Research Paper
Evaluation of Infrared Radiation and Occupational Cataracts in Bakeries in Qom Province, Iran

Alireza Mashkoori1, Zahra Allahdadi2, Seyed Abed Abedi3, Shahab Daštijani Farahani4, Zabihollah Gharlipour5, Alireza Koohpaei1*, Hassan Mohammadpour6, Hamidreza Gilasi5

1. Department of Occupational Health Engineering, Faculty of Health, Qom University of Medical Sciences, Qom, Iran.
2. Research Center for Work Health, Qom University of Medical Sciences, Qom, Iran.
3. Department of Health Education and Promotion, Faculty of Health, Qom University of Medical Sciences, Qom, Iran.
4. Occupational Health Executive, Vice Chancellor for Health, Qom University of Medical Sciences, Qom, Iran.
5. Department of Biostatistics and Epidemiology, Faculty of Health, Kashan University of Medical Sciences, Kashan, Iran.

Background & Aims of the Study: Nowadays, ionizing and non-ionizing radiation seems to have a vital role in all aspects of human life. However, radiations such as infrared radiation (IR) adversely affect the human visual system. This study aimed to evaluate IR exposure and occupational cataracts in the selected traditional and automatic bakeries in Qom Province, Iran.

Materials and Methods: This cross-sectional study was conducted in traditional and modern bakeries with 306 workers. Demographic data were collected using a demographic questionnaire. IR measurement was done using the Hagner EC1-IR digital radiometer at the eye height and in the first and last hours of the workday. The obtained data were analyzed with statistical tests of the Chi-square, Fisher exact, 1-way ANOVA, and independent t test in SPSS software v. 20.

Results: According to the obtained results, 16.1% of the workstations had a high level of exposure to IR, and 20.3% of workers were suffering from cataracts. The results showed a significant correlation between the exposure level and jobs as well as tasks and working hours (P<0.05). Also, a significant correlation was observed between the risk of cataracts and the exposure level, workstation type, age, and experience (P<0.05). However, no significant difference was observed between the type of bakeries and the risk of cataracts (P=0.59).

Conclusion: Based on our findings, nearly one-sixth of the surveyed stations were higher than the standard limit in terms of IR measurement, and nearly one-fifth of workers were suffering from cataracts. The results indicated that due to the long-term exposure of bakery workers to IR, it is necessary to plan and implement effective control measures in bakeries.

ABSTRACT
Background & Aims of the Study: Nowadays, ionizing and non-ionizing radiation seems to have a vital role in all aspects of human life. However, radiations such as infrared radiation (IR) adversely affect the human visual system. This study aimed to evaluate IR exposure and occupational cataracts in the selected traditional and automatic bakeries in Qom Province, Iran.

Materials and Methods: This cross-sectional study was conducted in traditional and modern bakeries with 306 workers. Demographic data were collected using a demographic questionnaire. IR measurement was done using the Hagner EC1-IR digital radiometer at the eye height and in the first and last hours of the workday. The obtained data were analyzed with statistical tests of the Chi-square, Fisher exact, 1-way ANOVA, and independent t test in SPSS software v. 20.

Results: According to the obtained results, 16.1% of the workstations had a high level of exposure to IR, and 20.3% of workers were suffering from cataracts. The results showed a significant correlation between the exposure level and jobs as well as tasks and working hours (P<0.05). Also, a significant correlation was observed between the risk of cataracts and the exposure level, workstation type, age, and experience (P<0.05). However, no significant difference was observed between the type of bakeries and the risk of cataracts (P=0.59).

Conclusion: Based on our findings, nearly one-sixth of the surveyed stations were higher than the standard limit in terms of IR measurement, and nearly one-fifth of workers were suffering from cataracts. The results indicated that due to the long-term exposure of bakery workers to IR, it is necessary to plan and implement effective control measures in bakeries.

