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# Hypertension and Occupational Health: A General Overview and Expert Consensus Suggestions

## Hipertansiyon ve İşyeri Sağlığı: Genel Değerlendirme ve Uzman Uzlaşı Önerileri

Listen to the interview with the author of this manuscript.

**ABSTRACT**

Hypertension is a common public health issue, and its incidene increases parallel to age. It is inevitable that certain occupational conditions may pose risks for high blood pressure or cause difficulties in managing blood pressure. Working under specific circumstances may compromise the safety of individuals with hypertension and potentially others. Therefore, it is crucial to implement activities that enhance awareness of hypertension, to ensure regular periodic examinations, and to establish necessary precautions in the workplace for the health of employees and the public. Given the limited resources offering guidance on hypertension in the context of occupational health, the authors of this paper, who hail from different disciplines, have prepared a set of consensus-based suggestions.

**Keywords:** Hypertension, occupational health, working

**ÖZET**

Hipertansiyon sıklığı yaşla beraber artan yaygın bir halk sağlığı sorunudur. Çalışma hayatı ile ilgili bazı durumların kan basıncını yükseltmesi veya kan basıncının kontrolünde zorluklara yol açması kaçınılmazdır. Hipertansif bireylerin bazı özel durumlarda çalışması kendilerinin ve başkalarının güvenliğini tehlikeye atabilir. İşyerlerinde hipertansiyona yönelik farkındalığı arttırıcı faaliyetlerde bulunulması, düzenli periyodik muayenelerin yapılması ve gereken önlemlerin alınması çalışan ve toplum sağlığı açısından önem arzetmektedir. Kaynakların sınırlı olması nedeniyle farklı tıbbi birimlerden oluşan bu derlemenin yazarları, fikir birliği ile hipertansiyonda iş sağlığına yönelik rehberlik edecek bazı önerilerde bulundular.

**Anahtar Kelimeler:** Hipertansiyon, iş sağlığı, çalışma

Hypertension (HT) is a common health concern due to its high frequency and the severity of its complications. It can be linked to acute, serious events such as cerebral hemorrhage. However, it is generally an insidious disease, and together with other cardiovascular (CVS) risk factors, it gradually precipitates deleterious outcomes including heart failure, coronary artery disease (CAD), hemorrhagic and ischemic strokes, kidney failure, peripheral artery disease, aortic dissection, and death.[1]

The incidence, awareness, treatment, and control of HT vary according to the occupational group. It has been reported that the prevalence of HT ranges from 10.5% to 28%, awareness of HT from 51% to 93%, the rate of antihypertensive treatment from 79% to 96%, and the achievement of target blood pressure (BP) levels from 48% to 85%, depending on the occupational group. The occupational subgroups with the highest prevalence of HT are motor vehicle operators (28.7%), repair workers and mechanics (28.4%), manufacturers, assemblers and sample workers (27.5%), and those in cleaning and construction service occupations (27.6%). These rates are significantly higher compared to the rest of the US worker population.[2-4]

Working women typically have increased self-esteem compared to homemakers. However, they face additional challenges and demands that can cause fatigue and exhaustion. The diversity of responsibilities related to occupational prestige and personal income may negatively affect BP.[5] Nevertheless, it has been suggested that the prevalence of HT is higher in working men than in women. Furthermore, awareness of this problem and the rate of antihypertensive drug use is lower in men. In addition,

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target BP levels are achieved less frequently in male workers than in females.[6]

The risk for CVS disease is not only related to BP levels but also to the involvement of target organs and the presence of CVS risk factors. For a 30-year-old patient without additional risk factors, the severity of a high blood pressure does not indicate a high risk for major CV events in the short term. Such a patient may only require adherence to the rules of a healthy lifestyle rather than drug therapy. However, an individual of the same age with similar BP and coexisting CVS risk factors (such as diabetes, hyperlipidemia, smoking, hyperlipidemia, and a family history of early CVS disease) has a higher risk for future CV events and warrants medication in addition to lifestyle measures.

Employers should identify and implement various strategies to improve employee health and reduce healthcare costs. Given the high prevalence of HT in the working-age population, it is obvious that early detection of HT by screening and implementing preventative measures for working environments and conditions that may impact blood pressure management are critical for worker safety and occupational health. Since HT may have no warning signs or symptoms, most people with HT are unaware of their condition. For successful management of HT, it is essential to ensure timely and accurate diagnosis of patients, to implement lifestyle changes effectively, to initiate drug treatment promptly, and to ensure adherence to the treatment regimen. The provision of BP measurement devices and the organization of BP check days in the workplace can enable early diagnosis for many individuals who do not have access to this facility at home. Evaluating workplaces as training centers for HT and other CVS risk factors – by providing regular mandatory trainings, hosting conferences with experts, distributing written brochures/booklets, and conducting regular periodic examinations of employees for the detection of end-organ damage, such as cardiac and renal involvement – will aid in early intervention and the prevention of complications. Workplace HT management programs can potentially reach a greater number of employees and offer better accessibility; thus, they should be considered for inclusion in more comprehensive HT control strategies.[7] A workplace-based HT management program has been associated with reduced BP levels and lower risks of major adverse CVS events and mortality in hypertensive workers.[8] For the employer, such investments may initially appear as an additional expenditure in the short term. However, considering the increased likelihood of HT and other comorbid conditions with advancing age, particularly in healthy individuals who start working at a young age, it is important to prevent HT, death, and the loss of labor due to diseases in the experienced worker group through early diagnosis and appropriate treatment. Therefore, these investments are likely to be cost-effective in the long term.[9]

