ACTA MYCOLOGICA
Vol. 38 (1/2): 71 -87
2003

Fungal infection risk groups among school children

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Ejdys E.: *Fungal infection risk groups among school children*. Acta Mycol. 38 (1/2): 70-87, 2003.

The aim of the study was to evaluate the relationship between occurrence of fungi in children and living environment (city – countryside), sex, age, diet, undergone diseases, therapy with antibiotics and exposure to hospital environment, and to indicate children potentially vulnerable to fungal infections.

The material was consisted of swabs collected from the oral cavity, the throat and the nose of healthy children, aged 6–9 and 10–15, from both urban and rural environments.

Candida albicans, the basic aetiological factor in the majority of mycoses recorded in humans, unquestionably prevailed in the group of the 13 species of yeast-like fungi and yeasts isolated. Records of *C. glabrata* and *C. krusei*, increasing numbers of whose strains show resistance to basic antimycotics, as well as relatively frequent records of *Trichosporon beigelii, Saccharomycopsis capsularis* and *Saccharomyces* sp., fungi whose expansiveness and enzymatic activity have been growing, may be considered disconcerting.

Vulnerability to fungal infection increases following anti-bacterial antibiotic therapy in the majority of subjects regardless of season or age. This is particularly true primarily of the most stable ontocoenosis of the throat. Younger children, on the other hand, are the most vulnerable following infections of the respiratory system. Fungi are likely to colonise the nose in this case.

Children living in the countryside who had been ill immediately prior to the collection of the material constitute the highest risk group of the occurrence of fungi in any of the ontocoenoses studied. A greater number of positive inoculations were recorded in these children in comparison to the children from the city. It may be indicative of a more extensive spectrum of natural reservoirs of fungi and the vectors of their transmission in rural areas than those in the city, lower health hygiene and lower immunity or of a more common carriage of fungi among rural children.

Key words: fungal infection, respiratory system, children

INTRODUCTION

Age is one of the most important physiological agents that predispose to a possible pathogenic development of fungal infection in humans. The maturity of the immunological system, resulting from a person's age, conditions a primary or secondary form of infection. Mycological literature deals most extensively with newborns and infants as the highest risk group for primary fungal infections (Borowski and Mierzejewski 1965, Miller 1990). This is particularly true of fungi of the genus *Candida*. Susceptibility to *Candida albicans* infection in infants may be attributed to a number of factors such as the inability to produce antibodies up to the age of 6–8 months, a decrease in the titre of maternal IgG antibodies up to the 5th week of life and a reduced ability of leukocytes to kill microorganisms in comparison with adults (Milewska-Bobula et al. 1997). The course of the disease in young patients is particularly serious, and the mortality rate high. Mycoses in children may occur in a number of different forms: generalised (Lauterbach 1995; Rabczyński, Dzięgiel and Ziółkowski 1998), pulmonary (Ellis 1994), situated in the skeletal system (Marcińska et al. 1995), in the urinary system (Ratajczak et al. 1996) and in the central nervous system (Kowalewska-Kantecka et al. 1993; Mikusz, Kułagowska-Timberman and Nowak 1997). According to Sekuła et al. (1993), apart from young age and low birth weight, antibacterial therapy with broad spectrum antibiotics, intensive care treatment, surgical procedures, central venous access and parenteral nutrition are other risk factors. No influence of long-term penicillin prophylaxis on the occurrence of fungi in children was observed (Brózik et al. 1980).

Latest findings have also contributed to a re-formulation of the traditional perspective on the participation of fungi in dental caries. As has been shown, there does not exist any direct relationship between the presence of fungi in the oral cavity and caries attack (Grodzka 1968). It is believed that fungi occur in the caries focus because of co-aggregation with streptococci and *Actinomycetales* (O'Sullivan, Jenkinson and Cannon 2000). Due to their hydrophobic properties, dental material, fillings and orthodontic devices increase the chances of colonisation and pathogenesis within the oral cavity (Białasiewicz, Kurnatowska and Śmiech-Słomkowska 1993). Fungal dissemination from the oral cavity and the nose to the paranasal sinuses and the lungs very often leads to mycoses of these organs (Burczyński et al. 1964; Klempous, Pośpiech and Rak 2000).

The range of factors predisposing to the incidence of mycoses does not differ significantly between individual age groups, high risk groups in particular. Except for physiological and pathological factors, therapy with broad spectrum antibiotics, cytostatics, corticosteroids, immunosuppressive drugs and chronic malnutrition are the most important ones (Bodey 1990; Kowalewska-Kantecka et al. 1993; Sekuła et al. 1993; Gelfand 1997).

A steady increase in fungal infections, accompanied by changes in the species structure of aetiological factors, has been observed not only in Poland (Dynowska 1990, 1995; Żaba and Dańczak-Pazdrowska 2001) and Europe (Bruun, Westh and Stehderup 1995; Krcmery et al. 2002) but also elsewhere in the

world (Malani et al. 2001; Obata et al. 2001, Slavin 2002). The tendency has been noticed both in adults and in children.

Not only immunocompromised children are especially prone to fungal infections but also healthy children may be quite susceptible to predisposing factors. There is relatively little literature on the likelihood of colonisation of children considered to be healthy. Such factors as sex, rural and urban environment (Dmochowska and Buluk 1971) as well as the influence of the family and personal hygiene on the occurrence of fungi of the genus *Candida* (Kurnatowska 1973) have been discussed. Due to the rate of changes in the composition of the ontocoenoses of the organs, the data obtained should be treated comparatively (Dynowska 1993b).

Due to the ever growing interest in pathogenecity of fungi representing different systematic groups and a continuous expansion of the list of potentially pathogenic species (Dynowska 1996, 1998), the analysis of mycoflora in different ontocoenoses in healthy children seems particularly called for. An early detection of fungi in children as well as monitoring of fungi could help ascertain the direction of changes in the composition of the mycoflora studied and to evaluate the degree of the development of fungi upon which both prevention and possible treatment depend (Dynowska and Ejdys 2000).

