depend very much on the specific demands of the task.

Tasks where **manual performance** is important, for example factory work, show a general increase in performance up to approximately 32°. However, performance drops as temperature increases beyond that up to 38°. These results were based on one study of acclimatised persons in South Africa; thus how performance varies with non-acclimatised Europeans is unknown. This might be an area for further research.

**Tracking tasks.** Heat effects on manual tracking task are difficult or impossible to generalise. There is some degradation at about 27°C WBGT<sup>1</sup> but consistency in such studies is rarely demonstrated.

**Cognitive and mental demands** such as recall, memory and reading comprehension show consistent effects of

<sup>1</sup> Wet bulb globe temperature

temperature. However these effects, may be linked to arousal in cognitive patterning theories. Thus the U-shaped functions often demonstrated might be helpful but do not necessarily reflect the complex tasks that occur in the real world. Curiously, where these tasks have been examined the optimum performances may not be at the temperatures usually considered to be comfortable.

Enander and Hygge (3) conclude that “the more complex the task at hand, the more likely it will deteriorate with heat or cold. Most manual performance measures are sensitive to effects of cold. Simple reaction time increases with heat but is little affected by cold. Complex reaction time slows down in heat, and more errors are made in cold. Vigilance tasks and dual tasks seem to have an optimal range from around 27 to 32°C (Effective temperature). Tracking tasks seem to deteriorate in the same range. Learning tasks seem to reach their optimum in the comfort zone around 21°C, while tasks in which the correct response consists of finding an unusual or unlikely answer, such as creative tasks, benefit from temperatures closer to 27°C, at which arousal is assumed to be low. Social behaviours, such as aggression or helpfulness, do not seem to have direct main effects from thermal stress. The effects reported are mediated by or in interaction with e.g. anger and feelings of negative affect.”

## Standards

Thermal Ergonomics Standards: Thermal ergonomic standards promote safety, productivity, health and well-being. ISO TC 159 is a technical committee involved in standardization in the field of ergonomics; ISO TC 159 SC5 is a subcommittee working on ergonomics of the physical environment. Within this category are thermal ergonomics standards for measurement of physical quantities, analysis and interpretation of thermal stress on workers, methods for the assessment of human responses to hot and cold as well as other standards (4)

## Heat and related illness in UK bakeries

No specific, systematic reviews or contemporary data relating to heat stress or heat exposure in bakery workers, in the UK or elsewhere, could be identified. The Decennial supplement found no deaths attributed to heat injury for the most recent three decades for which there is published information (1979-2010). RIDDOR data are similarly uninformative.

## Summary

Heat stress is well established as affecting the performance of both physical and mental tasks. It affects cognitive performance differentially, depending on the type of cognitive task. A relationship can be established between the effects of heat stress and deep body temperature. Hygge (2) concludes that there are marked effects on performance. The task complexity in ‘real world’ jobs means that predicting impact for anything other than very simple tasks is problematic. Social and other behaviours are also affected thus team work and organisational issues might need further consideration.

It appears that there are no environmental data on the temperatures experienced at work by UK bakery workers; and there seems to be no reported evidence of any relevant adverse health effects in this group.

Research into accidents and temperature in bakeries is required if further understanding of potential associations with heat are to be established. Any such research will need to consider the tasks being carried out and other work system factors that might impact on performance and well-being of the work force. A focus on working temperature alone is unlikely to generate the answers being sought, although robust data on current thermal (and other environmental) parameters and exposures is needed. Accident analysis of historical data may be a suitable starting place, coupled with data collection from bakeries on the recognised consequences of high heat exposure.

## B. OCCUPATIONAL ASTHMA

### Background

Asthma is termed 'occupational' if it is attributable directly to inhalation of an agent encountered in the workplace. Bakers who develop occupational asthma do so usually from flour dust; more occasionally their disease results from inhaling one or more of the 'improver' enzymes used in almost all modern, commercial bread mixes.

