OCCUPATIONAL RISKS OF AGRICULTURAL WORKERS EXPOSED TO HEAT: LITERATURE REVIEW

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ABSTRACT

Proposal: The aim of this study is to conduct a literature review on the occupational hazards of agricultural workers exposed to heat while carrying out their activities.

Theoretical Framework: Heat exposure poses a serious occupational risk for agricultural workers, increasing the incidence of dehydration, heat exhaustion, and sunstroke.

Method: The methodology adopted for this research involves a literature review using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) methodology. Data collection was carried out through a bibliographic survey from the period 2005 to 2024 in the Pubmed, Web of Science, and Scopus databases. The search used keywords such as "risks," "workers," "agriculture," and "heat."

Results and Discussion: The results revealed the selection of 109 articles, and after reading the abstracts, those that did not align with the research proposal were excluded. After filtering, 07 articles remained, whose topics showed affinity with the research. The literature points to a growing trend of studies addressing thermal discomfort as an occupational hazard, prevalent in open and semi-open environments. Specific studies for certain agricultural operations, such as groups of workers dealing with grain dryers and furnaces, are scarce and have limited conclusions.

Research Implications: The practical and theoretical implications of this research are discussed, providing insights into how the results can be applied or influence practical aspects in the field of occupational heat exposure for agricultural workers. These implications can encompass various sectors of post-harvest grain processing.

Originality/Value: This study contributes to the literature by gathering information published in different databases on occupational heat exposure. The significance and value of this research are highlighted by a limited number of works in the literature, stressing the need for further research in the field. Based on this premise, more studies on agricultural work in heat-prone environments and consequent thermal discomfort should be encouraged to stimulate discussions on actions to eliminate the risks involved in these operations.

Keywords: Risk, Worker, Agriculture, Heat.

RISCOS OCUPACIONAIS DOS TRABALHADORES AGRÍCOLAS EXPOSTOS AO CALOR:
REVISÃO DE LITERATURA

RESUMO

Proposta: O objetivo deste estudo é realizar uma revisão da literatura sobre os riscos ocupacionais dos trabalhadores agrícolas expostos ao calor, para a realização de suas atividades.

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Referencial Teórico: A exposição ao calor representa um grave risco ocupacional para trabalhadores agrícolas, aumentando a incidência de desidratação, exaustão térmica e insolação.


Resultados e Discussão: Os resultados obtidos revaleram a seleção de 109 artigos e, após leitura dos resumos, foram excluídos os que desacordavam com o proposto da pesquisa, após filtro restaram 07 artigos, cujos temas demonstraram afinidade com a pesquisa. A literatura aponta uma tendência crescente de estudos que abordam o desconforto térmico como risco ocupacional, sendo prevalentes em ambientes abertos e semi-abertos. Os estudos específicos para determinadas operações agrícolas, como os grupos de trabalhadores que lidam com secadores de grãos e fornalhas, são escassos e com conclusões limitadas.

Implicações da Pesquisa: As implicações práticas e teóricas desta pesquisa são discutidas, fornecendo insights sobre como os resultados podem ser aplicados ou influenciar práticas no campo de exposição ocupacional de trabalhadores agrícolas ao calor. Essas implicações podem abranger diversos setores da pós-colheita de grãos.

Originalidade/Valor: Este estudo contribui para a literatura ao reunir informação publicada em diferentes bases de dados acerca da exposição ocupacional ao calor. A relevância e o valor desta pesquisa são evidenciados por um pequeno número de trabalhos publicados na literatura, enfatizando a necessidade do desenvolvimento de maiores pesquisas na área. Com base nesta premissa mais estudos sobre o trabalho agrícola em ambientes com prevalência de calor, e consequente desconforto térmico devem ser estimulados, a fim de provocar discussões sobre ações para eliminação dos riscos envolvidos nestas operações.

Palavras-chave: Risco, Trabalhador, Agricultura, Calor.

