MEDICAL PRACTICE

Outside Europe

Is poliomyelitis a serious problem in developing countries? — the Danfa experience

DAVID D NICHOLAS, JAMES H KRATZER, SAMUEL OFOSU-AMAAH, DONALD W BELCHER

British Medical Journal, 1977, 1, 1009-1012**Summary**

Children were examined for lameness in the Danfa Project district of rural Ghana to assess the impact of endemic poliomyelitis and to test a widely held hypothesis that paralytic poliomyelitis is relatively rare in such districts (less than 1 per 1000 children affected). The observed prevalence of lameness attributable to poliomyelitis was 7 per 1000 school-aged children, and the annual incidence is estimated to be at least 28 per 100 000 population. Although no evidence for an epidemic was found, these rates are comparable with those in the USA and Europe during the years of severe epidemics and indicate that a high price is being paid in the Danfa district for the natural acquisition of immunity. As a result, immunisation against poliomyelitis has been given high priority. A teacher questionnaire was also

tested for use in postal surveys as a rapid means of estimating the prevalence of lameness attributable to poliomyelitis in countries with a reasonable network of primary schools.

Introduction

The extent to which endemic poliovirus causes paralytic disease in children of developing countries infected early in life has been controversial. Based primarily on anecdotal experience and the number of cases reported to the World Health Organisation, the most widely held consensus is that paralytic poliomyelitis is not yet an important problem in most of these countries.¹⁻⁸ The usual explanation is that, because of poor sanitation, these children are exposed to poliovirus early in life and are partially protected by maternal antibodies or other age-related mechanisms. Thus, their risk of developing paralytic manifestations would be insignificant, and almost all would acquire immunity through subclinical or minor infections. As a result, if vaccination against poliomyelitis is recommended at all for developing countries it is done so, not because of the number of cases occurring currently, but because of the imminent danger of epidemics should sanitation and hygiene continue to improve.⁸⁻⁹ On the other hand, there have been several disturbing reports of the slowly increasing incidence of paralytic poliomyelitis in some of these countries and of many cases being seen by clinicians.⁸⁻¹⁵

In 1957 Payne⁴ suggested that clinical surveys of residual paralysis could provide accurate information about the incidence of paralytic poliomyelitis. The sequelae of paralytic poliomyelitis are distinctive and, when observed, can be attributed to poliomyelitis with a high degree of probability, especially if a history of the acute attack and its progression is known. Reports from Africa indicate that in at least 90% of cases the legs are affected and onset is before the age of 6.¹²⁻¹⁶ Thus, by studying

School of Public Health, University of California, Los Angeles, California 90024, USA

DAVID D NICHOLAS, MD, MPH, lecturer in international health
DONALD W BELCHER, MD, lecturer in international health

School of Medicine, University of California, San Diego, California 92037, USA

JAMES H KRATZER, BS, medical student (present appointment: resident, Department of Paediatrics, Children's Hospital, San Francisco, California, USA)

Department of Community Health, Ghana Medical School, Accra, Ghana

SAMUEL OFOSU-AMAAH, FRCP(G), MPH, associate professor and head of department

cases of lameness among children of school age in endemic countries one should be able to determine accurately the prevalence of lameness attributable to poliomyelitis and to estimate the annual incidence rates in recent years. Nevertheless, epidemiological studies of this kind have not been reported.

Because there was no valid epidemiological evidence on which to assess the priority of poliovaccine in our immunisation programme, we undertook this study. We wanted to determine the prevalence of chronic sequelae caused by poliomyelitis in a rural area of Ghana, to test the hypothesis that this prevalence is insignificant (less than 1 child affected per 1000 children of school age), and to validate the use of a teacher questionnaire as a screening test for residual lameness caused by poliomyelitis.

Population and methods

During early 1974 the survey took place in the Danfa Rural Health Project district,^{17,18} which comprises four study areas located 32 to 80 km (20 to 50 miles) north of the capital, Accra. This district is 518 sq km (200 sq miles) and has a population of 60 000. The infant mortality rate is 100 per 1000 live-births. There was no piped water supply before 1970, although 22% of the population now have access. Poliovirus is endemic; 65% of children have antibodies to all three types by 5 years of age, and only 7% are triple negative.¹⁹ Fifty-nine per cent of the population live in villages (mean population 600) having either a primary or a middle school. Children start school at 6, and 60% of children aged 6-15 attend school. An annual census in the district affords accurate denominators for calculating epidemiological rates.

