

# COMPARATIVE EFFICACY AND SAFETY OF TOPICAL AND ORAL ANTIFUNGAL AGENTS IN THE TREATMENT OF TINEA CAPITIS: A SYSTEMATIC REVIEW

## **Abstract**

Ringworm is a common fungal skin infection, especially in warm, humid areas. This study examines its causes, symptoms, types, and treatments, highlighting factors like poor hygiene and weak immunity. It reviews diagnostic methods and compares antifungal treatments, noting challenges like drug resistance. High-risk groups include children and athletes. The study stresses the psychological impact of the infection and the importance of prevention through hygiene and awareness. It also explores new treatments like laser therapy and AI tools. The study recommends stronger public health efforts and better access to affordable care.

**Key words:-** Ringworm,  
Dermatophyte Infections,  
Antifungal Treatment, Diagnostic  
Methods, Epidemiology, Prevention  
Strategies

## **Introduction**

Ringworm is a fungal infection affecting the skin, scalp, and nails, not caused by a worm as the name implies. The fungi responsible, called dermatophytes, thrive in warm and damp conditions (CDC, 2020). This infection spreads easily through contact with infected individuals, animals, or contaminated objects (World Health Organization [WHO], 2022). Although treatment is typically effective, ringworm often recurs, posing a significant health issue globally, especially in hot, humid regions (Hay et al., 2017). Several factors contribute to ringworm, including environmental conditions, personal hygiene, and health issues like a weakened immune system or chronic diseases such as diabetes (Gupta et al., 2018). Ringworm can manifest in different forms: athlete's foot (tinea pedis) on the feet, scalp ringworm (tinea capitis), and nail fungus (tinea unguium). Each type exhibits distinct symptoms and requires specific treatments (Ely et al., 2014). This examination delves into the causes of ringworm, the variations among its types, and the effectiveness of different diagnostic and treatment approaches. It also highlights the growing challenge of antifungal resistance (Robbins et al., 2021), the psychological and social impacts of the infection (Havlickova et al., 2008), and recent advancements in treatment options (Zhan & Liu, 2019). Lastly, it emphasizes crucial prevention strategies and offers recommendations for improved disease management and public health education (WHO, 2022).

Ringworm is an infection caused by dermatophyte fungi that thrive in warm and humid environments. These fungi feed on keratin, a protein in our skin, hair, and nails (Ameen, 2010). Several factors contribute to the spread and severity of ringworm. Environmental conditions are a major factor. Hot and humid climates create ideal conditions for fungal growth. Studies indicate that ringworm is more common in warm regions compared to colder areas (Borman et al., 2016). Shared items such as gym equipment, towels, and clothing can harbor fungi, aiding in their spread (Robbins et al., 2011). Places with close human contact, like schools, dormitories, and public swimming pools, also increase infection risk due to frequent exposure to contaminated surfaces and infected individuals (Seebacher et al., 2008).

Health-related factors significantly impact susceptibility to ringworm. Individuals with weakened immune systems, such as those undergoing chemotherapy, organ transplant recipients, or people with HIV, have a harder time fighting off infections (Kauffman et al., 2011). Chronic diseases like diabetes elevate risk because high blood sugar levels favor fungal growth and impair the immune response (Pfaller & Diekema, 2010). Age is also a crucial factor. Children aged 2 to 10 are particularly prone to scalp ringworm, while adult men show a higher prevalence of other types (Fuller et al., 2003). In contrast, the elderly tend to have a lower incidence of ringworm, likely due to changes in skin composition and reduced exposure to common sources of infection (Weitzman & Summerbell, 1995).

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Behavior and lifestyle factors further contribute to the spread of ringworm. Poor personal hygiene, including infrequent washing and improper drying of the skin, increases the likelihood of infection (Crawford et al., 2002). Sharing personal items such as towels, combs, or footwear with an infected person can also spread ringworm (Ameen, 2010). Wearing closed shoes, especially non-breathable ones, creates a moist environment conducive to fungal growth. This explains why athlete's foot is common among those who wear such shoes for long periods, like athletes and military personnel (Ghannoum et al., 2010). Additionally, contact with infected animals, such as cats and dogs, poses a risk, as they can carry fungi and transmit the infection to humans (Moriello & DeBoer, 2012).