In the UK, commercial baking takes place in one of three settings (5):

- 'plant' bakeries, which produce high volumes of bread and similar goods. They are generally highly mechanised, employing relatively few workers with regular exposure to airborne flour and enzymes. Some large bakeries however, particularly those making more specialist products, operate in conditions where there is significant exposure for a high proportion of employees. There are around 500 large- or medium-sized plant bakeries in the UK but their total numbers of exposed workers is unknown.
- 'scratch' bakeries, located in large supermarket stores. These typically employ half a dozen bakers, all of whom have daily exposure to flour and enzymes. This sector – comprising the four largest supermarket chains - is larger in the UK than in most comparable countries and probably employs about 10,000 exposed workers.
- 'craft' bakeries, which vary in size but tend to employ relatively few bakers, all of whom have regular exposure to flour and enzymes. The size of the working population is unknown but will number several thousand.

The most recent Labour Force Survey lists 34,000 bakers/confectioners of whom 11,000 are self-employed; this figure is very likely to be a significant underestimate.

Note that some 'bakeries' do not make dough mixes but simply bake pre-formed batches of dough prepared at another site. Workers in such 'bake-off' bakeries do not incur exposure to airborne flour or enzymes and are not at risk of occupational asthma.

This picture is not stable and is likely to change substantially. The economics of supermarket scratch baking are fragile (the margins are very small); there is an increasing demand for non-traditional breads and associated goods; 'artisanal' baking is increasingly fashionable and is bringing with it a wider range of techniques, ingredients and personnel than is traditional.

### Frequency

Cases of occupational asthma that are diagnosed by specialty physicians in the UK are reported, on a voluntary basis, to a national surveillance scheme at the University of Manchester. The annual total of cases, from all causes, has fallen over the last decade; the explanations for this pattern are probably several but will include a true reduction in the incidence of the disease in some sectors. In stark contrast, the rate of occupational asthma in bakers has not followed this trend but has stayed unchanged (6); in other countries with comparable notification schemes the rates in bakers are similarly high (7,8, 9, 10).

Surveillance in this manner under-estimates the true frequency of occupational asthma but there are, in the UK, no routine methods that provide a more sensitive figure.

Evidence from academic studies – supported by clinical experience – suggests however that:

- in many established plant bakeries the incidence of occupational asthma is low; this is probably not the case for some of the more specialised enterprises



**Table 1:** inhalable dust exposures in UK supermarket scratch bakeries (11)

	all	baker	manager	confectioner	assistant
# samples	89	27	8	21	33
geometric mean (95%CI): mg/m <sup>3</sup>	0.5	1.2 (0.9–1.6)	0.5 (0.3–1.0)	0.3 (0.2–0.4)	0.3 (0.2–0.5)

- in contrast, the prevalence among scratch supermarket bakers is close to 10% (11); the frequency in small craft bakeries is likely to be similar.

Importantly, the evidence on contemporary disease frequency, in all baking sectors, is very limited.

### Exposures to flour in UK bakeries

There are no published data from systematic exposure measurements made in UK bakeries.

Measurements (n=1451) from the NEDB<sup>2</sup> between 1985 and 2003, and from a large plant bakery (63% of measurements), revealed a geometric mean value for flour dust exposure of 3.4mg/m<sup>3</sup>; values were highest for cleaners (6.9mg/m<sup>3</sup>) and dough shapers (4.5mg/m<sup>3</sup>). There was no evidence of a decline over the 18 year period (12). It should be noted that NEDB itself has an inherent bias, in that HSE Specialist Occupational Hygiene Inspectors as part of their enforcement duties obtained approximately 90% of the samples. Consequently, a tendency towards high levels of exposure would be expected, as companies with no perceived problems were generally not sampled. Even so, NEDB still contains many samples indicating low exposure (<25% of the appropriate occupational exposure limit), so the actual bias is not as large as would be expected. Whether or not NEDB should be considered as containing worst case data is debatable, but it cannot be regarded as being truly representative of occupational exposure in Great Britain given that it does not come from a random selection of workplaces and circumstances.

Elms et al (13) reported on results from personal flour dust exposure measurement in 55 UK bakeries collected. Results from 208 whole-shift, personal measurements of flour exposure showed a median value of 3.7mg/m<sup>3</sup> (range <LoD<sup>3</sup> – 47.0 mg/m<sup>3</sup>); with 17% exceeding the Workplace Exposure Limit (WEL) of 10 mg/m<sup>3</sup>. Measurements were higher in medium- or large-size bakeries.