School children

We sent a questionnaire to the headteacher of each of the 59 primary and 29 middle schools in the four study areas asking them to list lame children in their school or village (see Appendix). Lameness was defined as "not being able to walk properly or having one leg shorter or smaller than the other." After collecting the completed questionnaires we visited each school and, to be certain that all lame children were identified, we examined every child in the school for lameness by observing his gait as he paraded before us. Muscle and neurological examinations of both legs and any other affected parts were performed for each lame child. The strength of extensor and flexor muscle groups of each joint were tested using the system recommended by the Medical Research Council of Great Britain.²⁰ Muscle mass was determined by palpation and by measuring the mid-thigh and mid-calf circumference. Sensation was tested by ability to distinguish sharp and dull ends of a pin. When it was of critical diagnostic importance, we also tested position sense, vibratory sense, and temperature discrimination between hot and cold test tubes. The degree of disability was recorded as: (I) limited; (II) pronounced, but able to walk without mechanical aid; (III) able to walk only with mechanical aid; and (IV) unable to walk.

TABLE 1—Causes of lameness in school children

Causes	No (%) of cases
Poliomyelitis	81 (63.3)
Upper motor neuron disorders (such as cerebral palsy, acute hemiplegia, encephalitis)	15 (11.7)
Chronic osteomyelitis or arthritis	9 (7.0)
Congenital (such as clubfoot, genu valgum)	5 (3.9)
Gait disturbances of uncertain cause	7 (5.5)
Trauma	3 (2.3)
Guinea worm	2 (1.6)
Other	6 (4.7)
Total	128 (100.0)

TABLE 2—Age of onset of poliomyelitis reported for school children

Age in months:	<6	6–	12–	24–	36–	48–	>59
No (%) of cases	1 (1.3)	16 (21.1)	32 (42.1)	11 (14.5)	9 (11.8)	4 (5.3)	3 (3.9)
Cumulative percentage	1.3	22.4	64.5	79.0	90.8	96.1	100.0

A history was obtained in 95% of cases (68% from a parent) and included current age, age at onset, presence of fever at onset, history of injection, progression of neurological deficit, current village of residence, and residence at onset.

We attributed the lameness to poliomyelitis if all of the following criteria were met: muscle weakness and atrophy, diminished deep tendon reflexes, no diminution of sensory modalities, and a history of acute onset with no progression (four cases in which complete histories were not available were classed as poliomyelitis because of typical physical signs and our inability to attribute them to any other cause). Cases were attributed to sciatic nerve injury if the following were present: a history of injection in the affected limb near the time of onset and both motor and sensory deficits limited to the distribution of the sciatic nerve. If all but the sensory deficits were present the case was considered questionable and not included among those classified as poliomyelitis.

Non-school children

We also wished to determine the prevalence of lameness in pre-school and older children not attending school. In three of the four study areas we sent questionnaires to the chiefs of villages with schools asking them to list non-school children who were lame. Head-teachers were also asked to list such children on their questionnaires. Because resources did not permit us to examine every village child we examined only those non-school children reported on the questionnaires, using the same history and examination procedures described above. Histories were obtained in 97% of cases (82% from a parent).

Results

School children

Of the 11 249 children enrolled we found 128 cases of lameness. Of these 81 were attributed to poliomyelitis, a prevalence of 7.2 per 1000 school children (significantly different from 1 per 1000; $z_c = 20.7$; $P < 0.0001$) (table I). The prevalence of lameness attributable to poliomyelitis among the 8212 children enrolled in primary schools was 6.5 per 1000 children compared with 9.2 per 1000 among the 3037 children in middle schools. The difference was not significant ($z_c = 1.42$; $P > 0.10$) and, moreover, suggested that the high prevalence was not due to increasing incidence in more recent years among the younger primary school children. Of the 76 cases where the age was known, the median age of onset was 18 months with 96% of cases occurring before 5 years (table II). There was no significant difference between male and female rates. Twenty-eight per cent gave a history of having received an injection within a few weeks before the onset of paralysis.

Non-school children

In the 39 villages having schools in the three study areas 50 cases of lameness were reported among 8181 children aged 0-15 who were not attending school; we attributed 33 (66%) to poliomyelitis. The ages of onset of poliomyelitis were similar to those for schoolchildren, with 97% occurring before the age of 5. The male:female ratio was 17:16 and 30% gave a history of having an injection just before the onset of paralysis.

The prevalence of lameness attributable to poliomyelitis for children aged 6-15 not attending school was 5.7 per 1000, not significantly lower than the rate in those attending school ($z_c = 1.08$; $P > 0.20$) (table III). Based on a prevalence of 7.5 per 1000 after 5 years of age and the reported ages of onset, there was an expected prevalence of 5 per 1000 children aged 0-5 years. The prevalence observed for this age group was 3.4 per 1000, despite incomplete reporting of lameness among non-school children, indicating that the incidence of new cases

had not changed significantly in the previous five years ($z_c = 1.65$, $P > 0.05$).

