บทความปริทัศน์

การเปลี่ยนแปลงของโอโซน (O_3) ในอากาศโดยรอบต่อสุขภาพของมนุษย์: การทบทวนวรรณกรรม

นวพร ธนาธีรธร*, โชทิ์ปัณณ์ ปานะกุล**, ภูดิศ เสาเกลียว***, ศุจิมน มังคลรังษี****✉

*โรงเรียนสาธิตมหาวิทยาลัยศรีนครินทรวิโรฒ ประสานมิตร (ฝ่ายมัธยม)

**โรงเรียนนานาชาติเอกมัย

***โรงเรียนวิทยาศาสตร์จุฬาภรณราชวิทยาลัย ชลบุรี

****มหาวิทยาลัยอัสสัมชัญ

✉khunsujimon@gmail.com

บทคัดย่อ

ชั้นโอโซนที่ผันผวนส่งผลต่อสุขภาพของมนุษย์และสิ่งแวดล้อม เนื่องจากมีปฏิสัมพันธ์ที่ซับซ้อนกับมลพิษและแสงแดด การทำความเข้าใจผลกระทบของการเปลี่ยนแปลงระดับโอโซนในอากาศโดยรอบเป็นสิ่งสำคัญในการลดความเสี่ยงด้านสุขภาพที่เกี่ยวข้องกับโรคระบบทางเดินหายใจและการสัมผัสรังสียูวี การศึกษานี้มีจุดมุ่งหมายเพื่อทบทวนความสัมพันธ์ระหว่างการเปลี่ยนแปลงระดับโอโซนในอากาศแวดล้อมและผลกระทบที่มีต่อสุขภาพของมนุษย์ ด้วยการศึกษาการศึกษาและงานวิจัยที่เกี่ยวข้อง เพื่อศึกษาองค์ประกอบทางเคมีและความเป็นพิษของโอโซน สำรวจกลไกที่ส่งผลต่อการเปลี่ยนแปลงของโอโซนในชั้นบรรยากาศ และตรวจสอบผลกระทบที่หลากหลายของโอโซนที่มีต่อสุขภาพของมนุษย์ การศึกษานี้ค้นหาฐานข้อมูลทางวิชาการ รวมถึง Science Direct, Springer, Google Scholar, NIH และแหล่งข้อมูลจากทางการที่เกี่ยวข้อง การค้นหาครอบคลุมช่วงเวลาที่หลากหลาย และใช้คำสำคัญ เช่น “โอโซน” “ผลกระทบต่อสุขภาพ” และ “อากาศโดยรอบ” นอกจากนี้ รายการอ้างอิงและบทคัดย่อจากการประชุมระหว่างประเทศเกี่ยวกับการเปลี่ยนแปลงสภาพภูมิอากาศและพลวัตของโอโซนได้รับการตรวจสอบเพื่อให้แน่ใจว่ามีการทบทวนวรรณกรรมที่เกี่ยวข้องอย่างครอบคลุม

ผลการศึกษาแสดงให้เห็นเห็นธรรมชาติสองประการของโอโซน ซึ่งทำหน้าที่เป็นเกราะป้องกันรังสียูวีในชั้นบรรยากาศสตราโตสเฟียร์ ก่อให้เกิดความเสี่ยงต่อสุขภาพในระดับพื้นดิน มีการหาศึกษาถึงปัจจัยที่ผลักดันการเปลี่ยนแปลงของโอโซนในชั้นบรรยากาศ รวมถึงกระบวนการทางธรรมชาติและกิจกรรมของมนุษย์ เช่น การปล่อยคลอโรฟลูออโรคาร์บอนและภาวะโลกร้อน อธิบายผลกระทบที่หลากหลายของโอโซนต่อสุขภาพของมนุษย์ ความเสี่ยงที่เพิ่มขึ้นของโรคมะเร็งผิวหนังและต้อกระจก ไปจนถึงความบกพร่องในการทำงานของปอด และการกำเริบของโรคทางเดินหายใจ

โดยสรุปจำเป็นต้องมีการดำเนินการอย่างเร่งด่วนเพื่อจัดการกับปัจจัยที่เกิดจากมนุษย์ซึ่งส่งผลให้โอโซนสูญเสีย และดำเนินมาตรการเพื่อปกป้องทั้งสุขภาพของมนุษย์และสิ่งแวดล้อม การวิจัยอย่างต่อเนื่องเกี่ยวกับกลไกที่เกี่ยวข้องกับผลกระทบของโอโซนต่อสุขภาพของมนุษย์เป็นสิ่งจำเป็นสำหรับการพัฒนากลยุทธ์ที่มีประสิทธิผลในการปกป้องสุขภาพของประชาชนและบรรเทาผลกระทบด้านลบของมลภาวะของโอโซน

คำสำคัญ: โอโซน, อากาศโดยรอบ, สุขภาพของมนุษย์

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Review article

Changing Ozone (O_3) in ambient air to human health: A literature review

Nawaphorn Tanatiratorn*, Shopan Panakul**, Phoodit Saokleaw***, Sujimon Mungkalarungsi****✉
*Srinakharinwirot University Demonstration School Prasarnmit (Secondary Division)
**Ekamai International School
***Princess Chulabhorn Science High School Chonburi
****Assumption university
✉khunsujimon@gmail.com

