

## INCIDENCE OF TINEA PEDIS AMONG THE LOCAL POPULATION IN MADRAS

V. V. PANKAJALAKSHMI,\* T. SAICHAND,† T. SUNDARAVELU,‡  
C. S. LAKSHMINARAYANA || AND S. SUBRAMANIAN §

### Summary

Of 217 randomly selected subjects, investigated for the presence of pathogenic fungi in the interdigital spaces of foot, 32.7% showed some clinical abnormality. Mycological study revealed the presence of fungi only in 15.2%. The organism was isolated from 1.8% of individuals with apparently normal feet.

The age and sex incidence, its relationship to the nature of footwear and the species of fungi isolated in the study are analysed.

The infection was predominantly seen in the age group 21-30 years. Both sexes were more or less equally affected. 52.8% of those who use heavy to moderate footwear showed evidence of clinical abnormality and in 23.6%, the fungi could be isolated.

*Trichophyton rubrum* was the major offender (42.4%), followed by *Candida albicans* (27.3%) and *T. mentagrophytes, interdigitale* type (24.2%). *Epidermophyton floccosum* was isolated from only 2 persons.

Tinea pedis is a world-wide disease. It is more prevalent in temperate than in tropical areas. It is often believed that athlete's foot is unknown in those regions where large number of people walk bare footed on account of warm climate and or low income. In conformity with this belief, though a fairly high incidence of dermatomycoses have been noted in India, the incidence of tinea pedis is very low. It is possible

that because of minimal discomfort, only very few with tinea pedis seek medical advice and hence many of the cases go unrecorded. The present study was undertaken to find out the incidence of tinea pedis in the local population.

### Materials and Methods

The material was obtained from groups of individuals selected at random from the patients admitted to Government General Hospital, Madras for other diseases; medical, technical and menial staff of the Institute of Microbiology, Madras Medical College and students of the Madras Christian College High School, Madras. Data regarding their age, sex and habits of footwear were recorded. When foot-wears were used, they were classified

\* Associate Professor of Microbiology

† Postgraduate in Microbiology

‡ Director and Professor

Institute of Microbiology

Madras Medical College, Madras-3

|| Professor of Microbiology

Institute of Basic Medical Sciences

Taramani, Madras

§ Professor of Microbiology,

Stanley Medical College, Madras-1

Received for publication on 12-7-1979

as heavy (shoes with socks) or light (sandals) or moderate (in between). Most persons who wore shoes were found to use only close-knitted nylon socks. Hence no particular entry was made regarding the type of socks used. Each person's feet were then inspected for the presence of any lesion. Based on the findings patients were classified into the first five groups of Holmes and Gentles' (1956)<sup>1</sup>. The area of the foot selected was cleansed with 70% alcohol and when a clinical lesion was evident, scrapings were taken from that place. When there was no obvious lesion, scrapings were collected from the skin of the fourth interdigital spaces of both feet.

Direct examination of the scales in 20% KOH was done. Samples of scales were inoculated on Sabouraud's dextrose agar containing chloramphenicol (0.05 mg/ml) with and without cycloheximide (0.5 mg/ml). Tubes were kept at 26°C for 4 weeks before being discarded. Dermatophytes were identified on the basis of microscopical morphology and cultural characteristics of the colonies. Whenever necessary, slide cultures and additional media e.g.,

corn meal agar with 1% dextrose and urease agar for differentiation of *Trichophyton rubrum* from *T. mentagrophytes*: rice medium and Sabouraud's dextrose agar with 10 mg of thiamine/liter, to promote sporulation were used for identification of the isolates. *Candida albicans* was diagnosed on the basis of production of chlamydo spores on Rice Starch Tween agar and "Germ tubes" in serum within 2 hours. If results were inconclusive, sugar fermentation tests were done.

**Observations**

Of the 217 subjects investigated, 169 were males and 48 were females. Their ages ranged from 11 to 56 years.

Table 1 shows the prevalence incidence of clinical and mycologically proved cases of tinea pedis in relation to age and sex. Maximal prevalence was in the age group of 21-30. 33.7% of males and 29.2% of females showed some clinical abnormality on their feet, giving an overall clinical prevalence of 32.7%. When subjected to mycological studies only 14.9% of males and 16.7% of females (15.2% in both sexes) were found to carry pathogenic fungus.

