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REVIEW

The impact of climate change and environmental pollution on sleep health

Impact du changement climatique et de la pollution environnementale sur la santé du sommeil

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ABSTRACT

For most of us, sleep is a familiar daily need, we spend nearly 1/3 of our lives sleeping. But more and more people in many countries around the world do not get enough sleep." Less sleep due to higher nighttime temperatures is affecting large numbers of people globally. When the night temperature is higher than 25^{0}C, it will cause people to lose sleep. Rising temperatures due to global climate change are making it harder for people to sleep, especially women and the elderly. Therefore, as the climate warms, it will increase the impact on human health such as increasing the risk of heart attacks, and mental health crises, increasing the number of deaths, and also reducing productivity in human work.

Climate change has a close relationship with sleep disorders in all ages and are a burden on public health. Therefore, each locality and each country needs to have practical solutions and appropriate policies to minimize the adverse impacts of socio-economic development and urbanization on climate change and environmental pollution, causing adverse effects on sleep health because "Sleep is Essential for Health".

KEYWORDS: Climate change; Sleep health; Sleep quality; Insomnia; OSA; Greenhouse.

RÉSUMÉ

Pour la plupart d'entre nous, dormir est un besoin quotidien familier, nous passons près d'un tiers de notre vie à dormir. Mais de plus en plus de personnes dans de nombreux pays du monde ne dorment pas suffisamment. » Moins de sommeil en raison des températures nocturnes plus élevées affecte un grand nombre de personnes dans le monde. Lorsque la température nocturne est supérieure à 25^{0}C, les gens perdent le sommeil. La hausse des températures due au changement climatique mondial rend le sommeil plus difficile pour les gens, en particulier pour les femmes et les personnes âgées. Par conséquent, à mesure que le climat se réchauffe, cela augmentera l'impact sur la santé humaine, comme l'augmentation du risque de crise cardiaque et de crises de santé mentale. , augmentent le nombre de décès et réduisent également la productivité du travail humain.

Le changement climatique est étroitement lié aux troubles du sommeil à tous les âges et constitue un fardeau pour la santé publique. Par conséquent, chaque localité et chaque pays doivent disposer de solutions pratiques et de politiques appropriées pour minimiser les impacts négatifs du développement socio-économique et de l'urbanisation sur le changement climatique et la pollution de l'environnement, provoquant des effets néfastes sur la santé du sommeil, car *«Le sommeil est essentiel à la santé».*

MOTS CLÉS: Changement climatique; Santé du sommeil ; Insomnie; AOS; Serre.

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INTRODUCTION

Earth's climate change is a change in the climate system including the atmosphere, hydrosphere, biosphere, and lithosphere now and in the future due to natural and artificial causes. According to researches by scientists around the world, the climate change has been occurred on a global scale, causing increasingly strong impacts on every country and life on earth, especially its negative effects for human health [1]. The increases of temperature and weather changes affect sleep quality, causing short sleep time, sleep disruption, difficult to maintain sleep, and difficult to enter deep sleep.

Climate change is one of the biggest global public health threats of the 21st century. Addressing global warning and mitigating its impact on health is essential to improve and protect health worldwide. The healthcare sector is on the front line of the climate crisis, with patients bearing the increasing burden of disease attributable to a changing climate, along with injuries, illnesses, and displacement or migration related to extreme weather events [2].

THE IMPORTANT ROLE OF SLEEP IN HUMAN LIFE

Scientific evidence has confirmed the importance of sleep for human health. Indeed, decades of research have documented the negative impact of poor quality and insufficient sleep on a range of health problems across all ages, including high blood pressure and obesity, type 2 diabetes, cardiovascular disease, cognitive decline, dementia, neurodegeneration as well as impaired immune function [3-5].

There are many different causes that reduce sleep quality and insomnia (generally called sleep disorders) such as anxiety, stress, working or studying too much in the evening, prolonged use of smart phones or tablets at night, habit of using stimulants before bed time (alcohol, tea, coffee, or cigarettes), snoring and sleep apnea, or work in night shifts. However, besides these causes, sleep disorders caused by factors affecting the living environment such as climate change and environmental pollution, especially air pollution, have not yet been recognized by health care systems, environmentalists and communities [6,7,8].

THE RELATIONSHIP BETWEEN CLIMATE CHANGE AND SLEEP DISORDERS (FIGUE 1)

The direct consequence of global climate change is the gradual warming of the earth over the past decades and in the future. When the earth warms too quickly, nighttime temperatures will increase and affect sleep quality because the body's temperature regulation center at night can not adapt promptly to environmental temperature changes via harmful direction.

