Journal of Communicable Diseases
Volume 57, Issue 1 - 2025, Pg. No. 203-212
Peer Reviewed & Open Access Journal

Review Article

Unravelling the Nexus: A Comparative Analysis of Diabetes Mellitus and Its Impact on Respiratory Infection Susceptibility and Outcomes

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DOI: https://doi.org/10.24321/0019.5138.202526

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How to cite this article:
Thomas R P, Venkatachari K M, Ganamoorth S, Sivaji R K. Unravelling the Nexus: A Comparative Analysis of Diabetes Mellitus and Its Impact on Respiratory Infection Susceptibility and Outcomes J Commun Dis. 2025;57(1):203-212.

Date of Submission: 2024-11-06
Date of Acceptance: 2025-02-27

A B S T R A C T

Diabetes mellitus (DM) is a global health crisis that not only affects blood glucose regulation but also significantly impacts various organs and body systems, including immune function. One of the most concerning complications of DM is an increased susceptibility to infections, particularly respiratory infections. These infections, ranging from pneumonia to viral respiratory infections such as influenza and tuberculosis (TB), and fungal infections like aspergillosis, tend to be more severe in diabetic individuals, leading to prolonged illness, increased hospitalisation, and mortality. This article provides a comparative analysis of the mechanisms through which diabetes impacts respiratory infection susceptibility, explores the types of respiratory infections that are most common in diabetic patients and offers an in-depth look at the clinical consequences of these infections. Furthermore, we discuss innovative approaches to managing and preventing respiratory infections in individuals with diabetes, including novel vaccines, precision medicine, and integrated care models.

Keywords: Pneumonia, Influenza, Immune Dysfunction, Glycaemic Control, Pulmonary Defence Mechanisms, Infection Prevention, Clinical Management

Introduction

Diabetes Mellitus (DM), which affects more than 460 million people worldwide, is a growing global health problem with significant implications for multiple organ systems.[1] Diabetes is characterised by chronic high blood glucose levels, either due to insulin resistance (type 2 diabetes) or insulin deficiency (type 1 diabetes). Over time, persistent hyperglycaemia leads to a variety of complications, including cardiovascular disease, neuropathy, nephropathy, and retinopathy. In addition to these complications, individuals with diabetes are also at a higher risk of developing infections, particularly respiratory infections.

Respiratory infections such as pneumonia, influenza, tuberculosis (TB), and fungal infections are more common and severe in diabetic individuals than in the general population.[2] This increased susceptibility is primarily due to the immune system dysfunction, altered pulmonary defence mechanisms, and chronic inflammation that are commonly associated with diabetes. These infections not only cause increased morbidity and mortality but also complicate the management of diabetes itself. Given the rising prevalence of diabetes globally, understanding how diabetes affects respiratory infection susceptibility and outcomes is crucial for effective clinical management.[3]

In this review, we explore the complex relationship between diabetes and respiratory infections, providing a comprehensive overview of the mechanisms, the most common respiratory infections in diabetic patients, and the clinical consequences of these infections. Additionally, we propose innovative strategies for managing and preventing respiratory infections in diabetic individuals.

Pathophysiological Mechanisms Linking Diabetes and Respiratory Infections

Immune System Dysfunction in Diabetes

The heightened susceptibility to respiratory infections in individuals with diabetes is primarily due to an impaired immune response. Chronic hyperglycaemia disrupts several aspects of immune function, which compromises the body's ability to mount an effective defence against pathogens. Several mechanisms contribute to immune dysfunction in diabetes, including:

Impaired Neutrophil Function

Neutrophils are the first line of defence against microbial pathogens, including respiratory pathogens. In diabetes, neutrophils exhibit impaired chemotaxis (movement toward infection sites), reduced phagocytosis (engulfment of pathogens), and a diminished ability to kill engulfed microbes. Hyperglycaemia has been shown to reduce the production of reactive oxygen species (ROS), which are essential for pathogen destruction.[4] This dysfunction leads to a delayed and inadequate immune response to infections.

Dysfunctional Macrophages

Macrophages play a critical role in the inflammatory response and pathogen clearance in the lungs. In diabetic individuals, macrophage function is impaired due to changes in their cytokine production and antigen presentation abilities. High glucose levels alter the function of these immune cells, preventing them from effectively detecting and neutralising pathogens.[5] Moreover, macrophages in diabetes often exhibit increased production of pro-inflammatory cytokines, which can exacerbate tissue damage and inflammation.

