

# The impact of traveling on infectious diseases transmission with a focus on air travel: A Narrative Review

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## Abstract

The global tourism industry has experienced significant growth from 2009 to 2014, with international tourist arrivals increasing from 25.3 million in 1950 to 1.138 billion in 2014. This surge in travel, projected to grow at an annual rate of 6%, has implications for public health, particularly concerning the spread of infectious diseases. Travelers can act as carriers of pathogens, introducing them to new regions, often without showing symptoms. EIDs pose a considerable threat, exacerbated by increased global mobility and urbanization. Air travel, in particular, has facilitated the rapid transmission of diseases like SARS and influenza, highlighting the need for effective public health measures to mitigate risks. The interconnectedness of travel networks and infectious disease dynamics is evident, as pathogens can be transported across vast distances, leading to outbreaks in previously unaffected areas. Factors influencing disease transmission include human demographics, environmental changes, and technological advancements. The introduction of pathogens into new populations can lead to outbreaks, especially when immunity is lacking. Understanding the interplay between human mobility and infectious disease transmission is crucial for developing strategies to prevent and control outbreaks in an increasingly mobile world.

**Keywords:** Tourism, Infectious Diseases, Pathogens, Air Travel, Public Health

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## Introduction

The worldwide economic rebound and the rise of new source markets have resulted in a notable expansion in both the volume and size of global tourism from 2009 to 2014. The number of international tourist arrivals surged from 25.3 million in 1950 to 1,138 million in 2014. According to the World Tourism Organization (WTO), travel is projected to grow at an annual rate of 6%. According to the WTO statistics from 2015, international tourist arrivals hit 1.2 billion. Data indicated that 55% of these travelers were engaged in leisure and recreational activities. This current level and extent of travel are unparalleled, with repercussions affecting both the regions hosting tourists and the ecological systems. Historically, human migration has facilitated the spread of infectious diseases, and travel remains a significant contributor to the emergence of such diseases. It will persist in influencing the emergence, prevalence, and transmission of infections across various geographic regions and

populations.<sup>1</sup> The movement of populations influences the patterns and distribution of infectious diseases worldwide. The effects of travel are evident both in the travelers themselves and in the locations and communities they visit, often lingering long after their journeys. A traveler can be viewed as an interactive biological entity that acquires, processes, transports, and disperses microbial genetic material. They may introduce potential pathogens even when they exhibit no signs or symptoms of illness. Travelers can act as a sentinel population, and they can also be regarded as carriers who unintentionally transport pathogens and microbial genetic material to different regions.<sup>2</sup> Emerging infectious diseases (EIDs) are defined as diseases that have recently surfaced or have increased in frequency and geographical distribution. EIDs pose a significant threat to public health, driven by rising global commerce, travel, and disruptions to ecological systems, particularly due to urbanization. Migration is a worldwide

phenomenon that impacts the health of individuals and populations throughout their lives. Migrants are unique travelers, often migrating not by choice, and they are considered to be at a higher risk for various health issues, including infectious diseases such as HIV, hepatitis B, tuberculosis, schistosomiasis, and malaria.<sup>3</sup> The convenience of international travel has exposed large populations of travelers to a variety of exotic infections and health risks. Air travel has significantly contributed to the surge in trips from developed nations and emerging economies to the developing world. In 2015, tourist arrivals reached 279 million in Asia and the Pacific, 193 million in the Americas, 53 million in the Middle East, and 53 million in Africa. Past data suggests that up to half of these travelers may encounter health issues while abroad. Additionally, millions of travelers depart from tropical countries to visit other nations (for instance, from Asia to Sub-Saharan Africa), where the incidence of specific infections, such as falciparum malaria, can be significantly higher than in their home countries.<sup>4</sup> The impact of travel on the spread of infections is well acknowledged, with pathogens now able to move more rapidly than ever due to modernization and globalization. As a result, travel restrictions have become a crucial non-pharmaceutical intervention for halting or slowing the transmission of pathogens between different locations.<sup>5</sup> The purpose of this study is to investigate how travel affects the transmission patterns of infectious diseases and to identify the effective factors in increasing the risk of the spread of these diseases.

