

SUPERFICIAL FUNGAL INFECTIONS AMONG SCHOOL AGE CHILDREN: DOES PREVALENCE AND PATTERN DIFFER BETWEEN COMMERCIAL AND AGRARIAN COMMUNITIES?

KEYWORDS

Dermatophytosis, ringworm, skin fungal infections, south-east Nigeria, tinea capitis

ABSTRACT

Background: Superficial fungal infections (SFIs) are common and have considerable negative impact on school children in tropics.

Objectives: The study compared the prevalence and pattern of SFI among primary school pupils in an agrarian (Ukpor) and commercial (Nnewi) communities in Nnewi Area

Methodology: A cross-sectional study was conducted among primary school pupils in Nnewi Area. Subjects were selected using stratified random sampling technique. Data was analyzed using SPSS version 21.

Results: Final analysis involved 773 and 789 pupils in the agrarian and commercial communities, respectively. Their mean age was 9.0 ± 2.0 years and male: female ratio was 1:1. The agrarian community had a significantly higher proportion of children who were from low socio-economic class families, and had poorer hygiene practices ($p=0.000$). The overall prevalence of SFIs was 28.9%. Prevalence was significantly higher in the agrarian compared to commercial community (39.3% versus 18.6%; $p = 0.000$). Tinea capitis was the predominant form of SFIs accounting for 80.3% and 83.7% of SFIs cases in the agrarian and commercial communities, respectively. Black dot tinea capitis was the commonest variant of tinea capitis in

both communities. Of the variants of tinea capitis, only the diffuse scale type differed in the rate of occurrence in the two communities (6.3% in agrarian versus 0.0% in commercial communities, $p=0.023$). The most prevalent organisms were *T. tonsurans* (37.9%), *T. mentagrophytes* (28.8%) and *T. rubrum* (18.7%) of which *T. rubrum* was significantly higher in the commercial community (27.6% versus 14.9%, $p=0.036$).

Conclusion: The burden of SFI is high among primary school children in Nnewi area, especially among those in agrarian communities. More awareness should be created on the prevention, identification and treatment.

INTRODUCTION

Superficial fungal infection (SFI) are contagious, affect significant proportion of primary school children and impact negatively on their quality of life. Superficial fungal infection (SFI) refers to fungal infections superficially involving the skin, appendages, and mucosa. SFI is subdivided into cutaneous and superficial infections.^{1,2} Superficial infections are restricted to the stratum corneum and include tinea versicolor, piedra, and tinea nigra. On the other hand, cutaneous infections involve the skin and appendages and include onychomycosis or tinea unguim (nails), tinea capitis (scalp), tinea corporis (trunk and extremities), tinea barbae (beard), tinea pedis (feet), tinea faciei (face), and candidiasis of skin, superficial mucosa, and nails. These fungal infections are caused by several species of dermatophytes (*Trichophyton*, *Microsporum*, and *Epidermophyton* species), *Candida*, *Malassezia* and *Trichosporon*.^{3,4}

Children in the tropics and sub-tropics are particularly at risk of SFI due to the warm humid environment, which supports the thriving of causative organisms.⁵ Due to the highly contagious

nature of some SFI, the risk is higher among children with poor living conditions such as overcrowding, lack of portable water and poor hygiene.⁶ Frequent contact with contaminated soil and animals poses additional risk to children who live in farming communities.

Although skin SFI are generally believed to be benign, lesions are often chronic, unsightly and sometimes disfiguring. This may be attributed to the fact that majority of infected children are either untreated or subjected to unorthodox medications.⁷ Besides, there is growing evidence that associated features such as alopecia, itchiness and chronicity have considerable negative impact on the psychosocial health of school children especially the females.^{8,9} In addition, SFI could be complicated by superinfection with bacteria (pyoderma) and consequently post-streptococcal glomerulonephritis.⁶ It is therefore pertinent to reduce the burden of SFI in order to improve the quality of life of school children in the tropics. However, there is currently no public health intervention to address SFI among school children in Nigeria. This may be due to lack of data on current burden to guide relevant stakeholders in adopting control interventions. Therefore, this study was conducted to compare the prevalence, clinical and mycological patterns of skin SFI between pupils of primary schools in an agrarian and commercial communities in Nnewi area.