The school environment with which a healthy child aged 6–15 is most often associated in Poland constitutes a peculiar epidemiological threat (Ejdys 2001). Three basic links of the infection chain are found in schools: individuals potentially sensitive, the source of infection and infection routes. It was therefore undertaken to analyse groups of school children aged 6–15 living in the Warmińsko-Mazurskie province. Studies on the species composition and the physiology of the respiratory system in adults have been conducted in this area since 1986 (Dynowska 1995). A comparative analysis of different age groups could make it possible to identify fungi periodically and/or permanently related to the human body.

The aim of the study was to evaluate the relationship between the occurrence of fungi in children and the living environment (city – countryside), sex, age, diet, undergone diseases, therapy with antibiotics and exposure to hospital environment, and to indicate children potentially vulnerable to fungal infections. The results of preliminary studies have already been published (Dynowska and Ejdys 2000).

MATERIAL AND METHODS

The material was consisted of swabs collected from the oral cavity, the throat and the vestibular region of the nasal cavity (hereinafter called 'the nose') of 270 healthy children, pupils in elementary schools in the city of Olsztyn and the villages of Bartąg, Szczęsne and Warkałki. Samples were collected each year (1997-1999) in May and November, and particular attention was paid to two age brackets: 6–9 and 10–15.

The biological material obtained was inoculated onto the Sabouraud medium without antibiotics. Media with antibiotics that could modify typical fungal properties were excluded (Dynowska 1991). Incubation was conducted at 37°C for 48 hours. After fungal growth developed, the material was sifted two or three times onto a new Sabouraud medium to eliminate bacteria that relatively often accompanied fungi in the first inoculation.

Having obtained pure bacteria-free strains, microcultures on Nickerson agar were maintained. Fungi were inoculated on slides, covered with a thin film of the medium (ca. 2 mm). 2–3 drops of 1:1 dilution of serum broth were dispensed onto the inoculation place. Microcultures were incubated at 37°C for 48 to 72 hours.

Both macroscopic properties (size, colour, shape, texture, colony smell) and microscopic properties (size and shape of budding cells, blastospores and chlamydospores, the diameter of psuedohyphae and hyphae) as well as biochemical features obtained on bio–Mérieux API-tests (API 20C, API 20C AUX) were considered for identification. Bio–Mérieux CHROMagar was used to differentiate individual species of the genus *Candida*. The role of the test was auxiliary as it does not yield precise results in multiple species isolations (Bouchara et al. 1996; Białasiewicz 1998, Rosado et al. 1998). Microcultures were photographed throughout the study for the purposes of documentation.

The following keys were used for determination: Lodder and Kreger-van Rij (1967); Kreger-van Rij (1984); Barnett, Payn and Yarrow (1990), Kurnatowska (1995) and the atlas of fungi recorded in clinical material (de Hoog et al. 2000).

Each child examined was handed out a questionnaire to be completed by its parents. The questionnaire contains not only the child's personal data but also provides information on the child's diet, living environment conditions, undergone diseases, possible hospital treatment and administered antibiotic therapy. The latter seems to be of particular importance from the point of view of fungal infections.

The statistical analysis comprised quantitative data and questionnaire data. Linear logistic regression was used to examine factors predisposing to the occurrence of fungi. The significance level of the factor influence was established to be 10%. The odds ratio for compared factors and the number of fungi isolated was calculated and analysed on the basis of the data compiled in tables 1, 2. Variance analysis was used, and the number of individual species of fungi was transformed according to the Tukey-Freeman transformation. A generalised model of linear regression for the Poisson distribution was used in the examination of the differentiation of the frequency of fungi isolated from one child in relation to sex and age. The χ^2 test was used to examine individual factors.

The STATISTICA software was used to carry out the analyses.

RESULTS

As many as 168 isolates were obtained from the material examined. Thirteen fungal species in 5 genera were recorded: *Candida, Rhodotorula, Saccharomyces, Saccharomycopsis* and *Trichosporon.* Yeast-like fungi prevailed. The fungi that were isolated most frequently were *Candida albicans* (Robin) Berkhout, *Candida guilliermondii* Langeron et Guerra = *Pichia guilliermondii* Wickerham, *Candida tropicalis* (Castellani) Berkhaut and *Trichosporon beigelii* Vuillemin. *Candida parapsilosis* Langeron et Talice, *Candida krusei* (Castellani) Berkhout, *Rhodotorula glutinis* (Fresenius) Harrison and *Saccharomycopsis capsularis* Schiőnning occurred less frequently. *Candida glabrata* Yarrow et Meyer, *Candida intermedia* Langeron et Guerra oraz *Trichosporon capitatum* Diddens et Lodder = *Dipodascus capitatus* de

Table 1
Fungi isolated in spring and autumn from the oral cavity, nose and throat of 270 children aged 6 – 15

Species	Number of isolates	Time of collection						Age		Ontocoenosis		
		spring			autumn							
		oral cavity	nose	throat	oral cavity	nose	throat	6-9	10-15	oral cavity	nose	throat
C. albicans	101	27	11	19	19	3	22	43	58	46	14	41
C. glabrata	1	-	-	-	-	-	1	-	1	-	-	1
C. guilliermondii	14	9	-	3	1	1	-	6	8	10	1	3
C. intermedia	1	-	-	-	-	-	1	-	1	0	-	1
C. krusei	7	-	-	2	1	2	2	2	5	1	2	4
C. parapsilosis	5	1	1	-	-	-	3	2	3	1	1	3
C. tropicalis	8	2	-	1	1	-	4	3	5	3	-	5
Rh. glutinis	3	1	-	2	-	-	-	-	3	1	-	2
S. capsularis	6	1	3	1	1	-	-	4	2	2	3	1
S. cerevisiae	2	1	1	-	-	-	-	1	1	1	1	-
Saccharomyces sp.	9	3	-	2	3	1	-	3	6	6	1	2
T. beigelii	10	1	1	3	3	1	1	3	7	4	2	4
T. capitatum	1	1	-	-	-	-		1	-	1	-	-
SUM	168	47	17	33	29	8	34	68	100	76	25	67
TOTAL				97			71					

Hoog et al. occurred sporadically. Yeasts were represented by *Saccharomyces cerevisiae* Hansen. Nine isolates were included in the genus *Saccharomyces* (Tab. 1).