### **The Link Between Travel Networks and Infectious Diseases**

The emergence of infectious diseases is influenced by various factors, including microbial adaptation and change, human demographics and behavior, environmental changes, technology and economic development, breakdowns in public health measures and surveillance, as well as international travel and commerce. Travel facilitates the introduction of potentially pathogenic microbes into new geographic areas. However, for a microbe to establish itself and cause disease, it must survive, proliferate, and find a means to enter a susceptible host. Organisms that primarily or entirely survive in the human host and are transmitted through sexual contact, droplet nuclei, and close physical contact can be easily transported to any part of the world. Examples include AIDS, tuberculosis, measles, pertussis, diphtheria, and hepatitis B, all of which can be readily spread by travelers in new geographic areas. In contrast, organisms that rely on animal hosts, have environmental limitations, require arthropod vectors, or possess complex life cycles become increasingly challenging to

"transplant" to different geographic areas or populations. Epidemics of dengue fever and yellow fever can only occur in a geographic area if competent mosquito vectors are present. Similarly, schistosomiasis cannot spread in an environment unless there is a suitable snail intermediate host available in that region.<sup>6</sup> Air travel has significantly enhanced global transportation but has also escalated the transmission of infectious diseases and public health risks. The 2003 severe acute respiratory syndrome (SARS) outbreak exemplified how air travel can facilitate the rapid spread of disease, prompting many countries and airlines to adopt various measures to mitigate the spread of infectious diseases through air travel. These measures often include entry and exit screening to identify and manage potential cases before they can contribute to further transmission.<sup>7</sup> SARS is indeed a respiratory tract infection caused by the zoonotic coronavirus (SARS-CoV). The virus is believed to have originated in horseshoe bats, which are considered the natural reservoir for the virus. It is thought that the transmission to humans occurred through civets, which acted as intermediate hosts.<sup>8</sup> The increasing ease and affordability of air travel, along with the mobility of people, have made airborne, food-borne, vector-borne, and zoonotic infectious diseases a significant public health concern. The heightened fear of bioterrorism has prompted health officials to reassess the potential for these agents to be spread through air travel. The growing mobility of people and the popularity of airline transportation have intensified the risk of disease transmission to passengers not only during flights but also before and after. During flights, the aircraft cabin serves as a ventilated, enclosed environment that subjects passengers to hypobaric hypoxia, dry humidity, and close proximity to others, further increasing the potential for infectious disease spread.<sup>9</sup> Air travel has significantly altered the epidemiological landscape over the past fifty years, enabling infected individuals to traverse vast distances in much shorter times than the incubation periods of most infectious diseases. The air transportation system indirectly facilitates the global spread of directly transmitted diseases such as influenza and SARS. This highlights the critical impact of air travel on the dynamics of infectious disease transmission on a global scale.<sup>10</sup> The aircraft cabin is one of the environments with the smallest air volume per person among all public spaces, which significantly increases the risk of transmitting airborne infectious diseases such as influenza, tuberculosis, measles, SARS, Middle East Respiratory Syndrome (MERS), meningococcal infection, and the common cold. While the transmission of digestive tract infections, such as food poisoning caused by salmonella or staphylococcus, dysentery, cholera, or viral enteritis, has also been reported, these occurrences are less frequent.