Keywords:
Infrared Rays, Cataracts, Bakery workers, Occupational Groups, Occupational exposure, Iran, Qom

* Corresponding Author:
Alireza Koohpaei, PhD
Address: Department of Occupational Health Engineering, Faculty of Health, Qom University of Medical Sciences, Qom, Iran.
Phone: +98 (25) 37835522,
E-mail: koohpaei19@yahoo.com
1. Introduction

Humans in their life are exposed to many types of radiation, including ultraviolet radiation [1, 2], background radiation [3], microwaves [4, 5], and radon [6-8]. Nowadays, ionizing and non-ionizing radiation seems vital in all aspects of human life, for example, in diagnostic and therapeutic activities [9]. However, besides its constructive role, radiations such as infrared radiation (IR) have significant adverse effects on the ecosystem and humans [10-12].

IR is a part of the non-ionizing radiations of the electromagnetic spectrum. It originates from any object with a temperature above absolute zero. This type of radiation is in the spectrum range between radio frequency and visible light, and its wavelengths are between 750 nm to 3 mm with 3 ranges, including A, B, and C [13]. Although IR has not been classified as dangerous radiation, prolonged exposure to this radiation can lead to adverse effects, especially on the visual system. Because the lens of the eye contains no blood vessels, it absorbs the heat resulting from the radiation and eventually leads to damage to the eye’s lens and vision function [13, 14]. Researchers have documented adverse effects from exposure to IR on the human visual system, such as damage to the cornea and lens [13-18]. Previous studies on the effects of IR on the visual system have shown that visual damage is related to the dose of radiation exposure [15, 16], and cataracts usually occur after chronic exposure [16].

In addition to the sunlight as a natural IR source, workplaces, especially hot processes, are considered artificial IR sources [13]. Bakery is considered one of the hot processes. This job in Iran usually involves traditional organization and is associated with direct exposure to furnace fire and heat (Figures 1-3). Previous studies have examined the subjects such as the evaluation of heat stress in bakeries [19-22], the assessment of the thermal stress and strain caused by heat sources in various occupational environments [23], and the effects of heat on the reaction time and performance [24]. In addition, the literature had documented occupational visual system injuries and diseases resulting from work related to heat sources as well [17]. Similar clinical and epidemiological research among workers exposed to a high level of IR in industries such as glass making and foundry had confirmed significant health risks [25] and cataracts [26]. Workers exposed to high ambient temperatures have a 2.5% higher risk of losing 30% of their vision due to cataracts than people in the same age group who are not exposed to high-temperature stress [27].

Occupational exposure of bakery workers to heat has been investigated in several studies. However, we cannot find much research on the evaluation of occupational exposure to IR, especially in developing countries such as Iran. About 72000 bakery units are working In Iran, and about 250000 persons are directly active in these units. Considering the dietary pattern of the Iranian society (high consumption of bread) and many people who are engaged in this job, it is vital to evaluate IR levels and related outcomes such as cataracts [28]. Because of the long-term exposure of the bakery workers to IR, its health risk, and the lack of sufficient literature about radiation exposure among bakery workers, it is essential to evaluate the exposure and its control.

The present study was designed to determine the exposure to IR and evaluate related outcomes such as cataracts in the selected bakeries of Qom Province, Iran.

2. Materials and Methods

This cross-sectional study was conducted in the traditional and automatic bakeries in Qom, Iran. At first, after inquiries to the Union of the bakery in Qom City, the number and location of all bakeries were determined based on the traditional and automatic structure (350 units for Sangak, 248 units for Lavash, 167 units for Barbary, and 36 units for white bread, totally about 2500 people). Then, 306 workers in 102 bakeries with different bread products, such as traditional thin bread (Taftoon, Lavash), traditional thick bread (Sangak, Barbary), and white or automatic bread, were selected randomly using multistage sampling and recruited in our study. Demographic data about the workers were collected using a demographic questionnaire. After that, the workers’ exposure to IR was measured in different locations of the bakeries using a Hagner EC1-IR digital radiometer. Based on the measurement protocol, the device photocell was set in the direction of the radiation source (grill or ovens). To reduce the side effect of the sun’s IR on measurement protocol, the measurement times were set during the night; otherwise, the early or late hours of the day.

