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FATALITY, FACIAL SCARRING AND BLINDNESS FROM SMALLPOX IN BANGLADESH

by

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Introduction

Surveillance efficiency of a Smallpox Eradication Programme can be estimated by comparing reported cases of smallpox for a period of time with the incidence for the same period. The incidence of smallpox can be estimated from surveys of smallpox facial scarring, a technique first used by Keja (1968).[1]

The method requires the examination of a sample of the population (usually in the younger age-groups) for smallpox facial scarring, which is defined as the presence of five or more concentric depressed facial scars, one or more millimetres in diameter. However, to calculate the incidence of smallpox, it is necessary to correct for loss of facial scarring, case fatality, general mortality and age-distribution of cases.

Age-distribution of cases and case-fatality rates have been determined in a number of countries. For residual facial scarring rates, Foster (1971)[2] found in West Africa, that they were related to age varying from 29% for children under five to 90% in adults, with an overall rate of 67%. However, the number of cases in this study was small. Figures for general mortality are available from previous demographic studies.

A survey was undertaken during 1976 to determine these unknown factors in Bangladesh prior to carrying out a pock-mark survey.

Objectives

1. To determine the age and sex distribution of cases in smallpox outbreaks.

2. To determine case fatality rates from smallpox by sex and age.

3. To determine residual facial scarring rates from smallpox in different age-groups. To estimate the effect on these rates, if any, of previous vaccination.

4. To determine the rate of occurrence of corneal opacities as a complication of smallpox. It was decided to include this, though it is not relevant as a correcting factor in a pock mark survey.

Method

In Bogra district of Bangladesh a complete line-listing of smallpox outbreaks is available for the period from December 1974 to April 1975. Details include for individual cases, name, age, sex, malaria house number, date of onset of rash, and whether the case died.

For 46 outbreaks in Kotwali and Kahaloo thanas over this time period, a follow-up study was carried out between May and October 1976. Individual cases were identified, demographic data checked, and the person examined for facial scarring (five or more scars), presence or not of a vaccination scar, and corneal opacities giving blindness or impaired vision. The results were recorded on a standard form.

The follow-up of the outbreaks and the examination of all the cases was done by the author and and an estimation of intra-observer error in reading pock marks was made by examining a number of cases twice at a few days' interval, other cases being examined in between time.

It should be stressed that a scar had to be concentric, depressed, and one or more millimetres in diameter at the base, to be considered positive; wrinkling and discolouration of the skin were not included. This follow-up study was carried out at a particular time after the outbreak of smallpox (12 to 22 months) but there is evidence that the time interval after smallpox infection is not important in determining scar retention rates (Foster, 1971).[2]

Results

Of the 610 smallpox cases in 46 outbreaks, 111 had died from smallpox leaving 499 cured cases. At the follow-up it was found that five had died from other causes since the attack of smallpox. Of the 494 remaining cases 429 (86.8%) were identified and examined. The remaining 65 were not available at the time of the follow-up visit; no person refused to be examined.

Table 1 shows the age and sex distribution of the total 610 cases. No significant sex difference was found. However, it can be seen that children were more affected than adults, even after allowing for their greater proportion in the population. For example 57.5% of the cases were in children under 10 years, yet this age-group represents only 34.6% of the population of Bangladesh.

TABLE 1. AGE AND SEX DISTRIBUTION OF 610 SMALLPOX CASES

Age-group	Males cases (%)	Females cases (%)	Both sexes cases (%)	Both sexes % distribution Bangladesh[a]
0- 4	89 (14.6)	110 (18.0)	199 (32.6)	16.9
5- 9	68 (11.1)	84 (13.8)	152 (24.9)	17.7
10-14	38 (6.2)	32 (5.2)	70 (11.5)	14.7
15-29	35 (5.7)	35 (5.7)	70 (11.5)	21.0
30-44	28 (4.6)	44 (7.2)	72 (11.8)	16.2
45-64	18 (3.0)	28 (4.6)	46 (7.5)	10.7
65 +	1 (0.2)	0 (0)	1 (0.2)	2.8
All ages	277 (45.4)	333 (54.6)	610 (100.0)	100.0

[a] A. K. M. Alauddin Chowdhury et al. (1970) Demographic Studies in Rural East Pakistan, Pakistan SEATO Cholera Research Laboratory, Dacca.