Scientific evidences show that unusually hot temperatures at night will lead to insomnia, poor and restless sleep, fatigue during the day and increased respiratory and cardiovascular events in people with underlying diseases. This is also the reason why many families have to use air conditioners, fans at night and other means to reduce the temperature at night to get better sleep. However, people with low incomes will have more sleep disorders than people with high incomes because they do not have the financial condition to equip facilities such as air conditioners or fan systems because of the high electricity consumption. Thus, this system throughout the night will increase the financial burden.

Research results from many countries around the world have shown that if global warming due to climate change does not slow down by the end of the 21st century, increased ambient temperatures at night could cause tens billions of sleepless nights every year. Over the past decades, the earth's temperature has gradually increased by 0.2^0C per decade and will increase by 1.5^0C by 2026.

In addition to the direct impact of climate change on sleep through increased temperature at night, climate change also has negative impacts on the environment and ecosystems, directly affecting human health. The specific impact of increased temperature and weather changes due to climate change on sleep is that sleep time is reduced due to sleep disruption, causing difficulty in maintaining sleep and difficulty going into deep sleep. Elderly people, women, and people living in low-income households are most affected by the relationship between increased nighttime temperatures due to climate change and poor sleep quality, which has negative effects on health, quality of life and longevity [9,10].

Therefore, the obvious and potential impact on sleep of current and future climate change, which is increasingly hotter nighttime temperatures, will further erode human sleep. In addition, the public health risks of people not getting enough sleep and poor sleep quality are huge because they come with an increased risk of negative behaviour, learning and physical development quality (in children), work performance and productivity (in adults), occupational and traffic accidents, along with social and economic consequences.

Climate change prevention that focuses on the negative nocturnal impact of increased environmental temperatures on human sleep could be an effective early intervention to reduce adverse behavioural impacts associated with not getting enough sleep and minimizing the use of medical services for sleep health care [11,12].

THE RELATIONSHIP BETWEEN AIR POLLUTION AND SLEEP DISORDERS (FIGURE 1)

Environmental pollution, especially air pollution globally in general and in Vietnam in particular, is at an alarming level. According to statistics, more than 90% of the world's population lives in places that exceed the clean air threshold, meaning the environment is polluted. This phenomenon is getting worse with uncontrolled urbanization and accelerating climate change. Air pollution mainly comes from vehicle emissions, emissions from factories and industrial zones, fertilizers and chemicals used in farming, gas from biomass materials (coal, firewood, straw…). Air pollution is caused by a complex mixture of extremely small particles commonly classified as particulate matter (PM), including ultrafine particles (<1µm - PM1), fine particles (<2.5µm - PM2.5), coarse particles (<10µm - PM10), black carbon and other gaseous pollutants such as nitrite oxides (NOx), sulfur oxides (SOx) and ozone (O3).

Scientific evidence has demonstrated the relationship between air pollution and sleep disorders in children and adults. Regular exposure to air polluted by fine dust particles (PM2.5), smoke, and toxic emissions greatly affects sleep health at all ages. Even pregnant women living in an air environment polluted by fine dust particles can cause sleep disorders for both the mother and the newborn from the foetal stage until birth. Therefore, living in a polluted air environment causes a health burden for children and adults.

In addition to the growing awareness of the adverse effects of air pollution on respiratory health, the relationship between air pollution and sleep disorders is receiving increasing attention in developed countries. Recent evidence has also confirmed the consequences of air pollution on snoring and obstructive sleep apnea (OSA). Recently published systematic reviews showed the significant association between high levels of air pollution and the risk of sleep-disordered breathing (including OSA) in children and adults. In particular, the disease related to snoring and OSA has affected nearly one billion people globally and about 4 million people in Vietnam [11].

OSA is a medical condition characterized by intermittent and complete collapse (apnea) or partial collapse (hypopnea) of the oropharynx repeatedly during sleep, leading to disrupted sleep and refresh feeling does not restore health upon awakening. Its consequence is poor sleep quality, excessive daytime sleepiness, and impaired concentration. Snoring and OSA have been recognized as risk factors for cardiovascular complications, hypertension, depression and metabolic disorders of glucose and fats.

THE GREENHOUSE EFFECT LEADS TO CLIMATE CHANGE (FIGURE 2)

In the context of today's climate change, phenomena such as global warming, sea level rise, drought and environmental change have gradually become the fear of countries and especially people living in the world, in areas heavily affected by these phenomena [12,13].