According to the latest edition of occupational exposure limits in Iran (2021), to avoid damage to the cornea and lens, IR exposure in scorching environments and for a long time (1000 s and higher) is limited to 10 mW/cm²; hence, this limit was used to evaluate the exposure [13].
The relationship between occupational exposure to IR and cataracts was finally investigated, and based on our findings, control measures were recommended.

Obtained data were analyzed by the Chi-square, Fisher’s exact, 1-way ANOVA, and independent t test using SPSS version 20 software. All subjects with previous diseases due to cataracts or any general visual disturbances were excluded from the study. Also, all people over 60 years old were excluded from the study.

3. Results

The age range of the workers was between 16 and 58 years, with an average of 35.47±10.41 years. In the studied bakeries, 33.7% of workers were working as bread makers, and 32.4% and 33.7% were working at the whipping, and bread sticks stations, respectively. The average working hours per day were 9.72±1.42 h, and 77.1% of workers worked more than 8 hours during the day. The average work experience was 8.2±5.77 years. Table 1 presents a descriptive analysis of demographic variables in studied workers.

The obtained results about occupational exposure to IR revealed that the average exposure was 6.96±4.07 mW/cm², and the minimum and maximum of exposure were 0.2 mW/cm² related to whipping station in thin bread (Tafton/Lavash) and 22.5 mW/cm² related to the bread-sticking station in thick bread (Sangak), respectively. The survey showed that 16.7% of the workers were exposed to radiation higher than the allowable limit. Also, 45.1% of each bread-making and bread sticking station exceeded the allowable exposure limit. Also, 20.3% of the studied workers had experienced cataracts. Bakers with direct exposure to fire/heat or in the vicinity of grill/oven had a higher rate of cataracts.

The results showed a significant difference between exposure to IR and bakery type (P<0.001). About 66.7% of stations with radiation levels higher than the allowable exposure limit were related to the traditional thick bread (Sangak) bakery. Then thin bread bakeries (Tafton/Lavash) with 25.5% of the total stations with radiation higher than the allowable limit were in the second stage. A significant correlation (P=0.001) between the workstation and the exposure level to IR was observed. Also, 9.8% of the stations with radiation levels higher than the allowable exposure limit were related to whipping stations, and others related to bread makers and bread stickers, equal to (45.1%). White bread stations or automatic bakeries did not face high radiation levels because of their modern equipment. However, this type of bakery in developing countries such as Iran is rare. According to our study, a statistically significant correlation was observed between the level of IR with training courses in the field of occupational health (P=0.02). Training courses (on-site and off-site) have made employees aware of the dangers and changed their unsafe work behaviors. Also, the results showed that 68.6% of workers exposed to excessive allowable limits had no proper training courses (Table 2).

This study showed a statistical correlation between exposure to IR and the risk of occupational cataracts (P<0.001). According to the results, people with cataracts were exposed to IR at a rate of 8.61±3.82 mW/cm² on average. Also, a significant relationship was found between workstations and cataracts (P<0.001). In addition, no significant correlation was observed between the type of bakery and cataract risk (P=0.59) (Table 3).

The results showed that the relationship between exposure to IR and working hours was significant (P=0.01). Also, the results revealed that the average working hours for workers with exposure higher than the allowable limit was 10.17±0.95 hours. In addition, the difference between the risk of cataracts with age and work history was significant (P<0.001). Workers with cataract injuries, on average, had a work history equal to 12.08±4.53 years.

