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A STATISTICAL ANALYSIS OF THE RELATIONSHIP BETWEEN RESPIRATORY TRACT DISORDER AND FUNGAL TYPES

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Fifty sensitive patients, both male and female in the age group of 16-65 years, suffering from respiratory tract disorders, with duration ranging from 2 months to 20 years were skin prick tested (Phillips, 1967) with the antigen of 15 Aspergilli and four smuts. The symptoms manifest in the sensitized patients were sneezing, rhinorrhoea, nasal obstruction, throat irritation, cough, breathlessness, itching etc. which resulted in four main diagnoses viz. Bronchial asthma, Allergic rhinitis, Urticaria and others (Wadhwani *et al.*, 1986).

An application of the X^2 -test, to test the association of attributes was made. This test is frequently used in both medical and biological sciences to determine, whether the two attributes of a particular specimen are associated. This test is equally helpful between the various types of infecting microbes and the symptom manifestation in various patient. A brief description of the method used (Dixon and Massey, 1969; Elhance and Elhance, 1990) is as follow :-

The total number of patients was 50. The data has been classified according to the presence or absence of a particular attribute (reaction of a particular fungal type). The population (patients) were divided into two classes, one consisting of those in whom the attribute was present and the other consisting of those in whom it was not. The two attributes in the four analyses carried out were based on Table -1.

1. m(A) Fungal type and diagnosis (B)
2. (A) Symptoms and diagnosis (B)
3. (A) sex ratio and diagnosis (B)
4. (A) Duration of disease and diagnosis (B)

Attribute A was divided into a number of subgroups A_1.....As, similarly B was sub-divided into B_1, B_2.....B_t. Such a classification is manifold classification. The table obtained by dividing the observation into these classes is of the following type

In other words, if the observed frequency in each of the cells of a contingency table is equal to the expected frequency of that cell, A and B would be completely independent of each other. If these values are not equal in all the cells, there is an indication of association between the attributes A and B. In order to test the intensity of association, the difference between the actual and expected frequencies of various cells is calculated with these differences the value of X^2 is obtained-

$$\chi^2 = \Sigma \frac{(\text{Differences of actual \& expected frequency})^2}{\text{Expected frequency}}$$

$$\chi^2 = \Sigma \frac{(O - E)^2}{E}$$

O = observed frequency
E = expected frequency

This valus is called "square contingency." If this valuc does not exceed the theroretical value (Fisher and yates statistical tables) for (s-1) (t-1) degrees of freedom the attributes A and B are independent, otherwise A and B are associated.

The following is the worked example based on Table -1.

The theoretical value of X^2 at 1%, 5%and 50% levels of significance for (4-1) (2-1) = 3 degrees of freedom are 11.345, 7.815, 2.366.

The conclusions are stated as at 1% and 5% levels of significance the diagnoses are independent of the presence or absence of *A. amstelodami,* but at 50% level of significance there does exist a chance that *A. ametelodami* might be the cause of the diseases listed.

RESULTS AND DISCUSSION

The X^2-test analyses of 15 Aspergilli in relation to diagnoses and between symptoms and diagnoses, sex-ratio and duration of suffering are presented in Tables 5 and 6, respectively. At 1% and 5% levels of signifi-

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Table 1: The sex age, duration of suffering, chief complaints, diagnosis and results of antigens of fungi on 50 sensitized patients by skin prick test