Additionally, commercial flights and airport transit pose risks for vector-borne diseases, with known outbreaks of malaria and dengue fever having been documented.<sup>11</sup> The historical spread of infectious diseases through global transport networks is exemplified by the transportation of plague-infected rats from China, which led to significant epidemics in international ports such as Sydney, Bombay, San Francisco, and Rio de Janeiro. Cholera, caused by the bacterium *Vibrio cholerae*, results in severe dehydration, shock, and often rapid death. It first emerged as an epidemic in India in 1817 and quickly spread, partly due to British ship and troop movements that carried the infection to regions including China, Japan, and Indonesia. In the 20th century, influenza became the principal infectious disease affected by the expanding global transport network, exhibiting pandemic behavior and highlighting the profound impact of air travel. The 1957 pandemic, which originated in mainland China, spread globally within six months, a rapid dissemination attributed to a shift in the haemagglutinin surface protein of the virus that left the global population vulnerable to infection, along with the regular air and sea travel that facilitated the establishment of secondary epidemic sources. Similarly, the spread of the HIV/AIDS pandemic is a narrative closely tied to travel, with episodes traceable through molecular tools and epidemiological studies. Data indicate that the pandemic began in the mid-1970s and, by 1980, had affected between 100,000 and 300,000 individuals across at least five continents. A notable incident occurred on 21 February 2003, when a physician from Guangdong transmitted an infection to 16 other guests during a single day at a Hong Kong hotel. This event triggered outbreaks in Hong Kong, Toronto, Singapore, and Vietnam, leading to over 8,000 SARS infections in 26 countries across five continents within weeks.<sup>12</sup> The findings indicated that without travel restrictions, the spread of COVID-19 could have intensified considerably, particularly in regions such as Central Europe, France, and Spain. This highlights the crucial role that travel limitations played in mitigating the transmission of the virus during the pandemic, helping to prevent overwhelming healthcare systems and reducing the overall impact of the outbreak in these areas.<sup>13</sup> In 2008, there was a notable increase in dengue activity across endemic regions worldwide, particularly in South Central Asia, including India, and South America, especially Brazil, compared to the previous year. Several cases were reported from Asia, including infections in travelers returning from Bali, Indonesia, the Philippines, Thailand, Vietnam, and Myanmar. Additionally, five cases were imported into Marseille, France, and one case into Brescia, Italy, both of which are near areas inhabited by the mosquito vector *Aedes albopictus*.<sup>14</sup> The evolution

of airplane technology, particularly the increased speed of travel, has led to the emergence of 'new' disease threats and has made 'old' diseases seem even more daunting over the past century. Airports serve not only as crucial nodes in the global air traffic network but also as significant transit points that facilitate the rapid, worldwide spread of diseases. This significance is underscored by research indicating that during an era of unprecedented global aeromobility hundreds or even thousands of human pathogens circulating through the world's airways.<sup>15</sup>

### Transmission Dynamics During Travel

Humans significantly influence the spatial transmission dynamics of infectious diseases by introducing pathogens into environments that are susceptible to infection. The frequency of this introduction is closely linked to human mobility patterns. When infected individuals travel into new populations that lack immunity, they can introduce pathogens that may lead to disease outbreaks. Data on human travel that is pertinent to disease transmission, both spatially and temporally, is frequently lacking. As a result, researchers and public health officials often depend on mobility models to understand these dynamics. To enhance the accuracy of these models, incorporating the duration of trips into the analysis of trip counts could provide a more nuanced understanding of travel behaviors. This approach may help capture critical aspects of mobility that are relevant to epidemiology, allowing for a more realistic depiction of how human movement influences the spread of infectious diseases.<sup>16</sup> For directly transmitted infections, the transmission of pathogens is fundamentally dependent on human-to-human contact. The structures of kinship, households, and societal interactions significantly influence these contact patterns, which ultimately shape the dynamics of epidemics. In particular, labor migration among specific demographic groups—such as those involved in forest and plantation work, agriculture, livestock management, or gold mining—has been recognized for decades as a key factor driving regional patterns of malaria transmission. In the Sahel region of Africa, characterized by a significant and seasonal burden of malaria, pastoral livestock farming plays a crucial role in the economy. Pastoralist communities in this area are highly mobile, frequently relocating in search of pasture and water for their livestock. This mobility often leads them into regions that are conducive to malaria transmission. Seasonal migration patterns, both within and between countries, contribute to the movement of malaria parasites, which tend to shift from east to west as people travel between forested areas and more densely populated regions. Surveys have confirmed the critical role of labor migration to forested areas in this context, highlighting how the movement of

