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Prevalence, incidence, and epidemiological features of poliomyelitis in the Yemen Arab Republic

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There is a lack of reliable information on the extent of the poliomyelitis problem in developing countries, although the disease is thought to be more of a threat in urban than in rural areas. The Expanded Programme on Immunization (EPI) began operations in Yemen in 1977, and it was considered appropriate to try to establish the prevalence of residual paralysis due to poliomyelitis in children aged 5–13 years, in order to estimate the annual incidence of clinical cases of the disease, and to determine the epidemiological features of poliomyelitis in the country. The data thus obtained would provide a basis for assessing the impact of the immunization programme on the incidence of poliomyelitis.

The results of the survey showed a prevalence of lameness due to poliomyelitis of 4.0 per 1000 children. The estimated annual incidence of the disease is thus 18.6 per 100 000 of the general population, or approximately 1088 cases each year, with an estimated 163 deaths. An estimated 5000 children aged 5–13 years are lame as a result of poliomyelitis. There was no significant difference in the incidence of the disease in rural and urban areas. The median age of onset was 1.92 years in the urban setting and 1.29 years in the rural setting, with more than half of all cases occurring before the age of 2 years. Immunization efforts should therefore be directed towards infants aged under 2 years. Although a national disease notification system was established in 1976, 95% of the clinical cases discovered during the survey had not been reported. This underlines the importance of special surveys in gathering the data necessary to evaluate the effectiveness of the immunization programme.

Poliomyelitis is receiving increasing attention in the developing countries as a more serious and widespread public health problem than was previously recognized. The World Health Organization has demonstrated the importance attached to the control of poliomyelitis by including it in the Expanded Programme on Immunization (EPI). The EPI started activities in the Yemen Arab Republic in 1977, and aims to administer a 3-dose schedule of trivalent oral poliomyelitis vaccine at two-monthly intervals to children aged between 3 months and 4 years.

In order to assess the future impact of the immunization programme on poliomyelitis in Yemen, it was considered necessary to attempt to define the present extent of the problem. In addition, by determining the epidemiological characteristics of the disease in Yemen, in particular its age-specific incidence, it will be possible to determine the optimal age for immunization.

A survey was thus undertaken to establish the point prevalence of residual paralysis due to poliomyelitis, to estimate the annual incidence of clinical cases of the disease, and to determine the epidemiological features of poliomyelitis in Yemen.

SURVEY DESIGN

A survey of lameness resulting from poliomyelitis was conducted in Yemen between 8 November 1980 and 8 January 1981. The survey team consisted of two EPI regional supervisors who were frequently accompanied and advised in the field by senior national and WHO personnel.

The school survey methodology outlined by LaForce (*1*) was adapted to meet local requirements. Specifically, since school attendance in Yemen is low, it was necessary to conduct the survey through both

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school and community searches. A school survey alone, although easier to execute, might have given misleading results since lameness itself is possibly a factor influencing school attendance.

Rationale

A diagnosis of lameness due to poliomyelitis can be made with a high degree of confidence in the presence of flaccid paralysis with atrophy, no loss of sensation, and a history of acute onset with fever but without progression of the paralysis after the initial illness.

Since in most developing countries more than 90% of clinical poliomyelitis occurs in the first five years of life, studies of the prevalence of lameness in children over 5 years old can provide a retrospective estimate of the annual incidence of poliomyelitis. Certain corrections have to be made to account for paralysis not involving the legs, and for patients who died or recovered fully without residual paralysis, since such cases would naturally be missed in a survey.

Selection of survey sites

There were some differences in the methodologies used to select the rural and urban localities to be surveyed.

All localities throughout the country with a population of 5000 or more were deemed urban and three of these were selected at random. However, in selecting the rural survey sites, the country was divided into three zones to take account of different climatic conditions and cultural patterns which might influence the frequency and intimacy of contacts among young children, and hence the transmission of enterovirus infections. Within each zone, all localities with a population of less than 5000 (according to the 1975 census) were considered to be rural.

Since endemic poliomyelitis is assumed not to be a focal disease (*1*), it was considered far simpler statistically, as well as logistically, to consider only those rural localities within each zone with a 1975 population of more than 1500. These localities could more easily be identified from existing lists, located, and surveyed, and could be expected to have schools in which the survey could be conducted.

In light of the expected prevalence rates of residual paralysis due to poliomyelitis, a sample size of 6000 from the rural sites and a further 6000 from the urban sites was deemed to be sufficient to yield valid information. Therefore, 2000 children were surveyed in each urban location, and 2000 from rural sites in each of the three zones. Rural survey sites were selected randomly within each zone and were excluded only if the local administrative situation precluded a visit.

