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Wrestling Mats: Are They a Source of Ringworm Infections?

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Objective: To determine if the fungal molds (dermatophytes) responsible for causing ringworm could be isolated from a section of wrestling mat during the 1998–1999 season.

Design and Setting: A 2-part study was conducted. The first phase involved a culture evaluation of material taken from wrestling mats at 8 local high schools. The second phase was a bench laboratory study to determine if the fungus and molds could be grown from a wrestling mat in an optimal setting.

Subjects: We obtained material from areas of the practice mats of 8 high school wrestling teams at monthly intervals during the wrestling season. A 0.61-m (2-ft) × 0.31-m (1-ft) area of mat from 1 of the schools was used for the laboratory phase of the study.

Measurements: We cultured samples taken from each school's wrestling mats for growth of dermatophytes and used a questionnaire to determine the mat-washing habits and policies of each school. Also, wrestlers from the 8 schools were screened weekly by the designated team physician and certified athletic trainer. Any suspicious lesions were cultured for fungi.

Results: No dermatophytes were grown from the swab specimens taken at the 8 schools, and no dermatophytes were isolated from a section of mat evaluated in optimal laboratory conditions.

Conclusions: It is unlikely that wrestling mats are a source of ringworm infections in wrestlers.

Key Words: tinea gladiatorum, wrestling, tinea corporis, infection control

Dermatologic infections are a fairly common disease entity in contact sports. Wrestling in particular provides a competitive environment in which herpesviruses, *Staphylococcus* bacteria, and dermatophytes thrive. A small number of outbreaks of ringworm infections in wrestlers in the United States have been reported,[1–5] despite the widely held belief that these epidemics are quite commonplace in the wrestling world.[6] Prevention strategies such as hygienic practices, including showering and laundering clothing, in addition to educating officials, coaches, athletic trainers, parents, and athletes have been advocated in the literature.[7] We have found these measures to be inadequate in primary prevention.[8] As health care providers for these athletes, we must try to prevent these outbreaks by defining the disease entity better. With a better understanding of ringworm infections in this unique setting, we can better work to prevent and treat ringworm in wrestlers.

One strategy would be to determine the initial source of the organisms that cause ringworm. In doing so, we would be better equipped to understand the transmission and construct methods to prevent the transmission of the fungi and molds. It is most likely that the mode of transmission of these infections is person to person. Wrestling requires close body contact and often results in skin abrasions that provide a perfect opportunity for person-to-person transmission. However, dermatophytes have been isolated from several inanimate objects, including hairbrushes, combs, pillowcases, other bedding material, and dormitory floors.[9] Inanimate objects, or fomites, may be responsible for prolonged transmission of ringworm infections.[10] The competitive wrestling environment includes many fomites as possible sources of contagion. In a survey of 229 certified athletic trainers, athletic directors, and wrestling coaches in Pennsylvania, respondents identified towels, practice clothing, headgear, and wrestling mats as theorized sources of ringworm in high school wrestlers. Three fourths of those responding believed that ringworm could be contracted from wrestling mats (T.D. Kohl, unpublished data, 1999). To our knowledge, no one has proved that dermatophytes can exist on wrestling mats. We designed this 2-phase study to determine if dermatophytes could be found on samples of wrestling mats during the course of a season. We did not alter the environment or cleaning habits in any way during this study. During the season, each team involved was followed closely to diagnose and treat any ringworm infections that arose. If dermatophytes were isolated, we could infer that wrestling mats might be an additional source of ringworm infection. That information could lead to guidelines concerning mat cleaning and storage that may supplement evidence-based treatment and infection-control methods to lessen the number of cases of ringworm in competitive wrestlers.

METHODS

Eight schools with varsity wrestling programs in the same county and same league were involved in this study. We obtained consent from athletic directors and school boards

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before the season. Demographics of each school were obtained from the athletic directors of each school.

The first phase was a field study to evaluate cultured material from wrestling mats at each school. Culture samples were obtained from a 0.31-m × 0.31-m (1 square foot) area at the center of each school's practice mats. The surface area of each mat was swabbed before the regular season (early November) and monthly during the season (December, January, and February). The first sample was taken before any formal wrestling practices were conducted and after the mats had been sterilized. The subsequent monthly samplings were taken immediately after practice on the predetermined date each month, before any mat cleansing was done, to improve the chance of finding organisms. A sterile cotton swab was moistened with sterile water before collecting the specimen. Each specimen was acquired by rigorously rubbing the swab in multiple directions over the designated area at the center of the practice mats in the wrestling rooms of each school. This method of screening for dermatophyte growth on fomites has been shown to be effective in isolating the organisms.[11,12] The swab was returned to the culturette transport medium and transported to the microbiology laboratory within 24 hours. The reliability of using a cotton swab technique to isolate dermatophytes has been shown elsewhere.[13]

Each specimen was swabbed onto a Mycosel agar (Becton Dickinson, Sparks, MD). Mycosel is a Sabouraud-dextrose base agar that contains chloramphenicol, a broad-spectrum antibiotic to inhibit bacterial growth, and cycloheximide, which inhibits saprophytic fungi growth. Agar containing chloramphenicol and cycloheximide is the standard medium for growing dermatophytes.[14] Therefore, Mycosel would allow growth and recovery of dermatophytes responsible for ringworm infections while preventing the growth of contaminating organisms. We examined the agar plates weekly for growth. Colonies of mold suspected of possibly being a dermatophyte were reisolated to Sabouraud-dextrose plates for further identification.

