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Prevalence of Undetected Tinea Capitis in School Children in Nablus Area

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DEDICATION

TO

My wife for her support and

encouragement

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ABSTRACT

A study of tinea capitis was carried out during October 1998 in 8531 school children aged 6-14 years (4718 males and 3813 females), attending 12 primary schools located in urban, rural, and refugee camp communities in the Nablus district in the Palestinian Authority. A total of ~ 1389 of the school children aged 6-12 years (724 males and 665 females) were also surveyed on three occasions at 2-3 months intervals, over a 9-month period (October 1998 - May 1999) using the hair brush technique, for prevalence of asymptomatic tinea capitis carriage.

Twenty-three (0.27 %) mycologically proven cases of tinea capitis were detected. The incidence was higher in refugee camp children (0.43 %) than in rural and urban children (0.2 %). Also the incidence was higher in younger children (0.33 %; 22/6760) aged 6-12 years than in older children (0.06 %; 1/1771) aged 12-14 years. Boys were more commonly (0.38 %) affected than girls (0.13 %). The most prevalent etiological agent was the anthropophilic dermatophyte *Trichophyton violaceum* (82.6 % of all cases) followed by *Microsporum canis* (zoophilic) (17.4 %).

A total of 32 asymptomatic carriers (carriage rate = 0.78 %) were detected. The highest carriage rate was found in refugee camp school children (1.52 %) followed by rural (0.7 %) and urban (0.54 %) children. Carriage rate was higher in winter ranging from 1.02 - 3.01 % in the different communities, than in spring (0.3 - 1.5 %) and autumn (0 - 0.24 %).

Six dermatophytes species were isolated from asymptomatic carriers. The most prevalent species recovered was *M. canis* (65.6 %; 21/32), followed by *T. tonsurans* (12.5 %; 4/32), *M. nanum* (9.4 %; 3/32), *T. violaceum* (6.3 %; 2/32), and *T. concentricum* and *Epidermophyton floccosum* (3.1 % each; 1/32). Carriage rate was higher in male children (1.02 %; 22/2165) than in females (0.51 %; 10/1954). Also, carriage rate was higher in younger children < 10 years old (0.9 %; 24/2762) than in older children > 10 years old (0.6 %; 8/1357). Results on spore load distribution in asymptomatic carriers showed that 96.9 % (31 out of 32) had a spore load of 1-10 colonies per carrier, and only 3.1 % (1 out of 32) of carriers had a spore load of > 10 colonies per carrier. Weak correlation was found in both asymptomatic carriers and index cases between spore load of dermatophytes and non-dermatophytes. However, percentages of children with spore load of > 10 spores / carrier of both dermatophytes and non-dermatophytes were higher in index cases (4.3 % and 17.4%, respectively) than for those in asymptomatic carriers (3.1% and 3.1%, respectively).

Hair and scalp mycobiota of ~ 1389 clinically normal children aged 6-12 years attending 12 schools in the Nablus District, Palestinian Authority, was assessed on three occasions over 9-month period (October 1998 - May 1999) using the hair brush technique.

One hundred and one fungal species belonging to 33 genera were recovered: 6 dermatophytes, 16 dermatophyte-related keratinophilic fungi, and 79 other keratinophilic fungal species. Species varied considerably in their frequency of occurrence and abundance based on their relative importance values (RIVs).

The most frequent and abundant species were: *Cladosporium cladosporioides, Cl. herbarum, Penicillium chrysogenum* and *Aspergillus flavus. Microsporum canis, Aphanoascus fulvescence* and *Chrysosporum sulfureum* were the most frequent and abundant species of all dermatophytes and dermatophyte-related keratinophilic fungi recovered.

The most frequent and abundant dermatophytes in different communities were *M. canis* in rural (RIV 0.87) and urban children (0.45), and *Trichophyton violaceum* (1.41) in refugee camp children. *Chrysosporium* species were the most frequent and abundant dermatophyte-related keratinophilic fungus in children from all localities followed by *Aphanoascus fulvescence.*

Comparable results on the frequency and abundance of human hair and scalp mycobiota component fungi were obtained based on age group and sex of children.

Higher number of species was recovered in spring months (73 species) than in autumn (57) and winter (44) months. Similar occurrence pattern was also noted for dermatophyte-related keratinophilic species and dermatophytes.

Higher percentages of children with moderate (11-50) and heavy (> 50) spore loads (7.54 and 0.73, respectively) were found in urban school children community than in rural and refugee camp school children (4.7 and 0.1, respectively) ($p > 0.05$). Also significantly higher light (1-10) spore load percentages were found in rural (63.67) and refugee camp (62.9) than in urban children (52.6) ($p > 0.05$). Of all localities, school children with light spore load comprised the highest percentage of the children examined (37.4), followed by moderate (6.13), and heavy (0.41) spore load categories ($F= 4.51$, $df= 2, 33$, $p= 0.02$). However, children with undetected spore load comprised 36.05 % of all children. Spore load distribution did not show clear seasonal variations in the study period.

Significantly higher percentage of moderate and heavy spore load was found in male children (8.72 and 0.69, respectively) than in female children (3.4 and 0.1, respectively). However, higher percentages of undetected (38.3) or light spore loads (58.4) were found in females than in males (34.04 and 56.53, respectively). Spore load distribution in both male and female school children did not show clear seasonal variation.

CHAPTER ONE

GENERAL INTRODUCTION

CHAPTRER ONE

GENERAL INTRODUCTION

1.1 Asymptomatic carriage state

Tinea capitis, an infection caused by dermatophytes, is a common childhood disease. Family members and school children are known to be at higher risk to contract the disease (Silverman, 1992; MacKenzie, 1961). This was attributed partly to the asymptomatic carrier state and contaminated fomites (Elweski, 1996; Babel & Baughman, 1989).

The carrier is defined as an individual who harbors in his/her body a specific organism of a disease without manifest symptoms and thus acts as a carrier or distributor of the infection (Dorland's Illustrated Medical Dictionary, 1965). A semi-quantitative definition of the carrier state refers to those cases with less than 10 fungal colonies in cultures as carriers, and those with more than 10 as infected (Hay et al., 1996). However, most researchers accept a clinical definition of any person with no signs or symptoms of tinea capitis, but with a positive scalp fungal cultures, as being

asymptomatic carrier (Williams et al., 1995; Vargo & Cohen, 1993; Babel & Baughman, 1989).

MacKenzie et al. (1960) were among the first to recognize this state in tinea capitis. They considered it as the most important factor responsible for the inability to detect infection and thus resulting in the prevention of complete elimination of the pathogen.

Asymptomatic carriage is now considered as a major reservoir of infection (Vargo & Cohen, 1993; Neil et al., 1990; Hubbard & de Triquet, 1992; Head et al., 1984) and appears to be organism–specific (Frieden, 1999). Anthrpophilic organisms (usually *Trichophyton tonsurans* and *T. violaceum*) are thought to be associated with high rates of asymptomatic carriage (Frieden, 1999). These organisms generally cause varied signs of overt infection (seborheic dermatitis – like tinea capitis with a mild or absent inflammatory response), and lack host response which make them good candidates for asymptomatic carriage (Babel et al., 1990). Zoophilic organisms such as *Microsporum canis* and *T. mentagrophytes*, on the other hand,

cause a strong inflammatory response and are therefore, thought to be less likely to lead to asymptomatic carriage (Frieden, 1999).

The prevalence of asymptomatic carriers is thought to be correlated with incidence rates of tinea capitis in the community (Frieden, 1999). In Spain and Italy where tinea capitis has been relatively rare, prevalence rates of the carriage state were 0.2%, and 0.3%, respectively (Cuetara et al., 1997; Polonelii et al., 1982). On the other hand, a prevalence of 49% was reported from South Africa where *T. violaceum* tinea capitis is endemic (Neil et al., 1990). However, the majority of studies examining at-risk populations of children (i.e. those in a school or community where tinea capitis is common) have found point-prevalence rates for asymptomatic carriage ~15 % (c. f. Frieden, 1999).

Asymptomatic carriage has also been demonstrated in adults and children living with an index case of tinea capitis (Babel & Baughman, 1998; Vargo & Cohen, 1993). The risk factors for carriage are expected to be closely parallel to those of overt infection. Although it was reported in adults, most carriage has been reported in

children (especially those between 4 and 8 years) with male and female children equally affected (Figueroa et al., 1997).

1.2 Prognosis and treatment

The prognosis and the treatment of carrier state have been studied by only a few workers. Williams et al. (1995) studied a primary school with a 14% of asymptomatic carriage rate with no treatment and a mean of 2-3 months of follow-up, and found that 4% became overtly symptomatic, 58% remained culture-positive and 38% became culture negative. Ive (1966) and Neil et al. (1990) followed carriers of *M. audouinii* and *T. violaceum* for more than 6 weeks and noted persistent carriage of 42% and 25%, respectively.

A few studies has also been conducted to determine the efficacy of different shampoos for treating the carrier state of tinea capitis (Neil et al., 1990). Although this study shows that povidon-iodine may be the preferable topical medication, it remains unknown whether the responses with other dermatophytes would be similar to those with *T. violaceum* the organism responsible for the

infection in Neil's study. More studies are still needed to determine the most effective method of treating asymptomatic carriage since spontaneous clearing appears to occur in only a few cases (Frieden, 1999).

1.3 Human hair mycobiota

A knowledge of the frequency and extension of etiological agents of human and animal mycoses and other potentially pathogenic fungi on the healthy hair of humans is of prime importance for the understanding of epidemiological cycles of these fungi (Otcenasek, 1978). The presence and frequency of occurrence of dermatophytes and other keratinophilic fungi mainly forming hair mycobiota of domestic animals have been investigated by only a few workers from different parts of the world (Bagy & Abdel-Hafez, 1985; Bagy, 1986; Zaror et al., 1986). In Palestine (West Bank), Ali-Shtayeh et al. (1988a, 1988b, 1989) studied hair mycobiota of different healthy domestic animals, and found that the majority (55-88%) of keratinophilic fungi they isolated were pathogenic or had

been recorded from various animal lesions. It was therefore indicated that infected and carrier animals may act as a direct source of human and animal infection for subjects in direct contact with them, or as an indirect source of infection by contaminating work area and dwelling places. A similar situation might exist with human hair mycobiota. However, apart from a few studies on dermatophyte carriers on humans (Frieden, 1999), information on human hair mycobiota especially keratinophilic fungi is lacking.

1.4 Objectives

This study was designed to determine the prevalence of asymptomatic carrier of tinea capitis of school children in rural, refugee camps, and urban areas in the Nablus area. It was also aimed at quantifying and comparing spore loads of dermatophytes and non-dermatophytes in asymptomatic carriers versus individuals with apparent infections. This study was also aimed at investigating the biodiversity of dermatophytes and other keratinophilic mycobiota of healthy hair of school children, in an attempt to elucidate the role of hair in the

epidemiology of human mycoses, especially in the school environment.

CHAPTER TWO

SUBJECTS, MATERIALS AND METHODS

CHAPTER TWO
SUBJECTS, MATERIALS AND METHODS

2.1 Subjects

A total of 8531 children aged 6-14 years, comprising 4718 males and 3813 females, attending twelve primary schools in Nablus District, were surveyed for tinea capitis infections in October 1998 (Table 2.1). The schools were selected in a way as to represent different hygienic conditions, habitats, and socioeconomic backgrounds (i.e., urban, 6 schools; refugee camp, 2; and rural, 4). First to 8th grade classes (217 classes) were chosen for examination at each school. One class of each of 1st, 3rd, and 5th grade classes (3 classes of each of the 12 schools) were surveyed on three occasions over a period of 8 months (October 1998 - May 1999) for dermatophyte carriers and for hair and scalp mycobiota in children.

2.2 Clinical inspection and collection of epidemiological data

The survey procedure involved clinical inspection of children's scalps, and number of children with clinical signs of tinea capitis was

recorded. In all cases, details were taken of age, sex, parents' profession, family size, and presence of animal pets or domestic animals in the child's environment.

Table 2.1 Distribution of school children from different primary schools in Nablus area examined for tinea capitis (index cases) over an eight month period, on the basis of residence places, age, and sex.