124 children aged 6-9 and 146 children aged 10-15 were examined. Fungi were recorded in 98 children (37.3% of the group examined). The occurrence frequency

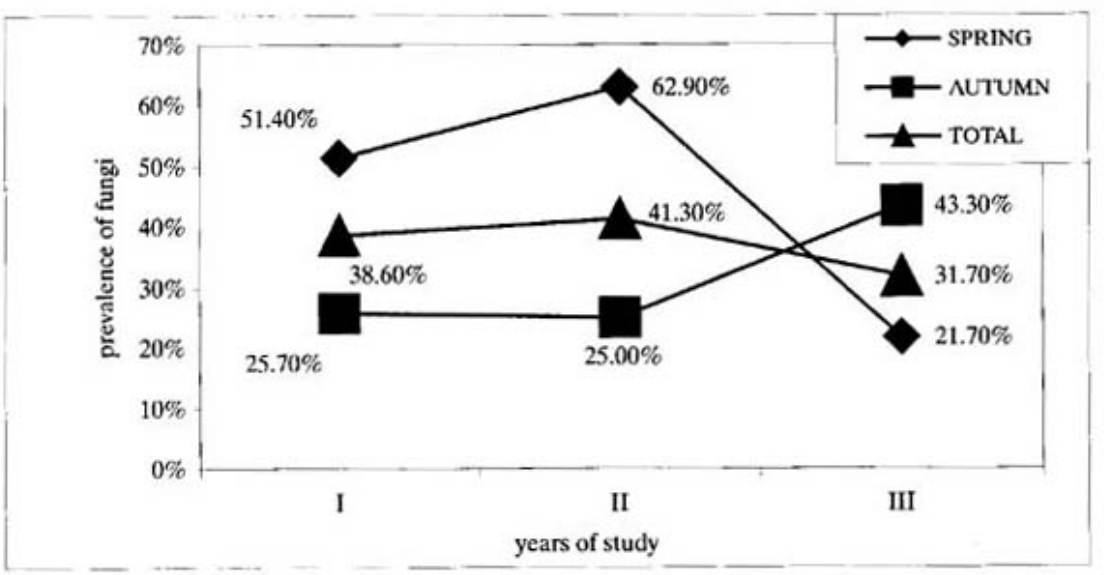

Fig. 1. Phenological changes in prevalence of fungi in individual years of study.

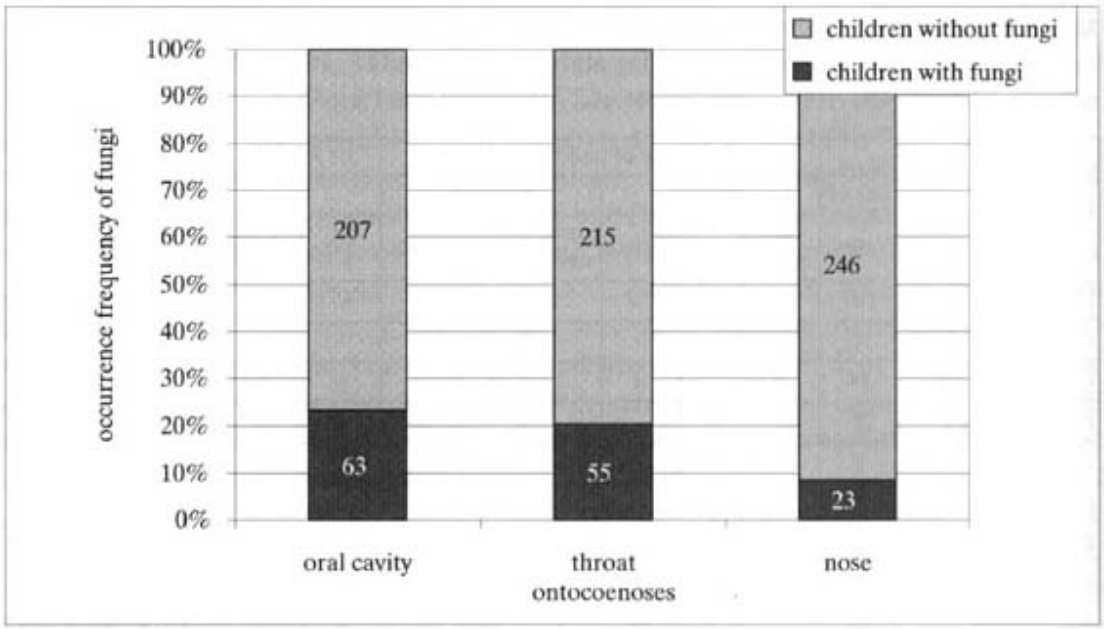

Fig. 2. Occurrence of fungi in individual ontocoenoses.