RIESGOS LABORALES DE LOS TRABAJADORES AGRÍCOLAS EXPUESTOS AL CALOR: REVISIÓN DE LITERATURA

RESUMEN

Propuesta: El objetivo de este estudio es revisar la literatura sobre los riesgos ocupacionales de los trabajadores agrícolas expuestos al calor para llevar a cabo sus actividades.

Marco Teórico: La exposición al calor representa un grave riesgo ocupacional para los trabajadores agrícolas, aumentando la incidencia de deshidratación, agotamiento térmico e insolución.

Método: La metodología utilizada para esta investigación incluye una revisión de la literatura a través de la metodología de Informes Preferidos de Revisiones Sistémicas y Meta-análisis (PRISMA). Se recopilaron datos mediante una búsqueda bibliográfica en el período de 2005 a 2024 en las bases de datos Pubmed, Web of Science y Scopus. Se emplearon palabras clave como "riesgos", "trabajadores", "agricultura" y "calor" para la búsqueda.

Resultados y Discusión: Se seleccionaron 109 artículos y, tras analizar los resúmenes, se excluyeron aquellos que no se ajustaban al objetivo de la investigación, resultando en 07 artículos pertinentes a la investigación. La literatura señala una creciente tendencia de estudios que abordan el malestar térmico como un riesgo ocupacional, especialmente en entornos abiertos y semicerrados. Los estudios específicos para ciertas operaciones agrícolas, como los grupos de trabajadores que manejan secadoras de granos y hornos, son escasos y con conclusiones limitadas.

Implicaciones de la Investigación: Se discuten las implicaciones prácticas y teóricas de esta investigación, proporcionando ideas sobre cómo los resultados pueden aplicarse o influir prácticamente en el ámbito de la exposición ocupacional al calor de los trabajadores agrícolas. Estas implicaciones pueden abarcar varios sectores de la poscosecha de granos.

Originalidad/Valor: Este estudio contribuye a la literatura al recopilar información publicada en diferentes bases de datos sobre la exposición laboral al calor. La relevancia y el valor de esta investigación se ven reflejados en la
Occupational Risks of Agricultural Workers Exposed to Heat: Literature Review

escasez de trabajos publicados en la literatura, subrayando la necesidad de llevar a cabo más investigaciones en este campo. Partiendo de esta premisa, se debería fomentar la realización de más estudios sobre el trabajo agrícola en entornos con alta presencia de calor y el consiguiente malestar térmico, con el propósito de generar debates sobre acciones para eliminar los riesgos asociados con estas operaciones.

Palabras clave: Riesgo, Trabajador, Agricultura, Calor.

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1 INTRODUCTION

Workers involved in agricultural activities often work in hot and/or humid environments. In these environments, risks related to health and safety are linked to several sources, but exposure to strong sunlight and the resulting sensation of heat are points that require further investigation. In addition to the threat to health, worker exposure to environments with temperatures outside safety limits also compromises performance and work capacity (Lucas, Epstein, & Kjellstrom, 2014).

El Khayat et al. (2022) present the impact of increasing global temperatures in the world as a result of climate change, concerns about health and safety, with an emphasis on rural workers, vulnerable to heat stress due to the strenuous nature of their work.

In the agricultural sector, there is a considerable incidence of occupational injuries related to the effects caused by exposure to high temperatures during work activities, hence the importance of prevention and awareness measures to reduce these risks (Blasi et al., 2023).

Climate change adopts a tendency towards instability and is becoming more widespread across the world. Extreme heat reaches agricultural workers in the United States (USA) and the rest of the world, leaving them in sensitive health conditions. The period of exposure to unsafe conditions will double by mid-century and, without mitigation, will triple (Tigchelaar, Battisti & Spector, 2020).

Global temperatures have continually increased due to climate change, with negative repercussions on people's health and work performance. In agriculture, workers, around 870 million worldwide, are exposed to greater risks of heat stress in a context of record temperatures (Erkul, 2023).

Climate instability causes significant damage to human health. For outdoor tasks, the consequence should be greater. Work is generally characterized by heavy activities, which
generate high metabolic heat. However, there are few efforts in the field of Occupational Health and Safety to find practical solutions to the effects of heat on workers. Furthermore, worker protection alternatives are reduced (Amorim, Labaki, Maia, Barros & Monteiro, 2020; Bitencourt, Maia, Ruas & Cunha, 2023).