Abstract

The fluctuating ozone layers pose significant challenges to human health and the environment due to their complex interactions with pollutants and sunlight. Understanding the implications of changing ozone levels in ambient air is crucial for mitigating health risks associated with respiratory ailments and UV radiation exposure. This study aims to comprehensively review the multifaceted relationship between changing ozone levels in ambient air and their impact on human health. By synthesizing existing literature, we seek to elucidate the chemical composition and toxicity of ozone, explore the mechanisms driving changes in atmospheric ozone, and examine the diverse effects of ozone on human health. A thorough search across scholarly databases, including Science Direct, Springer, Google Scholar, NIH, and official sources of information, was conducted. The search encompassed diverse temporal periods and utilized carefully selected keywords such as 'Ozone,' 'health effects,' and 'Ambient air.' Additionally, reference lists and abstracts from international conferences on climate change and ozone dynamics were examined to ensure a comprehensive review of relevant literature.

The review shed the lights of the dual nature of ozone, serving as a protective shield against UV radiation in the stratosphere while posing health risks at ground level. Factors driving changes in atmospheric ozone, including natural processes and human activities such as chlorofluorocarbon emissions and global warming, are discussed. The diverse effects of ozone on human health, ranging from increased risks of skin cancer and cataracts to impairments in lung function and exacerbation of respiratory conditions, are elucidated.

Urgent action is needed to address human-induced factors contributing to ozone depletion and implement measures to safeguard both human health and the environment. Continued research into the mechanisms underlying ozone's impact on human health is essential for developing effective strategies to protect public health and mitigate the adverse effects of ozone pollution.

Keywords: Ozone, ambient air, human health

คณะสาธารณสุขศาสตร์ มหาวิทยาลัยราชภัฏอุบลราชธานี
Faculty of Public Health, Ubon Ratchathani Rajabhat University
Ubon Ratchathani Rajabhat University

Introduction

The fluctuating ozone layers have long posed a significant challenge since the inception of industrialization. Understanding the multifaceted role of ozone (O_3) in our atmosphere and ambient air is crucial, as it holds profound implications for human health. This triatomic form of oxygen serves a dual purpose in the atmosphere, acting as a protective barrier against harmful ultraviolet (UV) radiation from the sun while also contributing to air pollution through complex interactions with pollutants and sunlight. Consequently, ozone becomes enmeshed in a web of environmental factors that can profoundly impact human health. Of particular concern is its potential to detrimentally affect respiratory health, including lung function and the exacerbation of conditions such as asthma and other respiratory illnesses. The dynamic interplay between ozone levels and human health presents an intricate puzzle that necessitates thorough examination, evaluation, and ongoing monitoring. Failure to address these complexities could lead to significant challenges for both human health and the environment we inhabit. Therefore, gaining a comprehensive understanding of the effects, causes, and functions of ozone layers is imperative to develop optimal strategies for mitigating these issues before they escalate beyond control.

Material and methods

For our extensive review titled "Changing Ozone (O_3) in Ambient Air and Its Impact on Human Health," we conducted a thorough search across several scholarly databases, including Science Direct, Springer, Google Scholar, NIH, Frontier and official sources of information. To ensure a comprehensive examination of the relevant literature, our search was conducted exclusively in English and spanned diverse temporal periods. Our search strategy was designed, utilizing a combination of carefully selected keywords. These key terms included 'Ozone,' 'health effects,' and 'Ambient air. ' By employing this approach, we aimed to unearth a wide-ranging collection of literature pertaining to the changing ozone levels in ambient air and its implications for human health. Additionally, we examined reference lists and abstracts from prominent international conferences on climate change and ozone dynamics. This comprehensive approach ensured that our review encapsulated a broad spectrum of research findings and insights. Ultimately, our review provides a profound understanding of the intricate relationship between changing ozone levels in ambient air and their impact on human health.

Chemical composition and toxicity of ozone When a third body molecule is present and capable of absorbing the heat of reaction, ozone is produced by the reaction of singlet oxygen and dioxygen. Extremely reactive and ephemeral singlet oxygen can be produced by ionization of oxygen or by photolysis of nitrogen dioxide. Ozone is a byproduct of processes such as water filtration, bleaching, and any other operation that results in the formation of an electric arc or spark in the presence of oxygen. It usually exists as a gas and consists of three oxygen atoms bonded together in a cyclic configuration. Its CAS number is 10028-16-6 and its molecular weight is 48. It looks like a blue liquid or explosive gas. With its deodorizing and antibacterial properties, it is a potent oxidizing agent. It is found mainly in the stratosphere, where higher altitudes have higher concentrations of ozone, and it acts as a shield to insulate the Earth's surface from the sun's harmful UV rays. Strong ultraviolet radiation from the Sun would clean the Earth's surface if the ozone layer did not exist. If this shield becomes less effective,

increased exposure to UV-B and UV-A rays on the skin's surface will accelerate the development of skin cancer and even diminish crop yields. Ozone is an essential component of the atmosphere because it absorbs many types of ultraviolet rays even though it only makes up a very small portion of the air. However, the ozone layer near the surface where we breathe and live is a dangerous pollutant that harms plants and lung tissue. When sunlight triggers chemical reactions in the atmosphere that involve pollutants, including a group of gases called nitrogen oxides emitted by vehicles and industry during combustion and with Volatile organic compounds, which are Carbon-containing chemicals that evaporate easily into the air, such as petroleum products., this bad ozone layer is created (Swanson, et al., 2022).