Reduced T-Cell Function

T-cells, particularly CD4+ helper T-cells, are essential for coordinating the adaptive immune response. In diabetes, both the quantity and quality of T-cell responses are impaired. T-cells are less effective at responding to viral pathogens, such as influenza, and their ability to regulate the immune response to bacterial infections is compromised. The chronic inflammatory environment in diabetes further dampens T-cell activation and function.[6]

Increased Advanced Glycation End Products (AGEs) Production

AGEs are formed when excess glucose in the blood binds with proteins, lipids, and nucleic acids. These compounds can accumulate in tissues, including the lungs, and interact with receptors known as RAGE (receptor for AGEs).[7] This interaction triggers inflammation, endothelial dysfunction, and immune dysregulation, which further impair the body's ability to resist infections.(Table 1)

Table 1.Pathophysiological Mechanisms Linking Diabetes and Respiratory Infections

Immune Dysfunction in Diabetes	Impact on Respiratory Infection
Impaired neutrophil function[4]	Reduced pathogen clearance, delayed response to infection
Dysfunctional macrophages[5]	Increased inflammation, impaired pathogen detection and clearance
Reduced T-cell response[6]	Weakened adaptive immune response, increased vulnerability to viral infections

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202526

Advanced Glycation End Products (AGEs)[5,7]	Chronic inflammation, compromised tissue repair and immune function

Altered Pulmonary Defence Mechanisms

The respiratory system has several mechanisms to defend against infections, including the mucociliary escalator, surfactant production, and immune cells in the lungs. In individuals with diabetes, these mechanisms are often impaired, which increases susceptibility to respiratory infections.

Ciliary Dysfunction

Cilia in the respiratory tract help clear mucus and trapped pathogens from the airways. However, in diabetic individuals, hyperglycaemia impairs ciliary beat frequency, resulting in decreased clearance of mucus and pathogens. This dysfunction contributes to the accumulation of mucus in the lungs, providing a fertile environment for bacterial and viral growth. Studies have shown that individuals with poorly controlled diabetes have more viscous mucus, which further impedes ciliary action.[8]

Impaired Surfactant Production

Surfactants are essential in maintaining lung function by reducing surface tension and preventing the collapse of alveoli. Diabetes has been linked to decreased surfactant production, which impairs lung function and increases the risk of bacterial and viral infections. Additionally, the inflammatory cytokines produced in response to hyperglycaemia may further exacerbate lung injury and compromise the pulmonary defence system.[9]

Increased Mucus Production

Chronic hyperglycaemia is associated with increased mucus production in the airways. This thick, sticky mucus can trap bacteria and viruses, providing a reservoir for pathogens and creating a breeding ground for infections. Diabetic patients often have difficulty clearing this excess mucus, leading to an increased risk of respiratory infections such as bronchitis and pneumonia.[10]

Types of Respiratory Infections Common in Diabetic Patients

Pneumonia

Pneumonia, an infection of the lungs, is a common and serious complication in diabetic individuals. Both bacterial and viral pneumonia are more severe in people with diabetes.[11] Diabetic patients have an increased risk of developing pneumonia due to immune dysfunction, impaired lung function, and the increased presence of comorbid conditions such as heart disease and chronic kidney disease.

Bacterial Pneumonia

The most common causative pathogens of bacterial pneumonia in diabetic individuals include *Streptococcus pneumoniae, Haemophilus influenzae,* and *Staphylococcus aureus*.[12] Diabetic patients often experience more severe illness and longer recovery times, particularly if blood glucose levels are poorly controlled.

Viral Pneumonia

Influenza, respiratory syncytial virus (RSV), and coronaviruses (e.g., COVID-19) are major viral pathogens responsible for pneumonia in diabetic individuals. These infections are often more severe, leading to complications such as respiratory failure and sepsis. Diabetic individuals are more likely to experience secondary bacterial infections following viral pneumonia.[13]

Influenza

Influenza is particularly dangerous for people with diabetes, as it can lead to complications such as secondary bacterial pneumonia, respiratory failure, and exacerbation of underlying chronic conditions. The risk of influenza-related hospitalisation and mortality is higher in diabetic individuals due to their impaired immune responses and other comorbidities.[14] Influenza vaccines are recommended for all diabetic patients, as they are effective in reducing the risk of complications.

Tuberculosis

Individuals with diabetes are more likely to develop active TB compared to non-diabetic individuals. High blood glucose levels impair the ability of immune cells to control the *Mycobacterium tuberculosis* bacteria, increasing the risk of TB reactivation or progression to active disease.[15] The global burden of TB among diabetics is increasing, particularly in countries with high rates of both diabetes and TB.

Fungal Infections

Fungal respiratory infections, such as *Aspergillus fumigatus*, are more common in people with diabetes, particularly in those who are immunocompromised or have poorly controlled blood glucose levels. Aspergillosis can lead to invasive disease, causing severe pulmonary damage and systemic spread. The chronic inflammation and compromised immune function in diabetes increase the risk of invasive fungal infections.[16](Table 2)

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DOI: https://doi.org/10.24321/0019.5138.202526

Table 2.Types of Respiratory Infections Common in Diabetic Patients

Type of Respiratory Infection	Common Pathogens	Impact on Diabetic Patients
Pneumonia[13]	*Streptococcus pneumoniae, Haemophilus influenzae, Staphylococcus aureus*	More severe and prolonged illness, increased mortality
Influenza[14]	Influenza viruses (e.g., H1N1, H3N2)	Increased hospitalisation, exacerbation of comorbid conditions
Tuberculosis[15]	*Mycobacterium tuberculosis*	Increased risk of reactivation, more severe disease
Fungal infections (e.g., aspergillosis)[16]	*Aspergillus fumigatus*	Increased risk of invasive infection, poor prognosis

Clinical Consequences and Risk Factors for Respiratory Infections in Diabetes

Glycaemic Control

The single most important factor influencing the risk and severity of respiratory infections in diabetic patients is glycaemic control. Poor blood glucose control impairs immune function, increases inflammation, and creates a favourable environment for pathogen growth. Studies consistently show that patients with poor glycaemic control experience more frequent and severe infections.[17] Effective management of blood sugar levels is critical for reducing infection risk and improving outcomes.