School name (sex)	Age (years)				Total
	6-8	8-10	10-12	12-14	
Urban area					
1.Iben Kotaiba (M)	194	207	257	230	**888**
2. Amro Ben Ala`s (M)	252	213	290	109	**864**
3. Saed Sayel (M)	90	94	115	95	**394**
Total males for Urban	**536**	**514**	**662**	**434**	**2146**
4. Fehmi Al-Saifi (F)	140	134	128	104	**506**
5. Rafidia (F)	128	155	139	113	**535**
6. Al- Nethameya (F)	107	114	90	-	**311**
Total females for Urban	**375**	**403**	**357**	**217**	**1352**
Total for Urban	**911**	**917**	**1019**	**651**	**3498**
Rural area					
7. Deir Sharaf (M)	59	66	47	46	**218**
8. Beit Foreek (M)	280	253	231	233	**997**
Total males for Rural	**339**	**319**	**278**	**279**	**1215**
9. Deir Sharaf (F)	72	58	55	55	**240**
10. Beit Foreek (F)	269	263	236	238	**1006**
Total females for Rural	**341**	**321**	**291**	**293**	**1246**
Total for Rural	**680**	**640**	**569**	**572**	**2461**
Refugee Camp area					
11. Third Balata (M)	355	444	321	237	**1357**
Total males for Refugee Camp	**355**	**444**	**321**	**237**	**1357**
12. First Balata (F)	**252**	360	292	311	**1215**
Total females for Refugee Camp	**252**	**360**	**292**	**311**	**1215**
Total for Refugee Camp	**607**	**804**	**613**	**548**	**2572**
Total (all schools)	**2198**	**2361**	**2201**	**1771**	**8531**
Total number of classes	**56**	**60**	**55**	**46**	**217**

2.3 Collection and processing of clinical specimens

Each lesion from each suspected case was thoroughly cleaned with 70 % ethyl alcohol and skin scrapings and hair were collected from the edge of the lesion using heat-sterilized razor blades. Specimens were wrapped in sterile brown paper packets, and transported to the laboratory and processed the same day or within 48 hrs of collection. Direct microscopic examination for each specimen was carried out using 10 % KOH solution to check for the presence of hyphae and/or arthrospores.

2.4 Culture of clinical specimens and identification of dermatophytes

A portion of each specimen was cultured on two slopes of Sabouraud dextrose agar (SDA) amended with chloramphenicol (0.05 mg/ml) and cycloheximide (0.5 mg/ml). Cultures were then incubated at 24-25 °C, regularly examined up to 3 weeks and identified using standard methods (Rebell & Taplin, 1979).

2.5 Determination of hair mycobiota and carriage rates of dermatophytes using the hair brush technique

Carriage rates of dermatophytes on the hair and scalps of clinically normal children attending the schools (1st, 3rd, and 5th grades; 36 classes) were assessed on three occasions (Oct. 98, Feb. 99, and May 99) using the hair brush technique (Mackenzie, 1963). Numbers of children (aged 6-11 years comprising 1.1 males: 1 females) examined on each occasion are presented in Table 2.2. Cultures from all children in a class of each of the above-mentioned grades at each school were performed. Scalp samples were collected by brushing the right and the left sides of the scalp of each child 4 times, using a commercially available massage brush that had been dipped in sterile 0.1 % Tween-80. The brush was then pressed onto plates of SDA amended with chloramphenicol (0.05 mg/ml) and cycloheximide (0.5 mg/ml). The plates were incubated at 24-25 °C, regularly examined up to 3 weeks and total colony counts of dermatophytes and other keratinophilic fungi (equivalent to number of colony forming units retrieved) on each plate were recorded for each child. Dermatophytes were identified based on gross and

microscopic morphology and by other *in vitro* tests, as required. A spore load system was assigned as follows: light, 1 to 5 colonies; moderate, 6 to 10 colonies; and heavy, > 10 colonies.

2.6 Statistical analysis

Data on distribution of spore load categories among children were analyzed using ANOVA test to detect for significant differences in relation to locality, season, sex and age. Means separation was carried out using the LSD, or Post-Hock (Scheffe's) tests. Also t-test was used to detect for significance between pairs of variables ($P < 0.05$). Results of statistical analysis are presented in Appendix B.

The relative importance value, RIV, for each species was calculated following (Ali-Shtayeh et al., 1999). This value was based on; number of positive children and number of isolates recovered of this species. The RIV was calculated as follows:

1. Frequency of occurrence of a species (A-value)= number of positive children / total number of children examined.

2. Mean sample frequency (B-value)= (number of isolates of the species / total number of isolates of all species X n). n= 220 number of fibers of comb used for sampling.

3. Relative mean frequency (C-value)= B-value of the species / sum of B-values of all species recovered.

4. RIV = (A-value + C-value) X 100.

Table 2.2 Distribution of school children from different primary schools in the Nablus area examined for asymptomatic carrier state and hair mycobiota, on the basis of residence places, age, sex, and sampling season.

School name (sex*)	Age group												
	1st, 6-7			3rd, 8-9			5th, 10-11			Total / season			
Season**	A	W	S	A	W	S	A	W	S	A	W	S	Total
Urban area													
1.Iben Kotaiba (M)	45	45	45	42	42	42	45	45	45	132	132	132	396
2. Amro Ben Ala's (M)	41	42	42	46	46	46	39	39	39	126	127	127	380
3. Saed Sayel (M)	39	41	41	49	49	49	30	30	30	118	120	120	358
Total males for Urban	125	128	128	137	137	137	114	114	114	376	379	379	1134
4. Fehmi Al-Saifi (F)	28	33	33	33	34	34	29	32	32	90	99	99	288
5. Rafidia (F)	30	30	30	40	42	42	35	38	38	105	110	110	325
6. Al- Nethameya (F)	26	29	29	26	27	27	43	44	44	95	100	100	295
Total females for Urban	84	92	92	99	103	103	107	114	114	290	309	309	908
Total for Urban	209	220	220	236	240	240	221	228	228	666	688	688	2042
Rural area													
7. Deir Sharaf (M)	35	35	35	33	33	33	23	23	23	91	91	91	273
8. Beit Foreek (M)	42	42	42	41	41	41	40	40	40	123	123	123	369
Total males for Rural	77	77	77	74	74	74	63	63	63	214	214	214	642
9. Deir Sharaf (F)	35	38	38	23	25	25	31	31	31	89	94	94	277
10. Beit Foreek (F)	43	44	44	35	37	37	38	46	46	116	127	127	370
Total females for Rural	78	82	82	58	62	62	69	77	77	205	221	221	647
Total for Rural	155	159	159	132	136	136	132	140	140	419	435	435	1289
Refugee Camp													
11. Third Balata (M)	40	43	43	41	42	42	46	46	46	127	131	131	389
Total males for Refugee Camps	40	43	43	41	42	42	46	46	46	127	131	131	389
12. First Balata (F)	41	43	43	46	48	48	42	44	44	129	135	135	399
Total females for Refugee Camp	41	43	43	46	48	48	42	44	44	129	135	135	399
Total for Refugee Camp	81	86	86	87	90	90	88	90	90	256	266	266	788
Total (all schools)	445	465	465	455	466	466	441	458	458	1341	1389	1389	4119

* * A, autumn; W, winter; S, spring. * M, male; F, female.

CHAPTER THREE

RESULTS

CHAPTER THREE

RESULTS

3.1 Prevalence of symptomatic tinea capitis in school children

The distribution of index tinea capitis cases (23 cases) (Table 3.1) showed a prevalence rate of 0.27 % in school children (8531). Highest infection rate (0.43 %; 11 out of 2572) was found in refugee camp population, followed by rural (0.2 %; 5 out of 2461) and urban children (0.2 %; 7 out of 3498) (χ^2 = 3.4; df = 2; p = 0.182). A higher proportion of tinea capitis cases were encountered in males (0.38 %; 18 out of 4718) than in females (0.13 %; 5 out of 3813) (χ^2 = 9.14; df = 1; p = 0.0025). Differences in the distribution of tinea capitis cases between age groups showed that the highest proportion of these cases (47.8 %; 11 out of 23) was found in the age group 10-12 years old, whereas the lowest proportion (4.3 %; 1 out of 23) was found in the age group > 12 years old (χ^2 = 7.5; df = 3; p = 0.0575).

3.2 Etiological agents isolated from symptomatic tinea capitis cases

Two etiological agents were isolated from tinea capitis cases: *Trichophyton violaceum* and *Microsporum canis*. The most prevalent

agent was *T. violaceum* (anthropophilic) being found in 19 out of 23 cases (82.6 %) followed by *M. canis* (zoophilic) which was found in 4 cases (17.4 %) (Table 3.2) (χ^2 = 8.51; df = 1; p = 0.003).

Table 3.1 Distribution of tinea capitis index cases according to age, sex and locality

	Urban		Rural		Refugee Camp		Total	
Sex	M	F	M	F	M	F	M	F
Number of children	2146	1352	1215	1246	1357	1215	4718	3813
Age group								
6-8	3	0	1	1	0	0	4	1
8-10	3	0	1	1	0	1	4	2
10-12	1	0	1	0	7	2	9	2
12-14	0	0	0	0	1	0	1	0
14-16	0	0	0	0	0	0	0	0
Total	7	0	3	2	8	3	18	5
Infection rate (%)	0.33	0	0.25	0.16	0.59	0.25	0.38	0.13
	0.2		0.2		0.43		0.27	

Table 3.2 Results of mycological studies of tinea capitis cases.

	Community			
Number of children examined Species	Urban 3498	Rural 2461	Refugee camp 2572	Total 8531
Microsporum canis	2	1	1	4
Trichophyton violaceum	5	4	10	19
Total	7	5	11	23

3.3 Distribution of asymptomatic tinea capitis scalp carriers and their carriage of dermatophytes

Distribution of asymptomatic tinea capitis scalp carriers and their carriage of dermatophytes in the surveyed school children are

presented in Tables 3.3 & 3.4. A total of 32 asymptomatic carriers (carriage rate = 0.78 %) were detected. The highest carriage rate was found in refugee camp school children (1.52 %) followed by rural (0.7 %) and urban (0.54 %) children (Table 3.3) (χ^2 = 7.14; df = 2; p = 0.028). Carriage rate was higher in winter ranging from 1.02 - 3.01 % in the different communities, than in spring (0.3 - 1.5 %) and autumn (0 - 0.24 %) (Table 3.3) (χ^2 = 15.5; df = 2; p = 0.0004).

Table3.3 Carriage of dermatophytes in asymptomatic tinea capitis scalp carriers.

	Community												Total
	Urban				Rural				Refugee camp				
Number of children surveyed	666	688	688		419	435	435		256	266	266		
Season* / Species	A	W	S	Total	A	W	S	Total	A	W	S	Total	
Epidermophyton floccosum	0	0	1	1	0	0	0	0	0	0	0	0	1
Microsporum canis	0	7	0	7	0	6	1	7	0	7	0	7	21
M. nanum	2	0	0	2	1	0	0	1	0	0	0	0	3
Trichophyton concentricum	0	0	0	0	0	0	1	1	0	0	0	0	1
T. tonsurans	0	0	1	1	0	0	0	0	0	0	3	3	4
T.violaceum	0	0	0	0	0	0	0	0	0	1	1	2	2
Total	2	7	2	11	1	6	2	9	0	8	4	12	32
Carriage rate (%)	0.3	1.02	0.3	0.54	0.24	1.38	0.46	0.7	0	3.01	1.5	1.52	0.78

*A. autumn; W, winter; S. spring

Six dermatophytes species were isolated from asymptomatic carriers (Table 3.3). The most prevalent species recovered was *M. canis* (65.6 %; 21 out of 32), followed by *T. tonsurans* (12.5 %; 4 out of 32), *M. nanum* (9.4 %; 3 out of 32), *T. violaceum* (6.3 %; 2 out of

32), and *T. concentricum* and *Epidermophyton floccosum* (3.1 % each; 1 out of 32) (χ^2 = 56.26; df = 5; p = 0.0006).

Carriage rate was higher in male children (1.02 %; 22 out of 2165) than in females (0.51 %; 10 out of 1954) (Table 3.4) (χ^2 = 2.72; df = 1; p = 0.09). Also, carriage rate was higher in younger children, < 10 years old (0.9 %; 24 out of 2762) than in older children, > 10 years old (0.6 %; 8 out of 1357) (Table 3.4) (χ^2 = 0.91; df = 2; p = 0.634).

Table 3.4 Distribution of asymptomatic carriers according to age and sex.

Sex	M	F	Number of children in each age group	Carriage rate (%)
Number of children	2165	1954		
Age group				
6-8	9	3	1375	0.9
8-10	8	4	1387	0.9
10-12	5	3	1357	0.6
Total	22	10	4119	0.78
Carriage rate (%)	1.02	0.51		

3.4 Results on spore load distribution in asymptomatic carriers

Results on spore load distribution in asymptomatic carriers showed that 96.9 % (31 out of 32) had a spore load of 1-10 colonies per carrier, and only 3.1 % (1 out of 32) of carriers had a spore load of > 10 colonies per carrier (Table 3.5).

Weak correlation was found in both asymptomatic carriers and index cases between spore load of dermatophytes and non-dermatophytes (Table 3.6). However, proportions of children with spore load of > 10 spores / carrier of both dermatophytes and non-dermatophytes were higher in index cases (4.3 % and 17.4%, respectively) than for those in asymptomatic carriers (3.1% and 3.1%, respectively).

Table 3.5 Spore load distribution in asymptomatic carriers (number of carriers and (%)).