The 1980 population in each of the rural survey sites was extrapolated from the 1975 census figure, assuming an annual rate of population growth of 2.4%. The population of the urban sites was estimated on the basis of the best available data (*2*).

Within each selected site, the population aged between 5 and 13 years was assumed to account for 28% of the total population on the basis of national age distribution figures (*3*). School enrolment rates in this age group were then determined from the primary school population in each site, and in the selected urban sites, used to determine the proportion of the sample that should be surveyed in the schools. For example, if the school enrolment rate was 40%, then only 40% (800) of the 2000 children examined were taken from the school population. The resulting sample in each survey site therefore reflected the ratio of school attenders to non-attenders in the wider community. In this way, any bias inherent in surveying only schoolchildren was eliminated.

The catchment areas of the randomly selected schools within each city could not be clearly demarcated. From census data, the average number of inhabitants per household was known for the district in which each site was located. The average number of children aged 5–13 years in each household could be calculated on the basis of age distribution figures. The number of households to be visited in order to survey the non-school-attenders could thus be derived. Five separate neighbourhoods were chosen within each city, to reflect the socioeconomic and ethnic mix of the population. The boundaries of each of these neighbourhoods were carefully defined before the community search began.

In rural survey sites, schoolchildren who lived outside the selected village were excluded from the survey, so that the catchment area of the school was restricted to the village itself. Since no single rural survey site had more than 2000 eligible children, it was not necessary to define neighbourhoods for the community search, as in the cities. The number of children aged 5–13 years within the village was assumed to be 28% of the overall population.

Survey method

Before conducting the survey, a trial school and community search in a non-selected site was carried out to test the methodology. As a result, the age range to be surveyed was fixed at 5–13 years, to correspond to the age of the primary school attenders. Also, it was discovered that surveying girls older than 13 years was difficult because of cultural restrictions.

The results of this trial also indicated that additional clinical training and experience would be helpful for the survey team. This was provided in part by the staff of the Rehabilitation Centre for the War Disabled, a physical rehabilitation centre in the capital (Sana'a), which also caters to the needs of children disabled as a result of poliomyelitis.

The conduct of the survey was identical in the rural and urban sites. First, the selected schools were visited and the principal was requested to assist the team. In each class, the eligible children were counted and their sex and class recorded on a School Lameness Survey Form. Teachers were requested to identify children with gait abnormalities, who were then examined by the team. All students were then observed walking, and a Clinical Data Form was filled out for any lame child.

Parents of these lame children were then interviewed to determine whether the clinical history was consistent with poliomyelitis and to determine the child's age, the place and year of onset of disability, and the nature of any medical assistance sought at the time. With the child in a sitting position, muscle tone was determined in both legs by passive range of motion. Muscle mass was determined by examination and palpation. Deep tendon reflexes were observed by examining the knee jerk, and sensation was tested by the ability to distinguish sharp and blunt ends of a pin. Finally, the degree of disability was estimated.

Community searches were also conducted in the same manner for rural and urban survey sites. The urban neighbourhood or the rural village was visited repeatedly during the course of two days. Village or urban leaders, market vendors, elders, passers-by, and members of randomly selected households were questioned about disabled children in general, and lame children in particular.

RESULTS

A total of 9 localities were surveyed from the 3 rural zones. Surveys were conducted in 7 of the country's 10 governorates.

The survey team required two months to complete the field work. This included 21 and 31 days of survey work in the rural and urban sites, respectively.

The number of children surveyed, the number of cases with lameness attributable to poliomyelitis, and the prevalence of residual paralysis are given in Table 1. The overall prevalence of lameness for rural and urban sites was 3.2 per 1000 children aged 5–13 years, with 95% confidence limits of 2.3 and 4.4. When corrected by a factor of 1.25 to take account of paralysis not involving the lower extremities, the prevalence of residual paralysis following poliomyelitis was 4.0 per 1000 children screened. The corrected rate in the rural sites was 3.7 per 1000, and the similarly corrected urban rate was 4.4. These figures suggest that approximately 5000 children in this age group in Yemen are lame as a result of poliomyelitis.

