Comparison of hairbrush, toothbrush and cotton swab methods for diagnosing asymptomatic dermatophyte scalp carriage

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Keywords
asymptomatic carriage, cotton swab, dermatophyte, diagnose, hairbrush, toothbrush

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Abstract

Background Tinea capitis may also present as a minimal infection, termed carrier state. Anthropophilic dermatophytes (i.e. *Trichophyton tonsurans* and *Trichophyton violaceum*) have been generally associated with high rates of asymptomatic carriage.

Objectives The aim of this study was to compare the efficacy of the hairbrush, toothbrush and cotton swab methods for diagnosing scalp carriage as well as to determine the prevalence and related dermatophyte species for both asymptomatic and symptomatic tinea capitis in Adana Province, Turkey.

Patients and methods A screening study was carried out between February 2006 and May 2006, covering three schools and a total of 1560 children with 857 (54.9%) boys and 703 (45.1%) girls, aged between 7 and 17 years (10.6 ± 2.3 years). The diagnosis was made by using three of the methods mentioned above with inoculation onto Sabouraud glucose agar.

Results Symptomatic tinea capitis was not detected in the study; however, 21 (1.3%) asymptomatic carriers, with 9 (42.9%) boys and 12 (57.1%) girls, aged 7 to 13 years (9.7 ± 1.9 years) were detected. The diagnosis was made via hairbrush in 13, via cotton swab in 4 and via toothbrush in 4. The mean age (*P* = 0.075) and gender differences were found to be statistically insignificant (*P* = 0.26). The most common isolated species was *Trichophyton mentagrophytes* var. *mentagrophytes* (90.4%) followed by *Trichophyton audouinii* (4.8%) and *Microsporum gypseum* (4.8%). Nine children had Arab origin (*P* = 0.005), and 12 had immigrated from the south-eastern region of Anatolia, Turkey. The screening of 32 households of 21 children with asymptomatic carriage enabled the researchers to detect the carrier state in three mothers and one sister, resulting in a total of four households (12.5%), with *T. mentagrophytes* var. *mentagrophytes* isolated, by hairbrush method in three cases and cotton swab in one case. If the methods were to be used alone, the prevalence of asymptomatic carriage would be found as 1.0% (16 of 1592) in the hairbrush, 0.3% (4 of 1592) in the toothbrush and 0.3% (5 of 1592) in the cotton swab methods; whereas the combined use of these three methods could reveal a total prevalence of 1.6% (25 of 1592). The hairbrush method was significantly found to be more effective in detecting dermatophyte fungi than the toothbrush (*P* < 0.01) and the cotton swab methods (*P* < 0.05). There was also a statistically significant difference between the use of a single method and the combination of all other three methods (*P* < 0.005).

Conclusions In summary, it was found that the prevalence of asymptomatic carriage did not cover symptomatic tinea capitis prevalence (1.6% vs. 0%), and the dominant species was zoophilic *T. mentagrophytes* (92%, 23 of 25). Asymptomatic carriage was not found to be related to age, gender and the coexistence of other dermatophytoses; however, race (Arab origin) was found to be the only risk factor. For laboratory diagnosis, no method was found to be nominated as a gold standard; hence, a combined use of diagnosing methods was suggested.
Introduction

In 1960, Mackenzie et al. first described dermatophyte-positive scalp cultures, obtained from hairbrushes and clothing of several children who were ‘not ostensibly infected’. Asymptomatic carrier is defined as an individual who has dermatophyte-positive scalp culture without signs or symptoms of tinea capitis. This should also include no evidence of hair shaft invasion confirmed by direct microscopy. Although the presence of dermatophytes on seemingly healthy scalps might, in many cases, be a transient event, it seems reasonable to assume that carriers play a role in the spread and the persistence of scalp ringworm in the community. The prevalence of asymptomatic carriage (AC) shows marked variation between 0.1% and 49%, yet tends to mirror the prevalence of symptomatic tinea capitis (STC) in the local population. In addition, Ghanem et al. state that variation in these prevalence may reflect differences in the study populations and methodologies diagnosing the carrier state (i.e. hairbrush, toothbrush, scalp blade, gauze, carpet disc or cotton swab methods).