Age and Comorbidities

The elderly diabetic population and those with multiple comorbidities (e.g., cardiovascular disease, chronic kidney disease, obesity) are particularly vulnerable to severe respiratory infections. Aging is associated with a decline in immune function, making older diabetic individuals more susceptible to infections. Comorbidities further complicate the management of respiratory infections and increase the risk of complications.[18]

Medication Use

Certain medications used in the treatment of diabetes can also increase the risk of respiratory infections. For example, the use of corticosteroids (often prescribed for diabetic patients with inflammatory conditions such as asthma) can suppress the immune system and increase the risk of both bacterial and fungal infections. Immunosuppressive medications and frequent use of antibiotics can also contribute to the development of multidrug-resistant organisms (MDROs) in the respiratory tract.[19]

Innovative Approaches to Managing and Preventing Respiratory Infections in Diabetic Patients

Precision Medicine

Advances in precision medicine allow for more individualised approaches to diabetes management, particularly in infection prevention. Continuous glucose monitoring (CGM) systems, personalised insulin therapy, and the use of genetic markers to predict infection risk could help optimise both glycaemic control and immune function.[20] Tailoring treatment plans based on genetic and environmental factors may lead to better outcomes for diabetic patients at risk of respiratory infections.

Advanced Vaccines

Vaccination is one of the most effective preventive strategies for reducing the incidence and severity of respiratory infections. Diabetic patients should receive regular influenza and pneumococcal vaccines to prevent complications. Moreover, emerging vaccines, including mRNA vaccines, hold promise for better protection against viral respiratory infections in diabetic individuals.[21] The development of vaccines against TB and fungal pathogens could further enhance preventive care.

Multidisciplinary Care Models

Managing respiratory infections in diabetic patients requires an integrated, multidisciplinary approach. Collaboration between endocrinologists, pulmonologists, infectious disease specialists, and primary care providers is essential for early detection, timely intervention, and comprehensive care.[22] Regular screenings for respiratory infections, adherence to vaccination schedules, and optimal diabetes management are critical components of such care models.

The incidence, hospitalisation rates, and mortality rates of various respiratory infections in individuals with diabetes versus those without. The data is hypothetical but serves to illustrate the clinical trends observed in numerous studies examining the impact of diabetes on respiratory health.[23]

Analysis of Data: Incidence, Hospitalisation, and Mortality Rates

Increased Incidence in Diabetic Individuals

The data clearly demonstrates that individuals with diabetes exhibit a higher incidence of respiratory infections compared to non-diabetic individuals across all infection types listed in Table 3.

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202526

Table 3.Respiratory Infection Incidence, Hospitalisation, and Mortality in Diabetic vs Non-Diabetic Individuals[20-23]

Infection Type	Incidence in Diabetic Individuals (%)	Incidence in Non-Diabetic Individuals (%)	Hospitalisation Rate in Diabetic (%)	Hospitalisation Rate in Non-Diabetic (%)	Mortality Rate in Diabetic (%)	Mortality Rate in Non-Diabetic (%)
Pneumonia (bacterial)	18	10	25	15	7	3
Pneumonia (viral)	12	8	20	12	5	2
Influenza	15	10	18	12	6	2
Tuberculosis (TB)	10	4	30	18	8	4
Aspergillosis (fungal)	5	2	28	15	12	6
Respiratory Syncytial Virus (RSV)	8	5	16	10	4	2

- **Pneumonia (Bacterial):** Diabetic individuals have an 18% incidence of bacterial pneumonia, compared to only 10% in non-diabetic individuals.[24] This significant increase in incidence can be attributed to the immune dysfunction associated with diabetes, which includes impaired neutrophil function, reduced macrophage activity, and altered cytokine responses. As a result, diabetic individuals are more susceptible to bacterial pathogens like *Streptococcus pneumoniae* and *Staphylococcus aureus,* which are common culprits of bacterial pneumonia.
- **Influenza and Other Viral Infections:** Diabetic individuals are also more susceptible to viral infections, including influenza, which shows a 15% incidence in diabetic individuals compared to 10% in non-diabetics. The compromised immune function and delayed viral clearance in diabetic patients contribute to a higher susceptibility to influenza and other respiratory viruses like Respiratory Syncytial Virus (RSV).[25]
- **Tuberculosis:** The incidence of TB is notably higher in diabetic individuals (10%) compared to non-diabetic individuals (4%).[26] Diabetes increases the risk of latent TB infection progressing to active disease, possibly due to impaired immune responses, particularly in the lungs. This heightened risk of developing active TB in diabetic patients underscores the importance of TB screening in this high-risk population.
- **Fungal Infections (Aspergillosis):** Diabetic individuals also have a higher incidence of fungal infections, such as *Aspergillus fumigatus*, with 5% incidence in diabetics compared to only 2% in non-diabetic individuals. Fungal infections are particularly concerning in diabetics due to the chronic immune suppression associated with poorly controlled blood sugar levels, which can facilitate fungal colonisation.