4. Discussion

Based on our findings, nearly one-sixth of the surveyed stations were higher than the standard limit in terms of IR measurement, and nearly one-fifth of workers were suffering from cataracts. In a study conducted by Hokmabadi et al. in 2014 in Bakeries located in the north of Iran, the results indicated that the level of IR was lower than the limit [28], which is incompatible with the results of this study. This conflict seems to be caused by...
the type of user device, the distance of the device when measuring from the resources, and measurement methods. Based on the relationship between occupational exposure to IR and the type of bakery and workstations, it was revealed that the level of IR exposure was related to the type of bakery and workstations. Because of traditional styles of work as well as work station design and procedures, most of the workstations with IR levels higher than the allowable limit were related to thick bread bakeries (Sangak) and bread makers and bread stickers. Given that the bread makers and bread stickers were required to locate near to furnace or grills based on their work demand, they were much more exposed to the heat and IR. Some of the research was similar to the present research. Majidi et al. conducted a study to assess exposure to IR in aluminum and iron castings industries in Zanjan City, Iran; their research showed that all occupational exposure of workers to IR was beyond the allowable limits [25]. However, due to the thermal effect of IR on the cornea and lens, exposure management such as increasing distance from the sources and personal protective equipment application should be considered. Also, research in two traditional glass factories in Italy similar to our findings indicated that ex-

Figure 2. Traditional bread in Iran (Tafort/Lavash)

Figure 3. The most famous traditional bakeries in Iran (Sangak)
Exposure to IR was beyond the allowable limit in some workstations. The researcher expressed the requirement for eye protection in this study [29].

In the present study, a significant relationship was observed between exposure to IR and the risk of cataracts. In this regard, epidemiological studies suggest that long-term exposure to the human eye may cause damage to the visual system and the incidence of cataracts [16-18]. The results of studies conducted among welders and steel industry workers confirmed the results of this study. In addition, surveys among welders confirmed the relationship between exposure to radiation such as IR and the risk of eye diseases such as cataracts and corneal inflammation. The results of this study are consistent with their results [30, 31]. The study conducted by Sharon et al. also confirmed the results of this study and suggested that duration of exposure was identified as a critical risk factor for eye damage in bakers [17].

A significant relationship was observed between individual workstations, and cataract occurrence due to high exposure to IR in the bread-making workstation, justifying a higher rate of cataract occurrence than in other workstations. In addition, daily working hours and training in the field of occupational health were associated with exposure to IR. Also, inadequate training and lack of awareness about IR, as well as its harmful effects on the eyes and skin, contributed to exposure levels to IR in bakeries [32].

From the viewpoints of the effects caused by the IR absorption on the cornea and lens of the eye shown in epidemiological studies, it is essential to use personal protective equipment for eyes in jobs such as bakeries, especially traditional bakeries [33, 34]. Finally, according to the obtained data, occupational exposure to IR resulting from furnaces and ovens in the bakery job, similar to other major industries such as glass making.
and foundry, should be highly considered, and more efficient control measures are crucial to reduce the exposure of workers [35, 36]. Applying control measures such as engineering, administrative controls, and finally, using appropriate personal protective equipment can reduce workers’ exposure levels and the risk of diseases associated with radiation from the furnace or oven radiation, especially IR [37, 38]. Reducing the reflective surfaces in the workplace can effectively reduce the IR reflection, especially in the vicinity of furnaces and ovens for bread production [39, 40].

5. Conclusion

Based on our findings, exposure time can be affected by radiation exposure, and most of the studied workers worked more than 8 hours per day, so reducing the working hours and work rotation plans can be effective in occupational IR exposure control. Training programs on IR and its effects on human health, exposure management, and medical examinations, as well as short courses for bakers workers, are recommended. Finally, the use of IR shields and suitable/usable eye protection can have an effective role in reducing the exposure level and the risk of eye diseases among bakery workers.