Anthropophilic dermatophytes (i.e. Trichophyton tonsurans, Microsporum ferrugineum and Microsporum rivalieri) are generally associated with high rates of AC. In contrast, zoophilic organisms, such as Microsporum canis or Trichophyton mentagrophytes, usually present with a symptomatic inflammatory response, and they less likely lead to AC. However, AC is associated mainly with the zoophilic dermatophytes by Al-Shtayeh et al. and Ilkit et al. reporting that M. canis and T. mentagrophytes as the predominant species, respectively. Geophilic species (Microsporum nanum, Trichophyton terrestre, Trichophyton ajelloi and Microsporum gypseum) are reported to be associated with AC, albeit in a decreased level.

In this study, we aimed (i) to determine the prevalence and the related dermatophyte fungi of the AC as well as STC (ii) to compare the efficacy of hairbrush, toothbrush and cotton swab methods for diagnosing the carrier state; (iii) to analyse the risk factors; and (iv) to discuss potential routes of transmission in Adana, Turkey.

Materials and methods

The Adana province, with over 1.5 million population, is the fifth largest province in Turkey and is located in the Cukurova region by the Mediterranean coast, at latitude 35°N and longitude 37°E. The climate is cold (9.5 °C) and rainy (132.2 kg/m²/month) in winter and hot (27.5 °C) and dry (1.6 kg/m²/month) in the summer. The relative humidity is high (57.9–76.9%) for most of the year.

Participants

The study was conducted in three rural areas: Havutlu, Solakli and Dogankent, in the district of Yuregir, Adana Province, Turkey. These areas were inhabited by people of Arab origin in one (Havutlu) and by south-eastern Anatolian immigrants in the other two. The inhabitants of the three regions were occupied with farming, and the socioeconomic conditions of those living in Havutlu were relatively better than the other two.

All of the students of the three primary schools participated in the study. The students were of lower socioeconomic status, and the physical conditions of the schools were under average. The study protocol was reviewed and approved by the Faculty of Medicine’s Ethics Committee of the University of Cukurova, and consent was obtained for each participant.

In this cross-sectional descriptive study, a total of 1560 children, aged between 7 and 17 years, with a mean of 10.6 ± 2.3, comprising 857 (54.9%) boys and 703 (45.1%) girls, attending 54 classes, were examined and sampled for AC and STC from February 2006 to May 2006. In all children age, gender, race, the presence of scalp scaling, itching, coexistence of other dermatophytes, parents’ profession, family size, type of housing, co-sleeping, comb sharing, use of antidandruff shampoo and presence of animal pets or domestic animals in the child’s environment were accepted as independent variables, and the fungal culture results as the dependent variable. The questionnaire form was filled face-to-face by two of the researchers.

Sample collection

Each child’s scalp was examined for broken hairs and/or alopecia, scaling and crust. However, scalp samples were taken from all children irrespective of the clinical symptoms. The scalp samples were taken by three methods (i.e. by gently brushing each side of the scalp four times vigorously via a plastic hairbrush and a plastic toothbrush and rubbing and rotating a cotton swab on the scalp). These procedures were carried out only after the three instruments had been dipped in sterile 0.1% Tween 80. There was a standard order of sampling (i.e. hairbrush first, toothbrush second and then cotton swab). Each method sampled the same area among the four quadrants of the scalp. The surface area of the hairbrush was 38 cm²; the cotton swab area was 3 cm² and the toothbrush area was 2 cm². The hairbrush was circular in shape and at a size to fit the Petri dish, and it consisted of 167 plastic prongs.

All the lesions detected on the feet were cleaned with 70% alcohol. Then, toeweb scrapings by scalpel blade

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were aseptically collected into sterilised paper packets. Mycological examination of the clinical material was carried out by direct microscopic examination and fungal culture.\textsuperscript{24}

**Culture**

Brushing the scalp with any plastic brush-based technique builds up static electricity on the brushes, which attracts particulate material (including fungal propagules) adsorbed onto the prongs of the brushes. This material is then dislodged when the brushes are inoculated onto the agar surface.\textsuperscript{11} Sabouraud glucose agar (SGA; Acumedia, Baltimore, MD, USA) in a Petri dish amended with a mixture of 100 \( \mu \text{g/mL} \) cycloheximide (Sigma, Steinheim, Germany), 100 \( \mu \text{g/mL} \) chloramphenicol (Fluka, China) and 50 \( \mu \text{g/mL} \) gentamicin (Sigma) was used as a study medium. Each hairbrush was stabbed onto the medium, creating 167 inoculations corresponding to the 167 prongs of the hairbrush. The toothbrush method was also streaked over the study medium. The cotton swab was inoculated onto the study medium by rotating the swab head while streaking the surface of the medium, and then the media were transferred to the Mycology Laboratory at the Faculty of Medicine, University of Cukurova. The cultures were incubated at 25 \(^\circ\text{C}\) in air and were examined after 7, 14 and 21 days for evidence of growth.