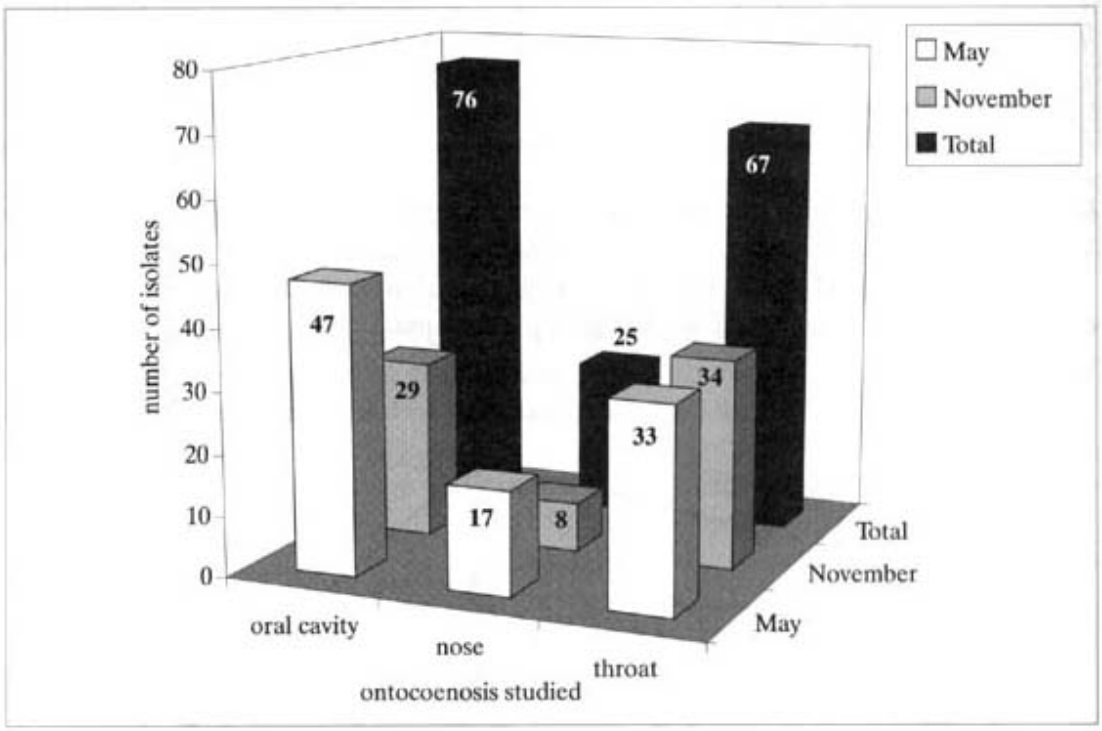

Fig. 3. Fungi isolated from ontocoenoses studied in spring and autumn.

oscillated around the mean value ranging between 31.7% and 41.3% in the successive years of study.

Small phenological differences were observed in the prevalence of fungi. Fungi were recorded in 53 children (40.8%) in the spring, and in 45 children (32.1%) in the autumn. The occurrence frequency remained at constant levels characteristic of the

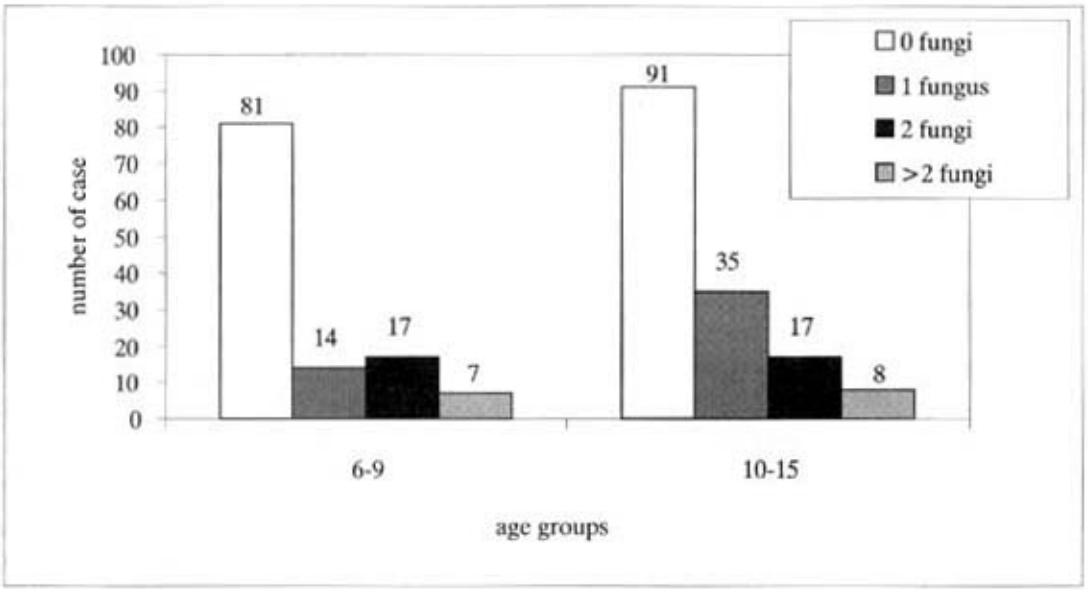

Fig. 4. Comparison of age groups in terms of number of fungi obtained from one child.

seasons in the first two years of study. It ranged between 51.4 and 62.9% in the spring, and was twice as low in the autumn. The values were reversed in the third year (Fig. 1).

Fungi were isolated most often from the oral cavity: 76 isolates from 63 children, and slightly less frequently from the throat: 67 isolates from 55 children (Fig. 2). Their prevalence in the nose was three times as low – 25 isolates from 24 children.

Seasonal changes of the occurrence of fungi in the throat were not recorded. Fungi in the other ontocoenoses were always isolated more frequently in the spring than in the autumn: by 38.3% in the oral cavity, and over twice as often in the nose (Fig. 3).

In the group of children aged 6–9, fungi occurred in 38 pupils – 31.93%, and in 60 pupils – 39.74%, in the group of older children aged between 10-15 (Fig. 4).