TABLE 1  
Age and sex incidence of Tinea pedis

Age in years	Number examined			Number showing clinically abnormal feet			Number of subjects from whom pathogenic fungus was isolated		
	Male	Female	Total	Male	Female (% in brackets)	Total	Male	Female	Total
10-20	83	16	99	18 (21.7)	3 (18.8)	21 (21.2)	3 (3.6)	1 (6.3)	4 (4.0)
21-30	61	25	86	32 (52.5)	9 (36.0)	41 (47.7)	17* (27.9)	6 (24.0)	23 (26.7)
31-40	13	7	20	5 (38.8)	2 (28.6)	7 (35.0)	3 (23.1)	1 (14.3)	4 (20.0)
41 and above	12	—	12	2 (16.7)	—	2 (16.7)	2 (16.7)	—	2 (16.7)
Total	169	48	217	57 (33.7)	14 (29.2)	71 (32.7)	25 (14.9)	8 (16.7)	33 (15.2)

\*This includes 2 cases which did not show any clinical abnormality

TABLE 2  
Showing the relation between clinical variety and fungus isolation rate

Holmes and Gentles' Clinical Groups	No. of subjects in each group			No. of subjects from whom fungus was isolated			Isolation rate of Fungus in each group (%)
	Male	Female	Total	Male	Female	Total	
Normal feet	112	34	146	2	—	2	1.4
Peeling and/or Maceration Erythema or peeling and erythema maceration and raw areas or slight fissures	41	9	50	13	5	18	36.0
Fissures or dermatitis	12	5	17	7	3	10	58.8
Vesicles	1	—	1	1	—	1	100.0
Total No. excluding those with normal feet	3	—	3	2	—	2	66.7
Total No. of Subjects surveyed	57	14	71	23	8	31	43.7
	169	48	217	25	8	33	15.2

The relationship between the clinical features and the fungus isolation rate is given in Table 2. Holmes and Gentles' group 1, comprising of normal feet showed an isolation rate of 1.4%. Groups 2 and 3 gave isolation rates of 36% and 58.8% respectively. The isolation rates in groups 4 and 5 were 100% and 66.7% respectively, but the numbers in these two groups are too small to have the results considered of significance.

Table 3 shows the incidence of tinea pedis in relation to the nature of footwear. Among those using heavy to moderate footwear with some type of

socks (mostly of spun nylon variety), 52.8% showed evidence of clinical abnormality and in 23.6% fungi could be isolated. In those using light footwear, clinical lesion was evident in 22.9% and the organism was isolated from 11.4%. In the small group comprising of individuals who walk bare-footed, neither clinical nor mycological evidence of tinea pedis was found.

The organisms isolated are given in Table 4. *T. rubrum* was the commonest etiological agent responsible for 42.4% of the infections. *Candida albicans* was the next common agent (27.3%) followed by *T. mentagrophytes*

TABLE 3  
Foot - Wear and incidence of tinea pedis

Type of Foot-Wear	No. investigated			No. showing clinical evidence of Tinea pedis			No. of mycologically proved cases of Tinea pedis		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Heavy to moderate foot-wear with nylon socks	78	11	89	41	6	47	16	5	21
Light foot-wear	74	31	105	16	8	24	9	3	12
No socks	17	6	23	—	—	—	—	—	—
No foot-wear							(0%)		(0%)

*interdigitale type* (24.2%) and *Epidermophyton floccosum* which was isolated only twice (6.1%).

The incidence of tinea pedis in the present study was compared with that reported by other workers from India is given in Table 5.

**Discussion**

Tinea pedis occurs in all parts of the world and is said to affect 50 to 90% of people sometime in their lives. The reported incidence of foot ringworm is very low in India possibly because no special attention was given to the study of tinea pedis as such, and it was studied along with other common dermatomycoses. Since tinea pedis most often causes only minor symptoms majority of the patients do not attend the hospital for treatment. Those pati-

ents who were studied, on the basis of hospital attendance gave a low infection rate. In our previous study<sup>2</sup> on 3002 cases of superficial mycoses confirmed by direct microscopic examination out of 6369 cases diagnosed clinically in the dermatology outpatient department of Government General Hospital, Madras during a period of one year (1965-1966) we encountered only 12 cases (0.2%) of tinea

TABLE 4  
Species of fungii isolated from the interdigital spaces

Species	Male	Female	Total	%
T. rubrum	12	2	14	42.4
T. mentagrophytes (interdigitale type)	8	—	8	24.24
E. floccosum	1	1	2	6.1
Candida albicans	4	5	9	27.3