**Spore load**

Colonies were counted on plate according to the hairbrush method, and a total colony count (equivalent to number of spores retrieved) was obtained for each child. A spore load system was assigned as follows: light for 1 to 5 colonies, moderate for 6 to 10 colonies, and heavy for > 10 colonies.

**Identification of dermatophyte species**

Fungal isolates, if any, were subcultured onto SGA and potato dextrose agar (Merck, Darmstadt, Germany). Identification of dermatophytes was done by macro-morphological and micromorphological examination of colonies, by biochemical methods [i.e. \textit{in vitro} hair perforation test, urease activity in Christensen’s urea broth, growth in bromcresol purple-milk solids-glucose agar (Himedia, Mumbai, India)] and growth in rice grains when necessary.\textsuperscript{24}

**Household members**

Once carriers were identified, household members of all participants were also sampled. The 32 household members of the 21 carriers, aged between 3 and 54 years, with a mean of 26.1 \( \pm \) 15.1, comprising nine (28.1\%) males and 23 (71.9\%) females, were questioned and inspected for dandruff, scalp scaling or recent hair loss as well as the presence of any dermatophyte infection. In addition, scalp samples of the households were collected by three of the methods as described above.

**Organisms**

The following reference strains were obtained from the Centraalbureau voor Schimmelcultures (CBS), Utrecht, the Netherlands: \textit{T. mentagrophytes} CBS 318.56, \textit{T. mentagrophytes} CBS 110.65, \textit{T. mentagrophytes} CBS 160.66, \textit{Trichophyton asteroides} CBS 424.63, \textit{Trichophyton lanigeroni} CBS 764.84, \textit{Trichophyton papillosum} CBS 347.55 and \textit{Trichophyton quinckeanum} CBS 572.75.

**Statistical analysis**

Statistical analysis was done using the statistical package SPSS version 10.0 and Epi Info version 6.04b. Univariate analysis was carried out to determine the risk factors for AC. The categorical data between groups were analysed by using chi-squared test. Age as a continuous variable was analyzed by using Student’s \( t \)-test. McNemar test was used in the dependent groups regarding the comparison of hairbrush, toothbrush and cotton swab methods. \( P < 0.05 \) was considered statistically significant.

**Results**

**School children**

STC was not detected in any of the participants. AC was observed in 21 (1.3\%) children out of 1560, and 13 of these were diagnosed via the hairbrush, 4 via the cotton swab and 4 via the toothbrush methods. No statistically significant difference was found between the mean ages of culture-positive (9.7 \( \pm \) 1.9) and culture-negative (10.6 \( \pm \) 2.3) cases (\( t = 1.8, \) d.f. = 1558, \( P = 0.075 \)). Nine (42.9\%) of the carriers were boys and 12 girls (57.1\%; \( \chi^2 = 1.25, \) \( P = 0.26 \)). The prevalence in Havutlu was 3.4\% (9 of 267), 1.1\% (9 of 848) in Solakli and 0.7\% (3 of 445) in Dogankent. Prevalence rates for carriers were also calculated for each classroom and varied between 0.0\% and 8.8\%. The most common isolated species was \textit{T. mentagrophytes} var. \textit{mentagrophytes} in 19 of 21 children (90.4\%) followed by \textit{T. audouinii} in 1 (4.8\%) and \textit{M. gypseum} in 1 (4.8\%).