Table 2 shows case-fatality rates by age and sex. Within age-groups no significant difference was found except in the 30-44 age-group where the male rate was 42.9% and the female rate 9.1%, this difference being highly significant using the chi-square test ($p < 0.001$). No significant pattern with regard to age was found but the highest fatality rate (24.1%) did occur in children under five years. There was an overall fatality rate of 18.2%.

TABLE 2. AGE AND SEX CASE-FATALITY RATES FROM SMALLPOX

Age-group	Males		Females		Both sexes	
	Cases	Deaths	Cases	Deaths	Cases	Deaths
0- 4	89	17 (19.1)	110	31 (28.2)	199	48 (24.1)
5- 9	68	5 (7.4)	84	15 (17.9)	152	20 (13.2)
10-14	38	7 (18.4)	32	4 (12.5)	70	11 (15.7)
15-29	35	3 (8.6)	35	5 (14.3)	70	8 (11.4)
30-44	28	12 (42.9)	44	4 (9.1)	72	16 (22.2)
45 +	19	4 (21.1)	28	4 (14.3)	47	8 (17.0)
All ages	277	48 (17.3)	333	63 (18.9)	610	111 (18.2)

To indicate intra-observer error in reading facial pock marks, 23 cases were examined twice. In no case was there disagreement as to whether the person was scarred or not, on the basis of the presence or not of five or more scars.

Table 3 shows the facial scarring rates by age-group of the 429 cases. No significant sex difference was found and so in this and subsequent analyses both sexes are combined. An overall facial scarring rate of 59.4% was found with lowest levels at the two extremes of the age-groups.

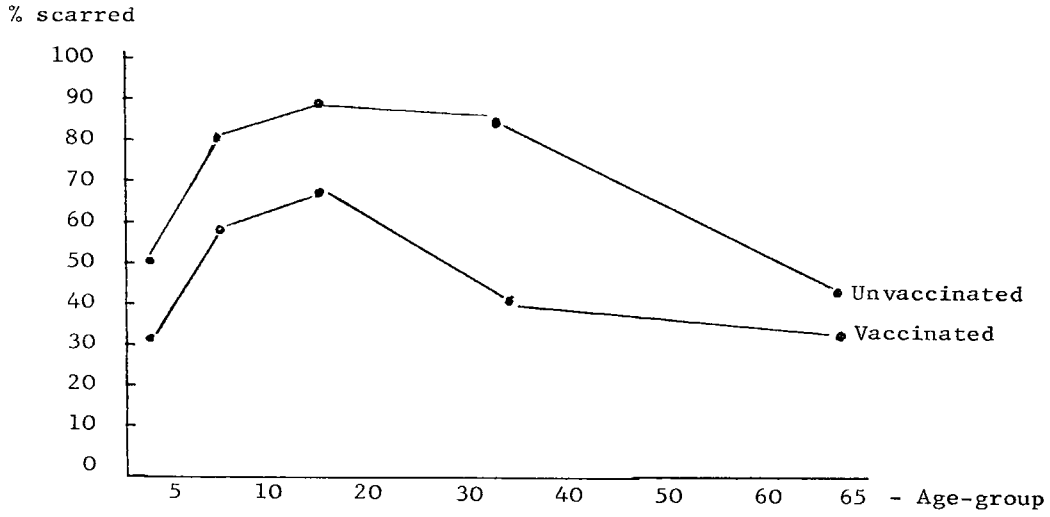
TABLE 3. SMALLPOX RESIDUAL FACIAL SCARRING RATES[a] BY AGE-GROUP

Age-group	No. examined	No. scarred	% scarred
0- 4	133	59	44.4
5- 9	120	86	71.7
10-19	58	47	81.0
20-39	70	46	65.7
40-64	48	17	35.4
All ages	429	255	59.4

[a] Five or more pock marks.

To remove the possible effect of different proportions of persons in the different age-groups who had been vaccinated, the scarring rates by age-group have been examined in vaccinated and unvaccinated persons separately. This is presented in Fig. 1. It should be noted that a person was classed as vaccinated if on follow-up a vaccination scar was present including those where vaccination had only been done in the incubation period. It can be seen from Fig. 1 that the same trend exists with the vaccinated and the unvaccinated. Lower rates are found in young children and older adults. These residual scarring rates by age-group for the vaccinated and the unvaccinated are shown in more detail in Table 4.

FIG. 1. SMALLPOX RESIDUAL FACIAL SCARRING RATES[a] BY AGE-GROUP, FOR VACCINATED AND UNVACCINATED PERSONS



[a] Five or more pock marks.