METHODOLOGY

A cross-sectional comparative study was conducted among pupils of selected primary schools in an agrarian (Ukpor) and commercial (Nnewi) communities in Nnewi Area. The area is in tropical rain forest vegetation zone and the climate is influenced by two major trade winds: the warm moist southwest trade winds during the rainy season (April –October) and the north east trade winds during the dry and dusty harmattan (November-March).¹⁰ Both towns share common

boundary with Ukpok located to the west of Nnewi. Generally, Ukpok is colder and less humid than Nnewi due to its hilly topography. The temperature of the area is generally high ranging from 19.4°C to 31.1°C in Ukpok and 23°C to 35°C in Nnewi. Most of the inhabitants of Ukpok are subsistence farmers while inhabitants of Nnewi are predominantly traders and public servants.¹⁰ Ukpok is the headquarter of Nnewi South Local Government Area (LGA) while Nnewi is a one town LGA. Ukpok is classified as urban town based on the fact that it hosts the Nnewi-South LGA headquarter, but the setting is agrarian and typical of a Nigerian rural community. On the other hand, Nnewi is an urban town and the 2nd largest commercial city of Anambra State. According to 2006 Nigerian national population Census, Nnewi has a population of 155,443 with an annual growth rate of 3.7% while the population of Ukpok was 25,000 to 35,000.¹¹

Eligible participants were children who had lived in the communities for at least 12 months, attend primary school in the town of residence, whose parents or guardians gave written informed consent, and who also gave an assent. The pupils were selected using a stratified random sampling technique.

Based on sample size formula for comparing proportions in two populations, minimum sample size of 750 pupils was calculated for each community.¹² Ethical approval for the study was obtained from the Research and Ethics Committee of Chukwuemeka Odumegwu Ojukwu University Teaching Hospital (COOUTH). Permissions were obtained from Anambra State Universal Basic Education Board (ASUBEB) and Anambra State Ministry of Health, LGA ASUBEB, LGA education secretaries, and school authorities. Privacy was maintained during examination and collection of specimen and a same sex teacher was used as chaperone during physical examination.

A proforma was used to collect participants' socio-demographic, hygiene related and sanitation related data. Socio-demographic data included age, sex, grade in school, family characteristics, parent's occupation and highest educational attainment. Their socio-economic status was determined using parent's occupation and highest educational attainment as described by Oyedeji.¹³

The specimens were collected using standard procedures.¹⁴ Skin scrapings (scales and crusts), hair shavings and nail snippings were collected from pupils who had cutaneous lesions suspected to be SFI. Affected areas were cleaned with 70.0% ethanol prior to specimen collection to remove dirt or bacterial contamination. On evaporation of the ethanol, specimens were collected on a clean piece of square shaped paper about 5cm in length.

All laboratory procedures were conducted by a consultant microbiologist. The laboratory work was done in the Medical Microbiology Department of Nnamdi Azikiwe University Teaching Hospital, Nnewi. Apart from samples from pityriasis vesicolor lesions, all samples were divided into two portions, one for culture and the other for microscopic examination. Samples collected from pityriasis vesicolor lesions were examined by microscopy alone. A portion of the specimen were examined microscopically in 20.0% potassium hydroxide (KOH) solution using standard procedure.¹⁴

Culture of remaining specimens were done to identify the species of fungi. This was done in NAUTH Mycology Laboratory, using Sabouraud's potassium dextrose agar (SDA) base (Oxoid UK). The SDA was supplemented with broad spectrum antibiotics chloramphenicol and gentamycin to inhibit gram positive and gram negative bacterial contamination as well as

cyclohexamide to inhibit saprophytic fungal contamination. Cultures were incubated aerobically for 1 to 4 weeks. However, to avoid overgrowth of contaminants, they were monitored every 2-3 days and sub-culturing was done as soon as significant growth was noticed. In the absence of any growth after 4 weeks, the culture was considered negative. Positive cultures were examined both microscopically and macroscopically. Macroscopic examination was for characteristic colour of surface and reverse, texture and topography. The species of dermatophyte was identified from the colonial appearance of the culture and by examining the mycelial growth microscopically using the lactophenol cotton blue stain. Specialized hyphae such as spiral, pectinate or antler hyphae, presence or absence and morphology of macroconidia, microconidia, and chlamydospores were used with reference to a mycology atlas to identify the individual fungal isolates.¹⁴⁻¹⁶

DATA ANALYSIS

Data were analyzed using Statistical Package for Social Sciences (SPSS) software version 21. The frequency distributions of categorical variables were presented in tables and charts where applicable. Means and standard deviations of the continuous variables such as age were calculated. The proportions of different groups were compared using chi-square test for categorical variables while student t-test was used to compare the means of continuous variables. Where conditions for chi-square test were violated, Fisher exact test was used. P-values less than 0.05 were considered statistically significant.

RESULTS

The study was conducted between April and July 2019. A total of 1562 primary school pupils with complete data were included in final analysis. This consisted of 773 and 789 pupils in Ukpok and Nnewi, respectively. The age of the pupils ranged from 5 to 15 years with a mean of 9.18 ± 2.03 and 8.77 ± 1.86 years in Ukpok and Nnewi, respectively. The male to female ratio was approximately 1:1. The pupils were predominantly Igbos (98.2% [1534/1562]), majority lived with their parents (89.8% [1402/1562]) and they were fairly uniformly distributed across primaries 1 to 6 in both towns.