High sodium consumption (> 2 g/day, equivalent to 1 teaspoon or 5 grams of salt per day) and insufficient potassium intake (< 3.5 g/day) contribute to high BP.[10] The Salt Intake in Turkish Population (SALTURK) studies conducted in Türkiye have shown that daily salt consumption is well above the recommendations, at 15-16 g/day.[11] A modest reduction in daily sodium intake has been associated with decreased BP in individuals with both elevated or normal BP.[12] Furthermore, long-term substitution of 25% of sodium with potassium in salt substitutes has resulted in significant reductions in stroke and CVS events.[13] If a patient is overweight, they should be encouraged to reduce their weight to an appropriate level, or at least achieve a 5-10% weight loss. The diet of patients with HT should primarily consist of vegetables, fruits, low-fat foods, whole grains, plant-derived proteins, and fish (at least twice a week). The consumption of fast foods and processed foods high in fat, refined sugar, and salt should be avoided. Precautions such as making meals less salty at the workplace, avoiding high-salt products like pickles and tomato paste, and providing low-salt diets and freshly cooked meals instead of ready-to-eat meals will aid in the prevention and treatment of HT among employees. Hypertensive patients should be advised and encouraged to quit smoking, as smoking cessation is one of the most effective means of reducing CVS risk. In Türkiye, the smoking ban practices initiated by the Law on the Prevention and Control of Harms of Tobacco Products No. 4207 should be meticulously implemented in workplaces. Hypertensive patients are also advised to abstain from alcohol consumption. If they do consume alcohol, it is recommended that their intake should not exceed 20-30 g/day of ethanol for men and 10-20 g/day of ethanol for women. Employees with high BP are recommended to adhere to these general guidelines as well. Regular dynamic exercise benefits BP regulation, glucose metabolism, and lipid levels, thereby reducing CVS risk. It is recommended to engage in regular exercise for 30-60 minutes daily, or at least five days a week.[14] Workplaces, if possible, may provide onsite exercise options and encourage employees to participate in local exercise events and sports teams.

It is known that various external factors pose risks for BP elevation and dysregulation in the workplace. Situations such as work stress, noise, thermal conditions, shift work, working at heights, hot and humid environments, weight lifting, and exposure to certain chemicals (e.g., Pb, Cd) can create health problems for employees (Table 1).[5,15-20]

### Work Stress and Discrimination

Work stress is a risk factor for the development and control of HT. Associations have been found between high BP and factors

## ABBREVIATIONS

| | |
|---|---|
| ACE | Angiotensin-converting enzyme |
| AMS | Aeromedical section |
| BP | Blood pressure |
| CAA | Civil aviation authority |
| CAD | Coronary artery disease |
| CVS | Cardiovascular |
| ECG | Eelectrocardiogram |
| FAA | Federal aviation administration |
| HT | Hypertension |
| JAR-FCL | Joint aviation requirements flight crew license |
| MIDUS | the Midlife in the United States |
| OML | Operational multi crew limitation |
| OSL | Operational safety pilot limitation |
| $PAO_2$ | Partial pressure of $O_2$ |
| PUR | Professional underwaterman regulation |
| SALTURK | The salt intake in Turkish population |
| SHGM | General directorate of civil aviation |
| TAF | Turkish armed forces |

like long working hours, labor-earnings imbalances, and job insecurity. Work stress has been associated with increased mean ambulatory BP measurements at work, at home, and during sleep. Occupations where work stress is prevalent, such as those of directors, professional drivers, jobs with few social interactions, emergency services (police, firefighters, health workers), and shift workers, can have more detrimental effects on employees' health, including HT. Management of HT in patients with high occupational stress requires appropriate measures to minimize work strain. This should include individual coping strategies and lifestyle changes, as well as improvements to the work environment. Offering employee assistance programs or counseling services may be beneficial for those dealing with work-related stress.[5,16]

Workplace discrimination, arising from factors such as ethnicity, race, gender, experience, and social status, is a potential risk factor for HT and CVS diseases among employees. Recent research suggests prospective links between workplace discrimination and depressive disorders. An analysis of data from the Midlife in the United States (MIDUS) study revealed that over an 8-year follow-up period, exposure to high levels of occupational discrimination was associated with a 54% increased risk of HT, a finding that was independent of sociodemographic, behavioral, and other psychosocial factors. A mean decrease of 2.0 mmHg in systolic BP has been reported following improvements in working conditions, such as reduced job demands and increased job control. Among hypertensive workers in the United States, 10 weeks of group-based training in cognitive-behavioral stress management resulted in a lower systolic BP reduction of 9.1 mmHg, compared to a decrease of only 1.7 mmHg in the control group. Such stress management interventions have also been clinically proven to reduce medical events and mortality in patients with coronary heart disease.[21]

**Recruitment and Periodic Follow-Up of Hypertensive Employees**

After conducting an appropriate medical examination, the "Recruitment/Periodic Examination Form" is filled out for each employee in accordance with legal regulations and professional standards. In the 'Opinion and Conclusion' section of the form, the physician notes the measures to be taken during job performance and determines whether the employee is fit for the job based on the nature of the work to be performed. It is prohibited to employ workers without a doctor's report and to hire workers who are not suitable for the age groups specified in the regulations.[17,18]

The periodic follow-up of a hypertensive employee at work is conducted similarly to the follow-up of other patients in the community. An employee who is started on a new antihypertensive medication should be scheduled for a follow-up 2-4 weeks later to measure their BP. Routine follow-up should be conducted six months after BP is under control. Additionally, BP should be measured at every periodic examination.[16,17] It is essential to control all factors in the workplace that could disrupt BP control; otherwise, the employee's work area should be changed.[17,19] BPs measured by physicians or nurses during periodic health examinations may be higher than those measured in the worksite community health centers by community health workers.[22] Therefore, it is crucial to strictly adhere to the advised BP measurement protocols. Implementing daily self-reported BP monitoring or ambulatory BP measurements is important to avoid the overestimation of HT prevalence and the overtreatment of those who are misclassified as having HT.