Understanding the causes and risk factors of ringworm is vital for prevention. Public health initiatives should emphasize hygiene practices, reducing exposure to contaminated environments, and promoting early diagnosis and treatment (Borman et al., 2016). By addressing both environmental and individual risk factors, we can reduce the spread of ringworm and enhance skin health.

## Types of Ringworm and Their Characteristics

Ringworm shows up differently depending on where it is on the body, each type having specific symptoms. These types are named based on where they occur, how severe the symptoms are, and how they respond to treatment. Common ones include tinea pedis (athlete's foot), tinea unguium (nail infection), tinea capitis (scalp infection), tinea corporis (body infection), and tinea cruris (jock itch). Understanding these types is crucial for accurate diagnosis and treatment (Ameen, 2010).

Tinea pedis, or athlete's foot, is the most frequent. It affects people who wear closed shoes for long periods, like athletes. Symptoms include itching, burning, and peeling skin on the soles and between the toes. Severe cases may lead to cracks and blisters, increasing the risk of bacterial infections. The warm, moist environment inside shoes helps the fungus grow, making prevention and treatment challenging (Crawford et al., 2002).

Tinea unguium, also known as onychomycosis, infects nails, mainly toenails, causing discoloration, thickening, and brittleness. As it progresses, the nail may deform or detach from the nail bed. This type is difficult to treat and often requires long-term oral medication or laser treatment (Ghannoum et al., 2010).

Tinea capitis is a contagious infection of the scalp, mostly affecting kids aged two to ten. It causes scaly patches, hair loss, and painful bumps called kerions. It spreads through contact with infected individuals, shared combs, or contaminated items. Treatment usually involves oral medications along with topical applications (Fuller et al., 2003).

Tinea corporis, or body ringworm, appears as red, round, scaly patches with raised edges and a clear center. It can occur anywhere on the body and spreads through contact with infected people, animals, or objects. Without treatment, patches can grow and cause discomfort. Topical antifungal creams are effective, though severe cases might need oral medication (Seebacher et al., 2008).

Tinea cruris, commonly known as jock itch, affects the groin, inner thighs, and buttocks, primarily in men. It presents as an itchy, red rash with a clear border, worsening in warm conditions. Factors like sweating, tight clothing, and physical activity contribute to its development. Maintaining hygiene and using antifungal treatments are essential for managing it (Weitzman & Summerbell, 1995).

Each type of ringworm varies in how common it is, its symptoms, and how it responds to treatment. Factors like age, lifestyle, and health affect susceptibility. Understanding each type helps healthcare providers select effective treatments and prevention strategies to reduce spread and recurrence (Borman et al., 2016).

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**Tinea Corporis**



**Tinea Unguium**



**Tinea Pedis**



**Tinea Capitis**

Figure 1. The most common dermatophyte infections affecting nails, body, feet, and scalp

### Diagnostic Methods

Accurate diagnosis of ringworm is vital for effective treatment and to prevent its spread. Various methods, from skin examinations to advanced lab tests, help distinguish ringworm from similar conditions like eczema or psoriasis. The first diagnostic step involves a doctor examining the skin for round, scaly patches, redness, and itching. A raised border with a clearer center is a typical sign. For scalp infections, known as tinea capitis, hair loss and scaling are checked. This initial assessment often requires further lab tests for confirmation (Fuller et al., 2003).

Microscopic diagnosis is a common lab technique involving the collection of skin, nail, or hair samples from the infected area. These samples are treated with potassium hydroxide (KOH), which dissolves keratin, making fungal elements like hyphae and spores visible under a microscope. This method is quick and cost-effective but doesn't specify the fungus type (Crawford et al., 2002).