Sharma, Alam, Suri and Kant, (2021) present details of the working conditions in environments with high temperature ovens, workers are exposed to strong thermal stress, an ignored risk for occupational health. The situation worsens during the summer, with many workers suffering the consequences of harsh thermal working conditions, with subsequent health challenges, a decline in their productivity and resulting financial loss.

Many segments of the industry use ovens in their operations, in ceramics it has been found that there are risk situations with high temperatures in the process of feeding and burning the materials used in the ovens and drying tunnels, as well as when placing and removing products (Lamera, Bentes, Mantovani, Possebon & Ferreira, 2012).

Considering the occupational risks of activities carried out by agricultural workers, linked to processes in environments made up of equipment that contribute to the generation of heat, and after identifying the lack of materials for discussing these determined topics, a review was carried out in a review format, with the aim of provide transparency on points that are still little explored on this topic. And beyond that, suggest solutions for practical measures to protect work for operations where the risk is hidden despite existing.,

2 THEORETICAL REFERENCE

The theoretical framework in a study comprises a critical and organized analysis of the literature relevant to the topic, providing a theoretical contextualization and defining the key concepts. It must comprehensively contain theories, models and previous research, identifying gaps, contradictions and consensuses in the literature that are important for the focus of the work being developed.

Occupational heat stress harms workers' capacity, with restrictions on health and productivity. Occupational environments with hot and humid climates, heavy physical work loads and/or protective clothing create a strenuous and potentially dangerous environment for the worker (Flouris et al., 2018; Lucas et al., 2014).

During the processing of agricultural products, the presence of risks such as noise, dust and high temperatures are constant in the environment. Activities involving replacing firewood
and handling the product near furnaces, boilers or other heat sources can cause harm to the health of workers exposed to extreme temperatures. Exposure to excessive heat can cause adverse reactions such as: peripheral vasodilation with increased blood circulation on the surface of the body, increased number of sweat glands, dehydration, heat cramps, thermal shock and fainting (Roscani, Maia & Monteiro, 2019).

Agricultural workers are at greater risk of heat stress and also suffer from high exposure to pesticides, which can also be harmful to their health, said a senior ILO official (Erkul, 2023). The work segments are diverse, and the regions influenced by heat variables during the production process. In the USA, in Washington and nearby regions, there is evidence of indicators of occupational exposure to heat among agricultural and construction workers. In developing countries, workers are also exposed to severe heat stress. Compared to developed countries, the absence of adequate regulatory guidelines and control policies increases the severity of risk under the unrestrained conditions (Flunker et al., 2022; Sharma, et al, 2021).

It is common for agricultural workers to be exposed to stressful weather conditions over a prolonged period of time (Hamed et al., 2018). This work routine includes post-harvest activities, such as the grain drying process, which involves the use of a wood-burning furnace or other fuels, generating exposure to the physical risk of heat, for feeding and maintaining the fire. Operations carried out in furnaces, boilers or other heat sources lead to excessive dehydration and fatigue and other damage to workers' health (Bellochio et al., 2022; Roscani et al., 2019; Camargo & Furlan, 2011).

However, furnaces are present in processes in different industrial segments, and are not exclusive to the agricultural environment. Monteiro, Pereira and Rios (2018) evaluated thermal stress when feeding firewood from a boiler furnace, and Vasconcelos, Maia, Almeida and Rodrigues (2015) analyzed fueling firewood from the furnace of a biscuit industry, the purpose of both would be to verify the compliance of the activity with the tolerance limit and thermal overload presented in the performance of the activities.

As for the field, it is normal, for example, during the application of phytosanitary products to coffee plants, workers are exposed to temperatures that could compromise their health. Ramirio, Sabino, Oliveira, Silva and Pereira (2020) demonstrated, through analyzes carried out in the field, IBUTG measurement results below the NR15 tolerance limit, for the month of September, values above the tolerance limit in the month of October, in the period from 11:00 to 14:59, considering continuous heavy activity and rest at the workplace, with the activity being considered unhealthy. Compared to the NHO 06 parameters, it was observed that
the occupational exposure limits were exceeded in the month of October, for acclimatized and non-acclimatized workers. In September, the NHO 06 occupational exposure limit was exceeded only for non-acclimatized workers.