The statistical analysis of factors predisposing to the occurrence of fungi showed a relationship between the occurrence of fungi in a child and the year in which it was examined, season and place of residence. Since years of study and individual schools as independent variables are not dichotomous or continuous, the odds ratio may not

Table 2

Odds ratio of occurrence of fungi in the presence of the factors studied

Factor	Season		Environment		Age group		Undergone diseases		Administration of antibiotics		Diet	
Ontocoenosis	spring	autumn	city	country side	6-9	10-15	YES	NO	YES	NO	Full	Poor
Oral cavity	4.425	0.562	0.332	3.016	-	-	-	-	-	-	0.528	1.890
Throat	-	-	-	-	-	-	-	-	1.943	0.515	-	-
Nose	3.454	0.289	-	-	5.000	0.200	4.283	0.233	-	-	-	-
Child	1.486	0.672	0.575	1.738		-	-	-	2.031	0.492	-	

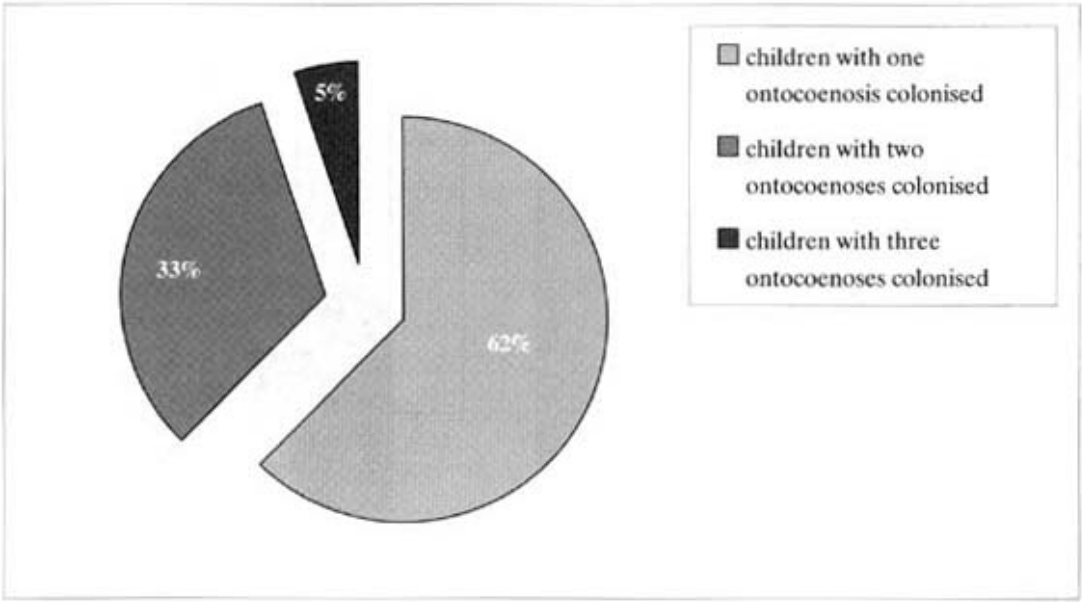

Fig. 5. Occurrence of fungi in children in relation to the number of ontocoenoses colonised.

be used. The odds that fungi in children will be isolated are ca. 1.5 higher in the spring than in the autumn. The odds ratio in the group of children from the rural environment is 1.739: the odds that fungi will occur in them are almost twice as high as in any other of the ontocoenoses studied (Tab. 2). The factors that influence the occurrence of fungi in individual ontocoenoses are slightly different from those that bear upon the child's body on the whole. While none of the factors described so far (years, environment, season, sex, age group) is significant for the occurrence of fungi in the throat, the season and the living environment influence the occurrence of fungi in the oral cavity. Fungi are three times more likely to occur in children in the countryside than in the city. The period of the year and age are factors predisposing to the occurrence of fungi in the nose. The odds of isolating fungi in the oral cavity and in the nose are four times and 0.5 times as high, respectively, in the spring than in the autumn. Younger children are five times as likely to suffer rhinitis than older children.

Three groups of children were distinguished in terms of the ontocoenoses colonised by fungi. Fungi were isolated from one ontocoenosis only in 61 children and from two ontocoenoses in 32 children. Three ontocoenoses colonised by fungi were recorded in five cases (Fig. 5).

The population studied may be divided into three groups from the point of view of the number of fungi isolated from the same child. One fungal isolate was obtained from 49 children, and two from 34 children. More than two fungi were isolated from 15 children. The maximum number of 6 isolates was recorded in one child.

A statistically significant differentiation was found between the number of isolates obtained from a child and age. Individual isolates were recorded 2.5 times more frequently in the group of older children than in that of younger children (Fig. 4).

Of the 270 questionnaires handed out, 245 questionnaires (90.7%) were returned.

The statistical analysis of the prevalence of fungi in a child and the child's individual ontocoenoses did not reveal a relationship between fungal isolates and hospitalisation, incidence of mycoses in the family (only one case) or the child's overall immunity, declared by the parents. It did show, however, a relationship between the occurrence of fungi and the undergone diseases as well as administration of antibacterial antibiotics (not, however, the results of the therapy with antibiotics) and the child's diet. It was shown that the odds of isolating fungi were twice as high in the group of children who had been given broad spectrum antibiotics than in children who had not been treated with antibiotics (Tab. 1).

It is noteworthy that the influence of a different factor predisposing to the development of fungi in each ontocoenosis studied was shown. Fungi were almost twice as likely to occur in the oral cavity in children avoiding certain foodstuffs than in children following a full diet. Therapy with antibiotics predisposed to the occurrence of fungi in the throat and caused a two-fold increase in the odds of infection. The ontocoenosis of the nose is vulnerable to infection over four-times more frequently in children who have undergone diseases. The most frequent diseases reported in the questionnaires are those of the respiratory system: catarrh, throat infection, bronchial infection, ear infection, sinus infection and pneumonia. Allergies were reported in 12 questionnaires, mycoses of the skin in two, and asthma was reported once.