To identify the specific fungus, a fungal culture is conducted. The sample is placed on a growth medium, such as Sabouraud dextrose agar, and incubated. After several days to weeks, fungal colonies develop, allowing identification based on their characteristics. While accurate, this method takes time, limiting its use in urgent situations (Kauffman et al., 2011).

The Wood's lamp examination is another useful method for certain ringworm types like tinea capitis. Under ultraviolet (UV) light from a Wood's lamp, some fungi, like *Microsporum canis*, fluoresce bright greenish-yellow. This test is quick and non-invasive but doesn't detect all fungi (Moriello & DeBoer, 2012).

Advancements in technology have introduced molecular diagnostic techniques like polymerase chain reaction (PCR). These methods detect fungal DNA with high accuracy and provide faster results than traditional cultures. PCR tests are particularly useful for early detection, crucial in settings like schools or hospitals, but their high cost and limited availability restrict routine use (Ghannoum et al., 2010).

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Each diagnostic method has its advantages and limitations. Clinical exams and KOH microscopy offer quick initial results, whereas fungal cultures and molecular techniques provide precise identification of the fungus. The choice of method depends on infection severity, the need for specific identification, and available healthcare resources. Often, combining multiple methods ensures an accurate diagnosis and effective treatment (Seebacher et al., 2008).

## Treatment Options and Challenges

Treating ringworm involves using antifungal creams or pills, depending on how severe the infection is and where it's located. Over-the-counter creams often work for many, but tougher or more widespread infections might need prescription medicines. Challenges like fungal resistance, side effects, and not following treatment instructions can complicate recovery (Thomas et al., 2010).

For mild infections on the skin, such as athlete's foot or body ringworm, antifungal creams like clotrimazole, terbinafine, miconazole, and ketoconazole are commonly used. These creams stop the fungus from growing, eventually killing it. To fully clear the infection, you need to apply them consistently for two to four weeks (Elewski et al., 2014). More serious infections, like those on the scalp or nails, usually require antifungal pills such as terbinafine, itraconazole, or fluconazole, which can reach areas creams can't. However, these pills may cause side effects like stomach issues, liver problems, and allergic reactions, so careful monitoring is needed, especially for people with other health conditions (Gupta & Cooper, 2008).

A significant problem in treating ringworm is when the fungus becomes resistant to medication, often due to improper usage or stopping treatment too early. This resistance makes usual treatments less effective, necessitating the search for new therapies. Researchers are continuously working on finding new antifungal drugs and better treatment methods (Cowen et al., 2015). Another issue is that patients might stop treatment once they feel better, not realizing the fungus could still be present. Stopping too soon can lead to the infection returning and being harder to treat. It's crucial to finish the full course of medication to completely eliminate the fungus and prevent resistance (Rex et al., 2000).

New methods like laser therapy and genetic research are also being explored. Laser therapy uses light to kill the fungus and shows promise, especially for nail infections (Watanabe et al., 2018). Genetic studies are looking at ways to change fungal behavior to improve treatment options (Perfect, 2017). Access to affordable antifungal treatments is another challenge, particularly in low-income areas where ringworm is more common. Ensuring that everyone can afford effective treatment is essential to controlling the disease. Public health initiatives, education campaigns, and improved healthcare infrastructure can help address these issues (Hay et al., 2015).

Hence, progress has been made in treating ringworm, but challenges like resistance, adherence to treatment, and access to affordable care remain. More research, better strategies, and increased public awareness are needed to overcome these obstacles and improve ringworm management.

## Epidemiology of Ringworm

Ringworm is a common fungal skin infection that affects people of all ages and backgrounds. Its prevalence is influenced by climate, individual vulnerability, and hygiene practices. Warm and humid climates typically experience higher rates of ringworm, whereas colder and drier regions see fewer cases (Havlickova et al., 2008). This relationship between climate and ringworm prevalence is illustrated in Fig. 2.