These prevalence figures can be translated into a retrospective annual incidence of 18.6 per 100 000 of the general population, assuming that all cases occurred before the age of 5 years and that a correction factor of 1.33 is needed to account for those who recovered completely or died within two months of

Table 1. Prevalence of residual paralysis due to poliomyelitis, Yemen, November 1980–January 1981

	No of children examined			No. of cases of residual paralysis			Prevalence of residual paralysis (per 1000 children)		
Category	Male	Female	Total	Male	Female	Total	Male	Female	Total
Rural									
School search	1374	369	1743	3	1	4	2.2	2.7	2.3
Community search	1995	2666	4661	11	4	15	5.5	1.5	3.2
Subtotal	3369	3035	6404	14	5	19	4.2	1.6	3.0
Urban									
School search	2279	957	3236	4	1	5	1.8	1.0	1.5
Community search[a]	1474	1329	2803	13	3	16	8.8	2.3	5.7
Subtotal	3753	2286	6039	17	4	21	4.5	1.7	3.5
Total	7122	5321	12 443	31	9	40	4.4	1.7	3.2

[a] Children found in the community search may, in fact, have attended an unsurveyed school.

disease onset. Children aged less than 5 years were assumed to comprise 17.4% of the population (*3*).

Poliomyelitis may be a more important public health problem in Yemen, in both rural and urban areas, than is generally realized. The calculated incidence implies that, with an estimated population of 5.85 million, some 1088 new clinical cases occur each year. This figure is probably applicable in the current situation, since there has been little, if any, improvement in general living conditions, and since, except in a few scattered health centres, poliomyelitis vaccine has only been available since late 1977 through the EPI.

On the assumption that 15% of all poliomyelitis cases are fatal (*4*), the annual number of deaths due to poliomyelitis in Yemen is 163.

A comparison of the prevalence seen in the school population with the overall rate confirms that a school survey alone would have seriously underestimated the true prevalence and, consequently, the annual incidence. The prevalence among schoolchildren was 2.3 per 1000 children in the rural areas and 1.6 per 1000 in the urban areas, compared with an overall rate of 3.0 and 3.5, respectively.

Sex distribution

The prevalence of paralysis per 1000 children was found to be 2.5 times as high for males as for females in rural areas (4.2 versus 1.7) and in urban areas (4.5 versus 1.8). This higher prevalence in males agrees with the known epidemiological pattern of poliomyelitis (*4*).

Although 52.6% of the general population of Yemen aged 5–13 years are male, the 3753 males surveyed in the urban localities represented 62% of the urban sample. This was because of the great excess of boys in the urban schools. Since the number of males, with their higher prevalence, outnumbered females in urban schools, the observed urban prevalence and that for the country as a whole may have been slightly higher than the true values.

Considering the combined data from urban and rural sites, the prevalence in the school population was similar for males (1.9 per 1000) and females (1.5 per 1000); however, the prevalence found in the community search was nearly four times higher for males (6.9 per 1000) than for females (1.8 per 1000). Lame females were more likely to attend school than their male counterparts.

Age distribution

The age-specific incidence of the 40 cases of paralytic poliomyelitis detected is given in Table 2, for urban and rural locations. It can be seen that 60% of all cases occurred in children aged under 2 years, 92.5% in children aged under 4 years, and 95% in children under 5 years of age.

The pattern of disease was different in urban and rural areas. Of the urban cases, 19% occurred in infants under 1 year of age; in the rural area, 42% of cases occurred in this age group. It is also noteworthy that there was a heavy predominance of males in the cases in this age group in the rural areas. In the urban areas 52.3% of cases occurred during the first two years of life, compared with 68.4% in the rural areas. These findings have particular significance for the EPI, indicating the need to concentrate efforts on infants under 1 year of age.

While the above findings suggest that children in rural areas of Yemen are exposed to wild poliovirus earlier than those in urban areas, a serological study would be needed to prove this. Improvements in

Table 2. Age-specific incidence of poliomyelitis in 40 cases of residual paralysis

Age of onset (years)	Rural survey			Urban survey			Combined results		
	No. of cases	%	Cumulative percentage	No. of cases	%	Cumulative percentage	No. of cases	%	Cumulative percentage
< 1	8	42.1	42.1	4	19.0	19.0	12	30.0	30.0
1	5	26.3	68.4	7	33.3	52.3	12	30.0	60.0
2	1	5.3	73.7	4	19.0	71.3	5	12.5	72.5
3	4	21.1	94.8	4	19.0	90.3	8	20.0	92.5
4	0	0	94.8	1	4.8	95.1	1	2.5	95.0
5	0	0	94.8	0	0	95.1	0	0	95.0
⩾ 6	1	5.3	100.1	1	4.8	99.9	2	5.0	100.0
Total	19	100.1	100.1	21	99.9	99.9	40	100.0	100.0

living conditions potentially decrease children's contact with wild poliovirus, leading to a delay in acquiring the infection and, therefore, an increased risk of paralysis. The later age of onset and higher prevalence rate seen in the urban areas might thus be attributed to better living conditions. However, observation did not suggest that the urban environment was any more hygienic than the rural one.