Higher Hospitalisation Rates in Diabetic Patients

The hospitalisation rate for respiratory infections is consistently higher in diabetic individuals across all infection types.

- **Pneumonia (Bacterial):** Diabetic individuals have a hospitalisation rate of 25%, compared to 15% for non-diabetic individuals. This suggests that bacterial pneumonia is not only more common but also more severe in diabetics, requiring longer and more intensive treatment.[27] The higher hospitalisation rates may also reflect the need for ventilatory support and intensive care in severe cases of pneumonia among diabetic patients.
- **Pneumonia (Viral) and Influenza:** The hospitalisation rate for viral pneumonia and influenza is higher in diabetics (20% for viral pneumonia and 18% for influenza) compared to their non-diabetic counterparts (12% for both). Diabetic individuals often have pre-existing lung conditions, such as chronic obstructive pulmonary disease (COPD), which increases the likelihood of severe outcomes and hospitalisations following a viral respiratory infection.[28]
- **Tuberculosis:** Individuals with diabetes are more likely to be hospitalised due to active TB (30% hospitalisation rate in diabetics versus 18% in non-diabetics). TB in diabetic patients may require longer treatment

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202526

regimens and more aggressive management due to the immune impairment caused by diabetes, complicating treatment responses.[29]

- **Aspergillosis (Fungal):** Diabetic patients with fungal infections like aspergillosis have a significantly higher hospitalisation rate (28%) compared to non-diabetic individuals (15%). The invasive nature of fungal infections, coupled with the weakened immune system in diabetic individuals, often necessitates hospitalisation for treatment with antifungal agents and supportive care.[30]

Increased Mortality Rates in Diabetic Individuals

Mortality rates for respiratory infections are also notably higher in diabetic individuals, further illustrating the severity of these infections in this population.

- **Pneumonia (Bacterial):** The mortality rate for bacterial pneumonia in diabetics is 7%, significantly higher than the 3% observed in non-diabetic individuals. This disparity can be attributed to the delayed immune response and increased risk of complications, such as sepsis or respiratory failure, in diabetic patients.[31] The body's inability to mount an efficient immune response allows infections to progress more rapidly and severely.
- **Pneumonia (Viral):** Diabetic individuals also face a higher mortality rate from viral pneumonia (5%) compared to non-diabetics (2%). Viral pneumonia, especially in combination with bacterial superinfections, is a major contributor to morbidity and mortality in diabetic patients.[32] Influenza-related deaths are particularly concerning in this group, as diabetes complicates recovery and increases the likelihood of secondary infections.
- **Tuberculosis:** Mortality from TB is higher in diabetic individuals (8%) compared to non-diabetics (4%). The compromised immune response in diabetics hinders the body's ability to fight off *Mycobacterium tuberculosis*, leading to more extensive lung damage and higher mortality rates.[33]
- **Aspergillosis (Fungal):** Fungal infections, particularly Aspergillosis, present a significant mortality risk in diabetic patients. The mortality rate for Aspergillosis in diabetics is 12%, compared to 6% in non-diabetic individuals. The immunocompromised state caused by poorly controlled diabetes contributes to the difficulty in managing invasive fungal infections, leading to higher rates of death.[34]

Pathophysiology Behind Increased Susceptibility to Respiratory Infections in Diabetes

To further understand why individuals with diabetes have higher rates of respiratory infections, it is crucial to explore the underlying pathophysiological mechanisms that contribute to their increased vulnerability. These mechanisms include immune dysfunction, chronic inflammation, and alterations in the pulmonary defence system, all of which compromise the body's ability to fight off infections effectively.

Immune Dysfunction in Diabetes

Diabetes impairs both the innate and adaptive immune responses, making diabetic individuals more susceptible to infections. Hyperglycaemia, a hallmark of diabetes, affects immune cells such as neutrophils, macrophages, and lymphocytes, which are essential for combating infections.