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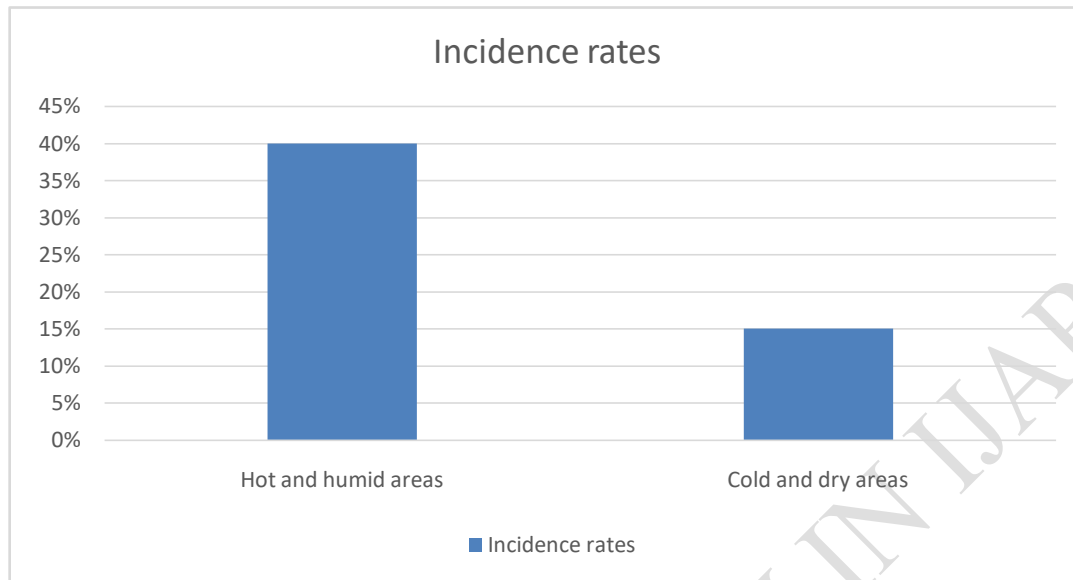


Figure. 2 The fungi that cause ringworm are more prevalent in warm and humid places compared to cold places

Certain demographics are more susceptible to ringworm due to specific risk factors. Age is a significant determinant, with children aged 2 to 10 being particularly vulnerable to scalp ringworm (tinea capitis). This is often due to close contact in schools and daycares and their developing immune systems (Fuller et al., 2003). In adults, men are more prone to ringworm than women, especially athlete's foot (tinea pedis), common among those who wear closed shoes for extended periods. Older adults have lower infection rates, likely due to reduced exposure and habits that limit fungal transmission (Weitzman & Summerbell, 1995).

Underlying health conditions also play a role in ringworm risk. Those with weakened immune systems, such as individuals with diabetes or immune disorders, are at greater risk and may experience more severe symptoms (Kauffman et al., 2011). Fig. 3 demonstrates that immunocompromised individuals face higher susceptibility, underscoring the need for targeted prevention and treatment strategies. Occupational and lifestyle factors are also important. Athletes in contact sports, like wrestling, face higher risks due to frequent skin contact and shared equipment.

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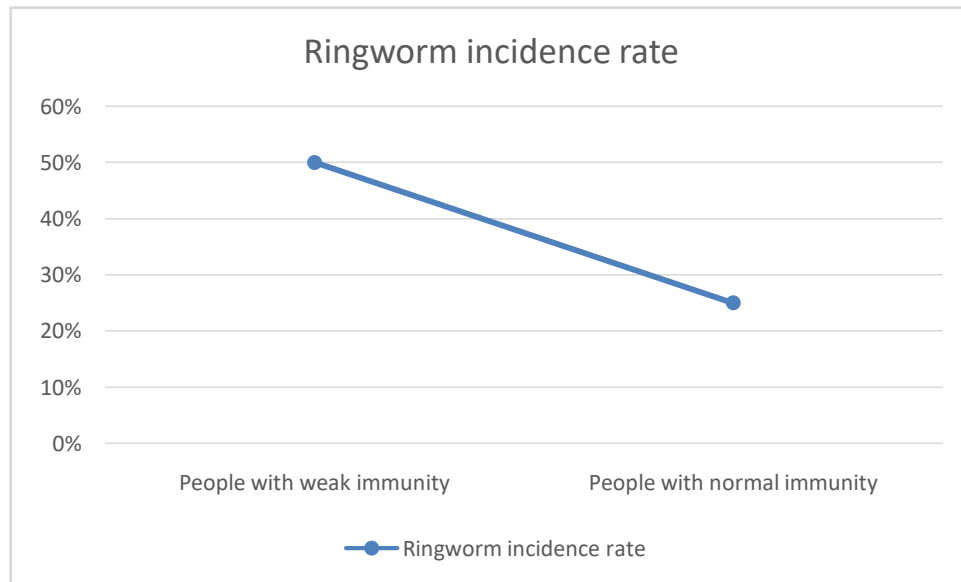