	Spore Load*								
	Light to Moderate				Heavy				Total
Locality	A**	W	S	Total	A	W	S	Total	
Urban	2(18.8)	7(63.6)	2(18.18)	11(١٠٠)	0(0)	0(0)	0(0)	0(0)	11(34.38)
Rural	1(11.1)	6(66.7)	2(22.2)	9(100)	0(0)	0(0)	0(0)	0(0)	9(28.12)
Refugee camp	0(0)	8(72.7)	3(27.3)	11(100)	0(0)	0(0)	1(100)	1(100)	12(37.5)
Totals	3(9.68)	21(67.74)	7(22.58)	31(100)	0(0)	0(0)	1(100)	1(100)	32(100)

* Light to moderate 1-10 colonies; heavy >10.
** A, autumn; W, winter; S, spring.

Table 3.6 Spore load of dermatophytes and nondermatophytes of asymptomatic carriers and index cases.

	Spore load			
	Spore free 0	Light 1-5	Moderate 6-10	Heavy >10
Index cases (n= 23)				
Dermatophyte	21 (91.3)	1 (4.3)	0 (0)	1 (4.3)
Nondermatophytes	2 (8.7)	12 (52.2)	3 (13.0)	4 (17.4)
Asymptomatic carriers (n= 32)				
Dermatophyte	0 (0)	30 (93.8)	1 (3.1)	1 (3.1)
Nondermatophytes	12 (37.5)	15 (46.9)	4 (12.5)	1 (3.1)

3.5 Human hair and scalp mycobiota

3.5.1 Distribution, frequency and abundance of component fungi

Results on distribution, frequency and abundance of component fungi of human hair and scalp mycobiota are presented in (Tables 3.7- 3.11). One hundred and one fungal species belonging to 33 genera were recovered (Table 3.7): 6 dermatophytes, 16 dermatophyte-related keratinophilic fungi, and 79 other keratinophilic fungal species. Species varied considerably in their frequency of occurrence and abundance based on their RIV values (RIV range 0.03-50); isolates recovered range (1-4312). Twenty - seven of all species isolated had RIV $\geq$ 1, whereas 74 species had RIV < 1.

The most frequent and abundant species among fungi with RIV $\geq$ 1 were: *Cladosporium cladosporioides* (50), followed by *C. herbarum* (22.8), *Penicillium chrysogenum* (14.3) and *Aspergillus flavus* (10.4). *Microsporum canis* (0.68), *Aphanoascus fulvescence* (3.1) and *Chrysosporum sulfureum* (1.52) were the most frequent and abundant species of all dermatophytes and dermatophyte-related keratinophilic fungi recovered.

Higher numbers of species were recovered from rural community school children (90) than urban school children (82) and refugee camp (76) (Table 3.8). Also higher numbers of dermatophytes (4 species) were isolated from rural children, and urban than refugee camp children (2). However, 13 dermatophyte related keratinophilic fungal species were recovered from each of the above mentioned communities. Higher number of keratinophilic species with RIV $\geq$ 1 were isolated from refugee camp (40) followed by rural children (31) and urban children (25).

The most frequent and abundant dermatophytes were *M. canis* in rural (RIV 0.87) and urban children (0.45), and *Trichophyton violaceum* (1.41) in refugee camp children. *Chrysosporium* species were the most frequent and abundant dermatophyte-related keratinophilic fungus in children from all localities followed by *Aphanoascus fulvescence*.

Results on the distribution of hair mycobiota in males and females indicated comparable composition, frequency, and abundance in both sexes (Table 3.9). However, *M. canis* showed

higher frequency and abundance in males (RIV= 0.96) than in females (0.48).

Comparable results on the frequency and abundance of human hair and scalp mycobiota component fungi were obtained in children based on age group (Table 3.10). However, younger age group (6-7 years old) children gave larger number of isolates of *M. canis* (RIV= 0.92) than children of the other two age groups studied.

Higher number of species was recovered in spring months (73 species) than in autumn (57) and winter (44) months (Table 3.11). Similar occurrence pattern was also noted for dermatophyte-related keratinophilic species and dermatophytes. Species with highest RIV values included *Penicillium chrysogenum* (36.3) in autumn, and *Cladosporium cladosporioides* in winter and spring with RIV's of 69.8, and 133, respectively. Dermatophytes species with highest RIV's were *T. violaceum* (0.41 in autumn), *M. canis* (2.29 in winter) and *T. tonsurans* (0.45 in spring). Dermatophyte related keratinophilic fungi with highest RIV included *Aphanoascus fulvescence* (4.47 in autumn), *Chrysosporum keratinophilum* (3.78 in winter) and *Ch. sulfureum* (5.67 in spring).

Table 3.7 Scalp hair mycobiota of school children surveyed in different schools in the Nablus area.

Species isolated	Total number of isolates recovered	Total number of positive children	RIV
Dermatophytes			
Epidermophyton floccosum (Hartz) Longeron et Milochevitch	2	1	**0.04**
Microsporum canis Bodin	31	21	**0.68**
M. nanum Fuentes	3	3	**0.09**
Trichophyton concentricum Blanchard	1	1	**0.03**
T. tonsurans Malmsten	5	4	**0.12**
T. violaceum Bodin	30	2	**0.21**
Dermatophyte related fungi			
Aphanoascus fulvescens (Cooke) Apinis	177	88	**3.1**
Arthroderma cuniculi Dawson	48	18	**0.7**
Chrysosporium asperatum Carm.	6	4	**0.13**
Ch.. carmichaelii Van Oorschot	52	27	**0.94**
Ch. farinicola (Burnside) Skou	9	2	**0.1**
Ch. georgii (Varsavsky & Ajello) Van Oorsch	2	2	**0.06**
Ch. keratinophilum D. Frey ex Carmichael	75	39	**1.35**
Ch. merdarium (ink ex Grev.) Carmichael	33	21	**0.69**
Ch. pannicola (Corda) Van Oorschot & Stalpers	26	16	**0.53**
Ch. pannorum (Link) Hughes	2	2	**0.06**
Ch. pseudomerdarium Van Oorschot	15	12	**0.37**
Ch. queenslandicum Apinis & Rees	3	2	**0.06**
Ch. sulfureum (Fiedl.) Van Oorschot & Samson	70	47	**1.52**
Ch. tropicum Carmaichael	23	17	**0.54**
Ch. xerophilum Pitt	50	14	**0.61**
Gymnoascus demonbreunii Ajello & Cheng	3	2	**0.06**
Other keratinophilic fungi with RIV $\geq$ 1*			
Acremonium furcatum F. & V. Moreau ex W. Gams	80	35	**1.28**
Ac. kiliense Grutz	143	72	**2.52**
Ac. strictum W. Gams	179	103	**3.47**
Alternaria alternata (Fr.) Keissler	225	141	**4.64**
Aspergillus flavus Link ex Gray	1047	190	**10.4**
As. glaucus Link ex Gray	76	28	**1.09**
As wentii Wehmer	101	46	**1.67**
Cladosporium cladosporioides (Fres.) de Varies	4412	1064	**50**
Cl. herbarum (Pers.) Link ex Gray	1763	542	**22.8**
Cl. macrocarpum Preuss	255	122	**4.35**
Cl. sphaerospermum Penz	307	86	**3.77**
Doratomyces stemonitis (Pers. ex steud.) Morton & G. Sm	96	47	**1.66**
Geotrichum candidum Link ex Leman	214	70	**2.87**
Memnoniella echinata (Riv) Galloway	52	34	**1.11**
Moniliella acetoabutans Stolk & Dakin	67	46	**1.48**
Penicillium brevi-compactum Dierckx	272	27	**2.15**
P. chrysogenum Thom	1661	214	**14.3**
P. citrinum Thom	229	76	**3.1**
P. fellutanum Biourge	211	36	**2.03**
P. griseofulvum Dierckx	179	52	**2.24**
P. purpurescens (Sopp) Raper and Thom	81	33	**1.24**
P. purpurogenum Stoll	55	36	**1.17**
Sporendonema casei Desmazieres ex Fries	55	36	**1.17**
Verticillium albo- atrum Reinke & Berthold	313	142	**5.15**

*Other keratinophilic fungi with RIV< 1. *Acremonium butyri* (Van Beyma) W. Gams, *Ac. cerealis* (Karts) W. Gams, *Ac.fusidioides* (Nicot) W. Gams, *Ac.rutilum* W. Gams, *Alternaria tenuissima* (Kunze ex Pers.) Wilts, *Amorphotheca resinae* Parbery, *Byssochlamys fulva* Olliver & G. smith, *Aspergillus candidus* Link ex Link, *As. flavipes* Wiley & Simmons, *As. fumigatus* Fres., *As. melleus* Yukawa, *As. mdulans* (Eidam), *As. niger* Van Tieghem, *As. ochraceus* Wilhelm, *As. parasiticus* Speare, *As. penicillioides* Spegazzini, *As. restrictus* G. Sm., *As. terreus* Thom, *As. ustus* (Bain) Thom & Church, *As. versicolor* (Vuill.) Tiraboschi, *Aureobasidium pullulans* (de Bary) Arnaud, *Beauveria bassiana* (Bals.) Vuill., *Botrytis* cinerea Mich. ex Fr., *Coccidioides immitis* Stiles in Rixford & Gilchrist, *Doratomyces columnaris*, *Doratomyces microsporus* (Sacc.) Morton & G. Sm, Doratomyces nanus (Ehrenb. ex Link) Morton & G. Sm, *Gliocladium catenulatum* Gilm. & Abbott, *Ghocladium roseum* Bain., *Monilia sitophila* (Montagoe) Saccardo, *Mucor racemosus* Fres., *Myceliophthora thermophila* (Apinis), *Paecilomyces lilacinus* (Thom) Samson, *Pa. marquandii* (Massee) Hughes, *Penicillium corylophilum* Dierckx, *P. digitatum* Saccardo, *P. expansum* Link ex S. F. Gray, *P. frequentans* Westling, *P. herquei*, *P. implicatum* Biourge, *P. janczewskii* Zaleski, *P. nigricans* Bain. ex Thom, *P. oxalicum* Currie & Thom, *P. simplicissimum* (Oudemans) Thom, *Scopulariopsis acremonium* (Dalacr.) Vuill, *Scopulariopsis brevicaulis* (Sacc.) Bain, *Sporotrix schenckii* Hektoen & Perkins, *Stachybotrys arta* Corda, *Verticillium catenulatum* (Kamyschko ex Barron & Onions) W. Gams, *V. chlamydosporium* Goddard, *V. lamellicola*, *V. lecanii* (Zimm.) Viegas, *V. nigrescens* Pethybr, *Wallemia sebi* (Fries) Von Arx, *Zygorrhynchus moelleri* Vuill.

Table 3.8 Scalp hair mycobiota according to locality

Species isolated	Urban			Rural			Refugee camp		
	Total number of isolates	Total number of positive children	RIV	Total number of isolates	Total number of positive children	RIV	Total number of isolates	Total number of positive children	RIV
Dermatophytes									
Epidermophyton floccosum	2	1	0.08	0	0	0	0	0	0
Microsporum canis	8	7	0.45	12	7	0.87	11	7	1.31
M. nanum	2	2	0.12	1	1	0.10	0	0	0
Trichophyton concenticum	0	0	0	1	1	0.10	0	0	0
T. tonsurans	1	1	0.06	4	3	0.34	0	0	0
T. violaceum	0	0	0	0	0	0	30	2	1.41
Dermatophyte-related fungi									
Aphanoascus fulvescens	90	35	2.89	54	32	3.95	33	21	3.93
Arthroderma cuniculi	4	2	0.15	21	9	1.27	23	7	1.77
Chrysosporium asperatum	1	1	0.06	5	3	0.37	5	3	0.57
Ch. carmichaelii	17	11	0.76	10	6	0.74	25	10	2.23
Ch. farinicola	1	1	0.06	0	0	0	8	1	0.43
Ch. georgii	0	0	0	2	2	0.21	0	0	0
Ch. keratinophilum	14	6	0.48	38	19	2.50	23	14	2.66
Ch. merdarium	15	10	0.69	13	8	0.97	5	5	0.83
Ch. pannicola	22	13	0.92	2	1	0.13	2	2	0.33
Ch. pannorum	2	2	0.12	0	0	0	0	0	0
Ch. pseudomerdarium	13	10	0.66	1	1	0.10	1	1	0.17
Ch. qeenslandicum	0	0	0	0	0	0	3	2	0.37
Ch. sulfureum	45	30	2.06	13	9	1.05	7	3	0.65
Ch. tropicum	9	7	0.46	11	8	0.92	3	2	0.37
Ch. xerophilum	4	4	0.25	3	2	0.24	43	8	2.67
Gymnoascus demonbreunii	0	0	0	3	2	0.24	0	0	0
Other keratinophilic fungi with RIV ≥ 1 in one or more of the localities *									
Acremonium butyri	8	6	0.40	14	5	0.77	21	8	1.82
Ac. cerealis	3	3	0.19	10	10	1.05	13	8	1.52
Ac. furcatum	43	15	1.30	4	4	0.42	33	16	3.30
Ac. kiliense	38	28	1.87	79	29	4.39	26	15	2.90
Ac. nutilum	23	16	1.08	15	5	0.79	2	1	0.20
Ac. strictum	50	32	2.22	86	47	5.98	43	24	4.70
Alternaria alternata	114	60	4.43	63	47	5.36	48	34	6.16
Al. tenuissima	16	8	0.60	15	5	0.79	17	14	2.43
Amorphotheca resinae	53	18	1.58	1	1	0.10	7	3	0.65
Aspergillus candidus	24	10	0.80	31	2	1.00	0	0	0
As. flavus	908	139	18.70	16	15	1.60	123	36	9.30
As. glaucus	17	10	0.71	50	12	2.29	9	6	1.11
As. niger	16	3	0.36	21	13	1.58	3	2	0.37
As. Parasiticus	13	9	0.61	4	3	0.34	19	6	1.49