As shown in Table 1, there were no significant difference in the age, sex and family size of the pupils in both towns. The pupils in Ukpok were predominantly from public schools (87.8% [679/773]) while those in Nnewi were predominantly from private school (74.7% [589/789]). Compared to Nnewi, Ukpok had a significantly higher proportion of pupils who were from low socio-economic class (69.4% versus 30.4%, $p=0.000$) or polygamous families (80.0% versus 20.0%, $p=0.000$). Nnewi had a significantly higher proportion of children who were not living with their biologic parents (79.6% versus 20.4%, $p=0.000$) compared to Ukpok.

TABLE 1: SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE PUPILS

Characteristic	Ukpor Frequency (%)	Nnewi Frequency (%)	p-value
Sex			
Female [n=800]	400 (50.0)	400 (50.0)	0.678
Male [n=762]	373 (49.0)	389 (51.0)	
Age (years)			
5 to 8 [n=640]	305 (47.7)	335 (52.3)	0.205
9-12 [n=859]	431 (50.2)	428 (49.8)	
>=13 [n=63]	37 (58.7)	26 (42.3)	
Tribe			
Igbo [n=1534]	767 (50.0)	767 (50.0)	0.003* (FET)
Hausa [n=19]	3 (15.9)	16 (84.1)	
Yoruba [6]	1 (16.7)	5 (85.3)	
Idoma [3]	2 (66.7)	1 (33.3)	
Class			
Primary 1 [n=278]	138 (49.6)	140 (50.4)	0.989
Primary 2 [n=259]	130 (50.2)	129 (49.8)	
Primary 3 [n=254]	124 (48.8)	130 (51.2)	
Primary 4 [n=263]	133 (50.6)	130 (49.4)	
Primary 5 [n=248]	124 (50.0)	124 (50.0)	
Primary 6 [n=260]	124 (47.7)	136 (52.3)	
Caregiver			
Parent [n=1402]	738 (52.6)	664 (47.4)	0.000*
Other extended family members [n=18]	6 (33.3)	12 (66.7)	
Guardian [n=142]	29 (20.4)	113 (79.6)	
Socio-economic Class			
Upper [n=268]	8 (3.0)	260 (97.0)	0.000*
Middle [n=545]	245 (45.0)	300 (55.0)	
Low [n=749]	520 (69.4)	229 (31.6)	
Family setting			
Single parent [n=10]	10 (100.0)	0 (0.0)	0.000*
Monogamous [n=1532]	747 (48.8)	785 (51.2)	
Polygamous [n=20]	16 (80.0)	4 (20.0)	

Total family size			
≤6 [n=684]	348 (50.9)	336 (49.1)	0.226
7 to 12 [n=863]	415 (48.1)	448 (51.9)	
≥13 [n=15]	10 (66.7)	5 (33.3)	

*Statistically significant

As shown in Table 2, pupils in Ukpör significantly had higher mean weekly frequency of walking barefoot on sand (5.13 ± 1.79 versus 1.76 ± 2.23 , $p = 0.000$), touching animals (2.58 ± 2.81 versus 0.92 ± 2.11 , $p=0.000$) and lower daily frequency of hand washing (2.42 ± 0.86 versus 5.55 ± 2.05 , $p=0.000$) compared to pupils in Nnewi.

Table 2: HYGIENE RELATED BASELINE CHARACTERISTICS I

Characteristics	Mean (SD)	IQR	p-value
Frequency of walking barefoot/week			
Ukpör	5.13 ± 1.79	3	
Nnewi	1.76 ± 2.23	3	0.000*
Frequency of touching animals/week			
Ukpör	2.58 ± 2.81	5	0.000*
Nnewi	0.92 ± 2.11	0	
Frequency of hand wash /day			
Ukpör	2.42 ± 0.86	1	0.000*
Nnewi	5.55 ± 2.05	2	