3 METHODOLOGY

3.1 SEARCH STRATEGY AND INCLUSION AND EXCLUSION CRITERIA

This study presents data available in the literature on occupational exposure to heat in different agricultural activities in the period between 2005 and 2024, following the Preferred Reporting Items for Systematic Review (PRISMA) methodology. The databases chosen were PubMed, Scielo and Web of Science. The keywords used were “risks” AND “Workers” AND “Agricultural” AND “Heat”. The searches were carried out in Portuguese and English, and articles that did not meet the inclusion criteria and duplicate articles were excluded from further analysis (Table 1).

Table 1

<table>
<thead>
<tr>
<th>Critérios de Inclusão</th>
<th>Critérios de Exclusão</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artigos publicados em inglês e português</td>
<td>Artigos publicados em outros idiomas</td>
</tr>
<tr>
<td>Artigos científicos originais</td>
<td>Abstracts, reviews, estados da arte</td>
</tr>
<tr>
<td>Artigos relacionados a área agrícola</td>
<td>Artigos fora da área agrícola</td>
</tr>
</tbody>
</table>

3.2 STUDY SELECTION AND DATA EXTRACTION

Two article selection cycles were carried out by a researcher (JAAF). The first cycle consisted of screening titles and abstracts. In the second cycle, the full texts of all potentially relevant studies were reviewed considering the inclusion and exclusion criteria. Potential disagreements in study selection were discussed and ultimately resolved by the other remaining researchers (ETA and FSO). One investigator (JAAF) extracted the data, and the other two reviewed these data. The following information was extracted manually: (1) Title; (2) Location; (3) Occupational Activity; (4) Index; (5) Relevant Results; (6) General Conclusions.
3.3 QUALITY ASSESSMENT

The risk of bias was assessed by two investigators (ETA and FSO). Within each study, this risk was assessed on two parameters divided as key criteria (type of activity performed, Index reported). The risk of bias for each criterion was assessed as “low”, “medium”, “high” or “not applicable”. Studies for which all key criteria and most other criteria were characterized as “high” were excluded.

4 RESULTS AND DISCUSSIONS

The flow diagram for selecting studies is shown in Figure 1. Initially, 109 articles were found through the database search, of which 44 were analyzed. A total of 37 were rejected for not meeting the inclusion criteria, the majority of which did not fit into measurements carried out in the agricultural area. Finally, the selection process resulted in 7 papers on occupational exposure to heat in agricultural activities.
After selecting the 7 studies on occupational exposure to heat in agricultural activities, the most relevant data were extracted and presented in the Table 2.
### Table 2