We used a questionnaire to determine the mat-washing habits and policies of each school, including the frequency of washing, the substance used to clean the mats, and the person(s) responsible for cleaning the mats. The athletic trainers or wrestling coaches, or both, at each school provided the information.

The wrestlers from these 8 schools underwent weekly screening examinations by the designated team physician and certified athletic trainer. If any lesions were found during a screening examination or were self-reported by the wrestler, an epidermal scraping was obtained from the suspicious lesion for fungal culture. The epidermal cells were collected into agar tubes containing Dermatophyte Test Medium (DTM [Acuderm, Fort Lauderdale, FL]). The culture tubes were incubated at room temperature for 4 weeks. A positive culture was defined as growth on DTM with characteristic color change from yellow to red indicating alkalinization. Positive DTM cultures were subcultured on a fresh Sabourad-dextrose plate for 72 hours. The isolates were then examined microscopically after staining with lactophenol blue dye. A small sample of the mold was then inoculated onto Trichophyton agars 1–4 and Christensen's urea agar (Becton Dickinson, Sparks, MD). These tubes were examined daily for 10 days to determine the growth patterns. Six of the positive DTM cultures were not further identified because of inability to recover the organism secondary to delay in transport to the microbiology laboratory.

The second phase of the study was a bench laboratory experiment to determine if dermatophytes could be isolated from a sample of wrestling mat in ideal conditions. A 0.61-m × 0.61-m (2-ft × 1-ft) piece of a practice wrestling mat from 1 of the participating schools was removed from an existing practice mat and transported to the microbiology laboratory for evaluation. Touch preparations of the mat onto a fungal medium plate were performed to determine if the mat could be a source of dermatophyte growth. If any dormant fungal or dermatophyte spores were present on the mat, they would sporulate and grow once they had optimal conditions for growth. All agars were incubated at 28°C to 30°C in a Thelco model #4 incubator (Thelco, Englewood, CO). Two areas of the mat were chosen for the touch preparations, 1 dirty area and 1 clean area. The dirty area contained debris and dust. The clean area was relatively free of debris and dust to the naked eye. The sample of mat had not been washed or disinfected in 23 hours.

RESULTS

The 8 schools included 1 urban, 5 suburban, and 2 rural schools. The average number of wrestlers per school was 20.3 (range, 14 to 29). Coaches at all schools reported an average of 15 hours of practice time per week. Only 1 school in this study was free of ringworm during the season. The number of infections, number of wrestlers, and mat-washing habits from each school are provided in the Table. Each school used a commercial mat cleaner (Mint Quat [3M, Minneapolis, MN], Brute [Hadco-Denver Chemical Co, Denver, CO], or Vionex [Viro Research International, Toledo, OH]) to clean its mats. All cleaners contained ammonium chloride as the primary active ingredient.

A total of 32 mat samples were analyzed from the 8 schools. None of the mat specimen cultures collected at any time before, during, or after the season produced any dermatophyte growth. A few suspicious molds were isolated from 7 cultures from 4 different schools. These mold colonies were positively identified as *Penicillium* and *Fusarium*, which are common environmental molds that do not cause clinical disease. One culture grew *Aspergillus*, which could produce infection in an immunocompromised host. Two samples produced a large amount of yeast, which again were most likely environmental in nature. Finally, bacteria were found in 4 cultures (from 3 different schools) during evaluation. The bacteria were not further identified.

Characteristics of the 8 Wrestling Programs for the 1998–1999 Season

School	Wrestlers (n)	Ringworm Cases*	Frequency of Mat Cleaning
B	16	1 (6.25)	Daily
G	22	6 (27.2)	Daily
H	14	0 (0)	Daily
R	19	3 (15.7)	Monthly
S	29	1 (3.4)	Daily
WE	17	3 (17.6)	Daily
WI	25	5 (20)	Daily
WY	21	3 (14.2)	Daily

*Number of cases during the regular wrestling season (team incidence in percent for the entire season).

The 2 touch preparations that were processed in the laboratory did not reveal any dermatophyte growth. Each preparation, 1 from a dirty area and 1 from a clean area of mat sample, produced yeast and environmental molds. No bacteria were isolated from the touch preparations.