**Risk factors**

The prevalence was closely related to race. For instance, nine participants who inhabited the Havutlu area were mostly of Arab origin and had relatively better socioeconomic
In this population of 21 culture-positive cases, the carrier state was found to be significantly higher than it was among the other participants (P = 0.005, Table 1). The presence of scalp scaling (n = 7), itching (n = 15), other dermatophytoses (n = 1), parents’ profession (farm workers = 9), family size (< 5 in 3), type of housing (animal shed proximity to residence in 2), co-sleeping (n = 13), comb sharing (n = 14), use of antidandruff shampoo (n = 6) and presence of animal pets or domestic animals (n = 13) were not found to affect the prevalence of AC (P > 0.05).

An animal contact was detected in only 13 of 19 (68.4%) school children diagnosed as carriers due to zoophilic *T. mentagrophytes*. Seven out of such carriers reported contact with dogs (five were Arab origin) and four with cats (two were of Arab origin). Being southeast Anatolian immigrants, two of the culture-positive cases reported stock breeding (cow). *Trichophyton rubrum* was isolated from the toewebs of 3 (0.2%) children, and only one of them was an asymptomatic carrier related to *T. mentagrophytes*.

### Households

The screening of 32 households of 21 children with AC made it possible to detect the carrier state in three mothers and one sister, aged between 3 and 40 years (mean, 27.0 ± 16.4 years), resulting in a total of four households (12.5%). The diagnostic method that yielded significant results in the analyses was the hairbrush method in three and the cotton swab method in one, with resulting isolation of *T. mentagrophytes* in all four. No statistically significant difference was observed in terms of gender of the carrier households (χ² = 1.8, d.f. = 1, P = 0.3). In addition, no glabrous skin and nail dermatophytosis was detected.

### Diagnosis

AC was diagnosed in 21 children and 4 households. The methods used were the hairbrush method in 16 (64%), the toothbrush in 4 (16%) and the cotton swab in 5 (20%). Clinical samples from any participant resulted positive with only one method; that is, carriage was not detected by more than one method. Although if the methods were to be used alone, the prevalence of AC would be found as 1.0% (16 of 1592) in the hairbrush, 0.3% (4 of 1592) in the toothbrush and 0.3% (5 of 1592) in the cotton swab methods, the combined use of these three methods could reveal a total prevalence of 1.6% (25 of 1592).

The hairbrush method was found to be more effective in detecting dermatophyte fungi than the toothbrush (χ² = 7.56, d.f. = 1, P < 0.01) and the cotton swab methods (χ² = 5.88, d.f. = 1, P < 0.05). There was also a marked statistically significant difference between the use of a single method and the use of a combination of methods (P < 0.005, Table 2). The number of colonies, formed by the 167 prongs per hairbrush stabbed in the culture medium, ranged from 1 to 5 in 10 of 16 (62.5%), from 6 to 10 in 4 (25%), and from 11 to 20 in 2 (12.5%).

### Table 1

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Culture positive</th>
<th>Culture negative</th>
<th>RR</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &lt; 10</td>
<td>10</td>
<td>562</td>
<td>1.6</td>
<td>0.67–3.67</td>
<td>0.29</td>
</tr>
<tr>
<td>Gender (Girl)</td>
<td>12</td>
<td>691</td>
<td>1.63</td>
<td>0.69–3.84</td>
<td>0.26</td>
</tr>
<tr>
<td>Race</td>
<td>9</td>
<td>258</td>
<td>3.55</td>
<td>1.51–8.33</td>
<td>0.005</td>
</tr>
<tr>
<td>Scaling</td>
<td>7</td>
<td>490</td>
<td>1.07</td>
<td>0.43–2.63</td>
<td>0.88</td>
</tr>
<tr>
<td>Itching</td>
<td>15</td>
<td>1105</td>
<td>0.98</td>
<td>0.38–2.52</td>
<td>0.97</td>
</tr>
<tr>
<td>Use of antidandruff shampoo</td>
<td>6</td>
<td>467</td>
<td>0.92</td>
<td>0.36–2.35</td>
<td>0.86</td>
</tr>
</tbody>
</table>

RR, relative risk; 95% CI, 95% confidence interval.