According to some studies, the greenhouse effect is a gaseous component capable of absorbing infrared radiation in the Earth's wavelength range, causing it to be reflected from the Earth's surface when illuminated by light of the sun, then dissipates heat back to the Earth and causes the greenhouse effect. The causes also include emissions from vehicles, industry, agriculture and urbanization. The use of fossil fuels in transportation and industrial activities creates emissions such as CO2, NOx and SOx, contributing to the increase in the greenhouse effect. The increased use of fertilizers and organic waste in agriculture also produces methane (CH4), a more potent greenhouse gas than CO2.

According to the annual report published by the US National Oceanic and Atmospheric Administration (NOAA), the series of indicators show that global warming is accelerating as a result of the burning of fossil fuels. Fossil fuels increase the concentration of greenhouse gases in the atmosphere.

The latest report just released recently showed that the concentration rates of the three most dangerous greenhouse gases released into the atmosphere, including carbon dioxide, methane and nitrous oxide have increased to new record levels. The annual concentration of carbon dioxide at the Earth's surface has reached 405 parts per million (ppm), "at its highest level since modern atmospheric measurements began" [14,15].

There are many gases that cause the greenhouse effect, including CO2, CH4, CFC, SO2, water vapor... When sunlight shines on the Earth, part of it is absorbed by the Earth and part is reflected into space. Greenhouse gases have the effect of retaining the sun's heat, not allowing it to be reflected away. If greenhouse gases exist in moderation, they help keep the Earth's temperature from being too cold, but if they are present in too much of the atmosphere The result is that the Earth warms up.

When the earth's temperature increases, ice melting at the poles will occur. This is not only a danger to creatures living in cold climates but also a potential danger to humans.
Increasing concentrations of greenhouse gases caused by humans, the anthropogenic greenhouse