Table 3.8/ continued

As. penicillioides	4	3	0.20	9	9	0.94	7	6	1.03
As. restrictus	11	8	0.54	0	0	0	4	2	0.41
As. wentii	73	32	2.52	12	7	0.87	16	7	1.50
Cladosporium cladosporioides	2553	568	1.24	1238	311	57.71	621	185	47.36
Cl. herbarum	391	143	12.12	773	241	39.66	599	158	43.09
Cl. macrocarpum	109	60	4.37	82	36	5.02	64	26	5.76
Cl. sphaerospermum	137	48	4.14	100	11	3.57	70	27	6.12
Doratomyces microsporus	6	5	0.32	5	3	0.37	10	5	1.02
D. stsmoritis	60	33	2.40	12	3	0.56	24	11	2.32
Geotrichum candidum	94	23	2.36	83	33	4.81	37	14	3.20
Memnoniella echinata	12	10	0.65	18	13	1.50	22	11	2.24
Monilia sitophila	5	4	0.26	18	7	1.03	1	1	0.17
Moniliella acetoabutans	36	27	1.79	23	13	1.63	8	6	1.07
Paecilomyces lilacinus	1	1	0.06	43	17	2.49	8	4	0.82
Penicillium brevicompactum	147	6	2.22	43	8	1.79	82	13	4.80
P. chrysogenum	1474	130	25.67	125	55	7.66	62	29	6.06
P. citrinum	140	48	4.18	88	33	4.95	93	31	7.51
P. expansum	16	8	0.60	4	4	0.42	23	7	1.77
P. fellutanum	180	22	3.43	10	7	0.81	21	7	1.70
P. frequentans	91	9	1.63	4	3	0.34	2	2	0.33
P. griseofulvum	146	33	3.53	20	11	1.40	13	8	1.52
P. herquei	1	1	0.06	22	2	0.75	9	5	0.98
P. oxalicum	99	7	1.64	11	2	0.45	7	4	0.78
P. purpurescens	6	4	0.27	34	16	2.16	41	14	3.35
P. purpurogenum	-	-	-	41	16	2.35	14	10	1.81
Scopulariopsis acremonium	22	9	0.73	35	15	2.11	2	1	0.20
S. brevicaulis	11	8	0.54	19	14	1.60	5	3	0.57
Sporendonema casei	18	10	0.73	16	12	1.36	21	14	2.58
Verticillium albo-atrum	121	57	4.38	104	56	7.17	88	29	7.06
V. chlamydosporium	12	7	0.50	4	3	0.34	12	6	1.22
V. nigrescens	10	5	0.38	5	4	0.45	41	13	3.23

* Other keratinophilic fungi with RIV < 1 were omitted.

Table 3.9 Hair mycobiota in male and female school children in the Nablus area

Species isolated	Males			Females		
	Total number of isolates recovered	Total number of positive children	RIV	Total number of isolates recovered	Total number of positive children	RIV
Dermatophytes						
Epidermophyton floccosum	0	0	0	2	1	0.1
Microsporum canis	21	16	0.96	10	5	0.48
M. nanum	2	2	0.11	1	1	0.07
Trichophyton concentricum	1	1	0.06	0	0	0
T. tonsurans	4	3	0.18	1	1	0.07
T. violaceum	20	1	0.26	10	1	0.28
Dermatophyte- related fungi						
Aphanoascus fulvescens	117	52	3.63	60	36	3.21
Arthroderma cuniculi	33	11	1.16	4	3	0.24
Chrysosporium asperatum	5	4	0.24	1	1	0.07
Ch. carmichaelii	30	17	1.1	22	10	1.02
Ch. farinicola	9	2	0.19	0	0	0
Ch. georgii	2	2	0.11	0	0	0
Ch. keratinophilum	50	21	1.5	25	18	1.49
Ch. merdarium	19	12	0.75	14	9	0.78
Ch. pannicola	16	11	0.68	10	5	0.48
Ch. pannorum	0	0	0	2	2	0.15
Ch. pseudomerdarium	13	10	0.6	2	2	0.15
Ch. queenslandicum	3	2	0.12	0	0	0
Ch. sulfureum	77	33	2.33	23	14	1.24
Ch. tropicum	20	14	0.86	3	3	0.22
Ch. xerophilum	48	13	1.1	2	1	0.1
Gymnoascus demonbreunii	2	1	0.07	1	1	0.07
Other keratinophilic fungi with RIV ≥1 in one or both sexes*						
Acremonium butyri	17	7	0.5	26	12	1.21
Ac. furcatum	66	24	1.8	14	11	0.88
Ac. kiliense	99	44	3.07	44	28	2.43
Ac. nutilum	17	12	0.73	23	10	1.04
Ac. strictum	97	59	3.75	82	44	4.13
Alternaria alternata	111	82	4.96	114	59	5.63
Al. tenuissima	28	16	1.03	20	11	1.02
Amorphotheca resinae	13	8	0.51	48	14	1.82
Aspergillus candidus	13	6	0.41	42	6	1.28
As. flavus	981	148	17.1	66	42	3.65
As. glaucus	60	17	1.42	16	11	0.93
As. niger	33	15	1.04	7	3	0.31
As. wentii	62	25	1.81	39	21	1.97
Cladosporium cladosporioides	2612	543	52.5	1800	521	68.1

Table 3.9 / continue

Cl. herbarum	1095	303	**25.5**	668	239	**27.6**
Cl. macrocarpum	96	46	**3.13**	159	76	**7.53**
Cl. sphaerospermum	221	53	**4.77**	86	33	**3.66**
Doratomyces stsmoritis	49	22	**1.53**	47	25	**2.35**
Geotrichum candidum	120	43	**3.25**	94	27	**3.55**
Mennoniella echinata	41	27	**1.68**	11	7	**0.61**
Moniliella acetoabutans	41	29	**1.77**	26	17	**1.46**
Paecilomyces lilacinus	27	11	**0.79**	21	11	**1.04**
Penicillium brevicompactum	182	14	**2.56**	90	13	**2.75**
P. chrysogenum	1514	165	**23.5**	147	49	**5.89**
P. citrinum	186	61	**4.77**	135	51	**5.71**
P. fellutanum	142	29	**2.83**	69	7	**1.96**
P. frequentans	94	11	**1.5**	3	3	**0.22**
P. griseofulvum	143	31	**2.93**	36	21	**1.9**
P. oxalicum	106	6	**1.39**	11	7	**0.61**
P. purpurescens	77	31	**2.24**	4	3	**0.24**
P. purpurogenum	24	12	**0.81**	31	14	**1.43**
Scopulariopsis acremonium	25	9	**0.68**	34	16	**1.6**
Sporendonema casei	37	24	**1.5**	18	12	**1.02**
Verticillium albo-atrum	198	82	**5.87**	113	60	**5.65**
V. catenulatum	18	6	**0.47**	31	8	**1.12**
V. nigrescens	42	17	**1.23**	14	5	**0.58**

*Other keratinophilic fungi with RIV < than 1 were omitted.

Table 3.10 Scalp hair mycobiota in school children according to age (Keratinophilic species with RIV < 1 in the three classes were not listed in this table)

Age group / whole	First class			Third class			Fifth class		
Species isolated	Total number of isolates	Total number of positive children	RIV	Total number of isolates	Total number of positive children	RIV	Total number of isolates	Total number of positive children	RIV
Dermatophytes									
Epidermophyton floccosum	0	0	0	2	1	0.12	0	0	0
Microsporum canis	13	9	0.92	10	5	0.58	8	7	0.69
M. nanum	0	0	0	1	1	0.09	1	1	0.10
Trichophyton concenticum	0	0	0	0	0	0	1	1	0.10
T. tonsurans	2	2	0.19	3	2	0.21	0	0	0
T. violaceum	0	0	0	20	1	0.51	10	1	0.30
Dermatophyte- related keratinophilic fungi									
Aphanoascus fulvescens	98	34	4.5	42	27	2.86	37	27	2.82
Arthroderma cuniculi	29	10	1.33	11	6	0.67	8	2	0.33
Chrysosporium asperatum	4	2	0.23	0	0	0	2	1	0.12
Ch. carmichaelii	30	13	1.57	10	6	0.65	12	8	0.86
Ch. farinicola	8	1	0.24	1	1	0.09	0	0	0
Ch. georgii	0	0	0	2	2	0.19	0	0	0
Ch. keratinophilum	14	9	0.94	40	14	1.88	21	16	1.65
Ch. merdarium	1	1	0.09	13	10	1.01	19	10	1.16
Ch. pannicola	9	8	0.77	13	4	0.57	4	4	0.38
Ch. pannorum	0	0	0	1	1	0.09	1	1	0.10
Ch. pseudomerdarium	11	9	0.88	1	1	0.09	3	2	0.21
Ch. qeenslandicum	2	1	0.11	0	0	0	1	1	0.10
Ch. sulfureum	41	26	2.74	13	8	0.86	16	13	1.32
Ch. tropicum	6	5	0.49	12	8	0.84	5	4	0.41
Ch. xerophilum	4	3	0.3	4	3	0.3	42	8	1.53
Gymnoascus demonbreunii	3	2	0.21	0	0	0	0	0	0
Other keratinophilic fungi with RIV ≥ 1 in one or more of the age groups *									
Acremonium butyri	11	8	0.81	4	3	0.3	28	8	1.21
Ac. cerealis	10	6	0.64	12	11	1.06	4	4	0.38
Ac. furcatum	16	9	0.99	51	16	2.27	13	10	1.03
Ac. kiliense	42	24	2.61	67	24	3.19	34	24	2.53
Ac. nutilum	21	9	1.09	12	7	0.77	7	6	0.60
Acremonium strictum	61	32	3.59	50	28	3.11	68	43	4.69
Alternaria alternata	78	46	4.96	97	58	6.3	50	37	3.84
Alternaria tenuissima	31	15	1.73	8	7	0.68	9	5	0.57
Amorphotheca resinae	20	6	0.85	31	10	1.4	10	6	0.67
Aspergillus candidus	39	4	1.1	11	6	0.67	5	2	0.26
As. flavus	298	58	10.4	396	76	14.1	353	56	12.01
As. glaucus	54	12	1.99	8	6	0.61	14	10	1.05
As. niger	15	11	1.11	22	6	0.91	3	1	0.14

Table 3.10 / continued

As. parasiticus	23	8	**1.06**	6	4	**0.42**	7	6	**0.60**
As. wentii	43	22	**2.49**	26	10	**1.29**	32	14	**1.75**
Aurobasidium pillulans	14	11	**1.09**	3	3	**0.28**	3	2	**0.21**
Cladosporium cladosporioides	1437	332	**53.8**	1424	361	**57.1**	1551	371	**61.97**
Cl. herbarum	646	195	**27.5**	488	167	**22.7**	629	180	**27.31**
Cl. macrocarpum	73	36	**4.13**	89	44	**5.12**	93	42	**5.17**
Cl. sphaerospermum	146	30	**5.2**	58	33	**3.65**	103	23	**3.99**
Doratomyces stsmoritis	50	18	**2.34**	36	23	**2.44**	10	6	**0.67**
Geotrichum candidum	104	24	**3.89**	46	19	**2.37**	64	27	**3.42**
Memnoniella echinata	8	5	**0.53**	37	22	**2.39**	7	7	**0.67**
Moniliella acetoabutans	27	21	**2.09**	18	12	**1.26**	22	13	**1.45**
Paecilomyces lilacinus	8	3	**0.38**	27	10	**1.31**	17	9	**1.04**
Penicillium brevicompactum	74	9	**2.18**	55	7	**1.71**	143	11	**4.00**
P. chrysogenum	595	68	**17.2**	880	91	**25.8**	186	55	**8.21**
P. citrinum	68	26	**3.3**	128	40	**5.68**	117	43	**5.78**
P. expansum	23	9	**1.13**	3	3	**0.28**	3	2	**0.21**
P. fellutanum	101	11	**2.89**	29	8	**1.21**	81	17	**3.06**
P. frequentans	22	3	**0.67**	16	4	**0.64**	59	7	**1.83**
P. griseofulvum	74	18	**2.84**	43	21	**2.45**	62	13	**2.34**
P. oxalicum	5	3	**0.32**	14	5	**0.67**	98	5	**2.56**
P. purpurescens	40	13	**1.77**	10	7	**0.72**	31	14	**1.72**
P. purpurogenum	29	14	**1.62**	25	11	**1.34**	0	0	-
Scopulariopsis acremonium	33	12	**1.55**	7	5	**0.51**	19	8	**1.01**
S. brevicaulis	12	8	**0.83**	8	7	**0.68**	15	10	**1.07**
Sporendonema casei	15	8	**0.89**	16	13	**1.29**	24	15	**1.64**
Verticillium albo-atrum	107	39	**5.05**	97	49	**5.65**	107	54	**6.37**
V. catenulatum	7	3	**0.36**	10	2	**0.36**	32	9	**1.38**
V. nigrescens	35	11	**1.52**	11	5	**0.6**	10	6	**0.67**

*Other keratinophilic fungi with RIV < than 1 were omitted.