TABLE 5  
Incidence of Tinea pedis compared with incidence reported earlier from India

Place	Reference	Total number of cases of superficial mycoses examined	Number of cases clinically diagnosed as Tinea pedis (%)	Number of cases confirmed by culture (%)
Delhi	Kandhari & Sethi <sup>16</sup>	1964 858	109 (13)	36 (4.2)
Delhi	Kalra et al <sup>7</sup>	1964 454	—	61 (13.4)
Delhi	Gugnani et al <sup>25</sup>	1967 303	—	19 (6.2)
Rohtak	Verma & Krishnabir Singh <sup>26</sup>	1972 100	11 (11)	3 (3)
Lucknow	Srivastava & Gupta <sup>27</sup>	1958 173	16 (9.2)	9 (5.2)
Lucknow	Gupta & Shome <sup>28</sup>	1959 145	25 (17.2)	—
Varanasi	Sehgal & Shome <sup>29</sup>	1973 334	28 (8.4)	—
Orissa	Panda et al <sup>30</sup>	1967 142	1 (0.7)	1 (0.7)
Bombay	Desai & Bhat <sup>24</sup>	1961 2664	268 (10.0)	—
Ahmedabad	Mankodi et al <sup>31</sup>	1967 110	10 (9.1)	—
Ahmedabad	Amin et al <sup>5</sup>	1971 141	—	—
Baroda	Verma et al <sup>4</sup>	1970 100	—	—
Warangal	Vasu <sup>18</sup>	1966 203	19 (9.3)	5 (2.5)
Hyderabad	Nagabushanam et al <sup>32</sup>	1969 1080	109 (10.0)	—
Trivandrum	Kurup & Ananthanarayanan <sup>6</sup>	1961 148	34 (22.97)	7 (4.7)
Madras	Pankajalakshmi & Subramaniam <sup>2</sup>	1974 3002	12 (0.2)	—
Madras	Kamalam & Thambiah <sup>3</sup>	1976 3885	193 (4.97)	14 (7.3)
Present Series		217	71 (32.7)	33 (15.2)

pedis. Kamalam and Thambiah<sup>3</sup>, in their recent study (1972—1973) from the same department reported an incidence of 4.97% among 3385 cases of superficial mycoses. The increase in the incidence may be due to an increasing awareness of the people of the condition.

Verma et al<sup>4</sup> from Baroda and Amin et al<sup>5</sup> from Ahmedabad did not report even a single case of tinea pedis in their studies of 100 and 141 cases of dermatomycoses respectively, whereas Kurup and Ananthanarayanan<sup>6</sup> from Trivandrum reported a clinical incidence rate of about 23% among 148 patients suffering from various ring worm infections. When cultural studies were done only 4.7% of these were found to be positive. Kalra et al<sup>7</sup> from Delhi reported the maximum incidence of 13.4% of mycologically proved cases of tinea pedis among 454 patients with ringworm infections. Thus various authors have reported varying levels of infection rates among different communities in different geographical areas. This difference can be attributed to the widely differing opportunities to get oneself infected, variations in environment and social factors as well as difference in general resistance of the host and certain local factors.

The true incidence of tinea pedis is difficult to assess. Assessment is based on those who seek medical help because of their symptoms. When the general population was screened and a search made for tinea pedis in individuals selected at random, 32.7% showed clinical evidence of infection, and in 15.2%, the organism was isolated. This prevalence is the highest of all the published reports from India.

A wide discrepancy exists between the clinical incidence of infection and the fungus isolation rate. In the present study, the organism was isolated in roughly one half of the subjects showing

clinical lesions. Ajello et al<sup>8</sup> showed fungi from scrapings in only 17.7% of young military recruits in the U.S.A., although clinical evidence of infection was found in 59.9%. Marples and di Menna<sup>9</sup>, in their study on the University students of New Zealand found 63.03% showing clinical lesions, but the fungus was demonstrated by culture in only 10.6%. Gentles and Holmes<sup>10</sup> reported an incidence of 21% of dermatophyte infection in coalminers in United Kingdom, although 90% of them had shown scaling or maceration. Menon<sup>11</sup> postulated that the scaling and maceration in the interdigital spaces might be entirely due to hyperhidrosis and the fungi, although potentially pathogenic, live at peace with their host in the warm, moist, interdigital skin. This hypothesis was further supported by the work of Marples and Chapman<sup>12</sup>.