*Data extracted from selected papers*

<table>
<thead>
<tr>
<th>Nº</th>
<th>TÍTULO</th>
<th>LOCAL (PAÍS)</th>
<th>ATIVIDADE OCUPACIONAL</th>
<th>METODOLOGIA</th>
<th>RESULTADOS IBUTG médio</th>
<th>CONCLUSÕES GERAIS</th>
<th>REFERÊNCIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Exposure of workers to occupational heat during the application of phytosanitary products in coffee crop.</td>
<td>BRASIL</td>
<td>Aplicação de produtos phytosanitários no cafeiro</td>
<td>Avaliou-se o calor ocupacional em lavras de café através do método de IBUTG médio, utilizando medidor de estréte térmico TGD 400. Os valores de IBUTG encontrados foram comparados aos limites de exposição da NR 15 para fins de classificação de insalubridade e com a NHO 06.</td>
<td>Setembro → 24,4°C (12:00 às 12:59) (máximo), 18,7°C (07:00 às 07:59) (mínimo); Outubro → 26,0°C (13:00 às 13:59) (máximo), 20,4°C (07:00 às 07:59) (mínimo)</td>
<td>Tendo como parâmetro os critérios da NHO 06, os limites exposição ocupacional ultrapassaram em ambos, para trabalhadores aclimatizados e não aclimatizados. Em setembro o limite de exposição ocupacional da NHO 06 foi superado somente para trabalhadores não aclimatizados. Portanto os trabalhadores devem ser submetidos a aclimatização durante a atividade de aplicação de produtos phytosanitários no mês de outubro.</td>
<td>Ramiro et al. (2020)</td>
</tr>
<tr>
<td>2</td>
<td>Quantificação do calor no abastecimento de forma a leche de um secador de girassol: um estudo de caso</td>
<td>BRASIL</td>
<td>Pós-colheita, recolha dos girassol</td>
<td>Foram calculados o índice de Bulbo Úmido Termômetro de Globo (IBUTG) e a taxa metabólica de cada situação térmica, no desempenho das atividades, os quais foram pontuados nas atividades realizadas pelo trabalhador durante o ciclo de trabalho. De acordo com o anexo 3 da NR 15 (2019)</td>
<td>IBUTG (°C) Abastecimento da forma → 43,6°C (máximo), Média Ponderada → 39,9°C (mínimo)</td>
<td>De acordo com o anexo 3 da NR 15 (2019), a atividade é considerada saudável, visto que, para a taxa metabólica definida para as atividades o trabalhador deve estar exposto a um IBUTG médio máximo de 30,3°C, o que não excede o limite de tolerância.</td>
<td>Bolídio et al. (2021)</td>
</tr>
<tr>
<td>3</td>
<td>Associations between heat exposure, vigilance, and balance performance in summer tree fruit harvesters</td>
<td>EUA</td>
<td>Coletores de abacaxi</td>
<td>Modelos lineares mistos foram usados para estimar a associação entre a temperatura máxima do bulbo úmido do turno de trabalho (IBUTG max) e a vigilância postural (tempo de reação) e oscilação postural (comprimento total do círculo)</td>
<td>Médias (DP)</td>
<td>IBUTG (°C)</td>
<td>Mediana Geral → 25,9 (4,25)°C (máximo), Agosto → 27,4 (3,27)°C (máximo), Setembro → 21,2 (2,0)°C (mínimo)</td>
</tr>
</tbody>
</table>
### Occupational Risks of Agricultural Workers Exposed to Heat: Literature Review

<table>
<thead>
<tr>
<th>No.</th>
<th>Study Title</th>
<th>Authors</th>
<th>Country</th>
<th>Population</th>
<th>Results/Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Heat exposure in sugarcane workers in Costa Rica during the non-harvest season</td>
<td>Costa Rica</td>
<td>Trab. da indústria canavieira</td>
<td>Indice de IBUTG: 22.9°C (maximo) 22°C (minimo) Empresa C</td>
<td>Este estudio demostró un riesgo clara de sobrecarga térmica para trabajadores en tareas fuera de la época de cosecha en tres empresas en Costa Rica. A la época de cosecha, se considera a menos intensivas las dos épocas para los trabajadores. Portanto, é importante tomar medidas para minimizar los riesgos asociados con el calor impostor por los trabajadores de las canas. En todas las regiones productoras de canas, a la temporada de cosecha.</td>
</tr>
<tr>
<td>5</td>
<td>Burst Sugarcane Harvesting – Cardiovascular Effects on a Group of Healthy Workers, Brazil</td>
<td>Brazil</td>
<td>Trab. da cana-de-açúcar</td>
<td>Indice de IBUTG: 24.4°C</td>
<td>O trabalho da cana-de-açúcar no período de colheita é um dos trabalhadores a maior exposição a fatores térmicos, sobrecarga e esforço físico, induzindo lesões musculares, alterações na reação e na saúde respiratória. O desequilíbrio autonômico pode ser um dos mecanismos envolvidos nas alterações da pressão arterial.</td>
</tr>
<tr>
<td>6</td>
<td>Avaliação da exposição ocupacional ao calor experimentada por operadores de caldeiras: Estudo de caso</td>
<td>Brazil</td>
<td>Operador de caldeira</td>
<td>Valores Máximos: 11.00 às 16.00</td>
<td>Com base no Anexo nº 3 da NR-15 da Portaria nº 321/98 do MIT, pode-se constatar que o trabalhador labora em condições insalubres e potencialmente prejudiciais à saúde e à integridade física (acima dos limites de tolerância estabelecidos).</td>
</tr>
<tr>
<td>7</td>
<td>Effect of heat stress on agricultural field workers safety</td>
<td>Egito</td>
<td>Debita de trigo</td>
<td>Valores Máximos: 11.00 às 1600</td>
<td>O trabalho nas regiões produtoras de canas em todas as condições térmicas impostas se encontra prejudicada. O trabalho em ambientes abertos, expostos ao calor no campo, muitas vezes sem parasol, os trabalhadores não têm orientação adequada sobre o estrés térmico.</td>
</tr>
</tbody>
</table>
Among the works selected for this review, the \( (IBUTG) \) behaved in a similar way to those in which the research was focused on operations carried out in an open environment, these represented the majority. The highest index was 34.2°C for wheat threshing, rice and cotton harvesting (Hamed et al., 2018), the research collections carried out in Egypt. As for the lower value, it remained for Brazil, for the work of applying phytosanitary products in coffee, with 18.77°C (Ramírio et al., 2020). When comparing the activities and regions, it should be considered that the coldest regions are chosen for the cultivation of coffee, which justifies the result.