Table 3.11 Scalp hair mycobiota according to season

Species isolated	Autumn			Winter			Spring		
	Total number of isolates	Total number of positive children	RIV	Total number of isolates	Total number of positive children	RIV	Total number of isolates	Total number of positive children	RIV
Dermatophytes									
Epidermophyton floccosum	0	0	0	0	0	0	2	1	0.14
Microsporum canis	0	0	0	26	20	2.29	5	1	0.24
M. nanum	3	3	0.27	0	0	0	0	0	0
Trichophyton concenticum	0	0	0	0	0	0	1	1	0.1
T. tonsurans	0	0	0	0	0	0	5	4	0.45
T. violaceum	20	1	0.41	10	1	0.4	0	0	0
Dermatophyte related keratinophilic fungi									
Aphanoascus fulvescens	92	39	4.47	54	24	3.49	31	25	2.81
Arthroderma cuniculi	32	11	1.36	0	0	0	16	7	1.03
Chrysosporium asperatum	0	0	0	0	0	0	6	5	0.56
Ch. carmichaelii	18	9	0.98	0	0	0	34	18	2.41
Ch. farinicola	0	0	0	0	0	0	9	2	0.44
Ch. georgii	0	0	0	0	0	0	2	2	0.21
Ch. keratinophilum	6	6	0.55	54	28	3.78	15	5	0.85
Ch. merdarium	0	0	0	0	0	0	33	21	2.59
Ch. pannicola	0	0	0	0	0	0	26	16	2
Ch. pannorum	2	2	0.18	0	0	0	0	0	0
Ch. pseudomerdarium	0	0	0	0	0	0	15	12	1.35
Ch. queenslandicum	3	2	0.2	0	0	0	0	0	0
Ch. sulfureum	0	0	0	0	0	0	70	47	5.67
Ch. tropicum	0	0	0	0	0	0	23	17	1.98
Ch. xerophilum	41	7	1.22	0	0	0	9	7	0.8
Gymnoascus demonbreunii	0	0	0	0	0	0	3	2	0.24
Other keratinophilic fungi RIV > 1 in one or more of the seasons *									
Acremonium butyri	42	18	2.05	0	0	0	1	1	0.1
Ac. cerealis	0	0	0	13	8	1	13	13	1.36
Ac. furcatum	24	9	1.08	0	0	0	56	26	3.7
Ac. kiliense	98	44	4.94	5	3	0.38	40	25	3.11
Ac. nutilum	9	1	0.23	31	21	2.53	0	0	0
Ac. strictum	6	6	0.55	113	62	8.16	60	35	4.48
Alternaria alternata	73	36	3.92	83	51	6.39	69	54	6.15
Al. tenuissima	48	27	2.83	0	0	0	0	0	0
Amorphotheca resinae	41	7	1.22	0	0	0	20	15	1.73
Aspergillus candidus	0	0	0	0	0	0	55	12	2.66
As. flavus	1028	177	30.6	14	10	1.18	5	3	0.38
As. fumigatus	0	0	0	0	0	0	13	8	1
As. glaucus	48	11	1.63	2	8	0.64	12	9	1.04

Table 3.11 / continued

As. niger	40	18	2.02	0	0	0	0	0	0
As. parasiticus	18	6	0.75	18	12	1.45	0	0	0
As. penicillioides	0	0	0	17	17	1.78	3	1	0.17
As. restrictus	0	0	0	15	10	1.21	0	0	0
As. versicolor	0	0	0	0	0	0	22	16	1.87
As. wentii	55	19	2.35	40	24	3.04	6	3	0.41
Cladosporium cladosporioides	288	121	13.9	1374	345	69.8	2750	598	133
Cl. herbarum	259	71	9.68	1073	345	60	431	126	23.2
Cl. macrocarpum	19	11	1.14	151	77	10.5	85	34	5.23
Cl. sphaerospermum	307	86	11.6	0	0	0	0	0	0
Doratomyces columnaris	0	0	0	0	0	0	14	10	1.18
D. stsmoritis	0	0	0	16	9	1.17	80	38	5.35
Geotrichum candidum	22	13	1.34	150	30	7.07	42	27	3.32
Memnoniella echinata	21	10	1.1	15	12	1.35	16	12	1.39
Monilia sitophila	0	0	0	0	0	0	24	12	1.65
Moniliella acetoabutans	0	0	0	0	0	0	67	46	5.5
Mucor racemosus	0	0	0	0	0	0	6	5	0.56
Myceliophthora thermophila	0	0	0	0	0	0	13	8	1
Paecilomyces lilacinus	42	16	1.9	0	0	0	10	6	0.76
Penicillium brevicompactum	125	21	3.68	147	6	5.24	0	0	0
P. chrysogenum	1493	148	36.3	79	39	5.39	89	27	4.86
P. citrinum	15	6	0.7	251	86	14.4	55	20	3.24
P. expansum	0	0	0	43	19	2.78	0	0	0
P. fellutanum	204	32	5.84	0	0	0	7	4	0.52
P. frequentans	94	11	2.41	0	0	0	3	3	0.31
P. griseofulvum	138	25	4.2	9	6	0.73	32	21	2.56
P. herquei	32	8	1.14	0	0	0	0	0	0
P. oxalicum	117	13	2.95	0	0	0	0	0	0
P. purpurescens	80	33	3.82	1	1	0.1	0	0	0
P. purpurogenum	54	25	2.78	1	1	0.1	0	0	0
P. simplicissimum	52	14	1.93	0	0	0	0	0	0
Scopulariopsis acremonium	0	0	0	25	14	1.83	34	11	1.9
S. brevicaulis	5	3	0.31	25	17	2.04	5	5	0.52
Sporendonema casei	0	0	0	54	35	4.29	1	1	0.1
Verticillium albo-atrum	19	12	1.22	153	79	10.7	139	51	8.22
V. catenulatum	0	0	0	46	11	2.3	3	3	0.31
V. chlamydosporium	0	0	0	0	0	0	28	16	2.07
V. lamellicola	0	0	0	18	14	1.6	0	0	0
V. lecanii	0	0	0	0	0	0	24	21	2.3
V. nigrescens	55	21	2.5	0	0	0	1	1	0.1

* Other keratinophilic fungi with RIV<1 in all seasons were omitted from this list

3.5.2 Spore load distribution of hair and scalp mycobiota

Spore load distribution of hair and scalp mycobiota among school children on the basis of locality, sex and season, is presented in Tables 3.12-3.14 & Figure 3.1.

3.5.2.1 Spore load distribution of hair and scalp mycobiota by locality

Higher percentages of children with moderate (7.54) and heavy spore loads (0.73) were found in urban school children community than in rural and refugee camp school children (moderate 4.7 and heavy 0.1) ($p > 0.05$) (Table 3.12). Also significantly higher light spore load percentages were found in rural (64.0) and refugee camp (59.39) than in urban children (52.49) ($p > 0.05$). However, higher percentage of children with undetected spore load was found in urban (39.2) than in refugee camp (35.7) and rural (31.2) school children ($p > 0.05$).

Of all localities, school children with light spore load comprised the highest percentage of the children examined (37.4), followed by moderate (6.13), and heavy (0.41) spore load categories

(F= 4.51, df= 2, 33, p= 0.02). However, children with undetected spore load comprised 36.05 % of all children. Spore load distribution did not show clear seasonal variations in the study period (F = 0.01, df = 2, 429, p = 0.99) (Table 3.12).

3.5.2.2 Spore load distribution of hair and scalp mycobiota by children sex

Significantly higher percentage of moderate spore load was found in male children (8.72) than in female children (3.22) (F = 12.873, df = 1, 34, p = 0.001). Also higher percentage (p > 0.05) of heavy spore load was found in males (0.69), than in females (0.1) (Tables 3.13-3.14). However, higher percentages of undetected (38.3) or light spore loads (58.4) were found in females than in males (34.04 and 56.53, respectively). Male school children in urban areas had higher percentages of moderate (10.7) and heavy (1.14) spore loads than in rural (7 and 0.15, respectively) (F = 7.272, df = 1, 34, p = 0.01), and refugee camp (5.65 and 0.25, respectively) school children (Table 3.13). On the other hand, female school children in the refugee camp had higher percentage of moderate spore load (3.76), than in urban (3.5) and rural (2.47) school children (Table 3.14). Percentage

of female school children with heavy spore load was found to be higher in urban (0.22), than in rural and refugee camp (0) school children. Higher percentage of male school children with spore free scalps (38.3) was found in refugee camp than in urban (35.7) and rural (28.5) school children. On the other hand, percentage of female school children with spore free scalps was found to be higher in urban (43.6), than rural (33.8) and refugee camp (33.3) school children. Spore load distribution in both male and female school children did not show clear seasonal variation (Table 3.13).

Table 3.12 Spore load (%) distribution of hair and scalp mycobiota in children in relation to locality, and season. (N=4119)

Locality	Season**	No of children	No of classes	Spore Load*			
				undetected	light	Moderate	Heavy
Urban	A	666	18	42.64 (284)	44.74 (298)	10.36 (69)	2.25 (15)
	W	688	18	37.20 (256)	58.57 (403)	4.21 (29)	0 (0)
	S	688	18	31.39 (261)	53.92 (371)	8.13 (56)	0 (0)
	Total	**2042**	**54**	**39.2 (801)**	**52.49 (1072**	**7.54 (154)**	**0.73 (15)**
Rural	A	419	12	48.68 204)	47.25 (198)	3.81 (16)	0.23 (1)
	W	435	12	26.20 (114)	71.26 (310)	2.52 (11)	0 (0)
	S	435	12	19.31 (84)	72.87 (317)	7.81 (34)	0 (0)
	Total	**1289**	**36**	**31.18 (402)**	**64.0 (825)**	**4.73 (61)**	**0.07 (1)**
Refugee	A	256	6	30.07 (77)	63.67 (163)	5.85 (15)	0.39 (1)
	W	266	6	33.08 (88)	61.65 (164)	5.26 (14)	0 (0)
	S	266	6	43.98 (117)	53.00 (141)	3.00 (8)	0 (0)
	Total	**788**	**18**	**35.7 (282)**	**59.39 (468)**	**9.27 (37)**	**0.12 (1)**
Total /season	A	1341	36	42.13 (565)	49.14 (659)	7.45 (100)	1.26 (17)
	W	1389	36	32.97(458)	63.13 (877)	3.88 (54)	0 (0)
	S	1389	36	33.26(462)	59.68 (829)	7.05 (98)	0 (0)
Total		**4119**	**108**	**36.05 (1485)**	**37.41 (2365)**	**6.13 (252)**	**0.14 (17)**

* Spore load: undetected (0); light 1-10 spores; moderate 11-50; heavy >50.
**A, autumn; W, winter; S, spring.

Table 3.13 Spore load (%) distribution of hair and scalp mycobiota in male children in relation to locality, and season. (N=2165)

Locality	Season**	No of children	No of classes	*Spore Load			
				Undetected	Light	Moderate	Heavy
Urban	A	376	9	29.5 (111)	49.7 (187)	17.3 (65)	3.45 (13)
	W	379	9	38.3 (145)	55.9 (212)	5.8 (22)	0 (0)
	S	379	9	39.3 (149)	51.5 (195)	9.2 (35)	0 (0)
	Total	**1134**	**27**	**35.7 (405)**	**52.5 (594)**	**10.7 (122)**	**1.14 (13)**
Rural	A	214	6	45.7 (98)	47.7 (102)	6.1 (13)	0.5 (1)
	W	214	6	25.2 (54)	70.6 (151)	4.2 (9)	0 (0)
	S	214	6	14.5 (31)	74.8 (160)	10.7 (23)	0 (0)
	Total	**462**	**18**	**28.5 (183)**	**64.33 (413)**	**7.0 (45)**	**0.15 (1)**
Refugee	A	127	3	26.8 (34)	63.8 (81)	8.7 (11)	0.8 (1)
	W	131	3	45.8 (60)	48.8 (65)	4.6 (6)	0 (0)
	S	131	3	41.9 (55)	54.2 (71)	3.8 (5)	0 (0)
	Total	**389**	**9**	**38.3 (149)**	**55.78 (217)**	**5.65 (22)**	**0.25 (1)**
Total for season	A	717	18	33.89 (243)	51.60 (370)	12.41 (89)	2.09 (15)
	W	724	18	35.77 (259)	29.11 (428)	5.11 (37)	0 (0)
	S	724	18	32.45 (235)	58.83 (426)	8.70 (63)	0 (0)
Total (%)		**2165**	**54**	**34.04 (737)**	**56.53 (1224)**	**8.72 (189)**	**0.69 (15)**

* Spore load: undetected (0); light 1-10 spores; moderate 11-50; heavy >50.
**A, autumn; W, winter; S, spring.