As long as HT is under control, it usually does not cause problems in working life, unless additional issues arise.[17,18] However, symptoms such as dizziness, fatigue, and loss of attention may occur when there are fluctuations in BP. Individuals with frequent BP fluctuations, high BP, and target organ damage should not be employed in jobs that could endanger themselves or others. While some patients may experience symptoms such as headaches, malaise, or numbness, the majority exhibit no symptoms. Therefore, regular daily BP checks should be conducted on employees in dangerous and safety-sensitive occupations such as public transport drivers, long-distance drivers, those who work at heights, underground, or underwater, and machine operators.[17-20]

Periodic examination intervals in the workplaces are every three months for lead and mercury exposure, every six months for arsenic, insecticides, and dusty environments, and annually for other workplaces.[17] However, employees with HT, especially those working in heavy and hazardous jobs such as in metal, construction, marble, mining, and at high altitudes, should be monitored more frequently.

**Noise**

Noise is the most common physical risk factor affecting health in workplaces.[17] Approximately 17% of the global workforce is exposed to occupational noise levels of 85 dB(A) or higher.[18] Noise-induced hearing loss is the most common occupational disease in most industrialized countries.[22] Numerous studies have established a causal relationship between work-related loud and prolonged noise and HT.[23,24] The abnormal BP response to noise has been linked to factors such as noise intensity, duration of exposure, cumulative exposure time, degree of hearing loss, age, and gender. Occupational noise exposure exceeding 85 dB(A) has been shown to increase BP and the prevalence of HT, with risks being higher at levels over 95 dB(A). With more than five years of exposure time, the risk of HT in workers doubles, and with over 15 years of exposure, the risk increases more than fourfold.[25] While the incidence of HT increases with exposure to industrial noise, the deterioration in HT regulation is more frequent.[26]

According to the "Regulation on the Protection of Employees from Noise-related Risks":[18,26,27]

1. Workplaces with an 8-hour working noise intensity of 80 dB(A) are considered noisy. It is mandatory for workers in these environments to have personal protective equipment: ear protectors.
2. If the 8-hour noise level is 85 dB(A), the use of ear protection is obligatory. Additionally, engineering measures must be taken to reduce the noise in the workplace.
3. It is prohibited to work in environments where the 8-hour noise level exceeds 87 dB(A) despite the use of personal protective equipment, including ear protection.

Engineering measures include providing quieter machinery and equipment, replacing surfaces in the working environment with more materials that absorb more noise, offering training and periodic audiometric tests, using personal ear protectors, and implementing rotational work for workers exposed to noise levels of ≥ 90 dB(A). [18,26,27]

**Thermal Conditions**

Hot and cold conditions in the working environment affect BP.[19,28] Blood pressure increases in a cold environment and decreases as the ambient temperature rises. Vascular resistance and BP decrease with the warming weather in summer.[28] A decrease of 1°C in indoor temperature is associated with an increase of 0.48 mmHg in systolic BP and 0.45 mmHg in diastolic BP.[29] If the temperature in the working environment drops below -25°C, employees are considered to be exposed to cold stress. Cold stress can be expected in operations conducted in cold rooms, freezing rooms, freeze-drying areas, and low-temperature research cabinets. Workers in such environments should wear insulating clothing and limit their exposure to 15-minute periods.[17] People who work in hot and humid environments, such as bakers, kitchen workers, foundries, rolling mills, blast furnaces, boiler rooms, cement and lime factories, and outdoor construction workers, may experience BP drops, particularly orthostatic hypotension, due to excessive sweating, water and salt loss, and vasodilation. Consequently, individuals working under such conditions should be provided with ample hydration and more frequent rest periods. Patients on antihypertensive medications should have their medications managed with strict BP monitoring to prevent hypotension. It is important to ensure that thermal conditions in the workplace are maintained at optimal levels to allow workers to perform their physical and mental tasks in comfort. Thermal comfort also depends on the nature of the work performed and the clothing worn by the employee. The recommended ideal temperature for a work environment ranges between 17°C and 23°C. Deviations from thermal comfort due to ambient temperature can lead to fatigue and inattentiveness, decreasing work efficiency and increasing the likelihood of occupational accidents. Work efficiency declines by 5% at 30°C and escalates to a 30% decrease at 32°C. It has been observed that occupational accidents increase at temperatures above 30°C.[18,19]

**Shift Works**

Shift work disrupts the body's circadian rhythm and can involve difficulties like insomnia during the sleep phase and/or excessive sleepiness during waking hours due to a work schedule that requires working outside of traditional hours. Extended working hours and night shifts, where nutrition and sleep patterns are irregular, may hinder the effective management of chronic conditions in employees, such as HT.[30] Healthcare workers, firefighters, police officers, military personnel, and drivers are among those who may be subjected to shift work. Working especially between 22:00 at night and 06:00 in the morning has been associated with metabolic syndrome, insulin resistance, diabetes,[31] HT, and CAD.[32,33] These adverse effects are particularly observed in individuals who work four or more night shifts per month, and in those with 20 or more years of night shift work. In a 14-year Japanese cohort study comparing 3,963 daytime workers with 2,748 shift workers, shift work was identified as an important and independent risk factor for increased BP.[34] In addition to its association with the development of HT, night and shift work also impair adherence to HT treatment.[20] Hypertensive patients working night shifts have lower BP control rates than those working daytime hours. Ambulatory BP monitoring can be used to detect impaired BP regulation due to disturbances in circadian rhythm.[35] Occupational physicians should avoid recommending night work for workers with HT as much as possible. It is crucial to prevent hypertensive patients, especially those with uncontrolled conditions, from engaging in prolonged and nighttime work.[18,19]