### Table 2

<table>
<thead>
<tr>
<th>Combination of all three methods</th>
<th>Positive</th>
<th>Negative</th>
<th>Total</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hairbrush</td>
<td>Positive</td>
<td>16</td>
<td>0</td>
<td>0.0019–0.0093</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>9</td>
<td>1567</td>
<td>1576</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>1567</td>
<td>1592</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toothbrush</td>
<td>Positive</td>
<td>4</td>
<td>0</td>
<td>0.0076–0.0188</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>21</td>
<td>1567</td>
<td>1588</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>1567</td>
<td>1592</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton swab</td>
<td>Positive</td>
<td>5</td>
<td>0</td>
<td>0.0071–0.0181</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>20</td>
<td>1567</td>
<td>1587</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>1567</td>
<td>1592</td>
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</table>
Discussion

STC studies targeting primary school children carried out in several provinces reported prevalence varying between 0.08% and 0.4% in Turkey.25–30 In the Adana Province, where the study was conducted, the prevalence was observed to be 0.05% and was slightly lower than other provinces in Turkey.31,32 The most common causative agents of STC according to regions were reported as M. canis in the Aegean,25 central33 and eastern Anatolia,26 T. violaceum in the Mediterranean31,32 and south-east Anatolia,27,28 and T. verrucosum in central29 and eastern Anatolia34 regions. Thus, the distribution of causative agents of STC differed from region to region and even within a single region in Turkey.

The prevalence of AC varies considerably but generally correlates well with the incidence of STC in the local population.8–10,14,17,21 In Europe, for instance, where STC has been relatively uncommon, M. canis was reported as the most common causative agent as well as T. tonsurans as an emerging pathogen.15 The prevalence of AC in school children was reported to be between 0.1% and 0.3%,7,9,10,20,21 except in the UK, where it was 4.9%.13 There was only one report from the Middle East (Palestine) with a prevalence rate of 0.8% with M. canis predominancy.14 The rate was observed to reach values as high as 4.0% to 14% in the USA, where T. tonsurans tinea capitis was endemic.8,18,19 The AC rate in Ethiopia was 17% as was stated by Figueroa et al.,17 and it was observed as 24.5% in Nigeria by Ive.11 Moreover, higher prevalence rates (49%) of AC were reported in the Cape Peninsula of South Africa, where T. violaceum tinea capitis was endemic.8

There may be different rates of detection of AC and STC in a population, but most studies indicate that the dermatophytes belong to the same species, particularly when anthropophilic species are involved.8–10,14–17,21 In contrast, Cuétara et al.10 reported M. canis as dominant species in STC and T. tonsurans in asymptomatic carriers, whereas Ali-Shtayeh et al.14 reported T. violaceum in STC and M. canis in carriers. In our study, STC was not detected in any of the participants. The absence of any STC could be explained by the low prevalence observed in the region as described above and by the relatively limited number of participants in this study. In the Cukurova region, the most common species detected in STC was anthropophilic T. violaceum followed by T. mentagrophytes, M. canis and T. tonsurans.31 However, in this study, zoophilic T. mentagrophytes (92%, 23 of 25) was the prevailing species associated with AC, as in our previous study,21 contrary to being of anthropophilic nature.1,8,10–13,15–19,22,23

More recently, we reported that AC as well as STC rates were found to be rather low, as 0.1% in Adana, probably due to the use of cotton swab method only or as an indicator of a lower prevalence in Europe.21 To the best of our knowledge, the methods for diagnosing AC were first compared in this study, and prevalence was found to be 1.6% by using the three methods in combination. It would seem that for any carrier, only one of the three methods was positive at any one time. In this case, it is true to say that total number of asymptomatic carriers detected is the sum of the results from three different methods. The high prevalence of AC may have resulted from the combined use of these three methods in diagnosing the carrier state (Table 2). However, the hairbrush method was found much more effective in detecting the dermatophyte fungi than the toothbrush (P < 0.01) and the cotton swab methods (P < 0.05). Our expectancy was to determine a method to be accepted as a gold standard for the isolation of dermatophyte fungi in carriers. But none of the three methods could identify all carriers. Hence, we ranked these three methods on their detecting rates, with the hairbrush method predominating on the others.

In this study, the hairbrush with a greater surface area (38 cm² vs. 3 cm² and 2 cm²) compared with the other methods is thought to cause higher rate of isolation. However, the more likely scenario would be that using hairbrush would first pick up these fungi, not leaving enough fungal material to be picked up by other methods. The results showed the hairbrush as the preferred method, but the disadvantage of this method was that its isolation power remained at 64%, having isolated 16 of 25 carriers, while the remaining ones being isolated by one of the two other methods.