Table 3.14 Spore load (%) distribution of hair and scalp mycobiota in female children in relation to locality, and season. (N=1954)

Locality	Season**	No of children	No of classes	Spore Load* % and (number of children)			
				Undetected	Light	Moderate	Heavy
Urban	A	290	9	59.7 (173)	38.3 (111)	1.38 (4)	0.7 (2)
	W	309	9	35.9 (111)	61.8 (191)	2.3 (7)	0 (0)
	S	309	9	36.3 (112)	56.9 (176)	6.8 (21)	0 (0)
	Total	**908**	**27**	**43.6 (396)**	**52.6 (478)**	**3.5 (32)**	**0.22 (2)**
Rural	A	205	6	51.7 (106)	46.8 (96)	1.5 (3)	0 (0)
	W	221	6	27.2 (60)	71.9 (159)	0.9 (2)	0 (0)
	S	221	6	23.9 (53)	71.0 (157)	4.9 (11)	0 (0)
	Total	**647**	**18**	**33.8 (219)**	**63.67 (412)**	**2.47 (16)**	**0 (0)**
Refugee	A	129	3	33.3 (43)	63.6 (82)	3.1 (4)	0 (0)
	W	135	3	20.7 (28)	73.3 (99)	5.9 (8)	0 (0)
	S	135	3	45.9 (62)	51.8 (70)	2.2 (3)	0 (0)
	Total	**399**	**9**	**33.33 (133)**	**62.9 (251)**	**3.75 (15)**	**0 (0)**
Total /season	A	624	18	51.60 (322)	46.31 (289)	1.76 (11)	0.32 (2)
	W	665	18	29.92 (199)	67.51 (449)	2.55 (17)	0 (0)
	S	665	18	34.13 (227)	60.60 (403)	5.26 (35)	0 (0)
Total		**1954**	**54**	**38.28 (748)**	**58.39 (1141)**	**3.22 (63)**	**0.10 (2)**

* Spore load: undetected (0); light 1-10 spores; moderate 11-50; heavy >50.
**A, autumn; W, winter; S, spring.

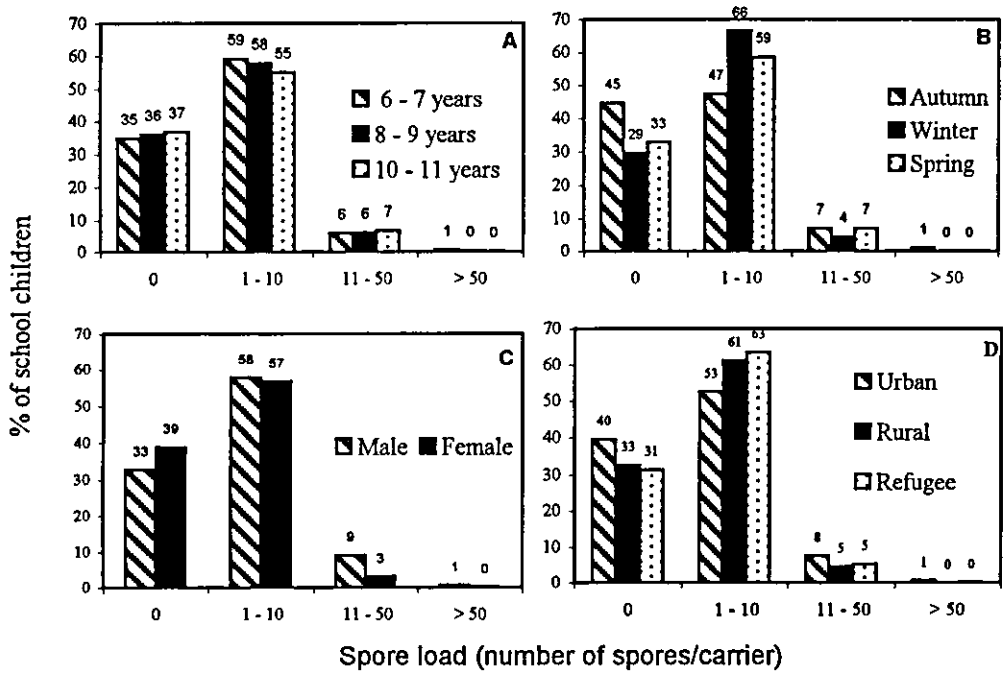

Figure 3.1. Distribution (%) of spore load categories in school children according to age A, season B, gender C, and locality D.

CHAPTER FOUR

DISCUSSION

CHAPTER FOUR

DISCUSSION

4.1 Symptomatic tinea capitis among school children

The present study demonstrates a lower prevalence rate (0.27 %) of symptomatic tinea capitis among school children in the Nablus area than previously reported (1.0 %) for 1996 from the same area (Ali-Shtayeh et al., 1997). In fact tinea capitis prevalence rate decreased between 1996-1998, by 10, 3, and 2 folds in rural, refugee camp and urban school children, respectively. This could be attributed to improvement in hygienic and socioeconomic conditions in the study area.

However, a comparison of the results on aetiological agents of tinea capitis from the current work with those obtained previously from school children from the same area (Ali-Shtayeh & Arda, 1986; Ali-Shtayeh et al., 1997), revealed that the anthropophilic dermatophyte *T. violaceum* continues to be the predominant etiological agent of tinea capitis in the Nablus district (49.8% of total isolates in 1986, 72.6% in 1996, and 82.6% in the present

study). This is particularly important, because *T. violaceum* is an endothrix, Wood's lamp is not useful in diagnosis, and infection is often difficult to eradicate. On the other hand, a decrease was noted in the role of zoophilic dermatophyte *M. canis*, as a causative agent of tinea capitis, from 31.8% in 1986 to 23.8 % in 1996, to 17.4% in the present study. The present findings are, obviously, in agreement with recent observations made by Leeming & Elliott (1995), Hay et al. (1996), Wilmington et al. (1996), and Ali-Shtayeh et al. (1997), who reported a significant rise in the incidence of infections due to anthropophilic dermatophytes and decreasing importance of zoophilic dermatophytes. The rise of anhropophilic fungi in school children in the study area means that there has been a trend toward more infections transmissible among children, with *T. violaceum* being the dominant dermatophyte (Ali-Shtayeh et al., 1997). These fungi seem to become increasingly more prominent as scalp ringworm causative agents in this area and there is sufficient evidence to indicate that these changes in anthropophilic and zoophilic dermatophytes reflect a continuing trend. This may be partly attributed to environmental factors, human migratory

patterns, new therapies, the pathogen, and the host (Filipello Marchisio et al., 1996).

A higher incidence of scalp ringworm disease in children aged 6-12 years (0.33 %) than in children aged 12-16 (0.06 %) and a higher incidence in boys (0.38 %) than in girls (0.13 %) in the current work, conform to the widely held view that the majority of cases occur in younger children (Rippon, 1988; Oyeka, 1990; Ali-Shtayeh et al., 1997) and that boys are more affected than girls (Sberna et al., 1993). This has been mainly attributed to the sensitivity of dermatophytes to certain sebaceous gland secretions that first appear at puberty and persist into adulthood, especially in males (Rippon, 1988).

4.2 Dermatophyte carriers among school children

The presence of dermatophytes on healthy scalps and hair of school children is considered as a potential source of infection (Babel & Baughman, 1989; Neil et al., 1990; Gupta & Summerbell, 1998; Greer, 1996). Their presence probably plays an important role in the spread and persistence of tinea capitis among this group of children

at an age group most susceptible to the disease. It is therefore important to identify the carriers of pathogenic dermatophytes and potentially pathogenic keratinophilic fungi in schools where children spend most of their times.

In populations of school children, asymptomatic carrier rates have been reported in countries where *T. violaceum* is the primary dermatophyte responsible for tinea capitis (0.4 % in Italy, 24.5 % in Nigeria) (Polonelli et al., 1982; Ive, 1966). Prevalence of asymptomatic carriers has been reported to correlate well with the amount of tinea capitis in the community. Thus, in Spain and Italy where tinea capitis has been relatively rare, the prevalence of scalp carriage was 0.2 % and 0.3 %, respectively (Cuetara et al., 1997; Polonelli et al., 1982). Similarly in our group of school children (tinea capitis rate = 0.27) the carriage rate was 0.78 %. In contrast, higher prevalence rates (49 %) of asymptomatic carriage have been reported in areas where *T. violaceum* tinea capitis is endemic (Neil et al., 1990). Also, in the USA where *T. tonsurans* is prevalent the carrier rates range from 8 % to 15 % (Sharma et al., 1988; Vargo & Cohen, 1993).

Higher scalp carriage rates (12-30 %) were found by Midgely & Clayton (1972) in classes with clinically infected cases than in classes with no index cases (1-5 %). In the latter work, fungal spores shed from a clinically infected child were thought to be responsible to transient contamination of the scalp in uninfected children, the carrier rate decreased and eventually disappeared. However, the results of Williams et al. (1995) did not substantiate these findings, where mean carrier rate for classes without index cases was higher than the mean rate for classes containing index cases. Also, in our work we did not detect index cases in classes with carriers. This would suggest that, in our population and that of Williams, index cases were not the primary means of transmission of spores to individuals within classrooms.

Although cultures outside this school population were not performed, its possible that children not attending the school and other family members, including adults, may have contributed to the asymptomatic carriers pool at the surveyed schools. In fact, some authors (Rauitschek, 1959; Vargo & Cohen, 1993) indicated that

home might be an even more important source of infection than schools.

The asymptomatic carrier state has been shown to persist in 10-25 % of carriers for as long as 6 weeks to 8 months (Sharma et al., 1988; Ive, 1966; Neil et al., 1990). In our carriers, spontaneous clearing took place within 3-4 months.

Our results indicate that carriage rate was higher in younger than in older children. This finding is in consistent with those of Hay et al. (1996), Williams et al. (1995), and Figuaroa et al. (1997), who indicated that most carriage was in children especially those between the ages of 4-8 years old. Our results also indicate that carriage rate was higher in male than in female children, which is in consistent with the fact that carriage rate correlates well with the amount of tinea capitis in the population (prevalence rate of index cases was higher in males 0.37 %, than in females 0.14 % in this study). However, our results did not substantiate the findings of other researchers (Frieden, 1999), who indicated that male and female children are equally affected.

The present results also indicate that carriage rate was higher in winter months than in spring and autumn months, this can be attributed to higher humidity during winter months, which favors fungal growth and less frequent hair washing in this season due to cold weather conditions.

Carriage rate is also higher in refugee camp children than rural and urban children, this can be attributed to differences in socioeconomic and hygienic conditions in different localities, with lower socioeconomic and hygienic conditions prevailing in refugee camps.

Anthropophilic organisms usually, *T. tonsurans* or *T. violaceum,* have been generally associated with high rates of asymptomatic carriage (Babel et al., 1990). This was attributed to relative lack of host response and hence these fungi were thought to be good candidates for asymptomatic carriage. On the other hand, zoophilic dermatophytes, such as *M. canis*, cause stronger host response and are therefore thought to be poor candidates for asymptomatic carriage (Frieden, 1999). However, our results did not substantiate these findings. In fact, asymptomatic carriage in our

population of school children was caused mainly by zoophilic dermatophyte *M. canis* (65.6 %), followed by anthropophilic dermatophytes (*T. tonsurans, T. violaceum*, *T. concentricum*, and *E. flocossum*) (25 %) and the geophilic dermatophyte *M. nanum* (9.4 %).

Epidermophyton flocossum was reported to cause sporadic cases of tinea capitis (Jacyk et al., 1982; Sekhon & Garg, 1986; Sberna et al., 1993) and to cause asymptomatic carriage (Cuetara et al., 1998). This again proves that this dermatophyte is capable of, in vivo, parasitization of hair.