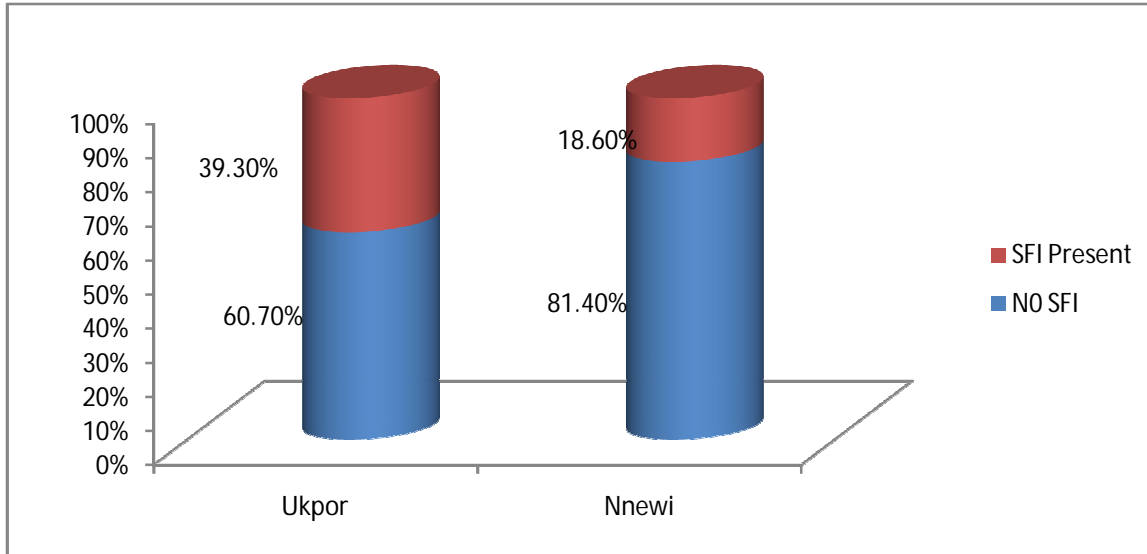
*IQR-Interquartile range, *Statistically significant*

The overall prevalence of SFI was 28.9%. (451/1562). The prevalence of SFI was significantly higher in Ukpör compared to Nnewi (39.3% [304/773] versus 18.6% [147/789], $p=0.000$) as shown in Figure 1.

Ukpör significantly had a higher prevalence of all forms of dermatophytosis and pityriasis versicolor ($P=0.000$). The only case of cutaneous candidiasis was seen in Nnewi. The predominant form of SFIs was tinea capitis as shown in Figure 2 and Table 3. There was no

significant difference in the pattern of skin SFIs in both communities as seen in Table 4. Multiple infections were seen in 5.1% of subjects (23/451)

FIGURE 1: PREVALENCE OF SFI IN NNEWI AND UKPOR



P<0.001(Statistically significant)

FIGURE 2 : PREVALENCE OF DIFFERENT FORMS OF SFIs (n=1562)

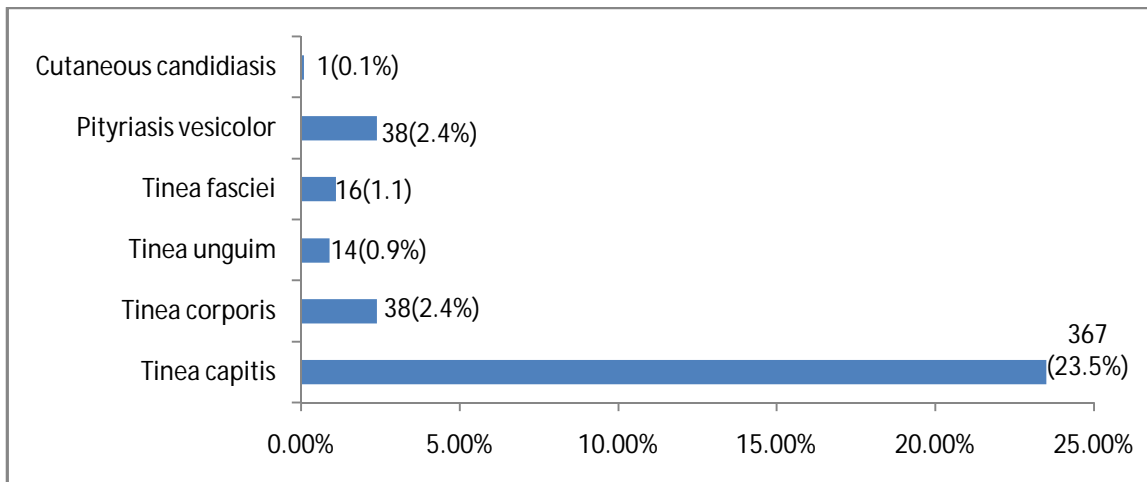


TABLE 3: CLINICAL PATTERN OF SFIs IN UKPOR AND NNEWI

Characteristic	Yes	No	p-value
Tinea capitis			
Ukpor	244(80.3)	80(19.7)	0.383
Nnewi	123(83.7)	24 (16.3)	
Tinea corporis			
Ukpor	30(9.9)	274 (90.1)	0,113
Nnewi	8 (5.4)	139(94.6)	
Tinea unguim			
Ukpor	8 (2.6)	296(97.4)	0.405
Nnewi	6 (4.1)	141 (95.9)	
Tinea fasciei			
UKpor	12 (3.9)	292 (96.1)	0.509
Nnewi	4(2.7)	143 (97.3)	
Pityriasis vesicolor			
Ukpor	28 (9.2)	276(90.8)	0.388
Nnewi	10(6.8)	137(93.2)	
Cutaneous candidiasis			
Ukpor	0 (0.0)	304(100.0)	
Nnewi	1(0.7)	146(99.3)	

