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Aging, heat, and health: understanding and preventing heat stroke among the elderly

Starzenie się, upał i zdrowie: zrozumienie i zapobieganie udarom cieplnym wśród osób starszych

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Abstract

Introduction and Objective. Heat waves represent a significant threat to the elderly, whose ability to regulate body temperature is compromised by age-related physiological changes. Additionally, socio-economic factors further increase the risk of heatstroke. The aim of the review is to analyze the risk factors for heat stroke in the elderly, and present prevention strategies, ranging from individual actions to community-wide measures.

Brief description of the state of knowledge. Physiological changes associated with aging, such as impaired thermoregulation, reduced sweating capacity, weakened thirst response, and diminished cardiovascular adaptability, significantly increase vulnerability to high temperatures. Co-existing chronic conditions and medications, particularly diuretics and anticholinergics, further exacerbate these issues. In addition to biological factors, socio-economic and environmental aspects are also crucial. Urban heat islands, poor living conditions, social isolation, and limited access to cooling devices, intensify the dangers faced by the elderly during heat waves. Studies have shown that older individuals with low socio-economic status, limited mobility, or those living alone, are at particularly high risk of heat-related mortality.

Summary. The review emphasizes the urgent need for coordinated individual and community interventions to reduce the incidence of heat stroke among the elderly, and safeguard their well-being during high temperatures. Educational campaigns promoting adequate hydration, early recognition of heat illness symptoms, and the proper use of cooling appliances are vital. Encouraging safe physical activity and maintaining social engagement are also essential to improve resilience.

Key words

heat stroke, heat waves, elderly, thermoregulation, dehydration

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Streszczenie

Wprowadzenie i cel pracy. Fale upałów stanowią poważne zagrożenie dla osób starszych, których zdolność do termoregulacji jest osłabiona z powodu zmian fizjologicznych związanych z wiekiem. Dodatkowo również czynniki społeczno-ekonomiczne zwiększają ryzyko wystąpienia udaru cieplnego. Celem artykułu jest analiza czynników ryzyka udaru cieplnego wśród osób starszych oraz przedstawienie strategii zapobiegania udarom, zarówno na poziomie indywidualnym, jak i społecznym.

Opis stanu wiedzy. Zmiany fizjologiczne związane ze starzeniem się, takie jak upośledzona termoregulacja, zmniejszona wydajność pocenia się, osłabione poczucie pragnienia oraz obniżona zdolność adaptacji układu sercowo-naczyniowego, znacząco zwiększają podatność na wysokie temperatury. Współistniejące choroby przewlekłe oraz stosowane leki, szczególnie diuretyki i leki antycholinergiczne, dodatkowo pogłębiają te zaburzenia. Oprócz czynników biologicznych istotne są także aspekty społeczno-ekonomiczne i środowiskowe. Miejskie wyspy ciepła, złe warunki mieszkaniowe, izolacja społeczna oraz ograniczony dostęp do urządzeń chłodzących potęgują zagrożenie dla osób starszych w czasie fal upałów. Seniorzy o niskim statusie ekonomicznym, z ograniczoną mobilnością lub żyjący samotnie są szczególnie narażeni na śmiertelne skutki przegrzania.

Podsumowanie. Artykuł podkreśla pilną potrzebę podjęcia skoordynowanych działań na poziomie indywidualnym oraz społecznym, aby zmniejszyć częstość występowania udarów cieplnych wśród osób starszych i chronić ich zdrowie podczas wysokich temperatur. Kluczowe znaczenie mają kampanie edukacyjne promujące odpowiednie nawodnienie, wczesne rozpoznawanie objawów udaru cieplnego oraz właściwe korzystanie z urządzeń chłodzących. Zachęca się do bezpiecznej aktywności fizycznej i utrzymywania kontaktów społecznych, gdyż takie działania również zwiększają odporność organizmu na wysokie temperatury.

Słowa kluczowe

udar cieplny, fale upałów, osoby starsze, termoregulacja, odwodnienie

INTRODUCTION

As global temperatures continue to rise due to climate change, heat waves are becoming increasingly frequent, intense, and prolonged [1]. These extreme weather events pose a significant threat to public health, particularly to vulnerable populations such as the elderly [2]. Older adults are disproportionately affected by heat-related illnesses, including heat stroke, which is a life-threatening condition characterized by an elevation of core body temperature above 40°C, accompanied by central nervous system dysfunction (CNS) [3]. The aging process brings about physiological changes that impair the body's ability to regulate temperature effectively, with studies demonstrating that elderly individuals exhibit a 25–40% reduction in sweating efficiency, impaired vasodilation, and reduced thirst response [4, 5, 6]. Additionally, the prevalence of chronic diseases and the use of medications, such as diuretics and anticholinergics, further compromise thermoregulatory mechanisms in older individuals [7].