In the stratosphere, ozone is created and destroyed by natural processes. The ozone layer is created and maintained by these mechanisms. The main source of ozone is sunlight. When atomic oxygen, also known as high-energy ultraviolet (UV-C) photons, collide with an oxygen molecule (O_2), they split that molecule into two individual oxygen atoms. Ozone (O_3) is created when a released oxygen atom interacts with another oxygen molecule. The ozone-oxygen cycle continuously absorbs high-energy ultraviolet (UV-C) radiation, completely blocking it from reaching Earth's surface due to the abundance of oxygen in our atmosphere. The upper stratosphere is warmed by the heat produced by this process. Ozone is a highly reactive gas that readily attacks other airborne molecules, frequently producing oxygen in the process. Additionally, ozone in the stratosphere absorbs a large portion of the sun's UV-B rays before breaking back into atomic and molecular oxygen. Regardless of how the oxygen atoms are created, they almost always react with oxygen molecules fast, regenerating ozone. Ozone is thus always being destroyed while simultaneously being constantly replenished. Sometimes this cycle is broken when an ozone molecule combines with an oxygen atom to create two oxygen molecules. The total amount will not change if the rates of ozone creation and destruction are equal. Ozone levels are observed to fluctuate regularly in accordance with typical natural cycles, including changes in seasons, wind movements, and long-term solar fluctuations. Ozone reacts with some infrequent solar events, such as skin rashes. Volcanic eruptions can also release substances into the stratosphere that can accelerate ozone depletion. (Zhang, et al., 2019) (Fig 1.)

The background level of ground-level ozone is influenced by ozone that can descend from the stratosphere to the troposphere. But high ozone concentrations in the troposphere are the result of photochemical processes involving volatile organic compounds and nitrogen oxides. NOx and a large portion of VOCs and CO are caused by anthropogenic emissions. Some VOCs, such as isoprene, are also given off by trees (Masschelein, 1996). The ability of PM2.5 from primary emission sources to interact with the free radicals that cause ozone generation helps to explain why elevated ozone levels have been observed in some places.

Changing of atmospheric ozone and shortwave radiation

Changing of atmospheric ozone The ozone layer depletion has been ongoing for decades, dating back to the 1930s with researcher of many kinds theorized about the possibility of our degrading atmosphere. During the last century, a plethora of human’s activity are badly affecting the atmosphere, depleting it of the ozone layer and causing permanent effect toward us going forward as a society. Life as we know of are protected from

UV (ultraviolet) rays from the depleting ozone layer which acts as defensive shield. UV radiations of the medium frequency (200 nm to 320 nm) are being absorbed up to 99% by the ozone layer which situated at the height of 10-16 kilometers above the surface. The layer is basically gas in the stratosphere region in which ozone particles, (O_3) which are made from 3 oxygens atoms are located, while most of the ozone is formed near the equator because of culmination of sunshine and wind that accumulates in the stratosphere. The term "ozone hole" applied when a depletion level is below 200 D.U (Dobson Unit), it essentially means the region in which ozone layer had been depleted. This phenomenon was first discovered in 1970 in the continent of Africa, following that there has been discovery of ozone hole appearing in arctic region during 2011 (Climate.gov., 2012). This harmful anomaly leads to the UV rays penetrating the troposphere layers, leading to injurious effects on the living organism under the protection of it.

The causes of ozone depletion can be categorized into 4 different distinctive virtue, starting from Chlorofluorocarbons (CFCs) which are composed of chlorine, fluorine, and carbon. The one special characteristic about this destructive compound is that they break up only through the presence of sunlight, which causes a division in their molecules, releasing chlorine and allowing them to react with the ozone to form oxygen and chlorine monoxide. As the molecule of chlorine monoxide comes into contact with another molecule of an oxygen, it reacts in a molecular level, releasing chlorine which could possibly dismantle another molecule of the ozone. The problem is that CFCs are distinctively volatile and cannot be combust thus causes them to evaporate at a quick level and can easily reached up to the stratosphere where the ozone layer are located at. CFCs has been observed to be linked with industrial production since the 1920s which resulted in a average ozone depletion of 3%. According to the chemical model for ozone destruction, the photolysis of Chlorofluorocarbons was the main source of the ozone depletion reaction over 20 years ago (National Research Council (US) Committee on Toxicology, 1984).