Table 4 shows that non-inflammatory black dot tinea capitis was the commonest variant of tinea capitis in both Ukpor and Nnewi. The only significant difference in clinical form was seen in diffuse scale type which was significantly higher in Ukpor (6.3% versus 0.0%, p=0.023)

TABLE 4: CLINICAL VARIANT OF TINEA CAPITIS IN NNEWI AND UKPOR

Variant of tinea capitis	Present?		p-value
	Yes	No	
Black dot			
Ukpor	105(50.7)	102 (49.3)	0.135
Nnewi	49(60.5)	32(39.5)	
Diffuse scale			
Ukpor	13 (6.3)	194 (93.7)	0.023*
Nnewi	0 (0.0)	81 (100.0)	
Gray Patch			
Ukpor	73 (35.3)	134(64.7)	0.932
Nnewi	27(35.8)	52 (64.2)	
Pustular type			
Ukpor	13 (6.3)	194(93.7)	0.391
Nnewi	3 (3.9)	79 (96.3)	
Kerion			
Ukpor	3 (1.4)	204 (98.4)	0.276
Nnewi	0 (0.0)	81 (100.)	

*Statistically significant n=207in Ukpor, n=81 in Nnewi

Organisms were isolated from 311 (84%) of 370 samples obtained from subjects with dermatophytosis or cutaneous candidiasis. *Aspergillus* and *penicillium* contamination occurred in 89 (28.6%) and 23 (7.4%), respectively. The commonest isolated pathogens in both towns were *T. tonsurans* (37.7%), *T. mentagrophytes* (28.6%) and *T. rubrum* (18.6%). Others were *M. gypseum* (6.0%), *M. canis* (4.5%), *M. aouduinii* (3.5%), *E. floccosum* (1.5%), *C albicans* (1.0%) Multiple pathogens were isolated in 1.5% (3/199) of subjects.

The only statistically significant difference in the organisms isolated occurred in *T. rubrum* which was significantly higher in Nnewi (27.6% versus 14.9%, p=0.036) as shown in Table 5.

TABLE 5: PATHOGENS ISOLATED FROM POSITIVE CULTURES IN UKPOR AND NNEWI

	Pathogens isolated from positive culture		p-value
	Yes	No	
<i>T. tonsurans</i>			
Ukpor	56 (39.7)	85 (60.3)	0.357
Nnewi	19 (32.8)	39(62.7)	
<i>T. Mentagrophytes</i>			
Ukpor	44 (31.2)	97 (68.8)	0.213
Nnewi	13 (22.4)	45 (77.6)	
<i>T. rubrum</i>			
Ukpor	21 (14.9)	120(85.1)	0.036*
Nnewi	16 (27.6)	42 (72.4)	
<i>M. gypseum</i>			
Ukpor	8(5.7)	133(94.3)	0.743
Nnewi	4 (6.9)	54 (93.1)	
<i>M.audouinii</i>			
Ukpor	6 (4.3)	135 (95.7)	0.379
Nnewi	1 (1.7)	59 (98.3)	
<i>M. canis</i>			
Ukpor	6 (4.2)	135 (95.7)	0.777
Nnewi	3 (5.2)	55 (94.8)	
<i>E. floccosum</i>			
Ukpor	2 (1.4)	139(98.6)	
Nnewi	1 (1.8)	57 (98.2)	
<i>C. albicans</i>			
Ukpor	1 (0.7)	140 (99.3)	
Nnewi	1 (1.8)	57 (98.2)	

*Statistically significant *n=141 in Ukpor,* *n=58 in Nnewi*

As shown in Table 6, a significantly higher proportion of pupils in public schools and from families with lower social class had SFI in both communities. Gender was significantly associated occurrence of SFI in only with the commercial community Nnewi where a significantly higher proportion of boys h