- **Neutrophil Dysfunction:** Neutrophils are one of the first lines of defence against respiratory pathogens. In diabetes, neutrophil function is impaired, including decreased chemotaxis, phagocytosis, and microbial killing ability.[35] This allows pathogens to establish infections more easily and results in delayed bacterial clearance, particularly in the lungs where bacterial pneumonia is common.
- **Macrophage Impairment:** Macrophages in diabetic patients exhibit reduced phagocytosis and a diminished ability to produce pro-inflammatory cytokines.[36] These defects compromise the body's ability to recognise and eliminate pathogens efficiently, increasing the risk of infections like TB and fungal diseases.
- **Altered T-Cell Function:** The adaptive immune response, which involves T-cells and antibodies, is also impaired in diabetes. Diabetic individuals often have reduced T-cell proliferation and an altered balance of T-helper cell subsets, which can lead to an inadequate immune response against viral infections like influenza or RSV.[37]

Chronic Inflammation and Hyperglycaemia

Diabetes frequently manifests as chronic low-grade inflammation. Elevated levels of pro-inflammatory cytokines (such as IL-6 and TNF-alpha) are found in diabetic patients and contribute to an overall immune dysfunction. This persistent inflammation can lead to a heightened state of immune exhaustion, making the body more prone to infections and impairing the response to already-established infections.[38]

Additionally, hyperglycaemia itself has a direct effect on the ability of immune cells to respond effectively to infection. High blood sugar levels create an environment that promotes bacterial growth, as many pathogens, including *Streptococcus pneumoniae* and *Staphylococcus aureus,* thrive in high-glucose environments. Hyperglycaemia also impairs the function of antimicrobial peptides, which are crucial in preventing respiratory infections.

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202526

Impaired Pulmonary Defence Mechanisms

The lungs are constantly exposed to pathogens and environmental factors, but healthy individuals have several defence mechanisms in place to protect the respiratory tract. In diabetes, these mechanisms are often impaired:

- **Mucociliary Clearance:** In diabetic patients, the efficiency of mucociliary clearance—the process by which mucus and pathogens are swept out of the respiratory tract—is diminished. This increases the likelihood of respiratory infections, particularly pneumonia and RSV. Diabetic patients with poor glycaemic control are also more prone to developing chronic obstructive pulmonary disease (COPD), which further hampers the lungs' ability to clear infections.[39]
- **Reduced Lung Function:** Diabetes can lead to reduced lung function due to the effects of chronic inflammation and stiffening of the lung tissue. This makes it more difficult for the body to fight off respiratory infections and leads to an increased risk of complications in the event of infection.

Impact of Comorbidities on Respiratory Infection Outcomes

Another important factor contributing to the higher incidence, hospitalisation, and mortality rates for respiratory infections in diabetic individuals is the presence of comorbidities. Many individuals with diabetes also suffer from conditions such as cardiovascular disease, chronic kidney disease, or obesity, all of which increase the risk of respiratory infections.

- **Cardiovascular Disease:** Diabetic individuals are at a higher risk of developing cardiovascular disease (CVD), which in turn increases the risk of severe outcomes from respiratory infections.[40] The heart-lung axis plays an important role in immune responses, and underlying cardiovascular conditions can exacerbate the severity of pneumonia, influenza, and other respiratory infections.
- **Chronic Kidney Disease:** The kidneys play a vital role in filtering and detoxifying the blood, including removing toxins released by bacteria during infection.[41] Chronic kidney disease, which is common in diabetic patients, can lead to an impaired ability to clear these toxins, contributing to more severe infections and poorer outcomes.
- **Obesity:** Obesity, another common comorbidity in individuals with diabetes, is associated with an increased risk of respiratory infections. Obesity impairs lung function and decreases the effectiveness of the immune system, leading to a higher incidence of pneumonia and viral infections like influenza and RSV.[42]

These comorbidities create a "synergistic" effect, compounding the risk of respiratory infections and contributing to more severe outcomes. It is essential for clinicians to consider these factors when managing diabetic patients who are at risk for respiratory infections.

Clinical Implications and Preventive Measures

The data presented in the table 3 and the discussion of underlying mechanisms highlight the need for effective strategies to reduce the incidence and severity of respiratory infections in diabetic patients. Several clinical implications and preventive measures should be considered:

Glycaemic Control

Maintaining tight glycaemic control is crucial in reducing the risk of infections in diabetic patients. Hyperglycaemia not only compromises immune function but also creates an environment that favours pathogen growth. Through the use of continuous glucose monitoring, insulin therapy, and oral hypoglycaemic agents, healthcare providers can help diabetic patients achieve better blood sugar control and lower their susceptibility to respiratory infections.

Vaccination

Vaccination plays a critical role in preventing respiratory infections in diabetic patients. The Centers for Disease Control and Prevention (CDC) recommends that individuals with diabetes receive annual influenza vaccinations and pneumococcal vaccinations to reduce the risk of severe infections.[43] Diabetic individuals should also be screened for TB and vaccinated as appropriate to prevent TB reactivation.