Launches of Rocket plays another vital role in depleting our ozone, despite the lessening believes in the idea, it has been proved that unregulated rocket launches can result in much more ozone depletion when compared to CFCs. Rocket launching emit particulates and gases that could cause harm to the ozone layer, liquid kerosine, cryogenic, hypergolic and solid are among them. The combustion process which includes these fuels means that our rocket is suitable to emitting water vapor, carbon dioxide, black carbon, alumina, reactive chloride and even nitrogen oxides, which are all known for damaging the ozone layer. An example of this can be seen from the exhaust pump of the rocket emitting chlorine and nitrogen compounds. Two different scenarios were conducted compares the calculations of ozone depletion on the local and global scale. It has been found that the axis of the space rocket exhausts' exhaustion level would be reduced by up to 100% for a period of 4 hours. Annually and globally averaged of ozone depletion due to 50 launches are valued to less than 1/10. It is estimated that the unregulated rocket launches could cause a much more compelling results to our ozone layer by the year 2050 than CFCs will have ever done (NASA, 2013).

The last 2 causes could be summarized into the topic of global warming and nitrogenous compound. Global warming has been an occurring problem since the dawn of time, primarily caused by green house gasses such as carbon dioxide

(CO_2), methane (CH_4), and nitrous oxide (N_2O) trapping heat from the sun and effecting Earth's atmosphere which could lead to many harmful and perpetual effect. The enhanced greenhouse effect is resulted from a plethora of humans' harmful actions ranging from impacts on agriculture to human health impacts. While global warming primarily occurs at a lower atmosphere (the troposphere), the ozone layer is located one layer above, at the stratosphere (U.S. Environmental Protection Agency, 2021). There are some interactions of a molecular level between the two layers due to the movement of air and substances in the two respective atmospheres. Despite many compounds, carbon dioxide can have an indirect effect on ozone layer, changing the stratosphere temperatures cause by green house which could further effect ozone depletion (U.S. Environmental Protection Agency., 2021). Another reason could also derive from the substance commonly used in refrigeration's, air conditioning and many more ozone depleting agents such as CFCs. When released into the atmosphere the CFCs rise into the stratosphere where they can break down from UV radiation and releasing bromine atom which catalytically destroy the necessary molecules. Lastly, nitrogenous compound emitted by human activities like NO, N_2O, NO_2 are observed to be greatly responsible for ozone depletion. When nitrogen oxides are transported into the stratosphere through human activities such as aviation, a series of chemical reactions could occur. Starting with the dissociation of nitric oxide (NO) into nitrogen dioxide (NO_2) which could react with ozone, leading to the formation of nitrogen trioxide (NO_3). This substance can regenerate nitric oxide allow nitrogen oxides to continue participating in ozone depletion.

This chart shows the average ozone hole area per 1 million kilometer quired during the 1995 season. As you can see from the chart presented, the area of ozone hole has seen an increase throughout the month. Subsequently the minimum ozone per Dobson units is depleting at a similar rate when compared to the ozone hold presented. (Fig 2.)

Changes in ozone in the atmosphere to surface temperature

The graph below shows the change in surface in temperature to the height of the ozone change. The person who first suggested an older model of his experiment, V. Ramanathan, to be used during this experiment. However, when the ozone perturbation experiment was performed using his model formulation, the results were within 10% of those in the graph below, which were calculated using a conventional radiative-convective model (Fig 3.) (Ramanathan, 1976)

The change in surface temperature to the height of ozone change. The figure was produced by increasing ozone concentrations by 10% in each 1 km thick layer of the atmosphere in turn. Results were collected by using a radiative-convective model and is the model for global mean atmospheric profile.

Effects of atmospheric ozone on pathogenic bacteria

After Rangel experiments on multiple bacteria in an O_3 concentration, it shows that the device's emission ranged from 0.6 ppm to 2.1 ppm, averaging at around 1.4 ppm. The graph below shows the number of colonies in different species of bacteria. There are 3 tests, not exposing the bacteria to the O3, exposing for 10 h and 12 h. The bacteria we used in the experiment are *A. baumannii, E. coli,*

P.aeruginosa, S. aureus and *S. enterica* (Fig 4.) (Rangel et al, 2021).

The results, depicted in a graph illustrating the number of bacterial colonies under different ozone exposure conditions, likely revealed several key findings. Firstly, variations in colony counts between bacteria not exposed to ozone and those exposed for 10 or 12 hours would indicate ozone's antimicrobial effects. Secondly, differential sensitivity among bacterial species suggests varying degrees of susceptibility to ozone exposure, highlighting the importance of species-specific responses.

These findings have important implications for healthcare, where controlling bacterial contamination is critical. Understanding the optimal ozone concentration and exposure duration for reducing bacterial growth can inform strategies for disinfection and sterilization in healthcare facilities. Moreover, insights gained from this research can guide future studies investigating the underlying mechanisms of ozone's antimicrobial effects and its potential applications in medical settings.

Effects of ozone (O_3) on human health

Ozone concentration levels for human health The potential health effect that derived from Ozone depletion and the global climate change allows the penetrating UV radiations to come into contact with Earth. As a results from this phenomenon, the radiations could cause severe diseases to the human body, which includes skin cancer, eye damage, etc. Other than the effects mentioned above, ozone depleting is affecting the biogeochemical cycles, air quality, as well as contributing to Global warming, the rapid increase in Earth's average surface temperature. Focusing on the effect toward the human body, we turn to the first major concern that ozone depletion plays a part in, our eyes. Cataracts, the major cause of blindness are caused by the aging or injury to the tissue which made up the eye's lens. As ozone depletions gets worse throughout time, so does our lens as a result of the oxidative agents. Oxidative oxygen, produced by UV radiation can damage the eye lens. This occurs because oxidative stress of the lens directly influences the solubility of the proteins which reside in the lens leading to the increase in the opacity that the lens contain. Numerous reactive oxygen species, superoxide anion radical (O_2-), H_2O_2, and hydroxyl free radical (OH) is the major cause of structural damage that the crystalline lens and contributes to cataract formation. As the ozone level decrease by 1%, 0.3-0.6% of cataracts' risks will increase, along with other disease such as photokeratitis or blindness (van der Leun, Takizawa, and Longstreth., 1989).