TABLE 6: FACTORS ASSOCIATED WITH SFI IN UKPOR AND NNEWI

Characteristic	Ukpor (n=773)			Nnewi (n=789)		
	Presence of SFI		p-value	Presence of SFI		p-value
Yes	No	Yes		No		
Gender						
Female	147 (36.8)	253 (63.3)	0.129	58 (14.5)	342 (85.5)	0.003*
Male	157 (42.1)	216 (57.9)		89 (22.9)	300 (77.1)	
School type						
Public	279 (41.1)	400 (58.9)	0.007*	72 (36.0)	128 (64.0)	<0.001*
Private	25 (26.6)	69 (73.4)		75 (12.7)	514 (87.3)	
Tribe						
Hausa	1 (33.3)	2 (66.7)	0.777	6 (37.5)	10 (62.5)	0.215
Igbo	1 (50.0)	1 (50.0)		0 (0.0)	1 (100.0)	
Idoma	301 (39.2)	466 (60.8)		140 (18.3)	627 (81.7)	
Yoruba	1 (100.0)	0 (0.0)		1 (20.0)	4 (80.0)	
Total family size						
≤ 6	138 (39.7)	210 (60.3)	0.763	54 (16.1)	282 (83.9)	0.194
7-12	161 (38.8)	254 (61.2)		92 (20.5)	356 (79.5)	
≥13	5 (50.0)	5 (50.0)		1 (20.0)	4 (80.0)	
Social class						
Upper	1 (12.5)	7 (87.5)	0.015 [†]	29 (11.2)	231 (88.8)	<0.001*
Middle	82 (33.5)	163 (66.5)		52 (17.3)	248 (82.7)	
Lower	221 (42.5)	299 (57.5)		66 (28.8)	163 (71.2)	
Total	304(39.3)	469 (60.7)		147 (18.6)	642 (81.4)	

* Statistically significant (chi-square test), [†] Statistically significant (Fisher's exact test)

DISCUSSION

The prevalence of SFI in this study (28.9%) corroborates previous reports that the prevalence of SFI ranges from 20-3% among African children.^{17,18} Our finding is also comparable to 35.0% reported by similar studies in Tanzania and Ile-Ife.^{19,20} However, the prevalence of dermatophytosis in the index study was lower than 40.6% documented in Awka-South LGA, Anambra State.²¹ This is not surprising since the Awka-South study was conducted among pupils in rural schools.

The significantly higher prevalence among school children in agrarian compared to commercial town was not unexpected and agrees with previous reports.²¹⁻²⁴ This may be attributed to prevailing poorer socio-economic circumstances in agrarian compared to commercial communities as found in this study. In addition, a significantly higher proportion of pupils in the agrarian community walked barefoot, touched animals more often and washed hands less frequently. These practices are believed to favour the transmission of SFIs causing organisms. Although the agrarian community had a relatively less climatic risk for SFIs due to the fact that it is relatively colder and less humid, it still recorded more SFIs.

The predominance of tinea capitis agrees with previous African and non-African reports.^{3,17, 25,26} Despite the slight variation in the occurrence of non-tinea capitis dermatophytosis, findings of the index study are in tandem with other African reports that tinea corporis and tinea faciei are commoner than other non-tinea capitis dermatophytosis. The absence of tinea cruris, tinea nigra and piedra agree with reports from Tanzania and Ile-Ife.^{19,20} Most school based SFIs studies did not report any cutaneous candidiasis. Nevertheless, a hospital laboratory based study, involving samples from the general population reported 4.4% as the rate of candida albicans isolation from SFIs, which is higher than 0.1% found in the index study.²⁷ However, the immune status of the

subjects in that study, which is an important determinant of cutaneous candidiasis occurrence, was not documented. The finding of cutaneous candidiasis was unanticipated in the index study involving immune competent children. However, exclusion of children with immunosuppressive illnesses such as HIV or cancer was based on only verbal response from caregivers which may not be completely reliable.

The findings of this study agree with report from Ile-Ife that pityriasis versicolor is the 2nd most common form of SFIs in primary school children. However, this was found to have the same prevalence with tinea corporis in contrast to lower prevalence of the later in Ile-Ife.²⁰ The prevalence of pityriasis versicolor was slightly lower than rates reported in Kenya and Ile-Ife.^{20,28} This may be attributed to the lower mean age of pupils in the index study compared to Ile-Ife (8.97 ± 1.95 versus 9.42 ± 2.0 years) since the risk of pityriasis versicolor increases with age.

All classes of dermatophytes including anthropophylic dermatophytes (*T. tonsurans*, *T. rubrum*, *T. mentagrophytes*, *E. floccosum*, *M. audouinii*), zoophilic dermatophytes (*M. canis*, *T. mentagrophytes*) and geophilic dermatophyte (*M. gypseum*) were isolated from the pupils in both communities. The predominance of anthropophilic dermatophytes reflects the commonest mode of transmission through direct or indirect skin contact, and agrees with previous reports from Kenya, South Africa and other parts of Nigeria.^{5,29,30}

The most prevalent organisms were *T. tonsurans* (37.7%), *T. rubrum* (18.6%) and *T. mentagrophytes* (28.6%). Our findings are in keeping with previous Anambra report which documented *T. tonsurans* and *M. audouinii* as the commonest and least prevalent organism, respectively.²³ Similar finding was also documented among children of Fulani/Hausa cattle herders in South-East Nigeria. Predominance of *T. tonsurans* has also been documented in Aba and Nairobi.^{30,31} *T. tonsurans* is a highly contagious anthropophilic dermatophyte which

predominantly causes dot-type tinea capitis. It is responsible for more than 95% of tinea capitis in North America and was previously thought to play less important roles in Africa. However, findings of the above studies and the index study suggest that *T. Tonsurans* also play a dominant role in the etiology of dermatophytosis among African children. The reason for the statistically significant higher isolation of *T. rubrum* in Nnewi compared to Ukpok is not clear. However, this may not be unrelated to variations in the survival of the athrospores of different dermatophytes. It is possible that *T. rubrum* is able to survive the relatively hotter and more humid atmosphere in Nnewi compared to Ukpok. Further studies are needed to verify this.