Of which 05 papers (Ramírio et al., 2020; Hamed et al., 2018; Spector et al., 2018; Barbosa et al., 2012; Crowe et al., 2010) had the \( (IBUTG) \) below 30°C, value cited in Annex 3 of NR 15 as not exceeding the tolerance limit. In the investigations carried out by Ramírio et al. (2020) and Spector et al (2018) \( (IBUTG) \) it was between 26.08°C and 27.4°C, interesting to note that both carried out in similar time cutouts, August and September, in the USA (summer) and Brazil (spring). Considering for this season Brazil was not in its warmest period, the result shows evidence of atypical thermal load. Hamed et al. (2018), Monteiro et al., (2018) and Bellochio et al., (2022) had the \( (IBUTG) \) above 30°C, temperatures justified first by the geographical location of collection, Egypt, country naturally with higher temperatures, and, in sequence by the nature of the operation, the drying of grain with presence of furnaces.

The results show a significant difference in exposure to heat between agricultural activities, when determining the different characteristics between them, in particular for operations with furnaces. In post-harvest, grain drying, and boiler operations in these IBUTG thermometers indicated 43.64°C at the highest temperature, both studies carried out in Brazil (Monteiro et al., 2018 and Bellochio et al., 2022). This topic is highlighted by only two publications of this review, signaling a lack of references to such an important issue in the agricultural environment, since furnaces are always present in the drying processes.

The boiler operating activity exposes the worker to high thermal overload, notably due to the high radiant heat index, which can cause serious damage to his health, such as cataracts and skin cancer. In this case, passive control measures (collective protections) should be adopted in the boiler, such as the construction of a refractory barrier, so as to reduce the incidence of radiant heat on the worker. The rest site of the boiler operator should be built in a location further away from it, with thermal insulation, adequate ventilation and fresh drinking water (Monteiro, Pereira & Rios, 2018).
The open air work activities in Brazil are expected to require greater efforts focused on research, technological innovation and public policies, with a target on actions to contain the effects of the rise in temperatures (Bitencourt, Maia, Ruas & Cunha, 2023).

The exposure of agricultural workers to variables of heat, cold, and also humidity, result in damage to health, and negatively impact their productivity, as they cause an increase in the index of operational errors (Alfano et al., 2021).

Exposure to chronic thermal stress poses a significant risk to occupational health. Developing protective interventions to reduce heat exposure is imperative in the temperature rise scenario to protect millions of workers worldwide. Strategies also for training and education, regulation and monitoring, in place to protect workers from diseases and accidents (Cheveldayoff et al., 2023 and Venugopal, et al., 2019).