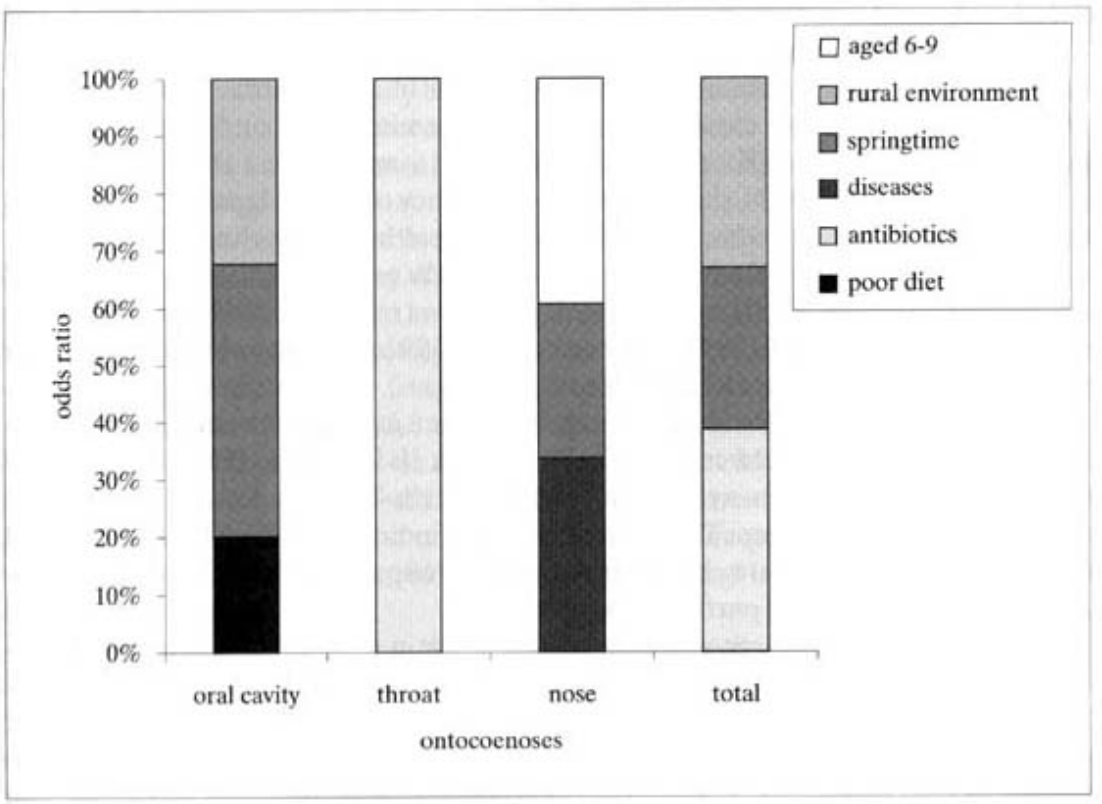

Fig. 6. Fungal infection risk groups.

A number of risk groups were identified on the basis of the analysis of factors predisposing to the occurrence of fungal infections. The odds of the occurrence of fungi

in any of the ontocoenoses studied were the greatest in children who had been ill prior to the sampling, living in the countryside and in the springtime. At the same time, a relationship was noticed in these children between a frequent colonisation of the oral cavity by fungi and a poor diet. Vulnerability to fungal infection in the ontocoenosis of the throat increases in children who have taken broad spectrum antibacterial antibiotics, regardless of age or season. Younger children, however, are more likely to suffer rhinitis in the spring, having undergone infections of the respiratory system (Fig. 6).

DISCUSSION

A continuous increase in the number and scope of different fungal infections reported by individual medical disciplines is brought about not only by the improvement of diagnostic methods but also by a growing population susceptible to mycoses (Richardson and Warnock 1995) as well as the expansion of the spectrum of predisposing factors (Dynowska 1995). This is true of both primary and secondary infections in persons of different ages, from neonatal period to old age. Mycotic sepsis in newborns, caused by *C. albicans*, is recorded in ca. 6-8% cases (Milewska-Bobula et al. 1997). Sepsis is often identified only during the autopsy. Some of these data may be greatly disturbing. For example, generalised candidiasis was detected only post mortem in 20-40% of persons with neutropenia (Sobel and Vazquez 1990). It is estimated that in the last decade of the 20th century, some fungi, yeast-like fungi in particular, constituted 5.1% of all confirmed systemic infections, and generalised candidiasis with fungaemia occur in general surgery departments most often (Kędzierska, Szyguła and Doleżal 2000).

At the end of the 1960s, the occurrence frequency of fungi, depending on the ontocoenosis studied, was estimated to be 44% in healthy persons and 68% in ill persons (Kurnatowska, Żabińska and Wara-Wąsowska 1969). In the 1990s, it ranged between 46.3% (Kurnatowska and Sosnowska 1981) and 53.6%, respectively, (Budak et al. 1993), and even over 95% in patients who had been operated on for cancer (Więckiewicz et al. 1999).

The figures on the occurrence of fungi in children are more diversified than those for adults and range between 7.5% (Pietrzak-Bilińska 1998) and 78.65% (Białasiewicz, Kurnatowska and Śmiech-Słomkowska 1993), and mostly deal with ill children. The positive present findings, 36.3%, fall within the mid section of this range and are characteristic of the group of the generally healthy children examined and of this particular population.

All the fungal species recorded commonly occur in nature, including water reservoirs exposed to strong anthropopressure that abound in the area studied (Dynowska 1995). This greatly facilitates all forms of the transmission of fungi. In their studies of adults, Dynowska (1995) and Biedunkiewicz (2001) also drew attention to the correlation between the occurrence of fungi and their biodiversity on the one hand and seasons on the other. The findings of these authors were consistent and showed at the same time that the greatest number of fungi from different biological material could be obtained in spring and autumn. As for the children examined, twice as many fungi were isolated in the spring than in the autumn in the first two

years of study, while the situation was reversed in the third year. The reversal may be attributed to an accidental concentration of positive results in rural children.