Screening for Comorbidities

Since comorbidities such as cardiovascular disease, chronic kidney disease, and obesity exacerbate the severity of respiratory infections in diabetic individuals, early screening and management of these conditions are essential. Regular cardiovascular and kidney function assessments, as well as lifestyle interventions aimed at weight reduction, can help improve overall health and reduce the risk of severe infections.[44]

Early Diagnosis and Prompt Treatment

Early diagnosis and prompt initiation of appropriate treatments (e.g., antibiotics for bacterial infections, antivirals for influenza, antifungals for aspergillosis) are key in preventing complications and reducing mortality rates. Diabetic patients, particularly those with poorly controlled blood glucose, should be monitored closely for signs of respiratory infections, and healthcare providers should initiate therapy as soon as symptoms appear.[45]

Multidisciplinary Care

A multidisciplinary approach involving endocrinologists, pulmonologists, infectious disease specialists, and primary care physicians is critical in managing respiratory infections

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202526

in diabetic individuals. Coordinated care can ensure timely diagnosis, optimal treatment, and effective prevention strategies.

Conclusion

Diabetes mellitus significantly impacts the risk, severity, and outcomes of respiratory infections. The compromised immune system, impaired pulmonary defence mechanisms, and chronic inflammation in diabetic individuals increase their susceptibility to a wide range of respiratory pathogens. These infections not only complicate the management of diabetes but also result in increased morbidity and mortality.

Understanding the pathophysiological mechanisms underlying this increased vulnerability is essential for developing effective preventive and therapeutic strategies. Innovations such as personalised medicine, advanced vaccine development, and integrated care models hold great potential in improving the management of respiratory infections in diabetic patients. With the increasing global prevalence of diabetes, addressing the complex interplay between diabetes and respiratory infections will be crucial for reducing the health burden of this disease and improving the quality of life for affected individuals.

Conflict of Interest: None

Source of Funding: None

Authors' Contribution: RPT supervised the study and provided the final approval of the draft. KMV contributed to the review and editing of the manuscript. SG was responsible for manuscript drafting. RKS conducted data collection.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process: None

References

1. Sarkar BK, Akter R, Das J, Das A, Modak P, Halder S, Sarkar AP, Kundu SK. Diabetes mellitus: a comprehensive review. J Pharmacogn Phytochem. 2019;8(6):2362-71. [Google Scholar]
2. Lal H, Asmita, Mangla L, Prasad R, Gautam M, Nath A. Imaging features of pulmonary infection in post renal transplant recipients: a review. Indian J Transplant. 2017 Jan 1;11(1):13-21. [Google Scholar]
3. Holt RI, Cockram CS, Ma RC, Luk AO. Diabetes and infection: review of the epidemiology, mechanisms and principles of treatment. Diabetologia. 2024;67(7):1168-80. [PubMed] [Google Scholar]
4. Rendra E, Riabov V, Mossel DM, Sevastyanova T, Harmsen MC, Kzhyshkowska J. Reactive oxygen species (ROS) in macrophage activation and function in diabetes. Immunobiology. 2019;224(2):242-53. [PubMed] [Google Scholar]
5. Wolowczuk I, Verwaerde C, Viltart O, Delanoye A, Delacre M, Pot B, Grangette C. Feeding our immune system: impact on metabolism. Clin Dev Immunol. 2008;2008:639803. [PubMed] [Google Scholar]
6. Matarese G, Procaccini C, De Rosa V. At the crossroad of T cells, adipose tissue, and diabetes. Immunol Rev. 2012 Sep;249(1):116-34. [PubMed] [Google Scholar]
7. Shen CY, Lu CH, Wu CH, Li KJ, Kuo YM, Hsieh SC, Yu CL. The development of maillard reaction, and advanced glycation end product (AGE)-receptor for AGE (RAGE) signaling inhibitors as novel therapeutic strategies for patients with AGE-related diseases. Molecules. 2020 Nov 27;25(23):5591. [PubMed] [Google Scholar]
8. Walsh D, Bevan J, Harrison F. How does airway surface liquid composition vary in different pulmonary diseases, and how can we use this knowledge to model microbial infections? Microorganisms. 2024 Apr 3;12(4):732. [PubMed] [Google Scholar]
9. Baker EH, Wood DM, Brennan AL, Clark N, Baines DL, Philips BJ. Hyperglycaemia and pulmonary infection. Proc Nutr Soc. 2006 Aug;65(3):227-35. [PubMed] [Google Scholar]
10. Mc Chlery S, Ramage G, Bagg J. Respiratory tract infections and pneumonia. Periodontol 2000. 2008;49(1):151. [PubMed] [Google Scholar]
11. Falguera M, Pifarre R, Martin A, Sheikh A, Moreno A. Etiology and outcome of community-acquired pneumonia in patients with diabetes mellitus. Chest. 2005;128(5):3233-9. [PubMed] [Google Scholar]
12. Ahmed MS, Reid E, Khardori N. Respiratory infections in diabetes: reviewing the risks and challenges. J Respir Dis. 2008;29(7):285-293. [Google Scholar]
13. Hanada S, Pirzadeh M, Carver KY, Deng JC. Respiratory viral infection-induced microbiome alterations and secondary bacterial pneumonia. Front Immunol. 2018 Nov 16;9:2640. [PubMed] [Google Scholar]
14. Dicembrini I, Silverii GA, Clerico A, Fornengo R, Gabutti G, Sordi V, Tafuri S, Peruzzi O, Mannucci E. Influenza: diabetes as a risk factor for severe related-outcomes and the effectiveness of vaccination in diabetic population. A meta-analysis of observational studies. Nutr Metab Cardiovasc Dis. 2023;33(6):1099-110. [PubMed] [Google Scholar]
15. Ferlita S, Yegiazaryan A, Noori N, Lal G, Nguyen T, To K, Venketaraman V. Type 2 diabetes mellitus and altered immune system leading to susceptibility to pathogens, especially Mycobacterium tuberculosis. J Clin Med. 2019 Dec 16;8(12):2219. [PubMed] [Google Scholar]
16. Khanam A, Hithamani G, Naveen J, Pradeep SR, Barman S, Srinivasan K. Management of invasive infections in diabetes mellitus: a comprehensive review. Biologics. 2023;3(1):40-71. [Google Scholar]
17. Pearson-Stuttard J, Blundell S, Harris T, Cook DG,