**Working at Height**

The definition of working at height varies between countries. In Türkiye, the legislation essentially defines working at height as any situation that carries the risk of injury from a fall. More practically, it is described as working at a level higher than one's waist.[36] In contrast, the "Work at Height Regulations" in England do not define a specific height; instead, it mandates that equipment selection be based on the potential the risk of death or injury from working at height.[37] Meanwhile, the International Labor Organization (ILO) and the Occupational Safety and Health Administration (OSHA) in the USA define working at height as being over 180 cm and recommend three basic protection systems: guardrails, safety nets, and personal fall arrest equipment.[38] Jobs that are considered to involve working at height include construction, building, scaffolding, steel structure assembly, towers, bridges, tunnels, subways, well drilling, chimneys, work on poles, cleaning at heights, exterior building repairs, shipbuilding, piers, ports, and crane operation, among others.[17] Periodic examinations of employees working at high altitudes should be conducted once a year.[17,19] The most significant risk associated with working at height is the potential for serious injury or death due to falls. Clearly, any condition that can induce vertigo will increase the risk of falls and accidents. Hypertension, especially with labile BP values, is one such condition. Orthostatic symptoms caused by antihypertensive drugs may trigger vertigo, thereby increasing the risk of potentially fatal occupational accidents for those working at height.[39] To ensure that individuals with HT can safely work at elevated levels, it is essential to first confirm that BP is well controlled. If there is uncertainty about office and home BP measurements, ambulatory BP monitoring can be requested. Exclusion of orthostatism is crucial before making a decision about working at height. For this purpose, after resting in the supine position for five minutes, serial BP measurements should be taken first at supine and then at two and five minutes after standing. A decrease of ≥ 20 mmHg in systolic BP and/or ≥ 10 mmHg in diastolic BP confirms the diagnosis of orthostatic (postural) hypotension.[40] If orthostatism is a side effect of medication, the drug should be properly substituted, and the orthostatic hypotension test should be repeated. If symptoms and signs of orthostatism persist despite these adjustments, it must be reported that the employee is unfit for work at height.[41]

**Table 1. External Factors That Can Affect Blood Pressure in Working Life[5,15-20]**

| | |
|---|---|
| **Work Stress** | Long working hours, labor-earnings imbalance, and job insecurity have been associated with hypertension. |
| **Noise** | Numerous studies have established a relationship between work-related noise and hypertension. |
| **Thermal Conditions and Humid Environments** | Blood pressure rises in cold environments and falls in hot ones. Workers in hot and humid conditions may experience blood pressure drops, particularly orthostatic hypotension, due to excessive sweating, loss of water and salt, and vasodilation. |
| **Shift Work** | Extended working hours and night shifts, which lead to irregular eating and sleep patterns, can disrupt the blood pressure regulation of employees. |
| **Working at Height** | Individuals with symptomatic labile hypertension and orthostatism are deemed unfit for working at elevated levels. |
| **Weight Lifting** | Extremely high blood pressure spikes may be observed during heavy lifting. |
| **Exposure to Certain Chemicals** | Long-term exposure to carbon disulfide, lead, cadmium, arsenic, and mercury has been linked to the development of hypertension. |

## Specific Working Groups and Hypertension

### Healthcare Workers

Healthcare workers are exposed to stress-related risk factors such as overtime, a high workload, insufficient breaks, complex tasks, and poor physical conditions. Additionally, prolonged standing due to the workload during treatment processes, nutritional irregularities, and insomnia related to shift work can trigger many diseases and increase the risk of HT. The prevalence of HT among healthcare workers has been reported to be between 21.3% and 26%.[42,43] Work-related stress was significantly associated with a higher prevalence of HT among healthcare workers.[44] Prolonged working hours and having more than one child increase the stress related to work-home interactions for physicians. Low support from family and colleagues was identified as an important predictor of stress.[45] Among healthcare workers in the emergency department, BPs were significantly higher when participants were on call.[46] However, another prospective study among female nurses indicated that workload or social support had no effect on ambulatory BP levels.[47] Higher rates of HT have been reported in healthcare workers during pandemics and curfews.[43] During extraordinary periods such as natural disasters and pandemics, it may be prudent to consider reducing the workload of healthcare workers with HT.[48] They should also be discouraged from working night shifts.

### Managers, Desk Workers (White Collars)

White-collar workers, including those in managerial and administrative positions, may face risks associated with a sedentary lifestyle, obesity, heavy workloads, and stress, which can lead to metabolic disorders. A prospective study found that excessive workload and work stress significantly affected BP among white-collar workers, including senior management staff, professionals, technical, and office staff.[49] Another prospective study noted that overtime work was associated with HT.[50] A cross-sectional study among female white-collar workers demonstrated that the combination of increased family responsibilities, workload, and work stress was associated with significant increases in BP on ambulatory monitoring.[51] Bank employees exhibited a wide range of HT frequencies, from 12% to 69%, across several reports.[52-54] Sociodemographic factors such as older age, male gender, family history, travel patterns, lack of physical activity, obesity and weight gain, duration of employment, and habits such as coffee consumption and smoking have also been reported to be significantly associated with HT.[55]

### Physical Workers (Blue Collars)

Blue-collar workers are laborers engaged in physical and manual labor, with the exception of farmers. The propensity for HT increases due to factors such as a high workload, imbalance in working conditions and hours, and tensions stemming from limited decision-making autonomy. HT prevalence is higher among individuals facing uncertainty about job security, job dissatisfaction, conflicts over interpersonal dominance, promotion deficiencies, suppressed anger, and elevated levels of work-related stress.[56] Stressful conditions and general job dissatisfaction have been strongly linked with HT.[57] Additionally, a lack of autonomy in work decisions and intensive workloads are also associated with an increased risk of HT.[58] In a prospective cohort study, work stress and the use of complex and demanding machinery were associated with a significant increase in BP. However, excessive workload, physical discomfort, and human relations did not impact HT.[59] Limited access to health services further exacerbates stress and delays the initiation of optimal treatment. Hypertension in blue-collar workers can be more effectively managed by ensuring optimal working conditions, proficiency in workplace health practices, and facilitating easier access to health services.