Sl. No.	Sex	Age (in Yr.)	Duration (in Yrs.)	Chief complaints							Dia	Results of antigens of fungi
				Sn	Rh	No	Thirr	Co	Breath	Itching & Others		
1.	F	22	2				+	+			AR	*A. Flavus, A. terreus*
2.	M	56	8					+			BA	*A. flavus, A. nidulans*
3.	F	30	2							+	U	*A niger*
4.	M	17	1 ¼							+	U	*A. nidulans, A. carneus*
5.	M	37	10					+			BA	*A. terreus, A. carneus, A. nidulans, A. niger*
6.	M	23	2							+	U	*A. japonicus, A. nidulans, A. flavus, A. niger*
7.	F	28	6	+	+	+	+	+	+	+	AR	*A. ustus, A. japonicus, A. amstelodami*
8.	M	22	1	+	+	+	+	+	+		AR	*A.amstelodami, A. niger*
9.	M	22	7	+	+	+	+	+	+		AR	*A. ustus, A. flavus, A. amstelodami*
10.	F	33	2	+	+	+		+	+		AR	*A. niveus, A. tamarii*
11.	F	30	8	+	+	+					AR	*A. niveus, A. tamarii*
12.	F	17	1							+	AD	*A. niveus, A. flavus, A. tamarii*
13.	M	18	7	+	+	+	+	+	+		BA	*A. tamarii*
14.	M	45	12	+							BA	*A. tamarii*
15.	M	18						+	+		BA	*A. flavus, A. terreus, A. niger*
16.	M	35	20							+	DA	*A. nidulans, A. tamarii, A. fumigatus*
17.	M	18	1				+	+	+		BA	*A. terreus, A. sydowi, A. flavus, A. nidualns, A. niger*
18.	F	16	7	+					+		BA	*A. flavus, A. sydowi*
19.	F	39	3	+				+	+		BA	*A. terreus, A. flavus, A. nidulans. A. niger*
20.	F	45	3					+	+	+	BA	*A. terreus, A. niger, A. nidulans, A. sydowi*
21.	F	25	5							+	U	*A. niger, A. versicolor, A. sydowi*
22.	M	65	20	+	+	+	+	+	+		BA	*A. terreus, A. versicolor, A. niger. A. nidulans, A. sulphureus, A. fumigatus*
23.	M	21	20	+				+	+		BA	*A. terreus, A. versicolor, A. niger, A. nidulans, A. flavus*
24.	F	25	3	+	+		+				BA	*A. sulphureus, A. flavus, A. ustus, A. fumigatus*
25.	M	35	1/6							+	U	*A. terreus, A. versicolor, A. niger A. nidulans, A fumigatus*
26.	F	20	2				+	+			AR	*A. terreus, A. versicolor, A. niger, A. flavus, A. fumigatus*
27.	M	42	4	+	+	+			+		AR	*A. sulphureus, A. flavus, A. fumigatus*
28.	F	22	1/6	+	+	+	+	+	+		BA	*A. sulphureus, A. flavus, A. fumigatus*
29.	M	32	3	+	+	+	+	+	+		BA	*A. terreus, A. fumigatus, A. niger, A. flavus, A. sulphureus*
30.	M	63	1	+	+				+		AR	*A. ustus, A. fumigatus, a. versicolor, A. niger, A. nidulans*
31.	F	29	1 ½							+	U	*A. niger, A. nidulans, A. flavus, A. fumigatus*
32.	M	16	3	+	+	+	+	+	+		AR	*A. fumigatus, A. terreus, A. versicolor A. niger, A. flavus*
33.	M	25	10	+	+	+					Ar	*A. fumigatus, A. terreus, A. versicolor A. niger, A. flavus*
34.	M	30	20							+	U	*A. terreus, A. versicolor, A. niger, A. chevalieri, A. flavus, A. fumigatus*
35.	M	28	15	+	+			+			AR	*A. terreus, A. versicolor, A.niger, A.chevalieri, A. flavus, a. fumigatus*
36.	M	40	3					+	+		BA	*A. fumigatus, A. terreus, A. versicolor A. niger, A. flavus*
37.	M	32	9	+	+	+	+	+	+		BA	*A. fumigatus, a. terreus. A. versicoior A. niger, A, flavus*
38.	F	37	2		+	+	+	+			AR	*A. niger, A. flavus, A. fumigatus*
39.	M	45	10	+	+	+	+	+	+		BA	*A. ustus, A. fumigatus*
40.	F	19	2	+	+	+	+	+	+		BA	*A. flavus, a. ustus, A. fumigatus*
41.	F	20	6	+	+				+		AR	*A. ustus, A. fumigatus*
42.	M	40	8	+	+	+	+	+	+		AR	*A. ustus, A. fumigatus*
43.	M	20	1/6							+	U	*A. ustus, A. fumigatus*
44.	M	45	6	+	+		+	+			BA	*A. ustus, A. fumigatus*
45.	M	64						+		+	BA	*A. ustus, a. fumigatus*
46.	M	2	+	+	+	+					AR	*A. ustus, A. fumigatus*
47.	M	26	12			+		+	+		AR	*A. ustus, A. fumigatus*
48.	F	25	5	+	+						AR	*A. fumigatus, A. ustus*
49.	F	37	10	+	+			+	+		BA	*A. ustus, A. fumigatus*
50.	F	50	20 days							+	U	*A. ustus, A. fumigatus*

Sn=Sneezing, Rh=Rhinnorrhoea, Nob=Nasal obstruction, Thirr=Throat irritation, Co=Cough, Breath=Breathlessness

Table 2: Many fold classification of Attributes A and B

Attribute	A_1	A_2———	As	Total
B_1	$(A_1 B_1)$	(A_2B_1)———	(AsB_1)	(B_1)
B_2				
Bt	(A_1Bt)	(A_2Bt)———	(AsBt)	(Bt)
Total	(A_1)	(A_2)	(As)	N

The total of various columns = $(A_1), (A_2)$———
rows = $(B_1), (B_2)$———

Grand Total = $N = (A_1) +$ ——— $+ (As) = (B_1) +$ ------- $+ (Bt)$

If A and B are completely independent, then the actual values $(A_1B_1), (A_2B_2)$ etc. must be equal to their expected values which are

$$\frac{(A_1)(B_1),}{M} \qquad \frac{(A_1)(B_2)}{N} \qquad \text{----------}$$

Table 3: Contingency Table for *Aspergillus amstelodami*

Diagnosis	Present	Absent	Column Total
BA	0	21	21
AR	3	15	18
U	0	9	9
Other	0	2	2
Row Total	3	47	50