Physiological vulnerabilities, socio-economic and environmental factors also amplify the risk faced by the elderly during heat waves. Urban heat islands, poor housing conditions, social isolation, and limited access to air conditioning, significantly increase morbidity and mortality [8, 9]. Previous extreme heat events, such as the 2003 European heat wave which resulted in approximately 70,000 excess deaths, and the 2010 Russian heat wave which caused about 55,000 deaths, have demonstrated the devastating consequences of inadequate protection of at-risk populations [10].

The aim of the review is to present a comprehensive account of the physiological, environmental, and social determinants that make older adults particularly susceptible to heat-related illnesses. In addition, it highlights evidence-based prevention strategies, ranging from individual interventions to community-wide initiatives, to inform about public health efforts and promote resilience in aging societies.

Physiological factors increasing heat stroke susceptibility in the elderly. Classical heat stroke primarily results from external heat exposure rather than physical exertion, with the elderly being among the most vulnerable, particularly during heat waves [11]. Research has shown that aging and chronic illnesses impair both thermoregulation and heat acclimatization [12]. Clinically, heat stroke is defined by extreme hyperthermia (core temperatures typically exceeding 40.5°C), CNS dysfunction, and multiorgan failure [13]. Heat stroke occurs due to an imbalance between heat production and dissipation, the latter usually mediated through evaporation, convection, conduction, and radiation [13]. As body temperature rises, the body attempts to regulate heat by increasing sweating and cardiac output, and by re-directing blood flow to the skin through vasodilation [13]. Compared to younger adults, elderly individuals exhibit impaired physiological responses to heat, including a higher threshold for sweating, a reduced sweat rate, diminished skin temperature sensitivity, impaired vasodilation, a smaller increase in cardiac output, and a weakened thirst response [14]. The ability to maintain normal body temperature is furthermore compromised in the elderly due to the presence of various chronic diseases, with additional effects arising from the medications commonly used to treat these conditions [14].

Loss of the capacity to sweat results from a decline in the function of individual sweat glands rather than a reduction in their number, and is believed to be caused by local structural skin changes due to aging, rather than central causes [15, 16]. Older adults also have a higher core temperature threshold for the onset of sweating, and combined with their inability to increase and sustain an elevated sweat rate, this delays the cooling effect of sweating, making it less effective and leading to higher core temperatures and increased heat stress and heat stroke [17].

Additionally, aging impairs adaptations of the autonomic nervous system, delaying the onset of thermoregulatory mechanisms, and increasing the risk of heat stroke [18]. Older adults also have reduced total body water conten – typically decreasing from 60% of body weight to about 50% after the age of 70 – making them more prone to dehydration and electrolyte imbalances [19]. Dehydration reduces blood volume, diminishes blood flow to the skin, and worsens heat dissipation [19].

Reduced cardiac output with age, impaired vasodilation (particularly in those with cardiovascular diseases) [20], and less efficient redistribution of blood from internal organs such as the kidneys and spleen, further decrease the ability of the body to manage heat [21].

Moreover, elderly individuals often exhibit reduced thirst perception, lower plasma volume, and inadequate fluid intake during heat exposure [22], with prolonged recovery times from dehydration increasing their risk of heat-related injuries during extended heat exposure, such as heat waves [23]. Medications used to treat chronic illnesses, such as antipsychotics, serotonergic agents, and anticholinergics, further impair thermoregulatory capacity [24]. Recognizing these physiological vulnerabilities is essential for healthcare providers who should promote preventive measures to mitigate the risk of heat stroke in older adults during periods of extreme heat [25].

Socio-economic and environmental factors contributing to heat stroke risk. In addition to physiological vulnerabilities, socio-economic and environmental factors further increase the risk of heat-related illnesses among the elderly.

Urban residency is associated with a greater risk of heat-related mortality, as cities typically experience temperatures 2–10°C higher than surrounding rural areas, due to heat retention by concrete surfaces and emissions from vehicles [26]. As for living conditions, it is worth recognizing that living on the top floor of a residence has been linked to a greater risk of heat stroke, most likely due to heat accumulation [27]. Poor building insulation results in higher indoor temperatures, which increases the risk of heat-related diseases [28].

Several studies suggest that the effects of heat waves are more dangerous for those with a low socio-economic status [29]. Individuals with lower education levels or living in poverty are more likely to reside in areas with limited green spaces, which otherwise provide natural cooling through shade and evapotranspiration [30, 31].