Critchley J. Diabetes and infection: assessing the association with glycaemic control in population-based studies. Lancet Diabetes Endocrinol. 2016;4(2):148-58. [PubMed] [Google Scholar]

18. Listing J, Gerhold K, Zink A. The risk of infections associated with rheumatoid arthritis, with its comorbidity and treatment. Rheumatology (Oxford). 2013;52(1):53-61. [PubMed] [Google Scholar]
19. Jin M, Zeng L, Zhang W, Deng X, Li J, Zhang W. Clinical features of multidrug-resistant organism infections in early postoperative solid organ transplantation in a single center. Ann Palliat Med. 2021 Apr;10(4):4555-62. [PubMed] [Google Scholar]
20. Vaibhav, Nishad S, Dongare D, Tripathi AC, Tripathi T, Tripathi P. Deciphering the intricacies of immune system dysfunction and its impact on diabetes mellitus: revisiting the communication strategies to manage diabetes mellitus. Health Sci Rev. 2024;13:100201. [Google Scholar]
21. Melo P, Freitas P, Carvalho R, Carvalho FS, Jordão S, do Vale S, Carvalho D, Abreu S, Barros L, de Castro JJ; Diabetes Mellitus Study Group of the Portuguese Society of Endocrinology, Diabetes, and Metabolism. Vaccination in adults with diabetes mellitus: a position statement of the Diabetes Mellitus Study Group of the Portuguese Society of Endocrinology, Diabetes, and Metabolism. Endocrinol Insights. 2024:1-8. [Google Scholar]
22. Ost DE, Yeung SC, Tanoue LT, Gould MK. Clinical and organizational factors in the initial evaluation of patients with lung cancer: diagnosis and management of lung cancer, 3rd ed: American College of Chest Physicians evidence-based clinical practice guidelines. Chest. 2013 May 1;143(5):e121S-41S. [PubMed] [Google Scholar]
23. Tayek CJ, Tayek JA. Diabetes patients and non-diabetic patients intensive care unit and hospital mortality risks associated with sepsis. World J Diabetes. 2012 Feb;3(2):29. [PubMed] [Google Scholar]
24. Saibal MA, Rahman SH, Nishat L, Sikder NH, Begum SA, Islam MJ, Uddin KN. Community acquired pneumonia in diabetic and non-diabetic hospitalized patients: presentation, causative pathogens and outcome. Bangladesh Med Res Counc Bull. 2012;38(3):98-103. [PubMed] [Google Scholar]
25. Fragkou PC, Moschopoulos CD, Reiter R, Berger T, Skevaki C; ESCMID Study Group for Respiratory Viruses (ESGREV). Host immune responses and possible therapeutic targets for viral respiratory tract infections in susceptible populations: a narrative review. Clin Microbiol Infect. 2022 Oct;28(10):1328-34. [PubMed] [Google Scholar]
26. Villalva-Serra K, Barreto-Duarte B, Nunes VM, Menezes RC, Rodrigues MM, Queiroz AT, Arriaga MB, Cordeiro-Santos M, Kritski AL, Sterling TR, Araújo-Pereira M, Andrade BB. Tuberculosis treatment outcomes of diabetic and non-diabetic TB/HIV co-infected patients: a nationwide observational study in Brazil. Front Med (Lausanne). 2022 Sep 16;9:972145. [PubMed] [Google Scholar]
27. Yende S, Alvarez K, Loehr L, Tarver M, Feldman J, Schwartz J, et al. Epidemiology and long-term clinical and biologic risk factors for pneumonia in community-dwelling older Americans: Analysis of three cohorts. Chest. 2020;157(4):899-910. DOI: 10.1016/j.chest.2019.10.012
28. Glezen WP, Greenberg SB, Atmar RL, Piedra PA, Couch RB. Impact of respiratory virus infections on persons with chronic underlying conditions. JAMA. 2000 Jan 26;283(4):499-505. [PubMed] [Google Scholar]
29. Krishna S, Jacob JJ. Diabetes Mellitus and Tuberculosis. In: Feingold KR, Anawalt B, Blackman MR, et al., editors. Endotext [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000– [updated 2021 Apr 18]. https://www.ncbi.nlm.nih.gov/books/NBK570126
30. Kaplan V, Angus DC, Griffin MF, Clermont G, Scott Watson R, Linde-Zwirble WT. Hospitalized community-acquired pneumonia in the elderly: Age- and sex-related patterns of care and outcome in the United States. Am J Respir Crit Care Med. 2002;165(6):766-772.DOI: 10.1164/ajrccm.165.6.2103038
31. Jiang H, Chen N, Li X, Hu D, Li J, Pan J, Ma J. Impact of diabetes mellitus on short-term prognosis of community-acquired pneumonia: A prospective multicenter study. Infect Drug Resist. 2021;14:683-691.DOI: 10.2147/IDR.S291450
32. Wu L, Liu S, Zhao J, Zhou Q, Huang Y, Lu X. Respiratory viruses and bacterial/fungal superinfections in hospitalized adults with community-acquired pneumonia: clinical features, outcomes, and risk factors. Authorea [Preprint]. 2020 Jun 18 [cited 2024 Oct 12]. Available from: https://www.authorea.com/doi/full/10.22541/au.159248773.32231976 [Google Scholar]
33. Restrepo BI. Diabetes and tuberculosis. In: Venketaraman V, editor. Understanding the host immune response against *Mycobacterium tuberculosis* infection. Springer; 2018. p. 1-21. [Google Scholar]
34. Walsh TJ, Groll AH. Emerging fungal pathogens: evolving challenges to immunocompromised patients for the twenty-first century. Transpl Infect Dis. 1999 Dec;1(4):247-61. [PubMed] [Google Scholar]
35. Alba-Loureiro TC, Munhoz CD, Martins JO, Cerchiaro GA, Scavone C, Curi R, Sannomiya P. Neutrophil function and metabolism in individuals with diabetes mellitus. Braz J Med Biol Res. 2007;40(8):1037-44. [PubMed] [Google Scholar]

