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# Is the protection afforded measles vaccinees the same in children of all age groups?

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## SUMMARY

A prospective study was carried out in the City of Gweru in 1988 to examine the relationship between age and protection afforded measles vaccinees by the measles vaccine. The age group 10 months to nine years accounted for 240 cases or 87 pc of the 276 measles cases reported in 1988. The disease had shifted towards older age groups with children aged 10 to 59 months accounting for 105 cases or 43,7 pc and those aged five to nine years accounting for 135 cases or 56,3 pc of the 240 measles cases reported in the age group 10 months to nine years. In all the sub-age groups of the age group 10 months to nine years i.e. 10 to 23 months, 24 to 35 months, 36 to 47 months etc. the proportion of vaccinated cases was more than that of unvaccinated cases and the incidence rates in the unvaccinated population were all higher than in the vaccinated population. A correlation of age and relative risk (relative risk was calculated for each sub-age group) showed a significant negative trend (correlation coefficient = -0,79;  $p = 0,012$ ).

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On account of the shift of the disease towards older age groups and a decline of relative risk as age increased, the study concludes that older age groups may be less protected by the measles vaccine than the young age groups. Possible reasons for this finding are explored.

### INTRODUCTION

In the City of Gweru (Zimbabwe) measles vaccination coverage rose from 7 pc in 1971 (when measles vaccination was commenced) to 91 pc in 1989. By 1984 the proportion of reported measles cases who had had vaccination (vaccination failures) had outstripped that of the unvaccinated cases. In 1986 and after, the disease showed features of a shift towards older age groups. A greater proportion of measles cases now occurred after five years of age. In the light of these two epidemiological occurrences a study was carried out in 1988 to examine the relationship between age and risk of infection in the vaccinated and unvaccinated child population.

Gweru, capital city of the Midlands province in Zimbabwe, has a population of 124 735 (1992 population census). In Gweru children are vaccinated against measles at nine months of age with a Schwarz-type vaccine. Vaccinations are carried out at static primary care health facilities on a "supermarket" approach basis.

### MATERIALS AND METHODS

The study was prospective in nature. Between January and December 1988, measles cases were identified in Gweru by use of a standard case definition which was availed to all primary health care facilities in the city, the city's infectious disease hospital and personnel who were assigned to investigate measles cases in the community. Details of each identified case were entered on a measles surveillance form. These details included the age of the person with the disease, vaccination status (including age at vaccination where applicable), date of commencement of the disease and its signs and symptoms (particularly in relation to the standard case definition).

In the analysis only children aged 10 months to nine years were considered because this group accounted for over 87 pc of all identified cases of measles. The population denominators used in calculating the incidence rates for the various age groups were obtained from annual census surveys carried out by the Town

Clerk's department in Gweru.

The relative risk was computed for each sub-age group of the 10 months to nine years age group (i.e. 10 to 23 months, 24 to 35 months, 36 to 47 months etc.) and in this study it was used to define the level of protection among the vaccinated, or the risk of acquiring infection in the non-vaccinated.

#### Limitations of the study:

1. There were problems with definition of vaccination status of cases, particularly where there was no documentary proof. It was therefore decided that in the absence of documentary proof (child health card) such a case of measles is deemed unvaccinated.
2. An effort was made to investigate measles cases in the community to avoid missing unreported cases (including deaths). There is no doubt that this was met with some success, but it is equally possible that some cases could have been missed in these investigations.

### RESULTS

In 1988, 276 cases of measles were reported from Gweru of which 240 or 87 pc were aged 10 months to nine years. In the age group 10 months to nine years 105 cases or 43,7 pc were aged 10 to 59 months while 135 cases or 56,3 pc were aged five to nine years. In the same age group (i.e. 10 months to nine years) 158 cases or 65,8 pc of cases were vaccinated while 82 cases or

*Table 1: Age and vaccination status of measles cases reported from the City of Gweru in 1988.*

Age (months)	Unvaccinated	Vaccinated	Total
0-9	19	0	19
10-23	14	25	39
24-35	11	14	25
36-47	5	13	18
48-59	5	18	23
60-71	8	23	31
72-83	18	30	48
84-95	7	15	22
96-107	7	16	23
108-119	7	4	11
120+	14	3	17
<b>Total</b>	<b>115</b>	<b>161</b>	<b>276</b>

**Table II: Incidence rates in unvaccinated and vaccinated children (per 100 000 population) and relative risk calculations for age group 10 months to nine years.**

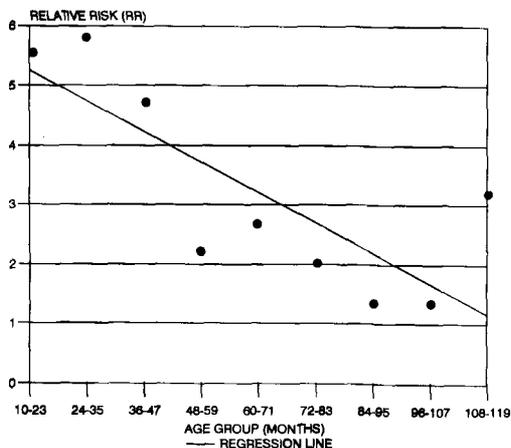
Age (months)	Incidence rates in the unvaccinated (/100 000 population)	Incidence rates in the vaccinated (/100 000 population)	Relative risk
10-23	5 785	1 041	5,6
24-35	2 083	362	5,8
36-47	1 577	334	4,7
48-59	1 082	482	2,2
60-71	1 732	679	2,6
72-83	2 446	1 218	2,0
84-95	876	694	1,3
96-107	1 032	745	1,4
108-119	766	246	3,1

34,2 pc were not vaccinated. (see Table I).