The association between low socio-economic class or attendance of public schools and SFI agrees with previous reports.^{32,33} Families with low socio-economic class may be less likely to afford materials for personal hygiene as well as cleaner and less crowded home or school environments. The same may apply to public compared to private schools.

CONCLUSION

The burden of SFIs is high among school children in Nnewi area. The prevalence is particularly high among school children in agrarian communities as well as those who come from poorer homes or attend public schools. The types of SFIs and their causative organisms are comparable in both agrarian and commercial communities. Tinea capitis is the dominant form of SFI and the commonest organisms implicated are *T. tonsurans* (37.7%), *T. mentagrophytes* (28.6%) and *T. rubrum* (18.6%). There is need to create more awareness on the prevention, identification and treatment of SFIs among school children in Anambra State. Given the high burden and negative impact of SFI among school children, it's important to institute a public health control intervention. Efforts should be intensified at improving the living condition and hygienic practices of school children in rural agrarian communities.

LIMITATIONS

Due to resource constraints, we were unable to use molecular methods for the identification of the fungi and unbundling the *T. rubrum* and *T. mentagrophytes* complexes. Further studies are needed, to determine the actual occurrence of the components of these complexes using molecular methods.

Acknowledgments

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Ethics approval

Ethical approval was obtained from the Research and Ethics Committee of Chukwuemeka Odumegwu Ojukwu University Teaching Hospital (COOUTH) Awka prior to commencement of the study.

Consent

The parents/caregivers of all participants gave a written informed consent. Assent was also obtained from all participants.

Competing interests

The authors hereby declare no competing interest that could be perceived to inappropriately influence the findings reported in this research work.

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Authors' contributions

OCU conceptualized and designed the study. OCU, EFU, SNU and INA collected the data, CUO analyzed and interpreted the data. CUO produced the initial draft of the manuscript. OCU, EFU, SNU and INA critically reviewed the manuscript. All the authors reviewed and approved the final version of the manuscript.

REFERENCES

1. World Health Organization. ICD-10: international statistical classification of diseases and related health problems 2004: 10th revision (2nd ed).
<https://apps.who.int/iris/handle/10665/42980>
2. Swartz RA. Superficial fungal infections. *Lancet* 2004; 364: 1173-1182
3. Havlickova B, Czaika VA Friedrich M. Epidemiological trends in skin mycoses worldwide. *Mycoses* 2008; 51 (Suppl. 4): 2-15.
4. Nenoff P, Krüger C, Ginter- Hanselmayer G, Tietz H. Mycology-an update Part 1: Dermatomycoses: Causative agents, epidemiology and pathogenesis *J Dtsch Dermatol Ges.* 2014;12(3):188-212.
5. Nweze EI. Dermatophytosis in western Africa: a review. *Pak J Biol Sci.* 2010;13(13):649-656.
6. World Health Organization. Epidemiology of management of common skin diseases in children in developing countries 2005. Accessed 5th May 2019. Available from
https://apps.who.int/iris/bitstream/handle/10665/69229/WHO_FCH_CAH_05.12_eng.pdf
7. Emele FE, Oyeka CA. Ringworm infections in Anambra State of Nigeria: epidemiologic features and antifungal potentials of local plant remedies. *Hair: Therapy and Transplantation* 2017; 7(1):1-5