Figure 3. People with weak immunity or chronic diseases such as diabetes are more susceptible to ringworm than healthy people who do not suffer from any chronic diseases.

Figure 4 shows that athlete's foot is the most prevalent form of ringworm, affecting not only athletes but also those wearing non-breathable footwear (Crawford et al., 2002). Workers in humid environments, such as farms or factories, are at increased risk due to moisture that encourages fungal growth (Seebacher et al., 2008).

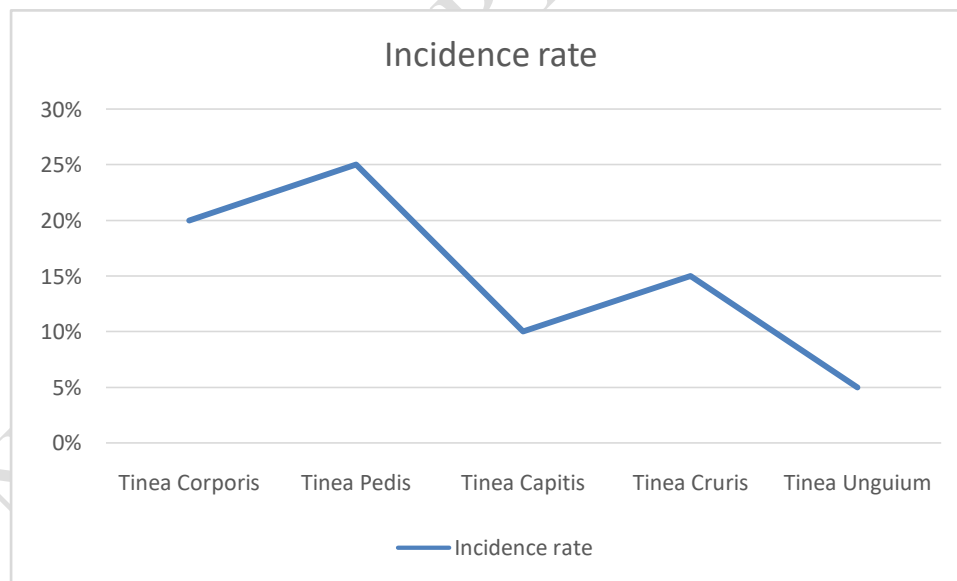


Figure. 4 Athlete's foot is the most common type of ringworm, especially among athletes and people who wear closed shoes for long periods.

Ringworm spreads easily through direct contact with infected individuals, animals, or contaminated surfaces. Pets and livestock can transmit the infection, emphasizing the importance of hygiene among pet owners, veterinarians, and animal workers (Moriello & DeBoer, 2012). Socio-economic factors further influence ringworm rates. Limited

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access to healthcare, crowded living conditions, and inadequate hygiene practices increase the risk in low-income areas. Without proper medical care, ringworm may remain untreated, leading to ongoing transmission and recurrence (Hay et al., 2015).

Understanding how ringworm spreads is crucial for developing effective public health strategies. Focus should be on education, prevention, and affordable treatment, especially for high-risk groups. By addressing environmental, demographic, and health-related factors, the burden of ringworm on vulnerable communities can be reduced (Borman et al., 2016).