In all the sub-age groups of the 10 months to nine years age group i.e. 10 to 23 months, 24 to 53 months etc. (see Table II) the incidence rates in the unvaccinated population were more than those in the vaccinated population.

The relative risk that was calculated for each sub-age group tended to decline as age increased. (see Table II) Correlation of age and relative risk showed a significant negative trend (correlation coefficient = -0,79;

**Figure 1: Relative risk (RR) vs age. RR of acquiring measles.**



**City of Gweru 1988: RR of vaccinated vs unvaccinated child populations.**

$p = 0,012$ ). (see Figure 1).

### DISCUSSION

An increase in the proportion (but not the rate) of cases which occur among children previously immunised is a consequence of high vaccination coverage.<sup>1,2,3</sup> The findings in the Gweru study confirm this observation. In this study, in all sub-age groups of the age group 10 months to nine years, the proportion of vaccinated cases was more than that of unvaccinated cases but the incidence rates in the unvaccinated population were always higher than in the vaccinated population.

A shift of the disease towards older children has been observed in this study. The shift of the disease towards older children or even young adults is said to be an expected consequence of moderately high vaccination coverage, in immunisation programmes whose target age group has been under two years of age (under one year of age in most developing countries).<sup>1,3</sup> The assumption in this statement, however, is that by sustaining high vaccination coverages in the young age groups, the older children and young adults who have not been vaccinated are a susceptible population to whom the disease would tend to shift.

The findings in the Gweru study do not concur with this observation. In Gweru in 1988 the coverage in the age group 10 months to nine years was 85 pc. Further, as indicated earlier, the finding of a high proportion of vaccinated cases (higher than the proportion of unvaccinated cases) in all sub-age groups of the 10 months to nine years age group is itself an indication of high vaccination coverage in this age group which accounted for 87 pc of all cases in Gweru in 1988.

In this study correlation of age and relative risk seems to strongly suggest that the protection afforded vaccinees by the measles vaccine declines with age. One reason for this occurrence could be that children who were five years of age and older in 1988 would have been vaccinated at a time when the more heat-stable measles vaccines were not available, and consequently the efficacy of the vaccine could have been affected by cold chain failure.<sup>4,5</sup>

Recent measles vaccine efficacy studies carried out in the City of Harare (Zimbabwe), Muyinga in Burundi and a few other countries on the African continent have found efficacies below 80 pc even where the cold chain has been managed properly.<sup>5,6,7</sup> On account of these

findings it has been concluded that in developing countries measles vaccine efficacy is lower than in developed countries on account of the effect of prenatally acquired maternal antibodies which interfere with sero-conversion at the time of vaccination at nine months of age.<sup>5,8</sup> The World Health Organisation (WHO) has warned that even a vaccination coverage of 100 pc with an 80 pc effective vaccine leaves 20 pc of vaccine recipients susceptible to measles, permitting continued transmission in the community.<sup>9,10</sup> Thus it could well be that the shift of the disease towards older age groups observed in the Gweru study represents an accumulation of vaccination failures (susceptibles) emanating from a low vaccine efficacy. This is supported in this study by findings of low relative risks for older age groups.

Another phenomenon which could lead to the shift of the disease towards older age groups is that of secondary vaccination failures (vaccinees who initially sero-convert and with time revert to a sero-negative state).<sup>11,12</sup> A study that was carried out in the United States of America has shown that up to 7 pc of measles cases could be attributed to secondary vaccination failures.<sup>11</sup> In the Gweru study it is not clear what contribution secondary vaccination failures could be making in the transmission of measles in the older age groups.

**Conclusion:** 1. The protection afforded measles vaccinees seems to decline with age. There is therefore a distinct possibility that older age groups could sustain measles transmission in the community even at high vaccination coverages. There is probably, therefore, an urgent need to work out modalities to boost protection in older children to halt their role as a vehicle for transmission, in order to break measles transmission cycles. This is particularly important when cognisance is taken of the fact that older age groups (five to nine years of age) now contribute 60 pc of reported measles cases.

2. In the light of the findings of this study it would be useful for Zimbabwe to carry out further studies in different settings to establish whether the risk of infection with measles increases with age, even at high vaccination coverages in the older age groups. If it is proven that such an occurrence does exist it would be important to identify the factors which are responsible

for the occurrence in order to rectify the problem of measles transmission in the older age groups.

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