Another major disease that could derive from UV radiations is skin cancer. As the radiations enter your skin, the composition of it alters the structure of biomolecules and lead to different disease. 2 types of skin cancer can be linked to UV radiations, Melanoma and Non-melanoma. Melanoma originates in melanocytes which is the cells responsible for producing melanin, giving color to the hair, skin and eyes. Most importantly, it provides protection against the harmful effects of the harmful radiation from the sun. With the thinning of the ozone layer, the increase of UV exposure can raise the risk of skin damage, including DNA mutations in melanocytes, which in turns contributes to the.

The graph below demonstrates the exposure of skin to UV damage (in minutes) compared to the UV index, the international standard measurement of the strength of the sunburn producing ultraviolet at a particular place and time. As the graph suggests, UV radiations seems to appear instantly, as the index of 1 2

always being displayed no from 10-20 minutes. (Fig 5.)

Other than UV exposure, higher incidence shows that area with greater ozone depletion, such as regions close to the ozone hole have a higher risk of developing the disease, suggesting a link between the ozone depletion and an increase of melanoma (Department of Health Tennessee, 2023).

Another type of skin cancer, non-melanoma is the most common type and seems to be of less harm. This cancer includes basal cell carcinoma (BCC) and squamous cell carcinoma (SCC) which are different form melanoma and have distinct causse. Similarly, UV exposure seems to have the most effect on it with over 70% of causes coming from the radiation. Another major cause is the geography variation, in which Areas closer to the ozone hole, such as parts of Australia or New Zealand have a higher risk of developing non-melanoma (Umar, & Tasduq, 2022; Specialist Clinics of Australia., 2024). There is also a considerable relationship between melanoma and exposure of sunlight and sunburn, as a direct relationship between air traveling and melanoma incidence. Though, studies reveals that genetic factors do have more of an effect that behavioral aspects and that epidemiological studies indicates that it does depends on person to person.

Effects of ozone on the human respiratory system

Ozone levels can impair lung function, making it challenging to breathe deeply and forcefully, particularly when exercising. Additionally, it irritates and harms lung cells, making them more prone to infection. Unhealthy ozone concentrations can exacerbate asthma, increasing sensitivity to allergens and the need for medical care. Reduced lung function and airway inflammation may have a more serious impact on asthmatics. Emphysema and chronic bronchitis are two more chronic lung disorders that ozone can exacerbate. Additionally, frequent short-term ozone damage to growing children's lungs may cause them to have lessened lung capacity as adults, hastening the aging process normal fall in lung capacity. Headaches, coughing, a dry throat, difficulty breathing, a heavy sensation in the chest, and fluid in the lungs can all be side effects of ozone exposure. More severe effects might develop at higher exposure levels. Asthma can develop with repeated exposure. Ozone exposure may be harmful to workers. The dose, timeframe, and type of work determine the exposure level. Ozone exposure results in irritation and inflammation of the tissues lining human airways, which can increase a number of symptoms. Shortness of breath can result from exposure to ozone because it reduces the amount of air that the lungs can take in (Smith, 2021).

When ozone is present in sufficient amounts, lung cells become more permeable, making them more vulnerable to poisons and microbes. Even when the amount and length of exposure are the same, the likelihood and severity of health impacts from ozone exposure varies greatly amongst people. Shortness of breath, chest discomfort, and coughing can occur in adults and children who inhale high quantities of ozone over a brief period of time (minutes or hours). High ozone exposure might make asthma symptoms worse. People with cardiac problems may have worsening symptoms after briefly inhaling ozone. Ozone can interact with other airborne molecules to create new compounds and small particles that can irritate eyes, nose, throat and lungs. Children who breathe ozone for long periods of time may suffer permanent lung damage, but this health

effect is less certain. Some information suggests that children who participate in outdoor sports in areas of high ozone levels have an increased chance of developing asthma. (Liang et al, 2022)

In the lungs, ozone reacts rapidly with certain biological molecules, especially those containing thiol or amine groups or unsaturated carbon-carbon bonds. These reactions and their products are poorly characterized, but the ultimate effects of ozone exposure are thought to be mediated by free radicals and other oxidizing species in ELF, which then react with other underlying epithelial cells, with immune cells, and with nerve receptors in the body. wall of the airway. In some cases, ozone itself can react directly with these structures. Several effects with distinct mechanisms occur simultaneously after short-term exposure to ozone. Ozone-induced changes in respiratory rhythm leading to faster shallow breathing may also be a manifestation of C-fiber stimulation and may be a protective response to limit the deep penetration of ozone into the airways. Such effects may also contribute to altered deposition and retention patterns of other inhaled substances such as allergens and particulate pollution. (U.S. Environmental Protection Agency, 2023)

