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Comprehensive Assessment of the Global Burden and Risk Determinants of Otitis Media

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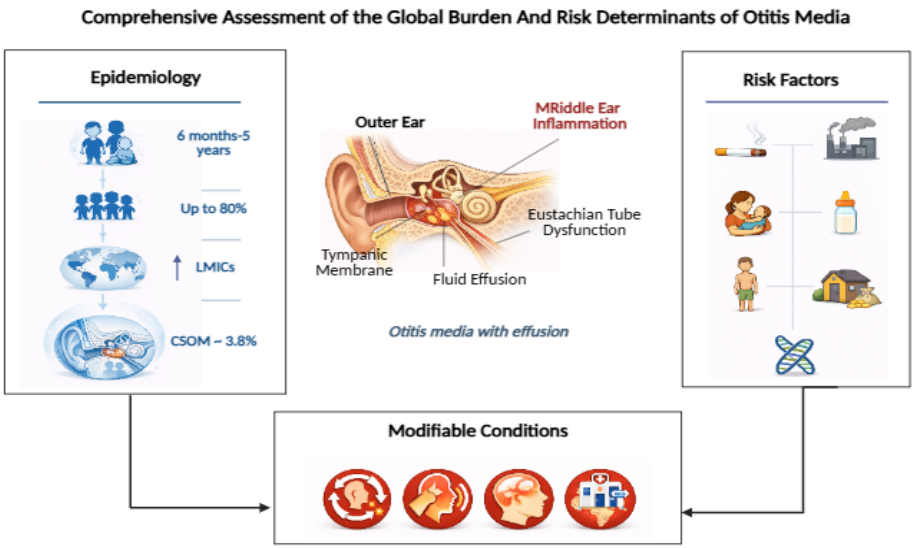
ABSTRACT

Otitis media (OM), a common inflammatory disease of the middle ear mostly affecting kids, is a serious global public health problem. Epidemiological studies indicate that early childhood sees at least one attack in up to 80% of children; the majority of incidents take place between the ages of six months to five years. One of the acute and chronic forms of the disease is Chronic Suppurative Otitis Media (CSOM), which strikes 3.8% of the world population, mostly in low- and middle-income countries. Major risk factors that provoke OM include smoking, weight, breastfeeding, socioeconomic status, genetic factors, and air pollution. Modifiable risk conditions of OM include adenoids, allergies, and craniofacial deformities. Though incidence is geographic, the burden of disease remains highest among underprivileged groups, where overcrowding, unhygienic conditions, and limited access to healthcare drive continuous infection and sequelae.

Keywords: chronic, epidemiology, otitis media (OM), therapeutics, tympanostomy

GRAPHICAL ABSTRACT



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Highlights

- Otitis media represents a major global health burden, disproportionately affecting children in low- and middle-income countries and contributing significantly to preventable hearing loss.
- The disease is multifactorial, with strong influence from immunogenetic factors, environmental exposures (passive smoking, pollution), socioeconomic conditions, nutrition, and allergic or upper airway comorbidities.
- Chronic and recurrent forms of OM lead to long-term complications, including hearing impairment and potential cognitive consequences, underscoring the need for early intervention and comprehensive preventive strategies.

1. INTRODUCTION

Otitis media (OM) is the most widespread pediatric ear infection and the principal cause of hearing impairment amongst children globally. OM is defined by middle ear inflammation and usually presents as acute otitis media (AOM) or otitis media with effusion (OME). AOM is an acute inflammatory process that usually occurs due to viral infections and is clinically characterized by redness and bulging of the tympanic membrane. Non-perforated AOM is related to acute suppurative inflammation and systemic manifestations, such as otalgia, otorrhoea, fever, irritability, anorexia, vomiting, or diarrhea. OME, being a chronic condition, is illustrated by the accumulation of fluid inside the middle-ear space, lacking apparent inflammatory features [1]. The main presentation is conductive hearing impairment caused by compromised transmission of sound through middle-ear effusion (MEE). Recurrent or prolonged OME has negative impacts on language development, behavior, and education. It is extremely common, and approximately 80% of children have at least one attack by ten years of age [2].