An update on these data was provided by HSL. It suggests that an additional 187 measurements were collected since the publication by Elms et al (13) and that the NEDB now contains 395 (whole-shift, time-weighted average) exposure measurements for flour dust, made between 2002 and 2011 in an unknown number of establishments. The updated values ranged from 0.1mg/m<sup>3</sup> to 148mg/m<sup>3</sup> with a median of 5mg/m<sup>3</sup>; 27% are above 10mg/m<sup>3</sup>. The median value, and the percentage of measurements that exceeded the WEL, are higher than those reported by Elms et al.

There are very few data on exposures in supermarket 'scratch' bakeries: whole-shift inhalable dust exposures in 25 such establishments (11) are summarised by job title above. Fungal alpha-amylase was undetectable in these samples.

These findings are, broadly, similar to those made in other countries; a summary of data from elsewhere was produced by the European Commission's Scientific Committee for Occupational Exposure Limits in 2008 (table 2, below). Mean values of flour dust exposure (measured as inhalable or total dust) ranged from 0.6 mg/m<sup>3</sup> for oven staff to 8.6 mg/m<sup>3</sup> in weighing and mixing areas.

<sup>2</sup> National Exposure DataBase; most of the measurements were collected between 1986 and 1993

<sup>3</sup> limit of detection

**Table 2:** review of flour exposures in bakeries (adapted from 14)

study	job titles	n	mean (range): mg/m <sup>3</sup>
1	all	49	1.7 (0.1-8.0)
2	dough makers oven staff	10 16	2.7 (0.6-14.1) 1.7 (0.0-37.6)
3	mixing dividing	3 16	8.6 (3.3-15.8) 4.7 (1.6-19.1)
4	dough makers bread makers	13 7	4.6 (0.9-14.7) 2.3 (1.5-3.5)
5	all	38	4.9
6	bakers oven staff	14 6	3.4 (0.7-8.7) 1.1 (0.5-2.7)
7	dough mixers dough formers oven staff	6 10 3	7.5 2.2 3.2
8	dough makers bread formers oven staff	34 62 10	5.5 (1.2-16.9) 2.7 (0.6-14.2) 1.2 (0.2-4.0)
9	dispensers roll mixers	24 32	5.0 (1.4-86.0) 2.4 (0.4-21.1)
10	dough makers oven staff	105 81	3.0 (0.4-37.7) 0.6 (0.1-5.1)
11	dough makers bread makers	7 10	8.4 (3.0-18.8) 3.2 (1.2-5.5)
12	bakers	96	2.1 (0.1-110)
13	mixers oven staff wrappers	11 48 9	2.1 (0.5-6.6) 0.6 (0.1-1.6) 2.3 (0.2-12.6)
14	dough makers mixers cleaners others	108 59 6 35	3.3 4.7 3.8 2.2

## Control

The determinants of bakers' asthma are well established and there is good evidence to suppose that the incidence of disease can be substantially reduced by control of exposures to airborne flour and enzymes. In the UK there is a WEL set for flour dust (8 hour time-weighted average of 10mg/m<sup>3</sup> inhalable dust) but not for bakery enzymes. Many believe that this WEL is too high and lower values are set in other countries<sup>4</sup>. Since both flour and enzymes are respiratory sensitising agents they are, in the UK, subject to an Approved Code of Practice which requires exposures to be maintained as low as is reasonably practicable.

In general, control may be easier in bakeries that are highly mechanised, and more difficult where most baking is done by hand, as in scratch or craft settings. The techniques of control include mechanical methods of dust containment and careful attention to tasks including cleaning. More elaborate approaches include the provision of enzyme (but not flour) mixes into a paste or other non-inhalable formulation; for technical reasons this has so far proved possible for only a limited number of dough mixes.