Access to air conditioning is another crucial factor: older adults without air conditioning are at significantly higher risk of heat-related morbidity and mortality [32]. Financial barriers often prevent seniors from purchasing or using cooling devices, and small, poorly-ventilated living spaces exacerbate the risk [32, 33]. However, studies have shown that access to public cooling centres, such as libraries, malls, or community shelters, can mitigate this risk [32].

Social isolation is another key determinant. Older adults with weak social ties or those living alone face a double risk of death during heat waves, compared to those living with others [34, 35]. Reduced mobility and confinement to bed further increase vulnerability, as these individuals often depend on assistance for basic needs, and are less able to respond independently to rising temperatures [35, 36]. This suggests that a sedentary, home-centred lifestyle can endanger the well-being of older adults [37].

These findings highlight the importance of a pro-active approach to support elderly individuals during extreme heat events.

Strategies for preventing heat stroke in the elderly. Given the particular vulnerability of the elderly to heat stroke, comprehensive preventive measures are essential. Effective strategies involve education, environmental adjustments, social support, and improved access to cooling resources.

Education plays a critical role. Both older adults and their caregivers must be informed about the risks associated with heat exposure, and the early symptoms of heat-related illnesses. Individuals with lower educational levels are less likely to recognize early warning signs, underscoring the need for targeted public health initiatives [38]. These findings highlight the need for public programmes that educate older adults about the importance of hydration, remaining in cooler places, and recognizing early warning signs in themselves and others. Public health campaigns should also involve caregivers, close family and friends of the elderly, ensuring that they have the support necessary to avoid potentially life-threatening situations [39].

Encouraging the use of cooling appliances is equally important. Research indicates that the proper use of this equipment is helpful in preventing heat-related illness. However, it has been found that many older individuals resist using air conditioning or fans, particularly at night. Programmes designed to encourage the elderly to use those devices can significantly lower exposure to heat stress, especially during sleeping hours, when the risk of dehydration is added to the equation [40]. It is important that these appliances are available for use, since hospitalization rates are higher among those without access to air conditioning [41].

Another strategy is building and maintaining communal facilities properly equipped for the physical activities of the elderly. They can encourage social interaction while promoting physical health, in addition to the mitigation of heat-related health risks [42]. Regular physical activity, adjusted for the individual fitness levels of the elderly, can help improve their resilience to heat. Studies have shown that elders who maintain a high fitness level can engage in activities under warmer conditions without as much risk of heat stroke as the elderly who have sedentary lifestyles [43]. Encouraging light exercise during cooler parts of the day promotes better acclimatization without overwhelming the elderly's thermoregulatory systems. One significant benefit of regular physical activity is improving vascular function, leading to better thermoregulation; the cardiovascular system adapts by improving blood flow to the skin, which facilitates heat dissipation [44]. Exercises also enhance the efficiency of the body's other cooling mechanisms, such as sweating [45].

Hydration is another critical component. Many older individuals do not consume adequate amounts of fluids during heat waves, often due to diminished thirst perception [46]. Studies indicate that more than a half of nursing home residents in the USA fail to meet recommended hydration levels during periods of extreme heat [47]. Clear education about daily fluid intake requirements and encouragement to drink even when not thirsty can significantly reduce dehydration risk [48].

Finally, community-level efforts are essential. Pro-active initiatives, such as visiting elderly individuals living alone and publicizing heat illness prevention strategies, as practiced in Japan, are effective in mitigating risks [49]. This pro-active community approach ensures that the elderly receive the support and resources necessary to manage heat effectively in time. Such initiatives not only provide immediate relief during heat waves, but also increase community awareness and engagement in helping the elderly. Loneliness and isolation also significantly increase the risk of heat-related illnesses. Consequently, maintaining community ties and programmes that include regular check-ins can enhance the safety of the elderly [50].

CONCLUSIONS

Heat stroke is a life-threatening condition that disproportionately affects the elderly, primarily due to impaired physiological mechanisms for thermoregulation, compounded by chronic diseases and medication use. Environmental and socio-economic factors, such as poor living conditions, low income, urban residency, and social isolation, further elevate the risk.

The review highlights the urgent need to implement preventive measures aimed at protecting older adults during heat waves. Educating elderly individuals and their caregivers, promoting hydration and proper nutrition, encouraging the use of cooling devices, and supporting moderate physical activity, are all critical strategies. Community engagement and access to cooling centres are equally vital. Through coordinated efforts at the individual, community, and policy levels, the vulnerability of the elderly to heat stroke can be significantly reduced.

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