TABLE III—Prevalence of lameness due to poliomyelitis among residents of villages with schools in three study areas

	Population	No of cases	Prevalence per 1000
School children aged 6-15	5051	42	8.3
Non-school children aged 6-15 ..	2296	13	5.7
All children aged 6-15	7347	55	7.5
Preschool children aged <5	5885	20	3.4
All children aged <15	13232	75	5.7

All children combined

From the two groups above, a combined list was made of all lame children aged 6-15 resident in villages having schools, thus eliminating any bias that might exist for or against children with lameness going to school. The prevalence for these children was 7.5 per 1000 (table III). After estimating the calendar year of onset from reported ages of onset and current ages, we could find no evidence of significant annual fluctuations in incidence, nor could we find clustering of cases by villages. This suggests that there had been no large epidemics in the recent past to explain the high prevalence of lameness due to poliomyelitis found in this study. Because of some imprecision in the reporting of current age or age of onset, however, small epidemics or significant fluctuations in incidence in one or more villages may possibly have been obscured by this method.

The degree of disability for children aged 6-15 years is shown in table IV; 89% could walk without mechanical aid, although many had scoliosis and were in need of calipers. We could find no relation between severity of impairment and age at onset. The muscle groups affected were similar to those reported in other studies.

TABLE IV—Degree of disability in children aged 6-15 with lameness due to poliomyelitis in villages with schools. Percentages in parentheses

	Degree of disability			
	I	II	III	IV
School children	21 (50)	17 (40)	4 (10)	
Non-school children	3 (23)	8 (62)		2 (15)
All children	24 (44)	25 (45)	4 (7)	2 (4)

VALIDITY OF QUESTIONNAIRE AS A SCREENING TEST

Teachers completed questionnaire forms before our visit in 61 of the 88 schools. The sensitivity (S_1) of the questionnaire as a screening test was calculated as the proportion of children with lameness attributable to poliomyelitis who were listed by the headteachers on the questionnaire and was found to be 0.831. The specificity (S_2) was calculated as the proportion of children without lameness attributable to poliomyelitis who were not listed on the questionnaire and was found to be 0.997. These statistics indicate that the questionnaire was a reasonably accurate diagnostic test for identifying cases of lameness attributable to poliomyelitis in this study. Assuming S_1 and S_2 to be constant for other populations where poliomyelitis is endemic, one could estimate the prevalence of children with lameness attributable to poliomyelitis from the prevalence of lameness reported on teacher questionnaires.²¹ Where the prevalence of lameness was low, teachers often did not fill out forms, although the S_1 and S_2 of their ability to identify lame children verbally to us was similar to that of those filling out questionnaires. Thus it is important to have a high return rate if the questionnaire is to estimate prevalence reliably.

Discussion

Based on these results we must reject the hypothesis that paralytic poliomyelitis is rare in this district of rural Ghana. If those who die or recover completely from their paralytic attack are included at least 1% of all children in the study areas have an attack of paralytic poliomyelitis before school age and 7 per

1000 are left permanently disabled. This prevalence is even higher than that found in the survey which Collins²² conducted in 1936 among 200 000 American families. In the age group 20-24, whose members had lived through numerous epidemics, Collins found a prevalence of residual paralysis of only 4.8 per 1000. Given the prevalence of 7 per 1000 among children aged 5 years and older, the annual incidence must be 1.4 per 1000 children aged 0-4. Since these children represent 20% of the total population, the annual incidence in this district may be estimated as being at least 28 per 100 000 population. From 1945 to 1954, years of the worst epidemics in the USA, the incidence rate ranged from 15 to 30 per 100 000 and exceeded 30 only in 1952, when it was 36 per 100 000. It is difficult to compare the residual disability found here with that found in studies from developed countries since the latter included only patients who had been in hospital.²³

The lack of clustering of cases by calendar year or village, the distribution by age of onset, and previous serological studies¹⁹ suggests that this prevalence of disability from poliomyelitis is occurring in what would generally be considered to be an endemic setting. Whether the polioviruses are always present in the Danfa villages or whether they are often introduced, resulting in small localised epidemics, cannot be answered by this study. In either case the price being paid for the natural acquisition of immunity in the Danfa district is high. For this reason we have given immunisation against poliomyelitis a high priority.