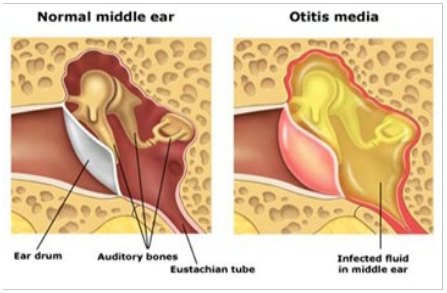
OM is a multifactorial infection shaped by demographic, genetic, and environmental determinants, as well as comorbidities, such as adenoid hypertrophy, cleft palate, eustachian tube dysfunction, allergies, and asthma [3]. MME persistence leads to long-term morbidity and hearing loss of different grades in children and adults. Globally, the rates of complications of childhood OM, both intracranial and extracranial, are quite varied. In industrialized countries, these complications affect about 0.04% to 0.69% of cases, while in developing nations, the complication rate can be as high as 3.2% [4]. The main objective of this study was to estimate the incidence and prevalence of OM from all over the world.

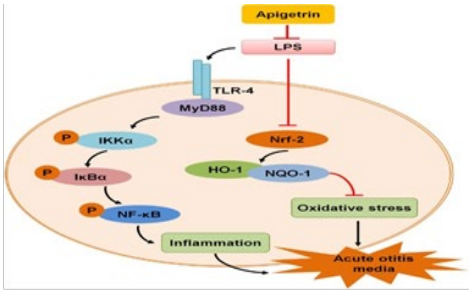
2. OTITIS MEDIA (OM): A PREVALENT INFLAMMATORY CONDITION OF THE MIDDLE EAR

When one has a middle ear infection, the middle ear cavity's lining becomes enlarged and inflamed, and fluid may start accumulating behind the eardrum, or tympanic membrane. Though numerous bacteria, illnesses, infections, and genetics (i.e., Streptococcus pneumoniae, influenza, upper respiratory infection, cleft palate, etc.) may cause OM, the primary cause of a middle ear infection is related to the eustachian tube [5]. Anatomically, the eustachian tube of infants and young children (<1-year-old) is shorter, broader, and more parallel compared to adults. This allows oro-pathogen transmission along the middle ear and a higher risk of OM, with middle ear fluid despite the absence of acute indications of inflammation, fever, or otalgia of the tympanic membrane. It causes a continual or mild conductive hearing loss that fluctuates

[6]. Additionally, otitis externa, also known as "swimmer's ear," is an irritation of the ear canal and outer ear. When this condition is present, touching or tugging the ears causes pain [1]. In conclusion, middle ear infection is followed by high viral respiratory infections. The illness manifests as swelling and inflammation in the back of the throat, particularly in the eustachian tube (Figure 1) [7].

Worldwide, 65–330 million people are suffering from CSOM, with 60 percent of them reporting deafness. The incidence of AOM is maximum between the ages of six and fifteen months. According to old studies, males are somewhat more prone than females to develop this infection, but the latest studies do not support this statement. At least one episode of AOM affects 50 percent to 85 percent of children by the age of three, and the chance of disease development reduces as the child grows older. Western Pacific countries have the highest prevalence (2.5% to 43%), followed by Southeast Asia (0.9% to 7.8%), Africa (0.4% to 4.2%), South and Central America (3%), the Eastern Mediterranean (1.4%), and finally Europe (average prevalence of 0.4%; see Table: 1).





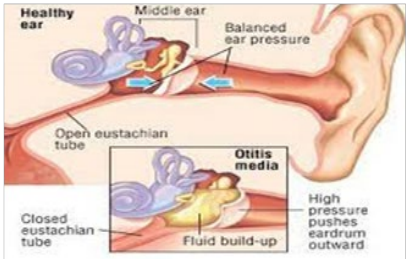


Figure 1. Pathophysiology of Acute Otitis Media

2.1 Otitis Media (OM) and Auditory Function Impairment

OM arises when the eustachian tube channel between the middle ear and the nasopharynx swells or becomes blocked, usually as a result of the common cold. The blockage impedes usual drainage and causes an increase in fluid in the middle ear, providing an excellent setting for bacterial growth and infection. Newborn and young children are especially susceptible since their eustachian tubes are shorter, narrower, in addition to more easily clogged. While the majority of ear infections pass without any subsequent effects, repeated or chronic occurrences may result in severe complications and permanent auditory damage.