Clayton & Midgely (1968) found that dermatophyte carriers in their school population had only 1-10 colonies isolated from their scalps, while index cases produced much higher number of colonies. Williams et al. (1995) also obtained similar results by using a semi-quantitative system. These results indicated that asymptomatic carriers of *T. tonsurans*, who had low spore loads and were likely to lose their carrier state, were transiently colonized with spores. Whereas carriers who had very high spore loads and were more likely to remain culture positive over time may have had

heavy colonization or an occult infection producing numerous spores. Our results are in agreement with those of Williams, where about 97 % of our carriers had a spore load of less than 10 colonies per carrier; 3 % of the carriers had spore load of > 10 colonies/ carrier. However, asymptomatic carriers with high spore load may be a more important vector in the transmission of tinea capitis than index cases, because they have the potential to shed large number of spores over a longer period of time (as long as carrier status remain undetected) (Williams et al., 1995).

Because an individual with a persistent carriage can be a source of infection and re-infection for all classroom mates, its necessary that a consistent follow up should be carried out (Vargo & Cohen, 1993). It is therefore recommended that the carrier state be eradicated by treating all individuals with positive cultures from the scalp with oral antifungal agents (Hebert, 1985).

4.3 Hair mycobiota of school children

The role of healthy human hair in the persistence and transmission of dermatophytes has been investigated and discussed in this work

and by other few researchers (Frieden, 1999). However, the role of healthy human hair in the persistence and transmission of other pathogenic or potentially pathogenic keratinophilic fungi has been for a long time overlooked by the majority of medical mycology researchers. Such information is obviously important in the understanding of epidemiological cycles of these fungi (Singh & Barde, 1986).

Studies on animal hair mycobiota in the Palestinian area demonstrated that component pathogenic and potentially pathogenic fungi comprised about 55-88% of hair mycobiota of different domestic animals studied including sheep, goats, cows, cats, dogs, and rabbits (Ali-Shtayeh et al., 1988a, 1988b, 1989). Our results show that a similar situation exists with human hair mycobiota. In fact, > 80 % of all isolates recovered from human hair were reported in the literature to be pathogenic or potentially pathogenic to humans, animals and plants.

Our results have clearly demonstrated that human hair mycobiota is rich in terms of number of component species isolated and their frequency of occurrence. More than 100 species belonging

to 33 genera were found on human hair in this study. Most of these species occur on school children hair in rural areas (90 species) followed by urban (82) and the refugee camp children (76 species). This could be partly attributed to differences in environmental and hygienic conditions in these localities. Rural school children are more likely to be exposed to higher levels of air dust due to non-paved roads and cultivation processes. In addition presence of domestic animals and lack of running tap water in this community may also contribute to higher contamination of hair with fungal spores. On the other hand, hygienic conditions and availability of running water in urban and refugee camp communities might contribute to the lower numbers of fungal species on the hair of school children.

Hair mycobiota did not seem to vary with age and sex of school children examined, since all children are generally exposed to similar conditions. However, hair and scalp mycobiota seems to be richer (in terms of number of species) in spring than autumn and winter months. Spring months seem to provide more favorable conditions (e.g., temperature and humidity) for these fungi, while

low temperature seems to be responsible for lower number of species encountered during winter months. Differences in RIV values of different species in relation to season can be partly attributed to the organism, and to variations in prevailing environmental conditions.

This investigation on keratinophilic fungi on school children hair is a part of a larger study in the field of ecology and epidemiology of these fungi in the scholastic environment. The present work centers on distribution of these fungi on human hair and scalp mycobiota and their role in the spread and persistence of mycotic infections among school children.

When human hair mycobiota is compared with that of animal hair, one can realize that the majority of human hair mycobiata component fungi including dermatophytes and dermatophyte-related fungi (62 out of 101 species), were also present on the hair of domestic animals studied in the Palestinian Area (Ali-Shtayeh et al., 1988a; 1988b; 1989). It was not unexpected however, to find that anthropophilic dermatophytes (*T. violaceum, T. tonsurans,* and

E. floccosum) encountered on human hair in this work, were not present on animal hair.

Furthermore, 23 out of 101 fungal species found on human hair, were also present in playgrounds soil and classrooms floor dust from schools studied for keratinophilic fungi in Nablus district (Ali-Shtayeh, 1989; Ali-Shtayeh & Arda, 1989). Similarities between human and animal hair mycobiotas may be attributed to similar substrate composition (keratinous substances). On the other hand, differences between these mycobiotas may be attributed to differences in behavioral and hygienic habits. It can also, be concluded that scholastic environment including school playgrounds and floor dust may form an important source of fungi for human hair mycobiota.

Spore load size on hair and scalp of school children reflects population densities of the component fungi. However, our results shows that spore load can be affected by several factors including children hygienic habits, location, sex, and overcrowding. Heavy and moderate spore loads were higher in the urban community than

refugee camp and rural communities. This can be attributed to overcrowding of classes in the city schools (~ 55 children / class).

On the other hand, numbers of children with spore free hair and scalp (undetected) were larger in urban school children (where running water, and paved roads and other municipal service are more readily available) than in the other two communities, probably due to differences in hygienic habits, sex, and location.

Further more, moderate and heavy spore loads were higher in males than females, probably due to hygienic habits and social behavior. Males school children are usually more exposed to the external environment, having the tendency to spend more time playing in the surroundings than females.

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APPENDICES

APPENDIX A

MEDIA, STAINS AND REAGENTS

Dermatophytes Test Medium (DTM). (Clayton & Midgley, 1985; Rebell & Taplin, 1978).

Used for isolating dermatophytes. This selective medium excludes most bacteria and many contaminant fungi, gives a yellow red indicator, positive growth and color change on (DTM) diagnosed dermatophytes.

Typical formula g/L

Phytone (BBL)	10
Dextrose	10
Agar (BBL or Difco).	20
Phenol Red solution	40mL
HCl (0.8N)	6mL
Cycloheximide	0.5
Gentamicine sulfate	0.1mg of active drug=100µg/mL
Chlortetracycline HCL	0.1mg (of 100µg/mL).

Preperation: -

1. Phyton, Dextrose and Agar are mixed in 1000ml distilled water, and boiled until dissolved.
2. 40ml of phenol red solution is added while stirring [Phenol red solution , 0.5gm phenol red (Difco Bacto) dissolved in 15ml 0.1N NaOH, made up to 100ml with distilled water].
3. 6ml 0.8N HCl is added with stirring.
4. 0.5gm cycloheximide is dissolved in 2ml aceton, and added to hot medium while stirring.
5. Gentamicine sulfate powder is dissolved in 2ml distilled water and added.
6. The solution is autoclaved at 121 C for 10 minutes and cool to 47 C.
7. 0.1gm chloratetracycline HCL is dissolved in 25ml of sterile distilled water then added to the medium while stirring.
8. The prepared medium is poured in sterile vial (as slants) or in plates and allowed to cool.
9. After inoculation the caps loose to allow adequate growth and to develop color change. Incubated at 28 C.

10. Color change of indicator (in case of dermatophytes growth) should be interpreted not later than two weeks after inoculation. A change in pH produced by the proteolytic activity of dermatophytes is demonstrated phenol red indicator that is added to the DTM, changing from yellow to red indicates dermatophyte presence.

Sabouraud Dextrose Agar (Oxoid) (SDA). (Koneman & Roberts, 1985).

Typical formula g/L

Dextrose	20
Peptone	10
Agar	17

Preperation: -

The ingredients are suspended in one-liter distilled water, and sterilized by autoclaving at 121^{O}C for 15 minutes.

Lactophenol-Analine Blue Stain (cotton blue). (Koneman & Roberts, 1985).

Ingrediants:

Distilled water	20mL
Lactic acid	20mL
phenol crystals	20gm
Aniline blue (cotton blue, poirrier's blue).	0.05gm
Glycerol	40mL

Phenol is dissolved in lactic acid, glycerol, and water by gentle heating. Then, aniline blue is added.

Potassium Hydroxide Solution (KOH). (Koneman & Roberts, 1985).

KOH crystals	10 gm
Glycerin	10 ml
Distilled water	80 ml

APPENDIX B

Table B.1 Spore load categories distribution (%) in the surveyed school children by school, class, sex, and location

	School [a]	Class [b]	Sex [c]	Location [d]	Spore load [e] categories (%)			
					undetected	light	moderate	heavy
1	1.0	1.00	2.0	1.00	20.0	75.44	2.22	2.22
2	1.0	3.00	2.0	1.00	43.6	52.68	3.46	.00
3	1.0	5.00	2.0	1.00	31.4	62.26	3.63	.00
4	2.0	1.00	2.0	1.00	47.1	48.21	4.82	.00
5	2.0	3.00	2.0	1.00	27.7	67.36	5.00	.00
6	2.0	5.00	2.0	1.00	56.0	40.00	3.76	.00
7	3.0	1.00	2.0	1.00	50.5	43.58	6.01	.00
8	3.0	3.00	2.0	1.00	54.9	43.29	2.00	.00
9	3.0	5.00	2.0	1.00	55.7	43.29	1.00	.00
10	4.0	1.00	2.0	3.00	26.0	70.15	3.99	.00
11	4.0	3.00	2.0	3.00	40.6	55.00	4.42	.00
12	4.0	5.00	2.0	3.00	32.3	64.76	3.03	.00
13	5.0	1.00	2.0	2.00	32.2	65.42	2.33	.00
14	5.0	3.00	2.0	2.00	31.1	66.52	2.80	.00
15	5.0	5.00	2.0	2.00	34.5	63.86	2.06	.00
16	6.0	1.00	2.0	2.00	33.8	61.68	4.42	.00
17	6.0	3.00	2.0	2.00	44.7	55.33	.00	.00
18	6.0	5.00	2.0	2.00	34.5	42.45	2.00	.00
19	7.0	1.00	1.0	1.00	56.0	38.49	5.00	3.33
20	7.0	3.00	1.0	1.00	42.8	49.01	8.15	.00
21	7.0	5.00	1.0	1.00	39.0	35.44	26.67	1.11
22	8.0	1.00	1.0	1.00	43.7	53.93	2.33	.00
23	8.0	3.00	1.0	1.00	47.7	49.33	3.25	.00
24	8.0	5.00	1.0	1.00	38.7	57.78	3.56	.00
25	9.0	1.00	1.0	1.00	19.6	64.60	15.10	079
26	9.0	3.00	1.0	1.00	16.1	57.17	22.38	4.35
27	9.0	5.00	1.0	1.00	18.8	63.36	16.97	.85
28	1.0	1.00	1.0	3.00	26.1	66.71	6.55	.78
29	1.0	3.00	1.0	3.00	29.8	64.68	5.43	.00
30	1.0	5.00	1.0	3.00	57.20	59.43	8.13	.00
31	11	1.00	1.0	2.00	23.0	66.60	9.63	.79
32	11	3.00	1.0	2.00	19.4	71.63	9.25	.00
33	11	5.00	1.0	2.00	22.7	72.50	5.17	.00
34	12	1.00	1.0	2.00	39.0	53.48	7.48	.00
35	12	3.00	1.0	2.00	33.3	60.66	6.05	.00
36	12	5.00	1.0	2.00	42.0	55.23	2.78	.00

[a] see Table 2.1 for school names; [b] 1 1st grade, 3 3rd grade, 5 5th grade; [c] 1 male, 2 female; [d] 1 urban, 2 rural, 3 refugee camp; [e] undetected 0 colonies/ child, light 1-10, moderate 11-50, heavy ≥ 50 colonies

Table B. 30 Means and standard deviation (SD) of spore load categories in all school children surveyed

Spore load categories	Mean	SD
Undetected	35.8134	11.4215
Light	57.2593	10.5135
Moderate	6.1339	5.7476
Heavy	.3953	.9733

Table B. 20 Means separation for data on the effect of sex on spore load distribution in school children surveyed using Sheffe's test.

Spore load categories	Sex	N	Mean	SD	SE	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
Undetected	M	18	32.8090	12.8737	3.0344	27.7644	40.5682
	F	18	38.8178	10.8063	2.5471	33.4439	44.1916
	Total	36	35.8134	11.4215	1.9036	31.9489	39.6779
Light	M	18	57.7802	10.1806	2.3996	52.7175	62.8429
	F	18	56.7385	11.1063	2.6178	51.2154	62.2615
	Total	36	57.2593	10.5135	1.7522	35.7021	60.8166
Moderate	M	18	9.1039	6.8584	1.6165	5.6933	12.5145
	F	18	3.1640	1.5156	.3572	2.4103	3.9176
	Total	36	6.1339	5.7476	.9579	4.1892	8.0786
Heavy	M	18	.6672	1.2326	.2905	5.424E-02	1.2801
	F	18	.1235	.5238	.1235	- 1370	.3839
	Total	36	.3953	.9733	.1622	6.602E-02	.7246

Table B: 7 Means separation for data on the effect of locality on spore load distribution in school children surveyed using Shefe's test.