We encountered pathogenic fungi in 2 cases with clinically normal interdigital spaces. Ajello et al<sup>8</sup> had observed fungal elements in 1.7% of subjects without clinical evidence of infection. Gentles and Holmes<sup>10</sup> isolated dermatophytes from 2.5% of clinically normal subjects. The highest such prevalence (8.9%) was reported by Marples and Baily<sup>13</sup> in their study on 45 University students. The presence of pathogenic fungi in undamaged interdigital skin may be explained on various factors. A person may be incubating the infection which has not resulted in disease in which case a follow-up examination may show the development of the clinical disease<sup>14</sup>. Secondly it is possible that fungus may produce a persistent infection without symptoms or signs. Thirdly a healthy carrier state may exist.

When classified into Holmes and Gentles' clinical groups, the percentage of isolation increased from group to group according to the provisional order of importance, in accordance with the findings of Holmes and Gentles<sup>1</sup>.

We were able to obtain positive culture in 2 out of 3 cases with vesicles and the single case with fissures and dermatitis. The second group which showed peeling and/or maceration gave an isolation rate of only 36%, showing that these two signs are not very reliable parameters for clinical diagnosis. In the third group with erythema, raw areas and mild fissures, the isolation rate of the fungus was 5%.

Though persons of all age groups are susceptible to infection, maximum prevalence was seen in the age group 21-30 followed by 31-40 years. Kandhari and Sethi<sup>16</sup> from Delhi showed that in their series, tinea pedis in the age group 21-40 years was 53.6% in males and 57.5% in females. Henrici<sup>17</sup> stressed the importance of repeated inoculation in the development of fungus infection and the role of the allergic response in the causation of symptoms.

When prevalence of the disease in the two sexes is studied, it is found that no appreciable difference exist between the males and females. The work of other authors both in India and abroad however points out that incidence is higher in males than in females. Only one author, Vasu<sup>18</sup> from Warangal reported a higher incidence in females. It has also been shown that when conditions of exposure were similar, both men and women had the same susceptibility<sup>15</sup>.

In the present study, a high prevalence ring worm infection was associated with the habit of using heavy footwear. In addition to providing a permanent reservoir of dermatophytes with opportunities for reinfection socks and shoes provide a confined, warm, moist environment which encourage the growth of these pathogens<sup>19</sup>. In their observations in different communities, Davies<sup>20, 21</sup>, Copland<sup>22</sup> and Nickerson et al<sup>23</sup> showed that a number of skin conditions including tinea pedis was

exacerbated by the use of heavy footwear, but this work was not mycologically confirmed. Kandhari and Sethi<sup>16</sup> from India showed that over 75% of their cases of tinea pedis gave history of wearing shoes and socks throughout the year and the disease was uncommon in those wearing sandals and those walking bare-footed. The low incidence was attributed to the inability of the fungus to invade the thick keratinized soles of the subjects in whom the skin was not protected by footwear<sup>24</sup>.

All the four important species of fungi which are incriminated in causing tinea pedis were encountered in the present study. *T. rubrum* was the major offender. Other pathogenic fungi obtained were *C. albicans*, *T. mentagrophytes* and *E. floccosum*. Though the incidence of various species reported by different workers varied considerably, *T. rubrum* was more common than *T. mentagrophytes* and *E. floccosum* was rare. The incidence of *C. albicans* varied from 8.3 to 66.7%. The gross variation in the results obtained by different workers may be due to the fact that the prevalent species causing dermatophyte infection differs from place to place and from time to time. Further environmental conditions, personal habits, individual susceptibility etc, also play significant roles.

Since tinea pedis is more commonly seen in those wearing closed shoes and socks, the advisability of insisting on such for school children especially in our hot humid climate should be reconsidered.

#### Acknowledgement

We are grateful to Prof. V. Sivarajan, Dean, Madras Medical College and Government General Hospital, Madras for permitting us to publish this paper.