3. Global Prevalence

Table 1. Prevalence of Otitis Media (OM) among Children

S. No.	Population	Age (Year)	Sample	Method	Type of OM	Prevalence in Children		References
						n	%	
1	America	3	615	Tympanostomy	AOM (in boys)	324	52.7	[11]
					AOM (in girls)	288	46.8	
2	Bangladesh	4 to 12	4280	Otoscopy	CSOM	241	5.6	[5]
3	Bangladesh	5 to 12	581	Otoscopic Examination	CSOM	61	3.7	[12]
					CSOM boys urban	9	1.8	
					CSOM girls urban	11	2.3	
4	Bangladesh	4 to 9	280	Otoscopic Examination	OME	53	19	[13]
5	Cameron	2 to 3	433	Tympanometry, clinical inspection	CSOM, OME	42	9.7	[6]
					unilateral CSOM	3	0.3	
					bilateral OME	7	1.6	
6	China	3 to 6	3013	Otoscopic Examination. Tympanometry	middle ear effusion	157	5.24	[14]
					OM	295	9.82	
7	China	2 to 8	2941	Tympanometry	OME	125	4.3	[15]
					OME in boys	70	4.7	
					OME in girls	55	3.9	
8	Egypt	<18	2003	Type B tympanogram	OME	310	15.5	[16]
9	Egypt	7 to 10	453	Otoscopy	OME	180	10.8	[3]
10	Fiji	0 to 18	467	Otoscopic Examination	AOM	13	2.78	[17]
					OME	37	7.92	
					COM	19	4.1	
11	India	18 D to 15 Yr	4626	Audiometry, Hearing screening	CSOM	168	3.6	[18]
					OME	93	2	
12	Nepal	5 to 15	1050	Tympanometry	CSOM and OME	139	13.2	[19]
13	Nepal	5 to 12	280 (govt) / 230 (private)	Otoscopic Examination	CSOM	15	5.7	[20]
					CSOM	11	4.8	

S. No.	Population	Age (Year)	Sample	Method	Type of OM	Prevalence in Children		References
						n	%	
14	Nepal	9 to 16	480	Tympanometry	OME (type B)	62	12.9	[21]
					OME	45	15.1	
					OME	17	9.3	
15	Kenya	5 to 18	91	Otoscopy	OME (B)	217	9.4	[22]
16	Korea	<12	806,396	hearing screening	AOM	20,000	121.6	[23]
17	Latin America	6 to 18	1119	Otoscopic Examination	CSOM	10	0.94	[24]
18	Nigeria	0 to 12	600	Otoscopic Examination	AOM	70	11.8	[25]
					CSOM	16	2.8	
					OME	6	1	
19	Nigeria	9 to 15	1500	Tympanometry	CSOM	35	2.3	[26]
					mild conductive hearing loss	20	38.5	
					moderate hearing loss	14	26.9	
21	Nigeria	2 to 5	1135	Otoscopy	CSOM	314	27.7	[27]
22	Tanzania	< 18	5519	otolaryngology	CSOM	79	1.4	[10]
					CSOM (male)	2958	52.4	
23	Turkey	7 to 13	978	Otoscopy	OME	3	0.3	[28]
24	Turkey	7 to 12	423	Otoscopy	OME	68	16.1	[29]
					OME in boys	37	16.1	
					OME in girls	31	16.1	
25	Turkey	7 to 12	1021	Otoscopic Examination	OME	69	6.8	[1]
26	UK	4 to 5	30828	Hearing screening	COME	12,639	41	[30]
27	Western Sicily	5 to 6	2097	Otoscopic Examination	OME	143	6.81	[31]
					OME (Bilateral)	82	3.91	
					OME (Unilateral)	61	2.9	
28	Yemen	6 to 16	686	Otoscopic Examination	CSOM	50	7.4	[28]

2.1.1. Intra-temporal Sequelae. Spontaneous damage of the tympanic membrane (STMP) can take place as a complication of AOM, diverting from the usual course of the disease. The condition is rooted in the overloading of purulent material in the middle ear cavity in the early stage of infection. The resulting pressure is disadvantageous for the tympanic membrane's vascular source, causing ischemia, necrosis, and final perforation. The incidence of AOM complicated by STMP varies between 5% and 30%, and those with a history of perforation have an advanced recurrence hazard in future AOM cases. Inflammation of the bone and mucosal lining of the mastoid air cell system is known as mastoiditis, and it typically develops as a side effect of acute suppurative otitis media. The frequency of infection depends on the virulence of the causative organisms and the immune status of the host. Another potential complication is cholesteatoma, a progressive and destructive lesion affecting the middle ear or mastoid that damages nearby structures. Although uncommon, severe complications occur in approximately 5% of patients with cholesteatomatous chronic otitis media (CCOM) [8].