## Psychological and Social Impact of Ringworm

Ringworm is a common fungal skin infection that affects people of all ages and backgrounds. Its prevalence is influenced by climate, individual vulnerability, and hygiene practices. Warm and humid climates typically experience higher rates of ringworm, whereas colder and drier regions see fewer cases. This relationship between climate and ringworm prevalence is illustrated in Fig.2 (Seebacher et al., 2008). Certain demographics are more susceptible to ringworm due to specific risk factors. Age is a significant determinant, with children aged 2 to 10 being particularly vulnerable to scalp ringworm (tinea capitis) (Fig 5). This is often due to close contact in schools and daycares and their developing immune systems (Fuller et al., 2003). In adults, men are more prone to ringworm than women, especially athlete's foot (tinea pedis), common among those who wear closed shoes for extended periods. Older adults have lower infection rates, likely due to reduced exposure and habits that limit fungal transmission (Weitzman & Summerbell, 1995).

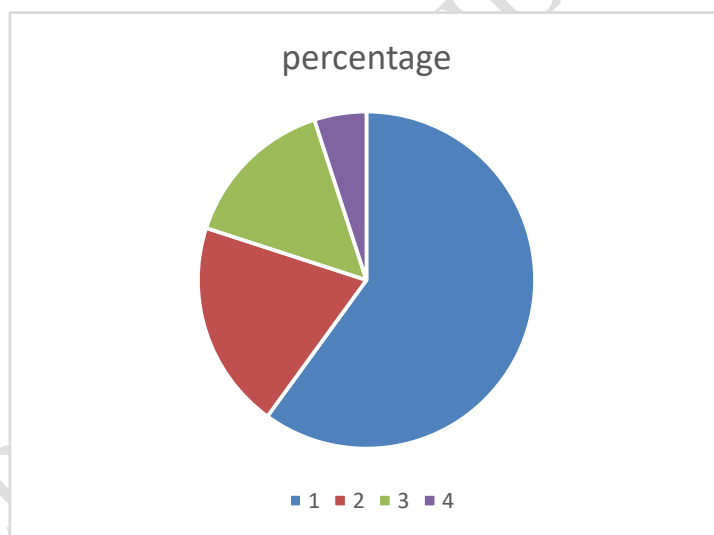


Figure. 5 The effect of age on the incidence of ringworm indicates that children aged 2-10 are more susceptible to ringworm, especially tinea capitis, and adult men are more susceptible than women to ringworm. As for the elderly, the incidence of ringworm is low.

Underlying health conditions also play a role in ringworm risk. Those with weakened immune systems, such as individuals with diabetes or immune disorders, are at greater risk and may experience more severe symptoms. Occupational and lifestyle factors are also important. Athletes in contact sports, like wrestling, face higher risks due to frequent skin contact and shared equipment. Figure 3 shows that athlete's foot is the most prevalent form of ringworm, affecting not only athletes but also those wearing non-breathable footwear (Crawford et al., 2002). Workers in humid environments, such as farms or factories, are at increased risk due to moisture that encourages fungal growth (Havlickova et al., 2008).

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### Prevention Strategies

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Underlying health conditions also play a role in ringworm risk. Those with weakened immune systems, such as individuals with diabetes or immune disorders, are at greater risk and may experience more severe symptoms. Figure 2 demonstrates that immunocompromised individuals face higher susceptibility, underscoring the need for targeted prevention and treatment strategies (Kauffman et al., 2011). Occupational and lifestyle factors are also important. Athletes in contact sports, like wrestling, face higher risks due to frequent skin contact and shared equipment. Figure 3 shows that athlete's foot is the most prevalent form of ringworm, affecting not only athletes but also those wearing non-breathable footwear (Crawford et al., 2002). Workers in humid environments, such as farms or factories, are at increased risk due to moisture that encourages fungal growth (Havlickova et al., 2008).