Dependent Variable	(I) Location +	(J) Location	Mean Difference (I-J)	SE	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Undetected	1.00	2.00	7.0067	4.135	.100	-1.4060	15.4194
		3.00	8.2766	5.230	.123	-2.3647	18.9179
	2.00	1.00	-7.0067	4.135	.100	-15.4194	1.4060
		3.00	1.2699	5.548	.820	-10.0169	12.5567
	3.00	1.00	-8.2766	5.230	.123	-18.9179	2.3647
		2.00	-1.2699	5.548	.820	-12.5567	10.0169
Light	1.00	2.00	-8.7680*	3.576	.020	-16.0439	-1.4921
		3.00	-10.9415*	4.798	.021	-20.1449	-1.7381
	2.00	1.00	8.7680*	3.576	.020	1.4921	16.0439
		3.00	-2.1735	4.798	.654	-11.9352	7.5882
	3.00	1.00	10.9415*	4.524	.021	1.7381	20.1449
		2.00	2.1735	4.798	.654	-7.5882	11.9352
Moderate	1.00	2.00	3.0183	2.137	.167	-1.3296	7.3662
		3.00	2.2583	2.703	.409	-3.2414	7.7579
	2.00	1.00	-3.0183	2.137	.167	-73662	1.3296
		3.00	-.7600	2.867	.793	-6.5933	5.0732
	3.00	1.00	-2.2583	2.703	.409	-7.7579	3.2414
		2.00	.7600	2.867	.793	-5.0732	6.5933
Heavy	1.00	2.00	.6374	.354	.081	-8.2E-02	1.3569
		3.00	.5743	.447	.208	-.3358	1.4844
	2.00	1.00	-.6374	.354	.081	-1.3569	8.217E-02
		3.00	-6.31e-02	.474	.895	-1.0284	.923
	3.00	1.00	-.5743	.447	.208	-14844	.3358
		2.00	6.306e-02	.474	.895	-9023	1.0284

+ 1, Urban; 2, Rural; 3, Refugee camp.

*The mean difference is significant at the .05 level.

Table B: 6 Means of spore load categories in relation to locality

Spore load categories	Location+	N	Mean	SD	SE
Undetected	1.00	18	39.5284	13.8568	3.2661
	2.00	12	32.5217	7.6933	2.2209
	3.00	6	31.2518	5.4267	2.2154
	TOTAL	36	35.8134	11.4215	1.9036
Light	1.00	18	52.5131	11.0931	2.6147
	2.00	12	61.2811	8.5314	2.4628
	3.00	6	63.4546	5.4075	2.2076
	TOTAL	36	57.2593	10.5135	1.7522
Moderate	1.00	18	7.5164	7.5313	1.7751
	2.00	12	4.4981	3.0697	.8861
	3.00	6	5.2581	1.8560	.7577
	TOTAL	36	6.1339	5.7476	.9579

+ 1. Urban; 2. Rural; 3. Refugee camp.

Table B: 31 Means of spore load categories in male children with relation to locality

Spore load categories	Location+	N	Mean	SD	SE
Undetected	1.00	9	35.8331	14.2190	4.7397
	2.00	6	29.9014	9.4961	3.8768
	3.00	3	37.6957	3.3527	1.9357
	Total	18	32.8090	11.5190	2.7150
Light	1.00	9	52.1243	10.1506	3.3835
	2.00	6	63.3503	8.1680	3.3346
	3.00	3	63.6076	3.7526	2.1666
	Total	18	57.7802	10.1806	2.3996
Moderate	1.00	9	11.4886	9.0812	3.0271
	2.00	6	6.7272	2.6017	1.0621
	3.00	3	6.7031	1.3574	.7837
	Total	18	9.1039	6.8584	1.6165
Heavy	1.00	9	1.1601	1.6007	.5336
	2.00	6	.1323	.3240	.1323
	3.00	3	.2584	.4476	.2584
	Total	18	.6672	1.2326	.2905

+ 1, Urban; 2, Rural: 3, Refugee camp.

Table B: 4 Means separation for data on the effect of Season on spore load distribution in school children surveyed using Shefe's test.

Season (I)	Season (J)	Mean Difference (I-J)	SE	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Autumn	Winter	.44	3.166	.990	-7.34	8.21
	Spring	.25	3.166	.997	-7.53	8.03
Winter	Autumn	-.44	3.166	.990	-8.21	7.34
	Spring	-.19	3.166	.998	-7.96	7.59
Spring	Autumn	-.25	3.166	.997	-8.03	7.53
	Winter	.19	3.166	.998	-7.59	7.96

Table B:32 Means of spore load categories in female children with relation to locality

Spore load categories	Location+	N	Mean	SD	SE
Undetected	1.00	9	43.2236	13.2334	4.4111
	2.00	6	35.1420	4.8534	1.9814
	3.00	3	32.9518	7.3287	4.2312
	Total	18	38.8178	10.8063	2.5471
Light	1.00	9	52.9018	12.5746	4.1915
	2.00	6	59.2118	9.1177	3.7223
	3.00	3	63.3016	7.6779	4.4328
	Total	18	56.7385	11.1063	2.6178
Moderate	1.00	9	3.5442	1.6001	.5334
	2.00	6	2.2690	1.4272	.5827
	3.00	3	3.8131	.7103	.4101
	Total	18	3.1640	1.5156	.3572
Heavy	1.00	9	.2469	.7407	.2469
	2.00	6	.0000	.0000	.0000
	3.00	3	.0000	.0000	.0000
	Total	18	1235	.5238	.1235

+ 1, Urban; 2, Rural; 3, Refugee camp.

Table B: 1 One way analysis of variance (ANOVA) table of data on the effect of locality on spore load categories distribution in school children surveyed.

Source	D.F	Sum of square	Mean square	F. Value	P. Value
Between groups	2	829.865	414.932	4.506	.019
Within groups	33	3638.806	92.085	-	-
Total	35	3868.671	-	-	-

Table B: 3 One way analysis of variance (ANOVA) table of data on the effect of season on spore load categories distribution in school children surveyed.

Source	D.F	Sum of square	Mean square	F. Value	P. Value
Between groups	2	13.875	6.938	.010	.990
Within groups	429	369599.9	721.678		
Total	431	369613.8			

Table B: 5 One way analysis of variance (ANOVA) table of data on the effect of sex on spore load categories distribution in school children surveyed.

Source	D.F	Sum of square	Mean square	F. Value	P. Value
Between groups	1	317.541	317.541	12.873	
Within groups	34	838.687	24.667		
Total	35	1156.228			

الحاملون لمرض القوباء الحلقية من تلاميذ المدارس في محافظة نابلس: دراسة وبائية

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الملخص

أجريت دراسة لمرض القوباء الحلقية خلال شهر تشرين أول ١٩٩٨م في ٨٥٣١ تلميذ تتراوح أعمارهم ما بين ٦-١٤ عاماً (٤٧١٨ ذكور، ٣٨١٣ إناث)، موزعين على ١٢ مدرسة أساسية موجودة في ثلاث مناطق (مدينة، ريف، مخيم) في محافظة نابلس. كما تم دراسة الحاملين لمرض القوباء الحلقية، وكذلك ميكوبيوتا الشعر وفروة الرأس في نحو ١٣٨٩ من هؤلاء التلاميذ واللذين تراوحت أعمارهم ما بين ٦-١٢ عاماً (٧٢٤ ذكور، ٦٦٥ إناث) وذلك على ثلاث مرات بمعدل ٢-٣ أشهر ما بين المرة والأخرى على مدى ثمانية شهور (تشرين أول ١٩٩٨ و أيار ١٩٩٩). مع استخدام تقنية فرشاة الشعر.

تم اكتشاف ٢٣ حالة (٠,٢٧%) من القوباء الحلقية على أساس الأعراض وعزل الفطريات المسببة للمرض. وقد كانت نسبة الإصابة بالمرض في أطفال المخيم (٠,٤٣%) أعلى منها في تلاميذ المدينة أو القرية (٠,٢%). كما كانت نسبة الإصابة أعلى في التلاميذ الأصغر عمراً (٦-١٢ عاما، ٠,٣٣%) منها في التلاميذ الأكبر سناً (١٢-١٤ عام، ٠,٦%). كما كانت نسبة المرض أعلى في الذكور (٠,٣٨%) عنها في الإناث (٠,١٣%).

وكان الفطر الجلدي الذي يصيب الإنسان فقط *Trichophyton violaceum* هو أكثر الفطريات المسببة للمرض شيوعاً (٨٢,٦%) من جميع الحالات، يليه الفطر *Microsporum canis* الذي يصيب

الحيوانات والإنسان (١٧,٤%)، كما تم اكتشاف ٣٢ تلميذ حامل للمرض (نسبة حمل المرض ٠,٧٨%) وكانت أعلى نسبة للتلاميذ الحاملين للمرض موجودة في مخيم اللاجئين (١,٥٢%) يليها الريف (٠,٧%) ثم المدينة (٠,٥٤%). وكانت نسبة التلاميذ الحاملين للمرض أعلى في فصل الشتاء (١,٠٢-٣,٠١%) منها في الربيع (٠,٣-١,٥%) من الخريف (٠-٠,٢٤%). تم عزل ستة أنواع من الفطريات الجلدية من التلاميذ الحاملين للمرض، وقد كانت أكثر هذه الأنواع شيوعاً هو فطر: *M.canis* (٦٥,٦) يليه فطر *T. tonsurans* (١٢,٥%) وفطر *M.nanum* (٩,٤%) وفطر *T.violaceum* (٦,٣) وفطر , *E.flocossum* *T. concentricum* (٣,١) لكل منهما. كما كانت نسبة حاملي المرض أعلى في التلاميذ أقل من عشر سنوات (٠,٩%) عنها في التلاميذ الأكبر سناً (٠,٦%). كما أظهرت نتائج دراسة توزيع الحمول البوغيه (spore load) في التلاميذ حاملين المرض، أن ٩٦,٩ % منهم كان لديهم حملة بوغيه (١-١٠) مستعمرات لكل حامل للمرض في حين فإن لدى الباقي (٣,١%) حمولة بوغيه أكثر من (١٠) مستعمرات لكل حامل للمرض. وأظهرت النتائج وجود ارتباط ضعيف بين كون التلميذ حامل للمرض أو مصاب وبين الحمولة البوغيه من الفطريات الجلدية أو غير الجلدية الموجودة لديهم. ومع ذلك فقد كانت نسبة التلاميذ الذين لديهم حمولة بوغيه تزيد عن (١٠) مستعمرات لكل تلميذ من الفطريات الجلدية أو غير الجلدية أعلى في المصابين (٤,٣، ١٧,٤%) منها في حاملي المرض (٣,١ %).

وأظهرت الدراسة أن ميكوبيوتا الشعر وفروة الرأس في تلاميذ المدارس تشتمل على ١٠١ نوعاً تنتمي إلى ٣٣ جنساً موزعه على النحو التالي: ٦ فطريات جلدية، ١٦ فطريات مجة للكيراتين ذات صلة بالفطريات الجلدية، و٧٩ نوعاً من الفطريات الأخرى المحبة للكيراتين. وقد اختلفت الأنواع فيما بينها من حيث تكرار وجودها ووفرتها، كما تبين ذلك من قيم الأهمية النسبية RIV. وكانت الأنواع التالية أكثر الأنواع تكراراً وتوفراً:*Cladosporium cladosporioides* وكانت أكثر الأنواع تكراراً وتوافراً من بين الفطريات الجلدية المحبة للكيراتين المتعلقة بها: *Microsporum canis*، *Aphanoascus fulvescence* ويليها *Chrysosporum sulfureum*. وأما أكثر الفطريات الجلدية شيوعاً وتوفراً في المناطق المختلفة

فهي: *M. canis* في الريف، والمدينة، و*T.violaceum* في مخيم اللاجئين، وأما أكثر الفطريات المحبة للكيرتين شيوعاً وتوفراً بحسب المنطقة فكانت *Chrysosporium* spp يليها *Aphanoascus fulvescence*.

وأظهرت النتائج بأن مكونات ميكوبيوتا الشعر وفروة الرأس لا تختلف بحسب جنس أو عمر التلاميذ. في حين كان عدد الأنواع المكونة للميكوبيوتا أكبر (٧٣ نوعاً) في فصل الربيع منه في الخريف (٥٧ نوعاً)، أو الشتاء (٤٤ نوعاً). وأظهرت النتائج أيضاً بأن نسبة التلاميذ الذين لديهم حمولة بوغية متوسطة (١١-٥٠ بوغه/ تلميذ)، أو عالية (≤٥٠ بوغة / تلميذ) أعلى في تلاميذ المدينة عنها في تلاميذ القرية أو المخيم. وكانت نسبة التلاميذ الذين لم يكتشف الفطر في الشعر أو فروة الرأس لديهم نحو (٣٦%) من جميع التلاميذ تحت الدراسة، وأظهرت النتائج أيضاً أن نسبة التلاميذ من الفئة المذكورة وكذلك التلاميذ الذين لديهم حمولة بوغية منخفضة أعلى عند الإناث عنها في الذكور.