2.1.2. Intracranial Sequelae of Otitis Media (OM). In addition to being directly caused by OM, these complications may also result from one or more otitic-intratemporal complications, such as mastoiditis, petrositis, or labyrinthitis, or from another suppurative OM issue that occurs inside the cerebral cavity. Pus may be collected between the bone and dura mater in acute and chronic infections of the middle ear and result in an extradural abscess. Pus can also accumulate between the arachnoid and dura, forming a subdural abscess. Leptomeningitis (pia and arachnoid inflammation) and cerebrospinal fluid inflammation can lead to meningitis [9].

2.1.3. Association of Hearing Loss with Cognitive Impairment. Epidemiological findings reflect an association between peripheral hearing loss and cognitive status in adults older than 60. Research in the area has investigated many important questions. These include whether cognitive ability varies between those by means of normal hearing and individuals with untreated or treated hearing impairment; whether the extent of hearing loss is associated with cognitive status in untreated as well as treated people; and whether cognition is weaker in those with untreated hearing loss than in those who have been treated [10]

4. MULTIFACTORIAL DETERMINANTS AND SUSCEPTIBILITY TO OTITIS MEDIA (OM)

The pathogenicity of infectious pathogens, host immunological status, environmental factors, and genetic predisposition all interact in the pathogenesis of OM. Numerous genes and gene variations linked to OM susceptibility have been found in human genetics research and animal models. OM is a contagious disease caused by viral and bacterial infections in an environment where the host's immune system has fought off the infection. Host-related or environmental factors are the main components of the likelihood of causing OM (see Table: 2) [32].

4.1. Immunogenetic and Perinatal Influences

Many epidemiological and clinical studies have determined multiple risk factors linked with OM during the previous two decades across different populations worldwide. Recent research in Finland showed that the changed frequency of surfactant protein A, a part of innate immunity, was remarkably linked with vulnerability to recurrent otitis media (ROM), highlighting the immunogenetic basis of the disease

[33]. Likewise, perinatal aspects—including gender, gestational age, and birth weight—were inspected in a Dutch cohort, where these early-life variables induced the probability of evolving chronic otitis media through effusion (COME), [6]. The family history of OM is a necessary risk variable for OM, indicating that heredity remarkably influences OM risk [34]. According to approximation, a positive family history of OM may increase the chance of OM to an extent that is proportional to subjection to passive smoking or childcare in large groups of children.

4.2. Environmental Exposures

Numerous epidemiological studies show that MMEs and OM are more common in winter and less common in summer in both hemispheres. The rise in children's attendance at daycare over the past three decades has been by far the biggest environmental element contributing to the "mini-epidemic" of OM and OME; one in five full-time daycare children may have ventilation tubes in place [35]. Environmental exposures, such as passive smoking, have also been consistently implicated. A Turkish follow-up study stated that toddlers who were exposed to secondhand smoke had a higher chance of persistent or recurrent OM with effusion.

4.3. Socioeconomic and Demographic Determinants

A case control study conducted in Nigeria demonstrated the effect of allergies, inside cooking smoke, lower socioeconomic status, and daycare use as significant predictors of chronic OM, screening a clear relationship between environmental exposures and their social determinants [36]. Furthermore, analysis from Louisville, United States found that allergic rhinitis, snoring, and chronic obstruction of nasal airflow were associated with a higher rate of tympanostomy tube insertion, demonstrating the implication of upper airway disease regarding recurrent OM [37]. A large case-control study from Korea with over 16,000 members found that the collision of low socioeconomic status, smoking, and crowding in the household were also significant risk factors for long-term OM and OME [4]. Finally, an extensive case-control study in Indonesia found that poor nutrition, household fire exposure, and family history of OM were linked with a greater risk of AOM in children aged five to twelve. This demonstrates how environmental, hereditary, and social determinants continue to shape the global load of disease [3].