### Teachers/Academicians

The impact on teachers and academicians may vary based on factors such as the individual's experience, duration in the profession, the number of groups addressed, the age group of students, and the sociocultural level of the environment. Consequently, risks for HT and CV diseases may vary within this group. A prospective study among teachers identified a correlation between excessive work demands and higher BP levels during the workday, after adjusting for confounding factors.[57] The working conditions were found to influence the development of

psychosomatic diseases and HT among university academics. A positive association has been observed between shift work, high work demands during nighttime hours, and HT.[60-62]

**Farmers**

There are contradictory results regarding HT in farmers. A case-control study in Italy found a higher prevalence of HT among farmers. However, some community surveys have indicated that farmers have a lower risk of HT. While high physical activity and greater autonomy in work decisions are protective factors for farmers, an increased risk of HT and CVS disease may arise due to environmental factors such as exposure to daylight, intense heat, seasonal changes, and irregular nutrition.[63-65]

**Highway Drivers**

Drivers, especially those who spend most of their time on the road, commonly lead unhealthy lifestyles characterized by irregular eating and sleeping patterns, low levels of physical activity, and smoking and tobacco use. Consequently, the prevalence of HT is higher among highway drivers compared to the general population. A meta-analysis that included 26 studies with a total of 15,702 drivers reported a combined worldwide prevalence of HT among drivers as 34%; the highest in the Western Pacific (56%) and the lowest in the Eastern Mediterranean and African regions (21%).[66] According to regulations and laws in Türkiye, HT should be assessed during driving license examinations. Those with BP > 200/120 mmHg despite treatment are ineligible for a class 2 driver's license and should be referred to a cardiologist.[67] Many specialist physicians argue that the threshold of 200/120 mmHg is excessively high and should be reduced to 180/100 mmHg, suggesting that drivers with 1-2 high BP readings per month should undergo a cardiologist's evaluation, regardless of regulation.[68] The Turkish Society of Cardiology also recommends that individuals with persistent BP > 180/100 mmHg should not drive commercial vehicles. After achieving BP control without side effects that could impair driving, they may be permitted to drive again.[69] Hypertension can be initially evaluated by a family physician, but those with hypertensive crises and target organ damage should be referred to an appropriate specialist (cardiology, nephrology, neurology, or endocrinology). Uncontrolled HT, defined as > 180/100 mmHg, should be managed by a cardiologist or nephrologist.[68]

The American Federal Motor Vehicle Safety Regulations state that individuals with BP < 140/90 mmHg can be certified to drive for two years. Those with stage 1 HT (140-159/90-99 mmHg) can be medically approved to drive for one year. Drivers with stage 2 HT (160-179/100-109 mmHg) must undergo antihypertensive therapy, receiving a 3-month certificate to reduce BP to ≤ 140/90 mmHg. If BP ≤ 140/90 mmHg is achieved and is well-tolerated, they should be recertified for one year from the date of the first examination, with annual certification thereafter. A driver with stage 3 HT (> 180/110 mmHg) is disqualified. The driver cannot qualify, even temporarily, until BP is ≤ 140/90 mmHg and treatment is well-tolerated. The driver may be certified for six months if BP is ≤ 140/90 mmHg upon reevaluation. Drivers with diabetes and kidney disease should be treated if their BP is > 130/80 mmHg. Furthermore, taking antihypertensive medication limits the driver's medical certificate duration to one year.[70] Physicians should counsel their patients about the potential impact of antihypertensive drugs on driving performance, which may include hypotensive effects such as dizziness, lightheadedness, and fatigue. Additionally, beta-blockers and sympatholytic agents such as clonidine, guanfacine, and methyldopa can cause sedation, confusion, or insomnia.[71]

**Machinists**

Railway transportation can lead to health issues for train workers due to chronic exposure to noise.[72] The "Republic of Türkiye Train Driver Regulations" stipulate that individuals with a BP of > 180/100 mmHg are not eligible to work as machinists. Once BP is controlled without side effects that may interfere with operating a train, they are permitted to work again.[73]

**Flight Personnel**

Traveling by aircraft at high altitudes leads to low atmospheric pressure and hypoxic conditions. Lower in-cabin atmospheric pressure relative to sea level causes a decrease in the partial pressure of $O_2$ ($PAO_2$). While healthy individuals can generally tolerate hypoxia that may develop, it can pose risks for people with CVS or respiratory diseases, or those with deep anemia. Hypertensive patients with effective BP control can usually tolerate conventional airway flights without difficulty, but uncontrolled HT and preeclampsia are significant contraindications for air travel.[74] Those with uncontrolled HT are reported to be at an increased risk of arrhythmia and pulmonary edema under hypoxic conditions associated with high altitudes.[75] Moreover, airline passengers with obesity-hypoventilation syndrome, which is frequently associated with HT, are at risk of severe hypoxia, despite effective nocturnal noninvasive ventilation therapy. Additionally, it has been observed that the BP and heart rates of hypertensive pilots during ascent and descent are significantly higher than those of pilots without HT.[76]

Here are some recommendations for hypertensive travelers:

1. Ensure BP is regulated before the flight,
2. Obtain a "flight eligibility" or "flight permit" by informing the airline transportation company/medical unit when necessary,
3. Discuss the antihypertensive medication regimen with their physician, especially for flights where jet lag is expected,
4. Keep antihypertensive medications in the cabin inside an easily accessible bag,
5. Wear comfortable clothing for the journey,
6. Arrive at the airport early to avoid the stress of being late,
7. Avoid lifting heavy luggage and prefer wheeled luggage,
8. Choose "Emergency Exit" seats for more legroom and/or aisle seats for easier access to the aisle.[74]

There are both differences and similarities among countries in the evaluation of flight crew, particularly pilots, for HT. All processes are conducted by the official civil aviation organizations and relevant departments within the countries in accordance with the provisions of their legislations: General Directorate of Civil Aviation (SHGM) in the Republic of Türkiye, Civil Aviation Authority (CAA) in the UK, and Federal Aviation