There are two reports of direct interventions designed to reduce dust exposures in bakeries. The first, a sector-wide intervention in the Netherlands (15), involved informing all employers and employees on the risks of occupational exposures and the provision of information on good work practices and control measures; the intervention had only a limited effect (annual downward trend of only 2% in flour exposures, 8% in amylase). A more encouraging result was reported from a controlled trial of an intervention in South African supermarket bakeries where 13% of employees had occupational asthma (16). In this case a 50% reduction in flour exposures was achieved through education accompanied by improvements in equipment to reduce dust emissions and the provision of divider oils. Neither of these reports measured a reduction in the incidence of sensitisation or disease.

A secondary approach to the prevention of occupational asthma may be provided through regular and routine screening of employees for (early) signs of the disease. Health surveillance of this type is mandatory in the UK for groups such as bakers who work with respiratory sensitising agents. High quality surveillance aims not only to identify cases of early disease so that progression can be halted but also, crucially, to determine the local factors that have given rise to the case(s) so that they can be ameliorated with the aim of preventing further cases. While surveillance is the rule in most plant bakeries, it is far less common in medium-sized establishments and generally not practised at all in small bakeries (5).

<sup>4</sup> For example; Sweden: 4mg/m<sup>3</sup>; US: 0.5 mg/m<sup>3</sup>

## Barriers to prevention

- The UK baking sector is complex; there is no 'industry' or trades union body that serves all types of bakery.
- The technologies employed in baking are similarly diverse; there will be no engineering solutions that will apply to all sectors
- The economic margins in baking tend to be small; costly interventions are unacceptable to most employers.
- There is only limited and non-systematic evidence on both the exposures and disease frequency in contemporary UK bakeries; this is true for all sectors but especially so for smaller enterprises.
- Much of the regulatory oversight of UK bakeries falls technically not to HSE but to Local Authorities (LA) whose responsibilities include the retail sector. LA Environmental Health Services are under-resourced and most focus their attention on food hygiene. There has traditionally been only limited collaboration between the two regulatory parties in this respect, although there are signs that this is growing.
- The WEL for flour dust is almost certainly higher than the threshold for sensitisation – which is nearer, overall,  $1\text{mg}/\text{m}^3$  (17). Since much baking is an episodic activity in which not all the tasks generate airborne dust, it is not difficult to achieve a cross-shift average exposure level of well below  $10\text{mg}/\text{m}^3$ .
- The knowledge level on the health risks of baking is very variable. Much training is now provided 'on the job', anecdotally with limited emphasis on control of exposure to flour dust.
- In a very competitive market, bakers' asthma may not be perceived as a priority among many employers and personal injury claims from affected bakers are few. The 'big four' supermarkets have, individually, been reluctant to embark on preventive programmes in isolation.
- Health surveillance in many parts of the industry – where it exists - appears to work poorly. It seems only rarely to be linked to exposure surveillance and even more rarely to improvements in exposure control. Bakers are reluctant to report symptoms when the likely outcome is removal from the bakery (18). Some employers tend to view the process as a barrier to production; a member of WHEC has received several anecdotal reports from occupational health professionals working in bakeries that they have been discouraged by their managers from confirming potential cases of occupational asthma.

## Conclusions

The use of a WEL for flour dust of 10 mg/m<sup>3</sup> and any other interventions in the UK appear not to have been effective in reducing either exposure levels or the incidence in occupational asthma in this sector. What information is available suggests that exposures to flour are, and remain, frequently higher than the level at which occupational asthma would develop; and that the incidence of the disease is similarly high and unremitting. Progress on prevention of occupational asthma in the industry has been very disappointing, especially when considered in relation to that in many other industries where workers are exposed to sensitising agents.

WHEC acknowledges that there are significant barriers to the control of exposure to flour dust and the incidence of occupational asthma in UK bakeries; they include the fact that the baking sector in the UK is complex and fragmented. We recommend that in close collaboration with the key stakeholders in the sector one or more evidence-based intervention studies are developed, implemented and evaluated.

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### What is WHEC?

The Workplace Health Expert Committee (WHEC) provides independent expert opinion to HSE by identifying and assessing new and emerging issues in workplace health. Working under an independent Chair, WHEC gives HSE access to independent, authoritative, impartial and timely expertise on workplace health.

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