people can facilitate the spread of malaria parasites.<sup>17</sup> Commercial aircraft transport over 3 billion passengers each year, serving not only as a means of transporting cargo and individuals but also as a potential conduit for the spread of infectious diseases. Within aircraft, infections can be transmitted through close contact among passengers and crew, primarily via large respiratory droplets. Additionally, airborne transmission can occur through small-particle aerosols, as seen in the case of SARS. Moreover, the risk of infection extends beyond respiratory routes; contaminated food served onboard or the presence of infectious disease vectors, such as insects, rodents, or parasites, can also facilitate the spread of diseases. While many respiratory pathogens are primarily transmitted through direct contact and large droplet spread, certain pathogens such as *Mycoplasma pneumoniae*, Influenza Virus, and Measles Virus can also be transmitted via airborne routes. The potential for disease spread associated with commercial flights is significant, arising from various factors. Opportunities for transmission include contact with contaminated fomites, which are surfaces such as countertops, seats, trays, handrails, and toilets that may harbor infectious agents. Additionally, the close-quarters movement of passengers during boarding, as well as seating proximity during the flight, creates further opportunities for transmission. Waiting areas and lines before boarding or after deplaning also pose risks, as passengers are often in close contact with one another. The rise in the spread of arthropod-borne viruses (arboviruses) has been partially linked to increased air travel, which can facilitate the movement of mosquito vectors that carry diseases such as West Nile Virus, Japanese Encephalitis, Venezuelan Equine Encephalitis, Rift Valley Fever, Dengue, Yellow Fever, Chikungunya, and Zika. However, the most frequently reported diseases transmitted on aircraft are those spread via the fecal-oral route, primarily through contaminated food. Between 1947 and 1999, a total of 41 documented in-flight foodborne outbreaks resulted in 11 fatalities. The most commonly implicated pathogens in these outbreaks include *Salmonella*, *Shigella*, and *Vibrio cholerae*.<sup>18</sup> Airport malaria is a significant public health concern, where individuals who do not travel can become infected by mosquitoes that have been transported via air travel. This situation presents a diagnostic challenge, as local healthcare providers may not immediately suspect malaria in patients presenting with symptoms. While measures such as spraying arriving aircraft have helped reduce the incidence of airport malaria cases, the ongoing increase in travel volumes poses a continued risk. The 1918 influenza pandemic is a significant historical event that showcased the potential of the influenza A virus to cause a global catastrophe. This pandemic occurred during a time of

increasing global mobility, which facilitated the rapid spread of the virus. It is estimated that the pandemic resulted in approximately 50 million deaths worldwide. Seasonal influenza strains are now more mobile than ever, with air travel being a well-established mechanism for facilitating global influenza transmission. The 2009 H1N1 influenza pandemic further illustrated this point, as it showcased how quickly a novel influenza virus could spread across the globe. Originating from a pig farm in Mexico, the H1N1 virus rapidly disseminated through global air travel networks, leading to an estimated 123,000 to 203,000 deaths worldwide.<sup>8</sup> Human movement significantly influences the dynamics of infectious disease epidemics, particularly in terms of introducing pathogens to previously disease-free areas and facilitating their spread throughout the course of an epidemic. The transmission of disease in a specific location where an infectious person travels is influenced by various local characteristics, including population density and patterns of interaction, among other considerations. Additionally, the dispersal of pathogens is structurally limited by the distribution and nature of transport infrastructure, which is often shaped by economic factors. Seasonal variations in human movement, such as during vacations, agricultural growing seasons, and religious events, can also impact the dispersal of pathogens.<sup>19</sup> Research has demonstrated that smaller commercial aircraft are more effective than larger ones in decreasing the incidence of new infections.<sup>20</sup> The World Health Organization (WHO) states that the primary mode of transmission for diseases like influenza and SARS is through respiratory droplets ( $\geq 5 \mu$ ) that are expelled over short distances ( $\leq 1$  m) when an infected individual sneezes, coughs, talks, or even breathes. Direct transmission occurs when droplets containing pathogens land on the conjunctiva or mucosa of a susceptible person or are inhaled. A passenger can have close ( $\leq 1$  m) contact with others in three ways: they may be seated nearby, they could walk past both seated and moving individuals, or while seated, a moving person could pass close to them.<sup>21</sup> As mentioned earlier the rapidity of air travel allows infected passengers to reach their destinations before the conclusion of the incubation period, potentially leading to the spread of disease even before symptoms manifest.<sup>22</sup>