Fig. 1 also shows that for all age-groups the proportion who retain five or more facial pock marks is less in vaccinated than unvaccinated persons. The figures within different age-groups are given in Table 4. Within age-groups 0-4 to 20-39 the numbers indicate a significant difference between vaccinated and unvaccinated persons. For all age-groups together Cochran's test has been used; this test allows for any variation in age-distribution between vaccinated and unvaccinated persons. For all vaccinated persons 44.5% had residual facial scarring and for all unvaccinated persons it was 68.7% and this difference was highly significant ($p \leq 0.01$).

Concerning corneal opacities it was found that out of the 429 persons examined, one was blind in both eyes and three were blind in one eye, so that four (0.9%) had smallpox blindness. In addition nine others had corneal opacities in one or both eyes giving some impairment of vision. Hence, 13 (3.0%) had visual defects consequent on smallpox infection. All four cases of smallpox blindness and seven of the nine cases of corneal opacities were unvaccinated.

Discussion

From the age-distribution of the cases it was found that children were more affected than adults. Lower vaccination rates may be part of the explanation. However, it has been shown by studying secondary attack rates that, in the unvaccinated, children are more likely to contract the disease than adults (Sommer, 1974).[3]

The case-fatality rate was significantly greater in males than females in the 30-44 age-group. The reason for this finding is speculative, but perhaps women in this age-group have developed increased immunity from exposure to infected children.

It was found that after an attack with variola major about 60% of persons retained facial scarring (five or more pock marks), and not the vast majority as is commonly supposed. Lower rates of facial scarring were found at the two extremes of the age-groups. The reason for the lower rates in young children is probably better reparative processess of the skin. The lower rates in older persons is more difficult to explain but perhaps there is a greater proportion of milder cases due to increased immunity from repeated vaccinations and exposures to variola virus.

TABLE 4. SMALLPOX RESIDUAL FACIAL SCARRING RATES[a] BY VACCINATION STATUS WITHIN DIFFERENT AGE-GROUPS

Age-group	Vaccination status	Residual scarring			Significance test
		Yes	No	Total	
0- 4	Vaccinated	14 (31.1)	31 (68.9)	45	$X^2 = 4.06$
	Unvaccinated	45 (51.1)	43 (48.9)	88	$P < 0.05$
	Total	59 (44.4)	74 (55.6)	133	
5- 9	Vaccinated	24 (61.5)	15 (38.5)	39	$X^2 = 2.23$
	Unvaccinated	62 (76.5)	19 (23.5)	81	$P > 0.1$
	Total	86 (71.7)	34 (28.3)	120	
10-19	Vaccinated	12 (66.7)	6 (33.3)	18	$X^2 = 1.05$
	Unvaccinated	35 (87.5)	5 (12.5)	40	$P > 0.1$
	Total	47 (81.0)	11 (19.0)	58	
20-39	Vaccinated	12 (42.9)	16 (57.1)	28	$X^2 = 9.20$
	Unvaccinated	34 (81.0)	8 (19.0)	42	$P < 0.01$
	Total	46 (65.7)	24 (34.3)	70	
40-64	Vaccinated	11 (32.4)	23 (67.6)	34	$X^2 = 0.13$
	Unvaccinated	6 (42.9)	8 (57.1)	14	$P > 0.1$
	Total	17 (35.4)	31 (64.6)	48	
All ages	Vaccinated	73 (44.5)	91 (55.5)	164	SND = 4.39
	Unvaccinated	182 (68.7)	83 (31.3)	265	$P < 0.01$
	Total	255 (59.4)	174 (40.6)	429	

[a] Five or more pock marks.

Immunity from previous vaccination was found to reduce significantly facial scarring. This is no doubt related to the fact that previous vaccination is more likely to lead to "modified smallpox", which is a less serious form of the disease with more superficial lesions (Rao, 1972).[4] There was some indication also that previous vaccination reduces the chances of the occurrence of corneal opacities.

Conclusion

Smallpox age-specific distribution of cases, case-fatality rates, and residual facial scarring rates, have been obtained by a follow-up study of known smallpox cases. It is suggested that these rates can be used as correcting factors in a pock-mark survey.

It was found at a significant level that previous vaccination reduces the chance of a person retaining facial pock marking (five or more pock marks) by about 20%.

The survey also showed that while smallpox blindness is a serious complication, it is an uncommon one.

ACKNOWLEDGEMENT

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