It was noticed that there were significant phenological differences in the frequency of individual fungal species isolated in the seasons analysed while biodiversity remained the same. The participation of *C. albicans* was the greatest in the ontocoenoses examined in both seasons. The occurrence frequency of *C. krusei, C. parapsilosis* and *C. tropicalis* decreased in the spring while the number of *C. guilliermondii, S. capsularis* as well as yeasts, *Saccharomyces*, increased. This tendency, observed also in adults by Dynowska and Biedunkiewicz (1999), may be laid down to the recession of species with weaker adaptive abilities for the benefit of those that adapt better and more quickly.

Factors predisposing to the development of fungal infection may directly affect the host's body, induce pathogenicity of fungi or act simultaneously on both parties of the "human – fungus" interaction (Macura 1998). The list of these factors given in literature is expanding as technology and medical diagnostics develop (Borowski 1973; Bodey 1990; Sobel and Vazquez 1990; Kowalewska-Kantecka et al. 1993; Sekuła et al. 1993; Gelfand 1997). Odds (1994) specifies six basic groups: (1) immunogenic factors, (2) chemotherapy and radiotherapy, (3) disruption of the normal continuity of tissue integrity, (4) surgeries, (5) physiological factors and (6) nutrition-related factors. Only some of them may be significant in fungal infection in a generally healthy person. In children aged 6-15, however, factors such as the physiological condition of the body, treatment with broad spectrum antibiotics, changing hormonal levels and dietary habits, as well as malnutrition, have to be taken into account. It would seem necessary to expand Odds' list (1994) and to add environmental factors that are of fundamental significance in multi-directional transmission of fungi.

A number of risk groups were distinguished in the analysis of the results of the influence of possible factors that may predispose children to fungal infections. Children who live in the countryside, having undergone diseases of the respiratory system, in the springtime, regardless of age, are most vulnerable to fungal infection. Slight differences in the occurrence frequency, observed between the groups of older and younger children examined, are consistent with the data obtained by Śmiech-Słomkowską et al. (1996). They confirm Majewski's suggestions (1973) that the "normal flora" of the oral cavity becomes established around the fifth year of life and is similar to the mycoflora of adults. The present study did not confirm the almost 25% difference in the occurrence of fungi in relation to sex observed by Kurnatowska (1973).

The questionnaire data show that respiratory system diseases were reported most frequently; allergies were declared less often. These findings closely correspond with frequent reports on the appearance of new risk groups concerning candidiases and other mycoses in adults with chronic respiratory system diseases (Dynowska 1990, 1993a; Budak et al. 1993; Batura-Gabryel et al. 1994; Batura-Gabryel 2000). In small children, pulmonary mycosis occurs most often as a result of infection spreading along the bronchial tree from the focus situated in the oropharynx (Ellis 1994). In the present study, a boy living in the countryside, often suffering from allergic rhinitis, was the child most infected with fungi – as many as 6 isolates.

Allergies to fungal allergens are now estimated to constitute 5-20% of allergies in general. Both yeasts and yeast-like fungi (*Candida* and *Rhodotorula*) to which the human body is often cross-reactive (Jeżyna 1975; Bogacka 1996) may be important causal factors in allergic reactions.

In the last 40 years, findings on the frequencies of occurrence of fungi in the oral cavity in a healthy person reported in literature have sometimes been greatly diversified. Fungi were isolated in 15 to 67% of the population in the 1960s and the 1970s (Kałowski 1964; Kurnatowska, Żabińska and Wara-Wąsowska 1969; Kowalczyk 1975; Macura, Majewski and Laskownicka 1976). At the end of the 20th century, a fungal prevalence shift was observed towards higher values ranging between 40 and 59% (Żurowski et al. 1994; Saneczko et al. 1998). A reverse tendency is noticed in children. According to Grodzka (1968), yeast-like fungi occurred in 44% of generally healthy children, while Dmochowska and Buluk (1971) demonstrated the presence of fungi in as many as 63.6% of children aged 8–15. Fungi were found in as many as 78.6% of children in the same age bracket in the 1990s. The present observations recorded them only in 23.3% of the population studied.

Of the risk factors analysed, environment, season and diet have the greatest influence on the occurrence of fungi in the child's oral cavity. An increased frequency of the occurrence of fungi in the oral cavity observed in the spring may be brought about by a poor diet in terms of both quantity and quality, hypovitaminosis and an immunity drop in the spring. Neonatologists and paediatricians have long pointed out the problem of malnutrition. Children with low weight are particularly vulnerable to the development of fungal infection (Sekuła et al. 1993; Lauterbach 1995; Rabczyński, Dziegiel and Ziółkowski 1998).

The statistical analysis clearly shows there exists a relationship between administration of broad spectrum antibiotics and occurrence of fungi in the ontocoenosis of the throat in children. A normal bacterial flora plays a greater role in the protection of the mucous membrane from the colonisation by fungi than an efficient immunological system. Bacteria (successfully) compete with fungi for receptors of epithelial cells thus decreasing cells' adhesive abilities. Administration of antibacterial antibiotics which leads to sterilisation of the ontocoenoses of organs reduces human symbiotic immunity and, by the same token, increases the frequency of fungal infection of the throat in the children examined (Macura 1990).

The almost two-fold decrease in the prevalence of fungi in the ontocoenosis of the throat (20.4%) in comparison with the findings of Dmochowska and Buluk (1971) as well as Budak et al. (1993) – 47.0% and 53.6%, respectively, may be caused by a more rational approach to administration of broad spectrum antibiotics or by a decreased access to them brought about by social impoverishment.

The ontocoenosis of the nose is the most vulnerable to fungal infection in the spring in children aged 6 - 9 who had been ill immediately prior to the collection of the material. It may be believed that an increased susceptibility of younger children to a fungal invasion is caused by weak airing of the nasal cavity as a result of frequent catarrhs or hyperthropy of pharyngeal tonsil (Saneczko et al. 1998). In healthy adults, the prevalence of fungi in the nose does not reach 2% (Kurnatowski 1980) and is four times as small as in the group of children analysed (8.1%). It is the

same as the percentage recorded in persons suffering from allergic rhinitis (Kurnatowska, Kurnatowski and Kalinowska-Graczyk 1980).