Ozone is highly reactive in the respiratory tract when breathed into the airways, ozone interacts with proteins and lipids on the surface of cells or present in the lung lining fluid, which decreases in depth from 1 0 μm in the large airways to 0.2 μm in the alveolar region. Epithelial cells lining the respiratory tract are the main target of ozone and its products. These cells become injured and leak intracellular enzymes such as lactate dehydrogenase into the airway lumen, as well as plasma components. Epithelial cells also release a variety of inflammatory mediators that can attract polymorphonuclear leukocytes (PMNs) into the lung, activate alveolar macrophages, and initiate a train of events leading to lung inflammation. Antioxidants present in cells and lining fluid may protect the epithelial barrier against damage by ozone or its reaction products (Fig 6.) (U.S. Environmental Protection Agency., 2023; Schlink et al, 2006).

Effects of ozone on lung function Ozone reduces the maximal inspiratory position and may slightly increase the residual volume. Reduction in maximum inspiration reduces forced vital capacity, and this causes a reduction in expiratory flow measurements, such as flow at 50% of FVC expired. Because ozone causes only a small change in resistance, the relationship between flow and volume is not changed to a large extent (U.S. Environmental Protection Agency, 2023). (Fig 7.)

The effects of ozone on lung function exhibit a dose-response relationship, with the severity of impact increasing with higher levels of ozone exposure. Short-term exposure to elevated ozone concentrations can induce acute respiratory symptoms and temporary reductions in lung function, while chronic or repeated exposure over time may lead to more persistent and severe respiratory effects. Individual susceptibility to ozone varies based on factors such as age, pre-existing respiratory conditions, genetic predisposition, and overall health status. Vulnerable populations, including children, the elderly, and individuals with respiratory diseases, are particularly at risk and may experience more significant declines in lung function and increased respiratory symptoms from ozone exposure. Chronic exposure to ozone can result in cumulative damage to the respiratory system, leading to long-term declines in lung function and increased susceptibility to respiratory conditions. Additionally, ozone often coexists with other air pollutants, such as particulate matter and nitrogen

oxides, which can synergistically interact to exacerbate the adverse effects on lung function and respiratory health. Efforts to reduce ozone pollution and improve air quality are essential for protecting respiratory health and minimizing the adverse effects of ozone on lung function over time (Holm & Balmes, 2022).

From the review, it shows the intricate interplay between atmospheric ozone dynamics and its multifaceted effects on human health underscores the critical importance of addressing this complex environmental issue.

Firstly, understanding the chemical composition and toxicity of ozone is paramount in comprehending its impact on human health. Ozone, while beneficial in the stratosphere as a shield against harmful UV radiation, poses significant risks when present at ground level, particularly in urban areas where it contributes to air pollution and respiratory ailments.

Secondly, the changing atmospheric ozone dynamics, driven by both natural processes and human activities, have led to alarming consequences such as ozone layer depletion and increased exposure to harmful UV radiation. Factors such as chlorofluorocarbons (CFCs), rocket launches, global warming, and nitrogenous compounds have all contributed to ozone depletion, further exacerbating the risks to human health.

Thirdly, the effects of ozone on human health are diverse and profound. From increasing the risk of skin cancer and cataracts due to UV radiation exposure to impairing lung function and exacerbating respiratory conditions such as asthma and chronic bronchitis, ozone poses significant threats to public health.

Conclusion

The study highlights the concerning impact of human activities and industrial processes on atmospheric ozone levels, revealing a current trend of ozone depletion driven by various life activities and industrial operations. These activities release toxic substances that ascend into the atmosphere, contributing to ozone destruction. This depletion exacerbates health risks associated with increased UV ray penetration into the Earth, leading to conditions like skin cancer and eye damage. Moreover, ozone in the air adversely affects respiratory health bycompromising lung function and damaging lung cells, heightening the risk of respiratory infections. This underscores the significant role of ozone in human health, with its loss in the atmosphere and presence in the air contributing to long-term health issues, all stemming from pollution linked to human lifestyles. Urgent solutions are imperative to lessen these risks, emphasizing the need to address human-induced factors contributing to ozone depletion and implement measures safeguarding both human health and the environment. In essence, the conclusion underscores a call to action, stressing the crucial need for concerted efforts to combat ozone depletion and its detrimental effects on public health and the planet.

Furthermore, continued research into the mechanisms underlying ozone's impact on human health is essential for developing effective strategies to protect public health and mitigate the adverse effects of ozone pollution. By addressing these challenges comprehensively, we can safeguard both human health and the environment for future generations.