8. Adeolu A, Olasode O, Onayemi O, Mejiuni A. The Impacts of tinea capitis on quality of life: a community based cross sectional study among Nigerian Children. *Clinical Medicine: Dermatology* 2013; 6: 9-17.
9. Fienemika AE, Okefor CU. The identification and grading of the psychosocial impact of tinea capitis in primary school children in a semi-urban area of Rivers State Nigeria. *Niger Postgrad Med J.* 2017; 24(1): 20-24
10. United Nations Programme on Human Habitation/Anambra State Government: Structure Plan for Nnewi and Satellite Towns 2009. UN-HABITAT, Nairobi: Kenya
11. National Population Commission (NPC). Nigeria Population Census Report 2006. NPC, Abuja.
12. Whitley E, Ball J. Statistics review 4 : sample size calculation. *Critical care* 2002; 6: 335-341
13. Oyedeji GA. Socio-economic and cultural background of hospitalized children in Ilesha. *Niger J Paediatr.* 1985, 12, 111-117
14. Cheeseborough M *District Laboratory Practice in Tropical Countries* 2006; (2nd ed.): 34-238. New York : Cambridge:University Press.
15. Hanafy AM. In Vitro Antifungal Drug Susceptibility of Dermatophytes Isolated from Patients In Al-Medina, Saudi Arabia. *Egypt J Exp Biol.* 2012; 8(2): 245 - 250.
16. Hanafy AM, El-Adly AA, Alsarani AQ, Ashfaq M, Karam El-Din AA. Epidemiology of cutaneous mycosis in the Medina region of Saudi Arabia correlated with studying the effect of light-induced gold nanoparticles on the growth of dermatophytes in vitro. *African Journal of Microbiology Research* 2012; 6: 6668-6677.
17. Coulibaly O, Ollivier C, Piarroux R, Stephane R. Epidemiology of human dermatophytoses in Africa. *Medical Mycology* 2018; 56: 145–161
18. Hay R, Bendeck SE, Chen S, Estrada R, Haddix A, McLeod T. Skin diseases. In: Jamieson DT, Breman JG, Meaashan AR et al editors. *Disease Control Priorities in Developing Countries* 2006; (2nd ed.): 707-722. New York: Oxford University Press.
19. Chikoi R, Nyawale HA, Mghanga FP. Magnitude and associated risk factors of superficial skin fungal infection among primary school children in Southern Tanzania. *Cureus* 2018; 10(7): e2993.

20. Olaide OO, Olaniyi OO, Abimbola OA, Gabriel O, Olumayowa AO. The Prevalence and Pattern of Superficial Fungal Infections among School Children in Ile-Ife, South-Western Nigeria, *Dermatol Res Pract*. 2014; 2014:1-7. <https://doi.org/10.1155/2014/842917>
21. Ogbu CC, Okwelogu IS, Ume AC. Prevalence of superficial fungal infections among primary school pupils in Awka South, Anambra State. *Journal of Medical Research* 2015; 2: 15-22
22. Coulibaly O, Kone AK, Niare-Doumbo S, Goita S. Dermatophytosis in three eco-climatic zones in Mali. *PLoS Negl Trop Dis*. 2016; 10 (4): e0004675, doi: 10.1371/journal.pntd.000467
23. Emele FE., Oyeka CA. Tinea capitis among primary school children in Anambra state of Nigeria. *Mycoses* 2008; 5: 536-541
24. Nwadiaro PO, Ogbonna CIC. Pattern of dermatophytosis in Jos North Plateau State of Nigeria. *Nig J Exp Appl Biol*, 2009; 10(2): 73-77
25. Gupta AK, MacLeod MA, Foley AK, Gupta G, Friedlander SF. Fungal Skin infection. *Pediatrics in Review* 2017; 38: 8-22.
26. Seebacher C, Bouchara J, Mignon B. Updates on the Epidemiology of dermatophyte infections. *Mycopathologia*, 2008; 166: 335–352
27. Emmy-Egbe IO, Ibeh AN, Opara F, Umeaku CN. Prevalence of fungal organisms associated with skin infections in Ihiala local government area of Anambra state, Nigeria. *International Journal of Natural and Applied Sciences* 2006; 2: 210-213
28. Schmeller W, Baumgartner S, Dzikus A. Dermatophytomycoses in children in rural Kenya: the impact of primary health care. *Mycoses* 1997; 40: 55–63.
29. Chukwu ID, Chukwu OO, Chuku A, Israel B, Enweani BI, Lamorde DAG. Dermatophytoses in rural school children associated with livestock keeping in Plateau State, Nigeria. *J Yeast Fungal Res*. 2011; 2: 13 -18.
30. Moto JN., Maingi JM., Nyamache AK. Prevalence of Tinea capitis in school going children from Mathare, informal settlement in Nairobi, Kenya. *BMC Res. Notes*. 2015;8:274. doi: 10.1186/s13104-015-1240-7
31. Ngwogu AC, Otokunfor VT. Epidemiology of dermatophytoses in a rural community in Eastern Nigeria and review of literature from Africa. *Mycopathologia* 2007; 164: 149-158.

32. Afolabi OT, Oninla O, Fehintola F. Tinea capitis: a tropical disease of hygienic concern among primary school children in an urban community in Nigeria. *J. Public Health Epidemiol.* 2018; 10: 313 – 319.
33. Olutoyin, OO, Onayemi O, Gabriel AO. Risk factors associated with acquiring superficial fungal infections in school children in South Western Nigeria: a comparative study. *Afr Health Sci.* 2017; 17: 330-336