4.4. Nutritional and Metabolic Factors

Nutritional influences were also evident. A Nigerian study found low serum retinol levels associated with CSOM, suggesting that vitamin A deficiency may prolong otorrhea and impair epithelial recovery [9]. About 13.7 million children under five suffer from severe acute malnutrition (SAM), a severe nutritional disorder that is primarily found in low- and middle-income areas of the world. Nutritional deficits raise the risk of OM infection by impairing immunity and mucosal barriers [38].

4.5. Allergic and Upper Airway Comorbidities

The nose and middle ear are connected parts of a system known as the rhinopharyngotubal unit or the "unified airspace". Research on the etiology of OM has exposed connections among allergic responses, infection, and ET dysfunction. The research on the combined role of atopy and upper respiratory tract infection (URTI) in the onset and/or maintenance of middle ear effusion further supported the association between OM and nasal allergies.

Table 2. Global Multifactorial Risk Factors Associated with Otitis Media (OM)

S.N	Risk factors	Sample Size	Study Period	Types of OM	Age of Participants	Study Type	Population	Diagnostic Criteria	Ref
1	Surfactant protein A frequency	375	2001	ROM	1-10years	Case-control	Finland	At least 5 episodes of AOM	[42]
2	Gender, gestational period, and weight at birth	83	2001	COME	2 Years	prospective cohort	Nether-land	Otoscopy and Tym-panometry	[43]
3	Passive smoking	154	1996-1998	ROM	3-8 years	Follow-up	Turkey, Istanbul	OME persisted for ≥ months, bilateral	[44]
4	Pharyngeal reflux, gastroesophageal reflux	37	2004	COME	3-7 years	Prospective cohort	Turkey, Konya	COME> 3 months	[45]
5	Passive smoking, daycare centers	616	1992-2001	COME/ROM	not men-tioned	Retrospec-tive cohort	America, Minnesota	Tympanostomy tube surgery for COME/ROM	[32]
6	Daycare attendees, Breastfeeding, snoring, Passive smoking, presence of siblings	90	1999-2003	ROM	2.1 to 7.5 years	Prospective cohort	Nether-land	MEE for at least 3 months	[46]
7	Breastfeeding	359	1988-19994	ROM	6-72 months	Prospective cohort	America	>3 Episodes of OM	[47]
8	Allergy, Indoor cooking, URTI, Low social status, attending daycare cen-ters, breastfeeding	289	2007	COME	30 days to 14 years	Case-control	Nigeria	> 3 episodes of OM in 1 year	[48]
9	Allergy, Snoring, Chronic nasal ob-struction	16321	1999-2004	ROM	5-7 years	Retrospec-tive	America, Louisville	Insertion of Tym-panostomy tubes and history of ROM	[37]
10	Serum retinol level	168	2009	CSOM	7.8 Years	follow-up	Ibadan, Nigeria	persistence of Otor-rhea ≥ 3 months	[49]
11	Properdin deficiency associated with recurrent otitis media and pneumo-nia, and identification of a male car-rier with Klinefelter syndrome	25	2009	ROM	All ages from 3 gen-erations	Retrospec-tive	Denmark	Several episodes of OM	[50]
12	Family History of COM, Gender, race, poor education of mother, breastfeeding	236	1996-2008	CSOM	11-15 years	Follow-up	Green-land, Si-simiut	≥2 weeks of Otor-rhea for less than 3 months	[51]