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คณะสาธารณสุขศาสตร์
มหาวิทยาลัยราชภัฏอุบลราชธานี
Faculty of Public Health, Ubon Ratchathani Rajabhat University
Ubon Ratchathani Rajabhat University

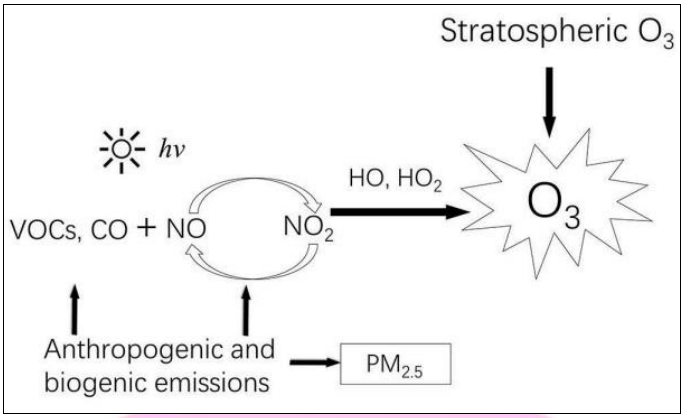


Fig.1 Formation of ground level ozone

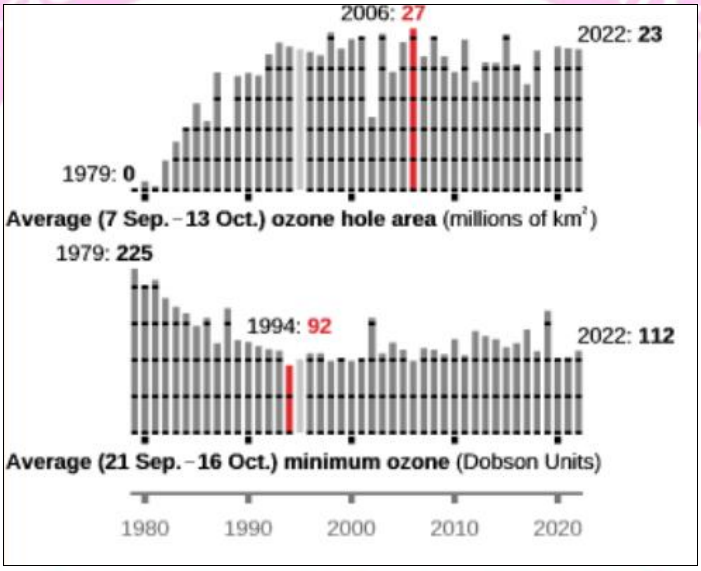


Fig.2 Changing of atmospheric ozone between 1980 to 2020

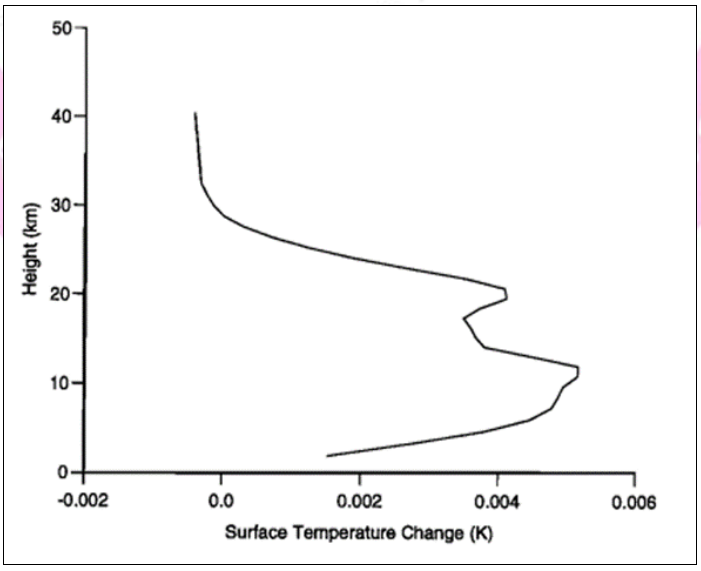


Fig.3 Changes in ozone in the atmosphere to surface temperature

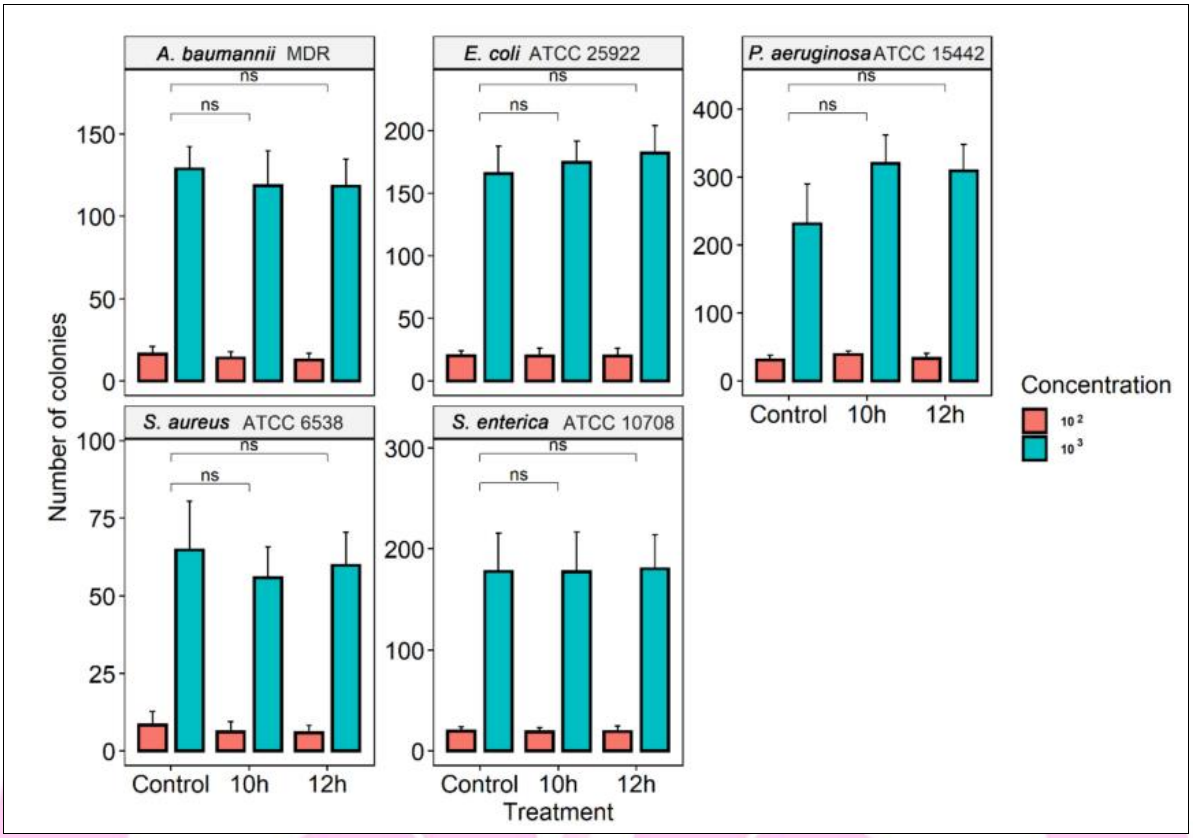