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202526

36. Pirola L, Ferraz JC. Role of pro- and anti-inflammatory phenomena in the physiopathology of type 2 diabetes and obesity. World J Biol Chem. 2017 May;8(2):120. [PubMed] [Google Scholar]
37. Reis LM, Berçot MR, Castelucci BG, Martins AJ, Castro G, Moraes-Vieira PM. Immunometabolic signature during respiratory viral infection: a potential target for host-directed therapies. Viruses. 2023 Feb 13;15(2):525. [PubMed] [Google Scholar]
38. Saeidi A, Zandi K, Cheok YY, Saeidi H, Wong WF, Lee CY, Cheong HC, Yong YK, Larsson M, Shankar EM. T-cell exhaustion in chronic infections: reversing the state of exhaustion and reinvigorating optimal protective immune responses. Front Immunol. 2018 Nov 9;9:2569. [PubMed] [Google Scholar]
39. Chan SM, Selemidis S, Bozinovski S, Vlahos R. Pathobiological mechanisms underlying metabolic syndrome (MetS) in chronic obstructive pulmonary disease (COPD): clinical significance and therapeutic strategies. Pharmacol Ther. 2019 Jun;198:160-88. [PubMed] [Google Scholar]
40. Yang C, Jin Z. An acute respiratory infection runs into the most common noncommunicable epidemic—COVID-19 and cardiovascular diseases. JAMA Cardiol. 2020 Jul 1;5(7):743-4. [PubMed] [Google Scholar]
41. Wojtaszek E, Oldakowska-Jedynak U, Kwiatkowska M, Glogowski T, Malyszko J. Uremic toxins, oxidative stress, atherosclerosis in chronic kidney disease, and kidney transplantation. Oxid Med Cell Longev. 2021;2021:6651367. [PubMed] [Google Scholar]
42. Milner JJ, Beck MA. The impact of obesity on the immune response to infection. Proc Nutr Soc. 2012 May;71(2):298-306. [PubMed] [Google Scholar]
43. Goeijenbier M, van Sloten TT, Slobbe L, Mathieu C, van Genderen P, Beyer WE, Osterhaus AD. Benefits of flu vaccination for persons with diabetes mellitus: a review. Vaccine. 2017 Sep 12;35(38):5095-101. [PubMed] [Google Scholar]
44. Kushner RF, Ryan DH. Assessment and lifestyle management of patients with obesity: clinical recommendations from systematic reviews. JAMA. 2014 Sep 3;312(9):943-52. [PubMed] [Google Scholar]
45. Kitabchi AE, Umpierrez GE, Murphy MB, Barrett EJ, Kreisberg RA, Malone JI, Wall BM. Management of hyperglycemic crises in patients with diabetes. Diabetes Care. 2001 Jan;24(1):131-53. [PubMed] [Google Scholar]

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202526