Administration (FAA) in the United States.[74] According to the Joint Aviation Requirements Flight Crew License (JAR-FCL)-3, the diagnosis of HT during routine controls necessitates the review of other potential vascular risk factors. In the medical examination of aviators, BP should be recorded using the classical sphygmomanometer method. BP should be measured twice during the follow-up examination. Among antihypertensive medications, non-loop diuretics, certain (usually hydrophilic) beta-blockers, angiotensin-converting enzyme (ACE) inhibitors, angiotensin II AT1 blockers, and slow channel calcium blockers are permitted. In contrast, reserpine, methyldopa, guanethidine, guanadrel, and guanabenz are not approved for flight personnel by the Aeromedical Section (AMS). Being on antihypertensive therapy necessitates an operational multi crew limitation (OML) for class 1 fliers and an operational safety pilot limitation (OSL) for class 2 fliers.[77] According to the SHGM in Türkiye, the BP values of hypertensive flight personnel are recorded during each flight examination, and BP values must be within normal limits. Individuals applying for a Class 1 or 3 health certificate who have symptomatic HT or persistent BP readings of > 160 mmHg systolic and/or 95 mmHg diastolic during the flight examination are evaluated as unfit for flight. A flier is considered temporarily unfit for flight until control of BP with treatment is achieved, ensuring that there are no significant side effects.[78,79]

**Seafarers**

The prevalence of HT is higher among seafarers compared to the general population. This increased susceptibility may stem from the nature of their job, which includes factors such as diets onboard, physical inactivity, and the use of alcohol and tobacco, as well as a high-sodium diet that often comes from processed and fatty foods. There are also some limitations in the workplace in terms of early diagnosis and treatment.[80-84] Traveling away from land for extended periods in a confined environment may cause psychological problems. Extreme stress can encourage behaviors that increase BP, such as poor diet, physical inactivity, and increased tobacco or alcohol use.[85] According to the Turkish Seafarers' Health Directive, a 2-year seafarer health license can be issued by a specialist physician or a coast health inspection center physician for persons managing regulated chronic diseases such as Type II diabetes and HT. However, those with malignant HT cannot be given a seafarer's health license, and active workers with this condition cannot be allowed to work at sea. Individuals with a BP > 160/100 mmHg are temporarily not allowed to work until their BP is under control. Those with persistent BP levels > 170/100 mm Hg are deemed unfit for work. Some antihypertensives may cause postural hypotension and an impaired cardiac response to exercise. Seafarers can work at sea after stabilization with treatment that does not cause such side effects. If they are taking medications with adverse effects that could negatively impact the journey, the risks and suitability should be assessed individually.[86]

**Military Divers, Submarine Personnel, Frogmen, and Underwater Workers**

Metabolic syndrome and HT are common among submarine crews due to factors such as inactivity, nutritional disorders, and disruptions in circadian rhythm. Prolonged indoor confinement may contribute to the development of HT, which can be secondary to psychological disorders.[87] High BP can pose a significant risk for myocardial infarction or stroke while diving. The presence of HT is likely to increase through various mechanisms during recreational diving. Diving induces peripheral vasoconstriction and a fluid shift of approximately 600-700 ml from the extremities to the trunk, especially in cold water. Additionally, exertion during diving can lead to increased BP.[88] The Marine Medical Research Laboratory in the USA disqualifies submarine crew members with persistent BP > 145/90 mmHg.[89] Health skills and periodic examinations for divers, submarine crew, frogmen, and candidates who are members of the Turkish Armed Forces (TAF), the Gendarmerie General Command, and the Coast Guard Command are regulated by the Health Skill Regulation (HSR).[90] For civilians, the qualifications for industrial divers are determined according to the "Professional Underwaterman Regulation" (PUR).[91] According to the TAF HSR, cardiological evaluations for diver and frogman specialty candidates should include an electrocardiogram (ECG) and transthoracic echocardiography every five years. According to both regulations, those with any heart disease (be it congenital, hypertensive, valvular, conductive, or atherosclerotic) that limits cardiac capacity cannot become professional underwatermen.[90,91] Candidates for diver and frogman roles who exhibit labile HT, postural hypotension, vasovagal syncope, or significant sinus tachycardia or bradycardia during examination may be suspended from diving for up to one year until appropriate treatment is administered.[90]

**Law Enforcement (Police) Officers**

Police officers are professionals who come into contact with both humanitarian and financial problems. They are exposed to threats to their own safety and that of their colleagues, as well as to violent incidents.[92,93] This professional group can experience acute and posttraumatic stress disorders.[94] Organizational stress, rules, and relationships between officers, working in shifts, irregular working hours, and consecutive working days may all lead to chronic stress.[95] Rathi and Singh[96] reported that 23.5% of police chiefs in Delhi were pre-hypertensive and 63.6% were in stage 1 HT. The level of perceived stress was found to be proportional to BP elevation and the number of coronary plaques.[97,98] The probability of HT was found to be lower among educated police officers.[99] In Türkiye, according to the "Regulation of Health Requirements for Police Officers", HT is an obstacle to becoming a police student. Police officers with complicated HT should be referred to a medical department dealing with target organ damage for disqualification or reassignment to another service category. The discrimination between working conditions and active and inactive duties is managed by police administrative units.[100] For the physical and psychological health of police officers, working conditions should be improved. Individuals who can tolerate the expected workload should be selected through tests conducted during recruitment, and periodical psychological health screenings should be carried out.

**Firefighters**

Firefighting is a profession fraught with extreme dangers, encompassing both psychosocial and physical risks. Firefighters have to contend with a large number of unpredictable dangers with limited resources. They are also subject to the demands of irregular working hours, a high volume of unpredictable calls, and

the expectation to perform flawlessly under time pressure. Cross-sectional studies have reported higher rates of HT in firefighters than in civilians.[101] Risavi and Staszko[102] reported a 45% HT rate among firefighters, with 50% of the participants being unaware of their BP status.[102] Ambulatory BP monitoring revealed that the BPs of hypertensive firefighters were higher during medical calls, and such calls caused higher BP fluctuations in hypertensive firefighters than in their normotensive counterparts.[103] Beyond work-related stress, firefighters are more prone to consuming fast food, high-sugar drinks, and other less healthy food options.[104] According to the "Municipal Fire Brigade Regulation" implemented by the Ministry of Environment, Urbanization and Climate Change in Türkiye, firefighters are required to undergo a health check-up once a year.[105] It is advisable for those with uncontrolled or labile HT to take a break from work until their BP is managed, with a particular recommendation to avoid night shifts.