## Travel-Related Infectious Diseases

### 1- Tuberculosis

Throughout history, tuberculosis (TB) has spread through the movement of human populations. Modern travel continues to pose a risk for tuberculosis infection and disease. TB transmission has been recorded on commercial flights, where personnel or passengers can transmit the infection to others, but the risk of

transmission remains low. Similar to other environments, the likelihood of transmission is dependent on the duration and proximity of contact. Travelers from low incidence to high incidence countries have a significant risk of acquiring TB infection, similar to that of the general populations in the countries they visit, with an even higher risk for those working in healthcare. It is recommended that these travelers undergo two-step tuberculin skin testing before departure, followed by single-step tuberculin testing after their return. In contrast, travelers from high incidence to low incidence countries have a low risk of acquiring new TB infections, making tuberculin screening unnecessary and not recommended. Although chest X-ray screening is expensive and complex, it may be beneficial for long-term migrants.<sup>23</sup> The prevalence of transmissible TB among air travelers is estimated to be between 5 to 100 cases per 100,000 passengers, varying based on the flight route. Given the average number of passengers on an airplane, there is approximately one encounter with a TB case for every 3 to 60 flights.<sup>24</sup> The development of active TB occurs in two stages. Initially, the risk of acquiring a new TB infection is largely influenced by the likelihood of contact with an individual who has infectious TB. Following this, the risk of developing the disease itself is determined by the immune status of the newly infected person.<sup>25</sup> Despite a gradual decline in global TB incidence over the last decade, TB continues to be one of the most significant infectious diseases globally, with an estimated 9.6 million new cases and 1.5 million deaths reported in 2014. Contracting TB can have serious consequences for individuals, including extended treatment durations, potential long-term health issues, and the risk of transmitting the infection to others. While TB acquisition is usually linked to prolonged close contact, it is important to note that infection can also occur with brief or unrecognized exposure. The global TB epidemic is complex and evolving, characterized by changing patterns of both drug-sensitive and drug-resistant strains. For instance, the annual incidence of TB in countries like South Africa can exceed 800 cases per 100,000 people, while multidrug resistance is observed in up to 19% of new cases in the Russian Federation. Recent surveys indicate that the risk of TB for travelers, both short and long-term, is generally low, with rates of acquiring latent TB being less than 1% per travel year in most settings. However, a thorough travel evaluation is essential to assess individual risk. Travelers with immunosuppressive conditions are at a heightened risk for progressing to active TB disease if infected and should receive special consideration in travel consultations.<sup>26</sup>