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Understanding how ringworm spreads is crucial for developing effective public health strategies. Focus should be on education, prevention, and affordable treatment, especially for high-risk groups. By addressing environmental, demographic, and health-related factors, the burden of ringworm on vulnerable communities can be reduced (Borman et al., 2016).

### Recent Advances in Diagnosis and Treatment

Recent advancements in ringworm diagnosis and treatment have made it easier to catch infections early and treat them effectively. Traditional methods, like examining skin samples under a microscope or growing fungi in a lab, have been improved with modern techniques such as molecular tests and imaging, resulting in faster and more precise identification of the fungi causing the infection (Borman et al., 2016). New antifungal medicines and drug combinations have also enhanced treatment, particularly for drug-resistant or recurring infections (Gupta et al., 2018).



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A significant breakthrough in diagnosis is the use of polymerase chain reaction (PCR) tests to detect fungal DNA. Unlike older methods that can take weeks, PCR provides quick and accurate identification of the fungus. This is especially important for scalp infections, where early detection can prevent scarring and hair loss (Zhan & Liu, 2019). Dermoscopy is now widely used to differentiate ringworm from other skin conditions like eczema or psoriasis (Errichetti & Stinco, 2016). Wood's lamp, which causes some fungi to glow under ultraviolet light, is still essential for identifying specific types of fungi (Seebacher et al., 2008).

In terms of treatment, new creams and pills are available for both mild and severe cases of ringworm. While medications like terbinafine and azoles (such as fluconazole and itraconazole) remain common, new liposomal drug formulations allow deeper penetration into the skin, enhancing effectiveness and reducing treatment time (Ghannoum et al., 2010). Research into nanotechnology is also ongoing to better target infections and minimize side effects (Watanabe et al., 2018). For persistent or recurring infections, combination therapy using both oral and topical antifungals has shown promise, especially for individuals with ongoing health issues like diabetes (Elewski et al., 2014).

Probiotics are being explored to help restore the skin's natural balance and boost its ability to fight infections (Kober & Bowe, 2015). Natural antifungal substances derived from plants and oils, such as tea tree oil, thyme oil, and garlic extracts, have demonstrated strong antifungal properties. Though not yet standard treatments, they could serve as alternatives for those who prefer natural remedies or lack access to conventional drugs (Carson et al., 2006).

Artificial intelligence (AI) and machine learning are now part of dermatology, helping detect and classify ringworm infections early. AI tools, including mobile apps that analyze skin photos, could improve access to dermatological care, particularly in remote areas (Esteva et al., 2017). These technologies assist doctors in distinguishing ringworm from other skin issues and suggesting appropriate treatments quickly.

Despite these improvements, challenges persist, especially with antifungal resistance. Misuse of antifungal drugs has led to drug-resistant fungi, requiring further research into new treatments (Cowen et al., 2015). Ensuring affordable access to these treatments is crucial, particularly in developing countries where ringworm is more prevalent due to climate and living conditions (Hay et al., 2015).

In conclusion, recent advances in diagnosing and treating ringworm have improved patient outcomes by enabling faster and more accurate detection of infections and enhancing treatment effectiveness. Progress in diagnostics, drug delivery, AI-assisted detection, and alternative therapies is shaping the future of ringworm management. Addressing issues like antifungal resistance and access to treatments is vital for effectively controlling and preventing this widespread skin condition.