#### References

1. Holmes JG and Gentles JC: Diagnosis of foot ringworm, Lancet, 2: 62, 1956.

INCIDENCE OF TINEA PEDIS AMONG THE LOCAL POPULATION IN MADRAS

2. Pankajalakshmi VV and Subramanian S : Mycoses in Madras (Superficial), Indian J Derm Vener, 40 : 228, 1974.
3. Kamalam A and Thambiah AS: A study of 3891 cases of mycoses in the tropics, Sabouraudia, 14 : 129, 1976.
4. Verma BS, Vaishnav VP and Bhatt RP : A study of dermatomycosis, Indian J Derm Vener, 36 : 182, 1970.
5. Amin AG, Shah CF and Shah HS : Analysis of 141 cases of dermatophytosis, Indian J Derm Vener, 37 : 123, 1971.
6. Kurup PV and Ananthanarayanan R : A preliminary study of 148 cases of dermatophytosis, Indian Pract, 14 : 33, 1961.
7. Kalra SL, Mohapatra LN and Gugnani HC : Etiology of dermatomycosis in Delhi, Indian J Med Res, 52 : 553, 1964.
8. Ajello L, Keeney EL and Broyles EN: Observation on the incidence of tinea pedis in a group of men entering military life, Bull John Hopk Hosp, 77 : 440, 1945.
9. Marples MJ and di Menna ME : A survey of the incidence of interdigital fungus infection in a group of students from the University of Otago, Med J Aust, 36(11) : 156, 1949.
10. Gentles JC and Holmes JG : Brit J Industr Med, 14 : 22 Cited by English and Gibson in Brit Med J, 1 : 1860, 1960.
11. Meenan FOC: J Irish Med Ass. 33, 102, 1953. Cited by English et al in Brit Med J, 1 : 1083, 1961.
12. Marples MJ and Chapman EN: Tinea pedis in a group of school children, Brit J Derm, 71 : 413, 1959.
13. Marples MJ and Bailey MJ : A search for the presence of pathogenic bacteria and fungi in the interdigital spaces of the foot, Brit J Derm, 69 : 79, 1957.
14. English MP, Gibson MD and Warin RP : Studies in the epidemiology of tinea pedis, VI Tinea pedis in a boy's boarding-school, Brit Med J, 1 : 1083, 1961.
15. Baer RL and Rosenthal SA : The Biology of Fungus infections of the feet, JAMA, 197 : 1017, 1966.
16. Kandhari KC and Sethi KK : Dermatophytosis in Delhi area, J Indian Med Assoc, 42 : 324, 1964.
17. Henrici AT : The characteristics of fungus diseases, J Bact, 39 : 113, 1940.
18. Vasu DRBH: Studies in Medical Mycology-Part I. Incidence of dermatophytosis in Warangal, AP (India) Indian J Med Res, 54 : 468, 1966.
19. Broughton RH : Reinfection from socks and shoes in tinea pedis, Brit J Derm 67 : 249, 1955.
20. Davies AJ: J Roy Army Med Cps, 97 : 168, 1951, Cited by English et al in Brit Med J, 2 : 573, 1960.
21. Davies AJ: J Roy Army Med Cps, 98 : 99, 1952, Cited by English et al, in Brit Med J: 2 : 573, 1960.
22. Copland W : J Roy Nav Med Serv, 38 : 8, 1952. Cited by English et al in Brit Med J, 2 : 573, 1960.
23. Nickerson WJ, Irving L and Mehmert HE: Arch Derm (Chicago) 52 : 365, 1945 cited by English et al in Brit Med J, 2 : 573, 1960.
24. Desai SC and Bhatt ML : Dermatophytosis in Bombay, Indian J Med Res 49 : 662, 1961.
25. Gugnani HC, Mulay DN and Murty DK : Fungus flora of dermatophytosis and T. simii infection in North India, Indian J Derm Vener, 33 : 73, 1967.
26. Verma KC and Krishnabir Singh : Dermatophytosis in Rohtak (An analysis of cases) Indian J Derm Vener, 38 : 238, 1972.
27. Srivastava OP and Gupta RN : Survey of human skin fungi in Lucknow and the effect of diaryl sulphones, sulphoxides and sulphides on T. rubrum, J Sci Indus Res, 17c : 87, 1958.
28. Gupta RN and Shome SK : Dermatophytosis in Uttar Pradesh, An analysis of 620 cases, Indian J Med Assoc, 33 : 39, 1959.
29. Sehgal VN and Shome SK : Dermatological study, Indian J Dermat, 18 : 25, 1973.
30. Panda CK, Mohanty D and Mohanty H et al : Incidence of Dermatophytosis in Burla, Indian J Path Bact, 10 : 332, 1967.
31. Mankodi RC, Shah BH and Kanvinde MS et al : A study of 110 cases of superficial mycotic infections. Indian J Derm Vener, 33 : 177, 1967.
32. Nagabhushanam P, Thirumalrao D and Patnaik R : Dermatophytosis in Hyderabad, Indian J Derm Vener, 35 : 120, 1969.