## 2- Influenza

Travel is associated with increased health risks, especially concerning infectious diseases. Influenza stands out as one of the most commonly acquired infectious diseases among travelers.<sup>27</sup> Influenza viruses, which belong to the Orthomyxoviridae family, are among the most diverse emerging infectious agents and primarily cause respiratory diseases in humans. Human influenza can be categorized into three main presentations: seasonal influenza, avian influenza, and pandemic influenza.<sup>28</sup> Respiratory tract infections are a common cause of illness among patients admitted to tertiary-care hospitals after returning from travel, with influenza accounting for approximately 6% of these cases. Among febrile travelers examined in hospitals post-return, influenza was diagnosed in up to 15% of cases. The WHO estimates that around 5% to 15% of the global population is affected by seasonal influenza viruses each year. Outbreaks of influenza linked to travel by air, ship, or train demonstrate that international travelers are at risk for this infection and may introduce novel strains into domestic populations. The incubation period for influenza ranges from 1 to 5 days, with adults being most infectious from 1 day before symptom onset to approximately 5 to 7 days after. In healthy adults, symptoms can vary widely, ranging from classic influenza and mild illness to asymptomatic infections. Due to its high contagion and short incubation period, travel likely plays a significant role in the rapid spread of the virus.<sup>27</sup> Air transportation plays a crucial role in accelerating and amplifying the propagation of influenza. Transmission can occur aboard airplanes, at the travel destination, and potentially at airports.<sup>29</sup> Guidelines and recommendations for the prevention and management of influenza in travelers are limited. Travel medicine particularly focuses on at-risk populations and circumstances that enhance the transmission and spread of the influenza virus, such as air travel, cruise ships, and mass gatherings. Pre-travel advice should include information on influenza and its prevention, tailored to the relevant epidemiological situation. Strong recommendations for preventative measures should be made for travelers who are at high risk of developing complications from influenza.<sup>28</sup> To mitigate the risk of travel-related influenza, several interventions can be implemented. These include the use of antivirals for self-treatment, combined with rapid self-tests, extending the shelf life of influenza vaccines to allow immunization during the summer months for international travelers, and providing access to the influenza vaccine used in the opposite hemisphere as a travel-related vaccine. Among the currently available vaccines, the most crucial preventive measure is optimizing seasonal influenza vaccination.<sup>30</sup> Novel influenza A virus strains

occasionally emerge, leading to global influenza pandemics. In the 20th century, pandemics occurred three times, and there has been one in the 21st century so far. The understanding that influenza pandemics can have significant social and economic repercussions, in addition to their public health impact, has heightened awareness and preparedness for future influenza pandemics. This concern has been further amplified by the emergence of highly pathogenic strains of avian influenza virus over the past 20 years. Due to delays in the availability of specific vaccines and limited supplies of antiviral drugs, nonpharmaceutical interventions (NPIs) play a crucial role in pandemic plans. International travel-related NPIs, which may include traveler screening, travel restrictions, and border closures, are commonly incorporated into national influenza pandemic preparedness strategies. Various NPIs can be implemented at international, national, and local levels, aiming to achieve several objectives: delaying the arrival of infected individuals, slowing the spread of infection, postponing the epidemic peak, and reducing the magnitude of the peak.<sup>31</sup>

### 3- Severe Acute Respiratory Syndrome

The SARS was indeed responsible for the first pandemic of the 21st century.<sup>32</sup> SARS is a new infectious disease that was first reported in November 2002 in the Guangdong province of China.<sup>33</sup> SARS was primarily transmitted in healthcare settings, although not exclusively. Transmission typically occurred five or more days after the onset of the disease and was mainly from patients who were severely ill.<sup>32</sup> SARS caused widespread public disruption as the new febrile respiratory illness spread globally along international air travel routes. Outbreaks were concentrated in transportation hubs and densely populated areas. The etiologic agent was identified as a novel coronavirus, SARS-CoV. The disease is transmissible from person to person through direct contact, large droplet contact, and indirect contact from fomites and unwashed hands.<sup>34</sup> SARS is characterized by the acute onset of fever, nonproductive cough, myalgia, shortness of breath, or difficulty breathing. Approximately 14% of case-patients require mechanical ventilation due to the severity of the symptoms. The syndrome is caused by the previously unrecognized SARS-associated coronavirus (SARS-CoV).<sup>35</sup> As of August 2003, when SARS was brought under control globally, it had spread to 30 countries and regions, with more than 8,000 patients diagnosed and 774 deaths attributed to the disease.<sup>33</sup> Risk factors for death from SARS included old age and comorbid illnesses, particularly diabetes. The mean incubation period for the disease was 6.4 days, with a range of 2 to 10 days. The duration between the onset of symptoms and