DISCUSSION

Tinea gladiatorum represents a significant nuisance to the wrestling world and to the health care professionals who care for wrestlers. Based on review of what little is in the literature and personal experience, outbreaks of ringworm infections seem to be the most common presentation. The best way to combat this problem is to determine the origin of the first dermatophyte. Prevention is the key to keeping wrestlers on the mats. Several possibilities may explain how these miniepidemics are started, but no single answer is likely to explain all the epidemics. If the dermatophytes responsible for ringworm infections have been isolated on inanimate objects before, it is logical to believe that they may exist on inanimate objects to which the wrestlers are exposed. We sought to prove or disprove 1 part of that theory with this study.

The mats that were used for practice at the 8 schools in Berks County did not harbor the organisms responsible for ringworm at the times and in the areas that we sampled. The mat-cleaning habits of the schools and the hygiene of the wrestlers were not controlled or altered in any way. We studied the mats in the state in which the participating schools kept them. We diagnosed infections in all but 1 of the schools. *Trichophyton tonsurans* was isolated from 17 of 23 positive DTM-screening cultures. The other positive DTM cultures could not be further identified. The predominance of *Trichophyton tonsurans* is consistent with other reports of ringworm infections in this population.[1–3,5,8,15] We showed in previous work[8] that it often takes more than 1 to 2 weeks to eradicate this dermatophyte in the wrestling population. Even if the mat was not the original source of the infections, there may have been exposure to the dermatophytes responsible for the infections when the infected wrestlers were practicing. Evidence has supported the existence of *Trichophyton tonsurans* outside a host for a prolonged period in an artificial setting.[16] If the dermatophyte or its spores were able to survive or perpetuate on wrestling mats, they should have been isolated.

Two explanations can illustrate why we were unable to isolate dermatophytes from the monthly mat cultures at the 8 schools. First, there may not have been enough dermatophytes present to spur growth. If this were the case, then there would not be enough organisms to produce or induce a clinical infection. Seven of the 8 schools washed or disinfected their mats daily. The disinfectant used by each school contains an active fungicidal ingredient. This would certainly limit the load of dermatophytes or any other organisms on the mats. Our results may make a strong argument in favor of washing the mats daily. By looking for the dermatophytes without altering the normal regimen of mat cleaning, we can infer that it is unlikely that the mats were the cause of the ringworm infections in these wrestlers because the mats were cleaned on a regular basis. Second, perhaps dermatophytes were there, but we missed them by only sampling a small area. We did sample the same area each month, and the area sampled was in the center of the mat, where much action presumably takes place. We may have also missed the opportunity to find any dermatophytes by only sampling monthly. We did increase our chance by sampling immediately after practice times. It is also difficult to determine if the wrestlers had sufficient contact with the mat at that particular area. A larger study with more random sampling may reveal dermatophytes on the mat.

Because we were unable to isolate dermatophytes from the mats and because we were limited in our ability to sample larger areas of the mats, the laboratory experiment phase was initiated. Under ideal growth conditions, the mat sample did not produce evidence of dermatophyte contamination. If dermatophytes could not be isolated under ideal conditions, it is difficult to believe that they can survive on mats in sufficient concentrations to produce clinical infections. The same limitations hold true of this part of the study. We only sampled 1 piece of mat from 1 school; this limited our ability to isolate any dermatophytes. The lack of growth under laboratory conditions does add some evidence to conclude that it is unlikely that dermatophytes can persist on wrestling mats in sufficient quantity or for sufficient duration to cause clinical infections.

The inability to isolate dermatophytes in either phase of this study lends more credence to the theory that person-to-person contact is the most likely mode of transmission. Others have reached a similar conclusion. Beller and Gessner[1] provided several reasons to believe the transmission of tinea gladiatorum is by direct skin-to-skin contact. Extensive cleaning of the mats with a disinfectant capable of killing dermatophytes failed in their study and in our study to prevent tinea infections. Beller and Gessner[1] also noted that there should have been more lower extremity infections if the mat played a role in the outbreak they studied. Direct contact with the fungus, in combination with other factors, including concomitant skin trauma and host susceptibility, is the most important source of infection.[17] Nosocomial outbreaks of *Trichophyton tonsurans* have affirmed direct personal contact as the prominent source of transmission.[11,18] The presence of a dermatophyte on a fomite or as part of a carrier state does not affirm it as the definitive source. The principles of infectious disease require a viable organism, a susceptible host, and an appropriate environment for clinical infection to occur. We need to study all aspects of this infection in this population in order to develop strategies to deal with it. We suggest focusing our efforts on studying the person-to-person transmission, studying when return to competition is safe, and looking at efficacy of treatment and prevention techniques such as the use of skin barriers[19] and pharmacologic prophylaxis.[20] We would suggest continuation of common-sense hygiene measures, including showering after every encounter, washing practice clothes daily, and disinfecting mats daily.[21] Until we have more definitive answers about ringworm in wrestlers, it is impossible to have sufficient infection control and prevention plans.

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