**Private Security Guards and Guardians**

In the annex of the "Regulations on Health Conditions for Private Security Guards" in Türkiye, although cardiac disorders are listed among the criteria that preclude one from becoming a private security guard, specific limitations for BP values are not mentioned.[106] Job-specific stress and shift work patterns increase the risk of HT and CVS diseases among guards.[107] Significant threats in prison environments can adversely affect mental and physical health.[108] According to regulations in Türkiye, all forms of essential and secondary HT that cannot be managed with treatment are considered disqualifying for appointments as enforcement or protection officers, regardless of the presence of complications.[108] It is recommended that physical and mental fitness examinations be performed for private security guards and guardians during recruitment. If HT is diagnosed during periodic examinations, the individual's work should be suspended until BP control is achieved (target < 140/90 mmHg). They should ideally not be assigned to night shifts, and if possible, their work area should be changed. Patients with ongoing BP > 180/100 mmHg or complicated HT with target organ damage should be evaluated for temporary leave or disability retirement by the relevant medical departments, following the guidelines of the institutions, if available.

**Electricity/High Voltage Lines**

There is conflicting information regarding the CVS disease risks for those working on high voltage lines. Occupational exposure to power frequency fields has been linked to an increased incidence of arrhythmia-related deaths.[109] However, death rates, including CVS deaths, of workers at a Quebec power company were lower than those in unexposed groups.[110] Savitz et al. reported that the risk of death due to cardiac arrhythmias and acute myocardial infarction increased with exposure to magnetic fields among electrical installation workers.[111] Nevertheless, Johansen found that exposure to electromagnetic fields up to 50 Hz was not associated with an increased rate of CVS disease or mortality.[112] Exposure to transformer-induced electromagnetic effects has not been linked to an increase in BP.[113,114] Electromagnetic field did not affect the BP of workers.[115,116] Conversely, Mitrov et al. reported a tendency toward hypotension in exposed workers.[117] According to the Electric High Current Installation Regulation, there are no restrictions regarding BP levels for working.[118] It can be concluded that there is no special consideration for HT management in electricity/high voltage line workers.

**Chemical Exposure and Hypertension**

There is a relationship between long-term exposure to carbon disulfide, lead, cadmium, arsenic, and mercury and the development of HT.[20] Exposure to carbon disulfide occurs in the production and use of viscose silk, rubber, glue, electroplating industry, paint, textiles, and varnish.[119] Although there are no clear cutoff levels for carbon disulfide exposure and HT, the data suggest a stronger link to the development of HT if exposure time exceeds five years.[17,18,20]

Lead enters the body through respiration. Chronic lead exposure in workers involved with paint, solder, bullets, insecticides, illegal alcohol, mineral purification, foundries, lead-based paint, ceramic work, lead pipe construction, vehicle exhausts, and beverage cans has been associated with an increased risk of HT.[17,27] A significant relationship has been found between high blood lead concentrations and increased BP, with a threshold of 50 mg/dL.[20] Cadmium, a toxic chemical that also enters the body through respiration and diet,[18,20] is a metal found in various mineral ores, particularly zinc, and is extensively used in industry.[17] It is employed as an anti-corrosive agent in electroplating and galvanizing processes and is also used in paint pigments, plastics, nickel-cadmium batteries, as well as in the production of ceramics and glass.[18] A positive relationship between blood cadmium levels and HT has been reported. Additionally, cadmium has nephrotoxic effects.[20]

Arsenic, which enters the body through food, seafood and water, is used in pesticides, pigments, rust-removing products, electroplating, the smelting process, and the production of semiconductor materials.[119] Arsenic exposure has been linked to high BP due to its role in causing inflammation, oxidative stress, endothelial dysfunction, and deterioration of kidney functions.[17-20,119] Mercury, widely used in industry and agriculture,[17] is found in cosmetics, batteries, fluorescent lamps, dental fillings, solvents, plastics, printer inks, lacquers, paints, thermometers, and power tools. It can enter the body through the air, water, skin, and gastrointestinal tract. The frequent use of pesticides containing mercury can lead to its ingestion through agricultural products. High-dose mercury exposure is associated not only with HT but may also lead to dilated cardiomyopathy.[119]

It may be advisable for individuals with HT or high normal BP to avoid working in environments with exposure to these chemicals.

**Miners**

In a study, the rate of HT among coal miners was found to be 17.4%, and 38% of these miners did not have a previous history of HT.[120] Chemical and physical factors may increase the risk of HT in the mining industry.[17,19] Chemical risk factors include exposure to particulate matter, carbon monoxide, coal dust, cyanide, arsenic, and mercury.[17,18] Physical risk factors include noise, temperature extremes, and vibration.[17,18] In addition to these, heavy manual labor, shift work, intermittent hypoxia, stress disorders, an increase in substance and cigarette use are other contributing factors.[18] Lifting heavy loads has been

demonstrated to cause spikes in BP, and long-term prospective follow-up studies have suggested that heavy occupational lifting tends to increase the risk of HT, especially among workers aged 50 years and older.[15]

**Conclusion**

It is not possible to manage HT solely through regulations in the work environment. Employee health is actually related to many factors, including the increase of awareness and education about healthy living for the general population, individual training and awareness, employer responsibility, workplace environment suitability, and careful supervision. Factors such as the inability to maintain a salt-restricted diet at work, work stress, long working hours, shift work, night shifts, and chronic noise exposure can complicate BP control. Beyond such general criteria, work-specific conditions such as altitude, extremely hot or cold environments, and exposure to chemical substances can also influence BP.

**Suggestions Regarding Occupational Health and Hypertension**

In the realm of occupational health and HT, we often face challenging decisions in clinical practice. Regrettably, there are limited resources available to guide us in these matters. To improve the health of employees and support physicians in their decision-making within the occupational health sector concerning HT, the authors of this paper, hailing from diverse disciplines, have collaboratively developed the following recommendations.