Year of onset

Fig. 1 shows the year of onset of the 40 cases detected. Poliomyelitis is seen to be an endemic disease. Although small localized outbreaks do occur, no significance should be attached to the apparent peak in incidence in 1975 and 1976, which might simply be due to the fact that more of the cohort of children now aged 5–13 years were alive then than in any of the preceding years.

Disability

Among the 40 cases with residual paralysis, 32 (80%) could walk without assistance (disability designated as mild), 4 (10%) could walk with the help of a mechanical aid (moderate disability), and 4 (10%) were unable to walk (severe disability). The severity was not affected by age of onset, sex of the child, or area of residence (urban or rural).

In addition to the 40 cases of lameness due to poliomyelitis, the survey identified another 20 lame children aged 5–13 years. The ratio of lameness due to poliomyelitis to all cases of lameness was thus 2:3. The causes of the other 20 cases included congenital malformation, birth trauma, broken bones and other accidents, brain damage, and osteomyelitis.

Site of paralysis

In 90% of the cases, a single leg was affected. Of these 36 cases, 26 were lame in the right leg and only 10 in the left leg. This observed difference is statistically significant ($P < 0.05$). The distribution according to affected limb was similar in the rural and urban areas. It has been reported elsewhere (*5*) that in a predominantly right-handed population, the right side of the body is affected more frequently than the left. Risk factors for an infected child subsequently to develop paralysis include strenuous exercise in a particular limb and intramuscular injections in the month prior to the onset of paralysis. Injections are extremely popular in Yemen, but it is not known whether the right leg is the preferred site.

School attendance

Teachers and schoolchildren were the best source of information on lame children in rural sites. They could usually identify almost all the lame children not

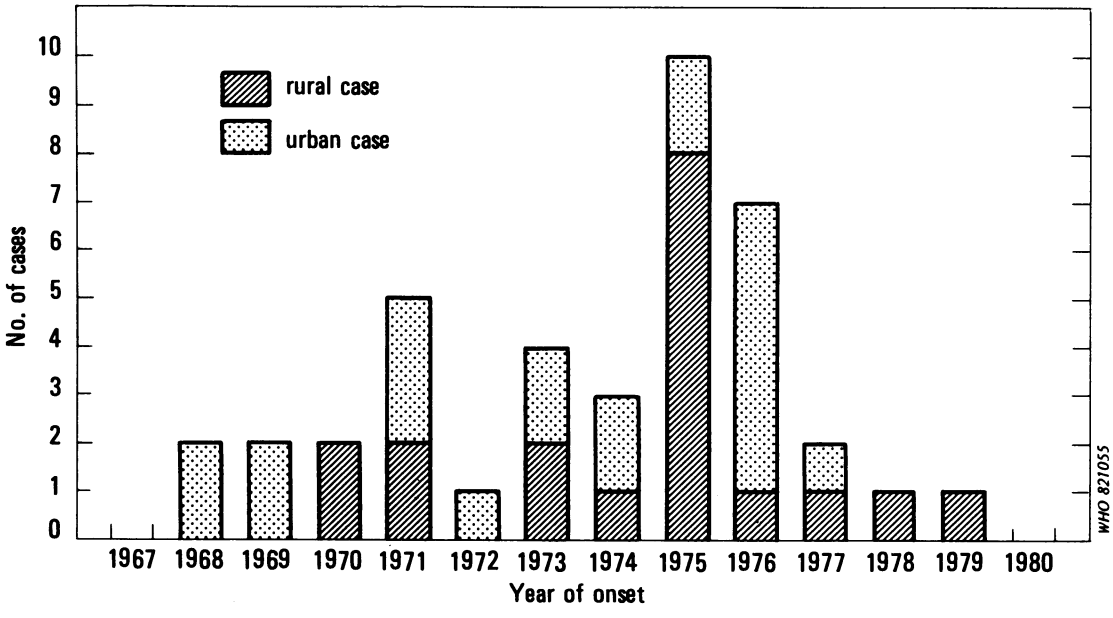

Fig. 1. Distribution of poliomyelitis cases by year of onset, for urban and rural areas.

attending the schools. In urban community searches, children, elder leaders, shopkeepers, and household residents were all useful in identifying neighbouring lame children, and each lame child was usually reported by several different sources.

Although 40% of the sampled children attended school, only 22.5% (22.6% in urban areas and 22.2% in rural areas) of the paralytic cases were found in schools. Children affected by poliomyelitis were apparently less likely to attend school than other children in their age group.