Table 4: Theoretical frequencies for *A. amstelodami*

Diagnosis	Present	Absent	Column Total
BA	$\frac{21x3}{50} = 1.26$	21-1.26=19.74	21
AR	$\frac{18x3}{50} = 1.08$	18-1.08=16.92	18
U	$\frac{9x3}{50} = 0.54$	9-0.54=8.46	9
Others	3-(1.26+1.08+0.54 =0.12	47-(19.74+16.92+8.46) =1.88	2
Row Total	3	47	50

$$\text{Calculated } \chi^2 = \frac{(1.26-0)^2}{1.26} + \frac{(1.08-3)^2}{1.08} + \frac{(0.54-0)^2}{0.54}$$

$$+ \frac{(0.12-0)^2}{0.12} + \frac{(19.74-21)^2}{19.74} + \frac{(16.92-15)^2}{16.92}$$

$$+ \frac{(8.46-9)^2}{8.46} + \frac{(1.88-2)^2}{1.88} = 5.6737$$

Table 5: X^2 - test analysis of 15 Aspergilli in relation to diagnoses

Fungal type	Calculated value of X^2	Theoretical value of X^2 X^2 3,0.05 7.815	$X^2$3, 0.01 11.345	$X^2$3, 0.050 2.366
A. amstelodami	5.6737	Independent	Independent	Associated
A. carneus	2.0503	Independent	Independent	Independent
A. chevalieri	2.2668	Independent	Independent	Independent
A. flavus	2.4126	Independent	Independent	Associated
A. fumigatus	0.9018	Independent	Independent	Independent
A. japonicus	2.2563	Independent	Independent	Independent
A. nidulans	3.5112	Independent	Independent	Associated
A. niger	5.1629	Independent	Independent	Associated
A. niveus	9.6138	Associated	Independent	Associated
A. sulphureus	3.5282	Independent	Independent	Associated
A. sydowi	2.9347	Independent	Independent	Associated
A. tamarii	16.0227	Associated	Associated	Associated
A. terreus	2.877	Independent	Independent	Associated
A. ustus	2.731	Independent	Independent	Associated
A. versicolor	3.0076	Independent	Independent	Associated

Table 6: X^2 - test analysis of between symptoms and diagnoses sex ratios and duration of suffering

Symptoms	Ccleulated value of x^2	Theoretical value of X^2 X^2 3,0.05 7.815	$X^2$3,0.01 11.345	$X^2$3,0.50 2.366
Sneezing	18.445	Assoc.	Assoc.	Associated
Rhinnorrhoea	19.0476	Assoc.	Assoc.	Associated
Nasal obstruction	14.846	Assoc.	Assoc.	Associated
Throat irritation	9.6561	Assoc.	Ind.	Associated
Cough	16.9391	Assoc.	Assoc.	Associated
Breathlessness	25.3416	Assoc.	Assoc.	Associated
Itching	26.6098	Assoc.	Assoc.	Associated
Sex Ratio	0.6818	Ind.	Ind.	Independence
Duration	12.8769	Assoc.	Assoc.	Associated

cance it is stated that BA, AR and U are independent of the presence or absence of *A. amstelodami* and *A. carneus*. There exists a 50% chance that *A. flavus*, *A. nidulans*, *A. niger*, *A. sulphureus* and *A. sydowi* cause the three diseases whereas *A. niveus* has a 95% chance to cause BA, AR, U whereas *A. tamarii*, has a 99% chance. *A. terreus*, *A. ustus* and *A. versicolor* have 99% chance not to cause BA, AR and U. *A. chevaleri*, *A. fumigatus* and *A. japonicus* were not involved in causing these diseases.

The seven, symptoms viz. sneezing, rhinoerrhoea, nasal obstruction, throat irritation, cough, breathlessness were related (99%) to the two diseases bronchial asthma and allergic rhinitis (Table 6). The sex-ratio was independent of the three diseases (BA, AR and U), either sex was equally susceptible to these diseases. However, the duration of diseases was dependent on the type of diseases, since the calculated value of X^2 12.8769 far exceeds the theoretical value. The X^2-test is a reliable one and the prominence and significance of this test has successfully been applied for the discovery of association between smoking and lung cancer (Fisher, 1959). The importance of *Aspergillus* as an agent of apportunistic infections has only recently been recognized. The toxic matabolites of *Aspergillus* species in food stuffs have assumed great significance (Neergaard, 1977). Asthmatic allergy to conidia of various *Aspergillus* species is a well known and defined disease. Transient infiltrates are sometimes seen during the immediate reaction and infiltrates are more associated with the other types of allergic pulimonary manifestations of aspergillosis, mainly cough, wheezing, chills, malaise, aches, pains etc. Rippon (1988) has described that manifestation of allergy to *Aspergillus* conidia usually occurred in individuals who have repeated exposure to organic dust that was heavily laden with conidia and mycelial debris. An interesting finding of present investigations is that, *A. fumigatus*, which has been found to be associated with many pulimonary diseases and Aspergillosis (Austwick, 1965, Rippon, 1988) is not associated with upper tract respiratory disorders. The four smuts. *Cintractia limitata*, *Schacelotheca sorghi*, *Ustilago scitamine* and *U. tritici*

were tested for, but none of the patients were sensitive to *Sphacelotheca sorghi* and *U. tritici* and results with other two were negligible, hence these were not considered for analysis.

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