**General Suggestions for Prevention**

1. Workplaces should offer courses that provide fundamental information about HT and other CVS risk factors.
2. Educational materials, both written and visual, should be developed in collaboration with the Ministry of Labor and Social Security, along with pertinent professional associations.
3. Instruction on preventable CVS risk factors, including HT, should be incorporated into the curricula of all formal educational institutions, ranging from primary schools to universities.
4. Brochures and booklets aimed at raising awareness about HT should be accessible in all workplaces, ideally in areas frequented by employees, such as dining halls and break rooms.
5. Employers should arrange for experts to deliver educational activities to their employees, especially during times of heightened awareness, such as World Hypertension Day.
6. The mass media should promote healthy lifestyle interventions.
7. Workplaces should provide areas for on-site exercise opportunities, such as bicycles and treadmills, or encourage walking during breaks in suitable environments.
8. The salt content in meals provided at workplaces should be limited. Foods high in salt, such as brine, pickles, canned goods, ready-to-eat products, processed foods, and fast food should be avoided. Trans fats should be eliminated, the intake of saturated fats should be reduced, and the use of olive oil in cooking should be encouraged.
9. The use of cigarettes and other tobacco products should be restricted in accordance with the existing laws.

**Periodic Examinations and Blood Pressure Measurements**

10. Blood pressure measurement devices should be accessible in all workplaces. Within this framework, regular screening and counseling play a crucial role in BP management.
11. Irrespective of job type, BP should be measured and documented for all employees during the hiring process.
12. BP assessments should be conducted and recorded during routine health check-ups for employees, regardless of their job type.
13. Individuals with hypertension being considered for employment should undergo further evaluations to investigate potential target organ damage, informed by their medical history and physical examination results.
14. Generally, well-controlled HT is not a barrier to employment in non-strenuous and non-hazardous positions.
15. Employees diagnosed with HT should have their treatment objectives and any complications reviewed every 6 to 12 months.
16. If an employee begins new antihypertensive medication, they should be reassessed by an occupational physician within 2 to 4 weeks.

**High Risk Works**

17. Blood pressure must be measured during periodic examinations of employees who work in shifts, in the construction and mining industry, are exposed to noise and chemicals, and work at heights. Furthermore, employees diagnosed with HT should be evaluated for target organ damage.
18. The chemical and physical conditions (such as cold, heat, noise, etc.) that prevent BP control in the work area should be corrected; if not possible, the employee's work area should be changed.
19. It is mandatory to perform measurements in the working environment at intervals suggested by legislation related to chemical substance exposure. Employees and employers should be informed about the exposure to chemicals that may cause HT or may endanger its regulation, especially carbon monoxide, solvents, carbon disulfide, lead, cadmium, arsenic, and mercury. Necessary occupational health and safety measures should be taken.
20. Individuals with HT should not be employed at night and/or on shifts, and/or for long hours (> 11 hours) if such working periods are shown to inhibit BP control on ambulatory monitoring.
21. Drivers with persistent BP readings higher than 180/100 mmHg are not allowed to drive commercial vehicles. They may be allowed to resume driving after achieving BP control if there are no treatment-related side effects that impair driving ability.
22. Hypertensive individuals should not be recruited into security and emergency response units such as police, military, wardens, guardians, and firefighters.
23. Those receiving a new diagnosis of HT and working in

security and emergency response units should be suspended from work until BP control is achieved (< 140/90 mmHg). The working area should be changed if possible. Those with persistent BP > 180/100 mmHg or with complicated HT with end-organ damage should be suspended, relocated, or retired according to institutional policies, if necessary, after evaluation by the relevant authorities.

24. Hypertension is evaluated according to national and international regulations in road drivers, machinists, aviators, sailors, divers, and submarine crews. However, generally, individuals with uncontrolled or resistant HT and symptoms secondary to medications, especially orthostatism, should not be employed.
25. The working environments of employees who work in cold or warm conditions should be modified if ambulatory BP monitoring reveals uncontrollable BP or hypotensive episodes secondary to the working climate conditions.

### Working at Height

26. For workers with hypertension, activities such as working at height, underground, above or below water, and operating machinery or vehicles should be considered high-risk.
27. Employees with uncontrolled HT, experiencing fluctuations in BP, or with advanced target organ damage should not be employed in jobs that pose a risk to themselves and/or others, as symptoms such as dizziness, fatigue, and loss of attention can occur when BP fluctuates.
28. Patients with uncontrolled HT and those experiencing symptoms or signs of orthostatic hypotension despite appropriate treatment should not be employed in jobs involving work at height, such as construction work, building, scaffolding, steel structure assembly, prefabricated structure assembly, towers, bridges, tunnels, subways, well drilling, chimneys, working on poles, cleaning at height, exteriors building repairs, ship construction, ports, or crane operation.
29. It is not advisable for patients with stage 2 HT, those taking three or more antihypertensive agents, and/or those with target organ damage to work at heights.
30. The BP of patients with stage 1 HT working at height should be measured daily, and their medication adherence should be monitored and recorded by the occupational physician or nurse.

### Noise

31. Given that exposure to occupational noise above 85 dB(A) has been shown to increase average BP and the prevalence of HT, it is imperative to implement engineering measures and use personal protective equipment in the work environment to reduce noise intensity.
32. Individuals with HT should not be employed in areas with high levels of noise.
33. In cases where HT is diagnosed during examinations of those working in noisy environments: if BP cannot be regulated, or if ambulatory BP monitoring indicates fluctuations in BP secondary to working conditions, the employee's work area should be changed.

### Job Stress

34. Since job stress is a risk factor for the development of HT, the BP of those working in high-stress jobs (especially senior managers and white-collar workers) should be checked and monitored periodically.
35. If there are factors increasing stress in the workplace, they should be investigated and identified.
36. In-service training and activities should be organized in the workplace to facilitate employees' learning of stress management skills and to help them cope with stress.

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