hospitalization typically ranged from 3 to 5 days.<sup>36</sup> International travel has been recognized as a significant factor contributing to the global spread of infectious diseases. The advent of modern, fast air transport has facilitated the rapid dissemination of infectious agents across borders, making it easier for diseases to spread globally.<sup>33</sup> Effective control of nosocomial transmission involves several key strategies, including early detection of disease, strict isolation of infected patients, adherence to droplet and contact precautions, and consistent use of personal protective equipment. In the community, controlling disease spread requires tracing and quarantining contacts of infected individuals. Additionally, the development of a validated diagnostic test and an effective vaccine, along with the elimination of potential animal reservoirs, are crucial measures needed to prevent future epidemics.<sup>36</sup>

### Vulnerable populations and surveillance challenges

Comprehending the travel patterns of vulnerable populations has emerged as a significant area of research across various fields, including social sciences, transportation studies, and urban studies.<sup>37</sup> Vulnerability can be described as the extent to which an individual or group is prone to physical or emotional harm. Travelers may be deemed vulnerable if they are at a higher risk of health issues associated with travel or encounter specific challenges or difficulties during their journeys. Within the category of tourist travelers, certain vulnerable groups that require special attention include children, pregnant and breastfeeding women, older adults, travelers with pre-existing medical conditions, physically challenged individuals, and those with compromised immune systems. Factors contributing to children's vulnerability include their heightened susceptibility to certain infections (such as malaria, tuberculosis, and rabies), greater sensitivity to temperature fluctuations and dehydration, and a higher likelihood of animal bites compared to adults. Additionally, there are specific precautions and contraindications for some vaccines and medications, especially for young children, as many vaccines have minimum age requirements. Pregnant and breastfeeding women are considered vulnerable travelers due to several factors, including their increased susceptibility to and severity of certain infections (such as malaria, hepatitis E, influenza, and travelers' diarrhea), a higher risk of venous thromboembolism, potential obstetric complications, and the limited safety data available for some vaccines and medications. Additionally, there are contraindications for certain vaccines and medications that may pose risks during pregnancy and breastfeeding.<sup>38</sup> Commercial air travel facilitates the swift transmission of infectious diseases

worldwide. Travelers are often in close quarters, making them vulnerable to the spread of infections in shared spaces like airport boarding areas, lounges, security lines, and within the aircraft itself. Several factors influence the transmission of infections in the densely populated, enclosed environment of airplane cabins, including cabin air quality, duration of exposure, length of the flight, and passenger interactions during in-flight movement. The high-efficiency particulate filters utilized in modern airplanes are effective at reducing contagions in the recirculated air. However, the shedding of viruses from infected passengers before the air is filtered can still result in the transmission of infections to other travelers. In this context, the location and movement of passengers, which can lead to close contact between infectious and susceptible individuals, play a critical role in the potential spread of diseases during air travel.<sup>20</sup> Travelers play a crucial role in the global spread of EIDs due to the increased frequency and speed of both local and international travel. International travelers may come into direct or indirect contact with previously isolated or remote populations and ecosystems. A significant challenge is that travelers returning home may carry exotic infections that are still in the incubation stage. Consequently, infections acquired during travel can be transmitted to others in the community by these returned travelers before a diagnosis is made. In addition to international travelers, imported animals, birds, foods, and insects from abroad—particularly from tropical developing countries—can pose a significant threat to public health in receiving countries. These imported items can serve as vehicles for pathogens, facilitating their transportation into new geographic areas.<sup>39</sup>