S.N	Risk factors	Sample Size	Study Period	Types of OM	Age of Participants	Study Type	Population	Diagnostic Criteria	Ref
13	Nutritional factors	149	2007	CSOM	0.9-15 years	Case-control study	Sanaa, Yemen	Diagnosis of CSOM and a history of persistent discharge for at least 2 weeks	[52]
14	Allergy	252	2017	CSOM	10-50 years	Retrospective Cohort	Iran, Mashad	CSOM has been diagnosed for at least 1 year	[53]
15	Age, poor high-genic condition, URTI, bacterial pathogens	378	2006 2007	AOM, COM, OME	<5 years	follow-up	Nigeria	examination by ENT	[54]
16	Macrolide resistance of Streptococcus pneumoniae	317	2009-2011	COM.AOM	6 months to 75 years	case-control	Egypt	examination by ENT	[55]
17	presence of older siblings, the introduction of other milk products at ≤4 months, allergies, and attending day-care centers	2280	2014	ROM	3 years	cohort study	western Australia	Otoscopic Examination	[56]
18	poor socioeconomic status, smoking, no. of household members, age, gender	16063	2015	COM, OME	> 20 years	Case-control	Korea	examination by ENT	[57]
19	Exposure to wood smoke and charcoal, persistent rhinitis, personal history of AOM, and poor socioeconomic status	2080	2011	AOM	0 to 5 years	cross-sectional	Northeast Parakou, Benin	Otoscopy	[58]
20	respiratory infection, exposure to pathogens, nasal obstruction	776	2011-2013	COME	3 to 4 years	Case-control	Auckland, New Zealand	Tympanometry	[59]
21	Gender, allergy. Passive smoking, prematurity	215	2008	SOM	<12 years	Retrospective cohort	France	Otoscopy	[60]
22	age, gender, size of cleft palate	84	2013-2018	OME	mean age 11 months	prospective cohort study	Nigeria	Tympanometry	[61]
23	Allergic rhinitis, bottle-feeding, pacifier use, adenoid hypertrophy, working mother	625	2020	AOM, COM,OME	6 months to 7 years	case-control, cross-sectional	Iran	Otoscopy, Tympanometry	[62]
24	family history of OM, poor nutritional status, household fire use	3574	2021	AOM	8-9 years	case-control	Indonesia	Otoscopic examination	[63]

In actuality, the allergic population's relative risk for OM rises 271 times when URTI is present. According to the World Health Organization (WHO), URTIs are responsible for 20% of annual deaths among children under 6 years of age, and for 13,000 hospitalizations [39].

4.6. Microbial and Antimicrobial Factors

Antimicrobial resistance plays a growing role; macrolide-resistant Streptococcus pneumoniae strains have been isolated from OM patients in Egypt, complicating therapeutic outcomes [17]. Studies from Nigeria further indicated that poor hygiene, upper respiratory tract infections, and bacterial pathogens were major causes of AOM, COM, and OME among children under five years [40]. More recent cross-sectional findings from Iran identified allergic rhinitis, bottle-feeding, pacifier use, adenoid hypertrophy, and maternal employment as important factors predisposing to OM [41].

5. CONCLUSION

Otitis media (OM) remains one of the most prevalent and consequential inflammatory diseases of the middle ear, particularly affecting children during critical stages of auditory and cognitive development. This comprehensive assessment demonstrates that the global burden of OM is substantial and unevenly distributed, with the highest prevalence and complication rates observed in low- and middle-income countries. The findings highlight that OM is not a single-cause condition but a multifactorial disorder driven by a complex interaction of immunogenetic susceptibility, environmental exposures, socioeconomic disadvantage, nutritional deficiencies, and comorbid upper airway and allergic conditions.

Evidence synthesized from diverse geographical regions indicates that modifiable risk factors such as passive smoking, daycare attendance, poor hygiene, malnutrition, and delayed access to healthcare play a decisive role in disease persistence and progression to chronic and suppurative forms. Additionally, recurrent and chronic OM contributes significantly to conductive hearing loss, which may extend its impact beyond auditory impairment to cognitive and educational outcomes, particularly when diagnosis and intervention are delayed. The increasing challenge of antimicrobial resistance further complicates disease management, emphasizing the need for rational antibiotic use and preventive strategies.

Overall, this review underscores the necessity for integrated public health approaches that combine early detection, improved living conditions, nutritional support, vaccination coverage, and awareness of genetic and environmental susceptibility. Addressing these determinants holistically is essential to reduce the long-term health, social, and economic consequences of otitis media and to mitigate global inequities in ear and hearing health.

Author Contribution

Sadia Zubair: data curation, formal analysis, writing – original draft. **Tasleem Kausar:** conceptualization, supervision. **Taskeen Aslam:** writing – original draft. **Eman Javed:** writing – original draft. **Musfira Maryam:** writing – original draft. **Maryam Ahsan:** writing – review & editing. **Uzma Ijaz:** writing – review & editing. **Amina Naz:** visualization & literature search

Conflict of Interest

The authors of the manuscript have no financial or non-financial conflict of interest in the subject matter or materials discussed in this manuscript.

Data Availability Statement

Data supporting the findings of this study will be made available by the corresponding author upon request.

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