The frequency of reported injections in the affected limbs is disturbing. As many Ghanaians attribute some orthopaedic problems to injections, these histories are open to suspicion. We found no cases that we could attribute to sciatic nerve injury. It is generally conceded, however, that certain intramuscular injections may increase the risk of a paralytic manifestation if given just before or simultaneously with poliovirus infections.²⁴ Children in Ghana may be given injections by professional health workers, unlicensed healers, or itinerant drug sellers, so a certain proportion of our cases of poliomyelitis may be related to injections.

The question remains whether the high prevalence of lameness attributable to poliomyelitis in the Danfa area is typical of Ghana or the rest of Africa. We recommend that similar studies be carried out elsewhere to provide better information about the impact of poliomyelitis. We have tested a teacher questionnaire that after appropriate validation could be used in postal surveys as a rapid means of estimating the prevalence of lameness attributable to poliomyelitis in countries with a reasonable network of primary schools. We carried out such a survey on a sample of schools throughout Ghana (see accompanying article).²⁵

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Requests for reprints or copies of questionnaires should be addressed to D D Nicholas.

Appendix

Dear Headmaster,

Polio is a disease often causing lameness in children. We are attempting to find out how much lameness there is in Ghana caused by polio.

One way we are doing this is by asking each school headmaster to report to us the number of children attending his school who are lame.

You may have noticed some children in your school who are lame (that is, they do not seem to walk properly or one leg may be shorter or smaller than the other).

Would you write down for us the names of these children, their house number, their age now, their age at the time they became lame, and their village and region of residence at the time they became lame. Also would you write down the enrolment in your school. Please use the attached form.

Also would you ask the children in your school if they know of any other children of school age who are lame or cannot walk and *do not attend school* and would you also list these children on the accompanying form.

I or my assistant will come by shortly to visit you, to pick up the list, and to examine these lame children. Please hold this list until our arrival.

Thank you for your co-operation.

Sincerely,
David D Nicholas, MD, MPH, FAAP,
Danfa Rural Health Project,
Department of Community Health,
Ghana Medical School,
PO Box 4236,
Accra.

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Is poliomyelitis a serious problem in developing countries? - lameness in Ghanaian schools

SAMUEL OFOSU-AMAAH, JAMES H KRATZER, DAVID D NICHOLAS

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Summary

A postal survey of lameness in schools throughout Ghana showed an estimated prevalence of lameness attributable to poliomyelitis of 5.8 per 1000 school-aged children and an estimated mean annual incidence of paralytic poliomyelitis of 23 per 100 000 population. Official reported incidence rates range from 0.1 to 2.1 per 100 000 population, indicating that at least 90% of cases are not reported. No evidence of epidemics was found to account for these high rates. These suggest that mean annual incidence rates in tropical endemic countries have always been as great, if not greater, than those experienced by temperate countries during epidemic periods in the

twentieth century and that the total number of cases of paralytic poliomyelitis occurring in the world each year has been reduced by only 25% since the advent of polio vaccine. Immunisation against poliomyelitis must have a high priority in Ghana and other tropical countries where the disease is endemic.

Introduction

Serological surveys have shown that poliomyelitis is endemic in Ghana.^{1,2} Low annual incidence rates of 0.1 to 2.1 (mean 1.0) per 100 000 population are reported for paralytic poliomyelitis.³ No epidemics have ever been recorded. Yet Nicholas and co-workers⁴ found a high prevalence of lameness attributable to poliomyelitis (seven per 1000 children aged 6 to 15) in the Danfa Project district of rural Ghana, implying a mean annual incidence of at least 28 per 100 000 population. This supported a suspicion first raised by Paul⁵ from studies in Egypt that the mean annual incidence rates in endemic countries might be as high as those in countries experiencing epidemics.

Lameness carries a high social cost. If the prevalence rates throughout Ghana were similar to those in the Danfa area it would mean that immunisation against poliomyelitis should be given a higher priority. During the Danfa study⁴ it was found that headteachers were reliable in reporting cases of lameness, and that the prevalence of lameness attributable to poliomyelitis could be estimated from the prevalence of reported cases of lameness due to any cause. We report here the results of a postal survey of lameness in a sample of schools throughout Ghana using a teacher questionnaire that was tested and validated during the Danfa study.

Department of Community Health, Ghana Medical School, Accra, Ghana

SAMUEL OFOSU-AMAAH, FRCP(G), MPH, associate professor and head of department

School of Medicine, University of California, San Diego, California 92037, USA

JAMES H KRATZER, BS, medical student (present appointment: resident, Department of Paediatrics, Children's Hospital, San Francisco, California, USA)

School of Public Health, University of California, Los Angeles, California 90024, USA

DAVID D NICHOLAS, MD, MPH, lecturer in international health