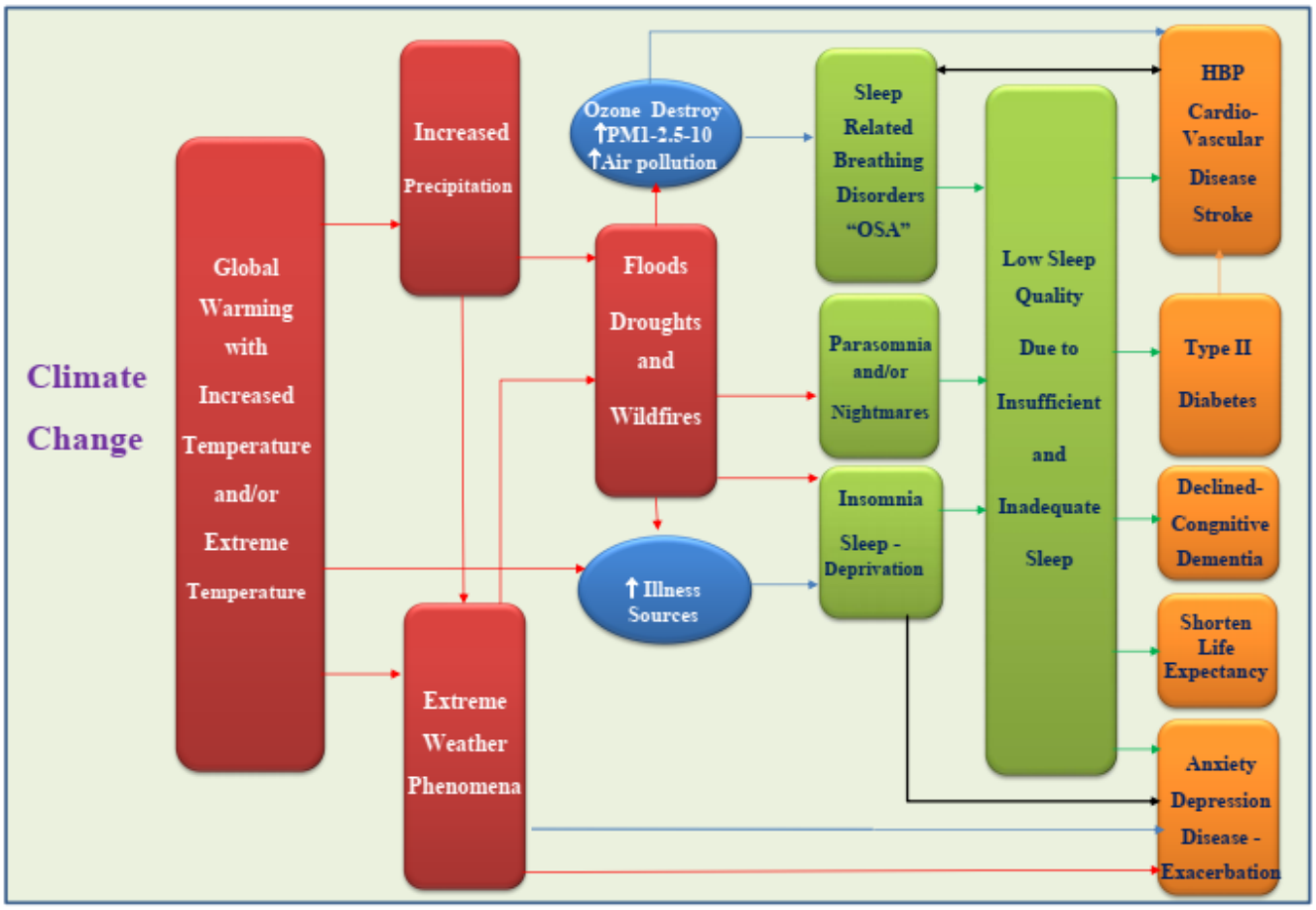

FIGURE 1. *The harmful effects of climate change and its consequences on sleep quality and human health. HBP: high blood pressure.*

FIGURE 2. *The harmful effects of green house due to the uncontrolled development of cultivating flowers and vegetables in Dalat city -Vietnam.*

effect, will increase temperatures around the globe (global warming) and thus will change the climate in these areas this decade to the next decade.

The research done by respiratory experts at the Royal Brompton Hospital in the United Kingdom confirmed the harmful effects of the greenhouse events on human health and that has been clearly identified. These harmful effects include increased risk of respiratory disease due to air pollution, especially pollutants such as PM2.5 fine dust and ozone, which cause diseases such as bronchitis, acute asthma exacerbation, decompensation of OSA and chronic obstructive pulmonary disease (COPD) [16-18]. In addition, the greenhouse effect also contributes to mental health problems, due to rising temperatures and climate change, causing stress, anxiety, depression and affecting sleep quality. At the same time, it also negatively impacts people's daily lives, causing discomfort at work, reducing labour productivity and threatening the sustainable development of the community.

Greenhouses absorb solar energy and emit infrared radiation. Greenhouses act like a glass wall of a greenhouse and are therefore called the greenhouse gas. By trapping the solar energy, greenhouses keep Earth's climate habitable for us and all other species. In turn, Earth's surface emits infrared radiation (IR) back to the atmosphere, where water, CO2, and methane absorb it. This absorption restored the lapse rate toward adiabatic stability through convection and evaporation (latent heat). At higher altitudes IR photons escape to the space [19-21].

The amount of heat absorbed or reradiated back to the surface is determined by life by the extent of various Greenhouses in the atmosphere. Although the effect of constant direct exposure of human body to these gases appears negligible, the increasing concentration of these gases along with time are the key cause of various human ailments. One of the most exposed and affected organs of our body is the respiratory system which might lead to breathing problems and asthma. Other affected organs include the cardiovascular system owing to hyper- or hypotension, the CNS affecting the brain cells which may lead to memory loss, the immune system damping the defence mechanism of the body to fight against infections, the digestive system, and especially sleep-related problems. The greenhouse with some extreme weather events are becoming more frequent and/or intense, posing risks to people's health and safety. For instance, droughts can create dust, which can lead to respiratory illness. Temperatures are also likely to rise in many places as the climate changes. Exposure to extreme or prolonged heat can cause exhaustion, heat stroke, kidney and heart disease, OSA, and sleep disorders. In fact, extreme heat is already the leading cause of death [19].

CONCLUSION

Sleep is key to our well-being, happiness, and general quality of life. It is also important for economic progress and productivity. A person's health may depend on many factors, such as their income, race, gender, age, existing medical conditions or genetics, occupation, and where they live. The greenhouse effect is one of the factors causing climate change. Climate change also affects people's health in many ways. As the climate changes, more people may be exposed to extreme weather like heat, floods, droughts, storms, and wildfires. These events can cause illness, injury, and even death. In addition, hazards related to climate change can stress people's mental health.

In summary, climate change has a close relationship with sleep disorders in all ages and are a burden on public health. Therefore, each locality and each country needs to have practical solutions and appropriate policies to minimize the adverse impacts of socio-economic development and urbanization on climate change and environmental pollution, causing adverse effects on sleep health because "*Sleep is Essential for Health*".

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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