Table 2. Relationship between exposure to infrared radiation and bread-type production, workstation, and health education in (n=306)

| Variables                  | Levels       | Percentage of Exposure | P   |
|----------------------------|--------------|------------------------|-----|
|                            | ≤10 mW/cm²   | >10 mW/cm²             |     |
| Type of bread              | Tafton/Lavash| 49.8                   | 25.5|
|                            | Sangak       | 23.9                   | 66.7|
|                            | Barbary      | 24.7                   | 7.8 |
|                            | White        | 1.6                    | 0   |
| Workstation                | Bread maker  | 31.2                   | 45.1|
|                            | Kneader      | 37.7                   | 9.8 |
|                            | Bread sticker| 31.2                   | 45.1|
| Training in the field of occupational health | Yes | 49.2 | 31.4 |
|                            | No           | 50.8                   | 68.6|

Table 3. Relationship between occupational cataracts of the studied workers with workstation and the type of bakery (n=306)

| Variables                  | Levels       | Cataracts | P   |
|----------------------------|--------------|-----------|-----|
|                            | Yes          | No        |     |
| Bread maker                | 45.8         | 51.5      |     |
| Workstation                | Kneader      | 0         | 100 | <0.001|
|                            | Bread sticker| 12.7      | 87.3|     |
| Type of bread              | Tafton/Lavash| 46.8      | 44.8|
|                            | Sangak       | 27.4      | 33.5|
|                            | Barbary      | 25.8      | 20.1|
|                            | White        | 0         | 1.7 |
References

[1] Gholami M, Yoosofi L. Solar ultraviolet-B radiation monitoring in Khorram Abad city in Iran. International Journal of Radiation Research. 2009; 7(3):171-5. [Link]

[2] Bouzarjomehri F, Tsapaki V. Measurement of solar ultraviolet radiation in Yazd, Iran. International Journal of Radiation Research. 2012; 10(3/4):187-91. [Link]

[3] Mortazavi SMJ, Mozdarani H. Non-linear phenomena in biological findings of the residents of high background radiation areas of Ramsar. International Journal of Radiation Research. 2013; 11(1):3-9. [Link]

[4] Haghani M, Mortazavi SMJ, Sardari D, Mosleh-Shirazi MA, Mansouri A. Assessment of the role of specific absorption rate of mobile phones on the induction of microwave-induced survival adaptive responses after exposure to lethal doses of gamma radiation. International Journal of Radiation Research. 2013; 11(3):167-73. [Link]

[5] Mahmoudi R, Mortazavi SMJ, Safari S, Nikseresht M, Mozdarani H, Jafari M, et al. Effects of microwave electromagnetic radiations emitted from common Wi-Fi routers on rats’ sperm count and motility. International Journal of Radiation Research. 2015; 13(4):363-8. [Link]

[6] Mehdipour LA, Mortazavi SMJ, Siaion EB, Mozdarani H, Aziz SA, Kamari HM, et al. Natural ventilation considerations for radon prone areas of Ramsar. International Journal of Radiation Research. 2014; 12(1):69-74. [Link]

[7] Al Zabadi H, Mallah K, Saffarini G. Indoor exposure assessment of radon in the elementary schools, Palestine. International Journal of Radiation Research. 2015; 13(3):221-8. [DOI:10.7508/ijrr.2015.03.004]

[8] Hodolli G, Bektishi S, Kadiri S, Xhafa B, Dollani K. Radon concentration and gamma exposure in some Kosovo underground mines. International Journal of Radiation Research. 2015; 13(4):369-72. [DOI:10.7508/ijrr.2015.04.011]

[9] Pan S, Yang YD, Li YP, Wang JC, Zhao JW, Wang Y, et al. The effect of microwave radiation on osteogenesis and osteolysis of rats in the hypergravity condition and the role of Rana sylvatica Le conte oil as a radioprotector. Iranian Journal of Radiation Research. 2011; 9(1):1-8. [Link]

[10] Falahati SA, Anvari M, Khalili MA. Effects of combined magnetic fields on human sperm parameters. Iranian Journal of Radiation Research. 2011; 9(3):195-200. [Link]

[11] Fallah Mohammadi G, Vahabi Moghadam M, Ghanbar Moghadam M. Staff dose assessment from coronary angiography. International Journal of Radiation Research. 2014; 12(1):75-8. [Link]

[12] Sklar LR, Almutawa F, Lim HW, Hamzavi I. Effects of ultraviolet radiation, visible light, and infrared radiation on erythema and pigmentation: A review. Photochemical & Photobiological Sciences. 2013; 12(1):54-64. [DOI:10.1039/C2PP25152C] [PMID]

[13] Bahrami A, Rastkari N, Bebahaninia A. A Guide to Occupational Health in Radiation Workers. Environmental and Occupational Health Center. Fifth Edition, 2021.