### Recommendations

We know a lot about how ringworm spreads, how to diagnose it, treat it, and its effects. With this knowledge, we can take several steps to prevent it, simplify diagnosis, and improve treatments. Educating people is crucial to stop ringworm from spreading, especially in warm and damp areas. Health organizations should run public campaigns to teach communities about what causes ringworm, how it spreads, and how to prevent it. Special focus should be on those at higher risk, such as athletes, people who wear closed shoes for long periods, and those with weak immune systems, including individuals with chronic illnesses like diabetes. Promoting good hygiene, like frequent handwashing, not sharing personal items, and keeping skin dry, is vital in stopping the fungus from growing and spreading. Preventive measures should be strengthened with specific plans for high-risk groups, like school kids and people in shared living spaces. Ensuring good air circulation and dryness in homes, schools, and locker rooms can reduce fungus growth. Regular check-ups in schools, gyms, and workplaces can help identify and treat infections early, reducing spread. For those prone to athlete's foot, using antifungal powders or sprays as a preventive measure is smart. Detecting and treating ringworm early is important to control infections. Healthcare workers should be trained to tell ringworm apart from other skin conditions using advanced tools like PCR tests and dermoscopy, avoiding wrong diagnoses and unnecessary treatments. Regular checks for people with weak immune systems should be encouraged for early detection and intervention. It's crucial to make modern diagnostic methods available in healthcare centers, especially in underserved areas, to improve patient

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care. Enhancing treatment methods is essential for tackling ringworm infections. For severe or recurrent cases, using both oral and topical antifungals should be considered. Research into new antifungal treatments, like those using nanotechnology or special delivery systems, should be promoted to make drugs more effective. Promoting the responsible use of antifungal drugs to prevent resistance is also important, ensuring health providers follow correct prescribing rules. Exploring alternative treatments, like essential oils and probiotics, might offer extra options, especially where access to antifungal drugs is limited. Addressing the emotional and social effects of ringworm is important as well. Support programs should be set up for those facing stigma or self-esteem issues due to visible infections, especially school-aged kids. Workplaces and schools should have policies to prevent discrimination against those affected and ensure proper treatment and hygiene practices are in place. Counseling and skin care consultations should be available for those feeling anxious or socially withdrawn due to long-term or frequent infections. Encouraging research and new technology is crucial to improving ringworm diagnosis and treatment. More study on antifungal resistance is needed to develop better treatments. AI tools and mobile apps should be explored to help spot infections early, especially in remote or underserved areas. Expanding clinical trials on new antifungal treatments, including natural and plant-based ones, can help find alternative treatment options. Finally, ensuring access to treatment and prevention is vital. Policies should make antifungal medications affordable, especially in low-income and high-infection areas. Community health programs should offer free or low-cost diagnostic services for early detection and treatment to lower transmission rates. Government agencies and health organizations should invest in ringworm prevention and control programs, ensuring both urban and rural areas receive adequate healthcare support. By following these recommendations, healthcare workers,

### Conclusion

Ringworm is a serious health concern because it is widespread, especially in warm and humid climates, and spreads easily through contact with infected people or objects. This infection is common in specific groups such as children, individuals with weakened immune systems, and those who frequently wear closed shoes, like athletes. The various forms of ringworm, including tinea capitis, tinea corporis, and athlete's foot, exhibit distinct symptoms and require specific diagnostic and treatment approaches. Diagnosing ringworm involves examining the skin, using microscopes, and advanced tests to differentiate it from other skin conditions. Even with available treatments, challenges remain, such as the fungus developing resistance to drugs, delayed diagnosis, and recurrence in high-risk populations. Recent advancements in diagnostic tools and treatments, like PCR-based tests and new antifungal medications, have improved patient outcomes, but further research is needed to enhance their effectiveness and availability. Ringworm can also lead to psychological and social challenges, such as stigma, anxiety, and low self-esteem, particularly in children and those with visible infections. Addressing these issues requires a combination of medical treatment, public education, and supportive measures. Preventing ringworm is the most effective control strategy. Practicing good hygiene, maintaining clean environments, and implementing public health initiatives can significantly reduce the spread, especially in places like schools and sports facilities. Encouraging early detection, the responsible use of antifungal treatments, and exploring alternative therapies can improve management efforts. Ensuring equitable access to treatment and prevention resources is crucial, particularly in regions with limited resources. In summary, a comprehensive strategy that includes prevention, early diagnosis, effective treatment, and psychosocial support is essential to lessen the impact of ringworm. By advancing research, improving healthcare accessibility, and raising public awareness, health professionals and policymakers can collaborate to reduce the effects of this common yet preventable fungal infection.

### Conflicts of Interest

Authors have no conflict of interest

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