Concerned researchers turn to science for the health conditions involved in agricultural work, to create practical and innovative solutions for a healthy, safe and sustainable future (Ferguson, Dahl & Longe, 2019).

Accidents in the work environment are no longer pointed out to the worker as independent responsibility. Analyzed from another perspective, one considers the environmental conditions, the intensity of the work, the human and physical variations of the production. In this view it is not a human error, but a consequence of the sum of factors of cause (Rocha et al., 2015; Soares & Curi, 2015).

By the homeothermic characteristic, man has need to keep his temperature constant. Through the risk of serious heat-induced illnesses, heat acclimatization, controlling thermal stress exposure, and maintaining hydration, can be beneficial attitudes. In this regard, organizations can make satisfactory conditions for thermal comfort possible (Rosa & Lima, 2019).

Temperature is a challenge for safety, heat is difficult to assess accurately, given the wide variety of environmental and individual factors that influence thermal sensation. Muscle activity is the most important, because the intensity of physical effort and environmental conditions act directly on body temperature. If heat production by the worker's metabolism is not in equilibrium, it can cause general debilitation in health and reduced production capacity (Kroemer & Grandjean, 2005).

Cheveldayoff et al. (2023) indicate the relationship of diseases to heat in occupational environments as complex and multifactorial, including environment (intrinsic and extrinsic), occupational clothing requirements and physiological factors. This premise is based on research into gold mines in South Africa, after the death of miners from heat-related diseases. Other
similar research was carried out during World War II and was crucial for the creation of acclimatization techniques and strategies for acquiring thermal tolerance. Techniques still used to prevent heat-related diseases.

Buralli, Albuquerque, Santo, Silva and Nerbass (2024) when investigating the possible causes of chronic kidney disease realized, based on epidemics in recent decades, the relationship between the cause of disease, with environmental and occupational factors (thermal stress due to high workloads at high temperatures and exposure to chemicals such as pesticides and metals).

In the post-harvest period, the process of drying the grains, which makes use of a wood-fired furnace or other fuels (such as chips, briquettes, agricultural residues, LPG, among others), generates exposure to the physical risk of heat, in the activity of feeding and maintaining the fire. Heat exposure or heat stress causes occupational diseases (Bellochio et al., 2022)

During the processing of agricultural products, the presence of hazards such as noise, dust and high temperatures are constant in the environment. In the areas close to the furnace, there is a risk of exposure of the workers, who carry out the replacement of the firewood and the handling of the product, to extreme temperatures. Activities involving operations near furnaces, boilers or other sources of heat may cause damage to the health of workers. Exposure to excessive heat can cause adverse reactions such as: peripheral vasodilation with increased blood circulation on the body surface, increased number of sweat glands, dehydration, heat cramps, thermal shock and fainting (Camargo and Furlan, 2011 and Roscani et al., 2019).

Spector et al. (2018) acknowledged in his studies that although heat exposure is not associated with compromised surveillance or balance, it stresses the importance of adequate hydration before the work shift in order to reduce the risk of occupational injuries and heat-related diseases for agricultural workers in open environments.

To safeguard the health and well-being of agricultural workers, actions such as: the increase of rest time and the availability of air-conditioned recovery areas can contribute, however, productivity, farm workers’ incomes and labor costs should be considered for these measures (Tigchelaar et al., 2020).
5 FINAL CONSIDERATIONS

The research data revealed that despite frequent topics related to concerns about the health of agricultural workers, there are still considerable gaps in discussion regarding the risks faced by these groups when carrying out their activities.

Heat occupies a prominent place among the causes of diseases in this environment, among the physiological effects caused by thermal stress, muscle fatigue that causes a drop in productivity. The outlook for improvement in these statistics is not positive, on the contrary, they show a tendency for indicators to worsen considering the accentuation of climate change and the consequent increase in global temperature.

For work activities carried out in open spaces, regulatory standards defining techniques for quantitative temperature assessments can be adjusted and improved. These must consider current climate data, making distinctions by geographic region, thus avoiding errors in analysis. It is also important to establish clear rules for carrying out actions to preserve the health of agricultural workers subject to exposure to high levels of temperature.

REFERENCES