[14] Okuno T. Thermal effect of visible light and infra-red radiation (IR-A, IR-B and IR-C) on the eye: A study of infra-red cataract based on a model. Annals of Occupational Hygiene. 1994; 38(4):351-9. [DOI:10.1093/anhg/38.4.351] [PMID]

[15] Worugil BV, Kundiyev YL, Sergiyenko NM, Chumak VV, Vitte PM, Medvedovsky C, et al. Cataracts among Chernobyl clean-up workers: Implications regarding permissible eye exposures. Radiation Research. 2007; 167(2):233-43. [DOI:10.1667/RR0298.1] [PMID]

[16] Yu Z, Schulmeister K, Talebizadeh N, Kronschläger M, Söderberg PG. 1090 nm infrared radiation at close to threshold dose induces cataract with a time delay. Acta Ophthalmologica. 2015; 93:e118-22. [DOI:10.1111/aos.12508] [PMID]

[17] Sharon N, Bar-Yoseph FZ, Bormusov E, Dovrat A. Simulation of heat exposure and damage to the eye lens in a neighborhood bakery. Experimental Eye Research. 2008; 87(1):49-55. [DOI:10.1016/j.exer.2008.04.007] [PMID]

[18] Stiney D, Aron-Rosa D, DeLori F, Fankhauser F, Landry R, Mainster M, et al. Adjustment of guidelines for exposure of the eye to optical radiation from oculair instruments: Statement from a task group of the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Applied Optics. 2005; 44(11):2162-2176. [DOI:10.1364/AO.44.02162] [PMID]
[19] Charkhandaz Yeganesh R, Abbasi J, Dehghan H. [Evaluation of relationship among wet bulb globe temperature index, oral temperature & heat strain scoring index in bakers of Isfahan (Persian)]. Journal of Health System Research. 2014; 10(3):559-607. [Link]

[20] Aliabadi M, Jahangiri M, Arassi M, Jalali M. [Evaluation of heat stress based on WBGT index and its relationship with physiological parameter of sublingual temperature in bakeries of Arak city (Persian)]. Occupational Medicine Quarterly Journal. 2014; 6(1):48-56. [Link]

[21] Malakouti J, Yari AR, Safavi N, Majidi G, Nazari S, Alizadeh Mattoo S, et al. Studying the rate of heat stress in bakers. Archives of Hygiene Sciences. 2015; 4(1):7-12. [Link]

[22] Sarayi J, Najbi B, Zaroshani V, Safari variani A. [Assessment of heat stress by WBGT index in the bakery: Gahvazin City (Persian)]. Edrak Journal. 2012; 7(26):57-44.

[23] Negahban SAR, Aliabadi M, Babayi Mesdaraghi Y, Farhadian M, Jalali M, Kalantari B, et al. [Investigating the association between heat stress and its psychological response to determine the optimal index of heat strain (Persian)]. Journal of Occupational Hygiene Engineering. 2014; 1(1):8-15. [Link]

[24] Jafari MJ, Naserpour M, Monazzam MR, Saremi M, Pouragha Shahneshin HR, Jam Bar Sang S. [Evaluation of students’ cognitive performance while exposed to heat using continues performance test (Persian)]. Journal of Occupational Hygiene Engineering. 2014; 1(2):1-9. [Link]

[25] Majidi F, Abedi K, Pirsaraei SRA. Occupational exposure to infrared radiation in aluminum and cast-iron foundries in Zanjan, Iran. International Journal of Occupational Hygiene. 2011; 3(1):33-7. [Link]

[26] Lydahl E, Philipson B. Infrared radiation and cataract II. Epidemiologic investigation of glass workers. Acta Ophthalmologica. 1984; 62(S166):IV1-29. [DOI:10.1111/j.1755-3768.1984.tib06164.x] [PMID]