Increasing attention is paid to the multifocality of fungal infections, especially in recurring mycoses, in mycological literature (Brózik et al. 1980; Kurnatowska, Kurnatowski and Kalinowska-Graczyk 1980; Kurnatowska 1985; Węgorska, Rawicka and Szczygielski 1992; Marcińska et al. 1995). However, evidence on the simultaneous colonisation of ontocoenoses by one or more fungal species is greatly diversified. According to Brózik et al. (1980), occurrence frequencies of fungi in one, two and three ontocoenoses in groups of healthy children are comparable and equal ~20%. Mycological examinations in children with mal-absorption syndrome showed 67.0% frequency of mutlifocal fungal invasions (Wąsowska-Królikowska and Loga 1981). An even higher percentage (80.0%) was recorded in children with abdominal pain, and fungi would colonise as many as 5 ontocoenoses of the digestive system (Kurnatowski et al. 2001). In women, cases of two-focal infections were recorded most often (67.9%), and tri-focal infections least often (13.2%) (Węgorska et al. 1992). In the study conducted, fungi found in 2/3 of children colonised one ontocoenosis. They were recorded in the oral cavity, the throat and the nose only in 5% of children with fungal infections. The age and the type of the ontonoenoses analysed may influence these differences. The statistical analysis demonstrates that individual isolates occurred more frequently in the group of older children. This is indicative of the incidental nature of the infection and a temporary decrease in immunity. In younger children, even if only one ontocoenosis was colonised, at least two fungal isolates were obtained. In this case, hypoimmunity may be graver and suggests a fungal carriage.

The above study does not make it possible to determine unequivocally which children in the fungal infection risk group could develop a mycosis in its full clinical picture in the ontocoenoses analysed and in which children infection would turn into a carrier state. The determining factor will most probably be the body's individual reaction of each child and the development of specific antibodies in response to colonising fungi.

CONCLUSIONS

1. *Candida albicans*, the basic aetiological factor in the majority of mycoses recorded in people, unquestionably prevails among the 13 species of yeast-like fungi and yeast isolated. Records of *C. glabrata* and *C. krusei*, growing strains of which show resistance to basic antimycotics, as well as relatively frequent records of *Trichosporon beigelii, Saccharomycopsis capsularis* and *Saccharomyces* sp., fungi whose expansiveness and enzymatic activity have been growing, may be considered disconcerting.
2. Vulnerability to fungal infection increases following an antibiotic therapy, regardless of season or age, in the majority of the children examined. This is particularly true of the most stable ontocoenosis of the throat. Younger children, on the other hand, are the most vulnerable in the spring, having undergone infections of the respiratory system. Fungi are likely to colonise the nose in this case.

3. Children living in the countryside who had been ill immediately prior to the collection of the material constitute the highest risk group of the occurrence of fungi in any of the ontocoenoses analysed. A greater number of positive inoculations were obtained in these children than in those living in the city. This may be indicative of a broader spectrum of natural reservoirs of fungi and their vectors of transmission in the countryside than those in the city, of lower health hygiene and lower immunity or of a more common carriage of fungi in rural children.
4. Qualitative and quantitative changes in the species structure of the fungi in the ontocoenoses analysed are indicative of environmental changes and are inferential of which fungi dominate at the moment in the external environment which continually changes, similarly to the population of children who come from different domestic environments every year. These environments, similarly to school ones, constitute an important link at different levels of interpersonal transmission of potentially pathenogenic fungi.

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Grupy ryzyka infekcji grzybami wśród dzieci w wieku szkolnym

Streszczenie

Celem badań była ocena zależności między występowaniem grzybów u dzieci, a środowiskiem życia (miasto-wieś), płcią, wiekiem, dietą, przebytymi chorobami, antybiotykoterapią i kontaktem ze środowiskiem szpitalnym oraz wskazanie dzieci potencjalnie zagrożonych zakażeniami grzybiczymi.

Materiał do badań stanowiły wymazy z jamy ustnej, gardła i nosa zdrowych dzieci, w wieku 6-9 i 10-15 lat, pochodzących ze środowiska miejskiego i wiejskiego.

Spośród 13 wyodrębnionych gatunków grzybów drożdżopodobnych i drożdży zdecydowanym dominantem jest *Candida albicans* – podstawowy czynnik etiologiczny większości grzybic notowanych u człowieka. Zjawiskiem niepokojącym może być notowanie *C. glabrata* i *C. krusei*, których coraz więcej szczepów wykazuje oporność na podstawowe antymikotyki oraz stosunkowo częste notowanie *T. beigelii, S. capsularis* i *Saccharomyces* sp. – grzybów o rosnącej ekspansywności i aktywności enzymatycznej.

U większości badanych zagrożenie infekcją grzybiczą wzrasta po antybiotykoterapii przeciwbakteryjnej, bez względu na porę roku czy wiek. Dotyczy to przede wszystkim najbardziej stabilnej ontocenozy gardła. Natomiast dzieci młodsze najbardziej zagrożone są wiosną po przebytych infekcjach układu oddechowego. W tym przypadku grzyby chętnie zasiedlają nos.

Grupę największego ryzyka wystąpienia grzybów w jakiejkolwiek z badanych ontocenoz stanowią dzieci zamieszkałe na wsi, które chorowały bezpośrednio przed pobraniem materiału. Od dzieci tych uzyskano więcej posiewów pozytywnych w porównaniu z miastem. Może to świadczyć o szerszym spektrum naturalnych rezerwuarów grzybów i wektorów ich przenoszenia na wsi niż w mieście, o mniejszej higienie zdrowotnej i mniejszej odporności lub też o powszechniejszym nosicielstwie grzybów wśród dzieci wiejskich.