The advantage of the hairbrush method was assessing the spore load and consequently the degree of contagiousity of carriage, providing foresee on how AC would be handled, whether clinical lesions would develop, whether carrier state would continue or it would become culture negative. Asymptomatic carriers, who had low spore loads and were likely to lose their carrier state, were transiently colonised with spores. Alternatively, carriers who had very high spore loads and were more likely to remain culture-positive overtime may have had a heavy colonisation or an occult infection producing numerous spores.12,14,18 In our study, only 2 of the 16 (12.5%) carriers had high spore load with the hairbrush method. The drawbacks of the use of toothbrush or cotton swab method were also their low efficacy in isolating the dermatophytes from scalp and their lack of ability to predict the spore load. In contrast, Williams et al.18 were able to quantify the spore load via the toothbrush method for both AC and STC.

Ghammoum et al.8 showed that the incidence of AC in children had increased in races like Afro American, the presence of scaling and the use of antifungal shampoo...
being important predictors. We detected the only risk factor as a race (Arab origin) that was associated with the increase of AC prevalence \( (P = 0.005, \text{Table 1}) \). Patients of Arab origin may have a higher risk of carriage as contact with cats and especially with dogs was more frequent in cases with Arab origin. The results of this study may reflect the role of a close contact with cats and dogs as well as stock breeding (cows) for asymptomatic carriers. Therefore, these animals might be potential source of infection involving zoophilic \text{T. mentagrophytes}. However, one of the limitations of this study was that it was conducted in a rural area, where pet feeding inside homes was uncommon hindering sampling from animals risky for contact with children. The predominance of zoophilic fungi may also derive from inadequate veterinary control in the region, furthermore indicating the need for emphasis on veterinary practice. In our study, anthropophilic \text{T. audouinii} (4%) and geophilic \text{M. gypseum} (4%) were also isolated. More recently, the latter was isolated as a causative agent of kerion Celsi in our region. 

Midgley and Clayton\textsuperscript{12} reported that AC occurred more often in patients with tinea cruris than in those with only loot and/or hand dermatophytosis. Cué\texttt{t}ara \textit{et al.}\textsuperscript{10} pointed out that 42\% of carriers had also evident ringworm lesions in other body sites (i.e. tinea faciei and tinea corporis or both). We also examined the glabrous skin and nails of the children; however, we detected only one case of tinea pedis due to \text{T. rubrum} among the school children. Our results were confirmed by Ghannoum \textit{et al.}\textsuperscript{17} who also did not observe any association between overcrowding in the home and the carrier state. On the other hand, Babel and Baughman\textsuperscript{22} noted that the majority of the adults studied were female (92.9\%) because most paediatric patients were accompanied at the clinic visits by their mothers or grandmothers. Similarly, all four of the households in our study were female, three being mothers and one sister.

It is clear that to better control the spread of AC, we need to know more about its epidemiology.\textsuperscript{18} However, ways of spreading are not clear.\textsuperscript{19} It is argued whether spread of anthropophilic infections is based on spread in schools, in the households or on the use of common barbers.\textsuperscript{5,36} In this study, relying on the findings, it was not possible to identify the source of transmission. However, the isolation of \text{T. mentagrophytes} from asymptomatic carriers and their households would suggest that these individuals were exposed to the same source of contamination (i.e. an infected animal, person-to-person transmission of zoophilic dermatophytes, though not being common).

As discussed above, it is understood that in any region, AC is important in determining scalp dermatophyte flora as well as STC. However, most of the carriers remain undetected and unreported. Therefore, carrier state has a significant public health importance.\textsuperscript{21} Our results may also suggest that actual prevalence of AC could be higher than the estimated prevalence. In summary, the total prevalence of AC was 1.6\%, with no STC being detected in this study. The most common dermatophyte (> 90\% of isolates) isolated from asymptomatic carriers was the zoophilic \text{T. mentagrophytes}. In addition, AC was not associated with age, gender and coexistence of other dermatophytes, whereas race (Arab origin) was the only risk factor associated with increasing prevalence. We conclude that the challenge still remains to determine the gold standard method for detecting the carrier state.

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References

Diagnosing asymptomatic scalp carriage

Akbaba et al.