Fig.4 Effects of atmospheric ozone on pathogenic bacteria

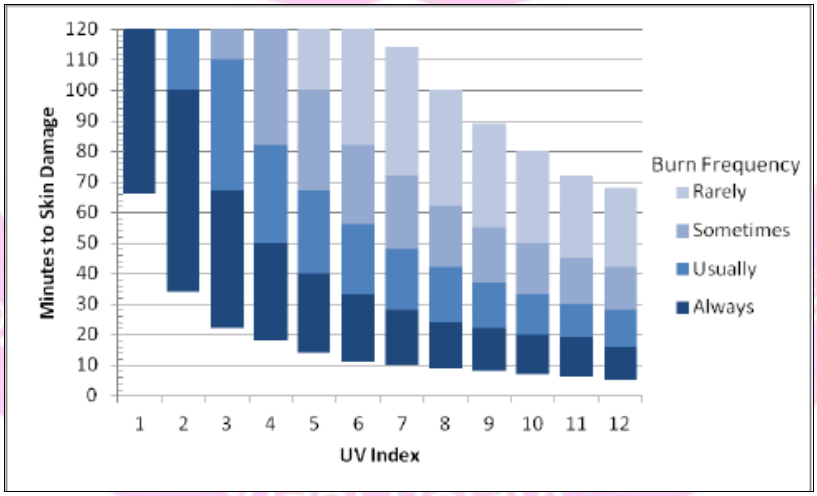


Fig.5 Effecting of UV radiations to human health

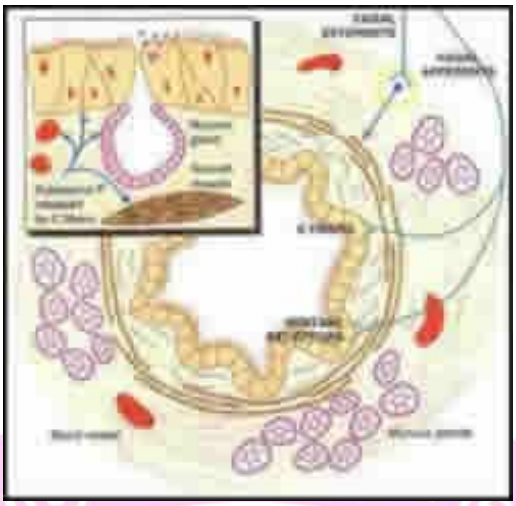


Fig.6 cells and lining fluid may protect the epithelial barrier against damage by ozone

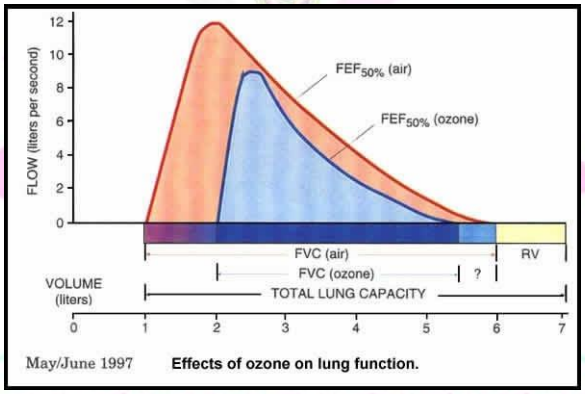


Fig.7 Effects of ozone on lung function

คณะสาธารณสุขศาสตร์
มหาวิทยาลัยราชภัฏอุบลราชธานี
Faculty of Public Health, Ubon Ratchathani Rajabhat University
Ubon Ratchathani Rajabhat University