### Preventive Measures

Traveling has become common in the modern world, and the risk of infection for travelers varies based on several factors. Key considerations include previous medical conditions, travel destination, geographical characteristics of that destination, duration of travel, types of tourist activities, and the accommodations used. However, there have been limited studies specifically addressing travel and the risk of infection in recipients of biologic and targeted therapies. Much of the existing data on this topic is extrapolated from studies involving all travelers. The most common clinical syndromes among travelers worldwide include systemic febrile illness, acute diarrhea, respiratory infections, and dermatological disorders. Before departure, it is essential for travelers to receive counseling about the disease risks in the countries they plan to visit, along with recommendations for preventing illness. Pre-travel services, including vaccinations, should be easily accessible to all travelers to help mitigate these

risks.<sup>40</sup> It is evident that environmental pollution, global warming, and changes in ecosystems will contribute significantly to the spread of infectious diseases through travel. Many communicable diseases, including chickenpox, diphtheria, influenza, measles, mumps, meningococcal meningitis, rubella, polio, and whooping cough, can be effectively prevented through active vaccination processes.<sup>41</sup> Addressing outbreaks of directly transmitted pathogens like pandemic influenza and SARS, as well as managing endemic diseases such as tuberculosis and meningococcal infections, are critical public health concerns. These goals can be accomplished through nonpharmaceutical measures like closing schools, imposing travel restrictions, and conducting contact tracing, or through healthcare strategies such as vaccination and the administration of antiviral or antibiotic medications.<sup>42</sup> To effectively combat an emerging epidemic, vaccination, quarantine, and the administration of antiviral medications must be strategically planned for specific segments of the population.<sup>43</sup> Policies related to travel and public health responses to epidemics involve various strategies, including imposing travel restrictions to and from impacted regions and conducting passenger screenings.<sup>8</sup> Closing borders will help countries restrict the entry of infected international travelers, allowing governments and health authorities to concentrate on the health of local populations without overwhelming the healthcare system. This is especially crucial for nations with inadequate public health infrastructure and resources.<sup>44</sup>

### Conclusion

The examination of infectious diseases in the context of travel highlights significant public health challenges and risks associated with the movement of populations. TB, despite a gradual decline in global incidence, remains a critical concern, particularly for travelers moving from low to high incidence countries. The risk of TB transmission on commercial flights, although low, underscores the importance of pre-travel screening and post-travel evaluations for at-risk populations. Influenza is another prevalent infectious disease among travelers, with its rapid spread facilitated by air travel. The high contagion rate and short incubation period of influenza necessitate effective preventive measures, including vaccination and public health guidelines tailored to travelers. The emergence of pandemics, such as SARS, further illustrates the role of international travel in the global dissemination of infectious diseases, emphasizing the need for stringent control measures and rapid response strategies. Vulnerable populations, including children, pregnant women, and individuals with pre-existing medical conditions, require special attention due to their

heightened susceptibility to infections during travel. The enclosed environment of airplanes and airports poses additional risks for disease transmission, necessitating comprehensive travel health assessments and preventive strategies. In conclusion, as global travel continues to expand, understanding the dynamics of infectious disease transmission during travel is essential for developing effective public health interventions. Preventive measures, including vaccination, screening, and public health policies, are crucial in mitigating the risks associated with travel-related infections and protecting both travelers and the communities they return to.

## Highlights

### What Is Already Known?

Traveling, particularly air travel, plays a significant role in the transmission of infectious diseases. Previous studies have established that the movement of people across borders can facilitate the rapid spread of pathogens, leading to outbreaks in new regions. Air travel, due to its speed and global reach, has been identified as a critical factor in the dissemination of diseases such as influenza, SARS, and more recently, COVID-19. Research has highlighted the importance of understanding travel patterns, passenger behavior, and the role of airports as potential hotspots for disease transmission.

### What Does This Study Add?

This study provides an examination of the intricate relationship between air travel and the transmission dynamics of infectious diseases. It highlights the significant increase in global travel and its implications for public health, particularly in the context of emerging infectious diseases. The study underscores how human mobility patterns contribute to the introduction and spread of pathogens in new geographic areas. Moreover, it identifies critical factors influencing the risk of disease transmission during travel. This research also contributes to the existing literature by identifying the unique challenges posed by travel-related infectious diseases.

### Conflict of Interest

There is no conflict of interest to declare.

### Authors' Contributions

All authors had an equal role in writing the article.

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