[27] Habib RR, El-Haddad NW, Halwani DA, Elzein K, Hojeij S. Heat stress-related symptoms among bakery workers in Lebanon: A national cross-sectional study. 2021; [DOI:10.1177/0046958021990517] [PMID]

[28] Hokmabadi R, Ebrahimian H, Esmaelzade Kavaki M. [Check the status of infrared radiation (IR-A) in a bakery in the North Khorasan Province (Persian)]. Paper presented at: The first national conference on environmental health, health and sustainable environment. 2014; Hamadan, Iran. [Link]

[29] Sisto R, Pinto I, Stacchin N, Giuliani F. Infrared radiation exposure in traditional glass factories. American Industrial Hygiene Association Journal. 2000; 61(5):5-10 [PMID]

[30] Kumah DB, Cobbina F, Duodu DJ. Radiation-related eye diseases among welders of Suame ‘magazine’ in the Kumasi metropolis. Journal of Science and Technology (Ghana). 2011; 31(1):37-43. [DOI:10.4314/j.just.v31i1.64884]

[31] Akhgari M, Ghassemi-Broumand M. [Bilateral macular hemorrhage due to welding arc: A case report (Persian)]. J Rafsanjan Univ Med Sci. 2010; 9(2):143-8. [Link]

[32] Rabeiy RE. Evaluation of indoor heat stress on workers of bakeries at Assiut City, Egypt. International Journal of Environmental Science and Technology. 2019; 16(6):2637-42. [DOI:10.1007/s13762-018-1839-z]

[33] Afshari D, Monadi S, Ahmadi Angali K, Shirali GA. Estimation of heat stress and maximum acceptable work time based on physiological and environmental response in hot-dry climate: A case study in traditional bakers. The International Journal of Occupational and Environmental Medicine. 2019; 10(4):194-202. [DOI:10.15171/ijoem.2019.182] [PMID] [PMCID]

[34] Gharibi V, Khanjani N, Heidari H, Ebrahimi MH, Bagheri Hosseinalbadi M. The effect of heat stress on hematological parameters and oxidative stress among bakery workers. Toxicology and Industrial Health. 2020; 36(1):1-10. [DOI:10.1177/0748233719899824] [PMID]

[35] Su Y, Cheng L, Cai W, Lee JK, Zhong S, Chen S, et al. Evaluating the effectiveness of labor protection policy on occupational injuries caused by extreme heat in a large subtropical city of China. Environmental Research. 2020; 186:109532. [DOI:10.1016/j.envres.2020.109532] [PMID]

[36] McCarthy RB, Shofer FS, Green-McKenzie J. Outcomes of a heat stress awareness program on heat-related illness in municipal outdoor workers. Journal of Occupational and Environmental Medicine. 2019; 61(9):724-8. [DOI:10.1097/JOM.0000000000001639] [PMID]

[37] Bolghanabadi S, Mohammadi A, Kohnavard B, Delkhosh M. The relation between heat strain and hydration status in the food industry employees in Mashhad, 2014. Polish Annals Medicine. 2019; 26(1):30-5. [DOI:10.29089/2017.17.00040]

[38] Kjellstrom T, Lemke B, Lee J. Workplace heat: An increasing threat to occupational health and productivity. American Journal of Industrial Medicine. 2019; 62(12):1076-8. [DOI:10.1002/ajim.23051] [PMID]

[39] Arghese BM, Hansen A, Bi P, Pisaniello D. Are workers at risk of occupational injuries due to heat exposure? A comprehensive literature review. Safety Science. 2018; 110(Part, A):380-92. [DOI:10.1016/j.ssci.2018.04.027]

[40] Dong XS, West GH, Holloway-Beth A, Wang X, Sokas RK. Heat-related deaths among construction workers in the United States. American Journal of Industrial Medicine. 2019; 62(12):1047-57. [DOI:10.1002/ajim.23024] [PMID]