Medical assistance

Enquiries were made about the nature of medical assistance sought at the time of the infection. Unfortunately, the elicited information did not differentiate between care sought during the pyrexial preparalytic phase and that received after the onset of paralysis. Altogether, 52% of the urban cases and 26% of rural cases had seen a nurse or physician. Unqualified practitioners had seen 24% of the urban cases and 37% of the rural ones. Medical help was not received by 10% of the urban cases and 37% of the rural cases. In 14% of the cases, it was not possible to determine whether medical assistance had been sought. These figures were consistent with the fact that, until recently, the health care system barely touched the rural areas where the great majority of the population resides.

While the nature of medical assistance sought in urban areas was similar for males and females, in rural areas males were much more likely than females to be taken to a trained or untrained practitioner.

Case reporting

On the basis of the annual incidence determined by the survey, approximately 1029 cases occurred annually from 1976 to 1979. A system of poliomyelitis notification was initiated in 1976, and, on average, 50 cases were reported each year from 1976 to 1979. The numbers of cases reported in 1978 and 1979 were 74 and 76, respectively. It thus appears that 95% of cases remained outside the surveillance network. In Yemen there are no systematic, routine case-finding activities and little reporting, except from some hospitals and a few outpatient facilities which cover only a small proportion of the population. In the absence of such a system, special surveys have an important role in providing the baseline incidence data against which the performance of EPI can be judged.

CONCLUSIONS

Given the poor personal hygiene and the insanitary conditions prevailing in Yemen, it can be assumed that wild polioviruses circulate freely and infect children at a young age when a paralytic outcome is probably less likely. Undoubtedly, the vast majority of infections remain clinically silent. Nevertheless, this poliomyelitis prevalence survey, conducted through both school and community searches in 9 rural and 3 urban localities, has shown a corrected prevalence of residual paralysis of 4.0 per 1000 children aged 5–13 years. Rates were similar in rural and urban areas. This prevalence can be translated into a retrospective annual incidence of 18.6 cases of poliomyelitis per 100 000 population. This represents 1100 new cases and 163 deaths each year in Yemen. Poliomyelitis is thus a more serious and widespread public health problem than is generally recognized. This incidence is comparable to that experienced between 1945 and 1954 in the United States of America, during an acknowledged epidemic.

Unless the Expanded Programme on Immunization can achieve a sufficiently high coverage nationwide, the already high incidence in Yemen may be expected to rise even higher over the coming decades as living conditions improve and as the disease undergoes its natural evolution from an endemic to an epidemic pattern.

RÉSUMÉ

PRÉVALENCE, INCIDENCE ET CARACTÉRISTIQUES ÉPIDÉMIOLOGIQUES DE LA POLIOMYÉLITE EN RÉPUBLIQUE ARABE DU YÉMEN

En l'absence de renseignements fiables, on ignore quelle peut être l'ampleur de la poliomyélite dans les pays en développement, mais il semble que la maladie soit plus menaçante en milieu urbain qu'à la campagne. Le programme élargi de vaccination (PEV) a commencé ses opérations au Yémen en 1977, et on avait jugé souhaitable d'établir la prévalence des séquelles paralytiques de la poliomyélite chez les enfants âgés de 5 à 13 ans afin d'évaluer l'incidence annuelle des cas cliniques et de déterminer les caractéristiques épidémiologiques de la poliomyélite dans ce pays. On pensait que les données ainsi obtenues pourraient servir de base à l'évaluation de l'impact du programme de vaccination sur la prévalence et l'incidence de la poliomyélite.

Les résultats de l'enquête ont révélé que la prévalence des cas de paralysie dus à la poliomyélite était de 4,0 pour 1000

chez ces enfants. Dans ces conditions l'incidence annuelle de la maladie s'établit à 18,6 pour 100 000 personnes de la population générale soit environ 1088 cas par an, le nombre estimatif de décès étant de 163. On évalue à 5000 le nombre des enfants âgés de 5 à 13 ans présentant des séquelles paralytiques de poliomyélite. Du point de vue de l'incidence il n'y a pas de différence sensible entre les campagnes et les villes. La maladie se contracte à un âge médian de 1,92 années en milieu urbain et de 1,29 années en milieu rural, la plupart des cas de déclarant avant l'âge de deux ans. Il apparaît par conséquent que l'effort de vaccination doit porter sur les enfants de moins de deux ans. Bien qu'un système national de déclaration des maladies ait été crée en 1976, 95% des cas cliniques découverts au cours de l'enquête n'avaient pas été signalés, d'où l'importance d'organiser des enquêtes spéciales pour rassembler les données nécessaires à l'évaluation de l'efficacité du programme de vaccination.

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